



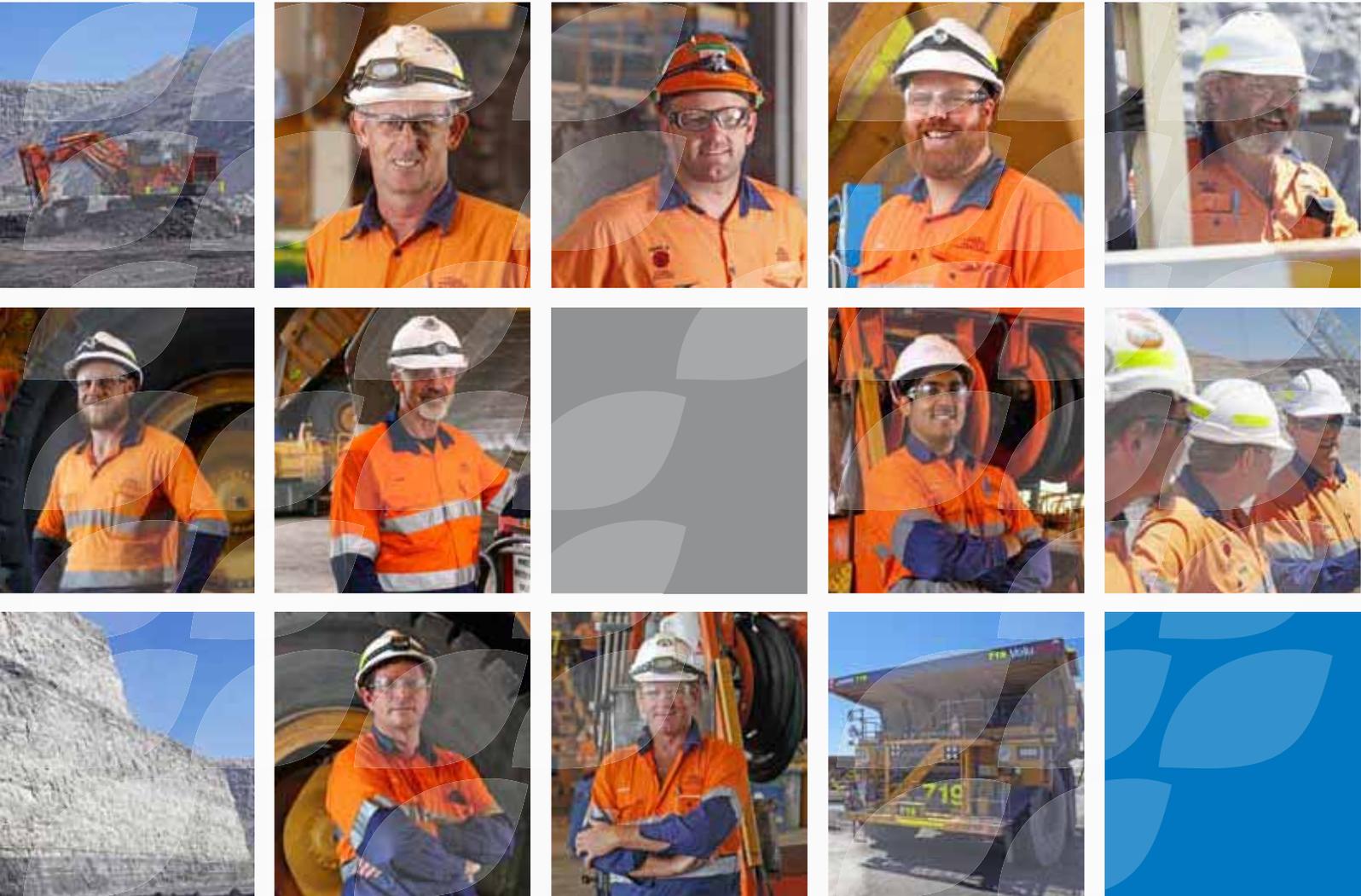
# Warkworth Continuation 2014

3

## Environmental Impact Statement

Prepared for Warkworth Mining Limited | June 2014

### VOLUME 3 — Appendix H



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**EMM**  
EMGA Mitchell McLennan

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Appendix H — Ecology study

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**WARWORTH CONTINUATION 2014**

**Ecological Impact Assessment**

For:

**EMGA Mitchell McLennan**

June 2014

**Final**



**PO Box 2474  
Carlingford Court 2118**

**Report No. 14001RP1**

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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.

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Approved by: David Robertson

Position: Director

Signed: 

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## Glossary of Terms

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2003 Extension Area	The area approved under the 2003 extension of Warkworth Mine as approved under development consent DA 300-9-2002i.
BAA	Biodiversity Assessment Area.
BBAM	Abbreviation for BioBanking Assessment Methodology, used by the Upper Hunter Strategic Assessment to calculate the suitability of offsets for a development proposal, expressed as species credits or ecosystem credits.
BCAM	Abbreviation for Biodiversity Certification Assessment Methodology, used by the Upper Hunter Strategic Assessment to calculate the impact of a project and determine the offset required, expressed as species credits or ecosystem credits.
Biodiversity offsets	<p>For the purposes of this report, biodiversity offsets are measures that benefit biodiversity by compensating for the predicted adverse impacts of the Proposal, particularly. Biodiversity offsets are intended to achieve long-term conservation outcomes where development and infrastructure projects are likely to impact biodiversity.</p> <p>Biodiversity offsets work by protecting and managing biodiversity values in one area in exchange for impacts on biodiversity values in another. For example, if a development requires an area of native forest or woodland to be cleared, another area of similar vegetation can be protected, improved and managed for conservation in perpetuity, effectively 'offsetting' the clearing at the development site. The gain in biodiversity achieved by improving a similar area of woodland is intended to balance the loss to biodiversity due to the clearing.</p>
Biodiversity Offset Strategy	The strategy that has been developed in relation to the use of offsets to compensate for the impacts of the 2003 Extension and the 2014 Proposal.
CEEC	Critically Endangered Ecological Community listed under the NSW TSC Act and/or Commonwealth EPBC Act.
CMA	Catchment Management Authority.
CPP	Coal Preparation Plant.
Credits	In the context of this report, credits are BCAM credits, used to calculate the impact of a project and the offset required.
Direct impact	Impact resulting in physical change as a result of the project, at the same time and place as the project; in the context of ecology this is most commonly the removal of habitat.
Disturbance boundary	The area of land proposed to be disturbed by the Proposal, and relates exclusively to the Proposal.
DoE	Commonwealth Department of the Environment.
DP&E	NSW Department of Planning and Environment.

EA	Ecological Assessment.
EEC	Endangered Ecological Community listed under the NSW TSC Act and/or the Commonwealth EPBC Act.
EIA	Ecological Impact Assessment.
EMM	EMGA Mitchell McLennan Pty Ltd.
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i> .
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
(draft) FBA	Abbreviation for the (draft) Framework for Biodiversity Offsets, a document that sets out the detailed operation of the Draft NSW Biodiversity Offsets Policy for Major Projects.
GDE	Groundwater Dependent Ecosystem
GPS	Global Positioning System.
Green Offset Strategy	The offset strategy developed in 2002 “offset the short and medium term loss of habitat and ensure connectivity until the rehabilitation of the mined land can restore these values”.
HMA	Abbreviation for Habitat Management Areas, which are offset areas defined in the Green Offsets Strategy (ERM, 2002b) for the 2002 approval as areas that “offset the short and medium term loss of habitat and ensure connectivity until the rehabilitation of the mined land can restore these values”
Indirect impact	An effect in the environment (impact) that has been caused by the direct impact, in other locations and times.
LGA	Local Government Area.
Local occurrence	The occurrence of a threatened species or ecological community within the study area.
Locality	The area within a 10 km radius of Warkworth Mine.
MNES	Matters of National Environmental Significance.
MTCL	Mount Thorley Coal Loader.
MTO	Mount Thorley Operations.
MTW	Mount Thorley Warkworth.
NBA	Northern Biodiversity Area.
NDA	Abbreviation for Non-Disturbance Areas, which are offset areas defined in the Green Offsets Strategy (ERM, 2002b) for the 2002 approval as areas that “preclude open cut mining and agriculture”.
NSW	New South Wales
OEH	NSW Office of Environment and Heritage.
Offset strategy	Current proposed offset strategy to compensate for ecological impacts of the Proposal.
Previous surveys	All previous flora and/or fauna surveys conducted within the study area prior to 2009.

the Proposal	The Proposal of Warkworth Continuation 2014 as outlined in <b>Section 2.1</b> of this report.
Region	Refers to the Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion which Warkworth sits within; in this case the Sydney Basin Bioregion.
Regional occurrence	The occurrence of a threatened species or ecological community within the Hunter-Central Rivers CMA.
SBA	Southern Biodiversity Area.
SEPP	State Environmental Planning Policy.
the Site	The area covered by the application.
SRs	Secretary's Environmental Assessment Requirements.
SSD	State Significant Development.
Study area	Includes all land on which flora and fauna studies have been conducted. The area is shown in <b>Figure 1.1</b> .
Threatened flora and fauna	Refers to communities, populations and species listed as Vulnerable or Endangered under the Commonwealth EPBC Act and NSW TSC Act.
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i> .
UHSA	Abbreviation for Upper Hunter Strategic Assessment, which is a strategic biodiversity assessment process for acquiring and managing future mining offsets for the Upper Hunter Valley coalfields.
UNE	University of New England.
WML	Warkworth Mining Limited.
WSG	Warkworth Sands Grassland.
WSW	Warkworth Sands Woodland.

# Executive Summary

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Cumberland Ecology was commissioned by EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of Warkworth Mining Limited to conduct an Ecological Impact Assessment (EIA) for a proposed extension of Warkworth Mine (the Proposal). Warkworth Mine is an open cut coal mine approximately 8 kilometres (km) south-west of Singleton in the Hunter Valley, NSW. The mine is operated by Coal & Allied on behalf of Warkworth Mining Limited (WML).

This EIA has been prepared to describe the ecological values of the area covered by the Proposal and to assess the potential impacts of the Proposal on native flora and fauna. Impact assessment focuses particularly but not exclusively on endangered ecological communities (EECs) as well as flora and fauna species protected under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The impacts from open cut mining at Warkworth have been avoided and mitigated where feasible to minimise the ecological impact. Residual ecological impacts are proposed to be compensated for by the provision of "biodiversity offsets", which are an integral part of the Proposal. This EIA report therefore provides details about the Biodiversity Offset Strategy that has been developed to compensate for residual ecological impacts.

This report will be incorporated into an Environmental Impact Statement prepared by EMM for submission to the Minister for Planning for assessment under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

## S1 Background

Warkworth Mine currently operates under Development Consent No. DA 300-9-2002-i (the development consent) issued by the then Minister for Planning in May 2003 under Part 4 of the EP&A Act. The mine site also operates under two separate Commonwealth approvals (EPBC Act); EPBC 2002/629 and EPBC 2009/5081.

Immediately to the south of Warkworth Mine is Mount Thorley Operations (MTO). Since 2004, the two mines have integrated at an operational level and are known as Mount Thorley Warkworth (MTW), with a single management team responsible for all the operations.

The 2003 development consent permitted the clearing of woodland and forest that are habitat for threatened flora and fauna on the condition that biodiversity offsets were provided under what was referred to as the Green Offsets Strategy (ie the offsets for the 2003 Extension that are provided under the current development consent). This included portions of land to the west and north of the 2003 Extension and rehabilitation to woodland following mining. These Green Offsets were designated as Habitat Management Areas (HMAs) and Non-Disturbance Areas (NDAs). The intent of the HMAs was for the temporary preservation

of ecological values as economic coal resources were known to occur beneath these areas. The intent of the NDAs was for long term preservation. Both the HMAs and NDAs are currently managed in accordance with the Green Offsets Strategy, which is proposed to be replaced and upgraded by the Biodiversity Offset Strategy.

## S2 The Proposal

WML seek to apply for a new development consent to allow an extension of North and West pits further west. The Proposal comprises:

- extension of the mining footprint by approximately 698 hectares (ha) to the west of current operations extending the life of North and West pits by 21 years;
- ability to transfer overburden and coal to MTO to assist in the final landform for MTO and processing of ROM coal from Warkworth Mine;
- ability to transfer and accept mine water from neighbouring operations (ie Bulga Coal Complex, Wambo Mine, Mount Thorley Operations and Hunter Valley Operations);
- closure of Wallaby Scrub Road;
- an optional underpass for the approved but yet to be constructed third bridge crossing on Putty Road;
- minor changes to the design of the Northern out-of-pit dam;
- use of existing secondary access gates to the mine sites and offset areas to allow for infrequent vehicle movements to enable activities such as drilling, offset management and equipment shutdown pad access; and
- maintain the approval of all aspects of the existing operations for Warkworth Mine approved under DA 300-9-2002-i, including integrations with MTO (such as an integrated management system for rejects and water) and other surrounding mines and Redbank Power Station.

Under the Proposal, WML is proposing to mine through some of the Green Offsets (ie the offsets for the 2003 Extension that are provided under the current development consent) extending mining beyond the current approval. As such WML are assessing the ecological impacts of the Proposal, as well as the implications for re-offsetting the impacts of the 2003 Extension for all non-Warkworth Sands Woodland/Warkworth Sands Grassland (non-WSW/WSG) vegetation (see further explanation in **Section S3**).

WML are proposing to quantify ecological impacts in accordance with the Upper Hunter Strategic Assessment (UHSA), which is preparing a strategic biodiversity offsetting strategy for Upper Hunter mines. In accordance with the UHSA a metric measurement tool called Biodiversity Certification Assessment Methodology (BCAM) has been used to objectively quantify ecological impacts (see further explanation in **Section S3**).

WMLs' proposed Biodiversity Offset Strategy:

- will provide additional offsets to compensate for the Proposal's residual impacts using the rules of the Upper Hunter Strategic Assessment; and
- will replace the Green Offset Strategy for the 2003 development consent in areas referred to as the Southern Biodiversity Area (SBA) and Northern Biodiversity Area (NBA) and by mine rehabilitation..

In accordance with the UHSA, , where offsets are to be provided directly by WML, a second metric measuring tool, the BioBanking Assessment Methodology (BBAM) has been used to calculate the contribution of each offset to addressing the ecological impacts measured using BCAM.

### **S3 Approaches to Biodiversity Offsetting**

As the Proposal will entail clearing of forest and woodland, biodiversity offsetting is a fundamental part of the application. Biodiversity offsets are measures that benefit biodiversity by compensating for the predicted adverse impacts of a proposal. Biodiversity offsets are intended to achieve long-term conservation outcomes where development and infrastructure projects are likely to impact biodiversity. An offset "package" is a package of related offset measures for a given project.

The required offset package for the Proposal will be included in WML's Biodiversity Assessment Area under the UHSA. The offset requirements have been estimated using BCAM, which measures the projected ecological impacts in terms of units called "credits" which are a measure of habitat quality. Credits include those for plant communities (ecosystem credits) and/or those for threatened species (species credits). Credit estimates for offsetting requirements that are presented in this report will be subsequently verified and certified by the Office of Environment and Heritage (OEH).

Impacts quantified using BCAM can be addressed in a number of ways. A proponent can retire the credit liability by paying funds to purchase credits from the trust to be established under the UHSA. Or, a proponent provides offsets directly, in which case the credits for the offsets have to match those determined by BCAM. For the Proposal, some of the offsets are being provided directly by the provision of offsets within the SBA and NBA.

The approaches to offsetting for the Proposal have been designed to consider the two broad types of vegetation that occur. The landscape within the Site is gently undulating and comprises areas where Quaternary aeolian sands have been deposited over various Permian sedimentary geological formations. Where sands occur, the resultant free-draining sandy soils support a distinctive type of vegetation reminiscent of coastal vegetation that is referred to as Warkworth Sands Woodland (WSW), which is listed as an endangered ecological community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act). Where the sands are absent, soils contain a higher clay content and the dominant vegetation comprises various forms of Ironbark (*Eucalyptus crebra*) forest, which are also listed EECs under the TSC Act.

For the purposes of this report, native vegetation other than WSW/WSG vegetation is referred to collectively as "non-WSW/WSG" vegetation. Both WSW/WSG and non-WSW/WSG vegetation provide habitat for threatened fauna and flora, particularly birds and bats. However, this EIA entails different approaches to offsetting ecological impacts to WSW/WSG and non-WSW/WSG vegetation given the restricted occurrence of WSW in the vicinity of the Proposal.

Biodiversity offsetting for this EIA therefore has been separated into the following components:

- Component 1: Offsetting the impacts to WSW/WSG vegetation for the Proposal;
- Component 2: Offsetting the impacts for non-WSW/WSG vegetation impacted by the Proposal; and
- Component 3: Offsetting the impacts to non-WSW/WSG vegetation for the 2003 Extension.

Areas of WSW/WSG vegetation impacted by the Proposal will be offset by conserving the remaining WSW/WSG vegetation within the SBA and NBA, as well as a suite of supplementary measures including funding the preparation of an Integrated Restoration Implementation Plan and research into completion criteria for the re-establishment of this community.

Non-WSW/WSG vegetation will be offset by protecting non-WSW/WSG vegetation in the SBA and NBA, as well as through rehabilitation of mined areas to provide additional areas of woodland.

Any ecosystem credits or species credits that cannot be provided directly within the SBA, NBA or rehabilitation will be offset through the retirement of credits under the rules of the UHSA.

## **S4 Methods**

The Site has been extensively studied since the 1990s and a range of field surveys have been conducted. The area within which field surveys have been conducted is referred to as the study area and comprises areas beyond the Site. This document relies on the data collected, synthesised and presented in the 2010 Ecological Assessment (EA) prepared by Cumberland Ecology. The results are considered directly applicable to the current assessment, are contemporary, and the ecological values of the study area are unlikely to have changed significantly in the intervening period.

Subsequent to the preparation of the EA in 2010, additional reports have been prepared by Cumberland Ecology and others. These have been reviewed and the results incorporated into this document where appropriate. This included additional field survey and literature review. Further, recent high resolution aerial photography has been examined to determine if the previously mapped boundaries of vegetation communities are still valid, and in some

cases some minor alterations have been made due to regrowth of canopy trees since the previous mapping was undertaken.

#### **S4.1 Database Analysis**

Database analysis of flora and fauna records was conducted for the locality surrounding the Site using the OEH Atlas of NSW Wildlife Database (OEH 2014). The lists generated from these databases were used to assist in designing surveys for threatened species considered to have the potential to occur in the study area as well as structuring habitat assessments to further assist in the determination of the likelihood of occurrence of threatened species.

#### **S4.2 Flora Surveys**

Flora surveys were conducted in the study area from 11-12 June 2009, 24-26 June 2009, 7-11 September 2009, and 28-30 October 2013. Flora survey methods involved the following:

- quadrat sampling (20 m x 20 m);
- random meander surveys;
- meander-transect surveys; and
- targeted searches for threatened flora.

In addition, targeted threatened flora searches for ground orchids were conducted on 20-21 September 2012 and 3-4 October 2012 with particular focus on *Pterostylis gibbosa* (Illawarra Greenhood), *Diuris tricolor* (Pine Donkey Orchid) and *Diuris sp. aff. dendrobioides* (Wedge Diuris). Targeted searches for these species were undertaken using transects, random meanders and area searches.

Cumberland Ecology ground truthed existing vegetation mapping in 2009, and this was further refined in 2012 following detailed review of additional information.

In conjunction with the quadrat sampling, additional plot data was collected using the survey methodology adopted by BCAM. Collection of the quadrat and plot data enabled the calculation of the number of credits required to offset the impacts of the Proposal in accordance with the UHSA.

#### **S4.3 Fauna Surveys**

Fauna surveys by Cumberland Ecology were conducted over four one-week periods from 15-19 June 2009, 29 June-3 July 2009, 13-17 July 2009 and 7-11 September 2009. In addition, a targeted threatened bird survey was undertaken by ornithologist Dr Stephen Debus during the winter blossoming period from 10-11 June 2009.

The following fauna survey methods for were utilised for the Cumberland Ecology fieldwork:

- amphibians: habitat searches, pitfall traps, spotlighting, call playback;

- birds: visual observation and call identification, nocturnal call playback, diurnal call playback;
- mammals: trapping (ground and arboreal trapping), hair tubes, Anabat call recording, spotlighting, infra-red cameras; and
- reptiles: pitfall traps, spotlighting, habitat searches.

Numerous surveys have been conducted over a number of years, range of seasons and conditions, thus providing a comprehensive data-set to use for this assessment.

## **S5 Results**

### **S5.1 Vegetation Communities**

The vegetation in the study area primarily consists of dry sclerophyll woodland, regrowth woodland and grassland. Of the suite of native vegetation communities occurring with the study area, the following six communities occur within the disturbance boundary:

- Warkworth Sands Woodland (WSW) (TSC Act EEC);
- Warkworth Sands Grassland (WSG);
- Central Hunter Grey Box – Ironbark Woodland (TSC Act EEC);
- Regenerating Central Hunter Grey Box – Ironbark Woodland (TSC Act EEC);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest (TSC Act EEC); and
- Central Hunter – Grey Box – Ironbark Derived Grassland.

### **S5.2 Groundwater Dependent Ecosystems**

Two vegetation communities recorded from the study area, Hunter Valley River Oak Forest and River Red Gum Floodplain Woodland, occur along the ephemeral Wollombi Brook to the west of the Site. It is likely that they are dependent to some extent on water in Wollombi Brook and are likely to be extracting groundwater from the shallow alluvial aquifer. Although this is an ephemeral stream, there is a groundwater component to its base flow, and these communities are potential Groundwater Dependent Ecosystems (GDEs).

An ephemeral perched aquifer is present in the aeolian Warkworth sands that overlie the coal measures to the north-east of Warkworth Mine. The Warkworth sands are recharged from rainfall derived recharge through the sandy soils; and due to their ability to store water, the sands support the WSW ecological community. This community is being assessed as a GDE due to the potential for groundwater drawdown as a result of the Proposal to affect this community.

### S5.3 Flora

Approximately 400 flora species have been recorded in the study area; with over 75% of the species being native. One threatened flora species, *Ancistrachne maidenii*, listed as Vulnerable under the TSC Act has been recorded from the study area. This species was recorded within Central Hunter Grey Box – Ironbark Woodland outside of the disturbance boundary. The Atlas of NSW Wildlife holds records of Slaty Red Gum (*Eucalyptus glaucina*), listed as Vulnerable under both the TSC and EPBC Acts, adjacent to the western boundary of the study area. However, despite numerous flora surveys, the species has never been confirmed.

A number of threatened flora species listed under the TSC Act and/or EPBC Act are known to occur within the locality and some species have potential to occur in the study area due to the presence of suitable habitat. Many flora surveys have been undertaken in the study area over many years, and these species have not been recorded. Accordingly, despite the presence of potential habitat, they are considered unlikely to occur.

### S5.4 Fauna

A suite of fauna species have been recorded in the study area and utilise a variety of available habitat types. A total of 21 threatened fauna species have been recorded within the study area, including the following:

- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable under the TSC Act);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) (Vulnerable under the TSC Act);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) (Vulnerable under the TSC Act);
- Speckled Warbler (*Chthonicola sagittata*) (Vulnerable under the TSC Act);
- Hooded Robin (*Melanodryas cucullata*) (Vulnerable under the TSC Act);
- Diamond Firetail (*Stagonopleura guttata*) (Vulnerable under the TSC Act);
- Varied Sittella (*Daphoenositta chrysoptera*) (Vulnerable under the TSC Act);
- Scarlet Robin (*Petroica boodang*) (Vulnerable under the TSC Act);
- Glossy Black-cockatoo (*Calyptorhynchus lathami*) (Vulnerable under the TSC Act); Spotted Harrier (*Circus assimilis*) (Vulnerable under the TSC Act);
- Little Eagle (*Hieraaetus morphnoides*) (Vulnerable under the TSC Act);
- Regent Honeyeater (*Anthochaera phrygia*) (Endangered under the EPBC and Critically Endangered under the TSC Act);
- Swift Parrot (*Lathamus discolor*) (Endangered under the EPBC and TSC Acts);

- Black-breasted Buzzard (*Hamirostra melanosternon*) (Vulnerable under TSC Act);
- Squirrel Glider (*Petaurus norfolcensis*) (Vulnerable under the TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act);
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable under the EPBC and the TSC Acts);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act);
- Little Bentwing-bat (*Miniopterus australis*) (Vulnerable under the TSC Act);
- Southern Myotis (*Myotis macropus*) (Vulnerable under the TSC Act); and
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable under the EPBC and TSC Acts).

A number of threatened fauna species listed under the TSC Act and/or EPBC Act are known from the locality. Although not recorded from the study area, a number of species recorded from the locality have potential to occur in the study area due to the presence of potential habitat.

## **S6 Impact Assessment**

### **S6.1 Avoidance**

Avoidance of impacts to listed species and communities was carefully considered during the planning process and has been achieved by modification of the design and location of mine associated infrastructure away from natural habitats, where feasible. Avoidance of impacts has also been achieved through the proposed closure of Wallaby Scrub Road rather than its relocation. These avoidance measures have reduced the impacts on the WSW EEC and avoided any impacts on the State and Commonwealth listed White Box Woodland EEC and other important vegetation communities such as TSC Act listed Central Hunter Grey Box – Ironbark Woodland EEC.

### **S6.2 Mitigation**

Where certain impacts are unavoidable through design changes, mitigation measures have been introduced to ameliorate the ecological impacts of the Proposal. Mitigation measures relevant to the Proposal include:

- existing management strategies and procedures, such as the Coal and Allied Environmental Management Strategy and Rio Tinto's Biodiversity Strategy;
- existing mitigation measures, such as dust minimisation, weed control and flora and fauna monitoring;

- minimising vegetation clearance and habitat loss through establishment of clearing limits;
- pre-clearance surveys including identification of transportable habitat features; and
- management plans which will outline the management techniques and monitoring that will be undertaken within the Site and biodiversity offset areas.

### S6.3 Impacts

The primary impact from the Proposal will be the additional clearing of vegetation within the Site. Approximately 611 ha of forest, woodland and grassland will be progressively cleared over the 21 year project life within the disturbance boundary. **Table S.1** provides a summary of the areas of each vegetation community to be cleared for the Proposal.

Considerable areas of the forest and woodland communities within the disturbance boundary were extensively cleared prior to the 1960s. As a result few old growth trees remain within the Site; however the regenerating vegetation does provide a range of habitat types for numerous species. The clearance of this vegetation will result in the direct loss of habitat for species known from or potentially occurring within the Site.

In addition to the direct removal of vegetation, potential indirect impacts resulting from the Proposal on the vegetation adjacent to the Site include; increased edge effects, modification of abiotic factors such as light regimes and water flow, fragmentation of the vegetation and isolation of patches of vegetation and the fauna that utilise them.

**Table S.1 Vegetation Communities in the Disturbance Boundary**

Vegetation Community	Area (ha)
<b>Forest and Woodland</b>	
Warkworth Sands Woodland	72.0
Central Hunter Grey Box - Ironbark Woodland	365.5
Regenerating Central Hunter Grey Box - Ironbark Woodland	6.5
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	15.0
<i>Subtotal Forest and Woodland</i>	<i>459.0</i>
<b>Grassland</b>	
Warkworth Sands Grassland	0.5
Central Hunter Grey Box - Ironbark Derived Grassland	151.5
<i>Subtotal Grassland</i>	<i>152.0</i>
<b>TOTAL</b>	<b>611.0</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

## S7 BCAM Quantification of Impacts

The BCAM analysis of ecological impacts of has been separated into the following components:

- Component 1: WSW/WSG vegetation impacted by the Proposal;
- Component 2: Non-WSW/WSG vegetation impacted by the Proposal; and
- Component 3: Non-WSW/WSG vegetation impacted by the 2003 Extension.

The ecosystem credits and species credits requirements for each offset component are presented in **Table S.2**.

**Table S.2 BCAM Ecosystem and Species Credits Required for each Component**

Aspect	WSW/WSG Vegetation for the Proposal (Component 1)		Non-WSW/WSG Vegetation for the Proposal (Component 2)		Non-WSW/WSG Vegetation for the 2003 Extension (Component 3)	
	Credits		Credits		Credits	
	Area (ha)	Required	Area (ha)	Required	Area (ha)	Required
<b>Ecosystem Credits</b>						
Warkworth Sands Woodland (EEC)	72.0	2,935				
Warkworth Sands Grassland	0.5	15				
Central Hunter Grey Box - Ironbark Woodland (EEC)			365.5	13,644	249.0	8,974
Regenerating Central Hunter Grey Box - Ironbark Woodland (EEC)			6.5	240		
Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC)			15.0	553	1.5	56
Central Hunter Grey Box - Ironbark Derived Grassland			151.5	1,546	227.0	2,545
<i>Total Ecosystem Credits</i>		2,950		15,983		11,575
<b>Species Credits</b>						
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	72.0	1,923	387.0	10,326	250.5	6,683
Large-eared Pied Bat (Breeding Habitat) ( <i>Chalinolobus dwyeri</i> )					10.5	139
Southern Myotis (Breeding Habitat) ( <i>Myotis macropus</i> )	11.5	875	153.5	11,810	72.0	5,538
<i>Total Species Credits</i>		2,798		22,136		12,360

**Table S.2 BCAM Ecosystem and Species Credits Required for each Component**

Aspect	WSW/WSG Vegetation for the Proposal (Component 1)		Non-WSW/WSG Vegetation for the Proposal (Component 2)		Non-WSW/WSG Vegetation for the 2003 Extension (Component 3)	
	Area (ha)	Credits Required	Area (ha)	Credits Required	Area (ha)	Credits Required
<b>TOTAL CREDIT REQUIREMENT</b>		<b>5,748</b>		<b>38,119</b>		<b>23,935</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

## S8 The Biodiversity Offset Strategy

### S8.1 General Strategy

In order to offset the impacts of the Proposal that were quantified using BCAM, the Biodiversity Offset Strategy may include:

- establishment of land-based offset sites that secure various ecosystem and species credits on land secured by the proponent;
- rehabilitation measures aimed at providing new habitats for native flora and fauna on mined land to adjoin and complement the surrounding native vegetation;
- supplementary measures to improve the management of EEC vegetation and threatened species or other measures that benefit biodiversity; and
- retirement of credits under the rules of the UHSA, which includes contributions to the Upper Hunter Offset Fund.

#### S8.1.1 Establishment of Land-based Offset Sites

The land-based offsets include the local properties contained within the SBA and NBA. The vegetation communities recorded from the SBA and NBA and the BBAM credits that they will provide are summarised in **Table S.3**.

**Table S.3 Ecosystem and Species Credits Generated by the SBA and NBA**

Vegetation Community	TSC Act Status	SBA (ha)		NBA (ha)		
		Area (ha)	Credits	Area (ha)	Credits	
<b>Ecosystem Credits</b>						
Warkworth Sands Woodland	EEC	56.0	382	19.5	191	
Warkworth Sands Grassland		2.5	24	156.5	1,706	
Central Hunter Grey Box - Ironbark Woodland	EEC	380.0	3,318	104.0	1,201	
Regenerating Central Hunter Grey Box - Ironbark Woodland	EEC	18.5	161			
Central Hunter Grey Box - Ironbark Derived Grassland		144	1,240	23	251	
White Box Woodland	CEEC	28.0	265			
Yellow Box Woodland	CEEC	7.0	77			
Hunter Valley Vine Thicket	EEC	0.5	6			
Hunter Lowlands Redgum Forest	EEC	32.5	319			
River Red Gum Floodplain Woodland	EEC	9.5	83			
	<i>Total</i>	678.5	5,875	303.0	3,349	
<b>Ecosystem Credits (non-'like-for-like')*</b>						
Hunter Valley River Oak Forest		25.5	238			
Regenerating Hunter Valley River Oak Forest		1.0	11			
	<i>Total</i>	26.5	249			
<b>Species Credits</b>						
Regent Honeyeater	CE	558.0	3,349	123.5	740	
Southern Myotis (breeding habitat)	E	160.0	962			

*Note: all areas are rounded to the nearest 0.5 ha*

*\* Not 'like-for-like' under UHSA and therefore unable to be used to offset the ecosystem credit requirement for impacts to non-WSW/WSG vegetation of the 2003 Extension. The habitat provided within these communities can however contribute to species credits if suitable habitat is identified.*

### S8.1.2 Mine Rehabilitation

The Biodiversity Offset Strategy includes the rehabilitation of mined land within the MTW operations. The aim of mine rehabilitation will be to replant woodland within portions of previously mined areas to create a large block of habitat in the future for native flora and

fauna. The credit value of the mine rehabilitation has been calculated using BBAM in accordance with the rules set out in the UHSA. A total of 11,204 ecosystem credits would be generated by mine rehabilitation as part of the Biodiversity Offset Strategy.

### S8.1.3 Supplementary Measures

Supplementary measures are actions other than acquisition of land that are taken to improve biodiversity or other relevant environmental values. They can include financial contributions to Recovery Plans, management actions for communities or species and/or for targeted research.

### S8.1.4 Retirement of Credits under the UHSA

The UHSA provides an option to contribute to the Upper Hunter Offset Fund that will be used to secure offset lands and fund ongoing management of such lands. Where a shortfall of the credit requirement exists for the Proposal, the Biodiversity Offset Strategy has allowed for contribution to be made to the UHSA. The value of the contribution will be calculated by the rules set out by the UHSA.

## S8.2 Summary of Outcomes

The Proposal will meet the offsetting requirements for each component as follows:

- Component 1: the provision of land-based offsets, supplementary measures and retirement of credits under the rules of the UHSA;
- Component 2: the provision of land-based offsets, mine rehabilitation and retirement of credits under the rules of the UHSA; and
- Component 3: the provision of land-based offsets, mine rehabilitation and retirement of credits under the rules of the UHSA.

A summary of the offset outcomes for each component is provided in **Table S.4**. The value of the land-based offsets and mine rehabilitation for each of the assessed components has been calculated using BBAM and compared against the BCAM requirements.

**Table S.4 Overview of the Biodiversity Offset Strategy for each Component**

Element	Component 1	Component 2	Component 3
<b>Ecosystem Credits</b>			
Total BCAM credits required	2,950	15,983	11,575
BBAM Credits supplied through land-based offsets	2,303	TBC*	6,921
BBAM Credits supplied through mine rehabilitation	0	6,550	4,654
Will supplementary measures be provided?	Yes	No	No
BBAM Credits to be retired by the rules of the UHSA	647	TBC*	0

**Table S.4 Overview of the Biodiversity Offset Strategy for each Component**

Element	Component 1	Component 2	Component 3
<b>Species Credits (Regent Honeyeater) (<i>Anthochaera phrygia</i>)</b>			
Total BCAM credits required	1,923	10,326	6,683
BBAM Credits supplied through land-based offsets	454	TBC*	3,759
Supplementary measures?	No	No	No
BBAM Credits to be retired by the rules of the UHSA	1,469	TBC*	2,924
<b>Species Credits (Large-eared Pied Bat) (breeding habitat) (<i>Chalinolobus dwyeri</i>)</b>			
Total BCAM credits required			139
BBAM Credits supplied through land-based offsets			0
Supplementary measures?			No
BBAM Credits to be retired by the rules of the UHSA			139
<b>Species Credits (Southern Myotis) (breeding habitat) (<i>Myotis macropus</i>)</b>			
Total BCAM credits required	875	11,810	5,538
BBAM Credits supplied through land-based offsets	61	TBC*	912
Supplementary measures?	No	No	No
BBAM Credits to be retired by the rules of the UHSA	814	TBC*	4,626
<b>TOTAL RESIDUAL CREDIT REQUIREMENT</b>	<b>2,930</b>	<b>31,569</b>	<b>7,689</b>

### **S8.3 Consistency with Draft NSW Biodiversity Offsets Policy for Major Projects**

In order to verify whether the Biodiversity Offset Strategy is suitable to offset the proposed impacts, it has been assessed against the offsetting principles within the Draft NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014c). In accordance with the principles the Biodiversity Offset Strategy:

- has been developed following avoidance and mitigation measures;
- has utilised BCAM to assess the impacts and BBAM to assess the value of the offsets;
- targets biodiversity values being lost or higher conservation priorities;
- includes offsets that are additional to other legal requirements;

- includes offsets that will be enduring, enforceable and auditable; and
- includes supplementary measures where direct offsets are unable to be utilised.

## **S9 Conclusion**

Avoidance and mitigation measures have been implemented through the design of the Proposal to reduce the ecological impacts. In accordance with the UHSA, BCAM and BBAM metrics have been used to objectively quantify the impacts and offsetting of the Proposal. The Biodiversity Offset Strategy comprises establishment of substantial land-based offset sites (the SBA and NBA), mine rehabilitation, supplementary measures and retirement of credits under the rules of the UHSA. A total of 1,008 ha of native vegetation will be protected within the SBA and NBA and an additional 2,100 ha will be rehabilitated within mined areas of the MTW operations.

The proposed Biodiversity Offset Strategy will meet the requirements of the UHSA and be consistent with the principles of the Draft NSW Biodiversity Offsets Policy for Major Projects. It will achieve the maintenance and improvement of a substantial area of native woodland and forest vegetation, including WSW and threatened species habitat that will be conserved in perpetuity. This represents a net positive ecological outcome as required by Rio Tinto's Biodiversity Policy.

# Introduction

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## 1.1 Purpose

Cumberland Ecology was commissioned by EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of Rio Tinto Coal Australia to conduct an Ecological Impact Assessment (EIA) for a proposed extension of Warkworth Mine (the Proposal). Warkworth Mine is an open cut coal mine approximately 8 kilometres (km) south-west of Singleton in the Hunter Valley, NSW. The mine is operated by Coal & Allied on behalf of Warkworth Mining Limited (WML).

The EIA has been prepared to describe the ecological values of the area covered by the Proposal and to assess the potential impacts of the Proposal on native flora and fauna. Impact assessment focuses particularly but not exclusively on endangered ecological communities (EECs) as well as flora and fauna species protected under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The impacts from open cut mining at Warkworth have been avoided and mitigated where feasible to minimise the ecological impact. Residual ecological impacts are proposed to be compensated for by the provision of "biodiversity offsets". For the purposes of this report, biodiversity offsets are measures that benefit biodiversity by compensating for the predicted adverse impacts of the Proposal, particularly. Biodiversity offsets are intended to achieve long-term conservation outcomes where development and infrastructure projects are likely to impact biodiversity. Biodiversity offsetting is thus an integral part of the Proposal.

This EIA report provides details about the Biodiversity Offset Strategy that has been developed to compensate for residual ecological impacts.

Specifically, the objectives of the study are to:

- describe and map vegetation communities within the study area, identifying any listed threatened communities;
- identify and map the location of threatened flora and fauna species;
- assess the likelihood that threatened flora and fauna species could occur within the study area;

- describe the types and extent of potential impacts on threatened communities and species arising from the Proposal;
- demonstrate where impacts have been avoided where practicable;
- where relevant, develop measures for mitigation in order to minimise potential impacts on threatened communities and species; and
- provide a Biodiversity Offset Strategy that proposes additional offsetting mechanisms for the Proposal and replaces the "Green Offset Strategy" of the current (2003) development consent.

The area covered by the application is hereafter referred to as "the Site" (see **Figure 1.1**). The study area is the area that has been subject to ecological studies for the Proposal, and is shown in **Figure 1.2**. The area of disturbance for the Proposal is termed the "disturbance boundary" and is shown in **Figure 1.2**. The Warkworth Mine and surrounding region are shown in **Figure 1.3**.

This report will be incorporated into an Environmental Impact Statement prepared by EMM for submission to the Minister for Planning for assessment under Part 4 of the NSW EP&A Act.

## 1.2 Background

### 1.2.1 Warkworth Mine

Warkworth Mine currently operates under Development Consent No. DA 300-9-2002-i (the development consent) issued by the then Minister for Planning in May 2003 under Part 4 of the EP&A Act. The mine site also operates under two separate Commonwealth approvals (EPBC Act); EPBC 2002/629 and EPBC 2009/5081.

Warkworth Mine has been in operation since 1981 and the originally approved operation has been modified several times. Immediately to the south of Warkworth Mine is Mount Thorley Operations (MTO). Since 2004, the two mines have integrated at an operational level and are known as Mount Thorley Warkworth (MTW), with a single management team responsible for all the operations. Equipment, personnel, water, rejects and coal preparation are all shared between the mines. The operations involve an existing workforce of an average of approximately 1,300 persons, which includes full-time personnel and a small number of short-term contractors. Ownership of the two mines remains separate.

Warkworth Mine currently operates three integrated open cut mining areas, namely North, West and South pits with West and North pits being the focus of production. Run-of-mine (ROM) coal from Warkworth Mine is transported to either the Warkworth or Mount Thorley coal preparation plant (CPP) for processing. Product coal from the CPPs is transported via conveyor to either the Mount Thorley Coal Loader (MTCL) or to the Redbank Power Station. Coal loaded onto trains at the MTCL is transported to the Port of Newcastle for export.

### **1.2.2 2003 Development Consent**

The 2003 development consent permitted the clearing of woodland and forest that are habitat for threatened flora and fauna on the condition that biodiversity offsets were provided under what was referred to as the Green Offsets Strategy (ie the offsets for the 2003 Extension that are provided under the current development consent) (ERM 2002). This included portions of land to the west and north of the 2003 Extension (ERM, 2002a) and rehabilitation to woodland following mining. These Green Offsets were designated as:

- **Habitat Management Areas (HMAs):** Approximately 889.5 ha of land owned by Warkworth Mining Limited (WML) to offset the short and medium term loss of habitat and ensure connectivity until the rehabilitation of the mined land can restore these values; and
- **Non-Disturbance Areas (NDAs):** Approximately 758 ha of land that will provide long term protection of vegetation communities and biodiversity values for the life of the consent and preclude open cut mining and agriculture.

The location of the HMAs and NDAs are shown in **Figure 1.4**. The intent of the HMAs was for the temporary preservation of ecological values as economic coal resources were known to occur beneath these areas. The intent of the NDAs was for long term preservation. Both the HMAs and NDAs are currently managed in accordance with the Green Offsets Strategy, which is proposed to be replaced and upgraded by the Biodiversity Offset Strategy.



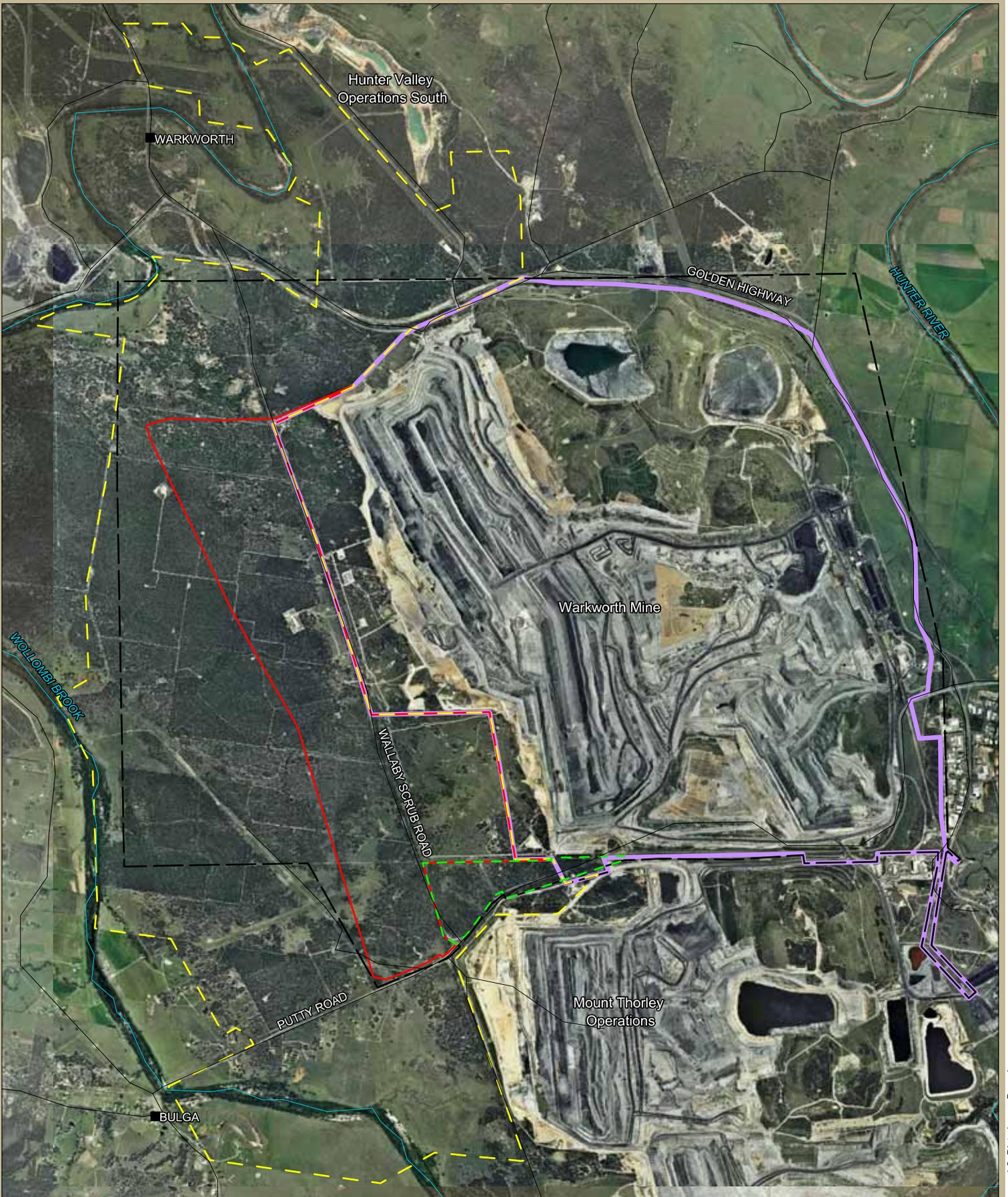
- Legend**
- The Site
  - Proposed Warkworth Mine Development Consent Boundary
  - Existing Warkworth Mine Development Consent Footprint
  - Waterway
  - Road
  - Town

Image Source: RTCA 2013



Figure 1.1. The Site

500 0 500 1000 1500 2000m

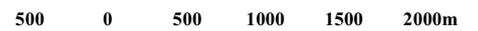


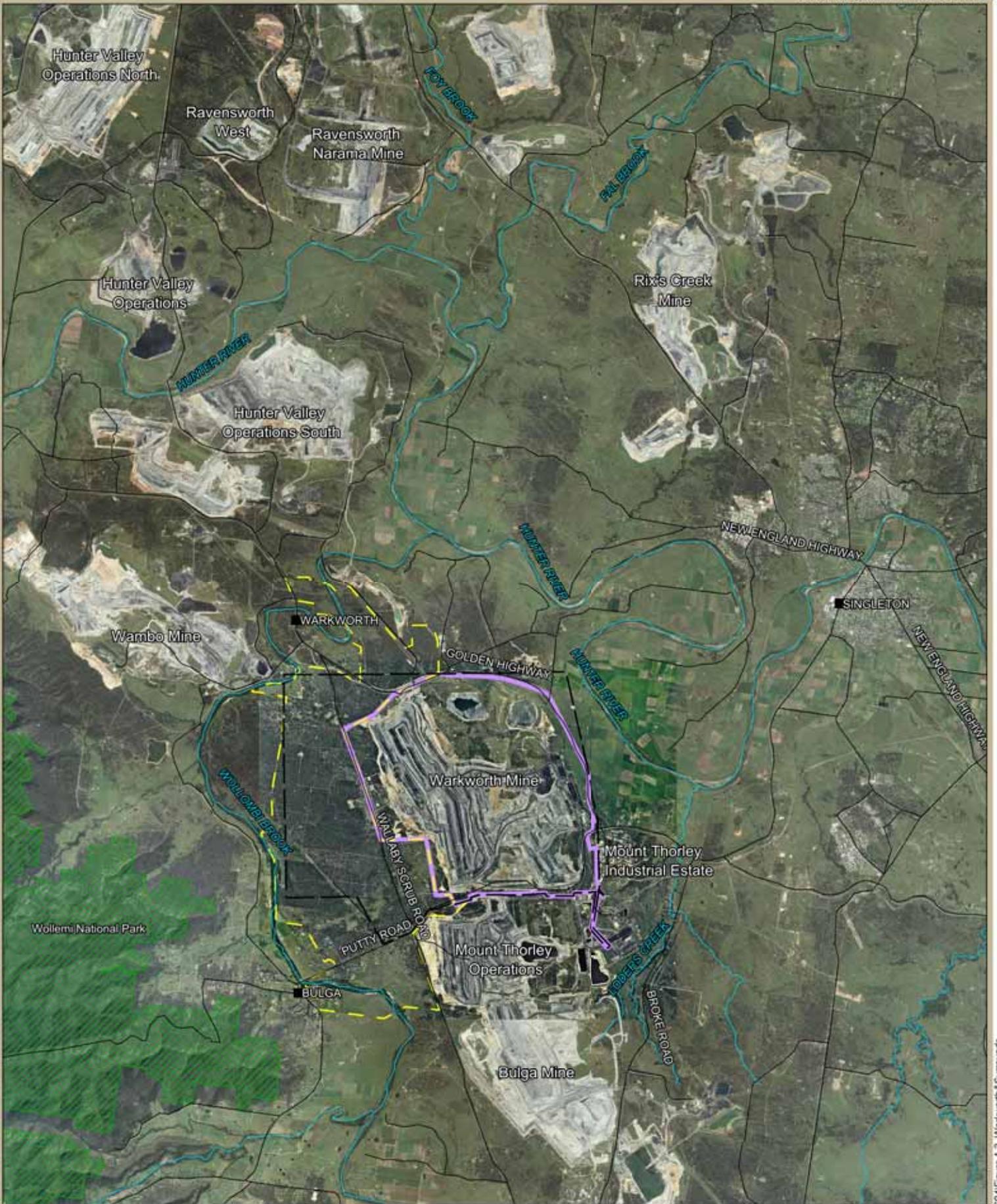
- Legend**
- Disturbance Boundary
  - Study Area
  - Existing Warkworth Mine Development Consent Footprint
  - Area already approved to be mined by MTO under DA 34/95
  - Proposed Warkworth Mine Development Consent Boundary

Image Source: RTCA 2013



Figure 1.2. Disturbance Boundary





- Legend**
- Existing Warkworth Mine Development Consent Footprint
  - Study Area
  - Proposed Warkworth Mine Development Consent Boundary
  - National Park
  - Road
  - Waterway
  - Town

Image Source: RTCA 2012 & 2013



Figure 1.3. Warkworth Mine and Surrounding Region

1000 0 1000 2000 3000 4000m



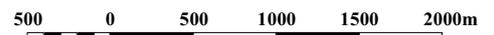
**Legend**

- Disturbance Area
- Habitat Management Area (HMA)
- Non Disturbance Area (NDA)
- Existing Warkworth Mine Development Consent Footprint
- Road
- Area already approved to be mined by MTO under DA 34/95
- Waterway
- Proposed Warkworth Mine Development Consent Boundary (The Site)
- Town
- Putty Road Conservation Area

Image Source: RTCA 2013



**Figure 1.4. Location of the HMAs and NDAs**



# The Proposal

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## 2.1 The Proposal

WML seek to apply for a new development consent to allow an extension of North and West pits further west. The Proposal comprises:

- extension of the mining footprint by approximately 698 hectares (ha) to the west of current operations extending the life of North and West pits by 21 years;
- ability to transfer overburden and coal to MTO to assist in the final landform for MTO and processing of ROM coal from Warkworth Mine;
- ability to transfer and accept mine water from neighbouring operations (ie Bulga Coal Complex, Wambo Mine, Mount Thorley Operations and Hunter Valley Operations);
- closure of Wallaby Scrub Road;
- an optional underpass for the approved but yet to be constructed third bridge crossing on Putty Road;
- minor changes to the design of the Northern out-of-pit dam;
- use of existing secondary access gates to the mine sites and offset areas to allow for infrequent vehicle movements to enable activities such as drilling, offset management and equipment shutdown pad access; and
- maintain the approval of all aspects of the existing operations for Warkworth Mine approved under DA 300-9-2002-i, including integrations with MTO (such as an integrated management system for rejects and water) and other surrounding mines and Redbank Power Station.

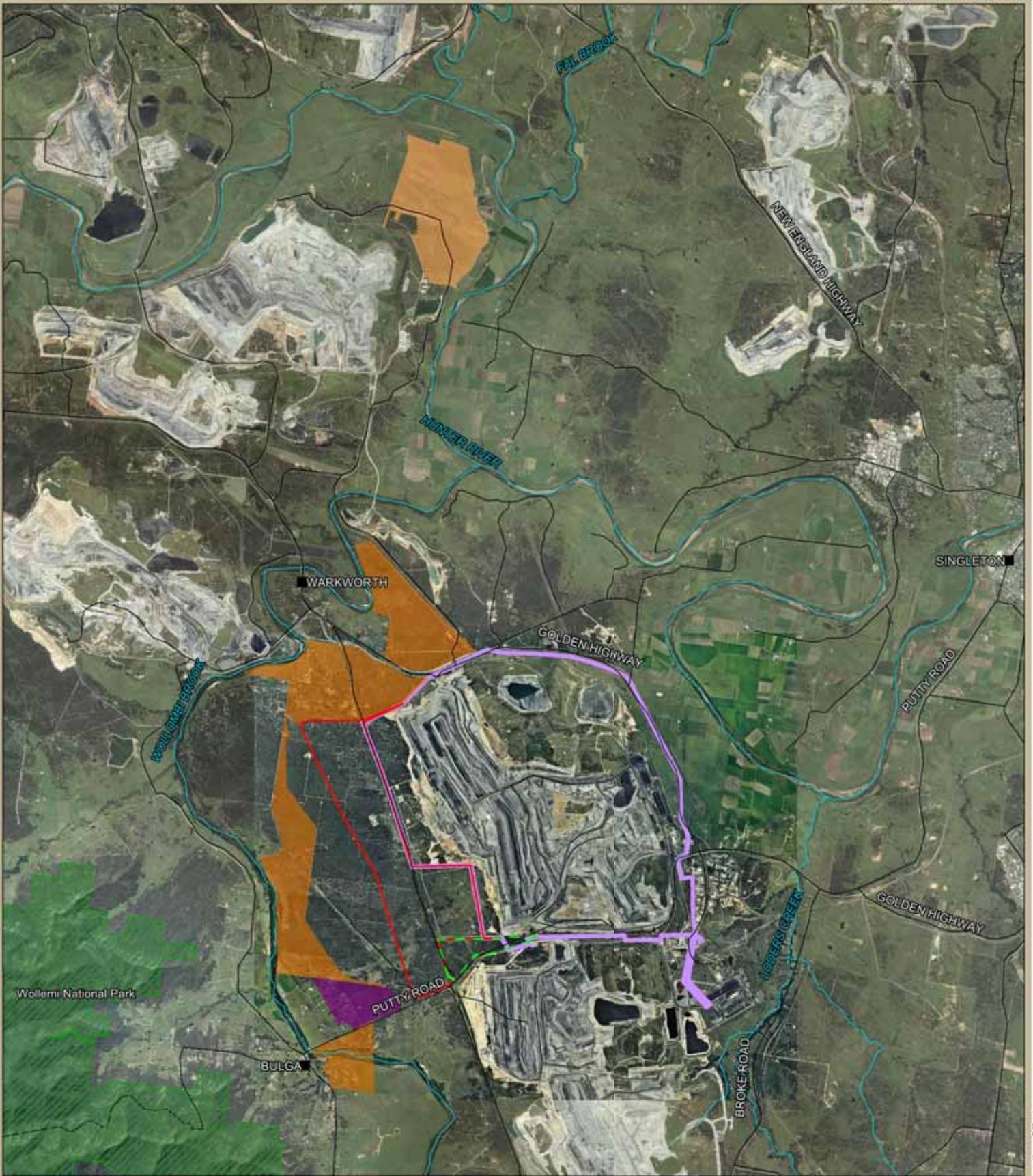
Under the Proposal, WML is proposing to mine through some of the Green Offsets (ie the offsets for the 2003 Extension that are provided under the current development consent), extending mining beyond the current approval (see **Section 1.2.1** and **Figure 1.4**). As such WML are assessing the ecological impacts the Proposal, as well the implications for re-offsetting the impacts of the 2003 Extension for all non-Warkworth Sands Woodland/Warkworth Sands Grassland (non-WSW/WSG) vegetation.

WML are proposing to quantify ecological impacts in accordance with the Upper Hunter Strategic Assessment (UHSA), which is preparing a strategic biodiversity offsetting strategy for Upper Hunter mines. In accordance with the UHSA, a metric measurement tool called Biodiversity Certification Assessment Methodology (BCAM) has been used to objectively quantify ecological impacts (see **Chapter 6**).

WML's proposed Biodiversity Offset Strategy:

- will provide offsets to compensate for the Proposal's impacts using the rules of the UHSA; and
- will replace the Green Offset Strategy established for the 2003 Extension in areas referred to as the Southern Biodiversity Area (SBA) and Northern Biodiversity Area (NBA) (see **Figure 2.1**) and by mine rehabilitation.

In accordance with the UHSA, where offsets are to be provided directly by WML, a second metric measuring tool, the BioBanking Assessment Methodology (BBAM) has been used calculate the contribution of each offset to addressing the ecological impacts measured using BCAM. The Biodiversity Offset Strategy is discussed further within **Chapter 7**.

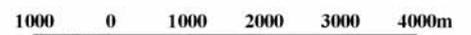


- Legend**
- Disturbance Boundary
  - Area already approved to be mined by MTO under DA 34/95
  - Warkworth Mine Development Consent Footprint
  - Southern Biodiversity Area
  - Northern Biodiversity Area
  - Putty Road Conservation Area
  - National Park
  - Road
  - Waterway
  - Town

Image Source: RTCA 2012 & 2013



Figure 2.1. Location of the Southern and Northern Biodiversity Areas



## 2.2 Site Description

The Site is bound by the Golden Highway to the east and north, Wollombi Brook to the west and Putty Road to the south. Wallaby Scrub Road runs north-south through the western portion of the mining lease. The Hunter River is located approximately 4.5 km north east of the Site; while Wollombi Brook, a tributary of the Hunter River, occurs approximately 1.5 km to the west. An unnamed ephemeral drainage line flows west into Wollombi Brook approximately mid-way through the Site.

The landscape within the Site is gently undulating and comprises areas where Quaternary aeolian sands have been deposited over various Permian sedimentary geological formations. Where sands occur, the resultant free-draining sandy soils support a distinctive type of vegetation reminiscent of coastal vegetation that is referred to as Warkworth Sands Woodland (WSW), which is listed as an endangered ecological community (EEC) under the TSC Act. The clearing of this community has resulted in the presence of Warkworth Sands Grassland (WSG), however this form is not listed under the TSC Act. Where the sands are absent, soils contain a higher clay content and the dominant vegetation comprises various forms of Ironbark (*Eucalyptus crebra*) forest, which are also EECs listed under the TSC Act.

For the purposes of this report the native vegetation other than WSW/WSG vegetation is referred to collectively as "non-WSW/WSG" vegetation. Both WSW/WSG and non-WSW/WSG vegetation provide habitat for threatened fauna and flora, particularly birds and bats.

Mining is currently being conducted in the eastern side of the Warkworth mining leases which cover an area of approximately 4,200 ha. A large portion of the mining leases are covered by currently operating mine works and associated infrastructure, while the remainder is a mosaic of land previously cleared for agriculture and regenerating remnant vegetation.

Since European settlement, the native forests and woodlands of the Hunter Valley catchment have been extensively cleared and used for agriculture. Much of this clearing took place over 100 years ago as some of the earliest farming ventures within NSW occurred in this location. This has resulted in much of the original native vegetation being either removed or heavily modified.

Much of the Hunter Valley is underlain by coal deposits, and numerous coal mines have been developed in the Hunter Valley coal fields – some dating back to the turn of last century. Large modern open cut mines have resulted in further clearance of native vegetation. However, within the extensive mining leases required for such mining operations, broad areas of land are typically released from livestock grazing and this has resulted in considerable regeneration of native vegetation in parts of the coal fields that is unlikely to have occurred under the previous land use regimes.

Existing mines that surround the Site include Hunter Valley Operations to the north, Wambo Mine to the west and MTO and Bulga mines to the south. To the east is Mount Thorley Industrial Estate and beyond lies agricultural land. Further afield to the west is Wollemi National Park which forms part of the EPBC Act listed Greater Blue Mountains World

Heritage Area. This area is also protected under the EPBC Act as a National Heritage Place. The location of the Site in relation to these regional features is illustrated in **Figure 1.3**.

## **2.3 Legislation, Government Policies and DGRs**

The following sections outline the relevant contemporary government legislation, policies and Director-General's requirements which are considered in this EIA.

### **2.3.1 Environment Protection and Biodiversity Conservation Act 1999**

Under the EPBC Act, any action (which includes a development, project or activity) that is considered likely to have a significant impact on Matters of National Environmental Significance (MNES) (including nationally threatened ecological communities and species, and listed migratory species) must be referred to the Commonwealth Minister for the Environment. The purpose of the referral is to allow a decision to be made about whether an action requires approval on a Commonwealth level. If an action is declared a "controlled action", then Commonwealth approval is required.

Any action that is considered likely to have a significant impact on MNES must be "referred" to the Department of Environment (DoE) to obtain confirmation of whether or not a Project constitutes a "Controlled Action". If an action is declared a Controlled Action, then Commonwealth approval is required.

Project approval was received by the DoE in 2009 (EPBC 2009/5081). The disturbance footprint that was approved by DoE in 2009 is the same as the current Proposal, and therefore the impacts to Matters of National Environmental Significance (MNES) have already been assessed and approved. Accordingly, this report does not consider MNES.

### **2.3.2 Environmental Planning and Assessment Act 1979**

The EP&A Act is the overarching planning legislation in NSW that provides for the creation of planning instruments that guide land use. The EP&A Act also provides for the protection of the environment, including the protection and conservation of native animals and plants. This includes threatened species, populations and ecological communities, and their habitats of biodiversity values, as listed in the TSC Act and NSW *Fisheries Management Act 1994*. The protection of the environment is addressed in Section 5A of the EP&A Act (Significant effect on species, populations or ecological communities or their habitats).

#### *i. Division 4.1 of Part 4 of the EP&A Act*

Upon the repeal of Part 3A of the EP&A Act on 1 October 2011, the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* inserted a new Division 4.1 in Part 4 of the EP&A Act. This Division provides for a new planning assessment and determination regime for State Significant Developments (SSDs). A SSD is a development declared by a State Environmental Planning Policy (SEPP) or Regional Environmental Planning Policy to be a SSD, or development that the Minister for Planning has called in for

determination. The Minister for Planning is the consent authority for SSD. The Project is considered to be a SSD and therefore Warkworth Mining Limited will seek development consent from the Minister for Planning under Division 4.1 of Part 4 of the EP&A Act.

Secretary's Environmental Assessment Requirements (SRs) were issued by the Department of Planning and Environment (DP&E) on 22 May 2014 for the Proposal and the provisions that are relevant to this EIA are provided in **Section 2.3.10**.

### **2.3.3 Threatened Species Conservation Act 1995**

The TSC Act is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. 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.

**Section 5.4** of this document presents an assessment of the potential impacts of the project on threatened species, populations and communities listed under the TSC Act.

### **2.3.4 Draft NSW Biodiversity Offset Policy for Major Projects**

The NSW Government is currently developing the NSW Biodiversity Offsets Policy for Major Projects for two categories of development proposed under the planning system: state significant development and state significant infrastructure. The policy:

- establishes a set of offsetting principles for major projects;
- defines key thresholds for when offsetting is required;
- adopts an assessment methodology to quantify and describe the offset required;
- defines preferred mechanisms to establish offset sites;
- provides a range of flexible options that can be used in lieu of providing offsets including rehabilitation actions and supplementary measures; and
- sets out how payments to the NSW Biodiversity Offsets Fund can be used to acquit offset requirements.

The Draft NSW Biodiversity Offsets Policy for Major Projects is underpinned by seven key principles for determining biodiversity offset requirements for major projects:

1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts;
2. Offset requirements should be based on a reliable and transparent assessment of losses and gains;

3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities;
4. Offsets must be additional to other legal requirements;
5. Offsets must be enduring, enforceable and auditable;
6. Supplementary measures can be used in lieu of offsets; and
7. Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal.

These offset principles have been considered during the development of the Offset Package for the Proposal, and an assessment of compliance with these principles is presented in **Section 7.5**.

### **2.3.5 Draft Framework for Biodiversity Assessment**

The (Draft) Framework for Biodiversity Assessment (FBA) sets out the detailed operation of the Draft NSW Biodiversity Offsets Policy for Major Projects. It contains the assessment methodology that is adopted by the policy to quantify and describe the impact assessment requirements and offset guidance that applies to major projects.

The FBA comprises three broad stages that set out the biodiversity assessment requirements and offset practices for major projects.

#### **Stage 1 – Biodiversity assessment requirements**

Stage 1 sets out the requirements and survey methods that must be undertaken by a proponent to identify, map and describe the native plant community types, threatened species and threatened species habitat on the development site and an offset site.

#### **Stage 2 – Impact assessment of a major project**

Stage 2 describes the methods to measure the loss to biodiversity caused by the direct and indirect impacts of the development. The FBA quantifies the loss and gain in biodiversity values through biodiversity credits. There are two categories of biodiversity credits:

1. Ecosystem credits – these are created or required for all impacts on biodiversity values, including EECs and threatened species that can be reliably predicted by habitat surrogates, except the threatened species or populations that require species credits.
2. Species credits – these are created or required for impacts on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates.

The loss of biodiversity values caused by the project will be expressed as a biodiversity credit requirement and set out in the biodiversity assessment report. It will set out the

number and type of biodiversity credits that would be required to offset the impact of development.

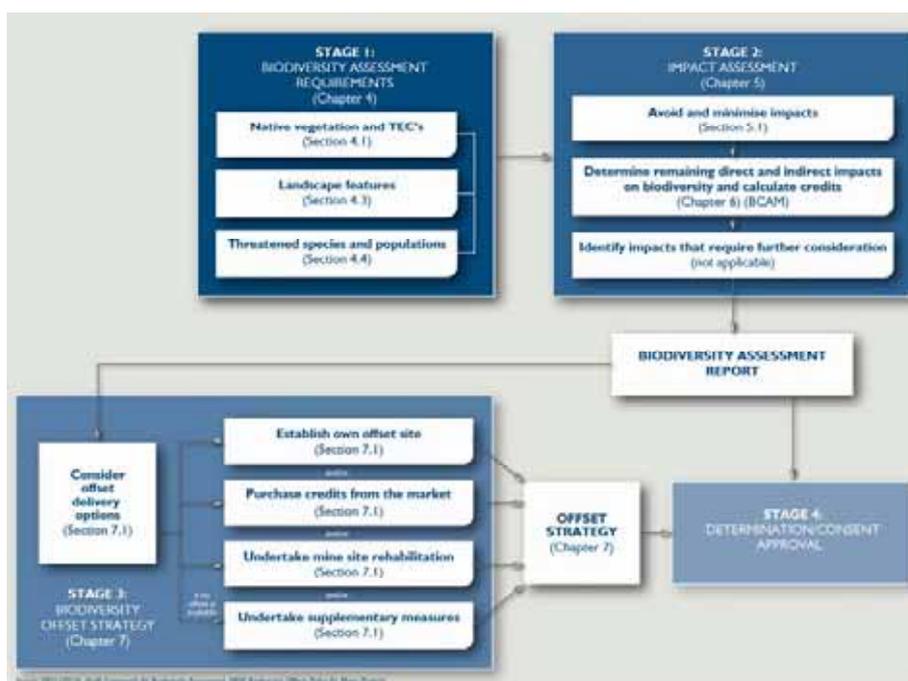
### Stage 3 – Biodiversity offset strategy requirements

Stage 3 sets out the requirements for preparing a biodiversity offset strategy for a development. The biodiversity offset strategy is submitted by a proponent and describes the measures proposed to meet the offset requirement determined in Stage 2. The FBA provides guidance on the options that a proponent can use to fulfil an offset requirement, including:

- establish their own offset site;
- undertake rehabilitation of degraded land; or
- purchase biodiversity credits that have been generated by a landowner with an offset site.

The FBA sets out the requirements for calculating the gain in biodiversity values (in biodiversity credits) that can be achieved at an offset site through management actions. In some circumstances, supplementary measures may also be used as part of a biodiversity offset strategy for a major project.

Although the FBA is still draft, the approach taken in this EIA is consistent with that specified by the FBA, with the loss and gain in biodiversity values calculated in terms of BCAM and BBAM credits respectively instead of the FBA methodology (which is still in development stages). (see **Chapter 8**). A schematic diagram of how the FBA is being applied to the Proposal is show in **Figure 2.2**.



**Figure 2.2 Schematic of the FBA Process (OEH, 2014b)**

### **2.3.6 Upper Hunter Strategic Assessment**

The UHSA was initiated by the NSW and Commonwealth Government in 2012 to provide a strategic biodiversity assessment process for acquiring and managing future mining offsets for the Upper Hunter Valley coalfields. The purpose of the UHSA is to implement a coordinated assessment of the current biodiversity values and current and future impacts of coal mining in the Upper Hunter Valley coalfields, in order to inform the Upper Hunter Biodiversity Plan. It is intended that the Upper Hunter Biodiversity Plan will fulfil all biodiversity impact assessment requirements at both the State and Commonwealth levels.

This is a voluntary process, and participating companies are required to survey and assess the area of land which they nominate as their Biodiversity Assessment Area (BAA). Individual Biodiversity Assessment Reports are being prepared for each nominated BAA by each participating company, and will be submitted to the NSW Office of Environment and Heritage (OEH) for review. The Biodiversity Assessment Reports and data layers created will be incorporated into the Upper Hunter Biodiversity Plan to set out the offsetting framework for future mining proposals for participating companies in the Upper Hunter Valley. This is expected to largely comprise the establishment of and contribution to, the Upper Hunter Offset Fund that will be used to secure offset lands and fund ongoing management.

Participating companies will also be able use mine rehabilitation to address up to 25% of their total offsetting commitments under the rules of the UHSA. In recognition of the associated risks, a discount rate of 50% is applied to the proportion of offsets to be addressed using mine rehabilitation, accordance with the UHSA rules.

The BAA for MTW includes the Site, which will form part of the Biodiversity Assessment Report being prepared for inclusion in the UHSA. Therefore, the offsets for the Proposal will form part of Warkworth Mine's inputs for the UHSA.

### **2.3.7 Biodiversity Certification Assessment Methodology**

BCAM is the methodology used by the UHSA. BCAM involves specific field survey requirements and on-ground methods for surveying threatened species habitat and vegetation condition, and using the results provides a methodology to determine whether biodiversity certification will improve or maintain biodiversity values. The methodology assesses the loss of biodiversity values on land proposed for biodiversity certification and the gains from conservation measures on land proposed for biodiversity conservation.

This is achieved by the calculation of impacts and offsets as credits. BCAM assesses general biodiversity values for their conservation significance including native vegetation types, condition and spatial configuration such as connectivity and extent of native vegetation. Using the methodology it is possible to determine how many credits would be required to offset an impact to biodiversity. Conversely, it is also possible to determine how many credits an offset property would be able to furnish in order to offset the impacts from an impact elsewhere. Under the TSC Act, biodiversity certification may only be conferred on land where the Minister makes a determination, on the basis of a biodiversity certification assessment made in accordance with the methodology, that the conferral of biodiversity

certification will improve or maintain biodiversity values. Further information about the BCAM is provided in the BCAM Manual (DECCW 2011).

BCAM assessments have been undertaken for the Proposal to determine how many credits are required to offset the impacts of the Proposal, in accordance with the UHSA. BCAM analysis has also been completed to quantify the reallocated Green Offsets (ie the offsets for the 2003 Extension that are provided under the current development consent).

### **2.3.8 BioBanking**

BioBanking is a market-based scheme that provides a biodiversity assessment process for development and an offsetting scheme.

BioBanking establishes an 'improve or maintain' test for biodiversity values. Improving or maintaining biodiversity values means avoiding important areas for conservation of biodiversity values, and offsetting impacts on other areas. The offsets are measured in terms of credits, using the BBAM. The scheme requires participating developers to meet this improve or maintain test based on the impact of their proposed development. Credits are created by the landowner, who establishes a BioBank site and commits to enhancing and protecting biodiversity values.

The credits represent an improvement in the condition of biodiversity values such as an improvement in the habitat or an increase in the habitat or population of a threatened species. The scheme creates a market for the credits. Landowners can sell the credits to provide income and fund the future management of the site. Developers can buy the credits to offset impacts from their development and to either the improve or maintain biodiversity values. Developers will need to source particular types of credits in accordance with the offset rules in the methodology:

- ecosystem credits can only be used to offset biodiversity impacts in the same ecological community, or in another community of the same formation that has an equal or greater percentage of land cleared and the same predicted threatened species; and
- species credits can only be used to offset biodiversity impacts on the same threatened species.

Under the UHSA, BBAM is currently the only available tool to determine the credits generated by an offset site. It has been used in this report to determine the likely credits generated by the proposed offsets, which will form part of Warkworth Mine's Biodiversity Assessment Report under the UHSA.

### **2.3.9 NSW State Groundwater Dependent Ecosystems Policy**

The NSW State Groundwater-dependent Ecosystems Policy provides guidance on how to identify, manage and protect groundwater dependent ecosystems. This applies to the Site as Groundwater Dependent Ecosystems (GDE) have been identified on the study area.

An assessment of potential GDEs in the study area is presented in **Section 4.2.3**.

### 2.3.10 Secretary's Requirements

As mentioned in **Section 2.3.2**, the SRs for the Proposal were received on the 22 May 2014. Those relevant to this study are reproduced below in **Table 2.1**.

**Table 2.1 SRs Relating to Biodiversity**

Requirement	Section within Report
<p>an assessment of the likely biodiversity impacts of the new development, having regard to the principles and strategies in the draft NSW Biodiversity Offsets Policy for Major Projects and the Upper Hunter Strategic Assessment – Interim Policy, using the Biodiversity Certification Assessment Methodology as amended by the Upper Hunter Strategic Assessment for credit calculation, and the Biobanking Assessment Methodology as amended by the Upper Hunter Strategic Assessment for calculating the credits of any offsets;</p>	<p>Chapter 5, 6 and 7</p>
<p>specific assessment of the likely impacts of the new development on the Section 5.2.1 and Section 6.2 Warkworth Sands Woodland endangered ecological community; and</p>	
<p>the provision of alternate offsets for the disturbance area approved under the 2003 development consent, using the Biodiversity Certification Assessment Methodology as amended by the Upper Hunter Strategic Assessment for credit calculation and the Biobanking Assessment Methodology as amended by the Upper Hunter Strategic Assessment for calculating the credits of any offsets.</p>	<p>Chapter 7</p>

## Methods

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This study draws on a large body of field survey and data analysis that has been conducted for the study area over many years, and provides a comprehensive description of the biodiversity values present, including threatened species of flora and fauna and EECs.

The Site has been extensively studied since the 1990s and a range of field surveys have been conducted. The area within which field surveys have been conducted is referred to as the study area and comprises areas beyond the Site. This document relies on the data collected, synthesised and presented in the 2010 Ecological Assessment (EA) prepared by Cumberland Ecology. The results are considered directly applicable to the current assessment, are contemporary, and the ecological values of the study area are unlikely to have changed significantly in the intervening period.

Subsequent to the preparation of the 2010 EA, additional reports have been prepared by Cumberland Ecology and others. These have been reviewed and the results incorporated into this document where appropriate. This included additional field survey and literature review. Further, recent high resolution aerial photography has been examined to determine if the previously mapped boundaries of vegetation communities are still valid, and in some cases some minor alterations have been made due to regrowth of canopy trees since the previous mapping was undertaken.

Full details of the methodology used in the field surveys are provided at **Appendix A**.

### 3.1 Database Analysis and Literature Review

Database analysis of flora and fauna records was conducted for the surrounding locality using the OEH Atlas of NSW Wildlife Database (OEH, 2014a). The lists generated from these databases were used to assist in designing surveys for threatened species considered to have the potential to occur in the study area as well as structuring habitat assessments to further assist in the determination of the likelihood of occurrence of threatened species.

### 3.2 Flora Surveys

Flora surveys were conducted in the study area from 11-12 June 2009, 24-26 June 2009, 7-11 September 2009 and 28-30 October 2013. Flora survey methods involved the following:

- quadrat sampling (20 m x 20 m);
- random meander surveys;
- meander-transect surveys; and
- targeted searches for threatened flora.

In addition, targeted threatened flora searches for ground orchids were conducted on 20-21 September 2012 and 3-4 October 2012 with particular focus on *Pterostylis gibbosa* (Illawarra Greenhood), *Diuris tricolor* (Pine Donkey Orchid) and *Diuris sp. aff. dendrobioides* (Wedge Diuris). Targeted searches for these species were undertaken using the following methods:

- transects: walking transects were conducted in grassy woodland areas with two ecologists spaced five to twenty metres (m) apart to run parallel transects at each location. The start and end points of each transect were recorded using a handheld Global Positioning System (GPS) unit;
- random meanders: walking meander transects were conducted in grassy woodland areas. Each meander was tracked using a GPS; and
- area Searches: 20 minute searches by two ecologists conducted in larger areas of open grassland. Each location was recorded using a GPS.

Cumberland Ecology ground truthed existing vegetation mapping in 2009, and this was further refined in 2012 following detailed review of additional information.

In conjunction with the quadrat sampling, additional plot data was collected using the survey methodology adopted by BCAM. Collection of the quadrat and plot data enabled the calculation of the number of credits required to offset the impacts of the Proposal in accordance with the UHSA.

Further details of the flora survey methodology are presented in **Appendix A**.

### 3.3 Fauna Surveys

Fauna surveys by Cumberland Ecology were conducted over four one-week periods from 15-19 June 2009, 29 June-3 July 2009, 13-17 July 2009 and 7-11 September 2009. In addition, a targeted threatened bird survey was undertaken by ornithologist Dr Stephen Debus during the winter blossoming period from 10-11 June 2009.

The following fauna survey methods for were utilised for the Cumberland Ecology fieldwork:

- amphibians: habitat searches, pitfall traps, spotlighting, call playback;
- birds: visual observation and call identification, nocturnal call playback, diurnal call playback;

- mammals: trapping (ground and arboreal trapping), hair tubes, Anabat call recording, spotlighting, infra-red cameras; and
- reptiles: pitfall traps, spotlighting, habitat searches.

Numerous surveys have been conducted over a number of years, range of seasons and conditions, thus providing a comprehensive data-set to use for this assessment. Further details of the fauna survey methodology are presented in **Appendix A**.

## Results

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This section synthesises the findings of numerous flora and fauna surveys across the study area and surrounds to present a comprehensive description of the biodiversity values present in the study area. A wide variety of woodland and open forest flora and fauna are known to occur in the study area and a considerable diversity of species has been identified. Total flora and fauna species lists are provided in **Appendix B** and **Appendix C**, respectively. A detailed discussion of the threatened fauna species recorded from the study area or considered to have potential to occur is presented in **Appendix D**.

### 4.1 Native Vegetation and Threatened Ecological Communities

The vegetation in the study area primarily consists of dry sclerophyll woodland, regrowth woodland and grassland. The vegetation communities recorded from the study area and their TSC Act status are indicated in **Table 4.1** below, and are shown in **Figure 4.1**. Of these, the following six native vegetation communities occur within the disturbance boundary:

- Warkworth Sands Woodland (WSW);
- Warkworth Sands Grassland (WSG);
- Central Hunter Grey Box – Ironbark Woodland;
- Regenerating Central Hunter Grey Box – Ironbark Woodland;
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest; and
- Central Hunter Grey Box – Ironbark Derived Grassland.

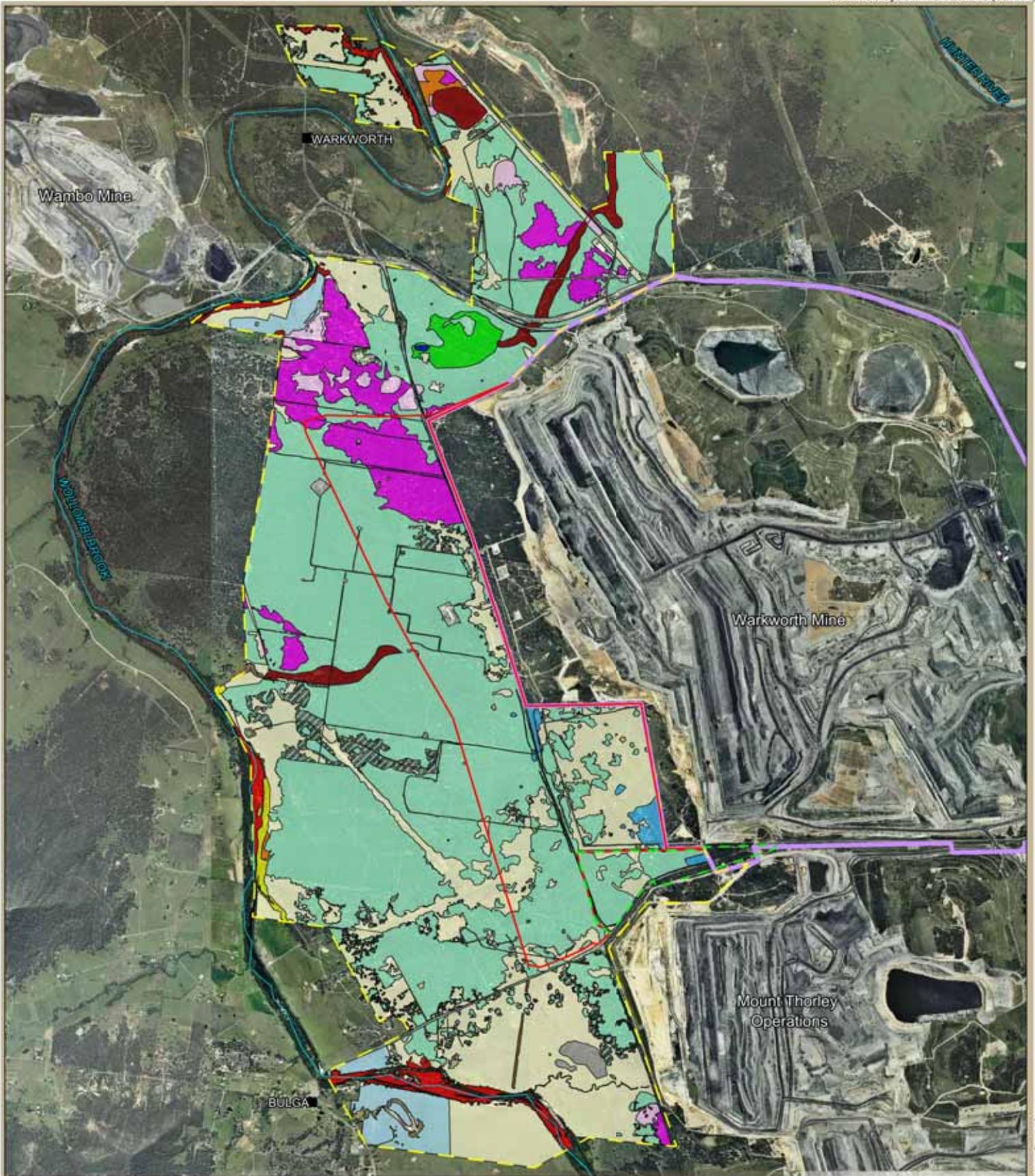
Descriptions of each native vegetation community occurring within the disturbance boundary are provided in subsequent subsections.

**Table 4.1 Vegetation Communities in the Study Area and Disturbance Boundary**

<b>Vegetation Community</b>	<b>TSC Act Status</b>	<b>Study Area (ha)</b>	<b>Disturbance Boundary (ha)</b>
<b>Forest and Woodland</b>			
Warkworth Sands Woodland	EEC	186.5	72.0
Central Hunter Grey Box - Ironbark Woodland	EEC	1,455.0	365.5
Regenerating Central Hunter Grey Box - Ironbark Woodland	EEC	49.0	6.5
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	EEC	17.0	15.0
White Box Woodland	EEC	28.0	
Yellow Box Woodland	EEC	7.0	
Hunter Valley Vine Thicket	EEC	0.5	
Hunter Lowlands Redgum Forest	EEC	48.5	
River Red Gum Floodplain Woodland	EEC	10.0	
Hunter Valley River Oak Forest		54.5	
Regenerating Hunter Valley River Oak Forest		1.0	
<i>Subtotal Forest and Woodland</i>		<b>1,857.0</b>	<b>459.0</b>
<b>Grassland</b>			
Warkworth Sands Grassland		45.5	0.5
Central Hunter Grey Box - Ironbark Derived Grassland		668.0	151.5
<i>Subtotal Grassland</i>		<b>713.5</b>	<b>152.0</b>
<b>TOTAL*</b>		<b>2,570.5</b>	<b>611.0</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

*\* Excludes non-native vegetation, cleared areas and unmapped vegetation.*



**Legend**

- Disturbance Boundary
- Study Area
- Area already approved to be mined by MTO under DA 34/95
- Existing Warkworth Mine Development Consent Footprint

**Vegetation Community**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: magenta; margin-right: 5px;"></span> Warkworth Sands Woodland (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: pink; margin-right: 5px;"></span> Warkworth Sands Grassland</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: lightgreen; margin-right: 5px;"></span> Central Hunter Grey Box - Ironbark Woodland (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: lightblue; margin-right: 5px;"></span> Regenerating Central Hunter Grey Box - Ironbark Woodland (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; margin-right: 5px;"></span> Central Hunter Grey Box - Ironbark Derived Grassland</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: cyan; margin-right: 5px;"></span> Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: limegreen; margin-right: 5px;"></span> White Box Woodland (C/EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: orange; margin-right: 5px;"></span> Yellow Box Woodland (C/EEC)</li> </ul> | <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: blue; margin-right: 5px;"></span> Hunter Valley Vine Thicket (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: brown; margin-right: 5px;"></span> Hunter Lowlands Redgum Forest (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; margin-right: 5px;"></span> River Red Gum Floodplain Woodland (EEC)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: red; margin-right: 5px;"></span> Hunter Valley River Oak Forest</li> <li><span style="display: inline-block; width: 15px; height: 10px; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></span> Regenerating Hunter Valley River Oak Forest</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: brown; margin-right: 5px;"></span> Planted Native and Exotic</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: lightblue; margin-right: 5px;"></span> Exotic</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: grey; margin-right: 5px;"></span> Dam/Infrastructure</li> </ul> |
|---|--|

Image Source:  
RTCA 2013



Figure 4.1. Vegetation Communities in the Study Area



#### 4.1.1 Warkworth Sands Woodland

WSW is listed as an EEC under the TSC Act. WSW occurs predominantly in the north and west of the study area in a relatively large band with scattered occurrences to the west and to the north (**Figure 4.2**).

WSW is a woodland to open forest that occurs on old dune formations, sand sheets, or swales between the dunes and all of these form part of the Warkworth Land System described in Story et al (1963). In the latter two landscape elements – sand sheets and swales - fewer species such as *Banksia integrifolia* occur but more mesic species such as *Melaleuca thymifolia* occur.

WSW is the name given to at least two and probably several recognisable vegetation assemblages, including:

- Rough-barked Apple (*Angophora floribunda*) and Coastal Banksia (*Banksia integrifolia*) dominated woodland on deeper sands (**Photograph 4.1**);
- Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*) dominated woodland (sometimes open forest) on shallower sand in swales (**Photograph 4.2**); and
- Other assemblages, such as *Callitris endlicheri* dominated woodland on higher, drier portions of the sand system.

Hundreds of native plant species have been recorded across the assemblages. The quality of this community varies considerably and can be considered to vary from high to low depending upon species composition, structural formation and the level of recent disturbance.

Dominant canopy species in the higher quality areas of this community include Rough-barked Apple (*Angophora floribunda*) and the small tree Coastal Banksia (*Banksia integrifolia*). Other small trees recorded in the canopy of this community include Bullock (*Allocasuarina luehmannii*), Black She-Oak (*Allocasuarina littoralis*), Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*), Black Cypress Pine (*Callitris endlicheri*) and White Cypress Pine (*Callitris glaucophylla*).

Common understorey species include Coffee Bush (*Breynia oblongifolia*), *Hibbertia linearis*, Slender Rice Flower (*Pimelea linifolia*), Silver-stemmed Wattle (*Acacia parvipinnula*) and Dogwood (*Jacksonia scoparia*). The groundcover is characterised by Bracken (*Pteridium esculentum*). Common grasses in this community are Three-awn Speargrass (*Aristida vagans*), Weeping Meadow Grass (*Microlaena stipoides*), Purple Wiregrass (*Aristida ramosa*), Brown's Lovegrass (*Eragrostis brownii*), Blady Grass (*Imperata cylindrica*) and Hairy Panic (*Panicum effusum*). Other common groundcovers include Rock Fern (*Cheilanthes sieberi*), Berry Saltbush (*Einadia hastata*), Pomax (*Pomax umbellata*) and Variable Glycine (*Glycine tabacina*).



**Photograph 4.1 WSW with Rough-barked Apple canopy**



**Photograph 4.2 WSW with Forest Red Gum / Blakely's Red Gum hybrid canopy**

#### 4.1.2 Central Hunter Grey Box – Ironbark Woodland

Central Hunter Grey Box-Ironbark Woodland is listed as an EEC under the TSC Act. This woodland community is the most common vegetation community within the disturbance boundary (**Figure 4.1**).

This community forms a large continuous tract of on the western side of Wallaby Scrub Road with a more fragmented distribution on the eastern side of Wallaby Scrub Road. The main structural features of this community are shown in **Photograph 4.3**. Much of this community had been cleared prior to the 1960s and as a result the majority of this vegetation community exists as regrowth (**Photograph 4.4**). To the south of the Site this community is fragmented, however genetic exchange between patches of this community is still likely to occur.

The dominant canopy species within this community are Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). There are also local abundances of Bulloak (*Allocasuarina luehmannii*) and White Feather Honeymyrtle (*Melaleuca decora*) in the midstorey.

Common understorey species include Fan Wattle (*Acacia amblygona*), *Acacia falcata*, Native Blackthorn (*Bursaria spinosa*) and Coffee Bush (*Breynia oblongifolia*). Common groundcover species include Purple Burr-Daisy (*Calotis cuneifolia*), Blue Trumpet (*Brunoniella australis*), Kidney Weed (*Dichondra repens*), Blue Flax Lily (*Dianella revoluta*), Threawn Speargrass (*Aristida vagans*), Wattle Matt-rush (*Lomandra filiformis*), Common Fringe-sedge (*Fimbristylis dichotoma*) and Rock Fern (*Cheilanthes sieberi*).



**Photograph 4.3 Central Hunter Grey Box – Ironbark Woodland with grassy understorey**



**Photograph 4.4 Central Hunter Grey Box – Ironbark Woodland with regrowth Narrow-leaved Ironbark**

#### **4.1.3 Regenerating Central Hunter Grey Box – Ironbark Woodland**

This community has been recently mapped in 2014 based on interrogation of recent aerial photographs. These aeriels showed that some areas that had been mapped as Derived Native Grassland from what was originally Central Hunter Grey Box – Ironbark Woodland show significant regeneration of canopy tree species. The regeneration has occurred to such an extent that they can no longer be described as grassland, and have therefore been described separately as Regenerating Central Hunter Grey Box – Ironbark Woodland. Although the derived native grassland of this woodland does not meet the criteria for the EEC under the TSC Act, it is considered that the regenerating areas do conform to the EEC listing of Central Hunter Grey Box – Ironbark Woodland.

The species composition of these areas is very similar to that described for the Derived Native Grassland form of Central Hunter Grey Box – Ironbark Woodland, except the characteristic species of Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) are present in juvenile form, as well as other species such as Bulloak (*Allocuarina luehmannii*) and White Feather Honey myrtle (*Melaleuca decora*).

#### **4.1.4 Central Hunter Ironbark – Spotted Gum – Grey Box Forest**

Central Hunter Ironbark Spotted Gum Grey Box Forest is listed as an EEC under the TSC Act. The extent of this community in the Site consists of one larger patch in the south eastern corner of Site and several smaller isolated patches along the eastern side of Wallaby Scrub Road (**Figure 4.1**). The smaller patches generally occur as small stands of forest

surrounded by grassland. The main structural features of this community are shown in **Photograph 4.5** and **Photograph 4.4**.

Dominant canopy species in this community include Narrow-leaved Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia maculata*) and Grey Box (*Eucalyptus moluccana*). Bulloak (*Allocasuarina luehmannii*) is a common midstorey species.

The common understorey species in this community are Fan Wattle (*Acacia amblygona*) and Gorse Bitter Pea (*Daviesia ulicifolia*). Common groundcover species include; Blue Trumpet (*Brunoniella australis*), Common Everlasting (*Chrysocephalum apiculatum*), Wattle Matt-rush (*Lomandra filiformis*), Many-flowered Mat-rush (*Lomandra multiflora*), Blue Flax-lily (*Dianella longifolia*), Three-awn Speargrass (*Aristida vagans*), Rock Fern (*Cheilanthes sieberi*) and Variable Glycine (*Glycine tabacina*).



**Photograph 4.5 Regrowth Central Hunter Ironbark – Spotted Gum – Grey Box Forest**



**Photograph 4.6 Central Hunter Ironbark – Spotted Gum – Grey Box Forest**

#### **4.1.5 Warkworth Sands Grassland**

This vegetation community consists of grasslands that have been derived from the clearing of previously occurring Warkworth Sands Woodland. WSG occurs on the aeolian sands that WSW grows upon and has been identified to enable an understanding of the areas of grassland suitable for the reestablishment of WSW community. This vegetation community is not listed under State or Commonwealth legislation despite being derived from the WSW EEC.

This community occurs as scattered patches in proximity to woodland remnants (**Figure 4.1**). The vegetation community is present as a result of previous land clearance and, as a consequence, canopy trees are sparsely scattered throughout this community. These comprise those found in Warkworth Sands Woodland.

This vegetation community lacks a shrub layer, with rare scattered occurrences of Black Wattle (*Acacia mearnsii*). The groundcover is generally dominated by grasses, particularly Couch (*Cynodon dactylon*) and the exotic African Lovegrass (*Eragrostis curvula*), with the native herb Common Everlasting (*Chrysocephalum apiculatum*) also dominant in places. Other native herbs and grasses also occur including Barbed Wire Grass (*Cymbopogon refractus*), Weeping Meadow Grass (*Microlaena stipoides*) and Slender Rat's Tail Grass (*Sporobolus creber*). This community is shown in **Photograph 4.7**.



**Photograph 4.7 Warkworth Sands Grassland**

#### **4.1.6 Central Hunter Grey Box - Ironbark Derived Grassland**

This vegetation community has been created by the clearing of the previously occurring Central Hunter Grey Box – Ironbark Woodland. Although Central Hunter Grey Box-Ironbark Woodland is listed as an EEC under the TSC Act, this grassland vegetation community is not listed under State or Commonwealth legislation.

A substantial proportion of the study area is comprised of this community (**Figure 4.1**). The vegetation community is present as a result of previous land clearance and, as a consequence, canopy trees are sparsely scattered throughout this community, mostly those found in the original woodland community, such as Grey Box (*Eucalyptus moluccana*), and Narrow-leaved Ironbark (*Eucalyptus crebra*).

This vegetation zone lacks an understorey. The groundcover is generally dominated by native grass species, however some herbs also occur. There is a low to moderate incursion of weed species within this vegetation community, particularly along areas that have been disturbed. Weed incursion is high where exotic species have been sown for soil stability control measures. This community is shown in **Photograph 4.8**.



**Photograph 4.8 Central Hunter Grey Box - Ironbark Derived Grassland**

## **4.2 Groundwater Dependent Ecosystems**

This section discusses the potential for Groundwater Dependent Ecosystems (GDE) to occur within the study area. Initially, the definition of what constitutes a GDE is discussed, followed by a discussion of potential GDEs within the study area.

### ***4.2.1 Definition of a Groundwater Dependent Ecosystem***

GDEs are defined as those that rely in some part for their survival on groundwater. Dependence ranges from complete reliance for some systems to others that rely partially on groundwater, particularly during times of drought. The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DECCW, 2009). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans, 1998).

Four main types of GDEs have been identified (Hatton and Evans, 1998), as described below:

- terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;
- wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;
- river baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and
- aquifer and cave ecosystems – the biology of karst or limestone caves, particularly micro-organisms and invertebrates, are heavily dependent on groundwater availability.

The only potential GDE type within the Site is “terrestrial vegetation”, as no permanently flowing rivers with a baseflow rate maintained by groundwater occur, no limestone or karst environments occur, and there are no wetlands that are seasonally waterlogged.

Knowledge of GDEs and their sustainability is relatively low and little is known about their location or condition (Eamus and Froend, 2006). For most wetlands and terrestrial ecosystems, it is unknown what the critical depth to the water tables is, and the characteristic dynamics (Hatton and Evans, 1998).

#### **4.2.2 National Atlas of Groundwater Dependent Ecosystems**

The National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) is a GIS based set of information that presents the current knowledge of GDE across Australia. It displays ecological and hydrogeological information on known GDE and ecosystems that potentially use groundwater. The GDE Atlas shows ecosystems including springs, wetlands, rivers and vegetation that interact with:

- subsurface presence of groundwater, or
- surface expression of groundwater.

The GDE Atlas shows the general location of GDEs and provides information to support the recognition and identification of GDEs. It indicates where ecosystems potentially interact with groundwater, and some of the characteristics of those ecosystems that may be useful in determining water requirements. Each polygon represents an area within which groundwater interaction potentially occurs; however, this does not mean that the whole polygon is interacting with groundwater. Similarly, it does not imply that an entire mapped ecosystem is using groundwater, but rather within the mapped ecosystem groundwater interaction may be occurring, since only part of the ecosystem may actually be interacting with groundwater.

### **4.2.3 Potential Groundwater Dependent Ecosystems in and Near the Study Area**

#### *i. Vegetation along Waterways*

Two vegetation communities recorded from the study area, Hunter Valley River Oak Forest and River Red Gum Floodplain Woodland, occur along the ephemeral Wollombi Brook to the west of the Site (see **Figure 4.2**). Hunter Valley River Oak Forest occurs directly adjacent to the creek, while River Red Gum Floodplain Woodland occurs further away, on the floodplain. Both of these communities are dependent on relatively high levels of water, which is why they occur adjacent to waterways and on the floodplains of waterways that are periodically inundated. It is likely that they are dependent to some extent on water in Wollombi Brook and are likely to be extracting groundwater from the shallow alluvial aquifer. Although this is an ephemeral stream, there is a groundwater component to its base flow, and these communities are potential GDEs.

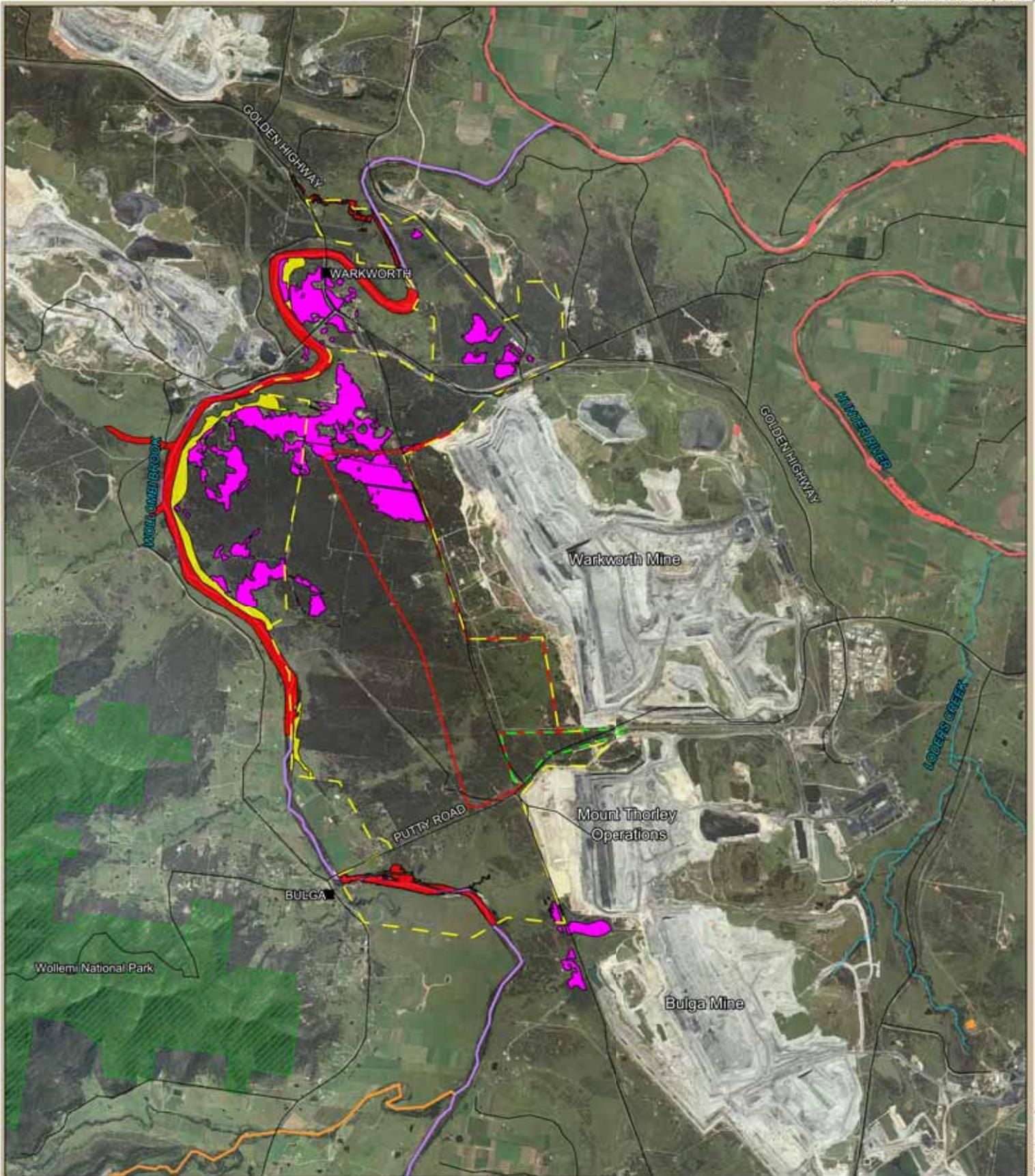
#### *ii. Warkworth Sands Woodland*

An ephemeral perched aquifer is present in the aeolian Warkworth sands that overlie the coal measures to the north-east of Warkworth Mine. The Warkworth sands are recharged from rainfall derived recharge through the sandy soils; and due to their ability to store water, the sands support the WSW ecological community. WSW that occurs on these sands, particularly in swales between dunes may be dependent on this ephemeral perched water table and is therefore considered to be a potential GDE.

The fine-grained sands are up to approximately 3 m thick and overlie a low permeability base of residual clay associated with the underlying strata (AGE, 2014). The presence of this impermeable clay layer is thought to impede downward percolation of recharge forming a locally perched aquifer system at the base of the sand mass. The permanence of groundwater with the formation is unknown but the water table would be expected to fluctuate with climatic patterns or rainfall and also from evapotranspiration. The thick relatively low permeability Permian overburden is thought to impede leakage of groundwater from the Warkworth sands towards the Warkworth Mine area. This community is being assessed as a GDE due to the potential for groundwater drawdown as a result of the Proposal to affect this community.

#### *iii. GDEs Identified by the National Atlas of Groundwater Dependent Ecosystems*

The GDE Atlas has identified several areas in the study area as containing potential GDEs (see **Figure 4.2**). These include Wollombi Brook that is considered by the GDE Atlas to be a GDE “*identified during previous study; fieldwork*”, and the Hunter River, which is considered to have “*high potential for groundwater interaction*”, and some nearby sections mapped as having “*moderate potential for groundwater interaction*”. No GDEs identified by the GDE Atlas occur within the Site.



- Legend**
- Disturbance Boundary
  - Study Area
  - Area already approved to be mined by MTO under DA 34/95
  - National Park
  - Road
  - Waterway
  - Town

- GDE Atlas - Surface Expression**
- High potential for GW interaction
  - Moderate potential for GW interaction
  - Identified in previous study: fieldwork
- Groundwater Dependent Ecosystems**
- Hunter Valley River Oak Forest
  - River Red Gum Floodplain Woodland
  - Warkworth Sands Woodland (EEC)

Image Source: RTCA 2013



Figure 4.2. Potential GDEs in the Disturbance Boundary and Surrounds



### 4.3 Landscape Features

Habitat assessment, supported by evidence from historical aerial photography (**Figure 4.3**), indicates that the study area has undergone large-scale clearing in the past for agriculture. Much of the open forest and woodland vegetation that now occurs within the study area is regrowth, although some scattered trees were historically retained. Some of the remaining mature trees and stags provide small to medium sized hollows suitable as shelter habitat for small arboreal mammals.

The primary fauna habitats located within the study area are:

- open forest communities (Central Hunter Ironbark – Spotted Gum – Grey Box Forest);
- woodland communities (WSW, Central Hunter Grey Box – Ironbark Woodland);
- derived native grassland; and
- permanent and ephemeral water bodies such as dams and creeks.

The forest and woodland communities within the study area consist of a small number of remnant old-growth trees surrounded by regenerating vegetation and provide suitable habitat for a range of fauna types including: amphibians, reptiles, birds, bats and arboreal and terrestrial mammals. Key habitat features recorded during the current study includes:

- ephemeral riparian environments suitable for fauna species dependant on these habitats (e.g. amphibians);
- ground cover, leaf litter, fallen timber and rocky outcrops suitable as shelter for small terrestrial fauna species;
- tree hollows suitable as shelter and breeding habitat for a range of hollow-dependant fauna;
- blossom-producing trees suitable as foraging habitat for a range of nectarivores; and
- primary and secondary Koala feed tree species.

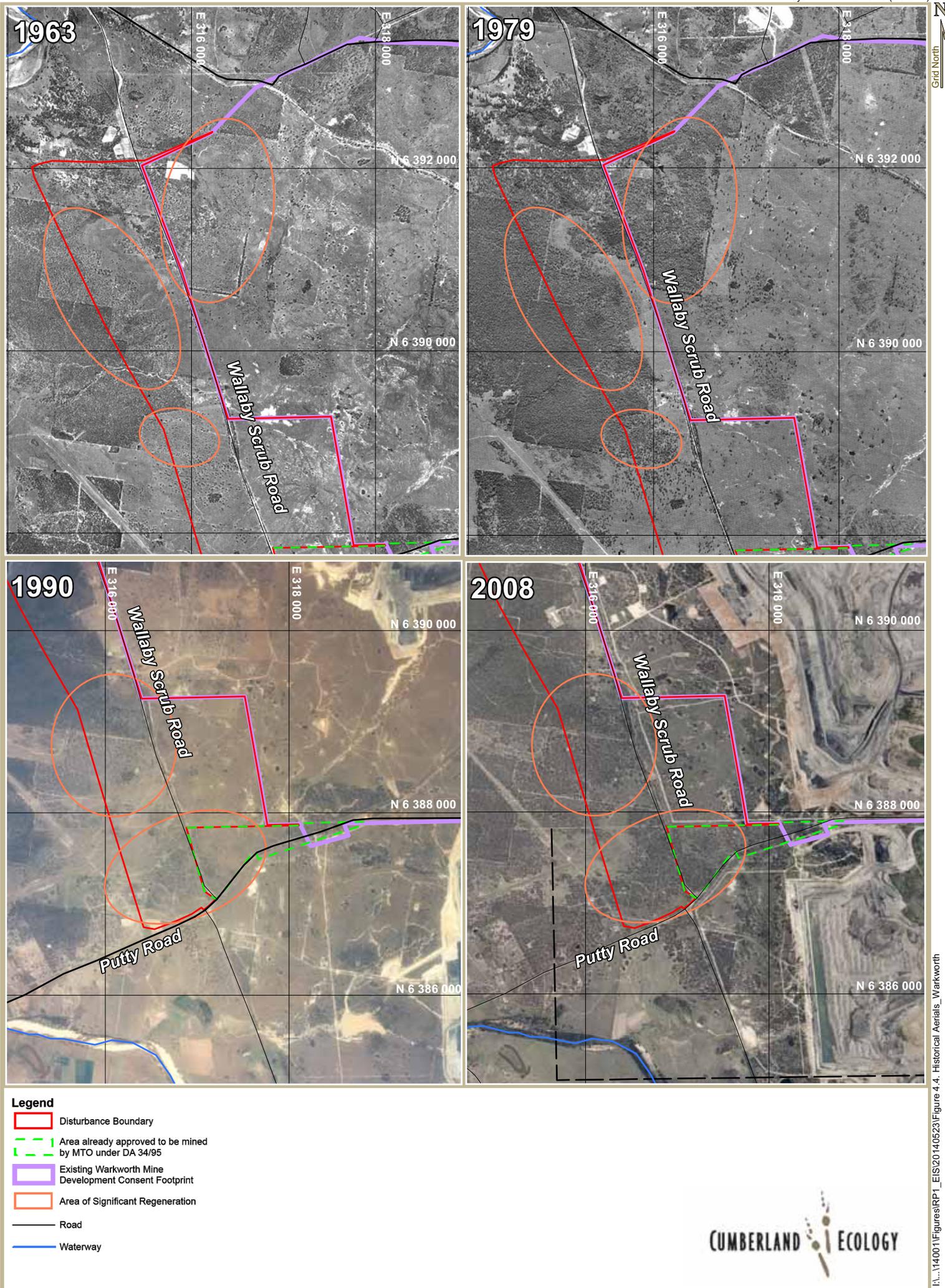
No naturally occurring wetlands or permanent streams occur within the study area. However, some ephemeral streams and farm dams occur. Some of these dams provide permanent water sources and support aquatic or riparian vegetation and are therefore likely to provide suitable habitat for some wetland-dependant species such as wetland birds and amphibians. The water in the dams provides a drinking source for terrestrial and arboreal mammals, birds and reptiles. The network of intermittent drainage lines would create temporary pools following heavy rain and provide suitable foraging and breeding habitat for some amphibian species. Features such as bush rock, fallen logs, leaf litter and ground vegetation, which provide shelter for many of the small to medium sized terrestrial fauna

species known from the wider locality, were generally limited to areas not previously cleared while cleared areas and regrowth lacked such habitat features. The habitat features described above can be found to some degree in most of the woodland communities within the study area. Generally, the types of terrestrial native species using the study area are likely to be restricted to those that are common and well-adapted to disturbed woodland and agricultural areas.

The mature living trees and stags that remain in forest and woodland communities within the study area provide a number of small to medium-sized tree hollows for fauna species dependant on this resource as shelter and breeding habitat. However, large hollows in tall trees that provide breeding and shelter habitat, particularly for large forest owls and large gliders, are relatively scarce throughout the study area. The scarcity of these larger hollows can be attributed to the regenerating nature of the vegetation following past agricultural uses throughout the area. Habitat assessment data indicates that the vegetation community Hunter Lowlands Red Gum Forest supports the largest number of tree hollows within the study area. This indicates that this vegetation community supports a greater amount of old growth trees than other communities and is most likely due to the reduced level of clearing that would have occurred along water courses during past agricultural land use in comparison with other communities present on suitable grazing land.

All open forest and woodland vegetation communities within the study area would provide suitable foraging habitat for a wide range of nectarivorous birds during blossom periods. Spotted Gum (*Corymbia maculata*) was at the end of blossoming, while ironbark species (*Eucalyptus crebra*) were commencing blossoming during the survey period. It is likely that a number of nectar-dependant bird species would be attracted to the study area during the blossoming periods of dominant trees.

No caves or rocky overhangs are present in the study area, and therefore no roosting or breeding habitat is present for cave-dependant microbats.



**Figure 4.3. Historical Aerial Photographs of the Vegetation in the Disturbance Boundary**

500 0 500 1000 1500 2000m

### **4.3.1 Fauna Corridors**

Fauna corridors are areas of habitat that allow the movement of fauna over small and large scales. At a local scale, small fauna corridors facilitate the migration of fauna through the landscape by providing shelter and foraging habitat required by groups or individuals to successfully move between areas of more extensive habitat. They also enable movement between breeding and non-breeding areas and provide access to seasonally available food.

On a regional scale, fauna corridors provide linkages between large areas of core habitat for species with a distribution greater than the locality, thus enabling genetic flows between core habitats and ensuring long-term survival of breeding populations. They also provide linkages of foraging habitat for migrating or highly nomadic species that undertake large-scale movements, or may form connective habitat for species with very large home ranges incorporating a matrix of foraging, shelter and breeding habitat at a regional scale.

### **4.3.2 Local Corridor Values of the Study Area**

The study area provides wildlife corridor values for a range of faunal groups at both a local and regional scale. Locally, forest, woodland and grassland communities within the study area provide suitable shelter and foraging habitat for small mobile species such as woodland birds that forage throughout the area in groups of mixed species during non-breeding periods. Further, regenerating vegetation within the study area provides suitable habitat for dispersing individuals of species such as the Squirrel Glider from more intact adjacent vegetation communities.

### **4.3.3 Regional Corridor Values of the Study Area**

The vegetation communities of the study area provide regional corridor values for migratory and nomadic species, particularly birds. Scarce records of both the Regent Honeyeater and the Swift Parrot indicate that the study area occasionally supports seasonal foraging habitat for both species as they move through the region. Other species, such as summer migratory birds have been recorded during surveys indicating that the study area provides seasonal foraging and potential breeding habitat for some of these species.

The regenerating vegetation communities within the study area also facilitate genetic flows in the region by providing suitable foraging and breeding habitat for species such as the Hooded Robin. Spotted-tail Quolls that have been recorded in surrounding lands would ultimately move into suitable habitat within the study area as vegetation communities mature. Dispersing Squirrel Gliders from adjacent areas may already have begun this process in the southern portions of the study area. The long-term establishment of breeding territories of newly established species would result in a flow-on effect as juveniles disperse into adjacent areas.

## 4.4 Species and Populations

### 4.4.1 Flora Species

Approximately 400 flora species have been recorded in the study area; with over 75% of the species being native. A total flora species list from these surveys is provided in **Appendix B**.

One threatened flora species, *Ancistrachne maidenii*, listed as Vulnerable under the TSC Act has been recorded from the study area. Andrews Neil (2006) recorded this species within the Central Hunter Grey Box – Ironbark Woodland approximately 500 m to the west of the disturbance boundary (**Figure 4.4**).

One species recorded in the study area, Lobed Blue Grass (*Bothriochloa biloba*), was previously listed as Vulnerable under both the EPBC Act and the TSC Act, however it has been removed from both listings due to numerous recent records (NSW Scientific Committee, 2004c).

The Atlas of NSW Wildlife records indicate that five individuals of Slaty Red Gum (*Eucalyptus glaucina*), listed as Vulnerable under both the TSC and EPBC Acts, have been identified adjacent to the western boundary of the study area (OEH, 2014a). Despite these records the species has never been confirmed in the numerous flora surveys that have been conducted within the study area since the initial recording in 1998. It is possible that such specimens were in fact misidentifications of Forest Red Gum / Blakely's Red Gum hybrids due to their somewhat similar features.

A number of threatened flora species listed under the TSC Act and EPBC Act are known to occur within the locality (OEH, 2014a). An assessment of the likelihood of occurrence of these species in the study area has been conducted and is presented in **Appendix E**. This assessment indicates that some species have potential to occur in the study area due to the presence of suitable habitat. Many flora surveys have been undertaken in the study area over many years, and these species have not been recorded. Accordingly, despite the presence of potential habitat, they are considered unlikely to occur.

#### *i. Regionally Significant Species*

The following six regionally significant flora species have been recorded within the study area (Andrews Neil, 2006) (Debus, 2008b) (ERM, 1995) (ERM, 2002b) (Flora Search, 2004) (Gross, 2007) (Kumar *et al.*, 2009):

- Variable Smoke-bush (*Conospermum taxifolium*);
- *Grevillea montana*;
- Woolly Mat-rush (*Lomandra leucocephala subsp. leucocephala*);
- *Macrozamia flexuosa*;
- Bulga Wattle (*Acacia bulgaensis*); and

➤ Hairy Clerodendrum (*Clerodendrum tomentosum*).

Three of these species: *Grevillea montana*, *Macrozamia flexuosa* and Bulga Wattle are listed as Rare or Threatened Australian Plants (ROTAP). None of these species is listed as threatened under the TSC Act or the EPBC Act.

*Grevillea montana* is listed as a 2KC- ROTAP species. This species is restricted to the southern rim of the Hunter Valley from Denman to Kurri Kurri (Bell, 2004). Within the study area this species has been recorded within Central Hunter Grey Box – Ironbark Woodland and WSW as well as in scattered occurrences across the study area. It is particularly concentrated in the WSW community.

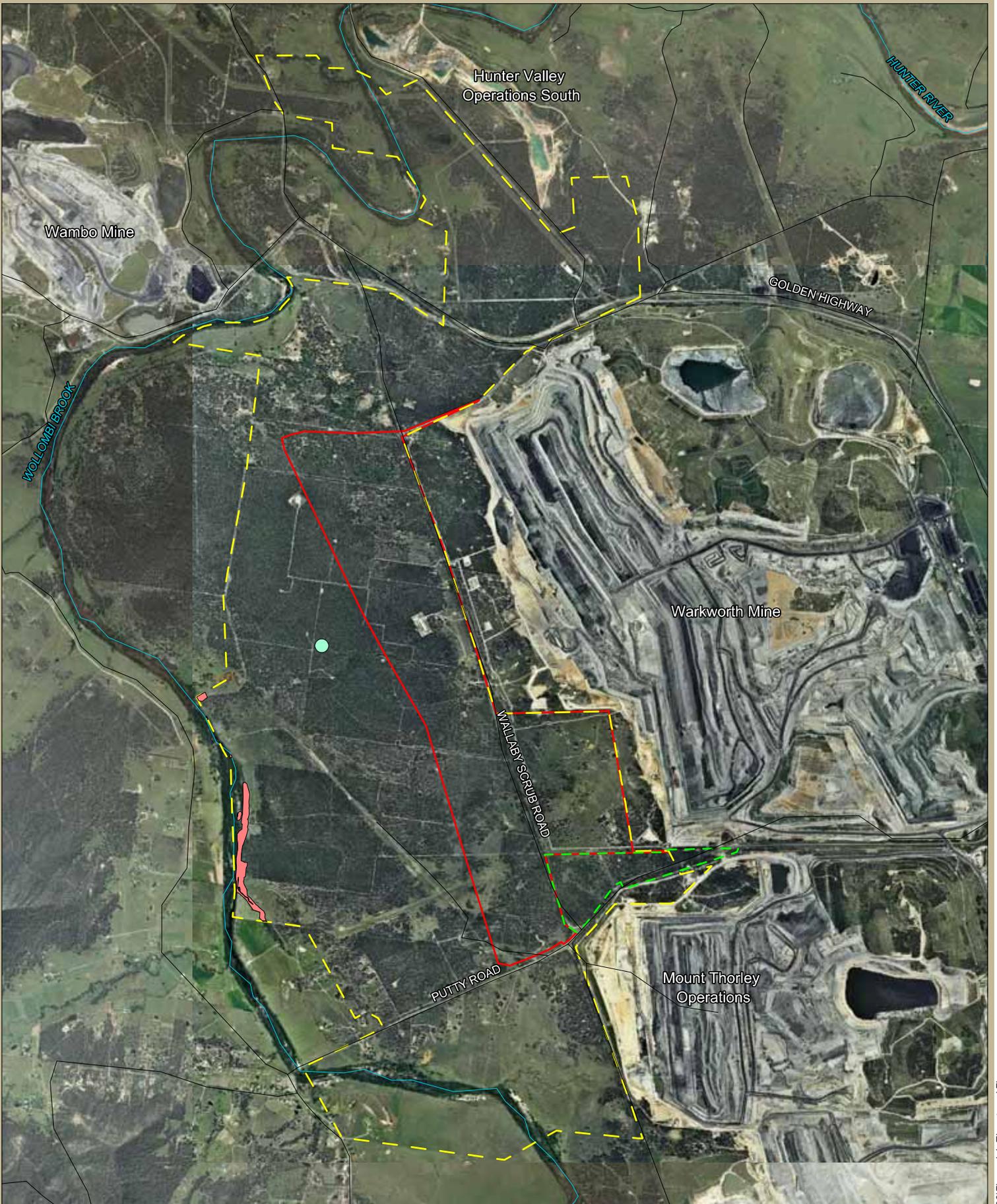
*Macrozamia flexuosa* is listed as a 2K ROTAP species. *Macrozamia flexuosa* occurs in sclerophyll woodland in siliceous soils and shallow clay loams (Whitelock, 2002). This species occurs on the northern and central coasts of NSW from Bulahdelah, through the Newcastle District to Lake Macquarie (Whitelock, 2002; Botanic Gardens Trust, 2013). Two individuals of *Macrozamia flexuosa* have been recorded from the study area within Central Hunter Grey Box – Ironbark Woodland.

Bulga Wattle (*Acacia bulgaensis*) is listed as a 2RC ROTAP species. This species is common in the Hunter Valley in the area of Bulga, Milbrodale and Broke where it grows within eucalypt forests on sandstone and shale grows in heath and dry sclerophyll woodland (Orchard and Wilson, 2001). One known population of this species occurs within the study area in the land to the west of the Site and the east of Wollombi Brook.

Woolly Mat-rush is not listed under the TSC Act, EPBC Act or as a ROTAP species. This species grows in dry sclerophyll forest on rocky slopes and sandy soils and occurs chiefly on the Western Slopes of the Great Dividing range in NSW and also in Queensland (Botanic Gardens Trust, 2013). This species has previously been recorded in the Hunter Valley, east of the Great Dividing Range and is potentially considered to be the eastern limit of distribution for the species (Peake, 2006).

Variable Smoke-bush is not listed under the TSC Act, EPBC Act or as a ROTAP species. This species grows in heath and dry sclerophyll woodland, typically in dry heath on deep sand dunes; on the coast and adjacent ranges, with isolated occurrences on the Slopes (Botanic Gardens Trust, 2013). Variable Smoke-bush has been recorded in the study area within outside of the proposed disturbance boundary.

Hairy Clerodendrum (*Clerodendrum tomentosum*) is not listed under the TSC Act, EPBC Act or as a ROTAP species. It is typically found on the margin of moist gullies and rainforest margins (Robinson, 1991) and occurs at the western limit of its distribution in the Hunter Valley (Peake, 2006). The potential indirect impact of the Proposal on one individual of this species is not considered to be significant on a local or regional scale. Two known occurrences of this species are present within the study area; both of which occur outside the disturbance boundary.



**Legend**

- Disturbance Boundary
- Study Area
- Area already approved to be mined by MTO under DA 34/95

**Threatened Flora**

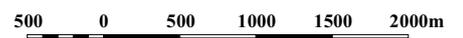
- *Ancistrachne maidenii* (Andrews & Niel 2006)
- River Red Gum population in the Hunter Valley

N.B. Records of Slaty Gum in the Study Area were OEH Atlas records and due to licencing restrictions, records cannot be shown at this scale.

Image Source: RTCA 2012 & 2013



**Figure 4.4. Threatened Flora Species Records**



#### 4.4.2 Fauna Species

##### i. Amphibians

A total of 13 amphibian species have been recorded during all surveys conducted within the study area. No threatened amphibian species were recorded during current or previous surveys.

Although not recorded from the study area, habitat assessments indicate that potential habitat for one threatened amphibian species occurs within the study area; the Green and Golden Bell Frog (*Litoria aurea*). The Green and Golden Bell Frog is listed as Vulnerable under the EPBC Act and Endangered under the TSC Act. This species was not recorded within the study area despite considerable targeted effort during current and previous surveys (Andrews Neil, 2006) (ERM, 1995) (ERM, 2002a). However, habitat assessment indicates that some of the dams within the study area may provide suitable habitat for this species. The Green and Golden Bell Frog requires water bodies with fringing vegetation to provide shelter and cover, and limited overhanging vegetation. That notwithstanding, numerous targeted surveys for the Green and Golden Bell Frog within the study area across many years have failed to record this species and it is not considered to occur.

##### ii. Reptiles

A total of 18 species of reptile have been recorded from the study area by Cumberland Ecology and by others during previous surveys (ERM, 1995). None of the reptile species recorded is listed as threatened under the TSC or EPBC Acts.

It is likely that a number of additional common species are also likely to occur as the study area provides suitable woodland habitat for reptiles known to occur in the wider locality.

##### iii. Birds

A total of 146 bird species have been recorded from within the study area by Cumberland Ecology and others. A list of all the bird species recorded from the study area is provided in **Appendix C**. Of these, 14 recorded from the study area are birds listed under the TSC Act and/or the EPBC Act, and include the following:

- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable under the TSC Act);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) (Vulnerable under the TSC Act);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) (Vulnerable under the TSC Act);
- Speckled Warbler (*Chthonicola sagittata*) (Vulnerable under the TSC Act);
- Hooded Robin (*Melanodryas cucullata*) (Vulnerable under the TSC Act);
- Diamond Firetail (*Stagonopleura guttata*) (Vulnerable under the TSC Act);

- Varied Sittella (*Daphoenositta chrysoptera*) (Vulnerable under the TSC Act);
- Scarlet Robin (*Petroica boodang*) (Vulnerable under the TSC Act);
- Glossy Black-cockatoo (*Calyptorhynchus lathamii*) (Vulnerable under the TSC Act);
- Spotted Harrier (*Circus assimilis*) (Vulnerable under the TSC Act);
- Little Eagle (*Hieraaetus morphnoides*) (Vulnerable under the TSC Act);
- Regent Honeyeater (*Anthochaera phrygia*) (Endangered under the EPBC Act and Critically Endangered under the TSC Act);
- Swift Parrot (*Lathamus discolor*) (Endangered under the EPBC Act and TSC Act); and
- Black-breasted Buzzard (*Hamirostra melanosternon*) (Vulnerable under the TSC Act).

An assessment of the likelihood of occurrence of threatened species recorded from the locality has been conducted and is presented in **Appendix E**. This assessment indicates that although not recorded from the study area, the following species recorded from the locality have potential to occur in the study area due to the presence of potential habitat:

- Masked Owl (*Tyto novaehollandiae*) (Vulnerable under the TSC Act);
- Powerful Owl (*Ninox strenua*) (Vulnerable under the TSC Act);
- Barking Owl (*Ninox connivens*) (Vulnerable under the TSC Act);
- Square-tailed Kite (*Lophoictinia isura*) (Vulnerable under the TSC Act);
- Black-chinned Honeyeater (*Melithreptus gularis*) (Vulnerable under the TSC Act);
- Painted Honeyeater (*Grantiella picta*) (Vulnerable under the TSC Act);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) (Vulnerable under the TSC Act);
- Black Bittern (*Ixobrychus flavicollis*) (Vulnerable under the TSC Act); and
- Turquoise Parrot (Vulnerable under the TSC Act).

The locations of all threatened birds recorded from the study area are shown in **Figure 4.5**. A detailed discussion of the threatened birds recorded from the study area or considered to have potential to occur is presented in **Appendix D**.

#### iv. *Mammals*

A total of 45 mammal species have been recorded from the study area, comprising mostly common and widespread species. Despite the presence of relatively good habitat for

terrestrial mammals, the results of the current surveys indicate that the study area is dominated by exotic pest species. Only two native small terrestrial mammal species were recorded during the current surveys and these were a single Common Dunnart (*Sminthopsis murina*) and two Bush Rats (*Rattus fuscipes*).

All remaining small terrestrial mammals sighted and trapped during the current surveys were exotic, and exotic fauna species are prevalent throughout the study area. The Black Rat (*Rattus rattus*) and the House Mouse (*Mus musculus*) were commonly trapped at various sites within the study area. European Brown Hares (*Lepus capensis*) and European Rabbits (*Oryctolagus cuniculus*) were sighted at various locations across the study area. Tracks, scats and images from infrared cameras indicate that the European Red Fox (*Vulpes vulpes*), Dog/Dingo (*Canis familiaris*) and Cat (*Felis catus*) are all present within the study area.

Results from previous surveys (Andrews Neil, 2006) (ERM, 1995) (ERM, 2002a) indicate a similar pattern of limited numbers of native small terrestrial mammals and an abundance of exotic species similar to that observed during the current surveys. The low abundance of small terrestrial native mammals is likely to be a result of the historical land use within the study area; which was maintained as predominantly cleared grazing land until the early 1990s. The vegetation within the study area is largely regrowth and much of it is still highly fragmented. The absence of connecting habitat is likely to have prevented the migration of many of these species back into the study area following the previous agricultural land use.

Records of native terrestrial fauna within the study area are dominated by larger species, including macropods, Short-beaked Echidna (*Tachyglossus aculeatus*), and Common Wombat (*Vombatus ursinus*). These species are generally more resilient to disturbance and are able to traverse larger areas of cleared land to migrate back into regenerating communities such as those within the study area.

Three arboreal mammals have been recorded within the study area; the Common Brushtail Possum (*Trichosurus vulpecula*), Sugar Glider (*Petaurus breviceps*) (ERM, 1995) and the Squirrel Glider (*Petaurus norfolcensis*), which is listed as Vulnerable under the TSC Act.

The Common Brushtail Possum and the Sugar Glider are both highly adaptable and resilient species that are frequently observed in disturbed forest and woodland communities such as those found within the study area. Small, hard to detect species such as the Feathertail Glider (*Acrobates pygmaeus*), may also occur in the open forest and woodland communities within the study area.

Seven threatened mammal species have been recorded from within the study area:

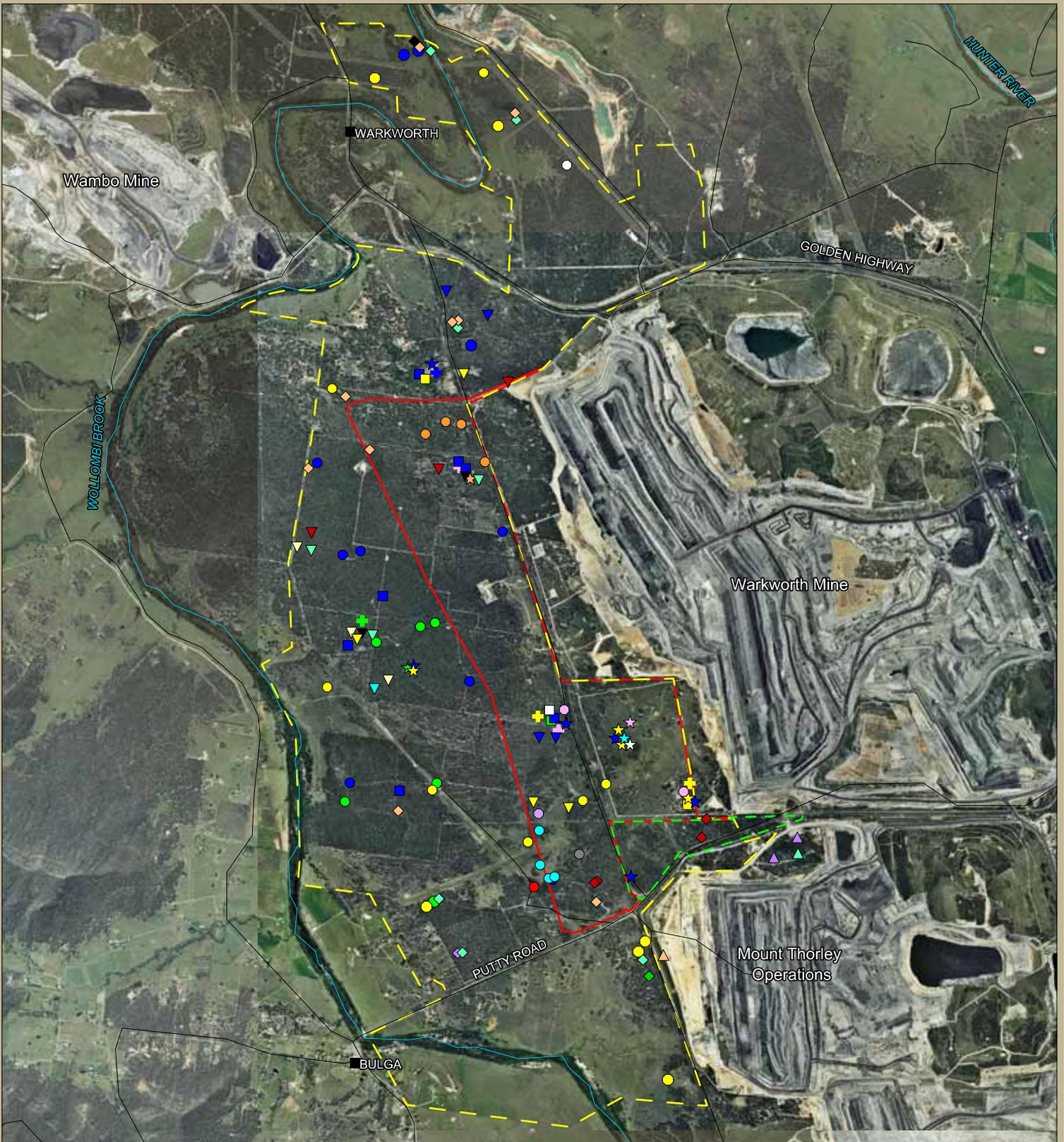
- Squirrel Glider (*Petaurus norfolcensis*) (Vulnerable under the TSC Act); and,
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act).
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable under both the EPBC Act and the TSC Act);

- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act);
- Little Bentwing-bat (*Miniopterus australis*) (Vulnerable under the TSC Act);
- Southern Myotis (*Myotis macropus*) (Vulnerable under the TSC Act); and
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (Vulnerable under the EPBC and TSC Acts).

An assessment of the likelihood of occurrence of threatened species recorded from the locality has been conducted and is presented in **Appendix E**. This assessment indicates that although not recorded from the study area, the following mammals recorded from the locality have potential to occur in the study area due to the presence of potential habitat:

- Spotted-tail Quoll (*Dasyurus maculatus*) (Endangered under the EPBC Act and Vulnerable under the TSC Act);
- Koala (*Phascolarctos cinereus*) (Vulnerable under the TSC Act and Vulnerable (NSW population) under the EPBC Act);
- Eastern Pygmy-possum (*Cercartetus nanus*) (Vulnerable under the TSC Act); and
- Brush-tailed Phascogale (*Phascogale tapoatafa*) (Vulnerable under the TSC Act).

The locations of all threatened mammals recorded from the study area are shown in **Figure 4.5**. A detailed discussion of the threatened mammals recorded from the study area or considered to have potential to occur is presented in **Appendix D**.



**Legend**

- Disturbance Boundary
- Study Area
- Area already approved to be mined by MTO under DA 34/95
- Road
- Waterway
- Town

**Threatened Fauna**

- Cumberland Ecology (2009)**
- Grey-crowned Babbler
  - Spotted Harrier
  - Little Lorikeet
  - Hooded Robin
  - Brown Treecreeper
  - Speckled Warbler
  - Scarlet Robin
  - Varied Sittella
  - Little Eagle
  - Glossy Black-cockatoo
  - Squirrel Glider
  - Eastern Bentwing-bat
  - Eastern Freetail-bat
  - Southern Myotis
  - Large-eared Pied Bat
  - Grey-headed Flying-fox

**Debus (2009)**

- ★ Speckled Warbler
- ★ Grey-crowned Babbler
- ★ Hooded Robin
- ★ Diamond Firetail
- ★ Little Lorikeet
- ★ Glossy Black-cockatoo
- ★ Brown Treecreeper

**Debus (2008)**

- Brown Treecreeper
- Speckled Warbler
- Grey-crowned Babbler
- Diamond Firetail

**Andrews&Neil (2006)**

- + Grey-crowned Babbler
- + Brown Treecreeper
- + Speckled Warbler
- + Little Lorikeet
- + Black-breasted Buzzard

**ERM (2002)**

- ▼ Speckled Warbler
- ▼ Squirrel Glider
- ▼ Hooded Robin
- ▼ Eastern Freetail-bat
- ▼ Little Bentwing-bat
- ▼ Southern Myotis
- ▼ Grey-crowned Babbler

**ERM (1995)**

- ▲ Large-eared Pied Bat
- ▲ Eastern Bentwing-bat
- ▲ Eastern Freetail-bat

Image Source: RTCA 2013



Figure 4.5. Threatened Fauna Species Records

500 0 500 1000 1500 2000m

## Impact Assessment

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This section considers potential impacts of the Proposal by firstly identifying measures taken to avoid and minimise the impacts. Then consideration is given to the potential impacts of the Proposal on vegetation communities and flora and fauna species. Consideration is also given to the impacts of the 2003 Warkworth Extension to guide offsetting requirements. The impacts of the Proposal can be divided into direct and indirect impacts. Direct impacts are caused as a primary result of the mine development, such as clearing of vegetation, while indirect impacts are a result of secondary processes such as potential weed proliferation and feral fauna species invasion.

### 5.1 Avoidance and Mitigation Measures

To the extent possible, the Proposal has been designed to avoid or minimise ecological impacts. Where certain impacts are unavoidable through design changes, mitigation measures have been introduced to ameliorate the ecological impacts of the Proposal. A suite of substantial measures has been prepared to manage these impacts in accordance with Rio Tinto's Biodiversity Strategy (Rio Tinto, 2004). This strategy commits Rio Tinto to achieving a net positive impact on biodiversity wherever it does business, and the impact mitigation measures developed for the Proposal accords with this commitment.

Details of the offset measures proposed to compensate for the residual impacts of the Proposal are discussed separately in **Chapter 7**.

#### 5.1.1 Avoidance Measures

Open cut mining projects cannot readily avoid impacts where mineral resources are beneath flora and fauna habitats. However, avoidance has been achieved by modification of the design and location of mine associated infrastructure away from natural habitats, where feasible.

Avoidance of listed species and communities was carefully considered during the planning process. The mine design considered a series of mine plan options that may have delivered substantially more coal from areas adjacent to the current mine plan. The existing mine plan delivers resource recovery while maintaining production and employment that is viable.

Avoidance of impacts has also been achieved through the proposed closure of Wallaby Scrub Road rather than its relocation. This measure has resulted in the reduction of the level of clearing associated with the project by approximately 30 ha. These avoidance

measures have reduced the impacts on the WSW EEC and avoided any impacts on the State and Commonwealth listed White Box Woodland EEC and other important vegetation communities such as TSC Act listed Central Hunter Grey Box – Ironbark Woodland EEC.

### 5.1.2 Mitigation Measures

#### i. Existing Management Strategies and Procedures

Biodiversity at Warkworth Mine is managed in accordance with a number of plans, strategies and procedures. Together, these provide a rigorous management regime and ensure Warkworth Mine is aligned with Rio Tinto’s biodiversity commitments. Strategies, plans and procedures currently implemented at the mine relevant to biodiversity comprise:

- Coal and Allied Environmental Management Strategy (2008);
- Coal and Allied Land Use Management Plan (2008);
- Coal and Allied Bushfire Management Plan (2005);
- Coal and Allied Erosion and Sediment Control Plan (2003);
- Rio Tinto’s Biodiversity Strategy (2008);
- EMS Procedure 5.1 Disturbance and Rehabilitation;
- EMS Procedure 10.2 Flora and Fauna; and
- EMS Procedure 10.3 Ground Disturbance Permit.

#### ii. Existing Mitigation Measures

The management strategies discussed above contain measures to limit impacts on native flora and fauna. The strategies include the measures summarised in **Table 2.1** below. The existing management strategies will be reviewed and updated and will be implemented in the Proposal.

**Table 5.1 Existing Warkworth Mitigation Measures Relevant to Flora and Fauna**

Existing Mitigation Measures	Ecological Benefits
Dust minimisation	Control of dust reduces the indirect impacts on vegetation condition and the habitat quality for all native species at Warkworth Mine.
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 mining leases 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

**Table 5.1 Existing Warkworth Mitigation Measures Relevant to Flora and Fauna**

Existing Mitigation Measures	Ecological Benefits
Rehabilitation of disturbed areas	animals that are key threats to many wildlife species. Rehabilitation of disturbed areas progressively 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	Increases the viability of the scattered patches of habitat that occur across the mining leases, connecting them and facilitating movement of native species between patches.
Creation of habitat corridors linking isolated remnant vegetation stands	Increases the viability of the scattered patches of habitat that occur mining leases, connecting them and facilitating movement of native species between patches.
Management of surface water, erosion and sedimentation	Protects the integrity of the landscape.
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 Warkworth mining leases	Provides data for ongoing adaptive management of threatened and regionally significant flora and fauna.

*iii. Minimising Vegetation Clearance and Habitat Loss*

Disturbance to areas of native vegetation and habitat will be unavoidable during the mine development process. However, in order to minimise clearing impacts and avoid unnecessary disturbance outside of the disturbance boundary, the limits of clearing will be clearly identified on plans and on the ground (using durable markers and/or signage).

Native vegetation beyond the identified clearing areas will not be disturbed. Ancillary facilities such as stockpile sites, site compounds and construction zones will not be located

beyond the limits of clearing and maintained within pre-existing disturbance boundaries as far as practically possible. During the detailed design stage, opportunities to further minimise vegetation disturbance will be considered.

*iv. Pre-clearance Surveys*

Pre-clearance surveys of forest and woodland areas to be removed will be conducted to identify any threatened flora and fauna species or habitat within areas of impact. These will provide an opportunity to avoid impacts to flora and fauna of conservation significance during clearing. Where clearing of vegetation and fauna habitats takes place, clearing protocols will be put in place, including checking trees for the presence of arboreal fauna prior to felling. Animals found to be occupying trees will be safely removed before the clearing of trees and relocated into nearby forest that will not be disturbed.

Where feasible, transportable habitat features such as large logs and boulders will be placed in adjacent retained areas or in areas ready for seeding, to allow their continuation as potential fauna refuge sites.

*v. Management Plans*

A Mining Operations Plan (MOP) and a Local Offset Management Plan (LOP) will be prepared for the Proposal. These plans will outline the management techniques and monitoring that will be undertaken within the Site, and SBA and NBA as well as outline the objectives, performance criteria for each area.

These plans will ensure that the project's conservation objectives are met and that impacts to biodiversity are adequately managed for the life of the project. The MOP and LOP will incorporate all of the impact mitigation measures as described in this chapter that are proposed to be undertaken for the project, and provide detailed specifications for their implementation. This will include, but not be limited to the following:

- pre-clearance surveys;
- translocation of habitat features;
- seed collection and propagation;
- weed and feral animal control measures;
- erosion and sedimentation control measures; and
- specifications for re-planting native trees where appropriate.

In order to ensure the management strategies are achieving the desired objectives, the MOP and LOP will prescribe monitoring to be undertaken of all vegetation enhancement and re-establishment works. Results of the monitoring will be assessed against performance criteria and key performance indicators to determine if the management objectives are being met. In the case vegetation enhancement and re-establishment key performance indicators

would be determined through comparison with pre-determined and permanent analogue sites. The main objectives of the monitoring are to:

- to evaluate the implementation of the MOP and LOP;
- to identify non-conformance;
- to identify any additional measures or improvement to measures currently being implemented;
- to evaluate the success of prescribed management measures and determine the need for additional management measures; and
- to monitor the improvement of habitat within the Site and Biodiversity Areas over the life of the mine.

## 5.2 Impacts on Native Vegetation and Threatened Ecological Communities

The primary impact from the Proposal will be the additional clearing of vegetation within the disturbance boundary. Approximately 611 ha of forest, woodland and grassland will be progressively cleared for the Proposal over the 21 year project life. It should be noted that roads and infrastructure account for approximately 20 ha within the disturbance boundary. In addition, approximately 63 ha of land approved to be mined by MTO under DA 34/95 and 4 ha of land inclusive of Putty Road and some land immediately to its south are included within the development application area and not included within disturbance boundary calculations.

Six native vegetation communities occur within the proposed disturbance boundary (see **Figure 5.1**). Disturbance areas for each of these communities are shown in **Table 5.2**. Of these, three are listed as EECs under the TSC Act:

- WSW;
- Central Hunter Grey Box – Ironbark Woodland; and
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

**Table 5.2 Vegetation Communities in the Disturbance Boundary**

Vegetation Community	TSC Act Listing	Area (ha)
<b>Forest and Woodland</b>		
Warkworth Sands Woodland	EEC	72.0
Central Hunter Grey Box – Ironbark Woodland	EEC	365.5
Regenerating Central Hunter Grey Box – Ironbark Woodland	EEC	6.5

**Table 5.2 Vegetation Communities in the Disturbance Boundary**

<b>Vegetation Community</b>	<b>TSC Act Listing</b>	<b>Area (ha)</b>
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	EEC	15.0
<i>Subtotal Forest and Woodland</i>		459.0
<b>Grassland</b>		
Warkworth Sands Grassland		0.5
Central Hunter Grey Box – Ironbark Derived Grassland		151.5
<i>Subtotal Grassland</i>		152.0
<b>Non-vegetated Areas (eg existing roads)</b>		20.0
<b>TOTAL</b>		<b>631.0</b>

*Note: all areas are rounded to the nearest 0.5 ha.*



**Legend**

- Disturbance Boundary
- Area already approved to be mined by MTO under DA 34/95
- Existing Warkworth Mine Development Consent Footprint

**Vegetation Community**

- Warkworth Sands Woodland (EEC)
- Warkworth Sands Grassland
- Central Hunter Grey Box - Ironbark Woodland (EEC)
- Regenerating Central Hunter Grey Box - Ironbark Woodland (EEC)
- Central Hunter Grey Box - Ironbark Derived Grassland
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC)

Image Source: RTCA 2013



**Figure 5.1. Vegetation Communities to be Impacted in the Disturbance Boundary**



### 5.2.1 Warkworth Sands Woodland

#### i. Local and Regional Significance

WSW is a woodland to open forest community that is confined to aeolian sand deposits in the vicinity of Warkworth, south-east of Singleton in the mid Hunter Valley (NSW Scientific Committee, 2011). This community occurs on old dune formations, sand sheets, or swales between the dunes and all of these form part of the Warkworth Land System described in Story et al (1963). In the latter two landscape elements – sand sheets and swales – fewer species such as *Banksia integrifolia* occur but more mesic species such as *Melaleuca thymifolia* occur. WSW comprises at least two and probably several recognisable vegetation assemblages, including:

- Rough-barked Apple (*Angophora floribunda*) and Coastal Banksia (*Banksia integrifolia*) dominated woodland on deeper sands;
- Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*) dominated woodland (sometimes open forest) on shallower sand in swales; and
- other assemblages, such as *Callitris endlicheri* dominated woodland on higher, drier portions of the sand system.

Hundreds of native plant species have been recorded across these assemblages.

It has been estimated that the WSW community had a pre-European distribution of approximately 3,000 ha (NSWLEC 2013), however estimates of the current distribution of WSW have varied since the community was gazetted under the TSC Act, with extant areas ranging from 800 ha (NSW Scientific Committee, 2002); 1,133.4 ha (Peake, 2006); 464.8 ha (Umwelt (Australia), 2011); and 400 ha (Bell, 2012).

For the purposes of this report, Cumberland Ecology uses the estimate of extant WSW from the L&E court judgement of 465 ha, with an additional 275 ha of what has been termed WSG. WSG refers to grassland with a native species component occurring on aeolian sand derived from the clearing of the original WSW canopy and midstorey from previous land use. This form of the community does not conform to the TSC Act listing for the EEC. However, if appropriately managed (through activities such as the removal of grazing stock, weed and feral animal control and assisted regeneration), there is a high probability that WSG can be successfully re-established to WSW. The extent of WSW is shown in **Figure 5.2**. Fragments of the community are scattered throughout the Warkworth area with a large portion of this community located to the west of Warkworth Mine, owned by Wambo Mine, south and south west of the study area. None of the fragments outside of the study area occur within conservation reserves and are therefore not protected in the long-term.

WSW forms a relatively large band in the north-west corner of the Site (see **Figure 5.3**). As such, the vegetation within the study area is likely to be an important source of genetic material for the community and facilitates genetic exchange between itself and smaller individual fragments of WSW. The quality of this community varies considerably and can be considered to vary from high to low depending upon species composition, structural

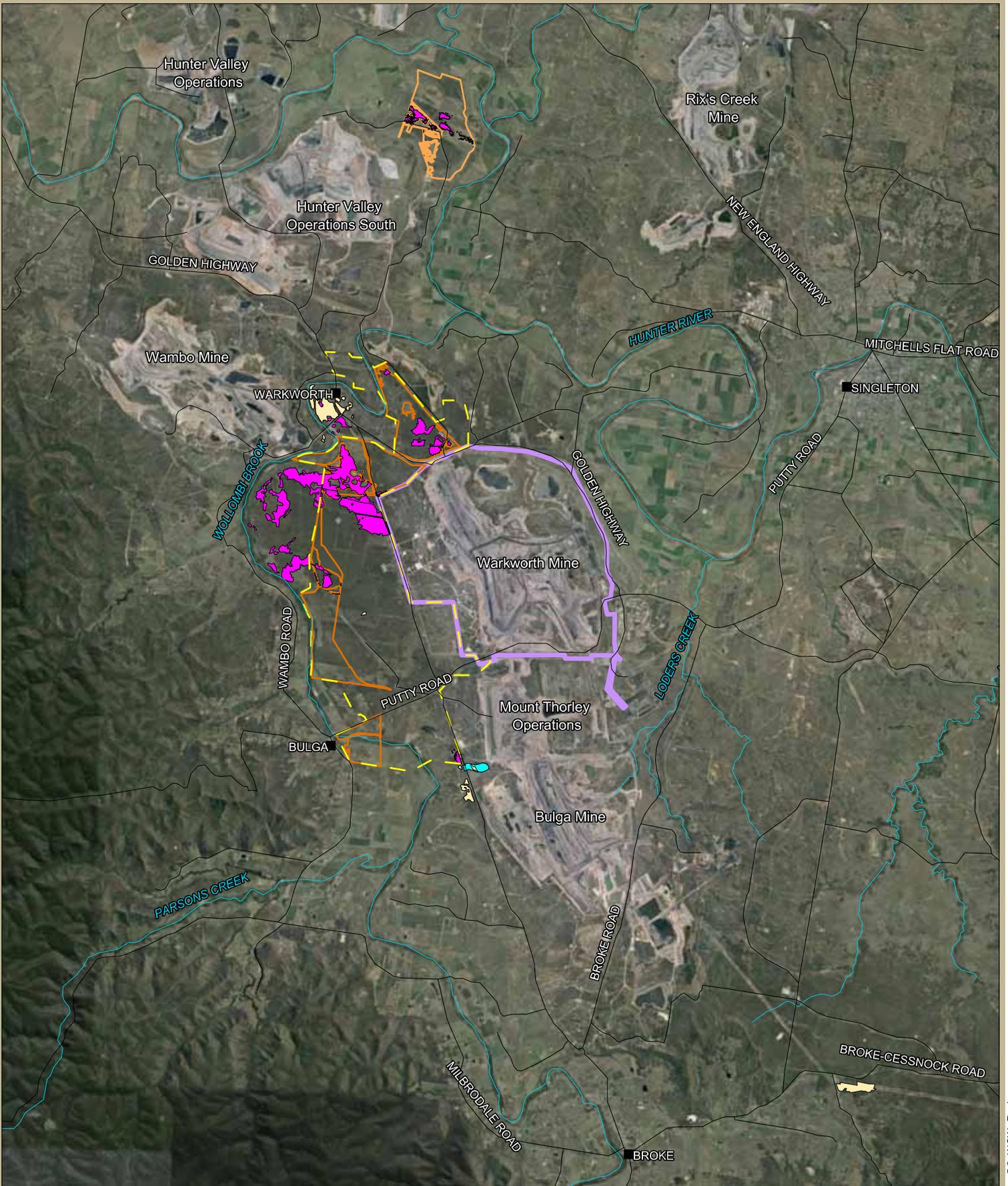
formation and the level of recent disturbance. No WSW is in pristine condition and all woodland that currently exists is regrowth that has regenerated from earlier episodes of clearing. Old aerial photographs of the Site show that the vegetation has regrown substantially since the 1960s. That notwithstanding, the majority of WSW is considered to be in moderate to good condition.

*ii. Impacts*

Approximately 72 ha of WSW EEC is proposed to be progressively cleared for the Proposal, consisting of high and medium quality vegetation. This is approximately 15.5% of the estimated extent of the community. As WSW is considered to comprise a GDE, potential impacts to these retained areas of this community could occur as a result of groundwater drawdown, or lateral movement of groundwater. The potential impacts of the Project on GDEs, including WSW are discussed in more detail in **Section 5.2.4**. Other potential impacts on this community include indirect impacts to retained areas such as edge effects, weed invasion, altered micro-climate and soil erosion. These are considered in more detail in **Section 5.5**.

A range of mitigation and compensation measures will be implemented, including conservation of large areas of this community as well as re-establishing considerably larger areas of this community within the NBA. Further details of the proposed mitigation and compensation measures are detailed in **Section 7.2**.

An assessment of significance (seven-part test) under Section 5A of the EP&A Act was completed to determine the significance of impacts to WSW. The assessment noted that the Proposal will remove approximately 72 ha of WSW and that in the absence of any mitigation or compensation measures, this would represent a significant impact to this community. However, a range of mitigation measures and offset measures will be implemented for this community, including the protection of large areas of this community in the SBA and NBA, and re-establishment of areas of WSW on Warkworth Sands Grassland. Considering the impact mitigation and compensation measures proposed, no significant impact is predicted to occur in the long term to WSW.



**Legend**

- Existing Warkworth Mine Development Consent Footprint
- Study Area
- Southern Biodiversity Area
- Northern Biodiversity Area
- Warkworth Sands Woodland
- Warkworth Sands Woodland (Peake, 2006)
- Warkworth Sands Woodland (KMH Environmental 2011)
- Road
- Waterway
- Town

Image Source:  
 Image © 2014 DigitalGlobe  
 Image © 2014 Sinclair Knight Merz

Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



**Figure 5.2. Warkworth Sands Woodland in the Region**

1000 0 1000 2000 3000 4000m

## 5.2.2 Central Hunter Grey Box – Ironbark Woodland

### i. Local and Regional Significance

Central Hunter Grey Box – Ironbark Woodland generally occurs on Permian sediments in the Hunter Valley and has been recorded from the Cessnock, Singleton and Muswellbrook LGAs (NSW Scientific Committee, 2010a). The total mapped area of the community is approximately 46,920 ha which has been estimated to be 32% of the pre-European distribution (NSW Scientific Committee, 2010a). The community is considered as highly fragmented as more than 1,000 small remnants are less than 10 ha in size (NSW Scientific Committee, 2010a). In total, approximately 19,140 ha of Central Hunter Grey Box – Ironbark Woodland occurs within the Central Hunter Valley (Peake, 2006) with only approximately 250ha occurring within National Parks.

Central Hunter Grey Box – Ironbark Woodland covers a large proportion of the study area. Nearby fragments of this community are located immediately adjacent to the study area with a number of larger patches and smaller fragments scattered throughout the locality, predominantly to the north and north-west of the study area.

### ii. Impacts

Approximately 372 ha of Central Hunter Grey Box – Ironbark Woodland is proposed to be progressively cleared under the Proposal. This predominately consists of regrowth vegetation with scattered remnant old growth trees. Clearing would occur over the 21 years of mine life. The clearing of 372 ha of Central Hunter Grey Box – Ironbark Woodland within the Site represents a loss of approximately 1.9% of the community within the Central Hunter region and 0.8% of the known distribution of the community.

The retained areas of Central Hunter Grey Box – Ironbark Woodland may also be indirectly impacted by the Proposal. Clearing of Central Hunter Grey Box – Ironbark Woodland within the Site will increase edge effects on retained vegetation. The retained vegetation may be impacted by weed invasion, altered micro-climate and soil erosion or other indirect effects (see **Section 5.5**).

The clearing of 372 ha of this community will result in a sizeable reduction in the extant area of this community. The mitigation and compensation measures proposed to ameliorate these impacts are discussed in **Section 7.3**.

An assessment of significance (seven-part test) under Section 5A of the EP&A Act was completed to determine the significance of impacts to Central Hunter Grey Box – Ironbark Woodland. The assessment noted that the Proposal will remove approximately 372 ha of Central Hunter Grey Box – Ironbark Woodland. In the absence of any mitigation or compensation measures, this would represent a significant impact to this community. However, a range of mitigation measures and offset measures will be implemented for this community, including the protection of large areas of this community in the SBA and NBA, and re-establishment of areas of this community. Considering the impact mitigation and compensation measures proposed, no significant impact is predicted to occur in the long term to Central Hunter Grey Box – Ironbark Woodland.

### **5.2.3 Central Hunter Ironbark – Spotted Gum – Grey Box Forest**

#### *i. Local and Regional Significance*

Central Hunter Ironbark – Spotted Gum – Grey Box Forest generally occurs on Permian sediments in the Hunter Valley and has been recorded from the Cessnock, Singleton and Muswellbrook LGAs (NSW Scientific Committee, 2010b). The total mapped area of the community is approximately 18,300 ha which has been estimated to be 29% of the pre-European distribution (NSW Scientific Committee, 2010b). The community is considered to be highly fragmented as more than 1,000 small remnants are less than 10 ha in size (NSW Scientific Committee, 2010b).

The Central Hunter Ironbark – Spotted Gum – Grey Box Forest within the Site consists of one larger patch in the south eastern corner and several smaller isolated patches along the eastern side of Wallaby Scrub Road.

The nearest significant fragment of this community, and the largest continuous fragment within the Hunter Valley, is located south east of the study area within the Singleton Military Training Area. A band of fragments of this community extend from the Singleton Military Training Area to the north east of the study area and further on to the north west of the study area. Approximately 280 ha of this community is currently known to occur within National Parks and is therefore protected in the long-term.

#### *ii. Impacts*

Approximately 15 ha Central Hunter Ironbark – Spotted Gum – Grey Box Forest occurs in the disturbance boundary. The area to be progressively cleared occurs in some scattered isolated patches within the south east portion of the proposed disturbance boundary.

Within the study area only a very small portion of the remaining fragments of this community are present outside the Site, adjacent to Putty Road. The retained areas of Central Hunter Ironbark – Spotted Gum – Grey Box Forest may be indirectly impacted by the Proposal through an increase in edge effects on retained vegetation. The retained vegetation may be impacted by weed invasion, altered micro-climate and soil erosion or other indirect effects (see **Section 5.5**).

The Proposal would involve the clearing of less than 0.08% of the remaining extent of this community. Given the current distribution throughout the Hunter Valley the removal of 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest is not considered to have a significant impact on this community at a regional scale.

### **5.2.4 Impacts on Groundwater Dependent Ecosystems**

Three potential GDEs have been identified in the study area, namely the Hunter Valley River Oak Forest and River Red Gum Floodplain Woodland that occur along Wollombi Brook to the west of the study area, and WSW. Hunter Valley River Oak Forest and River Red Gum Floodplain Woodland will not be cleared by the Proposal. The Hunter River is located outside of the study area, and is also considered to have high potential to support GDEs.

The water table formed at the base of the Warkworth Sands is perched and is not in direct hydraulic connection with the underlying Permian fractured rock (AGE, 2014). Therefore the proposed extension is not expected to impact on the Warkworth Sands ephemeral aquifer or the associated vegetation community.

The Hunter Valley River Oak Forest and River Red Gum Floodplain Woodland in the study area are located on the eastern bank of Wollombi Brook about 2.5 km from the proposed mine extension and within the alluvial aquifer. These vegetation communities are likely to be extracting groundwater from the shallow alluvial aquifer, which will not be impacted by mine dewatering in this location (AGE, 2014).

Groundwater models do not predict a significant change in baseflow to the Wollombi Brook or the Hunter River (AGE, 2014) and therefore any associated or aquatic and riparian ecosystems will not be impacted by the proposed extension.

### 5.3 Impacts on Landscape Features and Habitat

The open forest, woodland and derived grassland communities of the study area provide habitat for a range of fauna, including some species that are listed as threatened or migratory under the EPBC Act and/or the TSC Act. Within these vegetation communities, a range of habitat features provide foraging, shelter and breeding opportunities for fauna. The quality of habitat is dependent upon location and past land use. Regrowth areas generally lack many habitat features; however, areas of good quality habitat were identified at several locations.

Approximately 459 ha of forest and woodland and 152 ha of grassland will be removed as a result of the Proposal. Important fauna habitat features found within these habitat types include the following:

- dense understorey vegetation – shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- fallen logs, debris and leaf litter – shelter habitat for amphibians, reptiles and terrestrial mammals;
- rocky outcrops – shelter and breeding habitat for amphibians, reptiles and terrestrial mammals;
- hollow-bearing living trees and stags – providing shelter and breeding habitat for a range of reptiles, birds, arboreal mammals and microbats;
- nectar-producing trees and shrubs – foraging habitat for insects, blossom-dependant birds, arboreal mammals and megachiropteran bats (flying-foxes);
- feed trees, shrubs and grasses for a range of species – food for small birds, cockatoos and herbivorous mammals;
- ecotonal (edge) communities – foraging habitat for many species, particularly birds;

- ephemeral drainage lines – foraging, shelter and breeding habitat for amphibians, aquatic reptiles, wetland birds and aquatic mammals; and
- constructed farm dams with aquatic vegetation – foraging and breeding habitat for amphibians, aquatic reptiles and wetland birds.

The open cut mining process results in a number of actions numerous actions listed as Key Threatening Processes by OEH, for example:

- clearing of native vegetation (NSW Scientific Committee, 2004e) (NSW Scientific Committee, 2004e);
- loss of hollow-bearing trees (NSW Scientific Committee, 2006);
- removal of dead wood and dead trees (NSW Scientific Committee, 2004g);
- bushrock removal (NSW Scientific Committee, 2004d); and
- alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (NSW Scientific Committee, 2004a).

A range of mitigation and compensation measures will be implemented to ameliorate the impacts of habitat removal. These are described in **Chapter 7**.

### **5.3.1 Impacts on Fauna Corridors**

Under the Proposal, 459 ha of forest and woodland habitat will be progressively removed that currently forms part of a fauna corridor within the region. The landscape is already highly fragmented, and the increased fragmentation (see **Section 4.3**) from the Proposal is likely to exacerbate the existing impacts on this corridor. That notwithstanding, the vegetation within the study area is already disturbed and there are low number of records for threatened species that undertake regional movements.

Primarily, the Site provides “stepping stone” habitat for highly mobile fauna groups, especially birds and bats. Blossom-dependant species such as the Regent Honeyeater and Swift Parrot may utilise the Site as foraging habitat only during periods of abundant blossom production, however the unpredictable nature of the migration movements of these species means the Site would be used during occasional opportunistic periods. These species are discussed further below. Other species, such as the Glossy Black-cockatoo are likely to utilise foraging habitat within the Site periodically as they move throughout the wider locality.

At a local scale, the Proposal will result in the gradual removal of dispersal habitat, foraging habitat and “stepping stone” corridor values for a range of fauna groups, particularly woodland birds and small mammals. These corridors will be progressively replaced by rehabilitation and at the completion of the Proposal north-south and east west vegetation corridors will be maintained.

*i. North-south Movements of the Swift Parrot*

Depending on the migratory pattern taken in any one year, the Swift Parrot undertakes a north-south migration through the region between breeding grounds in Tasmania and winter foraging habitat at any location in eastern Australia. North-south movement between patches of suitable foraging habitat is critical to the survival of this species during the non-breeding period. The species does not rely on the vegetation in the Site for these movements but rather may pass through in selected winter seasons. Other species may utilise the north-south connectivity of habitat along Wollombi Brook, which connects “lobes” of adjacent vegetation such as that provided by the Site.

*ii. East-west Movements of the Regent Honeyeater*

The core breeding population of Regent Honeyeaters in the region is found to the west of Wollemi National Park in the Capertee Valley. Nomadic or seasonal movement of the species may occur through the Site between breeding habitat and coastal or sub-coastal foraging habitat. Analysis of the spatial distribution of recent records (DECC (NSW), 2009) of this species indicates that areas to the south of the study area (such as Cessnock) are likely to be of greater importance in this migratory pattern. Other species with large populations in core habitat such as Wollemi National Park may disperse to the east utilising small patches of habitat including the Site.

## 5.4 Impacts on Threatened Species and Populations

### 5.4.1 Impacts to Flora Species

Eleven threatened flora species are considered to have the potential to occur within the disturbance boundary (**Appendix E**). However, given these have not been identified by the extensive previous survey efforts, the majority of these species are not considered likely to occur. Although not recorded in the disturbance boundary, one flora species listed under the TSC Act has been recorded within the study area. For precautionary reasons, an impact assessment has been conducted and is presented below. A number of regionally significant flora species recorded in the study area have also been assessed.

*i. Ancistrachne maidenii*

*Ancistrachne maidenii* is listed as Vulnerable under the TSC Act. Known occurrences of this species are restricted to northern Sydney, around Berowra Waters, Brooklyn and Wisemans Ferry. There are seven known populations of this species and four of these are conserved within reserves. Surveys have indicated that populations occur in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes (NSW Scientific Committee, 2004b). The occurrence of this species within the study area is surprising as this occurrence is outside of its current known range and the record within the study area is a disjunct occurrence of this species. Therefore this population is considered significant in the longer term survival of the species within the region.

The occurrence of this species within the study area is approximately 0.5 km west of the boundary of the Site and will not be removed as part of the Proposal. No individuals will be directly removed, and due to the distance between the known record of this species and the disturbance boundary, indirect impacts are unlikely.

Some potential habitat for this species will be removed, however no critical habitat for this species has been listed and the potential habitat to be removed is not considered to be critical to the survival of this species. No significant impact is predicted to occur to *Ancistrachne maidenii* as a result of the Proposal (see **Appendix F**).

ii. *Impacts to Regionally Significant Flora Species*

Six regionally significant species have been recorded from the study area; three of which are listed as ROTAP species (*Grevillea montana*, *Macrozamia flexuosa* and Bulga Wattle). Although these species are not listed as threatened species under the TSC Act or the EPBC Act, for precautionary reasons an impact assessment has been completed for each of these regionally significant species and is presented below.

a. Variable Smoke-bush (*Conospermum taxifolium*)

Variable Smoke-bush has been recorded within the WSW towards the northern end of the study area, outside the disturbance boundary. No known occurrences of this species will be cleared under the Proposal; however some potential habitat will be removed.

The areas of known habitat are not considered to be indirectly impacted by the Proposal. Removal of vegetation within the Site is likely to only increase edge effects on the vegetation directly adjacent to the mine. This species is not considered likely to be impacted on a local or regional scale.

b. *Grevillea montana*

*Grevillea montana* has been recorded from the study area with particular concentrations in WSW. Two known occurrences of this species are within the disturbance boundary and some potential habitat for this species will also be removed.

Ten known occurrences of this species have been recorded outside of the disturbance boundary during surveys of the study area, together with large areas of potential habitat. Therefore, disturbance under the Proposal is not considered to adversely impact the species on a local scale.

Sizeable populations (over 1,000 plants) of *Grevillea montana* are known from the northern parts of Wollemi, Yengo and Lower Hunter National Parks, with other semi-conserved populations in the Myambat Logistics Company army base and the Singleton Military Area (Bell, 2001). Accordingly, the loss of small numbers of individuals and areas of known and potential habitat for this species is not considered significant on a regional scale.

c. Woolly Mat-rush (*Lomandra leucocephala* subsp. *leucocephala*)

Woolly Mat-rush has been recorded within WSW in the study area. No known occurrences of this species will be cleared under the Proposal; however, some potential habitat will be removed. Eleven other occurrences of this species have been recorded within the study area that will not be impacted by the Proposal.

The retained areas of known habitat are not considered likely to be indirectly impacted by the proposed project with the closest occurrence of the species 100 m from the disturbance boundary. No significant impact is expected to occur to this species as a result of the extension.

d. *Macrozamia flexuosa*

*Macrozamia flexuosa* has been recorded within Central Hunter Grey Box – Ironbark Woodland. Only two individuals of this species are known to occur within the study area, one of which will be removed. In addition, some areas of potential habitat will be removed.

Large areas of potential habitat for this species will be retained in the study area and although not recorded, it is considered likely that other individuals may occur. The retained areas of known habitat are not considered likely to be indirectly impacted by the Proposal. The removal of a single known individual and potential habitat is not likely to impact on this species on a local or regional scale.

e. Bulga Wattle (*Acacia bulgaensis*)

One known population of Bulga Wattle occurs within the study area to the west of the disturbance boundary and east of Wollombi Brook.

No known occurrences of this species will be removed under the Proposal; however, some areas of potential habitat will be cleared. This population exists outside of the Site and is not expected to be impacted either directly or indirectly as part of the Proposal.

The retained areas of known habitat are not considered likely to be indirectly impacted by the Proposal. The Proposal is unlikely to significantly impact on this species on a local and regional scale.

f. Hairy Clerodendrum (*Clerodendrum tomentosum*)

Two known occurrences of this species are present within the study area; both of which occur outside the disturbance boundary. Potential habitat for this species will be removed under the Proposal however substantial areas of suitable habitat are to be retained within the study area. No significant impact is predicted to occur to this species as a result of the mine extension.

#### **5.4.2 Impacts to Fauna Species**

A total of 18 threatened fauna species including 11 bird and seven mammal species have been recorded within the disturbance boundary. These are further discussed below.

*i. Amphibians and Reptiles*

A total of 13 amphibian species and 18 reptile species have been recorded from within the study area, however no amphibians listed as threatened under the TSC Act or the EPBC Act have been recorded and none are considered likely to occur.

All amphibian and reptile habitats within the Site are also commonly represented in the wider locality, including in nearby protected areas. Accordingly, it is considered unlikely that the Project will result in a significant impact on any threatened amphibian or reptile species.

*ii. Birds*

A total of 146 bird species have been recorded from within the study area during surveys of the study area including a number of birds that are listed as threatened under the TSC Act and/or the EPBC Act.

The Proposal will result in the removal of up to 611 ha of foraging and/or breeding habitat for birds. The impacts on threatened bird species are grouped in subsections below, based on their ecological requirements.

*a. Blossom-dependent birds*

Five blossom-dependent threatened birds have been recorded from Site or have potential to occur in the study area. These are:

- Regent Honeyeater (*Anthochaera phrygia*) (Endangered under the EPBC and Critically Endangered under the TSC Act);
- Swift Parrot (*Lathamus discolor*) (Endangered under the EPBC and TSC Acts);
- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable under the TSC Act);
- Black-chinned Honeyeater (*Melithreptus gularis*) (Vulnerable under the TSC Act); and
- Painted Honeyeater (*Grantiella picta*); (Vulnerable under the TSC Act).

**Regent Honeyeater and Swift Parrot**

The Regent Honeyeater and the Swift Parrot have both been recorded in the study area. The study area provides suitable foraging habitat for both of these species (see **Section 4.3**) and they may utilise this resource during locally prolific blossom periods or when other nectar sources are scarce.

The Swift Parrot is a non-breeding winter migrant to mainland Australia; while the nearest core breeding area for Regent Honeyeaters is in and around the Capertee Valley, to the west of Wollemi National Park. Accordingly, it is unlikely that either species would breed or remain resident within the study area and therefore impacts on both species as a result of the Proposal are likely to be limited to the removal of foraging habitat.

This habitat removal will be staged, resulting in the provision of habitat for these species throughout the life of the project. Additionally, rehabilitation of the mine will follow mineral extraction and will be revegetated with woodland habitat providing further suitable foraging habitat for these species. Extensive areas of forest, woodland and tree habitat for both of the EPBC Act listed species is being regenerated throughout the Hunter Valley. Much of this revegetation is associated with mines throughout the Hunter Valley however it is considered a real possibility that the provision of this area of foraging habitat could potentially benefit blossom foraging species such as the Swift Parrot and Regent Honeyeater.

Both the Regent Honeyeater and the Swift Parrot are more frequently recorded within other localities in the wider area; suggesting that more suitable foraging habitat occurs outside of the study area. It is likely that, although some suitable foraging habitat for both species will be removed under the Proposal, it is not important habitat.

A range of mitigation and compensation measures will be implemented under the Proposal, including the protection of habitat and the rehabilitation of woodland and forest. With the implementation of the proposed mitigation measures, no significant impact is predicted to occur to the Regent Honeyeater or Swift Parrot as a result of the Proposal (see **Appendix F**).

#### **Little Lorikeet**

The Little Lorikeet has been recorded from the study area. As with the Regent Honeyeater and Swift Parrot, it is likely that the Little Lorikeet would forage within the Site opportunistically during locally prolific blossom periods or when other nectar sources are scarce. Unlike the two previously discussed blossom nomads, the Little Lorikeet is likely to occur within the Site at any time of the year, and may breed in the locality if conditions are favourable. The Site therefore provides suitable breeding habitat for the Little Lorikeet in the form of small hollows in living trees in addition to suitable foraging habitat.

The Proposal will result in the removal of suitable foraging and nesting habitat for this species. However, OEH records do not indicate that the wider locality provides substantial habitat for the Little Lorikeet. Far more records of this species occur from State Forest and protected areas to the east and west within the locality, suggesting that these areas provide more abundant foraging and nesting habitat.

Although some impacts to the Little Lorikeet will occur on a local scale with the removal of forest and woodland vegetation under the Proposal, more abundant habitat for this species occurs in other areas. A range of mitigation and compensation measures will be implemented under the Proposal, including the protection of potential habitat and the rehabilitation of woodland and forest. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on the Little Lorikeet (see **Appendix F**).

#### **Black-chinned Honeyeater and Painted Honeyeater**

The Black-chinned Honeyeater and the Painted Honeyeater have not been recorded from the study area; however, they have potential to occur due to the presence of suitable habitat.

All forest and woodland communities found within the Site comprise potential foraging and nesting habitat for the Black-chinned Honeyeater and the Painted Honeyeater.

Although some impacts to the Black-chinned Honeyeater and the Painted Honeyeater will occur on a local scale with the removal of forest and woodland vegetation as a result of the Proposal, more abundant habitat for these species occurs in other areas including Wollemi National Park. A range of mitigation and compensation measures will be implemented for this project, including the protection of habitat and the rehabilitation of woodland and forest. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on the Black-chinned Honeyeater or the Painted Honeyeater (see **Appendix F**).

b. Woodland Birds

Seven woodland bird species listed as Vulnerable under the TSC Act have been recorded from within the Site, including the following:

- Speckled Warbler (*Chthonicola sagittata*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Diamond Firetail (*Stagonopleura guttata*);
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- Varied Sittella (*Daphoenositta chrysoptera*); and
- Scarlet Robin (*Petroica boodang*).

The Grey-crowned Babbler and Speckled Warbler are locally abundant within the Singleton area and have been recorded within all parts of the study area. The Grey-crowned Babbler seems particularly well established and is regularly sighted in semi-urban environments such as rural gardens and hotel car parks.

All of these species are largely dependent on woodland communities although some will also occur in forest communities (e.g. the Varied Sittella and Scarlet Robin) or the ecotonal zone between woodland and derived native grassland (e.g. the Diamond Firetail and Hooded Robin). The Proposal will result in the removal of forest, woodland and adjacent derived native grassland vegetation communities that provide foraging, shelter and breeding habitat for these threatened woodland birds.

A range of mitigation and compensation measures will be implemented under the Proposal, including the protection of known habitat for these species and the rehabilitation of woodland and forest. These measures will ensure the viability of populations of these species in the long term. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on woodland birds (see **Appendix F**).

c. Cockatoos

The Glossy Black-cockatoo is listed as Vulnerable under the TSC Act and was recorded on numerous occasions in the study area. Most records were from within WSW, and feeding signs (distinctively chewed seed cones of *Allocasuarina sp.*) were recorded throughout WSW, indicating that this vegetation community provides significant foraging habitat for a number of individuals.

The Gang-gang Cockatoo was not recorded from the study area, however it has potential to occur in winter when this species migrates to lower lying box-ironbark woodlands to forage. It is unlikely to breed in the study area as it breeds in spring and summer in highland forests, before moving to the lowlands for winter. The majority of the woodland habitats in the study area provide potential habitat for this species.

Approximately 72 ha of WSW will be removed as a result of the Proposal, and a further 387 ha of other woodland and forest types.

Not all of the WSW vegetation to undergo clearing supports suitable feed tree species for the Glossy Black-cockatoo. It is estimated that approximately one third of the area to be cleared (approximately 24ha) would provide suitable feed-tree habitat. It is highly unlikely that any individuals of this species rely on these feed sites for survival. Mitigation of this loss will be carried out through the re-establishment of this community within the locality on appropriate *in-situ* soils, these areas will contain appropriate Black She-oak feed trees.

Large areas of similar vegetation occur in the locality, including within conservation areas such as Wollemi National Park. Furthermore, a range of mitigation and compensation measures will be implemented under the Proposal, including the protection of known habitat for these species and the rehabilitation of woodland and forest. These measures will ensure the viability of populations of these species in the long term. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on the Glossy Black-cockatoo or Gang-gang Cockatoo (see **Appendix F**).

d. Raptors

Three threatened raptor species have been recorded within the study area:

- Black-breasted Buzzard (*Hamirostra melanosternon*) (Vulnerable under the TSC Act);
- Spotted Harrier (*Circus assimilis*) (Vulnerable under the TSC Act); and
- Little Eagle (*Hieraaetus morphnoides*) (Vulnerable under the TSC Act).

The Black-breasted Buzzard was recorded once from within the Site (Andrews Neil, 2006). As this is well outside of the typical range of this species it is possible that this record was either a misidentification or a vagrant forced to move towards the coast during drought conditions inland. This species is unlikely to make extensive use of habitats in the study area, and impacts on the Black-breasted Buzzard resulting from the Proposal are highly unlikely.

The Spotted Harrier and the Little Eagle were recorded several times from the study area and it is likely to form part of the foraging range of some of these species. Raptors are highly mobile and typically have very large home ranges, and therefore they are not likely to rely on the resources present in the study area. Rather, they are likely to utilise resources in the study area periodically as part of a much wider foraging territory. Large areas of similar habitat occur in the locality that will remain. Furthermore, a range of mitigation and compensation measures will be implemented under the Proposal, including the protection of habitat for these species and the rehabilitation of forest and woodland. These measures will ensure the viability of populations of these species in the long term. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on raptors (see **Appendix F**).

e. Large Forest Owls

Although not recorded from the study area, potential foraging habitat for the following Large Forest Owls is present:

- Masked Owl (*Tyto novaehollandiae*) (Vulnerable under the TSC Act);
- Powerful Owl (*Ninox strenua*) (Vulnerable under the TSC Act); and
- Barking Owl (*Ninox connivens*) (Vulnerable under the TSC Act).

All three of these large forest owls are known to have very large foraging ranges, and require tall hollow-bearing trees as nesting habitat (DEC (NSW), 2006). While not considered optimal habitat, the riparian vegetation along Wollombi Brook, may provide limited, roosting and breeding habitat for the Masked and Barking Owls. The Powerful Owl requires very large hollows to breed in, and these are largely absent from the study area.

These large Owl species are highly mobile and typically have very large home ranges and, therefore, are not likely to rely on the resources present in the study area. Rather, they are likely to utilise resources in the study area periodically as part of a much wider foraging territory. Large areas of similar habitat occur in the locality will remain. Furthermore, a range of mitigation and compensation measures will be implemented under the Proposal, including the protection of habitat for these species and the rehabilitation of woodland and forest. These measures will promote the viability of populations of these species in the long term. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on these Owl species (see **Appendix F**).

iii. Mammals

A total of 45 mammal species have been recorded from surveys of the study area. This included a number of mammals that are listed as threatened under the TSC Act and/or the EPBC Act. In addition, several threatened mammal species have potential to occur due to the presence of suitable habitat, although they have not been recorded. The potential impacts on these species as a result of the Proposal are considered in more detail below.

a. Squirrel Glider

The Squirrel Glider has been recorded within the study area, including the disturbance boundary. The Proposal will result in the removal of 459 ha of forest and woodland habitat, all of which provides suitable habitat for the Squirrel Glider. However, suitable habitat for the Squirrel Glider will remain in the western portion of the study area. Large areas of similar habitat are present in the locality that will remain. Furthermore, a range of mitigation and compensation measures will be implemented under the Proposal, including the protection of known habitat for this species and the rehabilitation of forest and woodland. These measures will promote the viability of populations of this species in the long term. With the implementation of the proposed mitigation measures, the Proposal is not predicted to significantly impact on Squirrel Gliders (see **Appendix F**).

b. Microbats

Five threatened species of microbats have been recorded within the study area:

- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable under the EPBC and TSC Acts);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act);
- Little Bentwing-bat (*Miniopterus australis*) (Vulnerable under the TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act); and
- Southern Myotis (*Myotis macropus*) (Vulnerable under the TSC Act).

The Little Bentwing-bat, Eastern Bentwing-bat and the Large-eared Pied Bat are predominantly cave-roosting species, although all three species have also been known to roost in mine shafts, culverts, roof cavities and other artificial structures. The Eastern Freetail-bat and Southern Myotis are known to roost in tree-hollows.

All forest and woodland habitats within the study area provide suitable foraging habitat for the Large-eared Pied Bat, however this is a cave-dwelling species and there is no suitable roosting or breeding habitat present within the Site. As it does not breed or roost in the study area, it is not considered to provide important habitat for the species.

The OEH Atlas database shows few records for the Eastern Freetail-bat and no records for the Southern Myotis in the study area. Both species have been more abundantly recorded in other parts of the region, particularly to the east and west in more extensively forested areas. Cumberland Ecology recorded the Eastern Freetail-bat via Anabat detection at a number of locations within the study area, and the species was recorded during previous surveys (ERM, 1995) (ERM, 2002a). It is unlikely that the Site would provide significant habitat for either the Eastern Freetail-bat or the Southern Myotis as both species have specific habitat requirements that are more adequately met in other parts of the locality, particularly in protected areas and State Forests with water bodies. It is therefore unlikely that the Proposal would significantly impact either the Eastern Freetail-bat or the Southern

Myotis due to their mobility and preference for other common habitat types as supported by OEH Atlas database records (see **Appendix F**).

The Little Bentwing-bat was only recorded during one of the previous surveys (ERM, 2002a) while the Eastern Bentwing-bat was recorded during the 2009 survey and previous surveys (ERM, 1995) (ERM, 2002a). Both species are likely to forage extensively throughout the Site utilising all forest and woodland communities present. The removal of approximately 610.6 ha of forest and woodland vegetation under the Proposal will therefore result in a substantial loss of foraging habitat for locally occurring Little and Eastern Bentwing-bats. However, the staged clearing of the mine combined with the conservation of adjacent foraging habitat in the medium-long term results in an extensive area of foraging habitat; large enough to mitigate this habitat loss.

As both the Little and Eastern Bentwing-bats are predominantly cave-dependant species it is unlikely that the Site would provide suitable roosting or breeding habitat for either species. It is likely that both species only frequent the area while foraging at night, and would return to roost sites outside of the Site each morning. The Proposal is therefore unlikely to result in any significant loss of roosting or breeding habitat for either the Little Bentwing-bat or the Eastern Bentwing-bat (see **Appendix F**).

c. Grey-headed Flying-fox

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under both the EPBC Act and the TSC Act. This species was recorded from the southern portion of the study area. No roosting or breeding habitat for this species is present in the study area, however it is considered likely to forage across the Site; particularly during the flowering periods of canopy trees.

The Site provides 611 ha of potential foraging habitat; however, more extensive foraging habitat is present within the wider locality. The species are known to travel considerable distances (up to 20km) per night from known roosting locations allowing access to various food sources in numerous locations. Given the high mobility of the species and its access to numerous potential foraging sites other than the Site it is considered unlikely that the gradual removal of 611 ha of forest and woodland will impact upon this species (see **Appendix F**).

d. Koala

The Koala is listed as Vulnerable under the TSC Act and the EPBC Act (populations in NSW, ACT and QLD). It is unlikely that a resident population of Koalas occurs within the Site; as no evidence of Koala use has been observed during extensive field surveys. There are also no historical or anecdotal records of Koalas from within the study area; although there are previous records from within the nearby National Park (DECC (NSW), 2009). Although some suitable habitat trees are present for the Koala, the area is not considered to contain core Koala habitat as defined under SEPP 44; hence the preparation of a Koala Plan of Management is not required.

No impacts are considered likely to occur to the Koala as a result of the Proposal (see **Appendix F**).

## 5.5 Indirect Impacts

In addition to direct impacts of vegetation clearing and loss of habitat, the Proposal may have indirect impacts on retained vegetation in and adjacent to the disturbance boundary, including:

- noise levels;
- dust levels;
- incidences of vehicle strike;
- light levels at night;
- potential changes in wind or water erosion due to clearance of ground vegetation;
- reduction in area of interior habitat of remaining woodland;
- edge effects due to changes in patch configuration and/or habitat fragmentation; and
- potential increase in weed invasion and feral pest impacts.

These potential indirect impacts are discussed in below. Mitigation measures will be implemented specifically to minimise the indirect impacts of the Proposal, including implementation of weed and feral species management and salvage of habitat features such as timber debris and habitat rocks (**Section 5.1**). An offset strategy is proposed to address the residual loss of habitat in the medium and long term. This is discussed in **Chapter 7**.

Potential impacts from a number of these aspects such as light, noise and dust impacts already exist as a result of existing operations at the mine and are being managed in accordance with relevant regulations. It is unlikely that the Proposal will exacerbate these impacts significantly above current levels.

### 5.5.1 *Habitat Fragmentation, Patch Size and Edge Effects*

The impacts of direct habitat loss can be increased by fragmentation of vegetation that is not cleared (Lindenmayer *et al.*, 1999). Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non-forest land (Primack, 1993; Fahrig, 2003; Lindenmayer and Fischer, 2006). Fragmentation results in smaller patch sizes and can put stress on native flora and fauna by increasing intraspecific and interspecific competition for space and resources in areas of remaining habitat. Small fragments are often unfavourable for species such as the Black-chinned Honeyeater which require interior habitat. Also several small, isolated forest patches will be unable to maintain a larger number of species than a single intact forest of the same total area.

Another consequence of habitat fragmentation is that it increases “edge effects”. Edge effects are impacts that occur at the interface between habitat areas and disturbed or

developed land (Yahner, 1988). When an edge is created between vegetation and a cleared area, changes to ecological processes within the vegetation can extend between 10 m and 100 m from the edge (Yahner, 1988). These include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species and therefore cause significant changes to the ecology of the patch (Lindenmayer and Fischer, 2006). These changes include; invasion by weeds, increase in feral animals, reduction in tree health, and barriers to dispersal or distribution (Yahner, 1988).

The Proposal is unlikely to significantly increase habitat fragmentation, as the vegetation to be removed is directly adjacent to existing mining operations, and therefore no area of habitat will be isolated or separated from other areas of proximate habitat. Some edge effects on residual vegetation have the potential to be exacerbated, however they are expected to be able to be managed with the implementation of proposed mitigation measures such as weed and feral animal management.

The threatened species found in the study area are mainly mobile birds and bats; these species have an ability to move across disturbed areas to other areas of habitat and so are capable of coping with a degree of habitat loss. Notwithstanding this, threatened woodland birds, such as Grey-crowned Babbler, Speckled Warbler and Brown Treecreeper are relatively sedentary and are susceptible to diminishing patch sizes and the associated decreases in patch quality (Reid, 1999).

### **5.5.2 Noise**

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts due to noise that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC Americas Limited, 2005). Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise created by the mine, has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC Americas Limited, 2005).

The Proposal has the potential to generate significant noise through routine mining operations. Examples of noise can come from large volumes of traffic, particularly large mining trucks, excavation machinery, noise from explosions used during the mining phase, and the noise from generators and machinery used in the daily operation of the mine.

Notwithstanding this, background noise levels already exist as a result of the current mining for the Warkworth Mine operations and are being managed in accordance with relevant regulations. It is unlikely that the Proposal will create noise significantly above current levels as the Proposal will continue to comply with regulatory standards.

### **5.5.3 Light**

The Proposal has the potential to increase the level of artificial night light in the natural environment. Increased night light levels may adversely impact wildlife by direct glare,

chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh, 2007; Longcore and Rich, 2010).

Research into impacts from altered lighting indicates that it can trigger behavioural and physiological responses that include but are not limited to:

- changes in foraging behaviour, such as when diurnal species begin foraging into the during night-time;
- a disruption of seasonal day length cues which trigger critical behaviours (Longcore and Rich, 2007; Saleh, 2007; Longcore and Rich, 2010).
- disorientation and/or temporary blindness; and
- interference with predator-prey relationships.

While the continued operation of the Proposal will have some effect on the surrounding woodland environment, the impacts from night light pollution are likely to remain close to the immediate disturbance boundary of the operational pit. Artificial night light will diminish within areas that are progressively rehabilitated and, in the long term, night light levels will return to normal following completion of rehabilitation of the total mined area and cessation of mining.

#### **5.5.4 Vehicle Strike**

Vehicle strike can pose a significant risk to some wildlife, particularly but not exclusively ground dwelling species (Taylor and Goldingay, 2010). Although mining results in vehicle movements such as haul trucks, light vehicles and other machinery, the Proposal involves a continuation of mining westward, and will continue at its current rate. This means that there will be a similar number of vehicle movements to the current situation and no overall increase in vehicle movements will occur.

Furthermore, vehicle traffic in the Site will decrease due to the closure of Wallaby Scrub Road. Traffic movements in the Site will continue to be managed in a number of ways, including establishment of appropriate speed limits and traffic safety policies. No increased risk of vehicle strike is anticipated from the Proposal.

#### **5.5.5 Dust**

Construction and mining activities have the potential to generate dust, which may impact on the ecology within the study area in a number of ways. Dust that settles can accumulate on leaf surfaces and reduce essential physiological processes including photosynthesis, respiration, and transpiration. It can also permit the penetration of phytotoxic gaseous pollutants (Farmer, 1993). Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. This can result in cumulative effects e.g. drought stress on already stressed species decreasing plant health, and even resulting in death in extreme circumstances. Consequently, changes in vegetation and community structure can result (Farmer, 1993).

The effect of dust deposition also affects animals that use plants, either as a source of food or habitat. Dust on the foliage and fruit may reduce palatability to animals and decreased health of trees and changed community structure may result in a reduction in the amount of available habitat (Farmer, 1993).

Current dust impacts are being managed at Warkworth Mine and no significant dust impacts have been observed in the vegetated areas of the study area. The Proposal will continue to manage potential dust impacts to limit the impacts on adjacent vegetation. No significant dust impacts are expected as a result of the Proposal.

### **5.5.6 Erosion**

The Proposal has the potential to increase the amount of erosion occurring in the study area through the disturbance of soil through mining operations, which can affect adjacent areas of vegetation if not properly managed. The project will also involve the establishment of soil stockpiles, which have the potential to erode in heavy rainfall if not adequately managed.

Soil management strategies are currently being implemented at Warkworth Mine to limit soil erosion and movement into adjacent areas. Erosion impacts due to the operations at Warkworth Mine are not currently impacting the native vegetation in the study area. Accordingly, erosion impacts on the surrounding residual vegetation from the Proposal are likely to be minimal.

### **5.5.7 Weeds and Feral Animals**

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions and may impact upon the original local native plant and animal species. The Proposal has the potential to facilitate the spread of weeds or increase the prevalence of feral species in the remnant vegetation areas that will be retained. Vegetation clearance and ground disturbance can create conditions favourable for weed species by increasing access to light and water, and by reducing competition when trees and shrubs are removed. Weed species can also be transported on plant equipment and vehicles to remnant vegetation areas.

Weeds and other introduced plants have potential to outcompete regenerating native plant species. Feral animals such as foxes, rabbits and some species of birds are also favoured by the creation of open areas following clearance of forest and woodland. These species can impact native fauna species by preying upon them or by competing with them for food and resources. The feral fox has been recorded from the study area and it has long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (DECCW (NSW), 2010). Similarly, Rabbits have been recorded in the study area which is known to impact on native fauna through grazing competition and the spread of diseases (NSW Scientific Committee, 2004f).

Feral fauna and invasive weeds are currently being managed in Warkworth Mine and they will continue to be managed appropriately for the Proposal. With ongoing monitoring and management when appropriate, weeds and feral animals are not likely to increase as a result of the Proposal.

## BCAM Quantification of Impacts

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This section summarises the findings of the BCAM analysis, with a detailed BCAM report provided in **Appendix G**. This analysis has been undertaken to assess potential impacts of the Proposal and quantify the offsetting requirements.

### 6.1 BCAM Analysis and Credit Requirements

BCAM analysis has been performed to provide an objective, numeric determination of the offsets that are required for the Proposal. BCAM assessments are based upon units called “credits”. These include “ecosystem credits” for vegetation communities, and “species credits” for some individual threatened species. BCAM requires calculation of species credits for only those species known to occur within the assessment area. Species credits have been generated by the area of available habitat.

The BCAM baseline calculations will be subject to review and certification by OEH, either under the UHSA or in accordance with Draft NSW Biodiversity Policy for Major Projects 2014. The figures presented in **Appendix G** are therefore indicative and may be updated pending review by OEH.

The impacts of the Proposal have been separated into the following components for the BCAM analysis:

- Component 1: WSW/WSG vegetation impacted by the Proposal;
- Component 2: Non-WSW/WSG vegetation impacted by the Proposal; and
- Component 3: Non-WSW/WSG vegetation impacted by the 2003 Extension.

Component 3 has been included within this assessment as the Proposal will impact portions of HMAs and NDAs established for the 2003 Extension that are relevant to non-WSW/WSG vegetation. As such, the Proposal includes the provision of alternative offsets to offset the BCAM credit requirement for the impacts to non-WSW/WSG vegetation for the 2003 Extension.

The assessment has categorised WSW/WSG vegetation separately from the non-WSW/WSG vegetation given the restricted occurrence of WSW in the vicinity of the Proposal.

## 6.2 BCAM Analysis for Component 1: WSW/WSG Vegetation for the Proposal

BCAM analysis has been completed to assess the impacts of the Proposal to WSW and WSG and to determine the offset requirement of ecosystem credits and species credits. The ecosystem credits and species credits requirements of the Proposal for these communities are presented in **Table 6.1**.

The Proposal requires a total of 2,950 ecosystem credits for WSW and WSG. Of this, 2,935 ecosystem credits are required for WSW and 15 ecosystem credits are required for WSG.

The Proposal also requires species credits for the Regent Honeyeater and Southern Myotis. These species are the only species credit species that have been assessed as occurring within the disturbance boundary. The Regent Honeyeater requires 1,923 species credits to offset the removal of foraging and breeding habitat. The Southern Myotis requires 875 species credits to offset the removal of breeding habitat.

**Table 6.1 BCAM Ecosystem and Species Credits Required for Component 1: WSW/WSG Vegetation for the Proposal**

Aspect	Area (ha)	Credits Required
<b>Ecosystem Credits</b>		
Warkworth Sands Woodland (EEC)	72.0	2,935
Warkworth Sands Grassland	0.5	15
<i>Total Ecosystem Credits</i>		2,950
<b>Species Credits</b>		
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	72.0	1,923
Southern Myotis (Breeding Habitat) ( <i>Myotis macropus</i> )	11.5	875
<i>Total Species Credits</i>		2,798
<b>TOTAL CREDIT REQUIREMENT</b>		<b>5,748</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

## 6.3 BCAM Analysis for Component 2: Non-WSW Vegetation for the Proposal

BCAM analysis has been completed to assess the impacts of the Proposal to non-WSW/WSG vegetation and to determine the offset requirement of ecosystem credits and species credits. The ecosystem credits and species credits requirements of the Proposal for these communities are presented in **Table 6.2**.

The Proposal requires a total of 15,983 ecosystem credits for 538.5 ha of non-WSW/WSG vegetation. The majority of the required ecosystem credits are from impacts to Central Hunter Grey Box-Ironbark Woodland.

The Proposal also requires species credits for the Regent Honeyeater and Southern Myotis. These species are the only species credit species that have been assessed as occurring within the disturbance boundary. The Regent Honeyeater requires 10,326 species credits to offset the removal of foraging and breeding habitat. The Southern Myotis requires 11,810 species credits to offset the removal of breeding habitat.

**Table 6.2 BCAM Ecosystem and Species Credits Required for Component 2: Non-WSW/WSG Vegetation for the Proposal**

Aspect	Area (ha)	Credits Required
<b>Ecosystem Credits</b>		
Central Hunter Grey Box – Ironbark Woodland (EEC)	365.5	13,644
Regenerating Central Hunter Grey Box – Ironbark Woodland (EEC)	6.5	240
Central Hunter Ironbark – Spotted Gum – Grey Box Forest (EEC)	15.0	553
Central Hunter Grey Box – Ironbark Derived Grassland	151.5	1,546
<i>Total Ecosystem Credits</i>		<i>15,983</i>
<b>Species Credits</b>		
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	387.0	10,326
Southern Myotis (Breeding Habitat) ( <i>Myotis macropus</i> )	153.5	11,810
<i>Total Species Credits</i>		<i>22,136</i>
<b>TOTAL CREDIT REQUIREMENT</b>		<b>38,119</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

## 6.4 BCAM Analysis for Component 3: Non-WSW/WSG Vegetation for the 2003 Extension

In order to quantify the alternate offsets for non-WSW/WSG vegetation in the disturbance area approved under the 2003 Development Consent, a BCAM analysis has been applied for the impacts of the 2003 Extension. The ecosystem credits and species credits requirements for the non-WSW/WSG vegetation for the 2003 Extension are presented in **Table 6.3**. Derived grasslands have been included in the BCAM calculations for determining offset requirements which comprise 22% of the ecosystem credit requirements for Component 3. The approved 2003 Extension only offset woodland.

The 2003 Extension requires a total of 11,575 ecosystem credits for 477.5 ha of non-WSW/WSG vegetation. The majority of the required ecosystem credits are from impacts to Central Hunter Grey Box-Ironbark Woodland.

The Proposal also requires species credits for the Regent Honeyeater, Large-eared Pied Bat and Southern Myotis. These species are the only species credit species that have been assessed as occurring within the non-WSW/WSG vegetation in disturbance area of the 2003 Extension. The Regent Honeyeater requires 6,683 species credits to offset the removal of foraging and breeding habitat. The Large-eared Pied Bat requires 139 species credits to offset the removal of breeding habitat. The Southern Myotis requires 5,545 species credits to offset the removal of breeding habitat.

**Table 6.3 BCAM Ecosystem and Species Credits Required for Component 3: Non-WSW/WSG for the 2003 Extension**

Aspect	Area (ha)	Credits Required
<b>Ecosystem Credits</b>		
Central Hunter Grey Box – Ironbark Woodland (EEC)	249.0	8,974
Central Hunter Ironbark – Spotted Gum – Grey Box Forest (EEC)	1.5	56
Central Hunter Grey Box – Ironbark Derived Grassland	227.0	2,545
<i>Total Ecosystem Credits</i>		<i>11,575</i>
<b>Species Credits</b>		
Regent Honeyeater ( <i>Anthochaera phrygia</i> )	250.5	6,683
Large-eared Pied Bat (Breeding Habitat) ( <i>Chalinolobus dwyeri</i> )	10.5	139
Southern Myotis (Breeding Habitat) ( <i>Myotis macropus</i> )	72.0	5,538
<i>Total Species Credits</i>		<i>12,360</i>
<b>TOTAL CREDIT REQUIREMENT</b>		<b>23,935</b>

*Note: all areas are rounded to the nearest 0.5 ha.*

## The Biodiversity Offset Strategy

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This section has been developed to provide an overview of the Biodiversity Offset Strategy and explain how the impacts of the proposal described in **Chapter 5** are to be offset in accordance with the credit requirements calculated and presented in **Chapter 6**. This chapter also assesses the consistency of the Biodiversity Offset Strategy with the Draft NSW Biodiversity Offsets Policy for Major Projects.

### 7.1 Offset Strategy Overview

In order to offset the impacts of the Proposal, the Biodiversity Offset Strategy includes:

- establishment of land-based offset sites that secure various ecosystem and species credits on land secured by the proponent;
- rehabilitation measures aimed at providing new habitats for native flora and fauna on mined land to adjoin and complement the surrounding native vegetation;
- supplementary measures to improve the management of EEC vegetation and threatened species or other measures that benefit biodiversity; and
- retirement of credits under the rules of the UHSA, which includes contributions to the Upper Hunter Offset Fund.

An overview of each of these measures is provided below. A combination of measures is proposed for the offsetting components outlined in **Chapter 6**. A detailed discussion of offsetting strategy for each of these components is provided in subsequent sections of this chapter.

#### 7.1.1 *Establishment of Land-based Offset Sites*

The land-based offsets include the local properties contained within the SBA and NBA (see **Figure 2.1**). The native vegetation communities recorded from the SBA and NBA and their TSC Act status are indicated in **Table 7.1** below. In accordance with the UHSA, the credit value of the SBA and NBA has been calculated using BBAM.

The SBA and NBA were selected as land-based offsets based on a number of considerations. The results from the assessment of these areas confirm that each contains a suite of strategic values including:

- the known occurrence of Warkworth Sands Woodland EEC and other EECs predicted to be impacted by the Proposal;
- the presence of known and potential habitat for relevant threatened flora and fauna species that could be impacted by the Proposal;
- linkages to sustainable ecological features (particularly permanent water sources such as the Hunter River and Wollombi Brook);
- the potential to form new, or improve existing ecological corridors; and
- provision of land that contributes to other existing offsets.

Land-based offsets within the NBA and SBA, provide a means to deliver (“retire”) a proportion of the credit requirements outlined in **Chapter 6**. Other land-based offsets may be provided to retire additional credits in consultation with OEH.

**Table 7.1 Native Vegetation Communities in the SBA and NBA**

Vegetation Community	TSC Act Status	SBA (ha)	NBA (ha)
<b>Forest and Woodland</b>			
Warkworth Sands Woodland	EEC	56.0	19.5
Central Hunter Grey Box – Ironbark Woodland	EEC	380.0	104.0
Regenerating Central Hunter Grey Box – Ironbark Woodland	EEC	18.5	
White Box Woodland	CEEC	28.0	
Yellow Box Woodland	CEEC	7.0	
Hunter Valley Vine Thicket	EEC	0.5	
Hunter Lowlands Redgum Forest	EEC	32.5	
River Red Gum Floodplain Woodland	EEC	9.5	
Hunter Valley River Oak Forest		25.5	
Regenerating Hunter Valley River Oak Forest		1.0	
<i>Subtotal Forest and Woodland</i>		558.5	123.5
<b>Grassland</b>			
Warkworth Sands Grassland		2.5	156.5
Central Hunter Grey Box – Ironbark Derived Grassland		144.0	23.0
<i>Subtotal Grassland</i>		146.5	179.5
<b>Other</b>			
Exotic Vegetation		72.0	
Cleared Areas		10.5	2.5

**Table 7.1 Native Vegetation Communities in the SBA and NBA**

Vegetation Community	TSC Act Status	SBA (ha)	NBA (ha)
	<i>Subtotal Other</i>	82.5	2.5
<b>TOTAL</b>		<b>787.5</b>	<b>305.5</b>

Note: all areas are rounded to the nearest 0.5 ha.

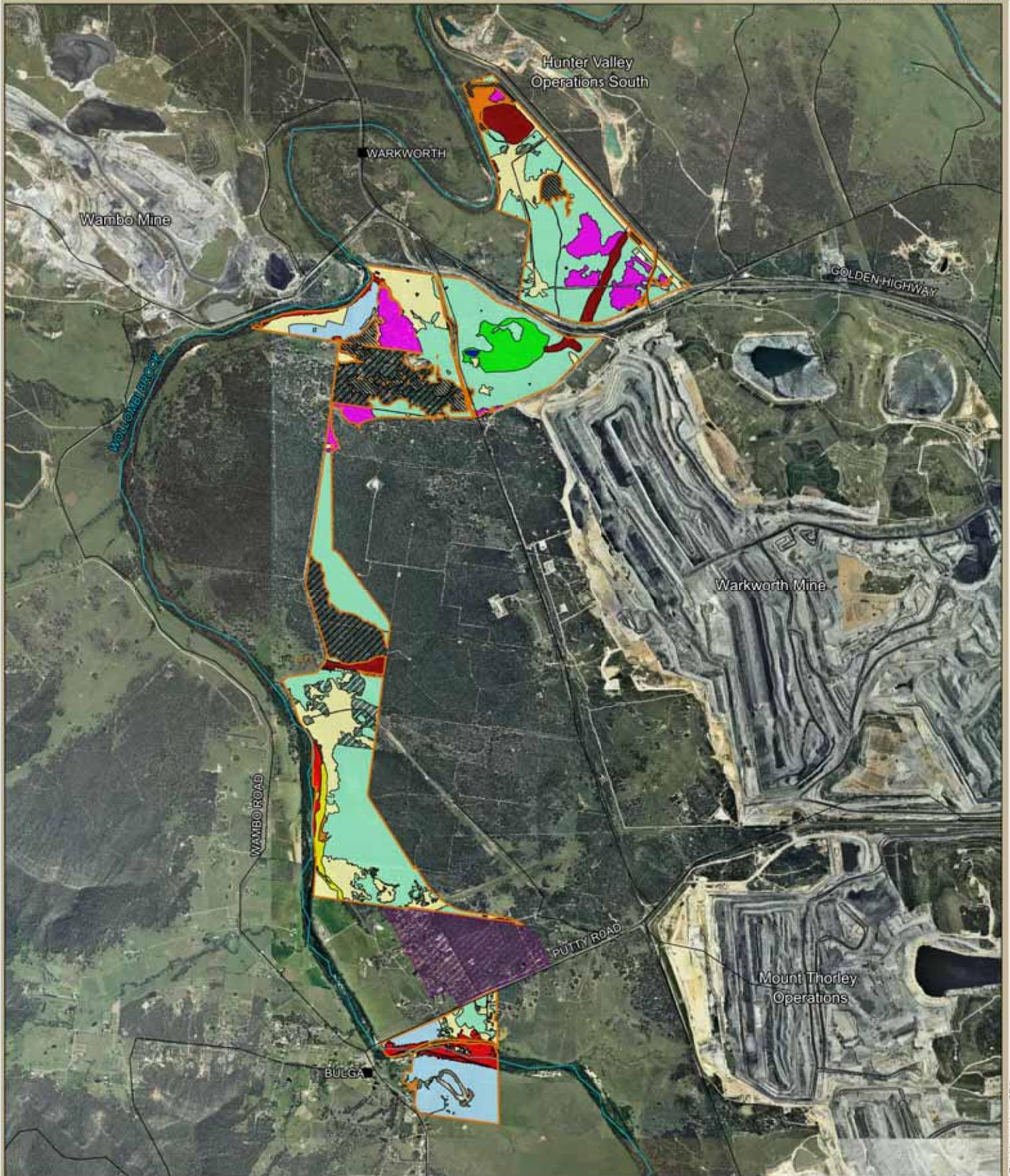
*i. Southern Biodiversity Area*

The SBA is approximately 788 ha in size and consists of land located in close proximity to the disturbance boundary. The SBA comprises a number of parcels of land and represents a largely intact area of woodland and forest, interspersed with some cleared areas. The vegetation within the SBA comprises both intact and regenerating woodland and areas of agricultural activity. It contains 558.5 ha of forest and woodland and 146.5 ha of grassland. The forest and woodland within the SBA comprises a number of listed communities including WSW, Central Hunter Grey Box – Ironbark Woodland and White Box Yellow Box Blakely's Red Gum Woodland. The distribution of vegetation communities within the SBA is shown in **Figure 7.1**.

Within the SBA, there are areas of forest, woodland and grassland that provide habitat for a variety of native species. The habitat features available within the SBA provide known and potential habitat for a suite of species listed under the TSC Act and/or EPBC Act. The following threatened flora and fauna species have been recorded during surveys of the SBA:

- River Red Gum (*Eucalyptus camaldulensis*) (Endangered Population in the Hunter Valley under the TSC Act).
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) (Vulnerable under the TSC Act);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) (Vulnerable under the TSC Act);
- Speckled Warbler (*Chthonicola sagittata*) (Vulnerable under the TSC Act);
- Little Eagle (*Hieraaetus morphnoides*) (Vulnerable under the TSC Act);
- Squirrel Glider (*Petaurus norfolkensis*) (Vulnerable under the TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act); and
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act);

The locations of threatened species recorded within the SBA are shown in **Figure 7.2**.



**Legend**

- Southern Biodiversity Area
- Warkworth Sands Woodland Offset Area (2003 Consent)
- Warkworth Sands Woodland Re-establishment Area (2003 Consent)
- Putty Road Conservation Area
- Road
- Waterway
- Town

**Vegetation Community**

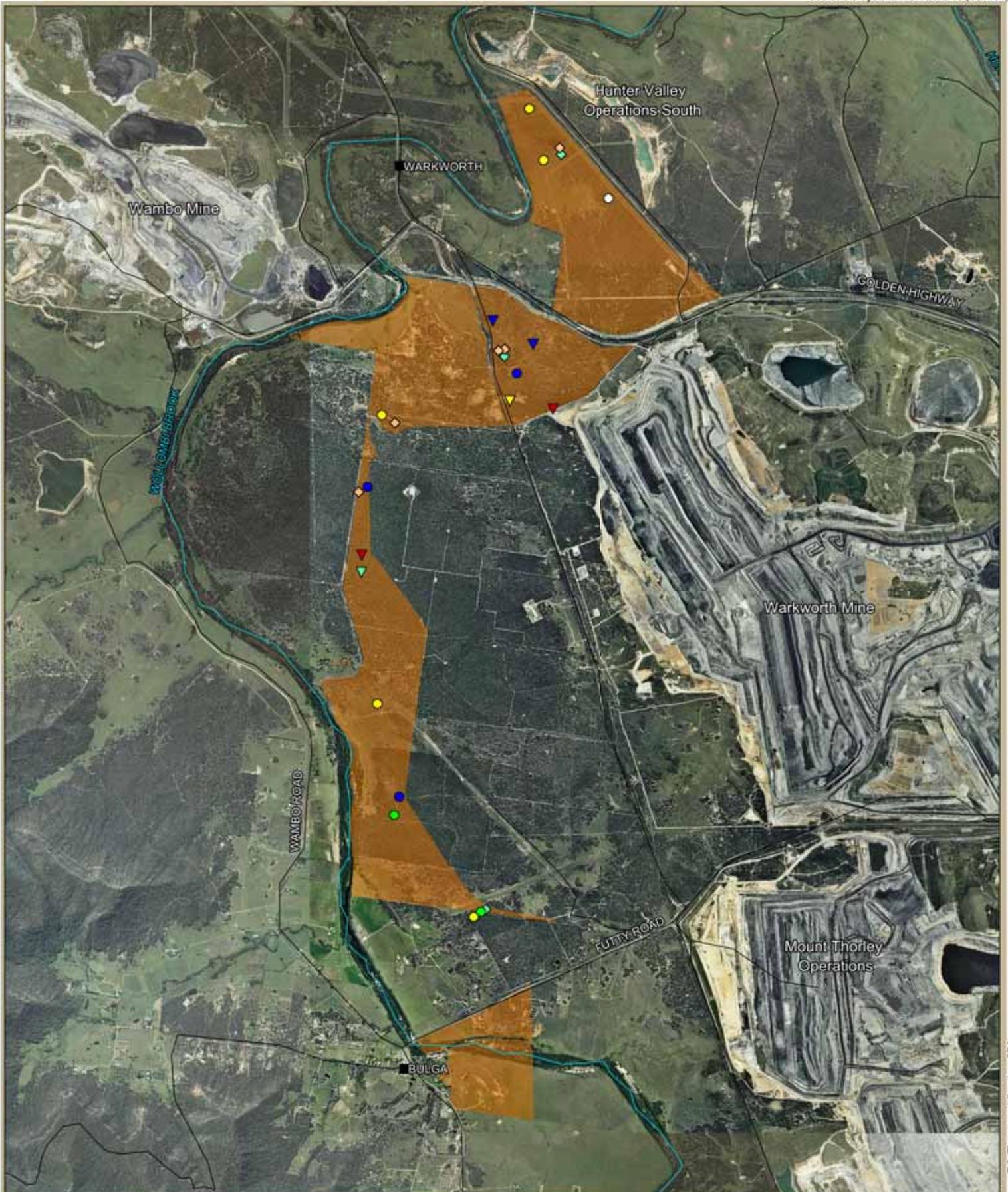
- |  |   |
|--|---|
| <span style="display: inline-block; width: 15px; height: 10px; background-color: magenta; margin-right: 5px;"></span> Warkworth Sands Woodland (EEC)                                   | <span style="display: inline-block; width: 15px; height: 10px; background-color: blue; margin-right: 5px;"></span> Hunter Valley Vine Thicket (EEC)   |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: lightpink; margin-right: 5px;"></span> Warkworth Sands Grassland                                      | <span style="display: inline-block; width: 15px; height: 10px; background-color: darkred; margin-right: 5px;"></span> Hunter Lowlands Redgum Forest (EEC)   |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: lightgreen; margin-right: 5px;"></span> Central Hunter Grey Box - Ironbark Woodland (EEC)             | <span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; margin-right: 5px;"></span> River Red Gum Floodplain Woodland (EEC)  |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: lightblue; margin-right: 5px;"></span> Regenerating Central Hunter Grey Box - Ironbark Woodland (EEC) | <span style="display: inline-block; width: 15px; height: 10px; background-color: red; margin-right: 5px;"></span> Hunter Valley River Oak Forest  |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; margin-right: 5px;"></span> Central Hunter Grey Box - Ironbark Derived Grassland              | <span style="display: inline-block; width: 15px; height: 10px; background: repeating-linear-gradient(-45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></span> Regenerating Hunter Valley River Oak Forest |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: green; margin-right: 5px;"></span> White Box Woodland (C/EEC)   | <span style="display: inline-block; width: 15px; height: 10px; background-color: lightblue; margin-right: 5px;"></span> Exotic  |
| <span style="display: inline-block; width: 15px; height: 10px; background-color: orange; margin-right: 5px;"></span> Yellow Box Woodland (C/EEC)                                       |   |

Image Source:  
RTCA 2013



**Figure 7.1. Vegetation Communities in the Southern Biodiversity Area for the Warkworth Continuation 2014**





**Legend**

- Southern Biodiversity Area
- Road
- Waterway
- Town

**Threatened Fauna  
Cumberland Ecology (2009)**

- Brown Treecreeper
- Grey-crowned Babbler
- Speckled Warbler
- Little Eagle
- Eastern Bentwing-bat
- Eastern Freetail-bat

**ERM (2002)**

- Speckled Warbler
- Squirrel Glider
- Eastern Freetail-bat
- Grey-crowned Babbler

Image Source:  
RTCA 2012 & 2013



Figure 7.2. Threatened Species Recorded in the Southern Biodiversity Area

500 0 500 1000 1500 2000m

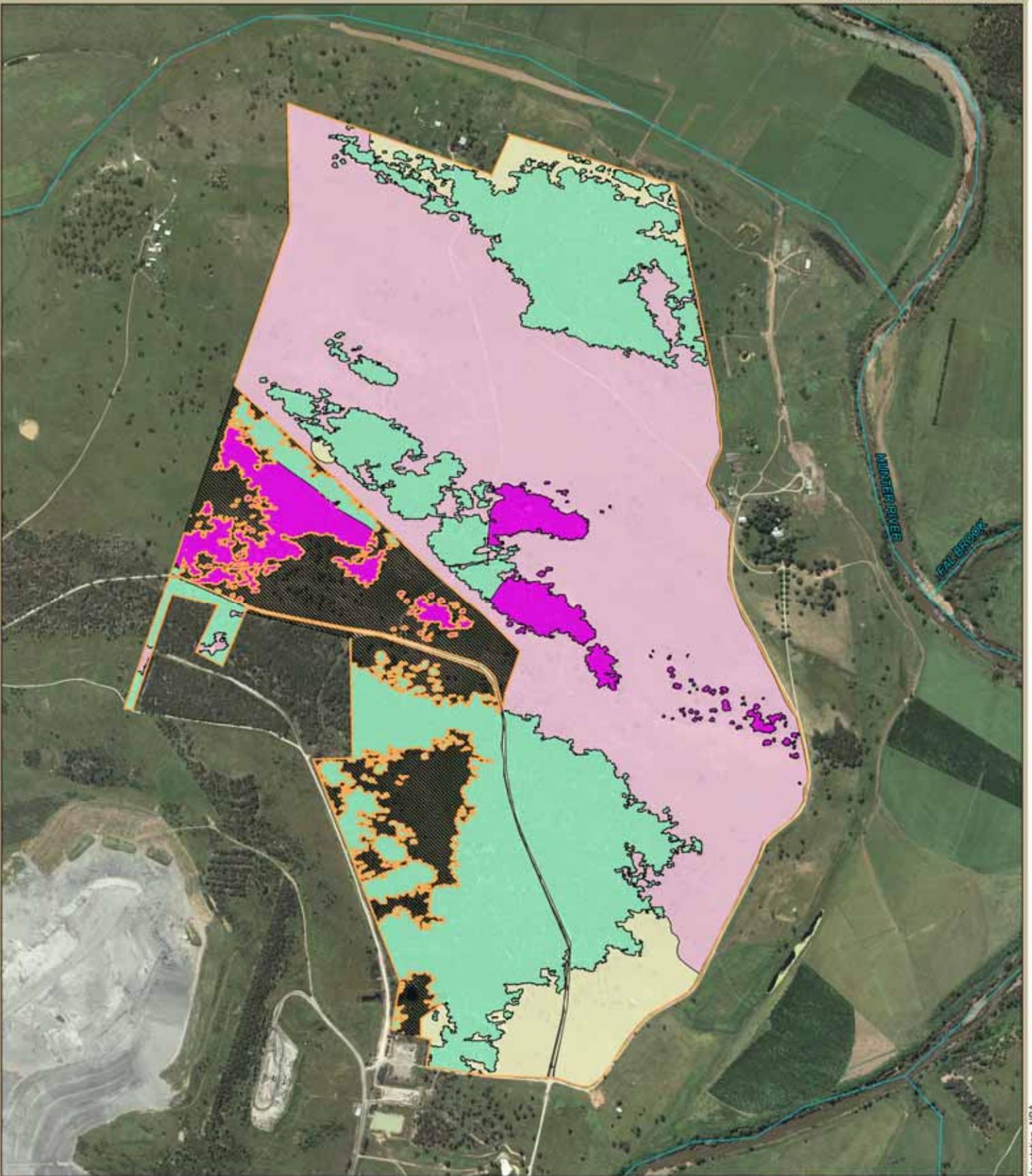
ii. *Northern Biodiversity Area*

The NBA is approximately 306 ha in size and is located approximately 7 km north of the Warkworth Mining Lease. It occurs on the western side of a loop of the Hunter River. The NBA comprises one parcel of that which has historically been utilised for agricultural purposes. Native vegetation occurs within the NBA, however is highly fragmented due to past agricultural land use. All livestock has been removed from the area in recent years. It contains 123.5.5 ha of woodland and 179.5 ha of grassland. The woodland within the NBA comprises two listed communities, namely WSW and Central Hunter Grey Box – Ironbark Woodland. The distribution of vegetation communities within the SBA is shown in **Figure 7.3**.

Within the SBA, there are areas of forest, woodland and grassland that provide habitat for a variety of native species. The habitat features available within the SBA provide known and potential habitat for a suite of species listed under the TSC Act and/or EPBC Act. The following threatened flora and fauna species have been recorded during surveys of the SBA:

- Tiger Orchid (*Cymbidium canaliculatum*) (Endangered Population in the Hunter Valley under the TSC Act);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) (Vulnerable under the TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act); and
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act).

The locations of threatened species recorded within the SBA are shown in **Figure 7.4**.



**Legend**

-  Northern Biodiversity Area
-  Warkworth Sands Woodland Re-establishment Area (2003 Consent)
-  Waterway

**Vegetation Community**

-  Warkworth Sands Woodland (EEC)
-  Warkworth Sands Grassland
-  Central Hunter Grey Box - Ironbark Woodland (EEC)
-  Central Hunter Grey Box - Ironbark Woodland Derived Grassland

Image Source: RTCA 2012



**Figure 7.3. Vegetation Communities in the Northern Biodiversity Area for the Warkworth Continuation 2014**

125 0 125 250 375 500m



**Legend**

■ Northern Biodiversity Area

**Threatened Flora**

■ *Cymbidium canaliculatum*

**Threatened Fauna**

● Grey-crowned Babbler

◆ Eastern Freetail-bat

◆ Eastern Bentwing-bat

Image Source:  
RTCA 2012



**Figure 7.4. Threatened Species Recorded in the Northern Biodiversity Area**

125 0 125 250 375 500m

### **7.1.2 Mine Rehabilitation**

The Biodiversity Offset Strategy includes the rehabilitation of mined land within the MTW operations. The aim of mine rehabilitation will be to replant woodland within portions of previously mined areas to create a large block of habitat in the future for native flora and fauna. The final land use for the MTW operations are shown in **Figure 7.5** and the biodiversity corridors associated with this land use plan are shown in **Figure 7.6**.

The credit value of the mine rehabilitation has been calculated using BBAM. The ability to deliver communities in rehabilitation and the time lag associated with this has been identified by OEH as a risk. Therefore credits calculated for delivering rehabilitation have been discounted by 50%. In accordance with the rules set out in the UHSA, the discounted credits generated from mine rehabilitation can only form a maximum of 25% of the total credit requirements of Proposal. Credits generated through mine rehabilitation can only contribute to offsets for ecosystem credits.

### **7.1.3 Supplementary Measures**

Supplementary measures are actions other than acquisition of land that are taken to improve biodiversity or other relevant environmental values. They can include financial contributions to Recovery Plans, management actions for communities or species and/or for targeted research. This option will only be applied to Component 1 (WSW/WSG impacted by the Proposal).

### **7.1.4 Retirement of Credits under the UHSA**

Outstanding credit requirements can be retired under the rules of the UHSA. The UHSA provides an option to contribute to the Upper Hunter Offset Fund that will be used to secure offset lands and fund ongoing management of such lands. Where a shortfall of the credit requirement exists for the Proposal, the Biodiversity Offset Strategy has allowed for contribution to be made to the UHSA. The value of the contribution will be calculated by the rules set out by the UHSA.



- Legend**
- Disturbance Boundary
  - Proposed Warkworth Mine Development Consent Boundary
  - Area already approved to be mined by MTO under DA 34/95
  - Existing Warkworth Mine Development Consent Footprint
  - Waterway
  - Town

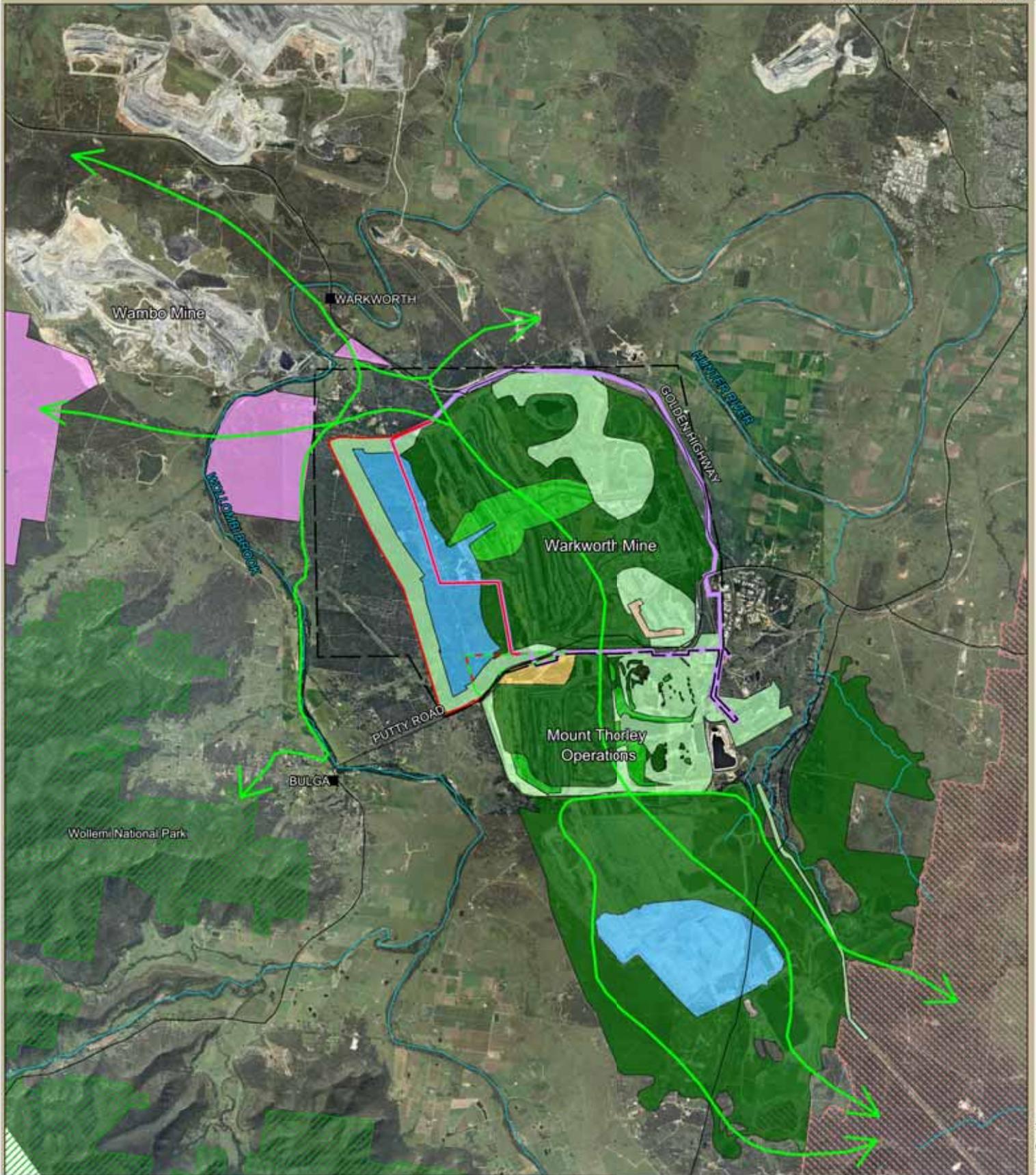
- Final Landuse**
- Remnant Woodland
  - Rehabilitated Woodland
  - Rehabilitated Trees over grass
  - Rehabilitated Grassland
  - Post-mining water level
  - Residual void

Image Source: RTCA 2013



Figure 7.5. Final Landuse





**Legend**

- |   |                                 |          |
|---|---------------------------------|----------|
| Disturbance Boundary                                    | Potential Biodiversity Corridor | Road     |
| Proposed Warkworth Mine Development Consent Boundary    | Remnant Woodland                | Waterway |
| Area already approved to be mined by MTD under DA 34/95 | Rehabilitated Woodland          | Town     |
| Existing Warkworth Mine Development Consent Footprint   | Rehabilitated Trees over grass  |          |
| Wambo Remnant Woodlands Enhancement Area                | Rehabilitated Grassland         |          |
| Singleton Military Area                                 | Post-mining water level         |          |
| National Park   | Residual void                   |          |

Image Source: RTCA 2012, 2013



Figure 7.6. Biodiversity Corridors

1000 0 1000 2000 3000 4000m

## 7.2 Component 1: WSW/WSG for the Proposal

### 7.2.1 Overview

The Proposal will meet the offsetting requirements for Component 1 (see **Section 6.2**) through the provision of land-based offsets, supplementary measures and retirement of credits under the UHSA. An overview of how the offset requirement for Component 1 will be achieved is provided in **Table 7.2**. Further discussion of each element is provided in subsequent sections.

A total of 75.5 ha of WSW will be protected in the SBA and NBA, resulting in an increase in the total area of WSW under long term conservation. In addition, 159.5 ha of WSG in the NBA and SBA will be used to re-establish WSW and develop high quality examples of WSW in the long term. This is considered to be a viable direct (ie land based) offset for WSW.

Additional supplementary measures will also be provided (see **Section 7.2.4**). These include the preparation of an Integrated Management Plan for WSW, and the development of appropriate completion criteria for the re-establishment of WSW. The direct and indirect offsets combined will provide a comprehensive package of offsets that will contribute to the long term viability of WSW.

**Table 7.2 Overview of the Biodiversity Offset Strategy for Component 1: WSW/WSG for the Proposal**

Element	Contribution
<b>Ecosystem Credits</b>	
Total BCAM credits required	2,950
BBAM Credits supplied through land-based offsets	2,303
BBAM Credits supplied through mine rehabilitation	0
Will supplementary measures be provided?	Yes
BBAM Credits to be retired by the rules of the UHSA	647
<b>Species Credits (Regent Honeyeater) (<i>Anthochaera phrygia</i>)</b>	
Total BCAM credits required	1,923
BBAM Credits supplied through land-based offsets	454
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	1,469
<b>Species Credits (Southern Myotis) (breeding habitat) (<i>Myotis macropus</i>)</b>	
Total BCAM credits required	875
BBAM Credits supplied through land-based offsets	61
Will supplementary measures be provided?	No

**Table 7.2 Overview of the Biodiversity Offset Strategy for Component 1: WSW/WSG for the Proposal**

Element	Contribution
BBAM Credits to be retired by the rules of the UHSA	814
<b>TOTAL RESIDUAL CREDIT REQUIREMENT</b>	<b>2,930</b>

### 7.2.2 Establishment of Land-based Offset Sites

The SBA and NBA contain areas of WSW/WSG that will contribute to the land-based offsets for Component 1. The ecosystem and species credits generated by the SBA and NBA for Component 1 are summarised in **Table 7.3**.

**Table 7.3 Ecosystem and Species Credits Generated by the Land-based Offsets for Component 1: WSW/WSG Vegetation for the Proposal**

Vegetation Community	TSC Act Listing	SBA		NBA		Total	
		Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits
<b>Ecosystem Credits</b>							
Warkworth Sands Woodland	EEC	56.0	382	19.5	191	75.5	573
Warkworth Sands Grassland		2.5	24	156.5	1,706	159.5	1,730
	<i>Total</i>	<i>58.5</i>	<i>406</i>	<i>176.0</i>	<i>1,897</i>	<i>235.0</i>	<i>2,303</i>
<b>Species Credits</b>							
Regent Honeyeater	CE	56.0	337	19.5	117	75.5	454
Southern Myotis (breeding habitat)	E	10.0	61			10.0	61

*Note: all areas are rounded to the nearest 0.5 ha.*

### 7.2.3 Mine Rehabilitation

No mine rehabilitation is proposed to be undertaken to meet the offsetting requirements of Component 1.

#### **7.2.4 Supplementary Measures**

A range of supplementary measures will be provided in consultation with OEH, which will include the re-establishment of large areas of this community in the NBA, preparation of an Integrated Management Plan for WSW and appropriate completion criteria for the re-establishment of this community. Further supplementary measures may be required by OEH.

##### *i. Preparation of an Integrated Management Plan*

An Integrated Management Plan would be prepared to establish an effective mechanism to work with neighbouring owners of WSW to provide improved conservation outcomes, through coordinated management activities, exchange of knowledge and consistency in monitoring programmes to increase the knowledge of management and re-establishment.

An Integrated Management Plan for WSW will be prepared in consultation with relevant stakeholders, including OEH and neighbouring mines including Bulga Coal and Wambo Mine.

##### *ii. Re-establishment of WSW*

As part of the Biodiversity Offset Strategy for the Proposal, the area of WSG available for offsets in the NBA will be re-established to a woodland form of WSW.

The areas of WSG would once have contained WSW, as these occur on the same sand deposits, and contain many similar species except the canopy trees have been removed. The goal of re-establishment is to provide a large, fully functioning example of this ecological community into the future. Through appropriate management techniques and ensuring the long-term conservation of the community, the vegetation will be managed to ensure its integrity and longevity in providing habitat for threatened species that occur within the region. This would be undertaken by enhancement of areas that are currently in reasonable ecological condition, and by re-establishing the community in areas where it is currently degraded.

Enhancement involves the addition of keystone species to degraded vegetation communities. Enhancement would be appropriate for areas that show good levels of recruitment and few weed infestations. In such areas, the community contains large canopy gaps that would benefit from the planting of key overstorey components. Re-establishment would be undertaken primarily in previously cleared areas and involves the addition of many components of the vegetation community.

Knowledge of this community has grown from research that has been conducted by the University of New England (UNE). Therefore success is considered achievable. Review of the area of WSW shown in **Figure 5.2** in conjunction with the historical aerials shown in **Figure 4.3** indicate that areas now considered good quality WSW were heavily cleared in the early 1960s. By 1979, the vegetation had undergone significant regeneration and is now considered a good quality example of this community. Precedence therefore exists that the community can regenerate naturally. However, re-establishment will not rely upon the

natural regeneration potential of this vegetation alone and will draw on the results of extensive research to ensure that the WSG is returned to a fully functioning form of the WSW community.

Coal & Allied has funded \$5 million of research as part of the 2003 consent. An additional \$500,000 was committed to for further research as part of the Warkworth Extension 2010. This additional \$500,000 component of the research was undertaken during 2012. UNE has researched a variety of aspects of this community from food webs and methods of pollination and gene dispersal, to soil structure and faunal interactions with mycorrhizal fungal associations. The results of this research will be used to provide leading-practice advice on the enhancement, re-establishment and management of the WSW. A WSW Restoration Manual has been prepared (Thackway *et al.*, 2013) to provide a sound basis for guiding best management practices to restore WSW, and set out a process for tracking the recovery of WSW sites toward a reference state, as a result of appropriate applied land management restoration interventions. This manual will be reviewed in 2015 to ensure that any potential improvements in these processes are able to be captured and incorporated into the on-ground application of the techniques. This adaptive management process will allow for the best possible outcome for the enhancement and re-establishment of WSW.

*iii. Development of Completion Criteria for Re-establishment of WSW*

Completion criteria for the re-establishment of WSW will be developed. These will consist of criteria that need to be achieved in order for successful re-establishment to have occurred. This will include but not be limited to the following:

- abundance of native species characteristic of WSW;
- diversity of native species characteristic of WSW;
- appropriate percentage cover of canopy, mid-storey and ground layer vegetation;
- diversity of habitats present;
- establishment of appropriate hydrological regime;
- presence of key indicator species; and
- weeds and feral animals below identified thresholds.

*iv. Conservation of WSG Re-established under the 2003 Consent*

Under the 2003 consent, areas of WSG in the SBA and NBA were identified for re-establishment but not protected as part of the offset. As part of the Proposal, these re-established areas will now be protected and conserved as part of the Biodiversity Offset Strategy in the long term. This results in an increased area of WSW being protected and managed in the long term.

### 7.2.5 Retirement of Credits under the UHSA

Following establishment of the land-based offset sites, the residual credits required for Component 1 will be offset through the rules of the UHSA. It is recognised that areas for offsetting WSW/WSG may not be available so purchasing credits for this community is not considered an option. The residual 649 ecosystem credits, 1,468 residual species credits for the Regent Honeyeater and 875 residual species credits for the Southern Myotis (breeding habitat) are also required to be offset via the rules of the UHSA.

## 7.3 Component 2: Non-WSW/WSG Vegetation for the Proposal

### 7.3.1 Overview

The Proposal will meet the offsetting requirements for Component 2 (see **Section 6.3**) through the provision of land-based offsets, mine rehabilitation or retirement of credits under the UHSA. An overview of how the offset requirement for Component 2 will be achieved is provided in **Table 7.4**. Further discussion of each element is provided in subsequent sections.

Although no land-based offsets are currently established, a suite of properties may be included in the offset package. In addition, 1,227.5 ha of Ironbark EEC (Central Hunter Grey Box – Ironbark Woodland/Central Hunter Ironbark – Spotted Gum – Grey Box Forest) will be created through the rehabilitation of mined areas. This will create a large area of treed vegetation in the landscape subject to long term conservation.

**Table 7.4 Overview of the Biodiversity Offset Strategy for Component 2: Non-WSW/WSG Vegetation for the Proposal**

Element	Contribution
<b>Ecosystem Credits</b>	
Total BCAM credits required	15,983
BBAM Credits supplied through land-based offsets	TBC*
BBAM Credits supplied through mine rehabilitation	6,550
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	TBC*
<b>Species Credits (Regent Honeyeater) (<i>Anthochaera phrygia</i>)</b>	
Total BCAM credits required	10,326
BBAM Credits supplied through land-based offsets	TBC*
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	TBC*

**Table 7.4 Overview of the Biodiversity Offset Strategy for Component 2: Non-WSW/WSG Vegetation for the Proposal**

Element	Contribution
<b>Species Credits (Southern Myotis) (breeding habitat) (<i>Myotis macropus</i>)</b>	
Total BCAM credits required	11,810
BBAM Credits supplied through land-based offsets	TBC*
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	TBC*
<b>TOTAL RESIDUAL CREDIT REQUIREMENT</b>	<b>31,569</b>

\* Residual offsetting requirements may be offset through provision of land-based offsite sites and/or retirement of credits under the USHA.

### **7.3.2 Establishment of Land-based Offset Sites**

No land-based offsets are currently established for Component 2. In order to provide the requisite number of BCAM credits to offset the impact of the Proposal, it is envisaged that a suite of properties may be acquired and protected for use as land-based offsets. Any proposed package of offset properties must fulfil the requirements of the BCAM analysis, and therefore they should “maintain and improve” the values being lost in the disturbance boundary.

### **7.3.3 Mine Rehabilitation**

#### *i. Quantum*

The Biodiversity Offset Strategy includes the rehabilitation of mined land for Component 2. A total of 6,650 of the outstanding ecosystem credit requirements will be achieved through mine rehabilitation, which represents approximately 17% of the total credit requirement for Component 2. These credits are generated from a 1,227.5 ha area, with a 50% discount applied to the calculated credits.

#### *ii. Rehabilitation Objectives and Framework*

A total of approximately 1,227.5 ha will be rehabilitated as Ironbark EEC Central Hunter Grey Box – Ironbark Woodland/Central Hunter Ironbark – Spotted Gum – Grey Box Forest, as part of the credit requirements of Component 2.

The objectives of mine rehabilitation are to:

- re-create woodland and forest communities;
- provide additional habitat for threatened species; and
- create an additional north/south wildlife corridor.

The rehabilitation will form a north/south connecting corridor of vegetation between the existing vegetation to the north of the Proposal through the rehabilitation areas of MTO and Bulga Mine (see **Figure 7.6**) and in the future will connect to the large tract of intact vegetation at Singleton Military Training Area. The proposed rehabilitation corridor reduces the impacts of edge effects by forming one large linear block of vegetation rather than numerous scattered patches allowing for easier management due to reduced weed invasion and similar edge effects. With time, the rehabilitation areas will provide additional suitable habitat for threatened fauna species that may be impacted by the Proposal.

The rehabilitation of woodland communities will be guided by leading-practice knowledge of rehabilitation and revegetation professionals. Research into the communities present within the study area has been undertaken by UNE and other regeneration practitioners. A sound understanding of the structure and functioning of these communities has been gained. The knowledge taken from this applied research will be used to ensure that the best available techniques of re-establishing a diverse tree, shrub and ground stratum layer within these communities are employed. All available knowledge will be used to maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities (Johnston, 2011; Thackway *et al.*, 2013).

Mine rehabilitation will use local native plant species and seed collection programs are currently being undertaken throughout the study area to ensure adequate seed is collected from all species to ensure species diversity is maintained. Where practical, topsoil will be translocated from proposed mining areas, with minimal stockpiling, in an attempt to maximise the viability of the native seed bank of local ecological communities.

#### **7.3.4 Supplementary Measures**

No supplementary measures proposed to be undertaken to meet the offsetting requirements of Component 2.

#### **7.3.5 Retirement of Credits under the UHSA**

The offsetting requirements for Component 2 may be met through the provision a contribution to the Upper Hunter Offset Fund for the total credits required or a portion of the total should land-based offset sites be sourced.

## **7.4 Component 3: Non-WSW/WSG Vegetation for the 2003 Extension**

### **7.4.1 Overview**

The Proposal will meet the offsetting requirements for Component 3 (see **Section 6.4**) through the provision of land-based offsets, mine rehabilitation and retirement of credits under the UHSA. An overview of how the offset requirement for Component 3 will be achieved is provided in **Table 7.5**. Further discussion of each element is provided in subsequent sections.

A total of 773.5 ha of non-WSW/WSG vegetation will be protected in the SBA and NBA, resulting in an increase in the total area of non-WSW/WSG vegetation under long term conservation. In addition, 872.5 ha of Ironbark EEC (Central Hunter Grey Box – Ironbark Woodland/Central Hunter Ironbark – Spotted Gum – Grey Box Forest) will be created through the rehabilitation of mined areas. This will create a large area of treed vegetation in the landscape subject to long term conservation.

**Table 7.5 Overview of the Biodiversity Offset Strategy for Component 3: Non-WSW/WSG Vegetation for the 2003 Extension**

Element	Contribution
<b>Ecosystem Credits</b>	
Total BCAM credits required	11,575
BBAM Credits supplied through land-based offsets	6,921
BBAM Credits supplied through mine rehabilitation	4,654
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	0
<b>Species Credits (Regent Honeyeater) (<i>Anthochaera phrygia</i>)</b>	
Total BCAM credits required	6,683
BBAM Credits supplied through land-based offsets	3,759
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	2,924
<b>Species Credits (Large-eared Pied Bat) (breeding habitat) (<i>Chalinolobus dwyeri</i>)</b>	
Total BCAM credits required	139
BBAM Credits supplied through land-based offsets	0
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	139
<b>Species Credits (Southern Myotis) (breeding habitat) (<i>Myotis macropus</i>)</b>	
Total BCAM credits required	5,538
BBAM Credits supplied through land-based offsets	912
Will supplementary measures be provided?	No
BBAM Credits to be retired by the rules of the UHSA	4,626
<b>TOTAL RESIDUAL CREDIT REQUIREMENT</b>	<b>7,689</b>

### 7.4.2 Establishment of Land-based Offset Sites

The SBA and NBA contain areas of non-WSW/WSG vegetation that will contribute to the land-based offsets for Component 3. The ecosystem and species credits generated by the SBA and NBA for Component 3 are summarised in **Table 7.6**. The land-based offsets provide:

- 60% of the of the required 11,575 ecosystem credits;
- 54% of the required 6,683 species credits for the Regent Honeyeater; and
- 16% of the required 5,538 species credits for the Southern Myotis (breeding habitat).

No species credits for the Large-eared Pied Bat (breeding habitat) are provided by the SBA and NBA within non-WSW/WSG vegetation.

**Table 7.6 Ecosystem and Species Credits Generated by the Land-based Offsets for Component 3: Non-WSW/WSG Vegetation for the 2003 Extension**

Vegetation Community	TSC Act Listing	SBA		NBA		Total	
		Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits
<b>Ecosystem Credits</b>							
Central Hunter Grey Box - Ironbark Woodland	EEC	380.0	3,318	104.0	1,201	484.0	4,519
Regenerating Central Hunter Grey Box - Ironbark Woodland	EEC	18.5	161			18.5	161
Central Hunter Grey Box – Ironbark Derived Grassland		144.0	1,240	23.0	251	167.0	1,491
White Box Woodland	EEC	28.0	265			28.0	265
Yellow Box Woodland	EEC	7.0	77			7.0	77
Hunter Valley Vine Thicket	EEC	0.5	6			0.5	6
Hunter Lowlands Redgum Forest	EEC	32.5	319			32.5	319
River Red Gum Floodplain Woodland	EEC	9.5	83			9.5	83
<i>Total</i>		<i>620.0</i>	<i>5,469</i>	<i>127.0</i>	<i>1,452</i>	<i>747.0</i>	<i>6,921</i>
<b>Ecosystem Credits (non-‘like-for-like’)*</b>							
Hunter Valley River Oak Forest		25.5	238			25.5	238
Regenerating Hunter Valley River Oak Forest		1.0	11			1.0	11

**Table 7.6 Ecosystem and Species Credits Generated by the Land-based Offsets for Component 3: Non-WSW/WSG Vegetation for the 2003 Extension**

Vegetation Community	TSC Act	SBA		NBA		Total	
	Listing	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits
<i>Total</i>		26.5	249	0.0	0	26.5	249
<b>Species Credits</b>							
Regent Honeyeater	CE	502.0	3,012	104.0	623	606.0	3,635
Southern Myotis (breeding habitat)	E	150.0	901			150.0	901

*Note: all areas are rounded to the nearest 0.5 ha.*

*\* Not 'like-for-like' under UHSA and therefore unable to be used to offset the ecosystem credit requirement for impacts to non-WSW/WSG vegetation of the 2003 Extension. The habitat provided within these communities can however contribute to species credits if suitable habitat is identified.*

### 7.4.3 Mine Rehabilitation

#### i. Quantum

The Biodiversity Offset Strategy includes the rehabilitation of mined land for Component 3. A total of 4,654 of the outstanding ecosystem credit requirements will be achieved through mine rehabilitation, which represents approximately 19% of the total credit requirement for Component 3. These credits are generated from an 872.5 ha area, with a 50% discount applied to the calculated credits.

#### ii. Rehabilitation Objectives and Framework

A total of approximately 872.5 ha will be rehabilitated as Ironbark EEC (Central Hunter Grey Box – Ironbark Woodland/Central Hunter Ironbark – Spotted Gum – Grey Box Forest), as part of the credit requirements of Component 3.

The objectives of rehabilitation are to:

- re-create woodland and forest communities;
- provide additional habitat for threatened species; and
- create an additional north/south wildlife corridor.

The rehabilitation will form a north/south connecting corridor of vegetation between the existing vegetation to the north of the Proposal through the rehabilitation areas of MTO and Bulga Mine (see **Figure 7.6**) and in the future will connect to the large tract of intact

vegetation at Singleton Military Training Area. The proposed rehabilitation corridor reduces the impacts of edge effects by forming one large linear block of vegetation rather than numerous scattered patches allowing for easier management due to reduced weed invasion and similar edge effects. With time, the rehabilitation areas will provide additional suitable habitat for threatened fauna species that may be impacted by the Proposal.

The rehabilitation of woodland communities will be guided by leading-practice knowledge of rehabilitation and revegetation professionals. Research into the communities present within the study area has been undertaken by UNE and other regeneration practitioners. A sound understanding of the structure and functioning of these communities has been gained. The knowledge taken from this applied research will be used to ensure that the best available techniques of re-establishing a diverse tree, shrub and ground stratum layer within these communities are employed. All available knowledge will be used to maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities (Johnston, 2011; Thackway *et al.*, 2013).

Mine rehabilitation will use local native plant species and seed collection programs are currently being undertaken throughout the study area to ensure adequate seed is collected from all species to ensure species diversity is maintained. Where practical, topsoil will be translocated from proposed mining areas, with minimal stockpiling, in an attempt to maximise the viability of the native seed bank of local ecological communities.

#### **7.4.4 Supplementary Measures**

No supplementary measures proposed to be undertaken to meet the offsetting requirements of Component 3.

#### **7.4.5 Retirement of Credits under the UHSA**

Following establishment of the land-based offset sites, the residual credits required for Component 3 will be offset through a contribution to the Upper Hunter Offset Fund. This includes 2,924 residual species credits for the Regent Honeyeater, 139 species credits for the Large-eared Pied Bat (breeding habitat) and 4,626 residual species credits for the Southern Myotis (breeding habitat).

### **7.5 Consistency of the Biodiversity Offset Strategy with the Draft NSW Biodiversity Offsets Policy for Major Projects**

In order to assess whether the Biodiversity Offset Strategy is suitable to offset the proposed impacts, it has been assessed against the offsetting principles within the Draft NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014c). **Table 7.7** shows how these offsetting principles have been addressed by the Biodiversity Offset Strategy.

**Table 7.7 Consistency with OEH Offsetting Principles**

Draft NSW Offset Principles for Major Projects	Justification
1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts	Impact avoidance and minimisation measures have been implemented where feasible, however further avoidance is unfeasible due to the location of the resource.
2. Offset requirements should be based on a reliable and transparent assessment of losses and gains.	The ecological impact of the Proposal has been assessed and quantified using BCAM. Land-based offset sites have been assessed using BBAM. The use of BCAM and BBAM has allowed for a transparent assessment of the losses and gains of the Proposal.
3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities	Under the BOP, communities and habitats impacted by the Proposal have been targeted. This includes provision of equivalent vegetation communities and habitat, such as WSW, and Regent Honeyeater habitat. Under the BBAM and BCAM offsetting rules, offsets need to be either like-for-like or needs to be the same vegetation formation as the impacted vegetation. The proposed offsets have been assessed using BBAM and BCAM and comply with their offsetting rules.
4. Offsets must be additional to other legal requirements	The proposed offsets are additional in that they are proposed exclusively for the Proposal and are not already utilised by any other legal requirement for biodiversity.
5. Offsets must be enduring, enforceable and auditable	The proposed offsets will be enduring, enforceable and auditable. The SBA and NBA will be managed as a BioBank site and will be permanently protected and audited in accordance with the mechanisms prescribed by BBAM. The offsets established by paying into the Upper Hunter Offset Fund to be established under the UHSA will be permanently protected and audited under the mechanisms provided for by the UHSA.
6. Supplementary measures can be used in lieu	To address Proposal impacts to WSW, a range of

**Table 7.7 Consistency with OEH Offsetting Principles**

Draft NSW Offset Principles for Major Projects	Justification
of offsets	<p>supplementary measures will be provided in consultation with OEH, the re-establishment of large areas of this community in the NBA, preparation of an Integrated Management Plan for WSW and appropriate completion criteria for the re-establishment of this community. Further supplementary measures may be required by OEH.</p>
<p>7. Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the Proposal</p>	<p>The Proposal will result in significant social and economic benefits to NSW, including revenue from mining royalties and significant employment. Discounting has not been applied but the decision maker might allow a discount for WSW.</p>

## Conclusion

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This EIA has been prepared in accordance with the SRs and relevant contemporary government legislation and policy. The Proposal will require the progressive additional clearing of 611 ha of native vegetation, including 72 ha of WSW EEC, 372 ha of Central Hunter Grey Box – Ironbark Woodland EEC and 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC within the disturbance boundary. No listed threatened flora species have been recorded within the disturbance boundary although one species is known to occur nearby. The vegetation to be removed comprises a suite of woodland and open forest communities, which provide habitat for several threatened fauna species.

Avoidance and mitigation measures have been implemented through the design of the Proposal to reduce the ecological impacts. Such avoidance includes the decision to close, rather than relocate, Wallaby Scrub Road to reduce impacts on EECs. Measures to mitigate and compensate for the loss of biodiversity features, including EECs and associated woodland habitat, have also been identified. Mitigation will be implemented under Rio Tinto Coal Australia's biodiversity commitments, which include a rigorous management regime to achieve a net positive impact on biodiversity.

In accordance with the UHSA, BCAM has been used as a tool to quantify the impacts of the Proposal. The impacts of the Proposal have been assessed separately for WSG/WSG vegetation (Component 1) and non-WSW/WSG vegetation (Component 2). The disturbance boundary of the Proposal includes some areas that were designated as HMAs and NDAs for the under approval for the 2003 Extension. As such, this assessment also includes a BCAM analysis of the impacts to non-WSW/WSG vegetation for the 2003 Extension (Component 3). The impacts calculated using BCAM will be compensated for by the provision of offsets.

In order to offset the impacts of the Proposal, the Biodiversity Offset Strategy includes establishment of land-based offset sites, mine rehabilitation, supplementary measures and the retirement of credits under the rules of the UHSA.

For Component 1, the clearing of 72 ha of WSW and 0.5 ha of WSG for the Proposal will be offset by the provision of 75.5 ha of WSW in the SBA and NBA, as well as the re-establishment of 159.5 ha of this community in the offset areas. In addition, a range of supplementary measures will be implemented for this community including preparation of an Integrated Management Plan for WSW and the development of completion criteria for the re-establishment of WSW.

For Component 2, the clearing of 538.5 ha of non-WSW/WSG vegetation may be offset by the provision of land-based offsets, mine rehabilitation or the retirement of credits under the

rules of the UHSA. Although specific offset properties have not been proposed at this stage, any package of offset properties must fulfil the requirements of the BCAM analysis, and therefore they will “maintain and improve” the values being lost in the disturbance boundary. In addition, 1,227.5 ha of Ironbark EEC will be created through the rehabilitation of mined areas.

For Component 3, the clearing of 477.5 ha of non-WSW/WSG vegetation within the disturbance area of the 2003 Extension will be offset by the provision of 773.5 ha of non-WSW/WSG vegetation in the SBA and NBA. In addition, 872.5 ha of Central Hunter Grey Box – Ironbark Woodland will be created through the rehabilitation of mined areas.

The proposed Biodiversity Offset Strategy will meet the requirements of the UHSA and be consistent with the principles of the Draft NSW Biodiversity Offsets Policy for Major Projects. It will achieve the maintenance and improvement of a substantial area of native woodland and forest vegetation, including WSW and threatened species habitat that will be conserved in perpetuity. This represents a net positive ecological outcome as required by Rio Tinto’s Biodiversity Policy.

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*Appendix A*

# Detailed Field Survey Methodology

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## A.1 Literature Review

All available literature pertaining to ecological aspects within the study area was reviewed during the preparation of this Study. The documents reviewed are listed in **Table A.1**.

**Table A.1 Documents Reviewed**

Author	Year	Document Title
ERM	1995	Extension of Mining at Mount Thorley Operations - Environmental Impact Statement – Chapter 6
ERM	2002	Extension of Warkworth Coal Mine Environmental Impact Statement Report Vol 1 to 4
ERM	2002	Extension of Warkworth Coal Mine – Green Offsets Strategy. Report prepared for CNA
Department of the Environment, Water, Heritage and the Arts	2004	Environmental Protection and Biodiversity Conservation (EPBC) Approval Issued by the Commonwealth Minister for the Environment, EPBC 2002/629, original dated 18th February 2004
Department of Planning	2004	Warkworth Mine Development Consent Conditions Issued by the NSW Minister for Planning – DA-300-9-2002-I, dated 19 May 2003 (with changes made to consent on 19 October 2004)
Andrews Neil	2006	Warkworth Fauna and Flora Baseline Survey and CNA Biodiversity and Rehabilitation Monitoring
Hunter-Central Rivers Catchment Management Authority	2006	The Vegetation of the Central Hunter Valley, NSW Vol 1: Main Report - A report on the findings of the Hunter Remnant Vegetation Project
Hunter-Central Rivers Catchment Management Authority	2006	The Vegetation of the Central Hunter Valley, NSW Vol 2: Profiles of Vegetation Communities
ERM	2007	Threatened Flora and Fauna of HVO North, HVO South and Mount Thorley Warkworth Literature Review and Gap Analysis. Report prepared for CNA
Gross, C	2007	The Vegetation of the Warkworth Sands and Associated Vegetation Communities
Lockwood, Peter	2007	Warkworth Sands Soil Survey Soil Sampling and Analysis within the Green Offsets and at Archerfield, a Report to CNA
Debus, S	2008	Mount Thorley Warkworth Operations Green Offsets Avifauna Monitoring Autumn 2008 Report To Coal & Allied (Debus, 2008a)
Debus, S	2008	Mount Thorley Warkworth Operations Green Offsets Avifauna Monitoring Spring 2008 Report To Coal & Allied (Debus, 2008a)

**Table A.1 Documents Reviewed**

Author	Year	Document Title
ERM	2008	Warkworth Coal Mine Green Offsets Fauna and Flora Management Plan
Kumar, L et al.	2009	Mapping Vegetation Communities to extract Warkworth Sand Woodlands in the Rio Tinto Coal Australia area in the Hunter Valley
SMEC Australia	2009	Ecological Assessment of Matters of National Environmental Significance - Mount Thorley Warkworth Expansion
Cumberland Ecology	2010	Warkworth Mine Extension Ecological Assessment
Cumberland Ecology	2012	Statement of Evidence Land and Environment Court of NSW. Class 1, Proceedings 10224 of 2012

## A.2 Database Analysis

A search was conducted of the NSW OEH Atlas of NSW Wildlife database (DECC (NSW), 2009) to generate records of threatened flora and fauna species listed under the TSC Act within the Singleton LGA. This analysis was undertaken in 2010 to inform the 2010 EA, and was conducted again in 2014 in order to provide a contemporary assessment and to determine if any additional species have been listed or recorded from the locality.

The lists generated from this database were reviewed against available knowledge of the Site to ascertain the likelihood of occurrence of threatened species.

## A.3 Vegetation Mapping

The study area has been extensively surveyed and mapped from 2004 until 2014. Florasearch (2004) mapping was used to inform initial vegetation surveys of the study area, and in 2009 Cumberland Ecology conducted extensive surveys to revise and update this existing vegetation mapping. Cumberland Ecology ground truthed the existing vegetation mapping by Florasearch, updating plant community names and making minor modifications to some vegetation areas where considered appropriate.

Vegetation communities were mapped using Geographical Positioning System (GPS) during flora field surveys. In addition, aerial photographs, satellite imagery, and topographic maps were used to assist in the delineation of vegetation communities. The mapping was investigated in the field via the following methods:

- quadrat sampling (20 m x 20 m, 20 m x 50 m) to characterise vegetation map units by their species composition and community structure;

- meander quadrat surveys to obtain information on community distribution in the study area; and
- detailed walks of vegetation units, recording boundaries using a handheld GPS unit.

Plant communities were described based on the dominant canopy species and community structure according to (Specht, 1970).

The vegetation mapping was further refined in 2012 by Cumberland Ecology following detailed review of available information. A total of eight 20 x 20 m quadrats were surveyed at the NBA (see **Figure A.2**). Each quadrat was used to obtain site-specific information on floristics and community structure. These quadrats were located within areas near mapped occurrences of WSW, principally up slope, to demonstrate the presence of further “characteristic” WSW woodland plant species, as defined in the Scientific Committee Final Determination (2011). These additional quadrats were completed to provide a snapshot of species present in 2012, and to illustrate that at least two recognisable assemblages of WSW occurred in close proximity to each other.

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;
- a waypoint to mark the location of the quadrat, using a handheld GPS; and
- photographs of the quadrat.

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993). Other references used to assist identification of selected plant taxa include Richardson et al (2006) and Brooker and Kleinig (1990). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from PlantNET (2012). Any specimens that were not readily identifiable were lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney.

The relative abundance and cover of each species within the quadrat was approximated using a scoring system based on the Braun-Blanquet scoring system (1927). The scores used are provided in **Table A.2** below.

**Table A.2 Braun-Blanquet Scoring System**

Class	Cover-abundance	Notes
R	Rare (less than 0.1% cover)	Herbs, sedges and grasses: within 1 m <sup>2</sup> Shrubs and small trees: 1 individual
+	Few Individuals (less than 1% cover)	Herbs, sedges and grasses: within 10 m <sup>2</sup> Shrubs and small trees: <5 individuals Medium - large overhanging tree
1	Many Individuals (less than 5% cover)	Herbs, sedges and grasses: within 50 m <sup>2</sup> 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	-
X	Incidental (adjacent but not within plot)	
(*)	Exotic species; not native to study area	

### ***A.3.1 Mapping of Warkworth Sands Woodland***

Initially, WSW in the study area was mapped as part of the overall fieldwork for the EA in 2009. This included completing quadrats in representative areas of this community, and recording floristic and structural details.

Subsequently in 2012, patches of vegetation previously mapped as WSW and Central Hunter Box - Ironbark Woodland were walked to ground-truth the occurrence and extent of the community types and to obtain a thorough understanding of key remnant areas of vegetation (general site floristics; topographical characters; and aspect).

Following the field survey, updated mapping of WSW was conducted utilising the results of the fieldwork combined with review of the latest soil mapping by Lockwood (2007), in particular mapping of aeolian sand deposits as this community is restricted to these areas. Previous vegetation mapping conducted in 2009 was overlain with the latest estimates of sand occurrence to re-estimate the area of WSW, in some cases substantially expanding its mapped boundaries.

Recent (2013) high resolution aerial photography of the study area was reviewed in 2014 to compare the areas of vegetation mapped in 2010 with those currently present. This resulted in some minor modifications to the vegetation communities present due to the some regrowth vegetation that had developed since the previous mapping was completed.

## A.4 Flora Survey

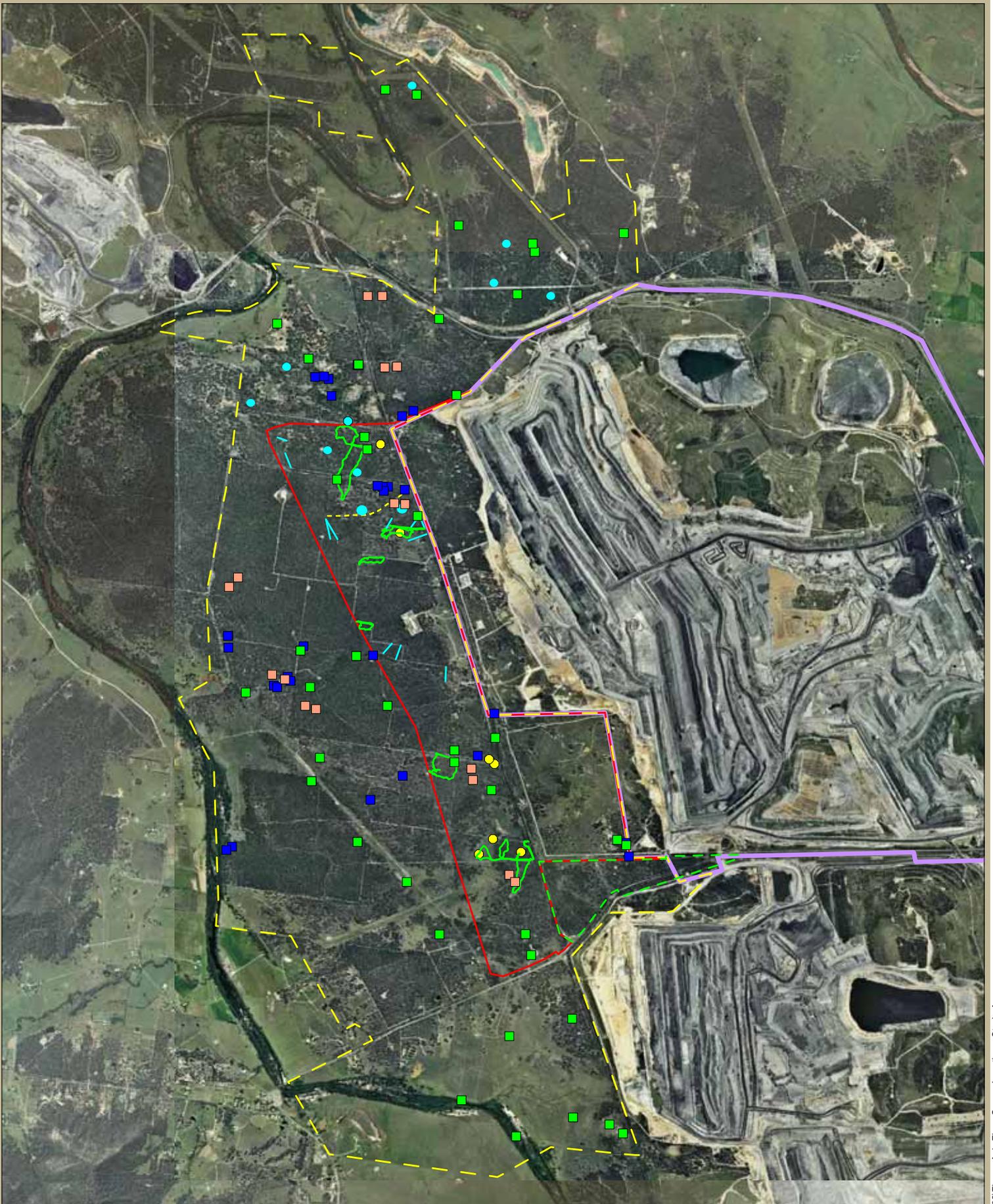
The flora of the study area has been studied in considerable detail across a range of sites, seasons and years by a suite of different botanists. Work has been done by ERM (2002a), Flora Search (2004), Andrews Neil (2006), Peake (2006), UNE (2008-2012), ACA (2011, 2012), Cumberland Ecology (2009) (2012) and Bell (2012).

Cumberland Ecology conducted flora surveys across the study area in three periods from 11-12 June 2009, 24-26 June 2009, 7-11 September 2009, 20-21 September 2012, 3-4 October 2012 and 28-30 October 2013, Flora surveys were conducted in accordance with the (then) DEC Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft) (2004) and involved the following:

- meander-transect surveys to ground-truth the occurrence and extent of vegetation community types, making records of boundary changes using a handheld Global Positioning Systems (GPS) unit;
- targeted searches for EECs known or considered likely to occur within the study area; and
- targeted searches for threatened flora known or considered likely to occur within the study area.

A total of 47 quadrats have been sampled, 45 within the study area, and two within adjacent lands. The quadrats were located in areas most representative of the condition and composition of the vegetation patch. Additional plots were taken within the 2003 approval area to allow collection of habitat data for use in BBAM calculations. These calculations were used as a tool to determine an appropriate amount of offsets. The quadrat locations are shown in **Figure A.1**. Flora survey locations on the NBA are shown in **Figure A.2**.

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (Harden, 1990-1993). Other references were used to assist identification, particularly for difficult specimens (Brooker and Kleinig, 1990; Richardson *et al.*, 2006). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from PlantNET (Botanic Gardens Trust, 2013).



**Legend**

- Disturbance Boundary
- Study Area
- Existing Warkworth Mine Development Consent Footprint
- Area already approved to be mined by MTO under DA 34/95

**Flora Survey Locations  
Cumberland Ecology (2009&2013)**

- Flora Quadrat Location
- East Coast Flora Survey (2012)**
- Flora Quadrat Location

- ACA (2012)**
- Flora Quadrat Location (multiple Quadrats in line)

**Andrews & Neil (2006)**

- Flora Quadrat Location

**ERM (2002)**

- Flora Quadrat Location

**Targeted Flora Survey Locations  
Cumberland Ecology (2012)**

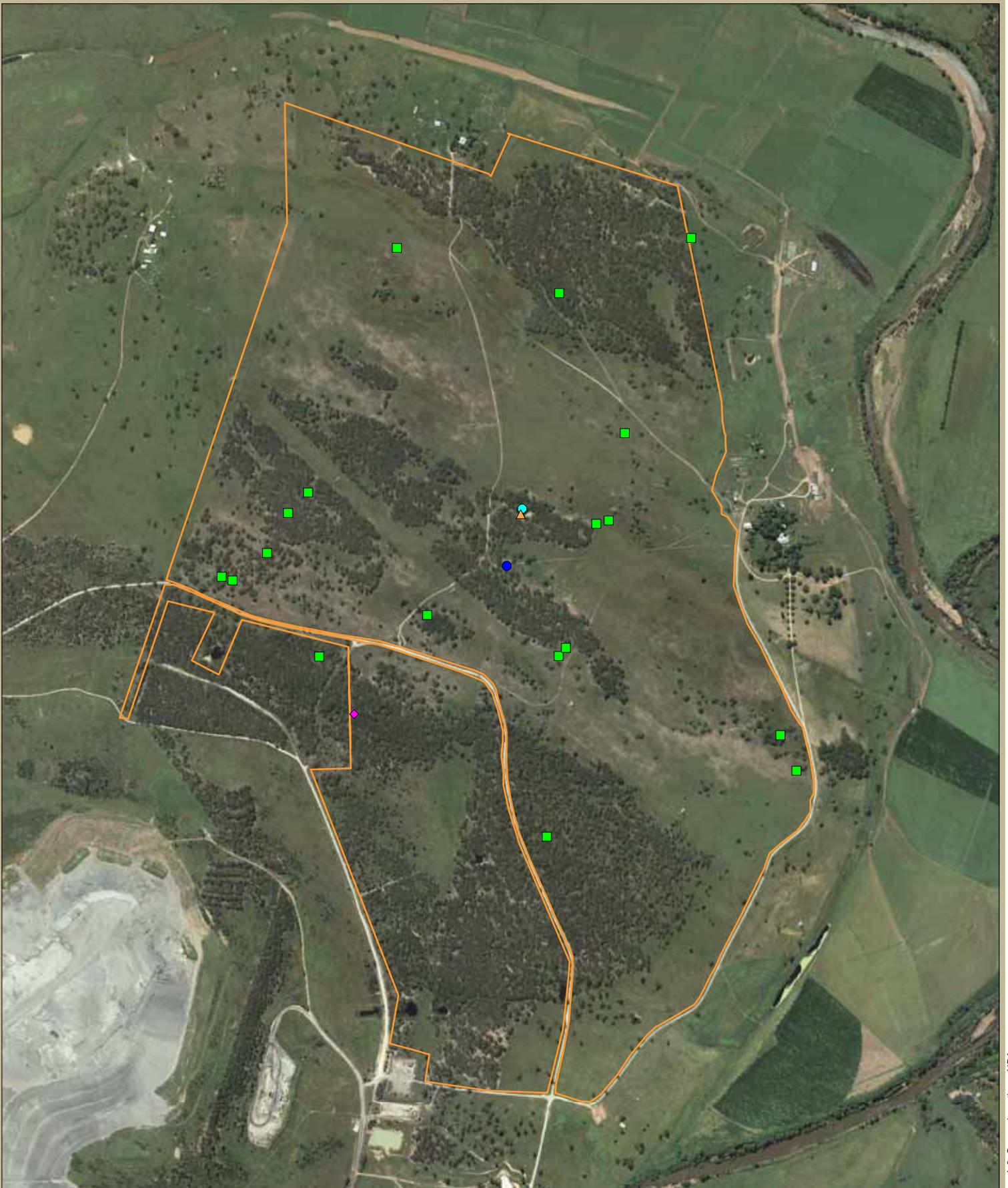
- Flora Area Search
- Flora Transect
- Random Meander

Image Source:  
RTCA 2013



**Figure A.1. Flora Survey Locations in the Study Area**





**Legend**

Orange outline Northern Biodiversity Area

**Flora Survey Locations**

Green square Quadrat Location

**Fauna Survey Locations**

Blue triangle Anabat

Purple diamond Habitat Assessment

Blue circle Harp Trap

Cyan circle Spotlight/Call Playback

Image Source:  
RTCA 2012



**Figure A.2. Flora and Fauna Survey Locations in the Northern Biodiversity Area**

125 0 125 250 375 500m

## A.5 Fauna Survey

Numerous fauna surveys have been carried out in the study area since 1995 (see **Table A.1**). Cumberland Ecology conducted additional field surveys in 2009 to address any gaps from previous studies within the study area.

Cumberland Ecology undertook fauna surveys over four one-week periods; 15–19 June 2009, 29 June–3 July 2009, 13–17 July 2009 and 7–11 September 2009. The fauna surveys were conducted, where possible, in accordance with the (then) DEC Threatened Biodiversity Survey and Assessment Guidelines (DEC (NSW), 2004). These results have been supplemented by previous field surveys dating back to 1995, and by recent (2014) database analysis. A precautionary approach has been taken in this assessment, and any species recorded from the locality with potential to occur has been assessed as occurring. Although these surveys were conducted over four years ago, taking this approach into consideration, they are considered to be appropriate to characterise the environment in the study area.

A summary of trapping and sampling effort during the field surveys conducted by Cumberland Ecology is provided in **Table A.3** and is shown in **Figure A.3**.

**Table 8.3 Cumberland Ecology Fauna Survey Effort**

Survey Technique	Cumberland Ecology Survey Effort (2009)
Amphibians	
Systematic day habitat search	5 person hours
Night habitat search of damp and watery sites	4 person hours
Night watercourse search	4 person hours
Reptiles	
Habitat search	4.5 person hours
Pitfall traps with drift nets	125 trap nights
Spotlighting	9.5 person hours
Diurnal Birds	
Incidental searches	Throughout survey periods
Targeted bird survey (S. Debus)	Visual and auditory searches totalling 13 hours over 2 days*
Nocturnal Birds	
Call playback	9 hours
Day habitat search	Throughout survey periods
Spotlighting on foot	15.5 person hours

**Table 8.3 Cumberland Ecology Fauna Survey Effort**

Survey Technique	Cumberland Ecology Survey Effort (2009)
Non-flying Mammals	
Small Elliott traps	1,054 trap nights
Large Elliott traps (terrestrial)	430 trap nights
Large Elliott traps (arboreal)	430 trap nights
Cage traps	172 trap nights
Pitfall traps with drift fencing	125 trap nights
Terrestrial Hair tubes	1,360 trap nights
Arboreal hair tubes	1,360 trap nights
Spotlighting on foot	9.5 person hours
Call playback	6 hours
Search for scats and signs	12 person hours
IR cameras	107 nights of data capture
Collection of predator scats	Throughout survey period
Bats	
Ultrasonic call recording	17 nights
Harp Traps	12 nights

*Note: \* Limited targeted bird surveys were conducted during the Cumberland Ecology survey periods due to the extensive amount of targeted bird surveys previously conducted.*

### **A.5.1 Fauna Habitat Assessments**

Standardised fauna habitat assessment plots were conducted at all locations that flora quadrats were undertaken. Habitat assessment plots were 50 m x 20 m in size and the following fauna habitat attributes were recorded within each plot:

- Canopy cover;
- Mid-storey cover;
- Ground cover;
- Number of tree hollows;
- Total length of fallen logs; and
- Any other significant fauna habitat feature, e.g. rocky outcrops, large stand of feed trees, etc.

These plots were used to gain an understanding of the extent of these kinds of fauna habitat features within the study area. The locations of the habitat assessment plots are shown in **Figure A.1** (same locations as flora quadrats by Cumberland Ecology).

In addition to these plots, fauna habitat assessments were undertaken across the study area at each trapping location by the fauna survey team (see below). The study area was assessed for 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 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 vegetation and the nature and extent of human disturbance throughout the study area was undertaken and considered.

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

### ***A.5.2 Cage and Elliott Trapping***

Trapping was used to detect arboreal and terrestrial fauna occurring in the study area. The following traps were utilised during the survey:

- Cage traps for medium to large sized terrestrial fauna;
- Elliot B traps for small to medium sized terrestrial and arboreal fauna; and
- Elliot A traps for small terrestrial fauna.

Arboreal trap lines were established with Elliot B traps and set approximately 25 m apart depending on available habitat. The traps were placed on platforms attached to habitat trees at a height of approximately 2 m. Traps were baited with a mixture of peanut butter, honey, rolled oats, diced bacon and vanilla essence. Each tree was sprayed with a honey and water mixture. Ten traps were placed along each of 12 transects, and were open for a period of three to four nights on each transect.

Terrestrial trap lines were established using Elliot A, Elliot B and cage traps. Elliot A traps were placed approximately 10 m apart along each trapping transect, while Elliot B and cage traps were spread evenly along each transect. Twenty-five Elliot A, ten Elliot B and four cage traps were placed along each of the trapping transects. The Elliot A traps were baited with peanut butter, honey, rolled oats, diced bacon and vanilla essence to target small mammals. The Elliot B traps were baited with the above mixture plus pieces of apple and sweet potato. Cage traps were baited with chicken carcasses. Traps were left out for a period of four nights along each of 12 transects.

Trapping lines were checked early morning, and any fauna captured were identified and released.

The locations of the cage and Elliott traps are shown in **Figure A.3**.

### ***A.5.3 Pitfall Traps***

Pitfall lines were established at four locations throughout the study area. Each pitfall line consisted of five pitfall bucket traps placed approximately 5 m apart. Drift fencing was erected along each pitfall line. Pitfall lines were checked early morning, and any fauna found were identified and realised. Traps were left open for a total of 125 trap nights. The locations of the pitfall traps are shown in **Figure A.3**.

### ***A.5.4 Hair Tubes***

'Faunatech' hair tubes were used during the survey period to detect arboreal and terrestrial mammals. Three transects of 40 hair tubes were established with one hair tube placed on the ground and one on a tree at each sampling location along the transects. One hundred of the hair funnels were baited with rolled oats, peanut butter and honey. The remaining one hundred hair funnels were baited with a mix of flour, sardines and tuna oil as used effectively during previous surveys specifically targeting the Spotted-tail Quoll in south-eastern NSW (Nelson, 2006). A total of 120 hair tubes were deployed for a period of between 12 and 28 nights depending on location, giving a survey effort of 2,720 trap nights. Hair samples were analysed by Georgeanna Story of 'Scats About'. The locations of the hair tubes are shown in **Figure A.3**.

### ***A.5.5 Bat Surveys***

Anabat Zero Crossings Analysis Interface Module (ZCAIM) units were employed on a total of 17 survey nights to record calls of microbats. Anabats were set at dusk and switched off after nocturnal surveys each night. Calls recorded on each Anabat unit were analysed to determine which species were present within the study area.

Harp traps were employed during the Spring surveys to identify microchiropteran bat species that are unable to be identified using Anabat detection. Harp traps were set up at dusk, and checked again at dawn. All bats captured were identified and then released, or kept in a bag in a dark place during the day and then released in the same location the following night.

Harp trap nights were used to sample for a total of 12 trap nights.

The locations of the Anabat units and the harp trap survey locations are shown in **Figure A.3**

### ***A.5.6 Diurnal Bird Surveys***

Visual observation and call identification of diurnal birds was carried out during targeted bird surveys by ornithologist Dr Stephen Debus from the 10–11 June 2009. Surveys were carried out throughout the study area, particularly targeting any areas with the winter flowering *Corymbia maculata* (Spotted Gum). Targeted bird surveys were conducted at several points throughout the study area. Diurnal birds were also identified and recorded as

they were encountered throughout the study area by Cumberland Ecology ecologists during the survey periods.

#### **A.5.7 Spotlight Surveys**

Spotlighting was conducted for nocturnal mammals, birds and reptiles. Nocturnal surveys were conducted using a hand-held 30 watt spotlight whilst walking or from a slow moving vehicle. Spotlighting transects were spread throughout the study area, and incidental spotlighting was also conducted while travelling between transects at night.

#### **A.5.8 Call Playback**

Nocturnal surveys were undertaken over several nights during each survey period for threatened bird species recorded from within the Singleton LGA and for which suitable habitat occurs within the study area.

During spotlighting surveys, call playback of nocturnal bird and mammal calls was broadcast using a megaphone to illicit a response from targeted threatened nocturnal species. These included the following birds: Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), and Bush Stone-curlew (*Burhinus grallarius*), and the following mammals: Koala (*Phascolarctos cinereus*), Spotted-tail Quoll (*Dasyurus maculatus*) and Squirrel Glider (*Petaurus norfolcensis*).

Surveys were precluded by a period of quiet listening prior to call playback. Recorded calls of the target species were then broadcast through an amplifier for two minutes, followed with quiet listening and spotlighting for a subsequent five minutes. After this time, the sequence was repeated.

#### **A.5.9 Infrared Cameras**

Infrared (IR) cameras were set up at five locations throughout the study area. The cameras were attached to trees and the focal point of the camera was on a cage on the ground. The cages were baited with chicken carcasses. A total of five cameras collected 107 nights of data with cameras being re-baited when necessary.

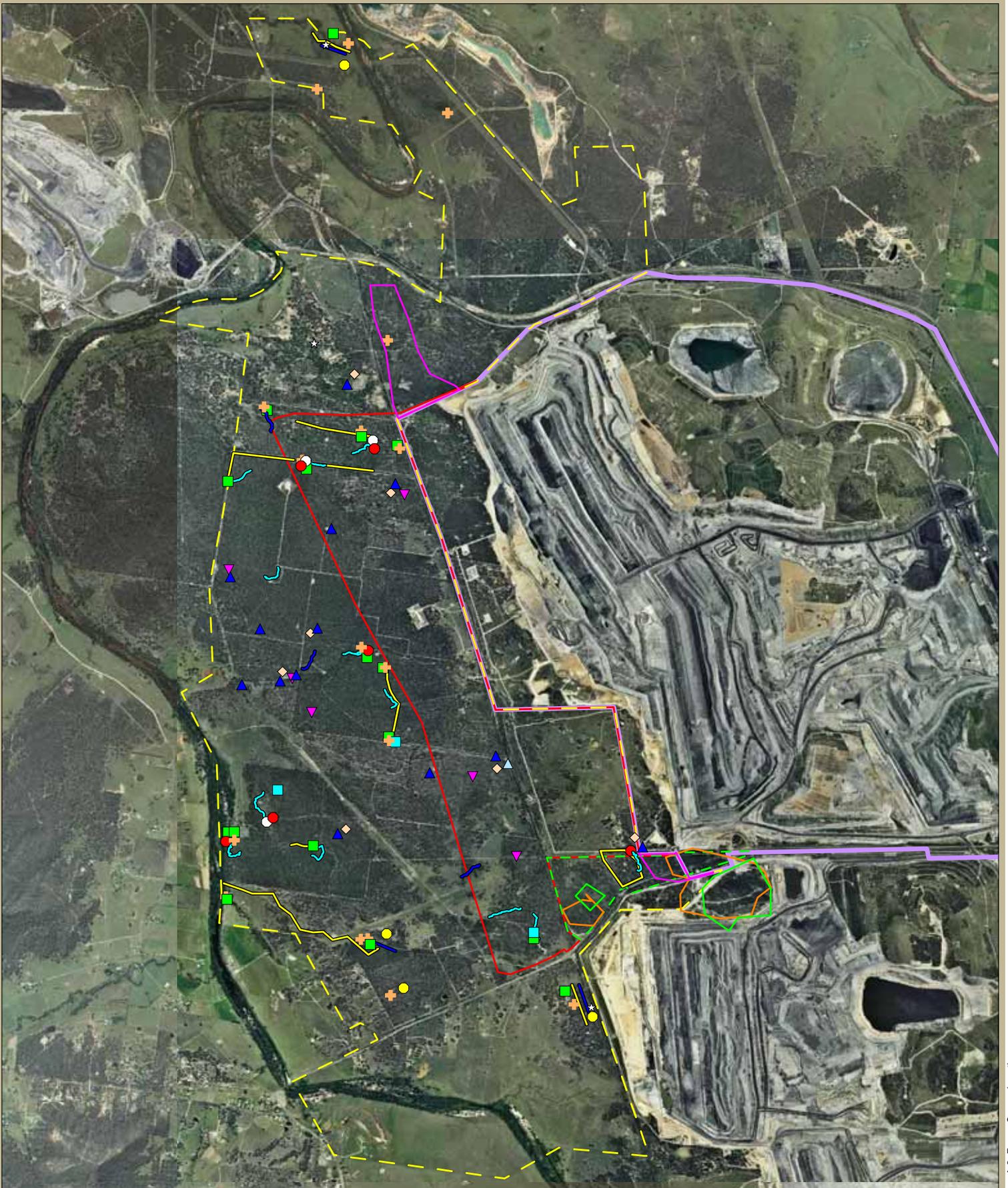
#### **A.5.10 Amphibian and Reptile Surveys**

Targeted diurnal and nocturnal active searches were conducted in suitable habitat for amphibians and reptiles throughout the study area. Diurnal active searches were conducted at various points for a set period of 30 minutes per sample site. Opportunistic active searches were also conducted during other diurnal and nocturnal activities. Searches involved the lifting of bark, fallen logs and bush rock and the scraping of top soil. Caught animals were identified and then released.

#### **A.5.11 Incidental Observations**

Any incidental vertebrate fauna species that were observed, heard calling, or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for

the study area. Incidental records of fauna recorded from areas adjacent to the study area during the survey period have also been included.



**Legend**

- |  |   |                                  |                   |
|--|---|----------------------------------|-------------------|
| Disturbance Boundary                                       | <b>Fauna Survey Locations<br/>Cumberland Ecology (2009)</b> | <b>Debus (2008)</b>              | <b>ERM (1996)</b> |
| Study Area   | Harp Trap   | Survey Location                  | Fauna Survey Area |
| Existing Warkworth Mine<br>Development Consent Footprint   | Bird Census   | <b>Andrews &amp; Neil (2006)</b> | Bat Survey Area   |
| Area already approved to be<br>mined by MTO under DA 34/95 | IR Camera   | Monitoring Location              |                   |
|  | Call Playback   | Survey Location                  |                   |
|  | Active search   | <b>ERM (2002)</b>                |                   |
|  | Anabat  | Fauna Survey Location            |                   |
|  | Pitfall Trap  | Fauna Survey Area                |                   |
|  | Spotlight Transect  |                                  |                   |
|  | Trap Line   |                                  |                   |
|  | Hair Tube Line  |                                  |                   |

Image Source:  
RTCA 2013



Figure A.3. Fauna Survey Locations in the Study Area



## A.6 Adequacy of Surveys

Numerous flora and fauna surveys of the study area have been conducted since 1995 (see **Section A.1**). Accordingly, there is a wealth of existing data on the biodiversity values of the study area. The 2009 surveys were undertaken to provide additional data for selected portions of the study area as well as to survey particular groups where survey effort was lacking.

The 2009 surveys were conducted in the winter months, providing optimal conditions for detecting mixed flocks of non-breeding resident and winter-migratory species, particularly the Swift Parrot (*Lathamus discolor*). The winter survey period was also suitable to determine if the study area is frequented by the threatened honeyeater species: Regent Honeyeater (*Anthochaera phrygia*), Black-chinned Honeyeater (*Melithreptus gularis gularis*) and Painted Honeyeater (*Grantiella picta*).

Spotted Gums (*Corymbia maculata*) in the Hunter Valley experienced prolific blossoming in the weeks leading up to the 2009 survey periods, and additional nectar-producing trees were commencing blossoming during the surveys. However, the blossoming of Spotted Gums within the study area was not as intense or prolific as that which occurred in other parts of the Hunter Valley (e.g. areas surrounding Cessnock) where sighting of Regent Honeyeaters, Swift Parrots and Black-chinned Honeyeaters were being regularly recorded at the time of the winter surveys (Eremaea Birds, 2009). Given the blossoming Spotted Gum and records of Regent Honeyeater and other nectarivorous species from within the Hunter Valley it is considered that the winter surveys of the study area were conducted at an appropriate time for detection of the Swift Parrot and Regent Honeyeater. Adequate surveys have been conducted for summer migrant species during previous surveys (ERM, 1995; ERM, 2002a; Andrews Neil, 2006; Debus, 2008a; Debus, 2008b)

Taking into consideration the combined survey effort of all surveys completed to date, it is considered that adequate survey effort has been undertaken for all fauna groups at appropriate times of the year throughout an extended period of time.

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*Appendix B*

Flora Species List

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**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	U	34		x		x	x
	<i>Pseuderanthemum variabile</i>	Pastel Flower	U	11		x			
Adiantaceae	<i>Cheilanthes distans</i>	Bristly Cloak Fern	U	35			x		x
	<i>Cheilanthes sieberi</i>	Rock Fern	U	30				x	x
	<i>Cheilanthes sieberi subsp. sieberi</i>	Rock Fern	U	75			x		
Aizoaceae	<i>Galenia pubescens*</i>	Galenia	U	44				x	x
Amaranthaceae	<i>Alternanthera pungens*</i>	Khaki Weed	U	3			x		
	<i>Alternanthera spp.</i>								x
	<i>Amaranthus spp.</i>								x
	<i>Ptilotus indivisus</i>		U					x	
	<i>Schinus areira*</i>	Pepper Tree	U	20				x	
Anthericaceae	<i>Arthropodium milleflorum</i>	Pale Vanilla-lily	U	13			x		
	<i>Arthropodium minus</i>	Small Vanilla Lily	U	7			x	x	
	<i>Arthropodium spp.</i>		U	9		x		x	x
	<i>Caesia parviflora</i>	Pale Grass-lily	U	6				x	
	<i>Laxmannia gracilis</i>	Slender Wire Lily	U	48		x		x	x
	<i>Tricoryne elatior</i>	Yellow Autumn-lily	U	12		x	x	x	
Apiaceae	<i>Actinotus spp.</i>							x	

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Apiaceae spp.</i>							x	
	<i>Centella asiatica</i>	Indian Pennywort	U	16			x		x
	<i>Cyclospermum leptophyllum*</i>	Slender Celery	U	11				x	
	<i>Daucus glochidiatus</i>	Native Carrot	U	9				x	
	<i>Hydrocotyle peduncularis</i>	a Pennywort	U	4			x		
	<i>Hydrocotyle spp.</i>								x
Apocynaceae	<i>Gomphocarpus fruticosus*</i>	Narrow-leaved Cotton Bush	U	40		x	x	x	x
	<i>Gomphocarpus spp.*</i>		U						x
	<i>Parsonsia lanceolata</i>	Rough Silkpod	U	3				x	
	<i>Parsonsia straminea</i>	Common Silkpod	U	16				x	
Arecaceae	<i>Phoenix dactylifera*</i>	Date Palm	U					x	
Asparagaceae	<i>Asparagus officinalis*</i>	Asparagus	U					x	
Asphodelaceae	<i>Bulbine spp.</i>							x	
Asteraceae	<i>Ageratina adenophora*</i>	Crofton Weed	U	3		x			
	<i>Bidens pilosa*</i>	Cobbler's Pegs	U	33		x	x	x	x
	<i>Bidens spp.*</i>							x	
	<i>Bidens subalternans*</i>	Greater Beggar's Ticks	U						x
	<i>Brachyscome multifida var. dilatata</i>	Cut-leaved Daisy	U	2		x			x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Calocephalus citreus</i>	Lemon Beauty-heads	U						x
	<i>Calotis cuneifolia</i>	Purple Burr-Daisy	U	35		x	x	x	x
	<i>Calotis hispidula</i>	Bogan Flea	U	2			x		
	<i>Calotis lappulacea</i>	Yellow Burr-daisy	U	25		x		x	x
	<i>Carthamus lanatus*</i>	Saffron Thistle	U	9				x	
	<i>Cassinia quinquefaria</i>		U	6		x			
	<i>Cassinia spp.</i>							x	
	<i>Chrysocephalum apiculatum</i>	Common Everlasting	U	50		x	x	x	x
	<i>Chrysocephalum semipapposum</i>	Clustered Everlasting	U						x
	<i>Cirsium vulgare*</i>	Spear Thistle	U	30		x	x		x
	<i>Conyza bonariensis*</i>	Flaxleaf Fleabane	U	27		x	x		x
	<i>Conyza canadensis var. canadensis*</i>	Canadian Fleabane	U	2		x			
	<i>Conyza spp.*</i>							x	x
	<i>Conyza sumatrensis*</i>	Tall fleabane	U	30		x			
	<i>Cotula australis</i>	Common Cotula	U	10			x		
	<i>Cymbonotus lawsonianus</i>	Bear's Ear	U			x			x
	<i>Epaltes australis</i>	Spreading Nut-heads	U	9		x			
	<i>Euchiton involucratus</i>	Star Cudweed	U	4				x	

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Euchiton sphaericus</i>	Star Cudweed	U						x
	<i>Facelis retusa*</i>		U	9			x	x	
	<i>Glossogyne tannensis</i>	Cobbler's Tack	U	18		x		x	x
	<i>Gnaphalium spp.*</i>								x
	<i>Hypochaeris microcephala var. albiflora*</i>	White Flatweed	U	7		x			
	<i>Hypochaeris radicata*</i>	Catsear	U	62		x	x	x	x
	<i>Lagenophora gracilis</i>	Slender Lagenophora	U	4		x			
	<i>Olearia elliptica</i>	Sticky Daisy-bush	U	12				x	
	<i>Olearia sp.?</i>								x
	<i>Olearia viscidula</i>	Wallaby Weed	U	3		x			
	<i>Onopordum acanthium*</i>	Scotch Thistle	U					x	
	<i>Ozothamnus diosmifolius</i>	White Dogwood	P13	31		x	x	x	x
	<i>Podolepis spp.</i>		U	1		x		x	
	<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	U	5			x		
	<i>Senecio jacobaea*</i>	Ragwort	U			x			
	<i>Senecio madagascariensis*</i>	Fireweed	U	88		x	x	x	x
	<i>Senecio spp.*</i>		U	6		x			
	<i>Solenogyne bellioides</i>		U	9			x		x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Soliva sessilis</i> *	Bindyi	U	6			x		
	<i>Sonchus asper subsp. glaucescens</i> *	Prickly Sowthistle	U					x	
	<i>Sonchus oleraceus</i> *	Common Sowthistle	U	24				x	x
	<i>Sonchus spp.*</i>		U	1				x	
	<i>Taraxacum officinale</i> *	Dandelion	U	11		x	x		
	<i>Vernonia cinerea</i>		U	34		x			x
	<i>Vittadinia cuneata var. cuneata forma minor</i>	A Fuzzweed	U				x		x
	<i>Vittadinia spp.</i>		U	15				x	x
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Wonga Vine	U	24			x	x	
Boraginaceae	<i>Cynoglossum australe</i>		U	3		x		x	
	<i>Echium vulgare</i> *	Viper's Bugloss	U					x	
	<i>Heliotropium amplexicaule</i> *	Blue Heliotrope	U	8				x	x
Brassicaceae	<i>Lepidium africanum</i> *	Common Peppercross	U	9		x			
	<i>Lepidium bonariense</i> *	Argentine Peppercross	U	14				x	
	? <i>Lepidium pseudohyssopifolium</i>	Peppercross	U						x
	<i>Lepidium spp.*</i>	A Peppercross	U	2				x	
Cactaceae	<i>Opuntia aurantiaca</i> *	Tiger Pear	U	20				x	x
	<i>Opuntia stricta</i> *	Prickly Pear	U	34		x	x	x	x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Campanulaceae	<i>Wahlenbergia communis</i>	Tufted Bluebell	U	27		x	x	x	x
	<i>Wahlenbergia gracilis</i>	Sprawling Bluebell	U	52			x	x	x
	<i>Wahlenbergia graniticola</i>	Granite Bluebell	U					x	
	<i>Wahlenbergia luteola</i>		U	1		x		x	
	<i>Wahlenbergia planiflora</i>		U			x			
	<i>Wahlenbergia planiflora subsp. planiflora</i>	Flat Bluebell	U			x			
	<i>Wahlenbergia spp.</i>		U	11				x	
	<i>Wahlenbergia stricta</i>	Tall Bluebell	U						x
Caryophyllaceae	<i>Paronychia brasiliana*</i>	Chilean Whitlow Wort, Brazilian Whitlow	U	6		x			
	<i>Paronychia brasiliana*</i>	Chilean Whitlow Wort, Brazilian Whitlow	U	6				x	
	<i>Petrorhagia spp.</i>							x	
	<i>Scleranthus pungens</i>		U					x	
	<i>Spergularia spp.</i>							x	
	<i>Stellaria media*</i>	Common Chickweed	U	3		x			
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-Oak	U	19		x	x	x	x
	<i>Allocasuarina luehmannii</i>	Bulloak	U	66		x	x	x	x
	<i>Casuarina cunninghamiana subsp.</i>	River Oak	P13	25				x	

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>cunninghamiana</i>								
	<i>Casuarina glauca</i>		U						x
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush	U	31			x		x
	<i>Einadia nutans</i>	Climbing Saltbush	U	10			x		x
	<i>Einadia nutans subsp. linifolia</i>	Climbing Saltbush	U	16		x			
	<i>Einadia nutans subsp. nutans</i>	Climbing Saltbush	U	5			x		
	<i>Einadia polygonoides</i>	Knotweed Goosefoot	U	11			x		x
	<i>Einadia spp.</i>		U	4				x	
	<i>Einadia trigonos</i>	Fishweed	U	11			x		x
	<i>Enchylaena tomentosa</i>	Ruby Saltbush	U	23		x	x		x
	<i>Maireana microphylla</i>	Small-leaf Bluebush	U	26				x	x
	<i>Maireana spp.</i>							x	
Clusiaceae	<i>Hypericum gramineum</i>	Small St John's Wort	U	29		x		x	x
Commelinaceae	<i>Commelina benghalensis*</i>		U	1			x		
	<i>Commelina cyanea</i>	Native Wandering Jew	U	36		x			x
	<i>Murdannia graminea</i>		U	8		x		x	
	<i>Tradescantia albiflora*</i>	Wandering Jew	U	7		x			
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed	U	86			x		x
	<i>Dichondra sp.</i>					x		x	

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Echium plantagineum*</i>	Patterson's Curse	U	2			x		
	<i>Heliotropium amplexicaule*</i>	Blue Heliotrope	U	8			x		
Crassulaceae	<i>Bryophyllum delagoense*</i>	Mother of millions	U	5			x		x
	<i>Bryophyllum spp.</i>							x	
	<i>Crassula sieberiana</i>	Australian Stonecrop	U	17			x		x
Cunoniaceae	<i>Bauera microphylla</i>		U	1			x		
Cupressaceae	<i>Callitris endlicheri</i>	Black Cypress Pine	U	21			x		
	<i>Callitris glaucophylla</i>	White Cypress Pine	U	5		x	x	x	
Cyperaceae	<i>Cyperus aggregatus*</i>		U	7		x			
	<i>Cyperus congestus*</i>		U				x		
	<i>Cyperus eragrostis*</i>	Umbrella Sedge	U	4		x			x
	<i>Cyperus gracilis</i>	Slender Flat-sedge	U						x
	<i>Cyperus leiocaulon</i>		U			x			
	<i>Cyperus spp.</i>		U	9		x			x
	<i>Eleocharis sp.</i>								x
	<i>Eleocharis sphacelata</i>	Tall Spike Rush	U						x
	<i>Fimbristylis dichotoma</i>	Common Fringe-sedge	U	27		x			x
	<i>Lepidosperma concavum</i>		U	4			x		

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Lepidosperma filiforme</i>		U	2			x		
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken	P13	49		x	x	x	x
Dilleniaceae	<i>Hibbertia empetrifolia subsp. empetrifolia</i>		U	3		x	x		
	<i>Hibbertia linearis</i>		U	10			x	x	x
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	U						x
	<i>Hibbertia spp.</i>		U	5				x	
Dioscoreaceae	<i>Dioscorea transversa</i>	Native Yam	U	6			x		
Droseraceae	<i>Drosera peltata</i>	A Sundew	U	6				x	
Ericaceae	<i>Brachyloma daphnoides</i>	Daphne Heath	U	9		x	x	x	
	<i>Leucopogon muticus</i>	Blunt Beard-heath	U	24			x		
	<i>Lissanthe spp.</i>					x			
	<i>Lissanthe strigosa</i>	Peach Heath	U					x	
	<i>Melichrus urceolatus</i>	Urn Heath	U	24		x			
	<i>Sprengelia sprengelioides</i>		U					x	
Euphorbiaceae	<i>Chamaesyce drummondii</i>	Caustic Weed	U						x
	<i>Ricinus communis*</i>	Castor Oil Plant	U					x	
Fabaceae (Caesalpinioideae)	<i>Senna coronilloides</i>		U	4				x	
	<i>Senna form taxon 'zygophylla'</i>		U	4				x	

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Fabaceae (Faboideae)	<i>Chorizema parviflorum</i>	Eastern Flame Pea	U	9		x	x		
	<i>Daviesia genistifolia</i>	Broom Bitter Pea	U	15			x	x	
	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea	U	52		x			x
	<i>Desmodium brachypodum</i>	Large Tick-trefoil	U	19		x			x
	<i>Desmodium gunnii</i>	Slender Tick-trefoil	U	1		x			
	<i>Desmodium rhytidophyllum</i>		U	10		x			
	<i>Desmodium spp.</i>		U	1				x	
	<i>Desmodium varians</i>	Slender Tick-trefoil	U	57		x			x
	<i>Dillwynia parvifolia</i>		U					x	
	<i>Dillwynia retorta</i>		U	23					x
	<i>Glycine clandestina</i>	Twining glycine	U	60		x	x		x
	<i>Glycine microphylla</i>	Small-leaf Glycine	U	22		x	x		x
	<i>Glycine spp.</i>		U	5		x			x
	<i>Glycine tabacina</i>	Variable Glycine	U	49		x	x		x
	<i>Gompholobium spp.</i>					x			
	<i>Hardenbergia violacea</i>	False Sarsaparilla	U	53				x	x
	<i>Hovea linearis</i>		U	20		x	x		x
	<i>Indigofera australis</i>	Australian Indigo	U	31		x		x	x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Jacksonia scoparia</i>	Dogwood	U	22			x	x	x
	<i>Jacksonia spp.</i>					x			
	<i>Mellilotus indicus*</i>	Hexham Scent	U	6			x		
	<i>Trifolium angustifolium*</i>	Narrow-leaved Clover	U	1				x	
	<i>Trifolium arvense*</i>	Haresfoot Clover	U	3				x	
	<i>Zornia dyctiocarpa var. dyctiocarpa</i>	Zornia	U	11		x			x
Fabaceae (Mimosoideae)	<i>Acacia amblygona</i>	Fan Wattle	U	54		x	x	x	x
	<i>Acacia bulgaensis</i>	Bulga Wattle	U	38					x
	<i>Acacia binervia</i>	Coast Myall	P13	31			x	x	
	<i>Acacia decora</i>	Western Golden Wattle	P13	19				x	x
	<i>Acacia elongata</i>	Swamp Wattle	U	18			x		
	<i>Acacia falcata</i>		U	58		x	x	x	x
	<i>Acacia filicifolia</i>	Fern-leaved Wattle	U	43		x		x	
	<i>Acacia floribunda</i>	White Sally	U	3			x		
	<i>Acacia implexa</i>	Hickory Wattle	U	22		x	x		x
	<i>Acacia mearnsii</i>	Black Wattle	U				x		
	<i>Acacia paradoxa</i>	Kangaroo Thorn	U	9			x	x	
	<i>Acacia parvipinnula</i>	Silver-stemmed Wattle	U	102			x	x	x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Acacia podalyriifolia</i>	Queensland Silver Wattle	P13	2				x	
	<i>Acacia salicina</i>	Cooba	U	18				x	x
	<i>Acacia saligna</i> *	Golden Wreath Wattle	U	4		x			
	<i>Acacia spp.</i>		U	31				x	
	<i>Acacia suaveolens</i>	Sweet Wattle	U	13			x	x	
Gentianaceae	<i>Centaurium ?tenuiflorum</i> *	Branched Centaury, Slender centaury	U	12				x	
Geraniaceae	<i>Erodium ?crinitum</i>	Blue Storksbill, Blue Crowfoot	U	2				x	
Goodeniaceae	<i>Goodenia bellidifolia subsp. bellidifolia</i>		U			x			
	<i>Goodenia hederacea</i>	Ivy Goodenia; Forest Goodenia	U	23		x			x
	<i>Goodenia hederacea subsp. hederacea</i>		U	14		x	x		
	<i>Goodenia heterophylla subsp. heterophylla</i>		U	3		x			
	<i>Goodenia rotundifolia</i>		U	15				x	x
	<i>Goodenia spp.</i>		U	4		x		x	x
	<i>Scaevola calendulacea</i>		U	2			x		
	<i>Velleia spp.</i>					x			

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Haloragaceae	<i>Gonocarpus</i> spp.								x
	<i>Gonocarpus tetragynus</i>	Poverty Raspwort	U	8				x	
	<i>Myriophyllum</i> spp.								x
Iridaceae	<i>Romulea rosea</i> var. <i>australis</i> *	Onion Grass	U	10			x		
	<i>Sisyrinchium</i> sp. A*	Scourweed	U	4				x	
Juncaceae	<i>Juncus</i> spp.	A Rush	U	7		x			
	<i>Juncus usitatus</i>		U	35				x	x
Juncaginaceae	<i>Triglochin procerum</i>	Water Ribbons	U	2					x
Lamiaceae	<i>Ajuga australis</i>	Austral Bugle	U	10		x		x	x
	<i>Scutellaria humilis</i>	Dwarf Skullcap	U	6				x	
	<i>Spartothamnella juncea</i>		U	16		x	x	x	x
Linaceae	<i>Linum marginale</i>	Native Flax	U	3				x	
Lobeliaceae	<i>Lobelia gracilis</i>	Trailing Lobelia	U	3			x		
	<i>Pratia purpurascens</i>	Whiteroot	U	66		x	x		x
Lomandraceae	<i>Lomandra confertifolia</i> subsp. <i>rubiginosa</i>		U	10		x			
	<i>Lomandra filiformis</i>	Wattle Matt-rush	U	14		x		x	x
	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	Wattle Matt-rush	U	22		x			
	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>		U	21			x		

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Lomandra glauca</i>	Pale Mat-rush	U	25		x	x	x	
	<i>Lomandra leucocephala</i> subsp. <i>leucocephala</i>	Woolly Mat-rush, Irongrass	U	1				x	
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	U	47		x		x	x
	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Many-flowered Mat-rush	U	80		x	x	x	x
	<i>Lomandra obliqua</i>		U	26		x			
	<i>Lomandra</i> sp.								x
Loranthaceae	<i>Amyema linophyllum</i> subsp. <i>orientale</i>		U					x	
	<i>Amyema miquelii</i>	Box Mistletoe	U	6				x	
	<i>Amyema pendulum</i> subsp. <i>pendulum</i>		U	1		x			
	<i>Amyema</i> spp.		U	3				x	x
	<i>Dendrophthoe vitellina</i>		U	11				x	
	<i>Lysiana</i> spp.							x	
Malaceae	<i>Malus</i> spp.*							x	
Malvaceae	<i>Howittia trilocularis</i>		U					x	
	<i>Pavonia hastata</i> *		U	14			x		
	<i>Sida ?corrugata</i>	Corrugated Sida	U	18		x			
	<i>Sida corrugata</i>	Corrugated Sida	U	18				x	x
	<i>Sida rhombifolia</i> *	Paddy's Lucerne	U	47		x	x	x	x

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Meliaceae	<i>Melia azedarach</i>	White Cedar	U	12				x	
Menispermaceae	<i>Stephania japonica</i>	Snake Vine	U					x	
	<i>Stephania japonica var. discolor</i>	Snake Vine	U	12			x		
Moraceae	<i>Ficus macrophylla</i>		U					x	
	<i>Ficus spp.</i>		U	3				x	
Myoporaceae	<i>Eremophila debilis</i>	Amulla	U	50			x	x	x
	<i>Myoporum montanum</i>	Western Boobialla	U	21				x	
	<i>Myoporum parvifolium</i>	Creeping Boobialla	U			x			
Myrsinaceae	<i>Anagallis arvensis*</i>	Scarlet/Blue Pimpernel	U	42		x	x	x	x
Myrtaceae	<i>Angophora bakeri</i>	Narrow-leaved Apple	U	12		x			x
	<i>Angophora floribunda</i>	Rough-barked Apple	U	66			x	x	x
	<i>Corymbia ?citriodora</i>	Lemon-scented Gum						x	
	<i>Corymbia maculata</i>	Spotted Gum	U	130		x	x	x	x
	<i>Eucalyptus albens</i>	White Box	U			x		x	
	<i>Eucalyptus albens x moluccana</i>		U					x	x
	<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	U	4		x	x	x	x
	<i>Eucalyptus blakelyi x tereticornis</i>	Blakely's Red Gum/Forest Red Gum						x	x
	<i>Eucalyptus camaldulensis</i>	River Red Gum	U	24				x	

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	U	125		x	x	x	x
	<i>Eucalyptus melliodora</i>	Yellow Box	U	4			x	x	
	<i>Eucalyptus moluccana</i>	Grey Box	U	72		x	x	x	x
	<i>Eucalyptus stenostoma</i>		U				x		
	<i>Eucalyptus tereticornis</i>	Forest Red Gum	U	71			x	x	x
	<i>Leptospermum polygalifolium subsp. polygalifolium</i>		U	3			x		
	<i>Leptospermum spp.</i>		U	3				x	
	<i>Melaleuca decora</i>		U	16		x	x	x	x
	<i>Melaleuca thymifolia</i>		U	8		x	x	x	x
Nyctaginaceae	<i>Boerhavia dominii</i>	Tarvine	U	3		x		x	x
Oleaceae	<i>Ligustrum sinense*</i>	Small-leaved Privet	U	3				x	
	<i>Notelaea longifolia</i>	Large Mock-olive	U	14			x		x
	<i>Notelaea microcarpa</i>	Native Olive	U	2				x	x
	<i>Notelaea microcarpa var. microcarpa</i>		U	14		x			
	<i>Notelaea neglecta</i>		U				x	x	
	<i>Notelaea spp.</i>							x	
	<i>Olea europaea subsp. cuspidata*</i>		U	41				x	
	<i>Olea europaea subsp. europaea*</i>		U			x	x		

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Orchidaceae	<i>Diuris punctata</i>	Purple Donkey Orchid	P13	1				x	
Oxalidaceae	<i>Oxalis corniculata*</i>	Creeping Oxalis	U	12			x		
	<i>Oxalis exilis</i>		U						x
	<i>Oxalis incarnata*</i>		U	1			x		
	<i>Oxalis perennans</i>		U	24		x	x		x
	<i>Oxalis rubens</i>		U					x	
	<i>Oxalis spp.</i>		U	19				x	x
Papaveraceae	<i>Argemone ochroleuca*</i>	Mexican Poppy	U					x	
Phormiaceae	<i>Dianella caerulea var. caerulea</i>		P13	11			x		
	<i>Dianella caerulea var. cinerascens</i>		P13	5			x		
	<i>Dianella longifolia</i>		U						x
	<i>Dianella revoluta var. revoluta</i>	A Blue Flax Lily	U	20		x			x
	<i>Dianella spp.</i>		U	6		x		x	
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush	U	63		x	x	x	x
	<i>Phyllanthus hirtellus</i>	Thyme Spurge	U	32		x			
	<i>Phyllanthus virgatus</i>		U						x
	<i>Phyllanthus spp.*</i>		U	4				x	
	<i>Poranthera microphylla</i>	Small Poranthera	U						x

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Phytolaccaceae	<i>Phytolacca octandra*</i>	Inkweed	U	2				x	
Pittosporaceae	<i>Bursaria spinosa subsp. spinosa</i>	Native Blackthorn	U	21		x	x	x	
Plantaginaceae	<i>Plantago ?debilis</i>		U	26		x			
	<i>Plantago debilis</i>		U	26			x	x	x
	<i>Plantago lanceolata*</i>	Lamb's Tongues	U	39		x	x	x	x
	<i>Plantago myosuroides subsp. myosuroides*</i>		U	7				x	
Poaceae	<i>Agrostis capillaris*</i>	Browntop Bent	U				x		
	<i>Agrostis spp.</i>							x	
	<i>Ancistrachne maidenii</i>		V				x		
	<i>Andropogon virginicus*</i>	Whisky Grass	U	2		x			
	<i>Aristida calycina</i>		U	2				x	
	<i>Aristida jerichoensis var. subspinulifera</i>	Jericho Wiregrass	U			x			x
	<i>Aristida ramosa</i>	Purple Wiregrass	U	38			x		x
	<i>Aristida ramosa var. ramosa</i>		U	3		x	x		
	<i>Aristida spp.</i>	A Wiregrass	U	30		x		x	
	<i>Aristida vagans</i>	Threeawn Speargrass	U	58		x	x		x
	<i>Aristida warburgii</i>		U	2		x	x		
<i>Austrodanthonia bipartita</i>	Wallaby Grass	U	11		x	x			

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Austrodanthonia fulva</i>	Wallaby Grass	U	12				x	
	<i>Austrodanthonia monticola</i>	Wallaby Grass	U					x	
	<i>Austrodanthonia racemosa</i>		U						x
	<i>Austrodanthonia racemosa var. racemosa</i>	A Wallaby Grass	U	1			x		
	<i>Austrodanthonia spp.</i>	A Wallaby Grass							x
	<i>Austrostipa ?scabra subsp. scabra</i>	Rough Speargrass	U	2		x			
	<i>Austrostipa scabra</i>	Speargrass	U	10				x	x
	<i>Austrostipa verticillata</i>	Slender Bamboo Grass	U	27		x			x
	<i>Axonopus fissifolius*</i>	Narrow-leafed Carpet Grass	U	16		x			x
	<i>Bothriochloa biloba</i>		U	3					x
	<i>Bothriochloa decipiens</i>	Red-leg Grass	U					x	
	<i>Bothriochloa decipiens var. decipiens</i>		U	26		x			x
	<i>Bothriochloa macra</i>	Red Grass	U	14					x
	<i>Briza minor*</i>	Shivery Grass	U	10				x	
	<i>Cheilanthes austrotenuifolia</i>	Rock Fern	U	10		x			
	<i>Cheilanthes sieberi</i>	Rock Fern	U	30		x			
	<i>Chloris gayana*</i>	Rhodes Grass	U	20			x		

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Chloris truncata</i>	Windmill Grass	U	19		x	x	x	x
	<i>Chloris ventricosa</i>	Tall Chloris	U	20		x			x
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	U	89		x	x		x
	<i>Cynodon dactylon</i>	Common Couch	U	70		x	x		x
	<i>Dichanthium sericeum</i>	Queensland Bluegrass	U	8					x
	<i>Dichelachne micrantha</i>	Shorthair Plumegrass	U	37		x			
	<i>Dichelanche spp.</i>								x
	<i>Digitaria diffusa</i>	A Finger Grass	U	2		x			
	<i>Digitaria longiflora</i>		U			x			
	<i>Digitaria spp.</i>	A Finger Grass	U	4		x		x	x
	<i>Echinopogon caespitosus var. caespitosus</i>	Tufted Hedgehog Grass	U	19		x			x
	<i>Ehrharta erecta*</i>	Panic Veldtgrass	U						x
	<i>Enteropogon acicularis</i>	Curly Windmill Grass	U	11		x		x	
	<i>?Enteropogon sp.</i>							x	
	<i>Entolasia marginata</i>	Bordered Panic	U	41			x		x
	<i>Entolasia stricta</i>	Wiry Panic	U	43		x	x		x
	<i>Eragrostis brownii</i>	Brown's Lovegrass	U	49		x	x		x
	<i>Eragrostis curvula*</i>	African Lovergrass	U						x

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Eragrostis elongata</i>	Clustered Lovegrass	U	5		x			
	<i>Eragrostis leptostachya</i>	Paddock Lovegrass	U	23		x			x
	<i>Eragrostis parviflora</i>	Weeping Lovegrass	U	1		x		x	
	<i>Eragrostis sororia</i>		U			x			
	<i>Eragrostis spp.</i>	A Lovegrass	U	9				x	
	<i>Eulalia aurea</i>	Silky Browntop	U						x
	<i>Imperata cylindrica var. major</i>	Blady Grass	U	38		x	x		x
	<i>Melinis repens*</i>	Red Natal Grass	U	20		x	x		x
	<i>Microlaena stipoides</i>	Weeping Grass	U			x		x	x
	<i>Microlaena stipoides var. stipoides</i>	Weeping Grass	U	34			x		
	<i>Panicum effusum</i>	Poison or Hairy Panic	U	25		x			x
	<i>Panicum simile</i>	Two-colour Panic	U	20		x			
	<i>Paspalidium distans</i>		U						x
	<i>Paspalum dilatatum*</i>	Paspalum	U						x
	<i>Pennisetum clandestinum*</i>	Kikuyu Grass	U	16			x		
	<i>Phragmites australis</i>	Common Reed	U	9		x			
	<i>Poa labillardierei</i>		U				x		
	<i>Setaria gracilis*</i>	Slender Pigeon Grass	U	12		x			x

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Setaria pumila*</i>	Pale Pigeon Grass	U	8		x			
	<i>Sporobolus creber</i>	Slender Rat's Tail Grass	U	41		x			x
	<i>Sporobolus elongatus</i>	Slender Rat's Tail Grass	U	6		x			
	<i>Themeda australis</i>	Kangaroo Grass	U	55		x		x	x
	<i>Themeda triandra</i>		U				x		
	<i>Poaceae Sp1</i>	Unknown Grass 1							x
	<i>Poaceae Sp2</i>	Unknown Grass 2							x
Polygonaceae	<i>Acetosella vulgaris*</i>	Sorrel, Sheep Sorrel	U	3			x	x	
Portulacaceae	<i>Calandrinia eremaea</i>	Small Purslane	U					x	
	<i>Calandrinia spp.</i>							x	
	<i>Portulaca oleracea</i>	Pigweed	U	6			x		
	<i>Portulaca spp.</i>								x
Proteaceae	<i>Banksia integrifolia</i>	Coast Banksia	U	10		x		x	x
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	U	7			x		
	<i>Conospermum taxifolium</i>		U	5				x	
	<i>Grevillea montana</i>		U	79		x	x	x	
	<i>Grevillea robusta</i>	Silky Oak	U	2				x	
	<i>Hakea laevipes</i>		U					x	

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Hakea sp.</i>								x
	<i>Persoonia levis</i>	Broad-leaved Geebung	P13	8		x	x		
	<i>Persoonia linearis</i>	Narrow-leaved Geebung	P13	100		x	x	x	x
Ranunculaceae	<i>Clematis aristata</i>	Old Man's Beard	U	14		x	x		x
	<i>Clematis glycinoides</i>	Headache Vine	U	17			x	x	
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash	U	11				x	
	<i>Cryptandra amara</i>	Bitter cryptandra	U	3		x			
Rosaceae	<i>Cydonia oblonga*</i>	Quince	U					x	
Rubiaceae	<i>Asperula conferta</i>	Common Woodruff	U	12		x		x	x
	<i>Canthium spp.</i>							x	
	<i>Opercularia spp.</i>					x			
	<i>Opercularia varia</i>	Variable Stinkweed	U						x
	<i>Pomax umbellata</i>	Pomax	U	66		x	x	x	x
	<i>Psydrax odorata</i>		U	5				x	
	<i>Richardia ?humistrata*</i>		U	2				x	
	<i>Richardia humistrata*</i>		U	2		x			
	<i>Richardia stellaris*</i>		U	14		x			x
Rutaceae	<i>Geijera salicifolia</i>	Brush Wilga	U	7				x	

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry/Cherry Ballart	U	32		x	x	x	x
	<i>Exocarpos strictus</i>	Dwarf Cherry	U	35			x	x	
Sapindaceae	<i>Dodonaea viscosa subsp. cuneata</i>	Broad-leaf Hopbush	U	11		x		x	
Scrophulariaceae	<i>Linaria pelisseriana*</i>	Pelisser's Toadflax	U	2				x	
	<i>Verbascum thapsus subsp. thapsus*</i>	Blanket Weed	U	1				x	
	<i>Verbascum virgatum*</i>	Twiggy Mullein, Green Mullein	U	2		x		x	
Solanaceae	<i>Veronica plebeia</i>	Trailing Speedwell	U	39		x	x	x	x
	<i>Cestrum parqui*</i>	Green Cestrum	U	7			x	x	
	<i>Lycium ferocissimum*</i>	African Boxthorn	U	22			x	x	
	<i>Nicotiana forsteri</i>		U					x	
	<i>Solanum cinereum</i>	Narrawa Burr	U						x
	<i>Solanum nigrum*</i>	Black-berry Nightshade	U						x
	<i>Solanum prinophyllum</i>	Forest Nightshade	U	37		x	x		x
	<i>Solanum pungetium</i>	Eastern Nightshade	U	2			x	x	
	<i>Solanum spp.</i>		U	5				x	x
	<i>Withania somnifera*</i>	Winter Cherry	U	2				x	
Stackhousiaceae	<i>Stackhousia ?monogyna</i>	Creamy Candles	U	2				x	

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Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Stackhousia muricata</i>		U	2		x			
	<i>Stackhousia viminea</i>	Slender Stackhousia	U	32		x			x
Sterculiaceae	<i>Brachychiton populneus</i>	Kurrajong	U	14		x		x	x
Stylidiaceae	<i>Stylidium eglandulosum</i>	Woolly-stemmed Triggerplant	U	1		x		x	
	<i>Stylidium graminifolium</i>	Grass Triggerplant	U	8				x	
	<i>Stylidium laricifolium</i>	Tree Triggerplant	U	2		x			
Thymelaeaceae	<i>Pimelea linifolia</i>	Slender Rice Flower	U	11			x	x	x
	<i>Pimelea linifolia subsp. linifolia</i>		U	10		x	x		
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi	U	12		x			
Urticaceae	<i>Pipturus argenteus</i>	White Nettle	U					x	
Verbenaceae	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum	U					x	
	<i>Lantana camara*</i>	Lantana	U	25			x	x	x
	<i>Verbena rigida*</i>	Veined Verbena	U	14			x	x	
	<i>Verbena bonariensis*</i>	Purpletop	U	32					x
	<i>Verbena hispida*</i>	Rough Verbena	U	5			x		
	<i>Verbena spp.*</i>								x
Violaceae	<i>Viola sieberiana</i>		U				x		
Vitaceae	<i>Cayratia clematidea</i>	Slender Grape	U	17		x			

**Table B.1 Flora Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC Act Status	LGA Count	EPBC Act Status	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Macrozamia pauli-guilielmi</i>		P13					x	
	<i>Parthenocissus quinquefolia</i> *	Virginia Creeper	U					x	
Xanthorrhoeaceae	<i>Xanthorrhoea</i> spp.								x

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*Appendix C*

# Fauna Species List

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**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
<b>Amphibians</b>					26							
Hylidae	<i>Litoria caerulea</i>	Green Tree Frog	P		74	x						
		Eastern Dwarf Tree Frog										
	<i>Litoria fallax</i>	Frog	P			x			x			
	<i>Litoria freycineti</i>	Freycinet's Frog	P		71	x						
	<i>Litoria latopalmata</i>	Broad-palmed Frog	P		82				x			
	<i>Litoria peronii</i>	Peron's Tree Frog	P		22				x			
Myobatrachidae	<i>Litoria verreauxi</i>	Whistling Tree Frog	P		232	x						x
		Common Eastern Froglet										
	<i>Crinia signifera</i>	Froglet	P		58				x			x
	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	P		19				x	x		x
	<i>Limnodynastes peronii</i>	Brown-striped Frog	P		268				x			
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	P		16	x			x			x
	<i>Pseudophryne bibronii</i>	Bibron's Toadlet	P		1					x		x
	<i>Uperoleia rugosa</i>	Wrinkled Toadlet	P		74							x
<i>Uperoleia laevigata</i>	Smooth Toadlet	P						x	x			

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
<b>Birds</b>					91							
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	P		174		x	x	x	x	x	x
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill	P		91	x				x		
	<i>Acanthiza nana</i>	Yellow Thornbill	P		248		x	x	x	x	x	x
	<i>Acanthiza pusilla</i>	Brown Thornbill	P		79		x	x	x	x		
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	P		10		x	x	x	x	x	x
	<i>Gerygone fusca</i>	Western Gerygone	P		50		x	x	x			
	<i>Gerygone olivacea</i>	White-throated Gerygone	P		106		x	x		x		
	<i>Chthonicola saggitatus</i>	Speckled Warbler	V		203		x	x	x	x	x	x
	<i>Sericornis frontalis</i>	White-browed Scrubwren	P		84		x	x		x		
	<i>Smicrornis brevirostris</i>	Weebill	P		29	x	x	x	x	x	x	x
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk	P		104			x		x		x
	<i>Aquila audax</i>	Wedge-tailed Eagle	P		6		x	x	x	x	x	x
	<i>Aviceda subcristata</i>	Pacific Baza	P		5		x					
	<i>Circus assimilis</i>	Spotted Harrier	V		36				x		x	
	<i>Elanus axillaris</i>	Black-shouldered Kite	P		11	x						

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status							(2006)	(2009)	(2009)
	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	P	M	19						x		
	<i>Haliastur sphenurus</i>	Whistling Kite	P		1					x		x	
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V		13						x		
	<i>Hieraaetus morphnoides</i>	Little Eagle	V		145		x					x	
Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	P		211	x		x	x			x	
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	P		57		x	x	x	x	x	x	x
	<i>Todiramphus sanctus</i>	Sacred Kingfisher	P		46	x	x	x	x	x	x		
Anatidae	<i>Anas gracilis</i>	Grey Teal	P		89				x	x			
	<i>Anas superciliosa</i>	Pacific Black Duck	P		85		x	x	x	x	x	x	x
	<i>Chenonetta jubata</i>	Australian Wood Duck	P		25		x	x	x			x	x
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail	P	M	8		x			x			
Ardeidae	<i>Ardea alba</i>	Great Egret	P	M	22					x			
	<i>Ardea pacifica</i>	White-necked Heron	P		61	x		x					
	<i>Egretta novaehollandiae</i>	White-faced Heron	P		4			x	x			x	x
	<i>Nycticorax caledonicus</i>	Nankeen Night Heron	P		57					x			

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						ERM	Neil	CE
			Status	Status	Count	(1995)	(2008a)	(2008b)	(2002)	(2006)	(2009)	(2009)
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow	P		126	x	x	x	x		x	x
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	P		144		x	x	x		x	x
	<i>Cracticus torquatus</i>	Grey Butcherbird	P		297		x	x	x	x	x	x
	<i>Gymnorhina tibicen</i>	Australian Magpie	P		304		x	x	x	x	x	x
	<i>Strepera graculina</i>	Pied Currawong	P		138	x	x	x	x	x	x	
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	P		72		x	x	x		x	
	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black- cockatoo	P		122					x		
	<i>Calyptorhynchus lathami</i>	Glossy Black-cockatoo	V		113		x	x			x	x
	<i>Eolophus roseicapillus</i>	Galah	P		177		x	x	x	x	x	
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo- shrike	P		14		x	x	x	x	x	
	<i>Coracina papuensis</i>	White-bellied Cuckoo- shrike	P		90							x
	<i>Coracina tenuirostris</i>	Cicadabird	P		18			x				
	<i>Lalage tricolor</i>	White-winged Triller	P		15	x		x				
Charadriidae	<i>Elsyornis melanops</i>	Black-fronted Dotterel	P		101	x						
	<i>Vanellus miles</i>	Masked Lapwing	P		5			x	x	x	x	x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
Climacteridae	<i>Vanellus tricolor</i>	Banded Lapwing	P		63						x	
	<i>Climacteris picumnus</i>	Brown Treecreeper										
	<i>victoriae</i>	(eastern subspecies)	V		348		x	x	x	x	x	x
Columbidae	<i>Cormobates leucophaea</i>	White-throated Treecreeper	P		3		x	x	x	x	x	x
	<i>Columba livia*</i>	Rock Dove	U		20	x						
	<i>Geopelia humeralis</i>	Bar-shouldered Dove	P		17			x			x	x
	<i>Geopelia placida</i>	Peaceful Dove	P		103		x	x			x	
	<i>Ocyphaps lophotes</i>	Crested Pigeon	P		65		x	x	x	x	x	
	<i>Phaps chalcoptera</i>	Common Bronzewing	P		9		x	x	x	x		x
	<i>Streptopelia chinensis*</i>	Spotted Turtle-Dove	U		46				x			
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird	P		158			x	x			
Corcoracidae	<i>Corcorax melanorhamphos</i>	White-winged Chough	P		242		x	x	x	x	x	x
Corvidae	<i>Corvus coronoides</i>	Australian Raven	P		3		x	x	x	x	x	x
	<i>Corvus mellori</i>	Little Raven	P		94				x			
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	P		25				x	x	x	x
	<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo	P		37			x	x	x		
	<i>Chalcites lucidus</i>	Shining Bronze-	P		2			x	x			

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
		Cuckoo										
	<i>Chalcites osculans</i>	Black-eared Cuckoo	P		19		x					
	<i>Cuculus pallidus</i>	Pallid Cuckoo	P		27			x		x		
	<i>Eudynamys orientalis</i>	Pacific Koel	P		46			x				
	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	P		155			x		x		
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird	P				x	x	x	x	x	x
	<i>Dicrurus bracteatus</i>	Spangled Drongo	P		117				x			
	<i>Grallina cyanoleuca</i>	Magpie-lark	P		31		x	x	x	x	x	x
	<i>Myiagra inquieta</i>	Restless Flycatcher	P		79				x	x	x	x
	<i>Myiagra rubecula</i>	Leaden Flycatcher	P		306	x	x		x			
	<i>Rhipidura albiscapa</i>	Grey Fantail	P		181		x	x	x	x	x	x
	<i>Rhipidura leucophrys</i>	Willie Wagtail	P		84		x	x	x	x	x	x
	<i>Rhipidura rufifrons</i>	Rufous Fantail	P	M	1		x	x	x			
Estrildidae	<i>Neochmia modesta</i>	Plum-headed Finch	P		179							x
	<i>Neochmia temporalis</i>	Red-browed Finch	P		32			x		x		x
	<i>Stagonopleura guttata</i>	Diamond Firetail	V		96	x		x				x
	<i>Taeniopygia bichenovii</i>	Double-barred Finch	P		213		x	x	x	x	x	x
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	P		35					x		
Falconidae	<i>Falco berigora</i>	Brown Falcon	P		87	x	x	x	x			x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status									
	<i>Falco cenchroides</i>	Nankeen Kestrel	P		18		x	x	x			x	x
	<i>Falco longipennis</i>	Australian Hobby	P		120	x	x			x			
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	P		20	x	x		x	x	x	x	x
	<i>Petrochelidon ariel</i>	Fairy Martin	P		22			x	x				
	<i>Petrochelidon nigricans</i>	Tree Martin	P		206		x	x					x
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	P		96		x	x	x	x	x	x	x
	<i>Malurus lamberti</i>	Variegated Fairy-wren	P		417		x	x	x	x			x
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	P		60			x	x	x	x	x	x
	<i>Anthochaera carunculata</i>	Red Wattlebird	P		379				x	x	x	x	x
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	P		16	x	x	x	x			x	x
	<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	P		152								x
	<i>Lichenostomus leucotis</i>	White-eared Honeyeater	P		113		x	x	x			x	x
	<i>Lichenostomus melanops</i>	Yellow-tufted Honeyeater	P		107				x				
	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	P		212	x	x	x	x	x	x	x	x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>Manorina melanocephala</i>	Noisy Miner	P		196		x	x	x	x	x	x
	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	P		36					x		
	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	P		154	x	x	x	x		x	x
	<i>Melithreptus lunatus</i>	White-naped Honeyeater	P		90	x			x		x	x
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	P		19		x	x	x			
	<i>Philemon citreogularis</i>	Little Friarbird	P		336					x		
	<i>Philemon corniculatus</i>	Noisy Friarbird	P		20	x	x	x	x	x	x	
	<i>Phylidonyris niger</i>	White-cheeked Honeyeater	P		70				x			
	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	P		83	x	x	x	x			x
	<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E, M	84				x			
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	P	M	58	x	x	x	x	x		
Motacillidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit	P		57						x	x
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V		107	x	x	x	x		x	
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole	P		286		x	x	x	x		
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	P		269	x	x	x	x	x	x	x
	<i>Pachycephala pectoralis</i>	Golden Whistler	P		264		x	x	x	x	x	x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
	<i>Pachycephala rufiventris</i>	Rufous Whistler	P		358	x	x	x	x			
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	P		100		x	x	x	x	x	x
	<i>Pardalotus striatus</i>	Striated Pardalote	P		26		x	x	x	x	x	x
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican	P		254				x			
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	P		21		x	x	x		x	x
	<i>Melanodryas cucullata</i>	Hooded Robin (south-eastern form)	V		73				x		x	x
	<i>Microeca fascinans</i>	Jacky Winter	P		31		x	x	x		x	x
	<i>Petroica boodang</i>	Scarlet Robin	V		21				x		x	
	<i>Petroica goodenovii</i>	Red-capped Robin	P		56		x	x	x		x	x
	<i>Petroica rosea</i>	Rose Robin	P		13				x		x	x
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant	P		26	x	x					
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	P		20	x	x				x	
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	P		8				x			
	<i>Phalacrocorax varius</i>	Pied Cormorant	P		25				x			
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail	P		141				x		x	
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth	P		9	x	x		x	x	x	
Podicipedidae	<i>Poliocephalus</i>	Hoary-headed Grebe	P		40	x						

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>poliocephalus</i>											
	<i>Tachybaptus</i>											
	<i>novaeollandiae</i>	Australasian Grebe	P		195				x	x	x	
Pomatostomidae	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler										
	<i>temporalis</i>	(eastern subspecies)	V		148		x	x	x	x	x	x
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot	P		8		x		x		x	x
	<i>Glossopsitta concinna</i>	Musk Lorikeet	P		74						x	x
	<i>Glossopsitta pusilla</i>	Little Lorikeet	V		10		x			x	x	
	<i>Lathamus discolor</i>	Swift Parrot	E1	E	186				x			
	<i>Platycercus adscitus</i>											
	<i>eximius</i>	Eastern Rosella	P		172		x	x	x	x	x	x
	<i>Platycercus elegans</i>	Crimson Rosella	P		44				x			
	<i>Psephotus haematonotus</i>	Red-rumped Parrot	P		9						x	x
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	P		104					x	x	x
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	P		22							x
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	P		200				x	x	x	x
Strigidae	<i>Ninox boobook</i>	Southern Boobook	P		7				x			
	<i>Tyto alba</i>	Barn Owl	P		14				x			
Sylviidae	<i>Acrocephalus australis</i>	Australian Reed-	P		11							x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
		Warbler										
	<i>Cincloramphus mathewsi</i>	Rufous Songlark	P		4	x		x				
Threskiornithidae	<i>Platalea regia</i>	Royal Spoonbill	P		44				x			
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	P		40			x				
Turnicidae	<i>Turnix varia</i>	Painted Button-quail	P		172	x	x	x				
Zosteropidae	<i>Zosterops lateralis</i>	Silvereye	P				x	x	x	x	x	x
<b>Mammals</b>					51							
Bovidae	<i>Bos taurus*</i>	Cattle	U		12	x						
Canidae	<i>Canis lupus familiaris*</i>	Dog	U		303	x			x		x	
	<i>Vulpes vulpes*</i>	Fox	U		175	x			x	x	x	
Dasyuridae	<i>Antechinus flavipes</i>	Yellow-footed Antechinus	P		112				x			
	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V		186	unconfirmed scat from 1979						
	<i>Sminthopsis murina</i>	Common Dunnart	P		12	x					x	
Equidae	<i>Equus caballus*</i>	Horse	U		26	x						
Felidae	<i>Felis catus*</i>	Cat	U		56	x			x	x	x	
Leporidae	<i>Lepus capensis*</i>	Brown Hare	U		125				x	x	x	
	<i>Oryctolagus cuniculus*</i>	Rabbit	U		219	x			x	x	x	

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status							(2006)	(2009)	(2009)
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	P		181	x			x	x		x	
	<i>Macropus rufogriseus</i>	Red-necked Wallaby	P		63	x			x	x		x	
	<i>Macropus robustus</i>	Common Wallaroo	P		196	x							
	<i>Wallabia bicolor</i>	Swamp Wallaby	P		8				x	x		x	
Molossidae	<i>Mormopterus "Species 2"</i>	Undescribed Freetail Bat	P		86				x				x
	<i>Mormopterus "Species 4"</i>	Undescribed Freetail Bat											x
	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V		5	x			x				x
	<i>Mormopterus planiceps</i>	Little Mastiff-bat	P		171	x							
	<i>Tadarida australis</i>	White-striped Freetail-bat	P		3	x			x				x
Muridae	<i>Hydromys chrysogaster</i>	Water-rat	P		462						x		
	<i>Mus musculus*</i>	House Mouse	U		123				x	x			x
	<i>Rattus fuscipes</i>	Bush Rat	P		23	x			x				
	<i>Rattus rattus*</i>	Black Rat	U		17				x				x
Peramelidae	<i>Perameles nasuta</i>	Long-nosed Bandicoot	P		167						x		
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider	P		38	x							

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status							(2006)	(2009)	(2009)
Phalangeridae	<i>Petaurus norfolcensis</i>	Squirrel Glider	V		305				x			x	
	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	P		59	x			x	x		x	
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	P		49								
Pteropodidae	<i>Pteropus pliocephalus</i>	Grey-headed Flying-fox	V	V									X
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	P		183				x				x
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	P		46	x					x		x
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V		118	x							
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	P		226				x				x
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	P		5				x				x
	<i>Miniopterus australis</i>	Little Bentwing-bat	V		60				x				
	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V		8	x			x				x
	<i>Myotis macropus</i>	Southern Myotis	V		64				x				x
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	P		158	x			x				x
	<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	P		59	x			x				x

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat										x
	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	P		216				x			
	<i>Vespadelus darlingtoni</i>	Large Forest Bat	P		41				x			
	<i>Vespadelus regulus</i>	Southern Forest Bat	P		11				x		x	
	<i>Vespadelus sp.</i>		P		525				x			
	<i>Vespadelus vulturnus</i>	Little Forest Bat	P		369	x			x		x	
Vombatidae	<i>Vombatus ursinus</i>	Common Wombat	P			x			x	x	x	
<b>Reptiles</b>					51							
Agamidae	<i>Amphibolurus muricatus</i>	Jacky Lizard	P		46				x	x		
	<i>Pogona barbata</i>	Bearded Dragon	P		44	x			x	x		
	<i>Physignathus lesueurii</i>	Eastern Water Dragon	P		46	x						
Chelidae	<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle	P		4				x	x		
Colubridae	<i>Dendrelaphis punctulatus</i>	Common Tree Snake	P		45						x	
Elapidae	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	P		18	x				x		

**Table C.1 Fauna Species Recorded within the Study Area**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>Pseudonaja textilis</i>	Eastern Brown Snake	P		27	x			x			
Gekkonidae	<i>Diplodactylus vittatus</i>	Wood Gecko	P		84				x		x	
Scincidae	<i>Carlia tetradactyla</i>	Southern Rainbow-skink	P		72				x	x		
	<i>Ctenotus robustus</i>	Robust Ctenotus	P		126				x	x	x	
	<i>Ctenotus taeniolatus</i>	Copper-tailed Skink	P		86	x						
	<i>Egernia striolata</i>	Tree Skink	P		154	x			x	x	x	
	<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	P		76				x			
	<i>Lampropholis guichenoti</i>	Pale-flecked Garden Sunskink	P		15					x		
	<i>Morethia boulengeri</i>	South-eastern Morethia Skink	P		15					x	x	
	<i>Tiliqua scincoides</i>	Eastern Blue-tongue	P		5					x		
Typhlopidae	<i>Ramphotyphlops nigrescens</i>	Blackish Blind Snake	P		99					x		
Varanidae	<i>Varanus varius</i>	Lace Monitor	P			x			x	x		

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*Appendix D*

# Detailed Fauna Results

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## D.1 Birds

### D.1.1 Blossom-dependent Birds

All of the open forest and woodland communities within the study area provide potential foraging habitat for the range of threatened blossom-dependant birds recorded from the study area and the locality, especially during the blossom periods of dominant trees within these communities.

Both the Regent Honeyeater and Swift Parrot were recorded from the study area. These two species are migratory and can undertake large-scale movements in the order of hundreds of kilometres. The Regent Honeyeater is a nomadic species that will move to areas where food is abundant, and may also undertake seasonal movements towards coastal areas during the winter months; however, the exact nature of these movements is still poorly understood. The nearest core breeding area for Regent Honeyeaters is in and around the Capertee Valley, to the west of Wollemi National Park.

The Swift Parrot breeds in Tasmania during spring and summer, migrating to south-eastern Australia between March and October. They return to some foraging sites on a cyclic basis depending on food availability.

The Little Lorikeet was recorded on a number of occasions from within the study area during current and previous surveys (Andrews Neil, 2006) (Debus, 2008a). As a blossom nomad, the Little Lorikeet is likely to forage in all of the open forest and woodland communities within the study area at any time of year providing there is substantial blossoming of the dominant trees present. Although the study area does provide suitable breeding habitat for this species, it is unlikely that study area forms critical breeding habitat.

Although not recorded from the study area, the Black-chinned Honeyeater (*Melithreptus gularis*) (listed as Vulnerable under the TSC Act) is considered to have potential to occur due to the presence of suitable habitat. The species occupies a number of forest and woodland habitats, but requires large areas of intact habitat with nectar-producing trees. Given the large home-range required for this species, there is potential that Black-chinned Honeyeaters in the wider locality would use flowering *Eucalyptus/Corymbia/Angophora* species as a food source during blossoming periods.

The Painted Honeyeater (*Grantiella picta*) (listed as Vulnerable under the TSC Act) is also considered to have potential to occur, although it has not been recorded from the study area. This species is known to occupy a range of habitats, including Box-Gum and Box-Ironbark woodlands such as those that occur within the study area. The Painted Honeyeater is a specialist feeder on the fruits of mistletoes, particularly of the genus *Amyema* which occurs within the study area. Nectar from these mistletoes and insects present on them are also consumed. Given the abundance of *Amyema* sp. mistletoes the Painted Honeyeater has potential to occur within the study area.

Being blossom dependent, the species listed above have a strong reliance upon the presence of suitable flowering trees. **Table B.1** below indicates that summer, autumn, winter

and spring flowering trees can be found in all forest and woodland communities within the study area. This table indicates that there is suitable foraging habitat in the study area for blossom-dependent species throughout the year.

**Table D.1 Blossom Periods for Dominant Tree Species**

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Eucalyptus moluccana</i>	x	x										x
<i>Angophora floribunda</i>	x	x	x								x	x
<i>Banksia integrifolia</i>		x	x	x	x	x						
<i>Corymbia maculata</i>			x	x								
<i>Eucalyptus crebra</i>				x		x	x		x	x		
<i>Eucalyptus tereticornis</i>						x	x	x	x	x	x	
<i>Eucalyptus blakelyi/tereticornis</i>										x	x	
<i>Eucalyptus camaldulensis</i>												x
<i>Eucalyptus albens</i>	sporadic											
<i>Eucalyptus melliodora</i>	sporadic											

Based on blossoming periods and nectar production, the tree species most likely to provide suitable foraging habitat for blossom-dependant bird species within the Site are:

- Rough-barked Apple (*Angophora floribunda*);
- Coast Banksia (*Banksia integrifolia*);
- Spotted Gum (*Corymbia maculata*);
- Narrow-leaved Ironbark (*Eucalyptus crebra*); and
- Forest Red Gum (*Eucalyptus tereticornis*).

#### **D.1.2 Woodland Birds**

The following woodland birds listed as Vulnerable under the TSC Act have been recorded from the study area:

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Varied Sitella (*Daphoenositta chrysoptera*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);

- Speckled Warbler (*Chthonicola sagittata*);
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- Scarlet Robin (*Petroica boodang*); and
- Diamond Firetail (*Stagonopleura guttata*).

The Brown Treecreeper, Speckled Warbler and Hooded Robin are all sedentary birds occupying home ranges of approximately 10 ha; although home ranges of Hooded Robins can extend to approximately 30 ha during non-breeding periods. Home ranges for family groups of Grey-crowned Babbler vary, but can be as large as 50 ha.

The Grey-crowned Babbler and Speckled Warbler were recorded throughout all of the open forest and woodland communities within the study area. The Site has been estimated to potentially support up to 15 family groups of Grey-crowned Babblers and up to 76 breeding pairs of Speckled Warblers.

The Hooded Robin and Brown Treecreeper were observed in relatively low densities within the study area. The Hooded Robin occurs in the woodland margins and open grassland communities within the study area; while the Brown Treecreeper was most frequently observed in the vicinity of ephemeral drainage lines in the study area. Two groups (pairs or family groups) of Hooded Robins and six groups (individuals, or breeding pairs with or without offspring) of Brown Treecreepers are known to currently occupy the study area, although there is potential for additional groups to occur that were not detected during the surveys.

The Diamond Firetail was recorded during current and previous surveys (Debus, 2008a) (ERM, 1995). Habitat assessment indicates that the majority of the woodland in the study area provides suitable habitat for this species. The home range size of the Diamond Firetail is uncertain and this species may be sedentary or locally nomadic. Given the low number of records it is likely that this species is relatively scarce within the study area.

The Scarlet Robin and the Varied Sittella are assumed to have a home range of approximately 10ha and 20ha, respectively. Potential habitat for both species is present within all of the open forest and woodland communities of the Site, and therefore there is potential for up to 70 pairs of Scarlet Robins and up to 35 family groups of Varied Sittellas to occur. However, given the low frequency of records for both of these species and large numbers of other woodland birds recorded, actual densities are likely to be far lower.

The Turquoise Parrot has not been recorded from the study area, however suitable breeding and foraging habitat for this species is present in the woodland communities within the study area. The occurrence of the Turquoise Parrot, especially breeding pairs, is considered unlikely due to the lack to records within the region. However, infrequent use of the woodland communities within the study area as occasional foraging habitat cannot be completely discounted.

### **D.1.3 Cockatoos**

Two threatened species of Cockatoo have been recorded from the study area or have potential to occur: the Glossy Black-cockatoo (*Calyptorhynchus lathami*) and the Gang-gang Cockatoo (*Callocephalon fimbriatum*).

The Glossy Black-cockatoo was frequently recorded during the current surveys, with flocks of up to eight individuals being observed at any one time. Previous surveys had only detected feeding signs (chewed *Allocasuarina littoralis* seed cones) within the study area (Debus, 2008a). All records of the Glossy Black-cockatoo during surveys were from the WSW community, indicating that this species has a strong association with this community within the study area. It is likely that the WSW provides optimal conditions for the growth of productive Black She-oak (*Allocasuarina littoralis*) that provide food for the Glossy Black - cockatoo. However, it is considered that the species is likely to utilise foraging habitat within the Site periodically as it moves throughout the wider locality.

It is likely that at least one, and probably more, breeding pair/s occupy the site along with offspring from previous years. No nest trees were recorded during surveys however, and potential nest sites for Glossy Black-cockatoos were relatively scarce within the study area due to the lack of large tree-hollows. It is possible that the Glossy Black-cockatoos that forage within the study area may nest some distance from the study area. Some observations of the South Australian sub-species of Glossy Black-cockatoo indicate individuals may travel up to 30 km from nest trees to forage (Garnett, 2000). Although there is no data available on the home range size for this species, it is likely that Glossy Black-cockatoos forage over a wide area throughout the locality, favouring specific foraging locations for a period of time before moving to other locations.

The Gang-gang Cockatoo has not been recorded from the study area, however it has been recorded from the locality, and potential habitat is present in the study area. This species occupies tall mountain forests in summer, but descends to lower altitude forests/woodlands during the winter months, particularly in box-ironbark assemblages. It favours old growth attributes such as large tree-hollows for nesting and roosting. Suitable habitat for this species is present in the study area, particularly box-ironbark vegetation and therefore there is potential for the Gang-gang Cockatoo to utilise the study area for foraging during the winter months. It breeds in spring and summer, and therefore is unlikely to utilise the study area for breeding.

### **D.1.4 Raptors**

Three threatened raptors (birds of prey) were recorded from the study area: the Spotted Harrier; the Little Eagle and the Black-breasted Buzzard.

Both the Spotted Harrier and the Little Eagle are wide ranging species that are known to occupy large home ranges. Pairs of Little Eagles are known to have a home range when breeding of about 1,600ha (Debus, 1984). It is therefore likely that, while the study area provides suitable foraging and breeding habitat for both these species, it is likely to be only as part of a larger home range.

The Black-breasted Buzzard was recorded flying over the study area once incidentally during one of the previous surveys (Andrews Neil, 2006). This species is occasionally recorded in the region; however, it is generally acknowledged that the region falls outside of the typical distribution for this species. Individuals that are sometimes recorded in the Hunter Valley are likely to be vagrants that have moved to coastal and sub-coastal areas during periods of inland drought. It is highly unlikely that the Black-breasted Buzzard would regularly utilise forage or breeding habitat within the study area.

While not recorded from the study area during current or previous surveys, the Square-tailed Kite (*Lophoictinia isura*) has been recorded nearby (ERM, 2008) and is considered likely to have potential to forage over the study area. The species requires a large hunting range of forest/woodland habitat, particularly containing timbered watercourses. Being a specialist hunter of passerines, particularly honeyeaters, it is likely that the blossom periods of dominant trees within the study area would attract prey species for the Square-tailed Kite. There are no OEH records for the Square-tailed Kite within the Singleton LGA. However, previous surveys did record this species at Wambo (ERM, 2008) (ERM, 2002a) and it is possible that despite the absence of records the Square-tailed Kite may forage within the study area infrequently as a component of a much larger home range.

#### **D.1.5 Large Forest Owls**

Although not recorded from the study area, potential foraging habitat for the following Large Forest Owls is present:

- Masked Owl (*Tyto novaehollandiae*);
- Powerful Owl (*Ninox strenua*) and,
- Barking Owl (*Ninox connivens*).

All three of these large forest owls are known to have very large foraging ranges, and require tall hollow-bearing trees as nesting habitat (DEC (NSW), 2006) (DEC (NSW), 2006). While not considered optimal habitat, the riparian vegetation along Wollombi Brook, may provide limited, roosting and breeding habitat for the Masked and Barking Owls. Habitat assessment indicates that this vegetation may also provide suitable forage and potential roost habitat for the Powerful Owl, however it is unlikely to provide suitable nest habitat given the preference of this species to choose very tall hollow-bearing trees within tall wet forest vegetation as nesting sites. It is possible that any of these species could forage across the study area.

#### **D.1.6 Wetland Birds**

While not recorded from the study area, the Black Bittern (*Ixobrychus flavicollis*) has the potential to occur. This species is known to occur in riparian habitats similar to those found near to the study area. Nearby records of this species combined with habitat assessments indicate that suitable habitat for the Black Bittern exists along Wollombi Brook.

## D.2 Mammals

### D.2.1 *Spotted-tail Quoll*

The Spotted-tail Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act and Vulnerable under the TSC Act, and has been recorded from the locality. Numerous records exist for this species within the Singleton LGA including some near to the study area. The species was recorded within the study area based on an unconfirmed scat found in 1979 (ERM, 1995) but none of the surveys undertaken more recently (1995 to present) have recorded the Spotted-tail Quoll. The species creates dens in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields or rocky-cliff faces. Numbers of the Spotted-tail Quoll are low, and males of the species are known to have extensive home ranges up to 3,500ha (DECC (NSW), 2005) (DECC (NSW), 2005a). While no den sites were located during recent habitat assessments it is considered possible that the species forages within the study area.

### D.2.2 *Squirrel Glider*

The Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act, and was recorded from two separate locations within the study area in the 2009 field surveys, both from spotlighting and by captures in arboreal traps. Squirrel Gliders were also recorded during previous surveys (ERM, 2002a) in other parts of the study area. Despite the low number of records, it is likely that the Squirrel Glider would occur throughout all open forest and woodland communities within the study area. However, densities are likely to be low given the low number of records and the relatively low abundance of suitable shelter hollows.

### D.2.3 *Koala*

The Koala is listed as Vulnerable under the TSC Act and Koala populations in QLD, NSW and the ACT are also listed as Vulnerable under the EPBC Act. Although not recorded from the study area, potential habitat occurs as primary and secondary food tree species occur, although the majority of these are young regrowth. Potential Koala feed tree species within the study area are Forest Red Gum/Blakely's Red Gum hybrids (*Eucalyptus tereticornis/blakelyi*) and Grey Box (*Eucalyptus moluccana*). Riparian vegetation supporting a primary feed tree species, River Red Gum (*Eucalyptus camaldulensis*) occurs along Wollombi Brook adjacent to the western portion of the study area. Koalas could potentially occur here, and may utilise the riparian vegetation along Wollombi Brook as a movement corridor. Despite this, no Koala scats or tree scratches were positively identified during habitat assessments throughout the study area or in adjacent vegetation of Wollombi Brook, and no Koalas were seen during the survey period.

### Approved Recovery Plan for the Koala

An approved Recovery Plan for the Koala has been prepared by (DECC (NSW), 2008). Within this plan, management areas have been delineated across NSW. Assessments of Koala habitat have been made according to each of these documents below.

Koalas occur in the Singleton LGA but have not been recorded within the study area. The approved Koala Recovery Plan (DECC (NSW), 2008) 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 identifies a suite of trees that are primary and secondary feed trees for Koalas in each management area. The study area contains forest and woodland vegetation that includes a number of these species. These are shown in **Table D.2**.

**Table D.2 Primary and Secondary Koala Feed Trees**

Koala Management Area 2: Central Coast	Koala Management Area 4: Northern Tablelands
<b>Primary food tree species:</b> Forest Red Gum ( <i>Eucalyptus tereticornis</i> )	<b>Primary food tree species:</b> Forest Red Gum ( <i>Eucalyptus tereticornis</i> )
<b>Secondary Food Tree Species:</b> Grey Box ( <i>E. moluccana</i> )	<b>Secondary Food Tree Species:</b> Grey Box ( <i>E. moluccana</i> )

The dominant trees across a high proportion of the woodland and open forest within the study area include species that are regarded as important primary feed species such as Forest Red Gum (*Eucalyptus tereticornis*) and secondary browse species for this animal, including Grey Box (*Eucalyptus moluccana*). There are also areas adjacent and to the north that include Yellow Box (*Eucalyptus melliodora*) and White Box (*Eucalyptus albens*).

The Recovery Plan also provides two systems to categorise Koala habitat, which are both based upon the abundance of primary and secondary feed tree species:

- Option 1: Within the first category system the study area is considered Secondary Habitat (Class A) as the primary food tree species is common and often grows in association with a secondary feed species. According to this category, the study area is capable of supporting a viable, medium density population of Koalas.
- Option 2: Within the secondary category system, the study area is considered Secondary Habitat (Class B) as areas of forest and woodland are present where the primary Koala feed tree species comprises less than 30% of the overstorey trees. According to this classification, the study area is considered capable of supporting a viable medium-low density Koala population.

#### **D.2.4 Eastern Pygmy Possum**

The Eastern Pygmy-possum (*Cercartetus nanus*) is listed as Vulnerable under the TSC Act. This species has not been recorded from the study area, however it has been recorded from the locality and due to the presence of potential habitat, it is considered to have potential to occur. The Eastern Pygmy-possum is found in a broad range of habitats, including woodland communities similar to the WSW community within the study area. This

community would provide suitable foraging habitat for the Eastern Pygmy-possum in the form of blossoms of Coast Banksia (*Banksia integrifolia*) and Rough-barked Apple (*Angophora floribunda*) as well as insects attracted to the blossoms.

### **D.2.5 Brush-tailed Phascogale**

The Brush-tailed Phascogale (*Phascogale tapoatafa*) is listed as Vulnerable under the TSC Act. Although not detected within the study area, it was detected at Wambo (ERM, 2008) to the north. This semi-arboreal species occurs in a range of forest habitats and potential habitat is present in the study area. As this is a cryptic species that is often difficult to detect, it is possible that the Brush-tailed Phascogale may occupy any of the woodland vegetation within the study area.

### **D.2.6 Microbats**

A total of 18 microbat species have been recorded from the study area using Anabat recorders and harp trapping, including five threatened species listed as Vulnerable under the TSC Act; one of which is also listed as Vulnerable under the EPBC Act. These include the following:

- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act);
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable under both the EPBC Act and the TSC Act);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (Vulnerable under the TSC Act);
- Little Bentwing-bat (*Miniopterus australis*) (Vulnerable under the TSC Act); and
- Southern Myotis (*Myotis macropus*) (Vulnerable under the TSC Act).

In addition, the following four threatened microbat species have been recorded from the locality, and due to the presence of suitable habitat have potential to occur in the study area:

- Corben's Long-eared Bat (*Nyctophilus corbeni*) (Vulnerable under the EPBC and TSC Acts);
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) (Vulnerable under the TSC Act);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (Vulnerable under the TSC Act); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (Vulnerable under the TSC Act).

Although none of these four microbat species have been recorded within the study area during the 2009 or previous surveys, habitat assessments indicate that the study area would provide suitable foraging and roosting habitat for all of these species.

### **Cave-dependant Bats**

Several of the threatened microbats recorded from the study area (Eastern Bentwing-bat, Little Bentwing-bat, and the Large-eared Pied Bat) are dependent on caves in which to breed or roost. No caves or rocky overhangs are present in the study area, and therefore no roosting or breeding habitat is present for cave-dependant microbats. Although these bat species has specific habitat requirements for roosting and breeding, the majority utilise a variety of forest, woodland and grassland communities as foraging habitat. The cave-dependant bats recorded from the study area are likely to breed and roost elsewhere and utilise the study area only for foraging.

The Eastern Bentwing-bat is a cave-dependant species that breeds annually in spring and summer in maternity caves. It roosts predominantly in caves but may also utilise culverts, mine shafts and the roofs of artificial structures. None of these structures are present in the study area, and therefore the study area does not support suitable breeding habitat for the Eastern Bentwing-bat, and suitable roosting habitat would also be very limited. It forages in woodland and forest however, and the records from the study are likely to be from foraging individuals.

The Little Bentwing-bat is also cave-dependant, and was recorded during previous surveys (ERM, 2002a) within the study area. As with the Eastern Bentwing-bat, the study area is likely to provide only foraging habitat for this species, as there is no suitable roosting or breeding habitat within the study area.

The Large-eared Pied Bat has been recorded from the study area. Despite requiring caves in which to roost and breed, the Large-eared Pied Bat has been shown to utilise the study area as foraging habitat.

### **Hollow-dependant Bats**

The remaining threatened bats recorded from the study area or with potential to occur utilise tree hollows as roosting and breeding habitat: Eastern Freetail-bat, Southern Myotis, Eastern Long-eared Bat, Yellow-bellied Sheath-tail-bat, Eastern False Pipistrelle, and the Greater Broad-nosed Bat. Habitat assessments indicate that a number of hollow-bearing dead and living trees are present within the study area that are likely to provide suitable roosting and breeding habitat for these hollow-dependant bat species. With the exception of the Southern Myotis, these species forage over woodland and forest for insectivorous prey, and large areas of this kind of habitat is present in the study area for these species.

The Southern Myotis roosts and breeds in tree hollows although it may also utilise caves. The Southern Myotis forages almost exclusively over water bodies, although suitable foraging habitat may include large or small dams, wetlands, permanent or ephemeral rivers and streams and even temporary puddles. The study area provides some suitable foraging habitat in the form of several small dams, and also provides some roosting habitat in the form of tree-hollows.

### ***D.2.7 Grey-headed Flying-fox***

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under both the EPBC Act and the TSC Act. This species was observed overflying the southern portion of the study area by Cumberland Ecology, however it has not been recorded in the study area during any of the previous fauna surveys (Andrews Neil, 2006) (ERM, 1995) (ERM, 2002a) (Andrews Neil, 2006, ERM, 1995, ERM, 2002a). The Grey-headed Flying-fox roosts and breeds in noisy, conspicuous colonies that are easily detected. No Grey-headed Flying-fox roosting or breeding colonies have been recorded within the study area; and habitat assessments indicate that the study area does not provide suitable roosting or breeding habitat for this species. A large roosting colony of Grey-headed Flying-foxes is located in Singleton town centre. The study area provides suitable foraging habitat for this species and, despite the absence of records, it is likely that individuals from the Singleton colony would forage within the study area during blossom periods of the dominant trees.

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*Appendix E*

**Assessment of the Likelihood of Occurrence of  
Threatened Species**

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**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Apocynaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	6	E1	E	Usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and Bracelet Honey Myrtle <i>Melaleuca armillaris</i> scrub to open scrub.	Possible. Nearest OEH record is 12km to south east of study area extension within the Singleton Military Training Area. Not detected in previous targeted flora surveys.
Asteraceae	<i>Olearia cordata</i>		9	V	V	Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges.	Possible. Records from 2001 occur within Yengo National Park. Not detected in previous targeted threatened flora surveys.
	<i>Ozothamnus tessellatus</i>		1	V	V	Grows in eucalypt woodland. Restricted to a few locations north of Rylstone.	Unlikely. One record within the Singleton LGA from 2003 to the north of the study area. Not detected in

**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Fabaceae (Faboideae)	<i>Dillwynia tenuifolia</i>		9	V	V	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. In the disjunct locality in Yengo, this species occurs in disturbed escarpment woodland on Narrabeen sandstone.	previous targeted flora surveys.  Unlikely. OEH record 5km south of the study area from 1998. Not detected in previous targeted threatened flora surveys
Fabaceae (Mimosoideae)	<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	5	E2		Typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations.	Possible. Records from 2006 occur 14km to the north of the study area. Not detected in previous targeted threatened flora surveys.
Lamiaceae	<i>Prostanthera cineolifera</i>	Singleton Mint Bush	4	V	V	Grows in open woodlands on exposed sandstone ridges. Known occurrences are in Walcha; Scone and St Albans.	Unlikely. Records from 1987, 12km south east of study area. Not detected in previous targeted threatened flora surveys.

**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Myrtaceae	<i>Callistemon linearifolius</i>	Netted Bottle Brush	1	V		Grows in dry sclerophyll forest on the coast and adjacent ranges. In northern distribution it has been recorded from Yengo National Park.	Possible. Nearest OEH record is 16km to the north of the study area from 1992. Not detected in previous targeted threatened flora surveys.
	<i>Darwinia biflora</i>		2	V	V	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas.	Unlikely. Records from 1998, 8km south of study area. Not detected in previous targeted flora surveys.
	<i>Darwinia peduncularis</i>		3	V		Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone.	Possible. Recorded in Wollemi National Park from 1998 to the south west of the study area. Not detected in previous targeted flora surveys.
	<i>Eucalyptus camaldulensis</i>	<i>Eucalyptus camaldulensis</i> population in the		24	E2	Forms stands of woodland and open woodland on the major floodplains of the Hunter and Goulburn rivers,	Present within the study area but not within the Site. Verified records along

**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
		Hunter catchment				especially in areas where water impoundment occurs after flood. May occur with <i>Eucalyptus tereticornis</i> , <i>Eucalyptus melliodora</i> ; <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> and <i>Angophora floribunda</i> .	Wollombi Brook and the Hunter River. Possible occurrence within Site but in few areas due to specific habitat requirements.
	<i>Eucalyptus fracta</i>	Broken Back Ironbark	22	V		Occurs in dry eucalypt woodland in shallow soils. Locally common but restricted to the northern Broken Back Range near Cessnock. Dominant tree in a narrow band along the upper edge of a sandstone escarpment.	Unlikely. OEH records from 2004 occur 22km south west of study area. Not detected in previous targeted flora surveys. Study area is outside known distribution. Not likely to occur.
	<i>Eucalyptus glaucina</i>	Slaty Red Gum	159	V	V	Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils.	Possible. OEH records from 1998 occur on the western boundary of the study area. Presence not confirmed in numerous surveys. Potential to occur.
	<i>Melaleuca groveana</i>	Grove's Paperbark	15	V		Grows in heath and shrubland, often in exposed sites, at high elevations,	Possible. Nearest OEH record is 10km to the south

**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Orchidaceae	<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum in the Hunter Catchment	1	E2		on rocky outcrops and cliffs. It also occurs in dry woodlands.  Grows in the hollows of trees in dry sclerophyll forest or woodland; north from the Hunter Valley, chiefly in inland districts, west to New Angledool.	of the study area from 2006. Not detected in previous targeted flora surveys.  Possible. Recorded at the NBA by Cumberland Ecology (2009) approximately 8km north of the study area.
	<i>Pterostylis gibbosa</i>	Illawarra Greenhood	6	E1	E	All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Likely. OEH records 8km south of the study area from 2001. Not detected in previous targeted flora surveys.
Proteaceae	<i>Grevillea evansiana</i>	Evans Grevillea	6	V	V	Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone. Known populations occur on the western side of Wollemi National Park and nearby private lands, within the Rylstone	Possible. Nearest record is approximately 45km south west of the study area within Wollemi National Park. Not detected in previous targeted flora surveys. The study area is outside known

**Table E.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the Study Area**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
	<i>Persoonia hirsuta</i>	Hairy Geebung	7	E1	E	Local Government Area. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	distribution. Unlikely. Records from 2006 in Yengo National Park, approximately 45km from study area. Not detected in previous targeted flora surveys. Has potential to occur, but potential is low.
Rutaceae	<i>Leionema lamprophyllum subsp. obovatum</i>	Leionema lamprophyllum subsp. obovatum in the Hunter Catchment	1	E2		Occurs in dry eucalypt forest on exposed rocky terrain. The Hunter Catchment population of L lamprophyllum subsp. obovatum occurs east of Maitland near Pokolbin in the Hunter Valley.	Unlikely. Nearest record is 22km south east of the study area from 1993. Not detected in previous targeted flora surveys. Site is outside known distribution.
	<i>Leionema sympetalum</i>	Rylstone Bell	3	V	V	Restricted to exposed rocky sandstone formations known as pagodas. The species occurs in dry sclerophyll forest and probably also occurs in open or closed heathland communities.	Unlikely. Recent records from the south western corner of Wollemi National Park. Not detected in previous targeted flora surveys.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Green and Golden Bell Frog	<i>Litoria aurea</i>	E	V	Inhabits marshes, dams and stream-sides, particularly those containing bulrushes ( <i>Typha</i> spp.) and Spikerushes ( <i>Eleocharis</i> spp.). Optimal habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow ( <i>Gambusia holbrooki</i> ), have a grassy area nearby and sheltering sites available. Can occur in highly disturbed areas.	Possible. Nearest recent OEH records (1997 and 2000) from near Ravensworth, approximately 20km north of the study area. Suitable habitat within the Site.
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	V	V	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. Breeds from August to March, laying eggs under vegetation in creeks or in yabby holes.	Possible. Not recorded within the study area during current or previous surveys. Suitable foraging habitat within the Site; particularly the WSW vegetation and the vegetation along sandy drainage lines. Nearest OEH records from upstream areas of Wollombi Brook. Suitable habitat within the Site but unlikely to occur due to scarcity of records and previous intensive agricultural land use.
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V		Occurs in open forests, mostly on Hawkesbury or Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of	Unlikely. Not recorded within the study area during current or previous surveys. No suitable habitat within the study land. Nearest OEH records and habitat within Wollemi National Park on different geology and topography to the study area

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				the tadpoles takes place in the egg. Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter.	
Red Goshawk	<i>Erythrotriorchis radiatus</i>	E	V	Mainly found along or near watercourses, in swamp forest and woodlands on the coastal plain. It favours patches of dense forest interspersed with open woodland or cleared land and often frequents forest edges.	Possible. Not recorded within the study area during current or previous surveys. Sub-optimal forage habitat. No recent records from wider locality.
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	V		Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Breeds from August to October near water in tall trees.	Likely. Recorded opportunistically in the southern portion of the study area during 2006 surveys.
Square-tailed Kite	<i>Lophoictinia isura</i>	V		Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses and is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Appears to occupy large hunting ranges of more than 100km <sup>2</sup> .	Likely. Not recorded during the current or previous surveys within the study area. Recorded during previous surveys at Wambo (ERM, 2008). No OEH records for the Singleton LGA. Suitable forage habitat within the Site which may form a component of a much larger home-range.
Black Bittern	<i>Ixobrychus flavicollis</i>	V		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded	Possible. Not recorded within the study area during current or previous surveys. Recorded during previous surveys at Wambo (ERM, 2008) in vegetation along

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground amongst dense reeds. Generally solitary, but occurs in pairs during the breeding season, from December to March. Nests, built in spring are located on a branch overhanging water.	Wollombi Brook, similar to that which occurs adjacent to the study area. Suitable habitat occurs in Wollombi Brook and other drainage lines within the study area and Site.
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E		Inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey items including fish, frogs, eels, turtles, snakes and crabs.	Unlikely. Not recorded within the study area during current or previous surveys. OEH records within the 10km buffer area surrounding the study area. No suitable habitat within the Site.
Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	V		Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1,000 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). Dependent on large hollow-bearing eucalypts for nest sites.	Present. Recorded during current surveys from within portions of the study area to the west of Wallaby Scrub Road, and from feeding signs during previous surveys.

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Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	V		In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet eucalypt forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Often found in urban areas. Favours old-growth attributes for nesting and roosting.	Possible. Not recorded within the study area during current or previous surveys. OEH records within the 10km buffer area surrounding the study area. Suitable winter forage habitat within the Site.
Speckled Warbler	<i>Chthonicola sagittata</i>	V		Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary, occupying a breeding territory of about 10ha; with a slightly larger home-range when not breeding.	Present. Recorded commonly during current and previous surveys throughout the Site. Common throughout the locality.
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus victoriae</i>	V		Found in eucalypt woodlands and dry open forests of the inland slopes and plains inland of the Great Dividing Range. Also occasionally occurs in suitable habitat in coastal areas. Mainly inhabits woodlands dominated by stringybarks and other rough-barked eucalypts, usually with an open grassy understorey,	Present. Recorded during current and previous surveys throughout the Site.

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Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Diamond Firetail	<i>Stagonopleura guttata</i>	V		<p>sometimes with one or more shrub species. Usually not found in woodland with a dense shrub understorey. Fallen timber is an important habitat component for foraging. Sedentary, with home-ranges from 1.1ha to 10.7ha. Hollows in standing dead or living trees and tree stumps are essential for nesting.</p> <p>Found in grassy eucalypt woodlands, including Box-Gum Woodlands. Also occurs in open forest, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas, and sometimes in lightly wooded farmland. Feeds exclusively on the ground, primarily on grass and herb seed. Nests and roosts mainly in dense shrubs.</p>	Present. Recorded during current surveys within the south-eastern portion of the Site and during previous surveys.
Regent Honeyeater	<i>Anthochaera phrygia</i>	CE	E	<p>Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include: Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany.</p>	Possible. Not recorded during current surveys. Recorded during previous surveys (ERM, 2002a) from within the Site. Suitable forage habitat within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Black-chinned Honeyeater (eastern subspecies)	<i>Meliphreptus gularis gularis</i>	V		Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark ( <i>Eucalyptus sideroxylon</i> ), 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> ). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees. Feeding territories are large making the species locally nomadic. The Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares	Possible. Not recorded within the study area during current or previous surveys. Nearby OEH records from within 10km of the study land boundaries. Suitable habitat within the Site; which may form a component of a much larger home-range.
Painted Honeyeater	<i>Grantiella picta</i>	V		Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	Possible. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres to the south of the study area. Suitable habitat within the Site.
Grey-crowned Babbler (eastern)	<i>Pomatostomus temporalis temporalis</i>	V		Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross	Present. Recorded commonly during current and previous surveys (Andrews Neil, 2006, Debus, 2008a, Debus, 2008b, ERM, 1995, ERM, 2002a) throughout the Site. Common in the locality

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				large open areas. Build and maintain several dome-shaped stick nests used for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts.	
Swift Parrot	<i>Lathamus discolor</i>	E	E	Migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany ( <i>Eucalyptus robusta</i> ), Spotted Gum ( <i>Corymbia maculate</i> ), Red Bloodwood ( <i>Corymbia gummifera</i> ), Mugga Ironbark ( <i>Eucalyptus sideroxylon</i> ), and White Box ( <i>Eucalyptus albens</i> ). Commonly used lerp infested trees include Grey Box ( <i>Eucalyptus microcarpa</i> ), Grey Box ( <i>Eucalyptus moluccana</i> ) and Blackbutt ( <i>Eucalyptus pilularis</i> ). Return to some foraging sites on a cyclic basis depending on food availability.	Possible. Not recorded during current surveys. Recorded during previous surveys (ERM, 2002a) from within the Site. Suitable forage habitat within the Site.
Little Lorikeet	<i>Glossopsitta pusilla</i>	V		Mostly occur in dry, open eucalypt forests and woodlands. Gregarious, usually foraging in small flocks, often with other species of lorikeet. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including Melaleuca and mistletoes. Nest hollows are located at heights of between 2m	Present. Recorded during current and previous surveys (Andrews Neil, 2006, Debus, 2008a) within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				and 15m, mostly in living, smooth-barked eucalypts. Nest-hollows are used “traditionally”, with the same hollow known to be occupied for at least 29 years. Breeding season extends from May to September.	
Turquoise Parrot	<i>Neophema pulchella</i>	V		Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. 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. Nests in tree hollows, logs or posts, from August to December.	Likely. Not recorded during the current or previous surveys within the study area. Recorded during previous surveys at Wambo (ERM, 2008) and from nearby OEH records with 10km of the study area. Suitable forage habitat within the Site.
Hooded Robin (south-eastern form)	<i>Melanodryas cucullata cucullata</i>	V		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. Territories range from around 10ha during the breeding season, to 30ha in the non-breeding season.	Present. Recorded during current surveys from two locations within and adjacent to the Site. Also recorded during previous surveys (ERM, 2002a).
Blue-billed Duck	<i>Oxyura australis</i>	V		Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. Blue-billed Ducks are partly migratory, with short-distance movements between breeding	Unlikely. Not recorded within the study area during current or previous surveys. Nearest OEH records for the Singleton LGA are approximately 20km to the north of the study area. No suitable habitat within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Powerful Owl	<i>Ninox strenua</i>	V		<p>swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes.</p> <p>Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation. Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. Powerful Owls nest in large tree hollows (at least 0.5m deep), in large eucalypts (diameter at breast height of 80-240cm) that are at least 150 years old.</p>	<p>Possible. Not recorded within the study area during current or previous surveys. Nearest OEH records are within the 10km buffer surrounding the study area; to the south. Sub-optimal forage habitat within the Site; which may form a component of a much larger home-range. No suitable roosting or nesting habitat.</p>
Barking Owl	<i>Ninox connivens</i>	V		<p>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 Acacia and Casuarina</p>	<p>Likely. Not recorded during current or previous surveys. Nearest OEH records are near Bulga; within 10km of the study area. Suitable habitat within the Site.</p>

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Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Masked Owl	<i>Tyto novaehollandiae</i>	V		species, or the dense clumps of canopy leaves in large Eucalypts. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Live alone or in pairs. Territories range from 30 to 200ha and birds are present all year. Breeding occurs during late winter and early spring. Lives in dry eucalypt forests and woodlands from sea level to 1,100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1,000ha. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Possible. Not recorded within the study area during current or previous surveys. Nearest OEH records are within 10km of the boundary of the study area; to the south and west. Suitable forage habitat within the Site; which may form a component of a much larger home-range. Potential roosting or nesting habitat adjacent to Wollombi Brook.
Sooty Owl	<i>Tyto tenebricosa</i>	V		Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) or Sugar Glider ( <i>Petaurus breviceps</i> ). Nests in very large tree-hollows.	Unlikely. Not recorded within the study area during current or previous surveys. No suitable habitat or nearby OEH records.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia; and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	Present. Recorded during Spring surveys by Cumberland Ecology. Suitable forage habitat within the Site. No known roost or breeding habitat. Large roosting colony in Singleton, individuals from which are likely to forage within the study area during blossom periods of the dominant trees.
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	V		Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats, with and without trees.	Likely. Not recorded within the study area during current or previous surveys. Recorded during previous surveys at both HVO South and Wambo (ERM, 2008). Nearest OEH records are within 10km from the boundary of the study area. Suitable forage habitat within the Site. No significant roost or breeding habitat present.
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V		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.	Present. Recorded in the Site during Cumberland Ecology Spring surveys. Recorded within the study area during previous surveys (ERM, 1995, ERM, 2002a). Suitable habitat throughout the study area.
Large-eared	<i>Chalinolobus</i>	V	V	Found in well-timbered areas containing gullies. Roosts in	Present. Recorded during Cumberland Ecology Spring

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Pied Bat	<i>dwyeri</i>			caves, crevices in cliffs and old mine workings frequenting low to mid-elevation dry open forest and woodland close to these features.	surveys. Recorded during previous surveys at Mt Thorley Mine (ERM, 1995) within the study area. Also recorded during previous surveys at Wambo (ERM, 2008) at several locations. Suitable forage habitat within the Site. No suitable roosting or breeding habitat within areas surveyed during current studies. Chartlon Ridge may provide potential roosting habitat.
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V		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.	Possible. Not recorded within the study area /during current or previous surveys. Nearby OEH records from within 10km of the study area. Limited suitable habitat within the study area; mainly adjacent to Wollombi Brook and along drainage lines.
Little Bentwing-bat	<i>Miniopterus australis</i>	V		Prefer moist eucalypt forest, rainforest or dense coastal banksia scrub. Roost in caves, tunnels and sometimes tree hollows during the day, and at night forage beneath the canopy of densely vegetated habitats.	Likely. Recorded within the study area during previous (ERM, 2002a) surveys. Suitable forage habitat within the Site. No suitable roost or breeding habitat present.
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V		Hunt in forested areas, catching moths and other flying insects above the tree tops. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centered on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity	Present. . Recorded during Cumberland Ecology Spring surveys Recorded during previous surveys (ERM, 1995, ERM, 2002a). Suitable foraging but no suitable roosting habitat within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300km range of maternity caves. Cold caves are used for hibernation in southern Australia.	
Southern Myotis	<i>Myotis macropus</i>	V		Most habitats near water, including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland. Forage over streams and pools catching insects and small fish. Generally roost close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.	Present. Possible records from within the study area during the current surveys. Recorded within the study area during previous surveys (ERM, 2002a). Suitable habitat within the Site; particularly adjacent to dams and other water bodies.
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	V	V	Inhabits a variety of vegetation types, including mallee, buloke <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 NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark. Slow flying agile bat, utilising the understorey to hunt non-flying prey. Mating takes place in autumn with one or two young born in late spring to early summer.	Possible. Not recorded within the study area during current or previous surveys. Nearest OEH records within the Singleton LGA are from west of Jerry's Plains. Suitable habitat within the Site.
Greater Broad-	<i>Scoteanax rueppellii</i>	V		Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most	Possible. Not recorded within the study area during current or previous surveys. Nearby OEH records from

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
nosed Bat				commonly found in tall wet forest. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6m. Although this species usually roosts in tree hollows, it has also been found in buildings. Females congregate at maternity sites located in suitable trees.	within 10km of the boundary of the study area. Limited suitable habitat within the Site; mainly adjacent to Wollombi Brook and along drainage lines.
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	V		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. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.	Possible. Not recorded within the study area during current or previous surveys. Nearby OEH records from within 10km of the boundary of the study area. Suitable habitat within the Site.
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V		Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) dreys or thickets of vegetation, (e.g. grass-tree skirts); tree hollows are favoured but spherical nests have been	Possible. Not recorded within the study area during current or previous surveys. Nearest OEH records are from within 10km of the boundaries of the study area; from Wollemi National Park. Suitable habitat occurs within the Site; particularly the WSW but the species is considered unlikely to occur.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				found under the bark of eucalypts and in shredded bark in tree forks. Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68ha and females about 0.35ha	
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	V	E	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. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Females occupy home ranges up to about 750ha and males up to 3500ha; usually traverse their ranges along densely vegetated creek lines.	Possible. Not recorded during current surveys. Unconfirmed record from old scats found within the study area in 1979 (ERM, 1995). Nearby recent OEH records from Warkworth locality, and other areas within 10km of the boundaries of the study area. Suitable forage habitat in the Site; which may form a component of a much larger home-range. Den habitat limited to fallen logs.
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	V		Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25cm diameter or greater. Females have exclusive territories of approximately 20 - 60ha; while males have overlapping territories of up to 100ha. Nest and shelter in tree hollows with entrances 2.5-4cm wide and use many different hollows over a short time span.	Possible. No records from within the study area during current or previous surveys. Recorded during previous surveys from Jerry's Plains Road at HVO South (ERM, 2008). Suitable habitat within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	E	V	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15ha.	Unlikely. Not recorded during current or previous surveys. Nearest recent OEH records are within 10km from the boundary of the study area to the south and west, mostly from within Wollemi National Park. No suitable intact habitat within the Site. Large number of feral predators within the study area known to heavily impact on this species.
Koala	<i>Phascolarctos cinereus</i>	V		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. Home range size varies with quality of habitat, ranging from less than 2ha to several hundred hectares in size.	Possible. Not recorded during current or previous surveys. Nearest recent (2006) OEH records are within 10km from the boundary of the study area. Most suitable habitat for Koala within the study area occurs adjacent to Wollombi Brook; some suitable habitat within the Site.
Yellow-bellied Glider	<i>Petaurus australis</i>	V		Den, often in family groups, in hollows of large trees. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by	Unlikely. Not recorded during current or previous surveys. Nearest OEH records are within 10km from the boundary of the study area; within Wollemi National Park. No suitable habitat within the Site.

**Table E.2 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the Study Area**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Squirrel Glider	<i>Petaurus norfolcensis</i>	V		incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Very mobile and occupy large home ranges of 20-85ha to encompass dispersed and seasonally variable food resources.  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 mid-storey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna; with invertebrates and pollen providing protein.	Present. Recorded within the south-eastern portion of the Site during current surveys. Also recorded in other portions of the Site during previous surveys (ERM, 2002a). Suitable habitat throughout the study area.

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*Appendix F*

# Assessments of Significance

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## **F.1 Assessments of Significance (7 part tests) for recorded and potentially occurring threatened species in the Study Area**

### ***F.1.1 Endangered Ecological Communities***

The following Assessment of Significance has been prepared as a composite test for three EECs listed under the TSC Act that are known to occur within the study area. These include the following:

- Warkworth Sands Woodland;
- Central Hunter Grey Box – Ironbark Woodland; and
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

#### **Warkworth Sands Woodland**

Warkworth Sands Woodland (WSW) occurs predominantly in the north and west of the study area in a relatively large band with scattered occurrences to the west and to the north. The quality of this community varies considerably and ranges from low to high quality depending upon species composition, structural formation and the level of recent disturbance.

Dominant canopy species in the higher quality areas of this community include Rough-barked Apple (*Angophora floribunda*) and the small tree Coastal Banksia (*Banksia integrifolia*). Other small trees recorded in the canopy of this community include Bulloak (*Allocasuarina luehmannii*), Black She-Oak (*Allocasuarina littoralis*), Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*), Black Cypress Pine (*Callitris endlicheri*) and White Cypress Pine (*Callitris glaucophylla*).

Common understorey species include Coffee Bush (*Breynia oblongifolia*), *Hibbertia linearis*, Slender Rice Flower (*Pimelea linifolia*), Silver-stemmed Wattle (*Acacia parvipinnula*) and Dogwood (*Jacksonia scoparia*). The groundcover is characterised by Bracken (*Pteridium esculentum*). Common grasses in this community are Three-awn Speargrass (*Aristida vagans*), Weeping Meadow Grass (*Microlaena stipoides*), Purple Wiregrass (*Aristida ramosa*), Brown's Lovegrass (*Eragrostis brownii*), Blady Grass (*Imperata cylindrica*) and Hairy Panic (*Panicum effusum*). Other common groundcovers include Rock Fern (*Cheilanthes sieberi*), Berry Saltbush (*Einadia hastata*), Pomax (*Pomax umbellata*) and Variable Glycine (*Glycine tabacina*).

Approximately 72.1 ha of WSW is proposed to be removed as part of the Proposal.

#### **Central Hunter Grey Box – Ironbark Woodland**

This vegetation community is the most common within the Site and forms a large continuous tract on the western side of Wallaby Scrub Road with a more fragmented distribution on the eastern side of Wallaby Scrub Road. Much of this community had been cleared prior to the 1960s and as a result the majority of this vegetation community exists as regrowth. To the

south of the Site this community is fragmented, however genetic exchange between patches of this community is still likely to occur.

The dominant canopy species within this community are Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). There are also local abundances of Bulloak (*Allocuarina luehmannii*) and White Feather Honeymyrtle (*Melaleuca decora*) in the midstorey.

Common understorey species include Fan Wattle (*Acacia amblygona*), *Acacia falcata*, Native Blackthorn (*Bursaria spinosa*) and Coffee Bush (*Breynia oblongifolia*). Common groundcover species include Purple Burr-Daisy (*Calotis cuneifolia*), Blue Trumpet (*Brunoniella australis*), Kidney Weed (*Dichondra repens*), Blue Flax Lily (*Dianella revoluta*), Threeawn Speargrass (*Aristida vagans*), Wattle Matt-rush (*Lomandra filiformis*), Common Fringe-sedge (*Fimbristylis dichotoma*) and Rock Fern (*Cheilanthes sieberi*).

Approximately 365.5 ha of Central Hunter – Grey Box Woodland is proposed to be removed as part of the Proposal.

### **Central Hunter Ironbark – Spotted Gum – Grey Box Forest**

This community consists of one larger patch in the south eastern corner of Site and several smaller isolated patches along the eastern side of Wallaby Scrub Road. The smaller patches generally occur as small stands of forest surrounded by grassland. .

Dominant canopy species in this community include Narrow-leaved Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia maculata*) and Grey Box (*Eucalyptus moluccana*). Bulloak (*Allocasuarina luehmannii*) is a common midstorey species.

The common understorey species in this community are Fan Wattle (*Acacia amblygona*) and Gorse Bitter Pea (*Daviesia ulicifolia*). Common groundcover species include; Blue Trumpet (*Brunoniella australis*), Common Everlasting (*Chrysocephalum apiculatum*), Wattle Matt-rush (*Lomandra filiformis*), Many-flowered Mat-rush (*Lomandra multiflora*), Blue Flax-lily (*Dianella longifolia*), Three-awn Speargrass (*Aristida vagans*), Rock Fern (*Cheilanthes sieberi*) and Variable Glycine (*Glycine tabacina*).

Approximately 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest is proposed to be removed as part of the Proposal.

### **Assessment of Significance**

- (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*

Not applicable to endangered communities.

- (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*

Not applicable to endangered communities.

*(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*

Approximately 72.1 ha of WSW will be removed for the Proposal. Approximately 464.8 ha of WSW is considered to remain, and the area proposed to be removed comprised approximately 15% of the total occurrence of this community. This is a substantial reduction that would place the occurrence of this community at risk of extinction. However, a range of impact mitigation and compensation measures will be implemented including the protection and management of large patches of remaining WSW and substantial areas of WSW will be established on Warkworth Sands Grassland to further increase the area of this community.

Approximately 365.5 ha of Central Hunter Grey Box – Ironbark Woodland will be removed within the Site, which represents a loss of approximately 3% of the community within the Central Hunter region and 3% of the known distribution of the community. This would not place the local occurrence at risk of extinction.

Approximately 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest will be removed within the Site. This represents less than 0.2% of the remaining extent of this community within the Central Hunter. This would not place the local occurrence at risk of extinction.

Accordingly, the project is unlikely to have an adverse effect on the extent of these communities such that their local occurrence is likely to be placed at risk of local extinction. With the exception of the areas to be cleared, which are discussed above, the Proposal will not substantially and adversely modify the composition of these ecological communities.

*(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*

Approximately 72.1 ha of WSW will be removed.

Approximately 365.5 ha of Central Hunter Grey Box – Ironbark Woodland will be removed.

Approximately 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest will be removed.

*(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*

No areas of habitat for these communities will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

*(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, and*

The area of potential habitat to be removed is considered to be important to the survival of WSW. The extent of this community is highly restricted and the 72.1 ha to be removed is considered to be important to its long term survival. However, a substantial compensation and mitigation package has been prepared which will re-establish large areas of WSW and protect substantial areas of existing WSW in the SBA and NBA.

The area of of Central Hunter Grey Box – Ironbark Woodland to removed (365 ha) is considered to be important to its long term survival. However, a substantial compensation and mitigation package has been prepared which will protect substantial areas of this community in the SBA and NBA as well as on offsite offset areas.

The removal of 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest is not considered to be important to the long term survival of this community.

*(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 WSW, Central Hunter Grey Box – Ironbark Woodland and Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these communities.

*(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 following KTP have potential to operate as a result of the Proposal and impact these communities:

- **Clearing of native vegetation** as this directly removes and reduces the extent of these ecological communities;
- **Loss of hollow-bearing trees** as this directly removes remnant trees of these communities and reduces the abundance of nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of these communities and reduces the abundance of important ground foraging and nesting habitat;

- **Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands** as this can significantly reduce the ecological function of ecological communities; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters these communities.

## Conclusion

The Proposal will remove approximately 72.1 ha of WSW. In the absence of any mitigation or compensation measures, this would represent a significant impact to this community. However, a range of mitigation measures and offset measures will be implemented for this community, including the protection of large areas of this community in the SBA and NBA, and re-establishment of areas of WSW on Warkworth Sands Grassland. Although successful re-establishment of WSW has not been conducted previously, it is considered likely that this will be able to be successfully undertaken for the Proposal. Warkworth Sands Grassland occurs on the same geology as WSW, and it contains a high diversity of the original species composition with the exception of the canopy trees. A WSW re-establishment manual has been prepared that presents best practice techniques and methodology for re-establishing this community and it is considered that over time, high quality examples of WSW will be able to be established in these areas. This will considerably extend the current extent of this community. Considering the impact mitigation and compensation measures proposed, no significant impact is predicted to occur in the long term to WSW because large remaining areas of WSW will be conserved and managed in the long term, and significant additional areas will be re-established.

The Proposal will remove approximately 365.5 ha of Central Hunter Grey Box – Ironbark Woodland. In the absence of any mitigation or compensation measures, this would represent a significant impact to this community. However, a range of mitigation measures and offset measures will be implemented for this community, including the protection of large areas of this community in the SBA and NBA, and re-establishment of areas of this community. Considering the impact mitigation and compensation measures proposed, no significant impact is predicted to occur in the long term to Central Hunter Grey Box – Ironbark Woodland because large areas of Central Hunter Grey Box – Ironbark Woodland will be conserved and managed in the long term, and significant additional areas will be re-established.

The Proposal will remove approximately 15 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest. This is a small proportion of the remaining areas of this community in the locality. No significant impact is predicted to occur to Central Hunter Ironbark – Spotted Gum – Grey Box Forest as a result of the Proposal.

### **F.1.2 Threatened Flora Species**

The following Assessment of Significance has been prepared as a composite test for three flora species listed under the TSC Act that are known to or have potential to occur within the study area. These include the following:

- *Ancistrachne maidenii*.
- *Eucalyptus glaucina*; and
- *Eucalyptus camaldulensis*.

A separate Assessment of Significance has been prepared for threatened orchids with potential to occur.

#### **Ancistrachne maidenii**

*Ancistrachne maidenii* is a scrambling perennial with slender, rigid horizontal stems and ascending branches that flowers in summer. The species requires areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes, and grows in dry sclerophyll forest on sandstone-derived soils. The occurrence of this species within the study area is surprising as this occurrence is outside of its current known range and the record within the study area is a disjunct occurrence of this species. Therefore this population is considered significant in the longer term survival of the species within the region.

The occurrence of this species within the study area is approximately 0.5 km west of the boundary of the Site and will not be removed as part of the Proposal.

#### **Eucalyptus glaucina**

*Eucalyptus glaucina* grows to 18 m tall, although some have been recorded up to 30 m. It grows in grassy woodland as well as dry eucalypt forest. It is found on deep and moderately fertile soils that are well-watered. This species is only found on the north coast of NSW in two separate districts. It is found near Casino where it is locally common and further south from Taree to Broke and west of Maitland. The species is only conserved in a flora reserve in the Bremer State Forest, south of Casino.

Wildlife Atlas records indicate that five individuals of *Eucalyptus glaucina* have been identified adjacent to the western boundary of the study area. Despite these records the species has never been confirmed in the numerous flora surveys that have been conducted within the study area since the initial recording in 1998. It is possible that such specimens were in fact misidentifications of Forest Red Gum / Blakely's Red Gum hybrids due to their somewhat similar features.

No individuals of this species occur in the Disturbance boundary or will be removed by the Proposal.

### **Eucalyptus camaldulensis**

The population of *Eucalyptus camaldulensis* in the Hunter is listed as an Endangered Population. It is unique in NSW being the only one to occur in a coastal catchment. Most of the occurrences are on private land and there are no known occurrences in conservation reserves. It is disjunct and at the limit of range of the species, it may be genetically distinct, and is of conservation significance as the community dominant in distinct riparian and floodplain vegetation types.

This species has been recorded in the study area, however it does not occur in the Disturbance boundary and no individuals will be removed by the Proposal.

### **Assessment of Significance**

*(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*

The threatened flora species listed above do not occur in the Disturbance boundary and will not be impacted by the Proposal. Accordingly, it is not considered likely that the Proposal will have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of local extinction.

*(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*

*Eucalyptus camaldulensis* individuals in the study area are part of an endangered population. However, this species does not occur in the Disturbance boundary and will not be impacted by the Proposal. Accordingly, it is not considered likely that the Proposal will have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of local extinction.

No endangered populations of *Ancistrachne maidenii* or *Eucalyptus glaucina* are listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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

(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

(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, and

No known habitat for *Ancistrachne maidenii*, *Eucalyputs glaucina* and *Eucalyptus camaldulensis* will be removed, however approximately 610.7 ha of forest, woodland and grassland that forms potential habitat for these species will be removed.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is not considered to be important to the long term survival of *Ancistrachne maidenii*, *Eucalyputs glaucina* and *Eucalyptus camaldulensis*. These species are not known to occur in this area and there are large areas of similar vegetation nearby that provide similar habitat values.

(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 *Ancistrachne maidenii*, *Eucalyputs glaucina* or *Eucalyptus camaldulensis*.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan or threat abatement plan has been prepared for *Ancistrachne maidenii*, *Eucalyputs glaucina* or *Eucalyptus camaldulensis*.

(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 action constitutes or is part of the following KTPs:

- Clearing of native vegetation;
- Loss of hollow-bearing trees; and
- Removal of dead wood and dead trees

These processes will not affect *Ancistrachne maidenii*, *Eucalyputs glaucina* and *Eucalyptus camaldulensis* as no individuals of these species will be removed.

## Conclusion

*Ancistrachne maidenii*, *Eucalyptus glaucina* and *Eucalyptus camaldulensis* have been recorded from the study area; however these species do not occur in the Disturbance boundary and will not be impacted by the Proposal. Approximately 610.7 ha of forest, woodland and grassland that forms potential habitat for these species will be removed, however no potential habitat will be fragmented and large areas of potential habitat will remain in nearby areas. An Biodiversity Offset Strategy has been prepared that will provide large areas of similar habitat for conservation, including the rehabilitation of mined land to woodland communities. The Proposal is therefore considered unlikely to have a significant impact on *Eucalyptus camaldulensis*, *Eucalyptus glaucina* or *Ancistrachne maidenii*.

### **F.1.3 Threatened Orchids**

The following Assessment of Significance has been prepared as a composite test for two orchid species listed under the TSC Act that are known to or have potential to occur within the study area. These include the following:

- *Pterostylis gibbosa*; and
- *Diuris tricolor*

#### **Pterostylis gibbosa**

*Pterostylis gibbosa* (Illawarra Greenhood) is listed as Endangered under the TSC Act and the EPBC Act. It is a deciduous, perennial terrestrial orchid known from five locations in NSW. Three locations occur in isolated woodland in the Illawarra region; one location is known near Nowra in the Shoalhaven region; and one site is known near Milbrodale in the Hunter Valley region, approximately 15km south-west of the study area. The total population is estimated to include approximately 4,500 individuals. All known sub-populations occur in open forest or woodland on flat or gently sloping land with poorly drained soils that are leached, acidic and have a clay subsoil that impedes water drainage.

The Milbrodale sub-population is estimated to consist of 1000 to 2000 individuals. It occurs at an altitude of 150-160m on a north-west facing terrace approximately 50 m off the valley floor on soils derived from Triassic sedimentary rocks of the Narrabeen group. Associated vegetation is open woodland dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus moluccana* (Grey Box), with *Callitris endlicherii* (Black Cypress Pine) present as a sub-dominant. The understorey at this location contains dense stands of the native shrub, *Dodonaea cuneata*.

*Pterostylis gibbosa* (Illawarra Greenhood) has not been recorded during past surveys of the study area. Suitable habitat occurs in the study area; however the species is considered unlikely to occur due to the lack of records and distance of the known occurrence.

#### **Diuris tricolor**

*Diuris tricolor* (Pine Donkey Orchid) is listed as Vulnerable under the TSC Act and as an Endangered Population in the Muswellbrook LGA. It is a deciduous, terrestrial orchid with widespread but sparse distribution in NSW and Queensland. In NSW, the species occurs on the northern and central tablelands, northern plains and western slopes. The species is often locally common and generally found in grassy sclerophyll forest and woodland vegetation on flats or small rises, on a range of substrates including sandy or loamy soils derived from granite, porphyry, laterite or alluvium at elevations of approximately 150-350m.

The species occurs as individuals or localised colonies in open grassy woodland often associated with Box-Gum Woodland. Occurrences of the species have been recorded in mine leases around Muswellbrook and Denman. Based on known populations in the region, the species appears to favour microenvironments where the cover and density of the grass component is suppressed and there is a diversity of small herbs present.

*Diuris tricolor* (Pine Donkey Orchid) has not been recorded during past surveys of the study area. Despite not being detected, there is potential for individuals to occur based on suitable habitat present. Some areas of grassland could potentially provide habitat for *Diuris tricolor* if it is native and diverse enough to create the appropriate microclimates to support the

### **Assessment of Significance**

*(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*

*Pterostylis gibbosa* or *Diuris tricolor* do not occur in the Disturbance boundary and will not be impacted by the Proposal. Accordingly, it is not considered likely that the Proposal will have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of local extinction.

*(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*

*Diuris tricolor* individuals in the Muswellbrook LGA are part of an endangered population. However, this species does not occur in the Disturbance boundary and will not be impacted by the Proposal. Accordingly, it is not considered likely that the Proposal will have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of local extinction.

No endangered populations of *Pterostylis gibbosa* are listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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*

*(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*

*(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, and*

No known habitat for *Pterostylis gibbosa* or *Diuris tricolour* will be removed, however approximately 610.7 ha of forest, woodland and grassland that forms potential habitat for these species will be removed.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is not considered to be important to the long term survival of *Pterostylis gibbosa* or *Diuris tricolour*. These species are not known to occur in this area and there are large areas of similar vegetation nearby that provide similar habitat values.

*(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 *Pterostylis gibbosa* or *Diuris tricolour*.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for *Pterostylis gibbosa* or *Diuris tricolour*.

*(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 action constitutes or is part of the following KTPs:

- Clearing of native vegetation;
- Loss of hollow-bearing trees; and
- Removal of dead wood and dead trees

These processes will not affect *Pterostylis gibbosa* or *Diuris tricolour* as no individuals of these species will be removed.

## **Conclusion**

*Pterostylis gibbosa* or *Diuris tricolour* have not been recorded from the study area, and these species do not occur in the Disturbance boundary and will not be impacted by the Proposal. Approximately 610.7 ha of forest, woodland and grassland that forms potential habitat for these species will be removed, however no potential habitat will be fragmented and large areas of potential habitat will remain in nearby areas. An offset strategy has been prepared

that will provide large areas of similar habitat for conservation, including the rehabilitation of mined land to woodland communities. The Proposal is therefore considered unlikely to have a significant impact on *Pterostylis gibbosa* or *Diuris tricolour*.

#### **F.1.4 Woodland Birds**

The following Assessment of Significance has been prepared as a composite test for woodland bird species listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Little Lorikeet;
- Brown Treecreeper;
- Grey-crowned Babbler;
- Speckled Warbler;
- Hooded Robin;
- Diamond Firetail;
- Varied Sitella;
- Scarlet Robin; and
- Turquoise Parrot

##### **Little Lorikeet (*Glossopsitta pusilla*)**

The Little Lorikeet is a small parrot about 16-19 cm long. It is bright green with a red face, black bill, olive-yellow undertail and a mantle imbued with light brown(OEH, 2012b). This species occurs mostly in dry, open eucalypt forests and woodlands but also moves into riparian habitats to forage. The species is partly nomadic (Higgins, 1999), with movements occurring primarily in response to food availability.

##### **Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)**

The Brown Treecreeper is Australia's largest treecreeper. It is a grey-brown bird with black streaking on the lower breast and belly and black bars on the undertail. The species is 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; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.

### **Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)**

The Grey-crowned Babbler is the largest of the four Australian babblers, reaching 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.

### **Speckled Warbler (*Chthonicola sagittata*)**

The Speckled Warbler is a heavily streaked ground-dwelling bird related to the scrubwrens, reaching a length of 13cm. The species 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. It requires large, relatively undisturbed remnants for the species to persist in an area.

### **Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*)**

The Hooded Robin is a large Australian robin reaching 17 cm in length. The male is strikingly marked in black and white, with a bold black hood extending down a white breast. The back is black with distinct white shoulder and wing-bar. The tail is black, with prominent white side-panels. Females and immatures are duller, with light brownish-grey upperparts, but the same striking black and white wings. The species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. It requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses (OEH 2012).

### **Diamond Firetail (*Stagonopleura guttata*)**

The Diamond Firetail is a large (length 10 to 12 cm, weight 17 grams), striking finch with a bright red bill, and red eyes and rump. The white throat and lower breast are separated by a broad black breast-band that extends into the strongly white-spotted, black flanks. It has a grey back and head, and ashy-brown wings. The species is found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. It also occurs in open forest, mallee, Natural Temperate Grassland, secondary grassland derived from other communities, riparian areas, and sometimes in lightly wooded farmland.

### **Varied Sittella (*Daphoenositta chrysoptera*)**

The Varied Sittella is a small (10 cm) songbird. This species is sedentary and inhabits eucalypt forests and woodlands. It prefers rough-barked tree species and mature smooth-barked gums with dead branches where it feeds on arthropods (OEH, 2012c).

### **Scarlet Robin (*Petroica boodang*)**

The Scarlet Robin is a small Australian robin that reaches 13 cm in length. The male has a black head and upperparts, with a conspicuous white forehead patch, white wing stripes and

white tail-edges. The female is pale brown, darker above, and has a dull reddish breast and whitish throat. The species lives in dry eucalypt forests and woodlands where the understorey is usually open and grassy with few scattered shrubs. It lives in both mature and regrowth vegetation, and occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Its habitat usually contains abundant logs and fallen timber: these are important components of its habitat (OEH 2012).

### **Turquoise Parrot(*Neophema pulchella*)**

The male Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. It 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 (OEH 2012).

### **Assessment of Significance**

*(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*

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for woodland birds. These are sedentary birds that are known to occur in the Disturbance boundary, and the removal of a large area of habitat may place the local population at risk of extinction. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. Accordingly, taking the mitigation and compensation measures into consideration, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of these species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of woodland and forest habitat will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is considered to be important to the long term survival of the local population of these woodland birds. However, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important ground foraging and nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## **Conclusion**

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for woodland birds. In the absence of mitigation measures this would be likely to constitute a significant impact. However, a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of large areas of woodland in the SBA and NBA and in offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on woodland bird species because large areas of remaining habitat will be conserved and managed in the long term, and significant additional areas of woodland habitat will be re-established in the locality.

### **F.1.5 Nectarivorous Birds**

The following Assessment of Significance has been prepared as a composite test for nectarivorous bird species listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Regent Honeyeater;
- Swift Parrot;
- Black-chinned Honeyeater;
- Painted Honeyeater; and
- Little Lorikeet

#### **Regent Honeyeater (*Anthochaera phrygia*)**

The Regent Honeyeater has a black head, with a patch of warty, dirty yellowish to pinkish skin around its dark red-brown eye, and a sturdy, decurved, black bill. This species inhabits temperate woodland and dry open forest; Box-Ironbark woodland and riparian forests of River Sheoak. It sometimes occurs in coastal forest, especially in stands dominated by Swamp Mahogany, Spotted Gum, and Southern Mahogany.

#### **Swift Parrot (*Lathamus discolor*)**

The Swift Parrot is a small parrot about 25 cm long with a distinctive thin, long tail, about 12 cm. This species migrates to the Australian south-east mainland between March and October and is found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*).

#### **Black-chinned Honeyeater (*Melithreptus gularis*)**

The Black-chinned Honeyeater is the largest of its genus, reaching 17 cm in length. The species occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). It also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees (OEH 2012).

#### **The Painted Honeyeater (*Grantiella picta*)**

The Painted Honeyeater is small (16 cm) and distinctive, with a black head and back and white under parts with dark streaks on the flanks. The species inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. It is a specialist feeder on the fruits of

mistletoes growing on woodland eucalypts and acacias and prefers mistletoes of the genus *Amyema*.

### **Little Lorikeet**

The Little Lorikeet is a small (16-19 cm; 40 g) bright green parrot, with a red face surrounding its black bill and extending to the eye. It is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability

### **Assessment of Significance**

- (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*

The Proposal will remove approximately 459 ha of potential woodland and forest habitat for nectarivorous birds, including some that are known to occur in the study area such as the Little Lorikeet. Although this is a large area of potential habitat, most nectarivorous birds are nomadic in search of suitable flowering trees, and as such have a wide distribution and utilise a wide variety of habitats.

Large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. With the implementation of the proposed mitigation measures, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

- (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*

No endangered population of these species is listed under the TSC Act.

- (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*

Not applicable to threatened species.

- (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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of woodland and forest that provides potential habitat for these nectarivorous birds will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is not considered to be important to the long term survival of these nectarivorous birds. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important nesting habitat; and

- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

### **Conclusion**

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for nectarivorous birds. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on nectarivorous bird species because large areas of remaining habitat will be conserved and managed in the long term, and significant additional areas of woodland habitat will be re-established in the locality.

### **F.1.6 Raptors**

The following Assessment of Significance has been prepared as a composite test for raptor bird species (birds of prey) listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Spotted Harrier;
- Little Eagle;
- Black-breasted Buzzard; and
- Square-tailed Kite

#### **Spotted Harrier (*Circus assimilis*)**

The Spotted Harrier is a medium-sized, slender bird of prey having an owl-like facial ruff that creates the appearance of a short, broad head, and long bare yellow legs. It is found in grassy open woodland including *Acacia* and mallee remnants, inland riparian woodland, grassland and shrub steppe. It commonly occurs in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.

#### **Little Eagle (*Hieraaetus morphnoides*)**

The Little Eagle is a small to medium sized raptor uncommon but with widespread distribution across mainland Australia (Birds Australia, 2011). The species is most commonly found in open eucalypt forest and woodland, She-oak or acacia woodlands and riparian woodlands with abundant prey availability (NSW Scientific Committee, 2010c).

#### **Black-breasted Buzzard (*Hamirostra melanosternon*)**

The Black-breasted Buzzard is one of the larger Australian birds of prey, with a wingspan of up to 1.5 metres. The species lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. It also hunts over grasslands and sparsely timbered woodlands (OEH 2012).

#### **Square-tailed Kite (*Lophoictinia isura*)**

The Square-tailed Kite is a reddish, medium-sized, long-winged raptor, about the size of a Little Eagle or harrier. The species is found in a variety of timbered habitats including dry woodlands and open forests, and shows a particular preference for timbered watercourses. It is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.

## Assessment of Significance

*(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*

The Proposal will remove approximately 459 ha of potential woodland and forest habitat for raptors, as well as approximately 151.6 ha of grassland that these species may forage over. That notwithstanding, large areas of similar woodland and grassland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. These are highly mobile species that have a large home range and are unlikely to be dependent on habitat in the Disturbance boundary for their survival. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of these species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 610.6 ha of woodland, forest and grassland that provides potential habitat for raptors will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. These are highly mobile species with large home ranges that are able to fly over disturbed areas to access new habitats.

The area of potential habitat to be removed is not considered to be important to the long term survival of raptors. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets. Furthermore, these large, wide ranging species would only likely use the study area as part of a larger territory and would be unlikely to depend on resources within it for their survival.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for raptors.

*(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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## **Conclusion**

The Proposal will remove approximately 610.6 ha of potential woodland and forest habitat for raptors. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on raptors.

### **F.1.7 Cockatoos**

The following Assessment of Significance has been prepared as a composite test for Cockatoos listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Gang-gang Cockatoo; and
- Glossy Black-cockatoo

#### **Gang-gang Cockatoo (*Callocephalon fimbriatum*)**

Gang-gang Cockatoos range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm and are mostly slate-grey. They are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests but can migrate to lower altitudes, drier more open eucalypt forests and woodlands in winter. They are often found in urban areas.

#### **Glossy Black-cockatoo (*Calyptorhynchus lathamii*)**

The Glossy Black-cockatoo is a dusky brown to black cockatoo about 50 cm in length. They are usually seen in pairs or small groups feeding quietly in she-oaks. This species is found along the coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species (Birds Australia, 2011). The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species).

### **Assessment of Significance**

- (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*

The Proposal will remove approximately 459 ha of potential woodland and forest habitat for Cockatoos. That notwithstanding, large areas of similar woodland and grassland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. These are highly mobile species that have a large home range and are unlikely to be dependent on habitat in the Disturbance boundary for their survival. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of Cockatoos such that a viable local population will be placed at risk of extinction.

- (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*

No endangered population of these species has been recorded from the locality or occurs on the Site.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of woodland and forest that provides potential habitat for Cockatoos will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. These are highly mobile species with large home ranges that are able to fly over disturbed areas to access new habitats.

The area of potential habitat to be removed is not considered to be important to the long term survival of Cockatoos. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets. Furthermore, these large, wide ranging species would only likely use the study area as part of a larger territory and would be unlikely to depend on resources within it for their survival.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

### **Conclusion**

The Proposal will remove approximately 459 ha of potential woodland and forest habitat for Cockatoos. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on Cockatoos.

### **F.1.8 Owls**

The following Assessment of Significance has been prepared as a composite test for owls listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Masked Owl;
- Powerful Owl; and
- Barking Owl

#### **Masked Owl (*Tyto novaehollandiae*)**

The Masked Owl is medium-sized owl, reaching lengths of 40 - 50 cm. This species occurs in dry eucalypt forests and woodlands but often hunts along the edges of forests, including roadsides. It nests in hollow trees.

#### **Powerful Owl (*Ninox strenua*)**

The Powerful Owl is Australia's largest owl reaching lengths of 60 cm. This species inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large hollows up to 1 m wide and 2 m deep in large remnant trees for nesting.

#### **Barking Owl (*Ninox connivens*)**

The Barking Owl is a medium-sized owl, about 42 cm long. This species inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Hunting can extend in to closed forest and more open areas(OEH, 2012a). It nests in hollow trees.

### **Assessment of Significance**

- (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*

The Proposal will remove approximately 459 ha of potential woodland and forest habitat for owls, as well as approximately 151 ha of grassland that these species may forage over. That notwithstanding, large areas of similar woodland and grassland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. These are highly mobile species that have a large home range and are unlikely to be dependent on habitat in the Disturbance boundary for their survival. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of owls such that a viable local population will be placed at risk of extinction.

- (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*

No endangered population of these species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 610.9 ha of woodland, forest and grassland that provides potential habitat for owls will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. These are highly mobile species with large home ranges that are able to fly over disturbed areas to access new habitats.

The area of potential habitat to be removed is not considered to be important to the long term survival of owls. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets. Furthermore, these large, wide ranging species would only likely use the study area as part of a larger territory and would be unlikely to depend on resources within it for their survival.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

A recovery plan has been prepared for Large Forest Owls, which covers the Powerful Owl and the Masked Owl. The Proposal is consistent with the overall objective of the recovery plan which is to ensure that viable populations of the three species continue in the wild in NSW in each region where they presently occur. The Proposal will result in the permanent protection of large areas of potential habitat for these species which will assist in the achievement of this objective.

*(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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## **Conclusion**

The Proposal will remove approximately 610.6 ha of potential woodland and forest habitat for owls. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on Owls.

### **F.1.9 Black Bittern (*Ixobrychus flavicollis*)**

The Black Bittern is a heron, dark grey to black in colour, with buff streaks on the throat and a characteristic yellow streak on the sides of the head and down the neck. The species inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. During the day, the species roosts in trees or on the ground amongst dense reeds.

#### **Assessment of Significance**

*(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*

No habitat for this species is present in the Disturbance boundary, and no habitat will be affected by the Proposal. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of the Black Bittern such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of this species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

No habitat for for the Black Bittern will be removed or modified by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat as the Disturbance boundary is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

No habitat for for the Black Bittern will be removed or modified by the Proposal. The woodland and forest that will be removed does not comprise habitat for this species and is not important for its long term survival in the locality.

*(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 this species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for this 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

These KTP will not affect the Black Bittern.

## Conclusion

The Proposal will not remove any known or potential habitat for the Black Bittern. No fragmentation of habitat will occur and the existing levels of habitat in the locality will remain. Accordingly, the Proposal is considered unlikely to have significant impact on the Black Bittern.

### ***F.1.10 Hollow Roosting Bats***

The following Assessment of Significance has been prepared as a composite test for microchiropteran bat species (microbats) listed under the TSC Act that are known to or are likely to occur within the study area and require tree hollows to roost in. Bats that require caves to roost in are considered in a separate Assessment of Significance due to their differing habitat requirements. The bats that are considered to be hollow-dependent include the following:

- Eastern Freetail-bat;
- Little Bentwing-bat; and
- Southern Myotis

Some of these species are also known to roost in caves and buildings, but because they also utilise tree hollows they are considered separately to those that only use caves and buildings.

#### **Eastern Freetail-bat (*Mormopterus norfolkensis*)**

The Eastern Freetail-bat is a solitary, insectivorous bat with dark brown to reddish brown fur on the back and slightly paler underparts. This species is most commonly found in open spaces in dry sclerophyll forests, woodland and swamp forests in eastern NSW. The species mainly roost in spout hollows of large mature trees and sometimes under bark or in man-made structures. It is also known to forage in gaps in upper-slope vegetation and over larger waterways.

#### **Little Bentwing-bat (*Miniopterus australis*)**

The Little Bentwing-bat is a small insectivorous bat with a body length of about 45 mm. The species inhabits a variety of habitats ranging from moist eucalypt forest, rainforest, wet and dry sclerophyll forests and vine thickets to *Melaleuca* swamps, dense coastal forests and Banksia scrub. It is generally found foraging in densely vegetated habitats and roosts in a variety of places such as caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings.

#### **Southern Myotis (*Myotis macropus*)**

The Southern Myotis has disproportionately large feet; weighs up to 15 grams and has a wingspan of about 28 cm. The species generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. It forages over streams and pools catching insects and small fish by raking their feet across the water surface.

## Assessment of Significance

- (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*

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for hollow dependant bats. This is a large area of habitat that in the absence of mitigation measures would be likely to place a viable local population of these bats at risk of extinction. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. Accordingly, with the implementation of the proposed mitigation measures, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

- (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*

No endangered population of these species is listed under the TSC Act.

- (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*

Not applicable to threatened species.

- (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*

Not applicable to threatened species.

- (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,*

- (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*

- (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*

Approximately 459 ha of potential woodland and forest habitat will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. Microchiropteran bats are highly mobile and are in any case able to fly over disturbed areas relatively easily to access new habitats.

The area of potential habitat to be removed is likely to be important to the long term survival of these species in the locality. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential roosting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important roosting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## Conclusion

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for hollow dependant bats. In the absence of mitigation and compensation measures, this would be likely to comprise a significant impact. However, a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on hollow dependant bat species

because large areas of remaining habitat will be conserved and managed in the long term, and significant additional areas of woodland habitat will be re-established in the locality.

### **F.1.11 Cave Roosting Bats**

The following Assessment of Significance has been prepared as a composite test for microchiropteran bat species (microbats) listed under the TSC Act that are known to or are likely to occur within the study area and require caves to roost in. The bats that are considered to be cave-roosting include the following:

- Eastern Bentwing Bat; and
- Large-eared Pied Bat

*i. Eastern Bentwing Bat (Miniopterus orianae oceanensis)*

The Eastern Bentwing Bat has a head and body length of about 6 cm and a wingspan of 30 - 35 cm. This species is insectivorous and almost exclusively roosts in caves and artificial constructions such as mines along the east coast of Australia (Churchill, 2008). In south eastern Australia the species hibernates in underground sites, usually large caves with a constant microclimate, during winter. It requires very specific conditions in terms of temperature and humidity for maternity sites. The species changes roosts in response to seasonal needs, and in turn long-distance movements occur.

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

The Large-eared Pied Bat is a small to medium-sized bat with long, prominent ears and glossy black fur. This species roosts in caves entrances, crevices in cliffs, gullies, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) in dry open forest and woodland. Maternity roosts are generally found in roof domes in sandstone caves and overhangs.

#### **Assessment of Significance**

- (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*

The Proposal will remove approximately 459 ha of foraging habitat for cave roosting bats, although no breeding or roosting habitat is present. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

- (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*

No endangered population of these species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of potential foraging habitat for cave roosting bats will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential foraging habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. Microchiropterans are highly mobile and are in any case able to fly over disturbed areas relatively easily to access new habitats.

The area of potential habitat to be removed is not considered to be important to the long term survival of these cave roosting bats. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

### **Conclusion**

The Proposal will remove approximately 459 ha of foraging habitat for cave roosting bats. In the absence of mitigation and compensation measures, this would be likely to comprise a significant impact. However, a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on cave roosting bat species because large areas of remaining habitat will be conserved and managed in the long term, and significant additional areas of woodland habitat will be re-established in the locality.

### ***F.1.12 Grey-headed Flying-fox ((Pteropus poliocephalus)***

The Grey-headed Flying-fox is a large bat, with a head and body length of 23 - 29 cm and a wingspan of up to 1 m. This species occurs in a variety of habitats, ranging from subtropical and temperate rainforests to tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They have roosting camps, often in gullies with dense vegetation and nearby water, which are generally located within 20 km of a regular food source. Individual camps may have tens of thousands of animals and are used for mating, giving birth and rearing young.

#### **Assessment of Significance**

*(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*

The Proposal will remove approximately 459 ha of foraging habitat for the Grey-headed Flying Fox, although no breeding habitat is present. Large areas of similar woodland foraging habitat will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of this species such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of this species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of potential foraging habitat for the Grey-headed Flying Fox will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential foraging habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur. The Grey-headed Flying-fox is highly mobile and is in any case able to fly over disturbed areas relatively easily to access new habitats.

The area of potential habitat to be removed is not considered to be important to the long term survival of the Grey-headed Flying-fox. No breeding habitat is present and there are large areas of similar vegetation nearby that provide similar foraging habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## Conclusion

The Proposal will remove approximately 459 ha of foraging habitat for the Grey-headed Flying-fox. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on the Grey-headed Flying fox.

### **F.1.13 Arboreal Mammals**

The following Assessment of Significance has been prepared as a composite test for arboreal mammal species listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Squirrel Glider;
- Brush-tailed Phascogale; and
- Eastern Pygmy possum

#### **Squirrel Glider (*Petaurus norfolcensis*)**

Squirrel Gliders have a head and body length of about 20 cm. The species 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. It also prefers mixed species stands with a shrub or Acacia midstorey.

#### **Brush-tailed Phascogale (*Phascogale tapoatafa*)**

The Brush-tailed Phascogale is tree-dwelling marsupial carnivore. Adults have a head and body length of about 20 cm, a tail length of about 20 cm and weigh 110 - 235 grams. The species prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. It also inhabits heath, swamps, rainforest and wet sclerophyll forest, prefers foraging in rough barked trees of 25 cm diameter or greater.

#### **Eastern Pygmy Possum (*Cercartetus nanus*)**

The Eastern Pygmy-possum is a small, active climber, with large, forward pointing ears and, a head and body length range of 70 – 110 mm. They are found in a broad range of habitats such as rainforests, sclerophyll forests, woodlands and heath with a preference for woodlands/heath appear.

### **Assessment of Significance**

- (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*

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for arboreal mammals. In the absence of mitigation measures, this would be likely to place the local population of the Squirrel Glider at risk of extinction as this species has been recorded numerous times in the Disturbance boundary and it represents a large area of habitat for this species.

That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. With the implementation of

the proposed mitigation and compensation measures, the Proposal is considered unlikely to have an affect on the life cycle of these species such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of these species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of woodland and forest habitat will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is considered to be important to the long term survival of these arboreal mammals, in particular the Squirrel Glider that is known to occur. However, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 these species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for these 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for these species;
- **Loss of hollow-bearing trees** as this directly removes potential nesting habitat;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important ground foraging and nesting habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## Conclusion

The Proposal will remove approximately 459 ha of known and potential woodland and forest habitat for arboreal mammals. In the absence of mitigation or compensation measures, this would be likely to result in a significant impact to the Squirrel Glider, and potentially the other two arboreal mammals that have potential to occur. However, a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA and the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on arboreal mammal species because large areas of remaining habitat will be conserved and managed in the long term, and significant additional areas of woodland habitat will be re-established in the locality.

### ***F.1.14 Spotted-tailed Quoll (*Dasyurus maculatus*)***

The Spotted-tailed Quoll is about the size of a domestic cat. This species is found 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. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. The majority of the woodland and forest in the study area provides potential foraging habitat for this species, however no suitable denning habitat is present. The Spotted-tailed Quoll may use the habitat in the study area as part of a much larger range.

#### **Assessment of Significance**

*(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*

The Proposal will remove approximately 459 ha of potential woodland and forest foraging habitat for the Spotted-tailed Quoll. That notwithstanding, large areas of similar woodland and grassland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA. This is a highly mobile species that has a large home range and are unlikely to be dependent on habitat in the Disturbance boundary for their survival. No suitable denning habitat is present in the Disturbance boundary. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of the Spotted-tailed Quoll such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of this species is listed under the TSC Act.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of woodland, forest and grassland that provides potential foraging habitat for the Spotted-tailed Quoll will be removed by the Proposal.

No areas of habitat will become isolated or fragmented from other areas of habitat. The area of potential foraging habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is not considered to be important to the long term survival of the Spotted-tailed Quoll. No breeding habitat is present and there are large areas of similar vegetation nearby that provide similar foraging values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets. Furthermore, this is a large, wide ranging species that would only likely use the study area as part of a larger territory and would be unlikely to depend on resources within it for its survival.

*(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 this species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan or threat abatement plan has been prepared for this 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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species;
- **Removal of dead wood and dead trees** as this removes structural components of the community and reduces the abundance of important foraging habitat; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## **Conclusion**

The Proposal will remove approximately 459 ha of potential foraging habitat for the Spotted-tailed Quoll. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA as well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on the Spotted-tailed Quoll.

### ***F.1.15 Koala (Phascolarctos cinereus)***

The Koala is an arboreal marsupial that inhabits eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species. They develop preferences for some species in any one area. They are generally inactive for most of the day, feeding and moving mostly at night. The Koala has not been recorded from the study area, however potential habitat is present in the form of eucalypt woodland and forest.

#### **Assessment of Significance**

*(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*

The Proposal will remove approximately 459 ha of potential habitat for the Koala. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other eucalypt woodland areas in the SBA and NBA. Accordingly, the Proposal is considered unlikely to have an affect on the life cycle of the Koala such that a viable local population will be placed at risk of extinction.

*(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*

No endangered population of this species has been recorded from the locality or is present in the study area.

*(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*

Not applicable to threatened species.

*(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*

Not applicable to threatened species.

*(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,*

*(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*

*(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*

Approximately 459 ha of potential woodland and forest habitat will be removed by the Proposal.

No areas of potential habitat will become isolated or fragmented from other areas of habitat. The area of potential habitat to be removed is located directly adjacent to existing disturbed areas of MTW, and no fragmentation will occur.

The area of potential habitat to be removed is not considered to be important to the long term survival of this species. It has not been recorded from the study area and is considered unlikely to occur. There are large areas of similar vegetation nearby that provide similar habitat values. Furthermore, a significant package of mitigation and compensation measures will be implemented including rehabilitation of mined land to eucalypt woodland communities, protection of large areas of woodland in the NBA and SBA and the provision of additional offsite offsets.

*(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 this species.

*(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

A recovery plan has been prepared for the Koala. The objective of this plan is to reverse the decline of the koala in New South Wales, to ensure adequate protection, management and restoration of koala habitat, and to maintain healthy breeding populations of koalas throughout their current range. The Proposal is consistent with the objectives of the recovery plan as it will protect and provide large areas of woodland that will form potential habitat for the Koala and will contribute to the maintenance of Koala habitat in the locality.

*(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 following KTP have potential to operate as a result of the Proposal:

- **Clearing of native vegetation** as this directly removes and reduces the extent of habitat for this species; and
- **Degradation of native riparian vegetation along NSW water courses** as this removes and alters habitat.

## **Conclusion**

The Koala has not been recorded from the study area and is considered unlikely to occur. Some potential eucalypt woodland habitat occurs however, and the Proposal will remove approximately 459 ha of potential habitat for the Koala. That notwithstanding, large areas of similar woodland will remain in nearby areas, and a range of mitigation and compensation measures are proposed including mine rehabilitation and conservation of other woodland areas in the SBA and NBA well as the provision of offsite offsets. With the implementation of the proposed mitigation and conservation measures, the Proposal is considered unlikely to have significant impact on the Koala.

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*Appendix G*

Upper Hunter Strategic Assessment  
Biodiversity Report

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**WARSWORTH CONTINUATION 2014**

**Upper Hunter Strategic Assessment Biodiversity  
Assessment Report**

For:

**EMGA Mitchell McLennan**

June 2014

**Final**



**PO Box 2474  
Carlingford Court 2118**

**Report No. 14001RP2**

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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.

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Revision	Date Issued	Reviewed by	Approved by	Date Approved	Revision Type
3	5/06/2014	DR	DR	5/06/2014	draft
4	6/06/2014	DR	DR	06/06/2014	Final

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Approved by: David Robertson

Position: Director

Signed: 

Date: 6 June, 2014

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## Glossary of Terms

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BAA	Abbreviation for Biodiversity Assessment Area, which is the area nominated by each participating mining company for inclusion in the UHSA for assessment. In the case of the current report, this is the area shown on <b>Figure 1.1</b> .
BBAM	Abbreviation for BioBanking Assessment Methodology, used by the UHSA to calculate the suitability of offsets for a development proposal, expressed as species credits or ecosystem credits.
BCAM	Abbreviation for Biodiversity Certification Assessment Methodology, used by the UHSA to calculate the impact of a project and determine the offset required, expressed as species credits or ecosystem credits.
Biodiversity Assessment Report	An assessment report prepared by each participating mining company in the UHSA that presents the findings of surveys within their BAA, and presents the calculations for credit requirements using BCAM.
CEEC	Critically Endangered Ecological Community listed under the NSW TSC Act and/or the Commonwealth EPBC Act.
Credit Converter	Calculation tool developed by OEH to convert offset biodiversity credit requirements into dollars.
CMA	Catchment Management Authority.
CPP	Coal Preparation Plant.
Credits	In the context of this report, credits are BCAM credits, used to calculate the impact of a project and the offset required.
Disturbance boundary	The area of land proposed to be disturbed by the Proposal.
DoE	Commonwealth Department of the Environment.
DP&I	NSW Department of Planning and Infrastructure.
Ecosystem credit species	Threatened species that can be reliably predicted to occur within the BAA based on the presence of habitat surrogates (ie through vegetation, distribution and habitat criteria) as identified by OEH's Threatened Species Profile Database.
EEC	Endangered Ecological Community listed under the NSW TSC Act and/or the Commonwealth EPBC Act.
EIA	Ecological Impact Assessment
EMM	EMGA Mitchell McLennan Pty Ltd.
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.
Locality	Land within 10 km radius of the BAA.

MNES	Matters of National Environmental Significance.
MTCL	Mount Thorley Coal Loader.
MTO	Mount Thorley Operations.
MTW	Mount Thorley Warkworth
NAA	No Access Area.
NP&W Act	NSW <i>National Parks and Wildlife Act 1974</i> .
NSW	New South Wales
OEH	NSW Office of Environment and Heritage.
PMST	EPBC Act Protected Matters Search Tool.
Previous surveys	All previous flora and/or fauna surveys conducted within the study area prior to 2009.
the Proposal	The Proposal of Warkworth Continuation 2014 as outlined in <b>Section 1.2.4</b> of this report.
Region	Refers to the Hunter Valley subregion.
RTCA	Rio Tinto Coal Australia, the proponent.
SEPP	State Environmental Planning Policy
Species credit species	Threatened species that cannot be reliably predicted to occur within the BAA based on the presence of habitat surrogates (ie through vegetation, distribution and habitat criteria) and/or cannot withstand further loss within the CMA as identified by OEH's Threatened Species Profile Database. Species credits can also apply to species that require protection of particular habitat elements, such as breeding habitat.
TEC	Abbreviation for Threatened Ecological Community, which are communities listed as vulnerable, endangered or critically endangered under the TSC Act and/or EPBC Act.
Threatened species	Flora and fauna species that are listed under the TSC Act, EPBC Act and NSW <i>Fisheries Management Act 1994</i> .
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i> .
UHSA	Abbreviation for Upper Hunter Strategic Assessment, which is a strategic biodiversity assessment process for acquiring and managing future mining offsets for the Upper Hunter Valley coalfields.
Upper Hunter Biodiversity Plan	The final document developed by OEH to support the UHSA, to assess potential impacts, and provide guidance on minimising impacts on biodiversity, rehabilitation requirements and locations of offsets.
Upper Hunter Offset Fund	A monetary trust fund set up to financially support the offsets sought and managed through the UHSA.

# Introduction

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## 1.1 Purpose

Cumberland Ecology has been requested by EMGA Mitchell McLennan (EMM) on behalf of Rio Tinto Coal Australia (RTCA) to prepare a Biodiversity Assessment Report for a proposed extension of Warkworth Mine (the Proposal) using the Biodiversity Certification Assessment Methodology (BCAM). This Biodiversity Assessment Report has been prepared to contribute to the Upper Hunter Strategic Assessment (UHSA) that is being undertaken by the New South Wales (NSW) Office of Environment and Heritage (OEH).

The UHSA utilises BCAM to assess the current biodiversity values and current and future impacts of coal mining in the Upper Hunter Valley coalfields, and to determine their offset requirements. The results of the UHSA will be used to develop the Upper Hunter Biodiversity Plan that will set out the offsetting framework for future mining proposals of participating companies in the Upper Hunter Valley. The Upper Hunter Biodiversity Plan will offset the impacts to species, populations and communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

## 1.2 Background

### 1.2.1 *The Upper Hunter Strategic Assessment*

The UHSA has been initiated by the NSW and Commonwealth Government to provide a strategic biodiversity assessment process for acquiring and managing future mining offsets for the Upper Hunter Valley coalfields. The purpose of the UHSA is to implement a coordinated assessment of the current biodiversity values and current and future impacts of coal mining in the Upper Hunter Valley coalfields, in order to inform the Upper Hunter Biodiversity Plan. This is a voluntary process, and participating companies are required to survey and assess the area of land which they nominate as their Biodiversity Assessment Area (BAA). For the purposes of the UHSA, a BAA must be defined and registered with the OEH.

The BAA identified for the purposes of this report is shown in **Figure 1.1** and includes the area of land within which the Proposal will be undertaken. The BAA is approximately 631 ha in size and includes proposed mining areas and associated infrastructure. The purpose of

this report is to present a Biodiversity Assessment Report of the BAA and assess the credit cost of potential impacts of the Proposal on current biodiversity values.

Individual Biodiversity Assessment Reports are being prepared for each nominated BAA by each participating company, and will be submitted to OEH for review. The Biodiversity Assessment Reports and data layers created will be incorporated into the Upper Hunter Biodiversity Plan. Using the data presented in the Biodiversity Assessment Reports, the Upper Hunter Biodiversity Plan will set out the offsetting framework for future mining proposals of participating companies in the Upper Hunter Valley. This is expected to largely comprise the establishment of and contribution to, the Upper Hunter Offset Fund that will be used to secure offset lands and fund ongoing management.

It is intended that the Upper Hunter Biodiversity Plan will fulfil all biodiversity impact assessment requirements at both the State and Commonwealth levels; this will simplify future project assessments as no site based assessment will be required with subsequent mine approval applications and offset requirements may be pre-determined. This is expected to save significant time and cost, reduce complexity of the approval process for mining projects and allow for better management of biodiversity impacts on a regional level.

The Upper Hunter Biodiversity Plan, once completed, will:

- Outline the requirements for the operation of the Upper Hunter Offset Fund;
- Outline the process for companies to meet their offset requirements by securing and managing offsets directly or by paying an equivalent amount into the Upper Hunter Offset Fund;
- Describe the method for converting offset requirements into a monetary figure to be paid into the Upper Hunter Offset Fund;
- Include a provision to allow the Upper Hunter Offset Fund Manager to direct a proportion of offset funds towards supplementary measures (such as restoration) with clear definitions and criteria for suitable supplementary measures;
- Outline the proportion of offset requirements that may be directed to supplementary measures, such as ecosystem restoration or research and the method for identifying suitable supplementary measures;
- Include procedures for the identification of offsets; and
- Provide for the preparation of guidelines for ecological restoration projects.

The UHSA process was initiated in 2012 and final endorsement is expected by the Commonwealth at the end of 2014.

### **1.2.2 Biodiversity Certification Assessment Methodology**

The UHSA employs the BCAM which has been developed by OEH. This methodology outlines various field survey requirements and defines on-ground methods for surveying

threatened species habitat and vegetation condition and outlines where offsets can be located. It also contains provisions for the calculation of impacts and offsets as credits.

BCAM assesses general biodiversity values for their conservation significance including native vegetation types, condition and spatial configuration such as connectivity and extent of native vegetation in the BAA and region. It also identifies which threatened species require ecosystem credits or species credits to be generated (including threatened species that are listed under the EPBC Act).

The process for calculating the number of ecosystem credits or species credits that are required for these species is described in the BCAM Manual (DECCW 2011). However, for the purposes of this report, it is worth noting the difference between 'ecosystem credit species' and 'species credit species':

- *Ecosystem credit species* are those that can be reliably predicted to occur within the BAA, based on the presence of habitat surrogates (ie through vegetation, distribution and habitat criteria) as identified by OEH's Threatened Species Profile Database; and
- *Species credit species* are threatened species that cannot be reliably predicted to occur within the BAA, based on the presence of habitat surrogates (ie through vegetation, distribution and habitat criteria) and/or cannot withstand further loss within the CMA as identified by OEH's Threatened Species Profile Database. Species credits can also apply to species that require protection of particular habitat elements, such as breeding habitat.

Different methods are used to calculate the credits required for offsetting ecosystem credit species and species credit species.

OEH is developing a Fund Calculator to convert offset credits into a financial contribution. The formula for deriving the financial contribution will be based on a combination of land value and ongoing management costs. Further information about BCAM is provided in the BCAM Manual (DECCW 2011).

### **1.2.3 Warkworth Mine**

Warkworth Mine is located approximately 8 km to the southwest of the township of Singleton, in the Central Hunter Valley, between the Hunter River and Wollemi National Park, NSW.

Warkworth Mine currently operates under Development Consent No. DA 300-9-2002-i issued by the then Minister for Planning in May 2003 under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The mine site also operates under two separate Commonwealth approvals (EPBC Act); EPBC 2002/629 and EPBC 2009/5081.

Warkworth Mine has been in operation since 1981 and the originally approved operation has been modified several times. Immediately to the south of Warkworth Mine is Mount Thorley Operations (MTO). Since 2004, the two mines have integrated at an operational level and are known as Mount Thorley Warkworth (MTW), with a single management team responsible

for all the operations. Equipment, personnel, water, rejects and coal preparation are all shared between the mines. The operations involve an existing workforce of an average of approximately 1,300 persons, which includes full-time personnel and a small number of short-term contractors. Ownership of the two mines remains separate.

Warkworth Mine currently operates three integrated open cut mining areas, namely North, West and South pits with West and North pits being the focus of production. Run-of-mine (ROM) coal from Warkworth Mine is transported to either the Warkworth or Mount Thorley coal preparation plant (CPP) for processing. Product coal from the CPPs is transported via conveyor to either the Mount Thorley Coal Loader (MTCL) or to the Redbank Power Station. Coal loaded onto trains at the MTCL is transported to the Port of Newcastle for export.

RTCA has elected to participate in the UHSA process to identify their potential offset requirements for the Proposal. The BAA is the 'Nominated Assessment Area' nominated by RTCA to be submitted to OEH for inclusion in the Upper Hunter Strategic Assessment. This comprises land which is not already approved for development.

It is intended that any biodiversity offsets required for the Proposal will be sought in accordance with the Upper Hunter Biodiversity Plan when it is finalised and approved. As outlined above, this will include contribution to the Upper Hunter Offset Fund that will be used to secure offset lands and fund ongoing management.

#### **1.2.4 The Proposal**

Warkworth Mining Limited seek to apply for a new development consent to allow an extension of North and West pits further west. The Proposal comprises:

- Extension of the mining footprint by approximately 698 hectares (ha) to the west of current operations extending the life of North and West pits by 21 years;
- Ability to transfer overburden and coal to MTO to assist in the final landform for MTO and processing of ROM coal from Warkworth Mine;
- Ability to transfer and accept mine water from neighbouring operations (ie Bulga Coal Complex, Wambo Mine, Mount Thorley Operations and Hunter Valley Operations);
- Closure of Wallaby Scrub Road;
- An optional underpass for the approved but yet to be constructed third bridge crossing on Putty Road;
- Minor changes to the design of the Northern out-of-pit dam;
- Use of existing secondary access gates to the mine sites and offset areas to allow for infrequent vehicle movements to enable activities such as drilling, offset management and equipment shutdown pad access; and

- Maintain the approval of all aspects of the existing operations for Warkworth Mine approved under DA 300-9-2002-i, including integrations with MTO (such as an integrated management system for rejects and water) and other surrounding mines and Redbank Power Station.

### 1.3 Regional Context

The Hunter Valley has long been recognised for its arable land and as a result, extensive clearing has occurred for agriculture. The region would have once supported extensive areas of grassy eucalypt woodlands and open forests. As a consequence of its farming history, a substantial proportion of the region has been historically cleared of its native vegetation and now supports agricultural uses such as dairy farming, crop farming, cattle grazing, horse breeding and viticulture.

Another major land use in the region is coal mining, and several large-scale, open cut coal mines are well established across the Hunter Valley landscape and have considerably altered the natural landform of the region. The current dominant land uses within and adjacent to the BAA include cattle grazing, industrial activities such as coal mining and rural residential areas.

The BAA falls within the following regions and landscapes:

- Catchment Management Authority (CMA): Hunter/Central Rivers;
- CMA Subregion: Hunter; and
- Mitchell Landscape: Central Hunter Foothills.

### 1.4 The Biodiversity Assessment Area

The BAA has a total area of approximately 631 ha and is shown in **Figure 1.1**. Native vegetation, to which this assessment applies, occupies approximately 611 ha of the BAA. The remaining area comprises cleared land which is not required to be assessed using BCAM. **Figure 1.2** illustrates the regional locality of the BAA in relation to the nearest town centres.

As is characteristic of the region, the majority of the land within the BAA comprises undulating hills on the western side of the Hunter River. The vegetation in the southern and eastern extents of the BAA has generally been disturbed by historic clearing and agricultural activities, resulting in vegetation existing as either a mosaic of exotic pasture grasses and low diversity native grassland, or native grassland derived from woodland forms. The remnant woodland and open forest vegetation that would have once been widespread across the landscape now occurs largely in the western portion of the BAA with derived grassland dominating the eastern portion. Extensive floodplain land is not contained within the BAA but does exist to the west of the BAA in relatively close proximity.

The operating Warkworth Mine occurs immediately to the east of the BAA.



**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse

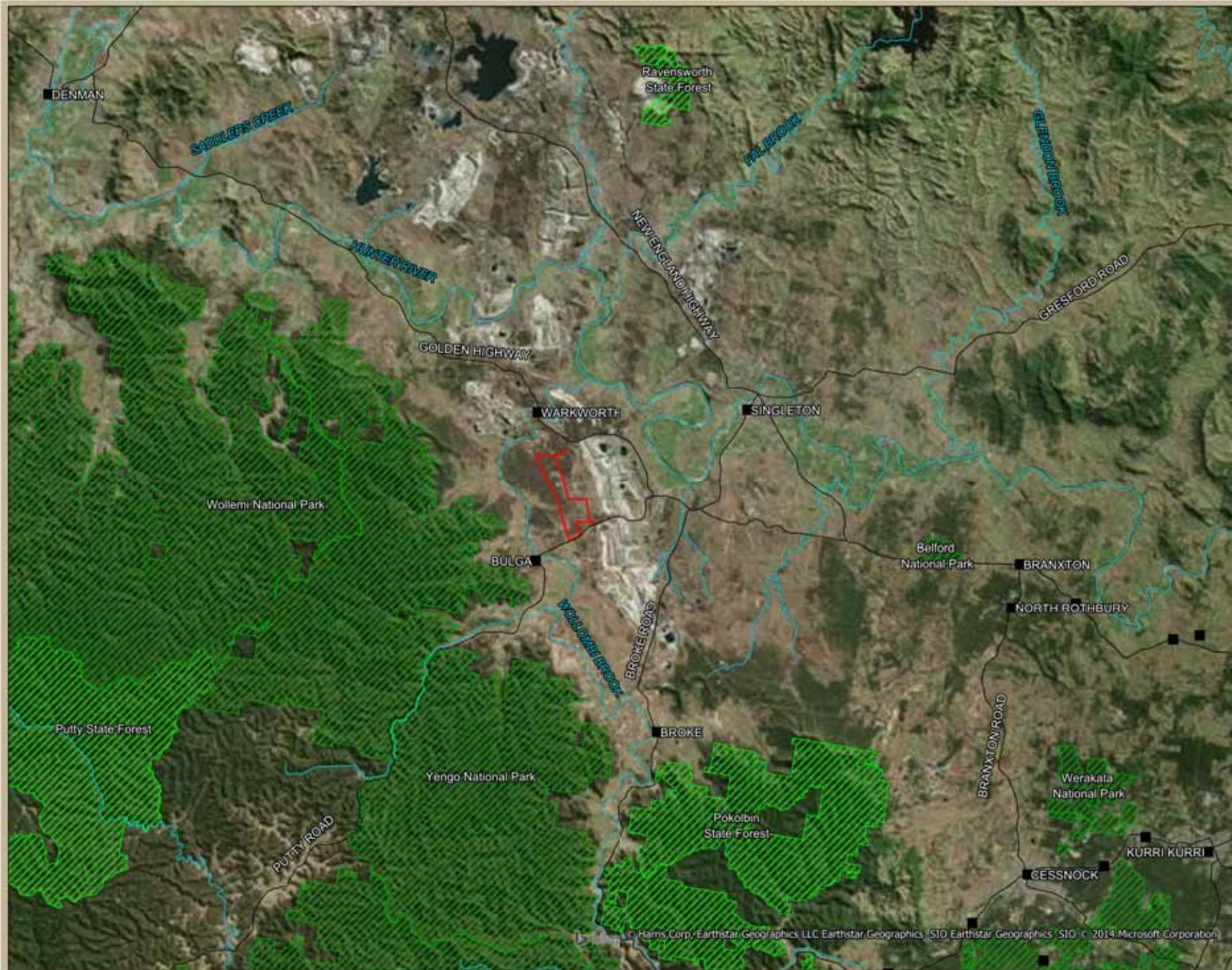
Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:28,000 @ A3 page  
 Date Prepared: 03/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



Figure 1.1. The Biodiversity Assessment Area





**Legend**

- Biodiversity Assessment Area
- National Parks and Reserves
- State Forest
- Road
- Waterway
- Town

Site Name: Mount Thorley Warkworth  
 Location: 9km South-West of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1: 234,000  
 Date Prepared: 03/06/2014

Data Source:  
 NPWS Estate 2012  
 Forests NSW, 2012  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



Figure 1.2. Regional Locality

## 1.5 Biodiversity Assessment Report Compliance

This Biodiversity Assessment Report has been prepared in accordance with BCAM reporting requirements. A compliance table which includes the applicable sections, chapters and appendices along with additional requirements presented by OEH in 'Attachment 1' (OEH 2012a) indicates where each item has been applied and assessed within this BCAM Assessment. The compliance table is provided in **Appendix A**.

## Methodology

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The biodiversity values in the locality of the BAA are well known due to a number of ecological studies that have been completed for coal projects in the Muswellbrook and Singleton areas. Field survey of the western portion of the BAA was done as part of previous surveys in 2009. Field surveys that furnish the data within this Biodiversity Assessment Report were undertaken during 2012 and 2013. The scope of the investigations included:

- Conducting a thorough literature review of the ecological studies completed in the locality;
- Interrogation of threatened species' database records;
- Field survey of the land relevant to Proposal; and
- Field surveys of BAA and surrounds.

The methods used during the field surveys are summarised in this chapter.

Numerous other field surveys have been undertaken within the BAA and surrounds over several years. The results of all of these surveys have been used as part of this Biodiversity Assessment Report.

### 2.1 Literature Review and Database Analysis

#### 2.1.1 Literature Review

Numerous ecological reports have been prepared for the MTW lease area over many years, and these were reviewed during the preparation of this report to identify the key ecological attributes and issues of the MTW lease area and its surrounds. The documents reviewed are listed in **Table 2.1**.

A comprehensive database of information relevant to the BAA and surrounds exists as a result of numerous ecological studies conducted for nearby coal projects. The information available was reviewed and used to assist in the preparation of this Biodiversity Assessment Report, including: Mount Pleasant Project Ecological Matters of National Environmental Significance Impact Assessment (Cumberland Ecology 2010), Drayton South Coal Project (Ecotone 2000, The Ecology Lab Pty Ltd 2000, Cumberland Ecology 2012a), Drayton Mine (Hansen Bailey 2007a, 2009), Mt Arthur Coal Complex (Cumberland Ecology 2009), Mount

Pleasant (ERM Mitchell McCotter 1997, Cumberland Ecology 2010b), Bengalla Mine (Envirosciences Pty Ltd 1993, Hansen Consulting 2006, Hansen Bailey 2007b, Cumberland Ecology 2010a), Muswellbrook Coal (HLA-Envirosciences 2002, Hansen Bailey 2010) and Bayswater B Power Station (Resource Planning Pty Limited 1993, Eco Logical Australia Pty Ltd 2009).

Regional-scale vegetation mapping that was completed on behalf of the Hunter-Central Rivers Catchment Management Authority (Peake 2006) was also reviewed for this assessment, as well as the Greater Hunter Native Vegetation Mapping (OEH, 2012).

**Table 2.1 Desktop Literature Review Documents**

Author	Year	Document Title
ERM	1995	Extension of Mining at Mount Thorley Operations - Environmental Impact Statement – Chapter 6
ERM	2002	Extension of Warkworth Coal Mine Environmental Impact Statement Report Vol 1
ERM	2002	Extension of Warkworth Coal Mine Environmental Impact Statement Report Vol 2
ERM	2002	Extension of Warkworth Coal Mine Environmental Impact Statement Report Vol 3
ERM	2002	Extension of Warkworth Coal Mine Environmental Impact Statement Report Vol 4
ERM	2002	Extension of Warkworth Coal Mine – Green Offsets Strategy. Report prepared for CNA
Sparke Helmore Solicitors	2003	Deed of Agreement between Warkworth Mining Limited and the Minister for Planning RE: Rezoning of the Non Disturbance Areas
Department of the Environment, Water, Heritage and the Arts	2004	Environmental Protection and Biodiversity Conservation (EPBC) Approval Issued by the Commonwealth Minister for the Environment, EPBC 2002/629, original dated 18th February 2004
Department of Planning	2004	Warkworth Mine Development Consent Conditions Issued by the NSW Minister for Planning – DA-300-9-2002-I, dated 19 May 2003 (with changes made to consent on 19 October 2004)
Andrews Neil	2006	Warkworth Fauna and Flora Baseline Survey and CNA Biodiversity and Rehabilitation Monitoring
Hunter-Central Rivers Catchment Management Authority	2006	The Vegetation of the Central Hunter Valley, NSW Vol 1: Main Report - A report on the findings of the Hunter Remnant Vegetation Project
Hunter-Central Rivers Catchment	2006	The Vegetation of the Central Hunter Valley, NSW Vol 2: Profiles of Vegetation Communities

**Table 2.1 Desktop Literature Review Documents**

Author	Year	Document Title
Management Authority		
ERM	2007	Threatened Flora and Fauna of HVO North, HVO South and Mount Thorley Warkworth Literature Review and Gap Analysis. Report prepared for CNA
Gross, C	2007	The Vegetation of the Warkworth Sands and Associated Vegetation Communities
Lockwood, Peter	2007	Warkworth Sands Soil Survey Soil Sampling and Analysis within the Green Offsets and at Archerfield, a Report to CNA
Debus, S	2008	Mount Thorley Warkworth Operations Green Offsets Avifauna Monitoring Autumn 2008 Report To Coal & Allied (Rio Tinto Coal Australia)
Debus, S	2008	Mount Thorley Warkworth Operations Green Offsets Avifauna Monitoring Spring 2008 Report to Coal & Allied (Rio Tinto Coal Australia)
ERM	2008	Warkworth Coal Mine Green Offsets Fauna and Flora Management Plan
Kumar, L et al.	2009	Mapping Vegetation Communities to extract Warkworth Sand Woodlands in the RTCA area in the Hunter Valley
SMEC Australia	2009	Ecological Assessment of Matters of National Environmental Significance - Mount Thorley Warkworth Expansion

### **2.1.2 Database Analysis**

Information on the biodiversity values of the BAA and its surrounds were obtained via interrogation of the OEH Atlas of NSW Wildlife database (OEH 2014) and the EPBC Protected Matters Search Tool (DoE 2014).

The Protected Matters Search Tool provided a list of Matters of National Environmental Significance (MNES) that were predicted to occur within the locality based on the presence of suitable habitat. The Atlas of NSW Wildlife was used to retrieve the number and age of records of threatened species recorded within a 10 km radius (locality) of the BAA. These databases provided information of the distribution of threatened species within the locality and were used when assessing the likelihood of occurrence of threatened species within the BAA.

Database information was also sourced using the BCAM Calculator developed for the UHSA. A list of species credit species was obtained and indicated which of these species have the potential to occur in the locality based on habitat values known to be present within

the BAA. A list of ecosystem credit species was obtained to indicate those threatened species predicted to occur with greater likelihood within the habitats present.

## 2.2 Field Surveys

Field investigations completed during surveys for the Proposal were conducted in the BAA during 2009 (Cumberland Ecology 2012b). Additional targeted threatened flora surveys were conducted in September and October 2012. Portions of the BAA not previously surveyed or which required additional survey for the purposes of this BCAM Assessment were surveyed between 28 October and 1 November 2013.

### 2.2.1 Weather Conditions during Field Surveys

**Table 2.2** provides a summary of the local weather conditions when survey was undertaken in 2009, 2012 and 2013 by Cumberland Ecology. Climate data has been obtained from the nearby Singleton STP meteorological station.

**Table 2.2 Weather Conditions During the 2009, 2012 and 2013 Surveys**

Date	Min. Temperature (°C)	Max. Temperature (°C)	Rainfall (mm)
11/06/2009	1.0	14.0	0.0
12/06/2009	1.3	15.4	0.0
15/06/2009	5.2	19.6	0.0
16/06/2009	3.0	17.6	0.0
17/06/2009	7.6	17.2	0.4
18/06/2009	6.7	16.6	2.1
19/06/2009	4.8	15.0	2.2
24/06/2009	1.7	19.2	0.0
25/06/2009	5.0	17.0	0.2
26/06/2009	5.5	17.7	0.0
29/06/2009	6.6	18.8	0.0
30/06/2009	7.4	20.9	0.0
1/07/2009	9.6	21.0	0.0
2/07/2009	7.3	18.6	0.0
3/07/2009	10.2	16.4	0.0
13/07/2009	8.0	16.0	0.0
14/07/2009	6.0	17.0	0.0
15/07/2009	3.3	16.0	0.0
16/07/2009	4.4	15.7	↓
17/07/2009	6.5	17.0	6.2 (2 days)

**Table 2.2 Weather Conditions During the 2009, 2012 and 2013 Surveys**

Date	Min. Temperature (°C)	Max. Temperature (°C)	Rainfall (mm)
7/09/2009	6.1	19.4	0.0
8/09/2009	6.9	22.1	0.0
9/09/2009	7.0	22.0	0.0
10/09/2009	4.5	22.0	0.0
11/09/2009	1.0	24.2	0.0
20/09/2012	6.5	25.1	0.0
21/09/2012	7.0	29.0	0.2
3/10/2012	-0.2	29.4	0.0
4/10/2012	5.2	31.8	0.0
28/10/2013	10.7	30.7	0.0
29/10/2013	8.2	32.5	0.0
30/10/2013	13.0	23.5	24.8
31/10/2013	7.0	28.6	0.0
01/11/2013	7.3	28.0	0.0

Source: Bureau of Meteorology (Singleton STP Station)

### 2.2.2 Flora Surveys

Flora surveys were conducted by Cumberland Ecology in six different survey sessions during 2009 (within the BAA and surrounds), in 2012 within the BAA and in 2013 adjacent to the BAA. Flora surveys were conducted to map vegetation communities present within the BAA and surrounds and to conduct targeted searches for threatened flora species considered to have the potential to occur. Survey effort over the duration of all survey sessions is shown in **Table 2.3**. For the 2009 surveys, this includes areas adjacent to the BAA which were part of a wider study area at that time.

Additionally, targeted surveys for *Pterostylis gibbosa*, *Diuris tricolor* and other orchids were undertaken in the BAA in September and October 2012.

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993). Other references used to assist identification of selected plant taxa include Richardson *et al* (2006) and Brooker and Kleinig (1990). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2013). Any specimens that were not readily identifiable were lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney.

**Table 2.3 Flora Survey Session, Date, Methods and Survey Effort**

Survey Type	Date	Flora Survey	Survey Effort
Vegetation Surveys (Winter and Spring)	11-12 June 2009,	Quadrat sampling (20x20)	47 quadrats
	24-26 June 2009,	Transect and random	66 hours*
	7-11 September 2009.	meanders**	
Targeted Flora Surveys	20-21 September 2012,	Area searches (20 minute	48 hours
	3-4 October 2012.	searches),  Transects and random meanders.	
Spring BCAM Surveys 2013	28 October - 1	BioBanking plots (20 x 50)	23 plots
	November 2013	Transect and random meanders**	18 hours

\* 66 hours reflects survey effort in the field over all three survey periods within the wider study area, including parts of the BAA.

\*\*Transect and random meander surveys include targeted searches for threatened flora.

#### *i. Vegetation Mapping*

This section provides a description of the methodology used to map the vegetation communities present within the BAA and surrounds. Vegetation mapping presented in this report is based on a large body of previous work that has been conducted in and near the BAA and presented in various reports since.

The resultant information was synthesised using Geographical Information Systems (GIS) to create a spatial database that was used to interpret and interpolate the data to produce a vegetation map of the BAA. Aerial, topographical and geological data were also used to interpret the survey data. Mapping was completed using MapInfo Version 12.0 (Pitney Bowes Software Inc. 2010).

#### *a. Surveys*

Regional mapping undertaken by Peake (2006) was utilised in the first instance to obtain a preliminary map of the vegetation within the BAA. The preliminary mapping was then investigated and ground-truthed in the field via the following methods:

- Quadrat sampling (20m x 20m) to characterise vegetation map units by their species composition and community structure;
- Random meander surveys within selected areas of vegetation to obtain information on plant community composition and to survey for threatened species in the BAA; and

- Detailed traverses of vegetation units and recording their boundaries using a handheld Global Positioning System (GPS) unit.

Ecological communities in the BAA were determined by comparing quadrat data, random meander data and field notes against published information, including descriptions within the TSC Act Final Determinations, EPBC Act Listing Advice and regional mapping completed by Peake (2006). Identification was based on community criteria such as geology, topography, known distribution, habitat descriptions and the number of recognised important or diagnostic species. Data was compared with the final determinations for listed communities under the TSC and EPBC Act to assess the presence of Threatened Ecological Communities (TECs).

#### b. Classification

Vegetation communities within and adjacent to the BAA have been mapped according to vegetation type and vegetation zone according to BCAM.

Vegetation Type is defined under the BCAM as:

*“... level of classification of native vegetation used in the methodology. Vegetation types are assigned to vegetation classes, which in turn are assigned to vegetation formations...”* (DECCW 2011).

In addition to Vegetation Types described above, the vegetation in the BAA has been divided into Vegetation Zones according to their vegetation type classification and their condition in accordance with the BCAM methodology.

Vegetation Zones are defined within the BCAM as:

*“... relatively homogenous area in a biodiversity certification assessment area consisting of a single vegetation type in the same broad condition state. A single zone must not contain a mix of vegetation in low condition and vegetation not in low condition. A zone may comprise one or more discontinuous areas.”* (DECCW 2011).

In the first instance, vegetation types within the BAA were named and described generally in accordance with *The Vegetation of the Central Hunter Valley, New South Wales* by Peake (2006). Vegetation types recorded and described in the BAA were then matched to the closest community described in the BioMetric Vegetation Types database (DECCW 2013) for use in the BCAM Calculator. A recent vegetation mapping project for the Greater Hunter Valley region (Sivertsen et al. 2011) has been published as a draft and is considered and incorporated into the recently revised Biometric Vegetation Types Database (OEH 2012d).

The matches were made using a variety of methods of analysis, including careful review of the dominant of characteristic flora species present, soil type and geographic position, and stated affiliations with other map units (such as Peake 2006). The vegetation types were then divided into vegetation zones which reflected their condition. For example, Central Hunter Grey Box – Ironbark Woodland has been split into condition classes and legislative

status. This allowed the final vegetation mapping units to represent both vegetation types and zones.

*ii. Quadrat Surveys*

Numerous quadrat plots were sampled in and near the BAA in 2009. The quadrat plot data assisted in determining vegetation communities and general floristics of the BAA. Additional quadrat surveys were conducted in October 2013 for use in a Biodiversity Assessment Report adjacent to (and directly comparable to) the BAA of this Biodiversity Assessment Report. This was to ensure that the minimum number of quadrat plots were conducted per vegetation zone, in compliance with BCAM. The quadrat plots were generally located in areas most representative of the condition and composition of each vegetation patch.

A total of 47 quadrats were surveyed in 2009 and 23 quadrats were surveyed in 2013. Of these, 32 quadrats were used for the calculations within this Biodiversity Assessment Report. The location of these quadrats is shown in **Figure 2.1**.

Within each 20 x 20 m quadrat, the following information was recorded:

- All vascular flora species present within the plot or directly adjacent to the plot;
- The stratum in which each species occurred;
- The location of the quadrat, using a handheld GPS; and
- Photographs of the quadrat.

During surveys conducted by Cumberland Ecology in 2013 the relative abundance and cover of each species within the quadrat was approximated using a scoring system based on a modified Braun-Blanquet scoring system (Braun-Blanquet 1927). Additional information was also collected on vegetation structural data (i.e. height and percentage cover of each stratum).

Generally, an appropriate number of quadrat plots were conducted in each vegetation zone according to the BCAM methodology. For Central Hunter Grey Box - Ironbark Woodland, all quadrats were undertaken in established woodland rather than the small areas of regenerating woodland that occurred within the Assessment Area. **Table 2.4** indicates the number of plots required for this BCAM Assessment and the number conducted in each vegetation zone. The location of plots was stratified according to Appendix 3 of the BCAM (DECCW 2011). That is, quadrat plots and transects have been located randomly, are representative of the vegetation zone and have been replicated.

**Table 2.4 Vegetation Zone, Cumberland Ecology Vegetation Type Name, BioMetric Vegetation Type Name, BioMetric Code, BioMetric Condition, Area within BAA, BCAM Plots Required and Completed**

Zone	CE Vegetation Community	Conservation Status	BioMetric Vegetation type	Code (2013)	BioMetric Condition	Area (ha)	Min BCAM Plots Required	No. Quadrats Done	Quadrat Numbers
1	Warkworth Sands Woodland	EEC (TSC Act)	Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area	HU872	Moderate/Good	72.12	4	6	MTW10, MTW12, MTW13, MTW26, MTW32, MTW33
2	Warkworth Sands Grassland	Not listed	Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area	HU872	Low	0.67	1	1	MTWA
3	Central Hunter Grey Box - Ironbark Woodland	EEC (TSC Act)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	HU817	Moderate/Good	365.54	6	16	MTW1, MTW2, MTW3, MTW7, MTW8, MTW9, MTW14, MTW17, MTW20, MTW22, MTW23, MTW34, MTW35, W1, W2, W12
4	Regenerating Central Hunter Grey Box - Ironbark Woodland	EEC (TSC Act)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	HU817	Moderate/Good	6.43			

**Table 2.4 Vegetation Zone, Cumberland Ecology Vegetation Type Name, BioMetric Vegetation Type Name, BioMetric Code, BioMetric Condition, Area within BAA, BCAM Plots Required and Completed**

Zone	CE Vegetation Community	Conservation Status	BioMetric Vegetation type	Code (2013)	BioMetric Condition	Area (ha)	Min BCAM Plots Required	No. Quadrats Done	Quadrat Numbers
5	Central Hunter Grey Box - Ironbark Derived Grassland	Not listed	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	HU817	Low	151.50	4	6	W13, W14, W15, W16, W17, W20
6	Central Hunter Ironbark - Spotted Gum - Grey Box Forest	Not listed	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	HU818	Moderate/Good	15.11	2	3	MTW5, MTW6, MTW21
<b>TOTAL NATIVE VEGETATION</b>						<b>611.37</b>			

*iii. Transect Surveys*

Random meander transect surveys were undertaken within selected areas of vegetation to obtain information on plant community composition and to survey for threatened species in the BAA. These surveys were undertaken as part of the vegetation mapping ground-truthing, quadrat surveys and targeted flora surveys. The random meander technique was as per the method developed for survey of threatened plants by Cropper (1993).

The locations of transect surveys are shown in **Figure 2.2**.

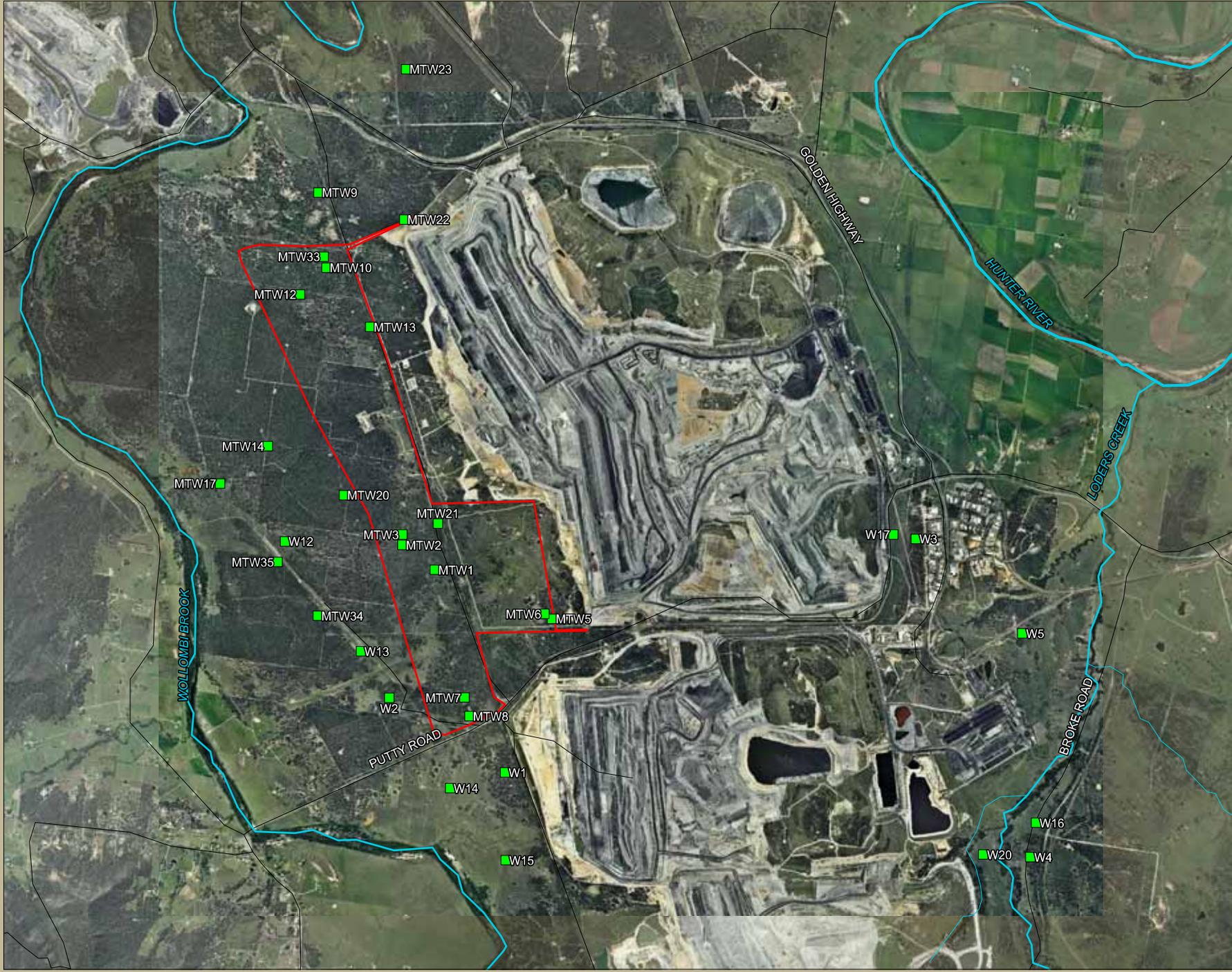
*iv. Targeted Flora Surveys*

Targeted flora searches have been undertaken across the BAA, for all TSC Act and EPBC Act listed threatened species considered likely to occur, using random meander surveys, meander-transect surveys and area searches of suitable areas of habitat. This information was also used to assess the likelihood of occurrence of flora species credit species in similar habitat in the other parts of the BAA.

During the surveys in September and October 2013, particular attention was given to threatened species which are species credit species generated from the database search mentioned in **Section 2.1.2** above and which are known to be present within the BAA or considered to have the potential to occur within the BAA. Spring flowering species credit species were surveyed for and specific meander transect locations are shown on **Figure 2.2**.

*v. Incidental Observations*

During all survey periods, both flora and fauna, any incidental threatened flora species that were detected were recorded. This equates to a significant amount of time/effort across several years and seasons. Any incidental records of threatened flora from areas adjacent to the BAA were also included.



**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse
- Flora Quadrat Locations

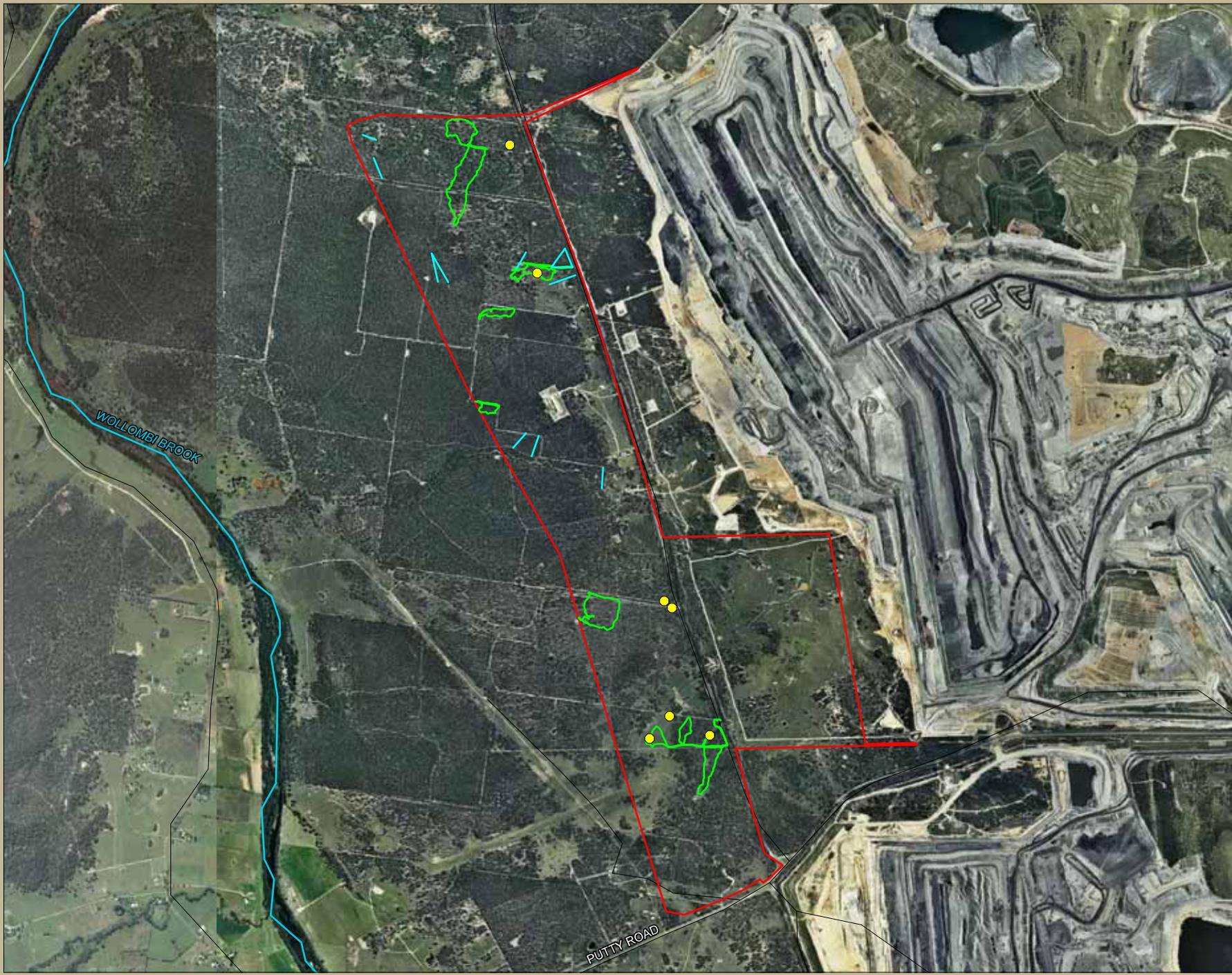
Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:40,650 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 2.1. Flora Quadrat Sampling Locations within the Biodiversity Assessment Area and Surrounds





**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Survey Locations**

- Flora Area Search
- Flora Transect
- Transect Meander

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 2.2. Targeted Threatened Flora Survey Locations within the Biodiversity Assessment Area



### 2.2.3 Fauna Surveys

Fauna surveys for the Proposal took place over the following four one-week periods: 15–19 June 2009, 29 June–3 July 2009, 13–17 July 2009 and 7–11 September 2009. Surveys were conducted, where possible, in accordance with OEH guidelines for ecological assessment (DEC (NSW) 2004).

Surveys were conducted during winter and spring to detect the large majority of threatened fauna species expected to occur. This supplemented information that had been previously collected from the site during various surveys conducted by a number of consultants (CE, 2012).

A summary of sampling method and effort used over the survey periods is provided in **Table 2.5**. Fauna survey locations are shown in **Figure 2.3**. Other fauna surveys undertaken within the BAA and surround have not been included, however the results of these surveys have been taken into account within this assessment.

**Table 2.5 Fauna Survey Methods and Effort during 2009 Winter/Spring Surveys\***

Survey Technique	Survey Effort
<b>Amphibians</b>	
Systematic day habitat search	5 person hours
Night habitat search of damp and watery sites	4 person hours
Night watercourse search	4 person hours
<b>Reptiles</b>	
Habitat search	4.5 person hours
Pitfall traps with drift nets	125 trap nights
Spotlighting	9.5 person hours
<b>Diurnal Birds</b>	
Incidental searches	Throughout survey periods
Targeted bird survey	Visual and auditory searches totalling 13 hours over 2 days*
<b>Nocturnal Birds</b>	
Call playback	9 hours
Day habitat search	Throughout survey periods
Spotlighting on foot	15.5 person hours
<b>Non-flying Mammals</b>	
Small Elliott traps	1,054 trap nights
Large Elliot traps (terrestrial)	430 trap nights
Large Elliott traps (arboreal)	430 trap nights
Cage traps	172 trap nights

**Table 2.5 Fauna Survey Methods and Effort during 2009 Winter/Spring Surveys\***

Survey Technique	Survey Effort
Pitfall traps with drift fencing	125 trap nights
Terrestrial Hair tubes	1,360 trap nights
Arboreal hair tubes	1,360 trap nights
Spotlighting on foot	9.5 person hours
Call playback	6 hours
Search for scats and signs	12 person hours
IR cameras	107 nights of data capture
Collection of predator scats	Throughout survey period
Bats	
Ultrasonic call recording	17 nights
Harp Traps	12 nights

\*Survey dates: 15-19 June, 29 June-3 July, 13-17 July 2009, 7-11 September 2009

Note: Limited targeted bird surveys were conducted during the Cumberland Ecology survey periods due to the extensive amount of targeted bird surveys previously conducted.

*i. Habitat Assessment*

Standardised fauna habitat assessment plots were conducted at all locations that flora quadrats were undertaken. Habitat assessment plots were 20 m x 50 m in size and the following fauna habitat attributes were recorded within each plot:

- Canopy cover;
- Mid-storey cover;
- Ground cover;
- Number of tree hollows;
- Total length of fallen logs; and
- Any other significant fauna habitat feature, e.g. rocky outcrops, large stand of feed trees, etc.

These plots were used to gain an understanding of the extent of these kinds of fauna habitat features within the BAA and surrounds.

In addition to these plots, fauna habitat assessments were undertaken across the study area at each fauna trapping location. Habitat condition and quality was 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. Notes were made as to the suitability of habitats to potentially support threatened fauna species.

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 dams, 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 BAA was undertaken and considered.

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

#### *ii. Trapping Surveys*

Trapping was used to detect arboreal and terrestrial fauna occurring in the BAA and surrounds. The following traps were utilised at the locations shown on **Figure 2.3**:

- Medium Elliot (B) traps for small to medium sized arboreal and terrestrial fauna;
- Small Elliot (A) traps for small terrestrial fauna; and
- Cage Traps for medium-large sized terrestrial fauna.

Traps were baited with a ball of peanut butter, honey and rolled oats. Trees which had arboreal traps located in them had their trunks sprayed with a honey mixture. Trapping lines were checked early morning, and any fauna captured were identified and released.

A total of 2,086 trap nights were surveyed, taking all trapping methods into consideration (see **Table 2.5**).

#### *iii. Pitfall Traps*

Pitfall trap lines were established at three locations adjacent to the BAA as shown on **Figure 2.3**. The pitfall traps were located so they would capture active reptiles and frogs. Each pitfall line consisted of pitfall buckets placed approximately five metres apart. Drift fencing was erected along each pitfall line. Pitfall lines were checked early morning, and any fauna found were identified and released. Pitfall traps were employed for a total of 125 trap nights (see **Table 2.5**).

#### *iv. Infra-red Cameras*

Infra-red (IR) cameras were set up at one location in the BAA (see **Figure 2.3**) and five locations adjacent to the BAA during the 2009 surveys. The cameras were located so they would detect fauna moving along well-used tracks, animal paths, creek beds etc. The cameras begin recording when fauna activates the motion sensor. IR cameras were used

for a total of 107 trap nights (see **Table 2.5**). Recorded footage was later analysed to determine fauna species that were detected.

v. *Hair Tubes (Arboreal and Terrestrial)*

'Faunatech' hair tubes were used during the 2009 surveys to detect arboreal and terrestrial mammals. Hair tube transects were set up at five suitable locations within the BAA and immediately adjacent to the BAA (see **Figure 2.3**). Hair tubes were placed on a tree (arboreal) and on the ground (terrestrial) and were baited with rolled oats, peanut butter and honey. Arboreal hair tubes were deployed for a total of 1,360 trap nights and terrestrial hair tubes were deployed for a total of 1,360 trap nights (see **Table 2.5**). Hair samples were later analysed for species identification.

vi. *Bat Surveys*

Microchiropteran bats (microbats) were surveyed in the BAA the 2009 surveys by recording ultrasonic bat calls using Anabat units; and by trapping using harp traps.

Anabat units were employed to record calls of microbats. Across all survey periods, a total of four Anabat units were employed at three locations across the BAA, with a total of eleven units employed including areas adjacent to the BAA (see **Figure 2.3**). Anabats were set before dusk each evening and switched off after dawn. Anabats were employed for a total of 17 trap nights (see **Table 2.5**). Calls recorded on each Anabat were analysed to determine which species were present within the BAA.

Harp traps were employed to trap microbats at night along suitable flyways at four locations in areas adjacent to the BAA, shown on **Figure 2.3**. Harp traps were employed for a total of 12 trap nights across the 2009 survey periods (see **Table 2.5**). Bats were collected from harp traps at dawn and the bat species subsequently identified.

vii. *Diurnal Bird Surveys*

Visual observation and call identification of diurnal birds was carried out throughout the BAA and adjacent areas. Diurnal bird area searches were carried out at three locations within and adjacent to the BAA (see **Figure 2.3**). In addition, diurnal bird surveys at point locations were conducted for a total of 13 total person hours over two days.

All species heard calling or observed were recorded in each area. GPS readings were taken near sightings of any threatened bird species. Incidental records were made of all birds observed or heard calling during all surveys.

viii. *Nocturnal Spotlighting and Call Playback Surveys*

Spotlighting was conducted for nocturnal mammals, birds and reptiles at four locations within the BAA and an additional 12 locations in areas adjacent to the BAA (see **Figure 2.3**). Nocturnal surveys were conducted using a hand-held spotlight while walking or from a slow moving vehicle. Incidental spotlighting was also conducted while travelling between transects at night. Spotlighting was carried out for a total of 9.5 total person hours for

reptiles and non-flying mammals and 15.5 total person hours for nocturnal birds within and near the BAA (see **Table 2.5**).

Call playback surveys of threatened nocturnal species likely to be present at the BAA land and adjacent areas were conducted. Calls were broadcast using a megaphone for two minute periods at five minute intervals to illicit a response from those species (including the Squirrel Glider, Spotted-tailed Quoll and Koala). This was followed with quiet listening and spotlighting. Call playback was carried out for a total of six total person hours for non-flying mammals and nine total person hours for nocturnal birds (see **Table 2.5**).

*ix. Active Reptile, Amphibian and Scat Searches*

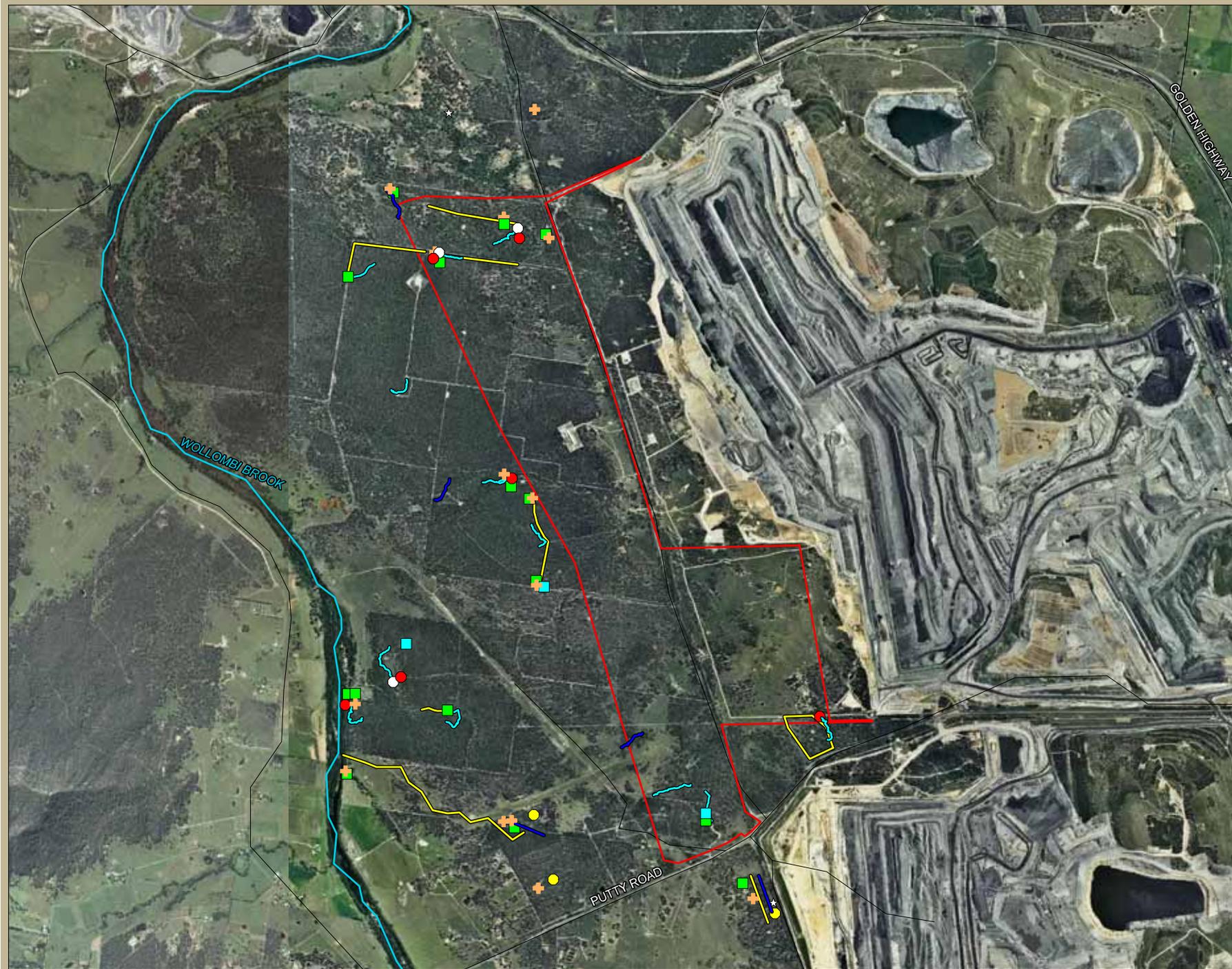
Active reptile and amphibian searches were conducted at one location within the BAA and an additional two locations in adjacent areas (see **Figure 2.3**). Reptile and amphibian searches involved lifting of bark, fallen logs, bushrock, scraping of top soil, active searching, call playback and spotlighting. Searches were completed in areas of suitable habitat for reptiles such as under logs and rocks, and for amphibians in areas such as dams and watercourses. Captured animals were identified and then released. These searches were conducted for a total of four total person hours (see **Table 2.5**).

*x. Scats and Signs*

During the survey periods, any incidental scats and signs of fauna species detected were collected, identified and listed in the total species list. A total of 12 person hours of dedicated searches for scats and signs were conducted.

*xi. Incidental Observations*

During the surveys, any vertebrate fauna species that was heard calling; observed or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the BAA and adjacent areas. Any incidental records of threatened flora and fauna from other areas nearby were also included.



**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse

**Fauna Survey Locations**

- ☆ Harp Trap
- Bird Census
- IR Camera
- Call Playback
- Active search
- + Anabat
- Pitfall Trap
- Spotlight Transect
- Trap Line
- Hair Tube Line

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:29,750 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 2.3. Targeted Threatened Fauna Survey Locations within the Biodiversity Assessment Area and Surrounds



## 2.3 Survey Limitations

The biodiversity values in the locality of the BAA are well known as a result of a number of ecological studies that have been completed for other mining projects in the area. As a result, detailed baseline vegetation and fauna data (including threatened species known and expected to occur within the locality) exists and are well documented on a spatial and temporal scale. Existing landscape information, vegetation mapping and baseline data on individual species was used to augment field results.

The field surveys have produced reliable information regarding flora and fauna species occurrences within the BAA and are considered to be adequate to support this BCAM Assessment. Notwithstanding this, the data produced by the surveys is intended only to be indicative of the types of species that could occur and not an absolute census of all flora and fauna species of the BAA. Although many species were detected during field surveys, additional species are likely to be present that have not been observed. Factors such as inclement weather, seasonality, migration schedules, population density and cryptic life histories can all affect the ability to detect species on ground.

To address this, the presence of suitable habitat was considered when assessing the potential occurrence of a given threatened species. Where potential habitat was present and the species was known to occur at other locations in the locality, it was assumed that the species had potential to occur and were thus assessed accordingly. However, only species with known occurrences in the BAA and surrounds were included in the assessment of species credits. Species credits were not generated for species where considered likely (possible) to occur but had not been recorded.

## Survey Results

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This section presents the results of the field surveys that have been conducted between 2009 and 2013 within the BAA and adjacent areas with particular focus on threatened species of flora and fauna and ecological communities. Comprehensive lists of flora and fauna recorded during the surveys are provided in **Appendix B** and **Appendix C**, respectively.

### 3.1 Vegetation Zones

Nine vegetation zones have been identified within the BAA and are shown in **Figure 3.1**. Quadrat data for each quadrat is provided in **Appendix B** and BCAM plot and transect data is provided in **Appendix D**. **Table 3.1** below shows each vegetation zone occurring within the BAA, its zone number, legal status (if applicable), corresponding BioMetric Vegetation Types Database community type (DECCW 2013), approximate area and BioMetric Condition. **Appendix E** provides the vegetation zones present in the BAA and corresponding communities as described by Peake (2006), Upper Hunter Vegetation Mapping (Sivertsen et al. 2011) and the BioMetric Vegetation Types (OEH 2012d) in order to demonstrate how vegetation zone classifications were established.

The vegetation communities listed in **Table 3.1** above are described in the subsequent sections.

**Table 3.1 Vegetation Community Types/Zones, Conservation Status, Area within BAA and Biometric Condition**

Vegetation Zone Number	Cumberland Ecology Vegetation Zone Name	Conservation Status	BioMetric Vegetation (2013) Equivalent	Total Area (ha) within BAA	BioMetric Condition
1	Warkworth Sands Woodland	EEC (TSC Act)	Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area	72.12	Moderate/Good
2	Warkworth Sands Grassland	Not listed	Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area	0.67	Low
3	Central Hunter Grey Box - Ironbark Woodland	EEC (TSC Act)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	365.54	Moderate/Good
4	Regenerating Central Hunter Grey Box - Ironbark Woodland	EEC (TSC Act)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	6.43	Moderate/Good
5	Central Hunter Grey Box - Ironbark Derived Grassland	Not listed	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	151.50	Low
6	Central Hunter Ironbark - Spotted Gum - Grey Box Forest	EEC (TSC Act)	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	15.11	Moderate/Good
<b>TOTAL NATIVE VEGETATION</b>				<b>611.37</b>	
n/a	Dam/Infrastructure/Cleared Areas	n/a	n/a	19.42	n/a
<b>TOTAL</b>				<b>630.79</b>	

### 3.1.1 Zone 1– Warkworth Sands Woodland

**TSC Act Status:** Endangered Ecological Community (EEC) - Warkworth Sands Woodland in the Sydney Basin Bioregion

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area

Warkworth Sands Woodland occurs predominantly in the north and west of the study area in a relatively large band with scattered occurrences to the west and to the north (**Figure 3.1**).

Warkworth Sands Woodland forms a woodland to open forest that occurs on old dune formations, sand sheets, or swales between the dunes and all of these form part of the Warkworth Land System described in Story *et al* (1963). In the latter two landscape elements – sand sheets and swales - fewer species such as *Banksia integrifolia* occur but more mesic species such as *Melaleuca thymifolia* occur.

Warkworth Sands Woodland is the name given to at least two and probably several recognisable vegetation assemblages, including:

- Rough-barked Apple (*Angophora floribunda*) and Coastal Banksia (*Banksia integrifolia*) dominated woodland on deeper sands (**Photograph 3.1**);
- Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*) dominated woodland (sometimes open forest) on shallower sand in swales (**Photograph 3.2**); and
- Other assemblages, such as *Callitris endlicheri* dominated woodland on higher, drier portions of the sand system.

Hundreds of native plant species have been recorded across the assemblages. The quality of this community varies considerably and can be considered to vary from high to low depending upon species composition, structural formation and the level of recent disturbance.

Dominant canopy species in the higher quality areas of this community include Rough-barked Apple (*Angophora floribunda*) and the small tree Coastal Banksia (*Banksia integrifolia*). Other small trees recorded in the canopy of this community include Bulloak (*Allocasuarina luehmannii*), Black She-Oak (*Allocasuarina littoralis*), Blakely's Red Gum/Forest Red Gum intergrades (*Eucalyptus blakelyi/tereticornis*), Black Cypress Pine (*Callitris endlicheri*) and White Cypress Pine (*Callitris glaucophylla*). Common understorey species include Coffee Bush (*Breynia oblongifolia*), *Hibbertia linearis*, Slender Rice Flower (*Pimelea linifolia*), Silver-stemmed Wattle (*Acacia parvipinnula*) and Dogwood (*Jacksonia scoparia*). The groundcover is characterised by Bracken (*Pteridium esculentum*). Common grasses in this community are Three-awn Speargrass (*Aristida vagans*), Weeping Meadow Grass (*Microlaena stipoides*), Purple Wiregrass (*Aristida ramosa*), Brown's Lovegrass (*Eragrostis brownii*), Blady Grass (*Imperata cylindrica*) and Hairy Panic (*Panicum effusum*).

Other common groundcovers include Rock Fern (*Cheilanthes sieberi*), Berry Saltbush (*Einadia hastata*), Pomax (*Pomax umbellata*) and Variable Glycine (*Glycine tabacina*).



**Photograph 3.1 Warkworth Sands Woodland with Rough-barked Apple Canopy**



**Photograph 3.2 Warkworth Sands Woodland with Forest Red Gum / Blakely's Red Gum hybrid canopy**

### 3.1.2 Zone 2– Warkworth Sands Grassland

**TSC Act Status:** Not listed

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Rough-barked Apple/ Narrow-leaved Ironbark/ Blakely's Red Gum/ Bull Oak/ Coast Banksia woodland on sands of the Warkworth area

This vegetation zone consists of grasslands that have been derived from the clearing of previously occurring Warkworth Sands Woodland. This community occurs as scattered patches in proximity to woodland remnants (**Figure 3.1**). This vegetation zone is not listed under State or Commonwealth legislation despite being derived from the EEC Warkworth Sands Woodland. The vegetation zone is present as a result of previous land clearance and as a consequence canopy trees are sparsely scattered throughout this vegetation zone. These comprise those found in Warkworth Sands Woodland.

This vegetation zone lacks a shrub layer, with rare scattered occurrences of *Acacia mearnsii* (Black Wattle). The groundcover is generally dominated by grasses, particularly Couch (*Cynodon dactylon*) and the exotic African Lovegrass (*Eragrostis curvula*), with the native herb Common Everlasting (*Chrysocephalum apiculatum*) also dominant in places. Other native herbs and grasses also occur including Barbed Wire Grass (*Cymbopogon refractus*), Weeping Meadow Grass (*Microlaena stipoides*) and Slender Rat's Tail Grass (*Sporobolus creber*). This community is shown in **Photograph 3.3**.



**Photograph 3.3 Warkworth Sands Grassland**

### 3.1.3 Zone 3 - Central Hunter Grey Box – Ironbark Woodland

**TSC Act Status:** EEC - Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter (HU817)

Central Hunter Grey Box-Ironbark Woodland is listed as an EEC under the TSC Act. This woodland community is the most common vegetation community within the disturbance boundary.

This community forms a large continuous tract of on the western side of Wallaby Scrub Road with a more fragmented distribution on the eastern side of Wallaby Scrub Road. The main structural features of this community are shown in **Photograph 3.4**. Much of this community had been cleared prior to the 1960s and as a result the majority of this vegetation community exists as regrowth (**Photograph 4.4**). To the south of the BAA this community is fragmented, however genetic exchange between patches of this community is still likely to occur.

The dominant canopy species within this community are Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). There are also local abundances of Bulloak (*Allocuarina luehmannii*) and White Feather Honeymyrtle (*Melaleuca decora*) in the midstorey.

Common understorey species include Fan Wattle (*Acacia amblygona*), *Acacia falcata*, Native Blackthorn (*Bursaria spinosa*) and Coffee Bush (*Breynia oblongifolia*). Common groundcover species include Purple Burr-Daisy (*Calotis cuneifolia*), Blue Trumpet (*Brunoniella australis*), Kidney Weed (*Dichondra repens*), Blue Flax Lily (*Dianella revoluta*), Threeween Speargrass (*Aristida vagans*), Wattle Matt-rush (*Lomandra filiformis*), Common Fringe-sedge (*Fimbristylis dichotoma*) and Rock Fern (*Cheilanthes sieberi*).



**Photograph 3.4 Central Hunter Grey Box – Ironbark Woodland with grassy understorey**



**Photograph 3.5 Central Hunter Grey Box – Ironbark Woodland with regrowth Narrow-leaved Ironbark**

### **3.1.4 Zone 4 - Regenerating Central Hunter Grey Box – Ironbark Woodland**

**TSC Act Status:** EEC - Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter (HU817).

This community has been recently mapped in 2014 based on interrogation of recent aerial photographs. These aeriels showed that some areas that had been mapped as Derived Native Grassland from what was originally Central Hunter Grey Box – Ironbark Woodland show significant regeneration of canopy tree species. The regeneration has occurred to such an extent that they can no longer be described as grassland, and have therefore been described separately as Regenerating Central Hunter Grey Box – Ironbark Woodland. Although the derived native grassland of this woodland does not meet the criteria for the EEC under the TSC Act, it is considered that the Regenerating areas do conform to the EEC listing of Central Hunter Grey Box – Ironbark Woodland.

The species composition of these areas is very similar to that described for the Derived Native Grassland form of Central Hunter Grey Box – Ironbark Woodland, except the characteristic species of Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) are present in juvenile form, as well as other species such as Bulloak (*Allocuarina luehmannii*) and White Feather Honeymyrtle (*Melaleuca decora*).

### **3.1.5 Zone 5 - Central Hunter Grey Box – Ironbark Derived Grassland**

**TSC Act Status:** Not listed

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Narrow-leaved Ironbark/ Bull Oak/ Grey Box shrub/ grass open forest of the central and lower Hunter

This vegetation zone has been created by the clearing of the previously occurring Central Hunter Grey Box – Ironbark Woodland (**Figure 3.1**). A significant proportion of the BAA is comprised of this community (approximately 573 ha), predominantly in the south-eastern portion of the BAA (**Figure 3.1**). Although Central Hunter Grey Box-Ironbark Woodland is listed as an EEC under the TSC Act, this grassland vegetation zone is not listed under State or Commonwealth legislation. The vegetation zone is present as a result of previous land clearance and as a consequence canopy trees are sparsely scattered throughout this vegetation zone, mostly those found in the original woodland community, such as Grey Box (*Eucalyptus moluccana*), and Narrow-leaved Ironbark (*Eucalyptus crebra*).

This vegetation zone lacks an understorey. The groundcover is generally dominated by native grass species, however some herbs also occur. There is a low to moderate incursion of weed species within this vegetation zone, particularly along areas that have been

disturbed. Weed incursion is high where exotic species have been sown for soil stability control measures. This community is shown in **Photograph 3.6**.



**Photograph 3.6 Central Hunter Grey Box-Ironbark Derived Grassland**

### **3.1.6 Zone 6 - Central Hunter Ironbark – Spotted Gum – Grey Box Forest**

**TSC Act Status:** EEC - Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions

**EPBC Act Status:** Not listed

**BioMetric Vegetation (2013) Equivalent:** Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter (HU818).

The extent of this community in the BAA consists of one larger patch in the south eastern corner and several smaller isolated patches along the eastern side of Wallaby Scrub Road. The smaller patches generally occur as small stands of forest surrounded by grassland. The main structural features of this community are shown in **Photograph 3.7** and **Photograph 3.8**.

Dominant canopy species in this community include Narrow-leaved Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia maculata*) and Grey Box (*Eucalyptus moluccana*). Bulloak (*Allocasuarina luehmannii*) is a common midstorey species.

The common understorey species in this community are Fan Wattle (*Acacia amblygona*) and Gorse Bitter Pea (*Daviesia ulicifolia*). Common groundcover species include; Blue Trumpet

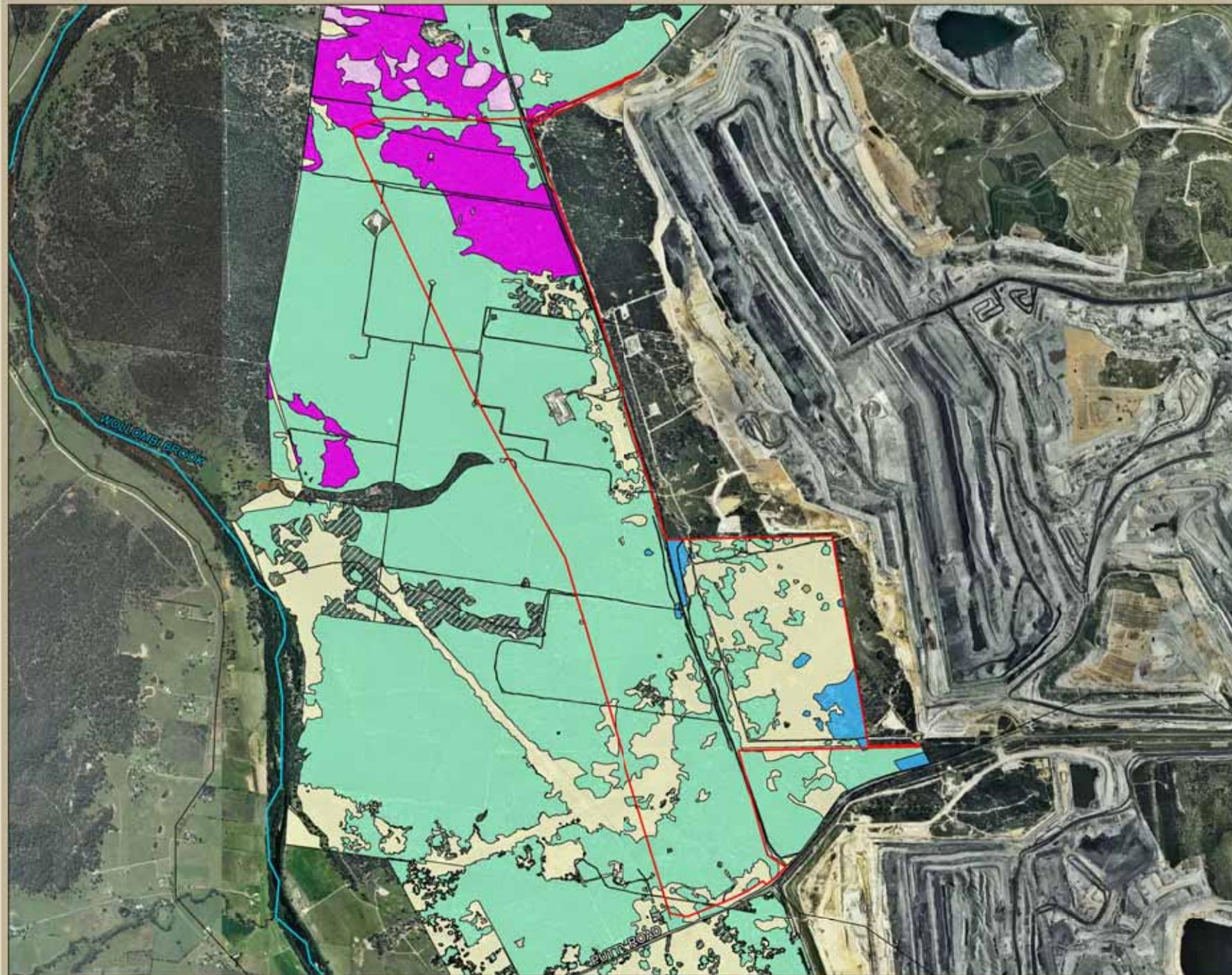
(*Brunoniella australis*), Common Everlasting (*Chrysocephalum apiculatum*), Wattle Matt-rush (*Lomandra filiformis*), Many-flowered Mat-rush (*Lomandra multiflora*), Blue Flax-lily (*Dianella longifolia*), Three-awn Speargrass (*Aristida vagans*), Rock Fern (*Cheilanthes sieberi*) and Variable Glycine (*Glycine tabacina*).



**Photograph 3.7 Regrowth Central Hunter Ironbark – Spotted Gum – Grey Box Forest**



**Photograph 3.8 Central Hunter Ironbark – Spotted Gum – Grey Box Forest**



**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse

**Vegetation Zone**

- Zone 1: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area
- Zone 2: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area\_Grassland
- Zone 3: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter
- Zone 4: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter\_Regen
- Zone 5: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter\_DG
- Zone 6: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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 (Geoscience Australia) 2006



Figure 3.1. Vegetation Communities/Zones within the Biodiversity Assessment Area and Surrounds



## 3.2 Flora Species

Approximately 400 flora species have been recorded in the BAA and surrounds; with over 75% of the species being native. A total flora species list from these surveys is provided in **Appendix B**.

An assessment of the likelihood of occurrence of threatened flora species in the BAA, including species credit species, is provided in **Appendix F**. The likelihood of occurrence of species credit species in the BAA is summarised below in **Table 3.2**.

**Table 3.2 Flora Species Credit Species Summary of Assessment of Likelihood of Occurrence in the BAA**

Scientific Name	Common Name	Conservation Status	Likelihood of Occurrence
<i>Ancistrachne maidenii</i>		V (TSC Act)	POSSIBLE
<i>Asperula asthenes</i>	Trailing Woodruff	V (TSC Act), V (EPBC Act)	UNLIKELY
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V (TSC Act), V (EPBC Act)	UNLIKELY
<i>Cymbidium canaliculatum</i> - endangered population	Cymbidium canaliculatum population in the Hunter Catchment	E (TSC Act)	POSSIBLE
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E (TSC Act), E (EPBC Act)	UNLIKELY
<i>Diuris tricolor</i>	Pine Donkey Orchid	V (TSC Act)	POSSIBLE
<i>Eucalyptus glaucina</i>	Slaty Red Gum	V (TSC Act), V (EPBC Act)	POSSIBLE
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V (TSC Act), V (EPBC Act)	UNLIKELY
<i>Monotaxis macrophylla</i>	Large-leafed Monotaxis	E (TSC Act)	UNLIKELY
<i>Persicaria elatior</i>	Tall Knotweed	V (TSC Act), V (EPBC Act)	UNLIKELY
<i>Pomaderris queenslandica</i>	Scant Pomaderris	E (TSC Act)	UNLIKELY
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E (TSC Act), E (EPBC Act)	POSSIBLE

Key: E = Endangered V = Vulnerable

### 3.2.1 *Threatened Flora Species Credit Species and Populations*

No threatened species credit flora species have been recorded within the BAA during surveys.

### 3.2.2 *Potential Threatened Flora Species Credit Species*

None of the species credit species listed above have been recorded within the BAA, however one is known from adjacent vegetation (see **Figure 3.2**). Five threatened flora species credit species are considered to have potential to occur within the BAA based on considerations of available habitat and/or occurrences known in the locality. Potential habitat for these species is shown in **Figure 3.3**. These species are discussed below.

#### i. *Ancistrachne maidenii*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Not listed

*Ancistrachne maidenii* is a scrambling perennial herb listed as Vulnerable under the TSC Act. Known occurrences of this species are restricted to northern Sydney, around Berowra Waters, Brooklyn and Wisemans Ferry. Surveys have indicated that populations occur in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes (NSW Scientific Committee, 2004b). This species was recorded to the west of the BAA by Andrews Neil (2006), within Central Hunter Grey Box – Ironbark Woodland (refer to **Figure 3.2**).

The occurrence of this species here is surprising as this occurrence is outside of its current known range and the record adjacent to the BAA is a disjunct occurrence of this species. Therefore this population is considered significant in the longer term survival of the species within the region. Areas of potential habitat for this species within the BAA are shown in **Figure 3.3** and totals approximately 372 ha.

#### ii. *Tiger Orchid (Cymbidium canaliculatum)*

**TSC Act Status:** Endangered Population in the Hunter Catchment

**EPBC Act Status:** Not listed

Tiger Orchid (*Cymbidium canaliculatum*) is an epiphytic orchid species that is listed under the TSC Act as an Endangered Population in the Hunter Catchment. Within the Hunter catchment, the species is commonly found in woodlands dominated by White Box (*Eucalyptus albens*) (NSW Scientific Committee 2011). The species has been found, less commonly, to grow on Slaty Gum (*Eucalyptus dawsonii*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*Eucalyptus moluccana*), Rough-barked Apple (*Angophora floribunda*) and Cooba (*Acacia salicina*) (Peake 2006). The species usually occurs singly or as a single clump between 2 and 6 m above the ground. However, the species has also been observed growing on stags or close to the ground on sizable logs and felled timber.

Although this species has not been recorded in the BAA, it is well known in the locality, often occurring in trees in open grassy woodlands of the Hunter Valley. Areas of potential habitat within the BAA are shown in **Figure 3.3** and total approximately 459 ha.

iii. *Pine Donkey Orchid (Diuris tricolor)*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Not listed

Pine Donkey Orchid (*Diuris tricolor*) grows in sclerophyll woodland and derived grassland on flats or small rises on substrates including sandy or loamy soils. It usually flowers between early September to late October (OEH 2012c).

Although not recorded from the Singleton LGA, this species is known to occur in the Muswellbrook LGA in grassy woodland within Hunter Floodplain Red Gum Woodland (unpublished information). Potential habitat for the species occurs in the BAA in Derived Native Grassland and grassy woodland areas as shown on **Figure 3.3**. The species persists below ground outside of flowering periods. The species also experiences short flowering events any time between early September to late October (Umwelt Environmental Consultants 2008, Botanic Gardens Trust 2011). For these reasons, the species is highly cryptic and is not readily detectable for the majority of the year.

Thus, although this species has not been recorded in the BAA during field surveys, or in the locality, it has the potential to occur in the BAA. A total approximate area of 610 ha of potential habitat occurs in the BAA.

iv. *Slaty Red Gum (Eucalyptus glaucina)*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Vulnerable

The OEH Atlas of NSW Wildlife indicates that five individuals of Slaty Red Gum (*Eucalyptus glaucina*), listed as Vulnerable under both the TSC and EPBC Acts, have been identified within the BAA. Despite these records, the species has never been confirmed in the numerous flora surveys that have been conducted within the BAA and surrounds since the initial recording in 1998. It is possible that such specimens were in fact misidentifications of Forest Red Gum / Blakely's Red Gum hybrids due to their somewhat similar features.

This species grows in grassy woodland and dry eucalypt forest, growing on deep, moderately fertile and well-watered soils. Many occurrences of this species have been recorded within the Singleton LGA. Therefore this species is considered to have potential habitat occurring within the BAA. A total approximate area of 459 ha of potential habitat occurs in the BAA for this species.

v. *Illawarra Greenhood (Pterostylis gibbosa)*

**TSC Act Status:** Endangered

**EPBC Act Status:** Endangered

A terrestrial orchid known from a small number of populations in the Hunter region and elsewhere. This species has been recorded in the LGA and the locality. All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine. This is a cryptic species and is considered to have 372 ha of potential habitat occurring in the BAA.



**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse

**Threatened Flora**

- *Ancistrachne maidenii*  
(Andrews & Niel 2006)

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:29,750 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
RTCA 2013

Data Source:  
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Figure 3.2. Locations of Threatened Flora Recorded within the Biodiversity Assessment Area and Surrounds





**Legend**

- Biodiversity Assessment Area
- Road
- Major River
- Minor River/Major Creek
- Minor Watercourse

**Potential Habitat**

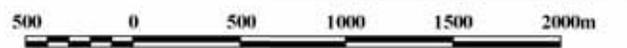
- Diuris tricolor*
- Cymbidium canaliculatum* and *Eucalyptus glaucina*
- Ancistrachne maidenii* and *Pterostylis gibbosa*

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 3.3. Habitat for Potential Threatened Flora Species Credit Species within the Biodiversity Assessment Area



### 3.3 Fauna Species

A suite of fauna species have been recorded in the BAA and surrounds and utilise a variety of available habitat types. This includes 13 amphibians, 18 reptiles, 146 birds and 45 mammals. A total fauna species list from these surveys is provided in **Appendix C**.

An assessment of the likelihood of occurrence of threatened fauna, including species credit species, within the BAA has been conducted and is presented in **Appendix G** and summarised in **Table 3.3**.

**Table 3.3 Fauna Species Credit Species Summary of Assessment of Likelihood of Occurrence in the BAA**

Scientific Name	Common Name	Conservation Status	Likelihood of Occurrence
<i>Pteropus poliocephalus</i> (Breeding Habitat)	Grey-headed Flying-fox (Breeding Habitat)	V (TSC Act), V (EPBC Act)	POSSIBLE*
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V (TSC ACT)	UNLIKELY
<i>Chalinolobus dwyeri</i> (Breeding Habitat)	Large-eared Pied Bat (Breeding Habitat)	V (TSC Act), V (EPBC Act)	POSSIBLE*
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	V (TSC ACT)	UNLIKELY
<i>Litoria aurea</i>	Green and Golden Bell Frog	E (TSC Act), V (EPBC Act)	POSSIBLE
<i>Litoria brevipalmata</i>	Green-thighed Frog	V (TSC ACT)	UNLIKELY
<i>Miniopterus australis</i> (Breeding Habitat)	Little Bentwing-bat (Breeding Habitat)	V (TSC ACT)	POSSIBLE*
<i>Myotis macropus</i> (Breeding Habitat)	Southern Myotis (Breeding Habitat)	V (TSC ACT)	KNOWN**
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E (TSC Act); V (EPBC Act)	UNLIKELY
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V (TSC Act)	POSSIBLE
<i>Phascolarctos cinereus</i>	Koala	V (TSC Act), V (EPBC Act)	POSSIBLE
<i>Planigale maculata</i>	Common Planigale	V (TSC Act)	UNLIKELY
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE (TSC Act), E (EPBC Act)	KNOWN***

E = Endangered, V = Vulnerable

Notes: \* These species are known to forage within the BAA but no breeding habitat is likely to occur.

\*\* The Southern Myotis is known to occur and suitable breeding habitat has been identified.

\*\*\* The Regent Honeyeater has been assessed as occurring due to a nearby record and expert report.

### 3.3.1 *Known Threatened Fauna Species Credit Species*

The locations of the species credit fauna species recorded from the BAA and surrounds are shown in **Figure 3.4**. Locations of non-species credit fauna species are also shown on **Figure 3.4** for reference. Potential habitat for these species is shown in **Figure 3.5**. These species are discussed below.

Two of the species credit species listed above have been assessed as occurring within the BAA. Southern Myotis (*Myotis macropus*) has been recorded within the BAA and is included as a species credit species for breeding habitat only. Although not known within the BAA, the Regent Honeyeater (*Anthochaera phrygia*) has been assessed as a known species as per an expert report prepared by Debus (2009).

The Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Little Bentwing-bat (*Miniopterus australis*) are known to forage on the within the BAA or surrounds. A known Grey-headed Flying-fox camp occurs within the Singleton LGA and foraging individuals recorded on site are likely to originate from there. No evidence of flying-fox camps has been found within the BAA. Similarly, no caves have been recorded within the BAA that would provide maternity roosts for the Large-eared Pied Bat and Little Bentwing-bat. Foraging habitat for these species is included in ecosystem credit considerations and these species are not discussed further here.

#### *i. Southern Myotis (Myotis Macropus) Breeding Habitat*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Not listed

The Southern Myotis has been recorded within the BAA by ERM (2000) and in the immediate vicinity (see **Figure 3.4**). Breeding habitat available to this species within the BAA includes woodland within 200 m of any watercourse that has some hollows present (OEH, 2013). Therefore, all areas having vegetation within 200 m of a watercourse has been considered to form breeding habitat for this species. Approximately 165 ha of breeding habitat occurs for this species within the BAA and is shown in **Figure 3.5**.

#### *ii. Regent Honeyeater (Anthochaera phrygia)*

**TSC Act Status:** Critically Endangered

**EPBC Act Status:** Endangered

Although this species has not been observed within the BAA, the general area provides habitat for the Regent Honeyeater and that this species would forage in these parts from time to time, following the flowering of winter eucalypts. As such, this species has been included as a 'known' species within this BCAM assessment,. Approximately 459 ha of suitable habitat occurs for this species within the BAA and is shown in **Figure 3.5**.

### 3.3.2 Potential Threatened Fauna Species Credit Species

Three threatened fauna species credit species are considered to have potential to occur within the BAA based on considerations of available habitat and/or occurrences known in the locality. Potential habitat for these species is shown in **Figure 3.6**. These species are discussed below.

*i. Green and Golden Bell Frog (Litoria aurea)*

**TSC Act Status:** Endangered

**EPBC Act Status:** Vulnerable

This species inhabits marshes, dams and stream-sides, particularly those containing bulrushes (*Typha* spp.) and Spikerushes (*Eleocharis* spp.). Optimal habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and sheltering sites available. The Green and Golden Bell Frog can occur in highly disturbed areas. The nearest recent OEH records (from 1997 and 2000) occur from near Ravensworth, approximately 12km north of the BAA. Suitable habitat occurs within the proposal area and although this species has not been found during numerous targeted surveys over several years, habitat for this species does occur in the BAA and is likely to occur in areas that could not be accessed for targeted surveys. Therefore this species is considered to have the potential to occur. Approximately 90.39ha of breeding habitat occurs for this species within the BAA and is shown in **Figure 3.6**.

*ii. Brush-tailed Phascogale (Phascogale tapoatafa)*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Not listed

The Brush-tailed Phascogale (*Phascogale tapoatafa*) is tree-dwelling marsupial carnivore, which prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. It also inhabits heath, swamps, rainforest and wet sclerophyll forest, prefers foraging in rough barked trees of 25 cm diameter or greater.

Although not detected within the BAA, it was detected at Wambo (ERM 2008) to the north. This semi-arboreal species occurs in a range of forest habitats and potential habitat is present in the BAA. As this is a cryptic species that is often difficult to detect, it is possible that the Brush-tailed Phascogale may occupy any of the woodland vegetation within the BAA. Approximately 459.20 ha of habitat occurs for this species within the BAA and is shown in **Figure 3.6**.

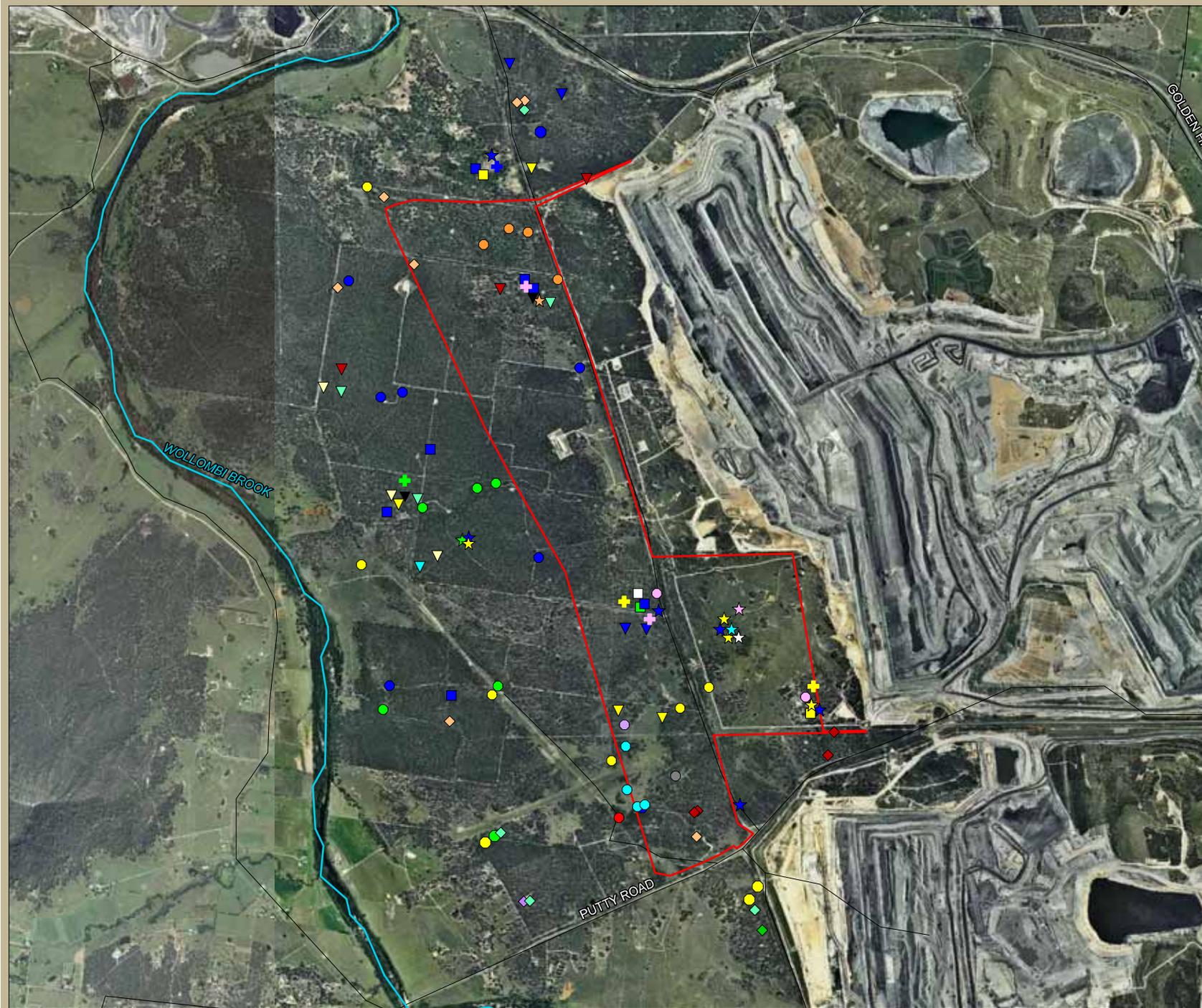
*iii. Koala (Phascolarctos cinereus)*

**TSC Act Status:** Vulnerable

**EPBC Act Status:** Vulnerable (combined populations of Queensland, NSW and the Australian Capital Territory)

The Koala is an arboreal marsupial that inhabits eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species. They develop preferences for some species in any one area.

It is unlikely that a resident population of Koalas occurs within the BAA and no individuals were observed during surveys. There are also no historical or anecdotal records of Koalas from within the BAA and surrounds; although there are previous records from within the nearby National Park (DECC (NSW) 2009). Although some suitable habitat trees are present for the Koala, the area is not considered to contain core Koala habitat as defined under *State Environmental Planning Policy 44* (SEPP 44). Approximately 387.09 ha of habitat occurs for this species within the BAA and is shown in **Figure 3.6**.



**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Threatened Fauna**

<b>Cumberland Ecology (2009)</b>	<b>Andrews &amp; Neil (2006)</b>
<span style="color: blue;">●</span> Speckled Warbler	<span style="color: yellow;">+</span> Grey-crowned Babbler
<span style="color: green;">●</span> Brown Treecreeper	<span style="color: green;">+</span> Brown Treecreeper
<span style="color: yellow;">●</span> Grey-crowned Babbler	<span style="color: blue;">+</span> Speckled Warbler
<span style="color: cyan;">●</span> Hooded Robin	<span style="color: pink;">+</span> Little Lorikeet
<span style="color: purple;">●</span> Little Lorikeet	
<span style="color: red;">●</span> Scarlet Robin	
<span style="color: grey;">●</span> Varied Sittella	
<span style="color: grey;">●</span> Spotted Harrier	
<span style="color: orange;">●</span> Glossy Black-cockatoo	
<span style="color: white;">○</span> Little Eagle	
<span style="color: red;">◆</span> Squirrel Glider	
<span style="color: orange;">◆</span> Eastern Bentwing-bat	
<span style="color: purple;">◆</span> Large-eared Pied Bat	
<span style="color: black;">◆</span> Southern Myotis	
<span style="color: green;">◆</span> Grey-headed Flying-fox	
<span style="color: green;">◆</span> Eastern Freetail-bat	

<b>ERM (2002)</b>	
<span style="color: blue;">▼</span> Speckled Warbler	
<span style="color: yellow;">▼</span> Grey-crowned Babbler	
<span style="color: red;">▼</span> Hooded Robin	
<span style="color: cyan;">▼</span> Squirrel Glider	
<span style="color: green;">▼</span> Eastern Freetail-bat	
<span style="color: yellow;">▼</span> Little Bentwing-bat	
<span style="color: black;">▼</span> Southern Myotis	

**Debus (2009)**

- ★ Speckled Warbler
- ★ Brown Treecreeper
- ★ Grey-crowned Babbler
- ★ Hooded Robin
- ★ Little Lorikeet
- ★ Diamond Firetail
- ★ Glossy Black-cockatoo

**Debus (2008)**

- Brown Treecreeper
- Speckled Warbler
- Grey-crowned Babbler
- Diamond Firetail

Site Name: Warkworth Mine

Location: 9km South-west of Singleton, NSW

Lot/DP Information:  
See Appendix H for Lot and DP details

Scale: 1:28,670 @ A3 page

Date Prepared: 03/06/2014

Image Source:  
RTCA 2013

Data Source:  
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(Geoscience Australia) 2006

I:\114001\Figures\RP2\_BCA\120140603\Figure 3.4\_Threatened Fauna\_BAA

Figure 3.4. Locations of Threatened Fauna Recorded within the Biodiversity Assessment Area and Surrounds





**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Species Habitat**

- Regent Honeyeater
- Southern Myotis (Breeding Habitat)

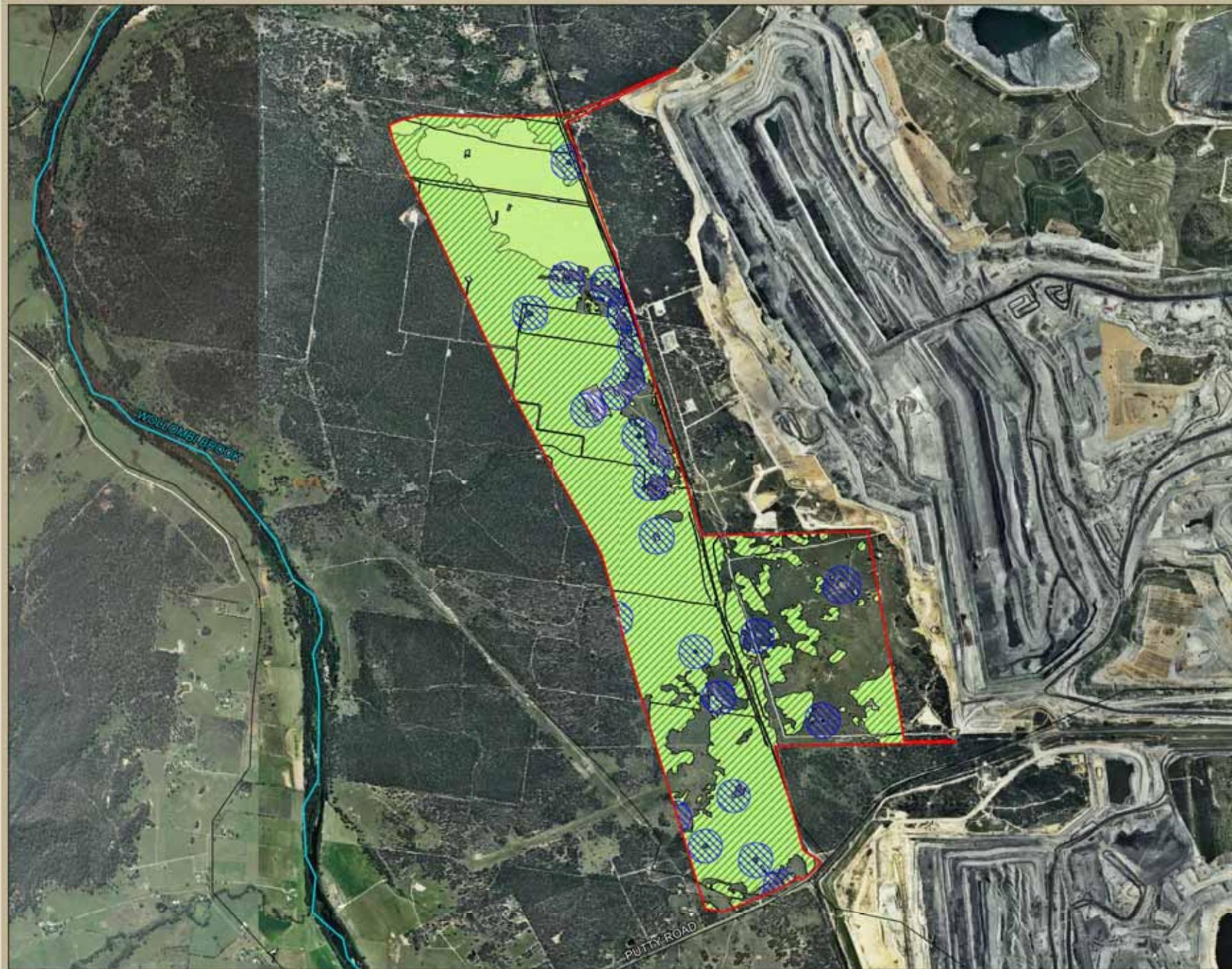
Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 3.5. Habitat for Known Threatened Fauna Species Credit Species within the Biodiversity Assessment Area





- Legend**
- Biodiversity Assessment Area
  - Road
  - Minor River/Major Creek
- Potential Species Habitat**
- Brush-tailed Phascogale Habitat
  - Koala Habitat
  - Green and Golden Bell Frog Habitat

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
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Figure 3.6. Habitat for Potential Threatened Fauna Species Credit Species within the Biodiversity Assessment Area



## Matters of National Environmental Significance

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### 4.1 Matters of National Environmental Significance

There are two approvals under the EPBC Act in place for Warkworth Mine comprising EPBC 2002/629 and EPBC 2009/5081. Approval of EPBC 2009/5081 was granted for the Warkworth Extension 2010 and its predicted impacts on listed threatened species and communities and listed migratory species. Disturbance and required offsets associated with the proposal are covered by EPBC 2009/5081. This approval covers the BAA.

Despite this, the Upper Hunter Biodiversity Plan being prepared will offset the impacts to MNES as well as TSC Act species, populations and communities. For this reason, all MNES with potential to occur in the BAA, and potential to be impacted by the Proposal have been identified and assessed in this Biodiversity Assessment Report. This section identifies all MNES recorded from or with the potential to occur in the BAA.

The EPBC Act Protected Matters Search Tool identified four threatened ecological communities, 31 threatened flora species and 24 threatened fauna species listed under the EPBC Act that are known or have potential to occur within the Singleton LGA. In addition, 12 migratory fauna species have been recorded. An assessment of the likelihood of occurrence of these species within the BAA is presented in **Table 4.1**. BCAM species credit species and ecosystem credit species have been marked to indicate those accounted for within this assessment. Profiles for species either known, likely or having potential to occur there are provided below.

Migratory species listed under the EPBC Act are MNES; however they do not constitute ecosystem credits or species credits generated by the BCAM Calculator. Therefore the findings of the database assessment have been included in this chapter separately to the ecosystem and species credit species.

MNES that are known or considered likely to occur in the BAA are described in the sections below.

**Table 4.1 MNES Relevant to the Project and their Likelihood of Occurrence within the BAA**

Common Name	Scientific Name	EPBC Act Status	Species Credit Species	Ecosystem Credit Species	Assessment of Likelihood of Occurrence
FLORA					
Slaty Red Gum	<i>Eucalyptus glaucina</i>	V	Yes	No	Possible. OEH records from 1998 occur to the west of the BAA. Presence not confirmed in numerous surveys. Potential to occur.
Illawarra Greenhood	<i>Pterostylis gibbosa</i>	E	Yes	No	Likely. OEH records 8km south of the BAA from 2001. Not detected in previous targeted flora surveys but suitable habitat within the BAA
Heath Wrinklewort	<i>Rutidosia heterogama</i>	V	Yes	No	Possible. Suitable habitat occurs within the BAA. However, not previously recorded in the BAA and surrounds during surveys.
FAUNA					
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	V	Yes	No	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Suitable foraging habitat within the BAA; particularly the Warkworth Sands Woodland vegetation and the vegetation along sandy drainage lines. Nearest OEH records from upstream areas of Wollombi Brook. Suitable habitat within the BAA but low chance of occurrence due to scarcity of records and previous intensive agricultural land use.
Green and Golden Bell Frog	<i>Litoria aurea</i>	V	Yes	No	Possible. Nearest recent OEH records (1997 and 2000) from near Ravensworth, approximately 20km north of the BAA. Suitable habitat within the proposal area.
Australasian Bittern		E	Yes	No	Possible. It is considered to have potential to occur based on the availability of sub-optimal potentially suitable habitat along creeklines

**Table 4.1 MNES Relevant to the Project and their Likelihood of Occurrence within the BAA**

Common Name	Scientific Name	EPBC Act Status	Species Credit Species	Ecosystem Credit Species	Assessment of Likelihood of Occurrence
					within the BAA.
Black-faced Monarch	<i>Monarcha melanopsis</i>	M	No	No	Possible. Not recorded during surveys within the BAA and surrounds. Potential habitat in taller vegetation adjacent to Wollombi Brook during the spring/summer months.
Cattle Egret		M	No	No	Possible. The Cattle Egret has not been recorded within the BAA or in the locality (OEH, 2014). However, it may occasionally forage there.
Eastern Great Egret	<i>Ardea alba</i>	M	No	No	Possible. Not recorded within the Warkworth Mining Leases during surveys. Could potentially forage within the BAA.
Fork-tailed Swift	<i>Apus pacificus</i>	M	No	No	Possible. Not recorded within the BAA and surrounds during surveys. Could potentially forage infrequently over the BAA.
Latham's Snipe	<i>Gallinago hardwickii</i>	M	No	No	Possible. Could potentially forage near dams and inundated areas within the BAA and surrounds. Summer migrant only, breeds exclusively in the northern hemisphere.
Rainbow Bee-eater	<i>Merops ornatus</i>	M	No	No	Likely. Known to occur adjacent to the BAA within the footprint of the 2003 consent area as well as the additional area beyond 2003 consent area (Debus 2008a; Debus 2008b; ERM 2002c; Andrews Neil 2006; and ERM 1995).
Red Goshawk	<i>Erythrorchis radiatus</i>	V	Yes	No	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Sub-optimal forage habitat. No recent records from wider locality.

**Table 4.1 MNES Relevant to the Project and their Likelihood of Occurrence within the BAA**

Common Name	Scientific Name	EPBC Act Status	Species Credit Species	Ecosystem Credit Species	Assessment of Likelihood of Occurrence
Regent Honeyeater	<i>Anthochaera phrygia</i>	E	Yes	No	Known. Not recorded on the BAA but recorded nearby during previous surveys (ERM, 2002a) from within the proposed mining extension area. Suitable forage habitat within the BAA
Rufous Fantail	<i>Rhipidura rufifrons</i>	M	No	No	Likely. Recorded within areas adjacent to the BAA during numerous previous surveys (Debus 2008a; Debus 2008b; and ERM 2002c).
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	M	No	No	Possible. Not recorded during surveys within the BAA and surrounds. Potential habitat in taller vegetation adjacent to Wollombi Brook during the spring/summer months
Swift Parrot	<i>Lathamus discolor</i>	E	No	Yes	Possible. Not recorded in BAA but recorded in adjacent areas (ERM, 2002a) Suitable forage habitat within the BAA
White-bellied Sea-eagle		M	No	No	Possible. Not recorded within the BAA but may occasionally fly over the BAA and could possibly occasionally utilise the woodland habitats present for foraging.
White-throated Needletail		M	No	No	Possible. The White-throated Needletail has not been recorded within the BAA. May occasionally utilise woodland habitats in the BAA as flyover foraging habitat only, but would be unlikely to rely on such habitats for its survival
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	Yes (breeding habitat)	Yes (foraging habitat)	Present. Recorded during surveys by Cumberland Ecology. Suitable forage habitat within the BAA. No known roost or breeding habitat. Large roosting colony in Singleton, individuals from which are likely to

**Table 4.1 MNES Relevant to the Project and their Likelihood of Occurrence within the BAA**

Common Name	Scientific Name	EPBC Act Status	Species Credit Species	Ecosystem Credit Species	Assessment of Likelihood of Occurrence
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	Yes (breeding habitat)	Yes (foraging habitat)	forage within the BAA and surrounds during blossom periods of the dominant trees. Likely. Recorded during Cumberland Ecology surveys adjacent to the BAA. Recorded during previous surveys at Mt Thorley Mine (ERM, 1995). Suitable forage habitat within the BAA. No suitable roosting or breeding habitat.
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	V	No	Yes	Possible. Not recorded within the BAA and surrounds during surveys. Nearest OEH records within the Singleton LGA are from west of Jerry's Plains. Suitable habitat within the BAA.
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	E	No	Yes	Possible. Not recorded during surveys of the BAA and surrounds. Unconfirmed record from old scats found in the surrounding area in 1979 (ERM, 1995). Nearby recent OEH records from Warkworth locality, and other areas within 10km of the boundaries of the BAA. Suitable forage habitat in the BAA; which may form a component of a much larger home-range. Den habitat limited to fallen logs.

CE = Critically Endangered; E = Endangered, V = Vulnerable, M = Migratory

#### **4.1.1 Ecological Communities**

No threatened ecological communities listed under the EPBC Act occur within the BAA, or are considered likely to occur.

#### **4.1.2 Flora Species**

##### *i. Slaty Red Gum (Eucalyptus glaucina)*

Slaty Red Gum (*Eucalyptus glaucina*) is listed as Vulnerable under the EPBC Act, and is described further in **Section 3.2.3**. Several records of this species have been previously identified within the BAA but have not since been re-recorded despite numerous surveys. It is possible that such specimens were misidentifications of Forest Red Gum / Blakely's Red Gum hybrids due to their somewhat similar features.

This species grows in grassy woodland and dry eucalypt forest, growing on deep, moderately fertile and well-watered soils. Many occurrences of this species have been recorded within the Singleton LGA. Therefore this species is considered to have potential habitat occurring within the BAA.

##### *ii. Illawarra Greenhood (Pterostylis gibbosa)*

Illawarra Greenhood (*Pterostylis gibbosa*) is listed as Endangered under the EPBC Act, and is described further in **Section 3.2.3**. The species has not been recorded in the BAA. However, it is considered to have potential to occur based on the availability of suitable habitat in the BAA (typically open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine).

##### *iii. Heath Wrinklewort (Rutidosia heterogama)*

Heath Wrinklewort (*Rutidosia heterogama*) is listed as Vulnerable under the EPBA Act. It grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides. It is considered to have the potential to occur within the BAA. Suitable habitat occurs within the BAA. However, this species has not been previously recorded in the BAA and surrounds during surveys.

#### **4.1.3 Fauna Species**

##### *i. Birds*

##### *a. Regent Honeyeater (Anthochaera phrygia)*

The Regent Honeyeater (*Anthochaera phrygia*) is listed as Endangered and Migratory under the EPBC Act. It is a winter migrant confined to Victoria and NSW and is strongly associated with the western slopes of the Great Dividing Range (Garnett and Crowley 2000). The species is found in temperate eucalypt forests and woodlands, particularly in blossoming trees and mistletoe (DEC (NSW) 2006). The Regent Honeyeater is strongly nomadic and follows blossoming trees (Franklin et al. 1989, NSW Scientific Committee 2004b). The species uses patches of vegetation as 'stepping stones' to travel across landscapes.

Regent Honeyeaters are migratory and are likely to occur in the locality during the winter as they preferentially use fertile lowland woodlands such as those found in the BAA on their migratory routes. The species is reliant on box/ironbark woodlands for foraging and is strongly associated with flowering and lerp bearing *Eucalyptus* spp. (Saunders and Heinsohn 2008) which form a significant proportion of the diet during poor flowering seasons (Oliver D. L. 2000, NSW Scientific Committee 2004b).

There are 4 records for the Regent Honeyeater in the Singleton LGA and they have been recorded consistently in Wollemi National Park and on the timbered slopes around Manobalai Nature Reserve since 1980. Regent Honeyeaters have been recorded in the wider area (OEH, 2014) and woodland within the BAA is considered to form known habitat for this species.

b. Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift (*Apus pacificus*) is listed as Migratory under the EPBC Act. In NSW, the majority of records occur east of the Great Divide, with a few populations having been recorded to the west (SEWPaC 2012a). The Fork-tailed Swift does not breed in Australia (SEWPaC 2012a). The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above the ground and possibly much higher (SEWPaC 2012a). It occurs mostly over inland plains but sometimes above foothills or in coastal areas (SEWPaC 2012a).

The Fork-tailed Swift has not been recorded within the BAA. The Fork-tailed Swift may occasionally fly over the BAA, such as dams and creek areas, when inundated. However, it is unlikely to rely on any habitat in the BAA.

c. Cattle Egret (*Ardea ibis*)

The Cattle Egret (*Ardea ibis*) is listed as Migratory under the EPBC Act. The Cattle Egret is widespread and common within Australia (SEWPaC 2012b). It occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (SEWPaC 2012b). It has been recorded in high numbers in moist, low-lying poorly drained pastures with an abundance of high grass (SEWPaC 2012b). It often forages away from water on low lying grasslands, improved pastures and croplands and is commonly found in cattle fields and other farm areas that contain livestock (SEWPaC 2012b). It roosts in trees, or amongst ground vegetation in or near lakes and swamps (SEWPaC 2012b).

The Cattle Egret has not been recorded within the BAA or in the locality (OEH, 2014). However, it may occasionally forage there.

d. Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret (*Ardea modesta*) is listed as Migratory under the EPBC Act. The Eastern Great Egret has a widespread distribution within Australia (SEWPaC 2012c). The Eastern Great Egret has been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial) (SEWPaC 2012c).

In Australia, breeding sites are located in wooded and shrubby swamps including mangrove forests (the main habitat of the species in the Top End), *Melaleuca* swamps (on the eastern coast of Australia and south-western Western Australia) and mixed eucalypt/acacia/lignum swamps (in the Channel Country and Murray-Darling Basin) (SEWPaC 2012c).

The Eastern Great Egret has not been recorded within the BAA. The Eastern Great Egret may occasionally utilise the water resources within the BAA, such as dams and creeks, when inundated.

e. Australasian Bittern (*Botaurus poiciloptilus*)

The Australasian Bittern (*Botaurus poiciloptilus*) is listed as Endangered under the EPBC Act. This species favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.) (OEH, 2014).

The Atlas of NSW Wildlife (OEH, 2014) holds no records of this species within the locality. The species has not been recorded in the BAA. However, it is considered to have potential to occur based on the availability of sub-optimal potentially suitable habitat along creeklines within the BAA.

f. Latham's Snipe (*Gallinago hardwickii*)

Latham's Snipe (*Gallinago hardwickii*) is listed as Migratory under the EPBC Act. Latham's Snipe is a non-breeding visitor to south-eastern Australia (SEWPaC 2012d). In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level (SEWPaC 2012d). They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies) (SEWPaC 2012d).

Latham's Snipe has not been recorded within the BAA or within the locality (OEH, 2014). However, some marginal habitat may occur for this species along the creeklines in the BAA and Latham's Snipe may occasionally forage within the BAA.

g. White-bellied Sea-eagle (*Haliaeetus leucogaster*)

The White-bellied Sea-eagle (*Haliaeetus leucogaster*) is listed as Migratory under the EPBC Act. The White-bellied Sea-eagle is found in coastal habitats, especially those close to the sea-shore, and around terrestrial wetlands in tropical and temperate regions (SEWPaC 2012e). The habitats occupied by this species are characterised by the presence of large areas of open water, and have been recorded flying over a variety of terrestrial habitats (SEWPaC 2012e). Breeding sites have been recorded on the coast, inland sites and offshore islands, and are located close to water and mainly in tall open forest or woodland (SEWPaC 2012e).

The White-bellied Sea-eagle has not been recorded within the BAA. The White-bellied Sea-eagle may occasionally fly over the BAA and could possibly occasionally utilise the woodland habitats present for foraging.

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

The White-throated Needletail (*Hirundapus caudacutus*) is listed as Migratory under the EPBC Act. Most White-throated Needletails spend the non-breeding season in Australasia (SEWPaC 2012f). The White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1,000 m above the ground (SEWPaC 2012f). 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. (SEWPaC 2012f).

The White-throated Needletail has not been recorded within the BAA. The White-throated Needletail may occasionally utilise woodland habitats in the BAA as flyover foraging habitat only, but would be unlikely to rely on such habitats for its survival.

i. Swift Parrot (*Lathamus dicolor*)

The Swift Parrot (*Lathamus dicolor*) is listed as an Endangered species under the EPBC Act. It is a predominantly nectarivorous, migratory parrot endemic to south eastern Australia (Birds Australia 2011). The species breeds in Tasmania and migrates to the mainland in winter, where it is most commonly found in dry, open eucalypt forests and woodlands containing Grey Box, White Box and Yellow Gum, all of which occurs in the BAA (Garnett and Crowley 2000). The species is reliant on Box-Ironbark communities for winter foraging, and movement is strongly associated with the availability of lerps and winter-flowering eucalypt species such as *Eucalyptus sideroxylon* (Mugga Ironbark). Swift Parrots often occur in urban areas, including farmland with remnant patches of eucalypt woodland (DEC (NSW) 2005c, Saunders and Heinsohn 2008).

Eucalypt tree species of various ages within the BAA provide flowering resources such as nectar and psyllid lerps. As such, the BAA and surrounding areas are likely to provide foraging habitat for winter-foraging migratory birds.

Swift Parrots have not been recorded in the BAA but have been recorded in the wider area (CE, 2013) and have the potential to occur within the BAA. Box Ironbark Woodland that occurs within the BAA is therefore likely to be utilised as occasional foraging habitat for this species, when passing through the locality during migration. However, due to the species being an opportunistic blossom feeder, habitat usage of the BAA would likely vary annually, and the Swift Parrot is unlikely to be heavily reliant on the foraging habitat present.

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

The Rainbow Bee-eater (*Merops ornatus*) is listed as Migratory under the EPBC Act. The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands (SEWPaC 2012g). The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (SEWPaC 2012g). It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (SEWPaC 2012g). The nest is located in an enlarged chamber at the end of long burrow or tunnel that in flat or sloping ground, in the banks of rivers, creeks or dams,

in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces (SEWPaC 2012g).

The Rainbow Bee-eater has been recorded in the wider area during previous surveys (Debus 2008; Andrews Neil 2006; ERM 1995). It is likely to fly over or forage within the BAA occasionally, mostly in woodland habitats.

k. Black-faced Monarch (*Monarcha melanopsis*)

The Black-faced Monarch (*Monarcha melanopsis*) is listed as Migratory under the EPBC Act. It occupies rainforest, mangroves, eucalypt forest and woodland (Morcombe 2007).

The Black-faced Monarch has not been recorded within the BAA or in the locality (OEH, 2014). The Black-faced Monarch may occasionally fly over the BAA in woodland habitats but is unlikely to be more than a rare visitor due to generally unsuitable habitat.

l. Satin Flycatcher (*Myiagra cyanoleuca*)

The Satin Flycatcher (*Myiagra cyanoleuca*) is listed as Migratory under the EPBC Act. In NSW, they are widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains (SEWPaC 2012h). Satin Flycatchers mainly inhabit eucalypt forests, often near wetlands or watercourses (SEWPaC 2012h). They also occur in eucalypt woodlands with open understorey and grass ground cover, and are generally absent from rainforest (SEWPaC 2012h). Satin Flycatchers prefer to nest in a fork of outer branches of trees, such as paperbarks, eucalypts, and banksias (SEWPaC 2012h).

The Satin Flycatcher has not been recorded within the BAA. The Satin Flycatcher may occasionally fly over or forage within the BAA in woodland habitats but is unlikely to be more than a rare visitor due to generally unsuitable habitat for both foraging and breeding.

m. Rufous Fantail (*Rhipidura rufifrons*)

The Rufous Fantail (*Rhipidura rufifrons*) is listed as Migratory under the EPBC Act and occurs in coastal and near coastal districts of northern and eastern Australia. Breeding populations occurring from about the South Australia-Victoria border, through south and central Victoria, on and east of the Great Divide in New South Wales (NSW), and north to about the NSW-Queensland border (DoE, 2014). In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests (DoE, 2014).

The Rufous Fantail has not been recorded within the BAA. However, it has been recorded within the wider area during numerous previous surveys (Debus 2008; ERM 2002). It may

occasionally fly over or forage within the BAA in woodland habitats but is unlikely to be more than a rare visitor due to generally unsuitable habitat for both foraging and breeding.

n. Red Goshawk (*Erythrotriorchis radiatus*)

The Red Goshawk is listed as Vulnerable under the EPBC Act. This species is mainly found along or near watercourses, in swamp forest and woodlands on the coastal plain. It favours patches of dense forest interspersed with open woodland or cleared land and often frequents forest edges. It has not been recorded within the BAA or surrounds during surveys. Sub-optimal forage habitat occurs within the BAA. It is considered to have the potential to occasionally utilise the BAA.

ii. *Bats*

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

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act. The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands and is generally rare with a very patchy distribution in NSW (OEH 2012b). It is found in well-timbered areas containing gullies and roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo aerial*), frequenting low to mid-elevation dry open forest and woodland close to these features (OEH 2012b).

Woodland habitats present in the BAA may provide foraging habitat for this species. The breeding habitat of Large-eared Pied Bat is listed as a species credit, however, no caves are known in the BAA, and therefore no known breeding habitat occurs.

b. Corben's Long-eared Bat (*Nyctophilus corbeni*)

Corben's Long-eared Bat (*Nyctophilus corbeni*) is listed as Vulnerable under the EPBC Act. This species is an insectivorous microchiropteran bat with rare distribution around south eastern Australia, including the Hunter Valley (Churchill 2008). The species is most commonly found in inland woodland vegetation types including Box-Ironbark dominated communities and mallee. In the Hunter Valley the species is found in national parks, including Wollemi National Park, where it has primarily been recorded in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. Little is known about the species, but it is expected to roost solitarily in tree crevices and shedding bark, and forage in flight, on the ground or around patches of trees (DEC (NSW) 2005a).

Corben's Long-eared Bat has not been recorded within the BAA. However, hollow-dependent microbat species are highly mobile and although this species has not been previously recorded in the locality (OEH, 2014) it has consistently been recorded within the nearby Muswellbrook local government area. The BAA therefore potentially supports habitat for this species, in woodland present in the BAA.

c. Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under the EPBC Act. The Grey-headed Flying-fox is distributed primarily along the eastern coastal plain from Bundaberg in Queensland, through NSW and south to eastern Victoria (NSW Scientific Committee 2004a). Within its extent, the Grey-headed Flying-fox occurs in rainforests, open forest, woodlands, Melaleuca swamps and Banksia woodlands (NSW Scientific Committee 2004a).

The Grey-headed Flying-fox was recorded within the BAA during surveys undertaken in 2009. Woodland habitats present in the BAA provide suitable foraging habitat for this species. The breeding habitat of Grey-headed Flying-fox is listed as a species credit, however, the closest known camp approximately 34 km to the south, in the town of Singleton, and no known breeding habitat occurs in the BAA.

iii. *Other Mammals*

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

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act. It occurs on the east coast of mainland Australia from Queensland through Victoria, and in Tasmania. The mainland population occurs in very low densities and is considered to be rare. The Spotted-tailed Quoll (*Dasyurus maculatus*) 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. Females breed once a year and typically establish grass-lined dens in burrows or hollow logs. The species usually traverse their ranges along densely vegetated creeklines (DEC (NSW) 2005b).

The Atlas of NSW Wildlife (2014) holds five records of this species within the locality. The species has not been recorded in the BAA. However, the species has potential to occur within the BAA from time to time and is likely to utilise vegetation corridors and habitat in the BAA for movement and foraging. Habitat is available in the form of habitat features such as large hollow logs, although it is unlikely that there is a breeding den on site. It is also unlikely that the Spotted-tail Quoll occurs in the area in significant densities.

b. Koala (*Phascolarctos cinereus*)

The Koala is not considered to be an affected species; however, as the Koala is listed as a species credit species, it is discussed here for completeness. Although some koala feed trees are present within the BAA (Forest Red Gum), no resident population of koalas is considered to occur with the BAA, and no evidence of koala use was observed during extensive field surveys. There are also no historical or anecdotal records of koalas from within the BAA and surrounds; although there are previous records from within the nearby National Park (DECCW, 2009). Therefore this species is considered unlikely to occur within the BAA. A full discussion of the likeliness of koalas occurring within the general area and an assessment of available habitat for this species under the NSW *State Environmental*

SEPP 44 is included in the 2014 EIA for the Proposal (CE, 2014). This species is not discussed further in this report.

iv. *Amphibians and Reptiles*

a. Green and Golden Bell Frog (*Litoria aurea*)

The Green and Golden Bell Frog (*Litoria aurea*) is listed as Vulnerable under the EPBC Act. This species inhabits marshes, dams and stream-sides, particularly those containing bulrushes (*Typha* spp.) and Spikerushes (*Eleocharis* spp.). Optimal habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and sheltering sites available. The Green and Golden Bell Frog can occur in highly disturbed areas. The nearest recent OEH records (from 1997 and 2000) occur from near Ravensworth, approximately 12km north of the BAA. Suitable habitat occurs within the proposal area and although this species has not been found during numerous targeted surveys over several years, habitat for this species does occur in the BAA and is likely to occur in areas that could not be accessed for targeted surveys. Therefore this species is considered to have the potential to occur.

b. Giant Burrowing Frog (*Heleioporus australiacus*)

The Giant Burrowing Frog is listed as Vulnerable under the EPBC Act. This species generally lives in the heath or forest and will travel several hundred metres to creeks to breed. It has not been recorded within the BAA and surrounds during surveys. However suitable foraging habitat occurs within the BAA; particularly the Warkworth Sands Woodland vegetation and the vegetation along sandy drainage lines. The nearest OEH records are from upstream areas of Wollombi Brook. Suitable habitat occurs within the BAA for this species but it is considered to have a low chance of occurrence due to the scarcity of records and previous intensive agricultural land use.

## 4.2 Impacts to MNES

In accordance with the BCAM, potential impacts to MNES are assessed below using the EPBC Act significant impact criteria (DEH 2006).

The following tables (**Table 4.2** to **Table 4.4**) consider whether there is a real chance or possibility that development of the entire BAA will result in the impacts listed in the tables. Impacts are assessed only for EECs or EPBC Act listed threatened species known to be present or having potential to occur within the BAA. This assessment is based on the assumption that all land within the BAA will be impacted.

**Table 4.2 Significant Impact Criteria for Critically Endangered and Endangered Species**

Significant Impact Criteria	Pterostylis gibbosa	Regent Honeyeater	Australasian Bittern	Spotted-tailed Quoll	Swift Parrot
Lead to a long-term decrease in the size of a population	No	No	No	No	No
Reduce the area of occupancy of the species	Yes	No	Yes	Yes	No
Fragment an existing population into two or more populations	No	No	No	No	No
Adversely affect habitat critical to the survival of a species	No	No	No	No	No
Disrupt the breeding cycle of a population	No	No	No	No	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	No	No	No	No
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	No	No	No	No	No
Introduce disease that may cause the species to decline	No	Yes	Yes	No	Yes
Interfere with the recovery of the species	No	Yes	Yes	No	Yes
Is a Significant Impact likely?	No	No	No	No	No

**Table 4.3 Significant Impact Criteria for Vulnerable Species**

Significant Impact Criteria	Eucalyptus glaucina	Green and Golden Bell Frog	Large-eared Pied Bat	Corben's Long-eared Bat	Grey-headed Flying-fox
Lead to a long-term decrease in the size of an important population of a species	No	No	No	No	No
Reduce the area of occupancy of	No	No	No	No	No

**Table 4.3 Significant Impact Criteria for Vulnerable Species**

<b>Significant Impact Criteria</b>	<b>Eucalyptus glaucina</b>	<b>Green and Golden Bell Frog</b>	<b>Large-eared Pied Bat</b>	<b>Corben's Long-eared Bat</b>	<b>Grey-headed Flying-fox</b>
an important population					
Fragment an existing important population into two or more populations	No	No	No	No	No
Adversely affect habitat critical to the survival of a species	No	No	No	No	No
Disrupt the breeding cycle of an important population	No	No	No	No	No
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No	No	No	No	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No	No	No	No	No
Introduce disease that may cause the species to decline	No	Yes	No	No	No
Interfere substantially with the recovery of the species	No	No	No	No	No
<b>Is a Significant Impact Likely?</b>	No	No	No	No	No

**Table 4.4 Significant Impact Criteria for Migratory Species**

Significant Impact Criteria	Fork-tailed Swift	Cattle Egret	Eastern Great Egret	Latham's Snipe	White-bellied Sea-Eagle	White-throated Needletail	Rainbow Bee-eater	Black-faced Monarch	Satin Flycatcher	Rufous Fantail
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	No	No	No	No	No	No	No	No	No	No
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	No	No	No	No	No	No	No	No	No	No
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	No	No	No	No	No	No	No	No	No	No
Is a Significant Impact Likely?	No	No	No	No	No	No	No	No	No	No

## BCAM Calculation Results

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This section summarises the findings of the BCAM analysis. This analysis has been undertaken to assess the credit cost of potential impacts of the Proposal.

### 5.1 Assumptions

Although the BCAM is systematic, there is also considerable scope for “professional judgement” to be applied; meaning different operators may arrive at differing credit calculations. Thus, when preparing a Biodiversity Assessment Report, it is essential to provide explanation of any assumptions made by the practitioner that may influence the results.

The assumptions made while preparing this BCAM Assessment include the following:

- The Assessment Circle used for this BCAM Assessment was scaled to be a 3,000 ha circle to encompass the BAA;
- Vegetation condition has been assumed to be in moderate to good condition for native vegetation in the BAA and within the 3,000 ha assessment circle. This is based on the ‘definition of low condition vegetation’ in Box 1 of Section 2 of the BCAM (DECCW 2011);
- BioMetric Vegetation Types are chosen as a best fit for vegetation zones present within the BAA;
- In order to meet the minimum guidelines for BCAM Assessment, plot data has been used from the same vegetation communities at adjacent sites but within the MTW mining lease (see **Figure 2.1**);
- Plot data has not been collected for the Regenerating Central Hunter Grey Box - Ironbark Woodland (HU817). However; plot data from the Central Hunter Grey Box - Ironbark Woodland (HU817) was used as it is the same vegetation community in a more mature form. As such, the BioMetric condition of the regenerating woodland as stated in **Table 3.1** is likely to be higher than what the vegetation community condition is within the BAA;
- Vegetation types which had a woodland and grassland component were separated into different vegetation zones; the grassland component was given the ancillary

code “\_DNG”. This is the case with the BioMetric Vegetation Types coded HU817 and HU872;

- Vegetation Type HU817 was split into 3 types using the ancillary codes \_Regen and \_DNG, to keep the Cumberland Ecology mapped vegetation separate in the assessment, to distinguish the different types of the Vegetation Type; and
- The EEC Status for Zone 1: HU872\_Moderate/Good should be “Warkworth Sands Woodland in the Sydney Basin Bioregion”. The BCAM Tool does not have an option to select this EEC for HU872 in Step 2: EEC and Red Flag Status. Only “Not an EEC” is able to be selected and therefore has been used for this vegetation zone.

In some areas, the ground cover vegetation is a mosaic of native and exotic species and it is impractical to record each small patch of native versus exotic grasses. Additionally, certain grasses dominate at certain times of the year. It is possible that, in some areas where the percent foliage cover of native ground-cover is close to 50%, it could easily change from over 50% to under 50% over the seasons. This fact, however, will not influence the total of ecosystem credits for native ground cover because as long as there is native canopy over 5% foliage cover, the vegetation patch is not in low condition under the BCAM rules. This will influence the total of ecosystem credits, where the difference in native ground cover versus exotic can change over the seasons, where ground cover can change from being exotic to become native ground cover.

## 5.2 Vegetation Mapping and Zones

This information has been provided within **Section 3.1** and **Figure 3.1**.

## 5.3 Site Value Scores

Quadrat data for each quadrat is provided in **Appendix B** and BCAM plot and transect data is provided in **Appendix D**. The Site Value Scores allocated to each vegetation zone are provided in **Table 5.1**.

**Table 5.1 Site Value Scores Allocated to Each Vegetation Zone**

Vegetation Zone	Code	Condition	BioMetric Vegetation Type	Site Value Score (Before)	Site Value Score (After)
1	HU872	Moderate/Good	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	81	0
2	HU872	Moderate/Good	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	40	0
3	HU817	Moderate/Good	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	76	0
4	HU817	Moderate/Good	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	76	0
5	HU817	Low	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	14	0
6	HU818	Moderate/Good	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	76	0

## 5.4 Landscape Value Score

The landscape value score takes into account (in summary):

- Percent native vegetation cover in the landscape;
- Connectivity value; and
- Adjacent remnant area.

This information is used as a determinative indicator of the BAA's quality.

Using Table 3 of BCAM, the percent native vegetation before the development was 41-50 (or >400-500ha) which provides a score of 15 (loss). The percent native vegetation after the development is 31-40% ( or >300-400ha) which provides a score of 13 (loss), resulting in a value of loss of 2. As a 3,000 ha assessment circle was used for this assessment, a scaling factor of 3 must be applied to the value of the percent native vegetation cover, resulting in a value of 6, The land within the BAA does not contain a Biodiversity Link and therefore the connectivity value is 0 (See Table 4 of BCAM). The adjacent remnant area is 501 ha, with a score of 10 (See Table 5 of BCAM). Therefore, the total landscape value score is 16. **Figure 5.1** shows the landscape value assigned.

## 5.5 Red Flag Areas

Red Flag Areas are defined within the BCAM (DECCW 2011) (Page 6) as:

An area of land is regarded as a red flag area if it contains one or more of the following:

- a. A vegetation type that is greater than 70% cleared as listed in the Vegetation Types Database (that is, has 30% or less remaining of its estimated distribution in the catchment management authority (CMA) area before the year 1750), and the vegetation is not in low condition as defined in Box 1 below;
- b. A critically endangered or endangered ecological community listed under the TSC Act or EPBC Act, and the vegetation is not in low condition as defined in Box 1 below;
- c. One or more threatened species identified in the Threatened Species Profile Database that cannot withstand further loss in the CMA area because of one or both of the following:
  - i. The species is naturally rare, is critically endangered, has few populations or a restricted distribution; or
  - ii. The species or its habitat needs are poorly known

- d. Areas of vegetation recognised as having regional or state biodiversity conservation significance. These areas are:
- i. Land that is mapped or defined as a state or regional biodiversity link in accordance with section 3.7.2 of the methodology;
  - ii. A riparian buffer 40m either side of a major river on the coast and tablelands or 100m either side of a major river on the western slopes and plains;
  - iii. A riparian buffer 30m either side of a minor river or major creek on the coast and tablelands or 60m either side of a minor river or major creek on the western slopes and plains;
  - iv. A riparian buffer 20m either side of a minor creek on the coast and tablelands or 40m either side of a minor creek on the western slopes and plains; or
  - v. Areas listed as a SEPP 14 wetland.

Red Flag Areas are present within the BAA and are shown in **Figure 5.2**. **Table 5.2** below shows what vegetation zones, species credit species habitat and species credit species are Red Flagged and their respective area or number of individuals within the BAA.

**Table 5.2 Red Flag Areas Present in the BAA**

Red Flag Area	Conservation Status	Total Area (ha) within BAA	Total No. Individuals within BAA	Total Area (ha) of Habitat within BAA
1 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	EEC (TSC Act)	72.12	N/A	N/A
3 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	EEC (TSC Act)	365.54	N/A	N/A
4 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter_Regen	EEC (TSC Act)	6.43	N/A	N/A
6 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter_DG	EEC (TSC Act)	15.11	N/A	N/A
Regent Honeyeater	E (EPBC Act),	N/A		459.21

**Table 5.2 Red Flag Areas Present in the BAA**

Red Flag Area	Conservation Status	Total Area (ha) within BAA	Total No. of Individuals within BAA	Total Area (ha) of Habitat within BAA
	CEEC (TSC Act)			
Southern Myotis ( <i>Myotis macropus</i> ) – Breeding Habitat	V (TSC Act)	N/A		164.89

Key: CEEC = Critically Endangered Ecological Community; EEC = Endangered Ecological Community; E = Endangered; V = Vulnerable

As this BCAM Assessment is part of the UHSA, the preparation of a report addressing matters outlined within Section 2.4 of the BCAM (DECCW 2011) is not required.

## 5.6 Ecosystem Credits

The land within the BAA contains the vegetation zones listed in **Table 5.1** and their associated habitat value for ecosystem species. Ecosystem credits have been calculated for each vegetation zone using the BCAM and results are shown in **Table 5.3** below. The total number of ecosystem credits which would be generated from the clearing of the entire BAA is 18,933.

**Figure 5.3** shows the total ecosystem credits which would be required for each polygon assessed that has been generated from the BAA, for inclusion in the Upper Hunter Biodiversity Plan (OEH, 2012).

**Table 5.3 Ecosystem Credits Generated for each Vegetation Zone within the BAA**

Vegetation Zone	Area (ha)	BioMetric Vegetation Type	Code	Condition	Credits Required
1	72.12	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	HU872	Moderate/Good	2,935
2	0.67	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area_Grassland	HU872	Low	15
3	365.54	Narrow-leaved Ironbark - Bull Oak -	HU817	Moderate/Good	13,644

**Table 5.3 Ecosystem Credits Generated for each Vegetation Zone within the BAA**

Vegetation Zone	Area (ha)	BioMetric Vegetation Type	Code	Condition	Credits Required
		Grey Box shrub - grass open forest of the central and lower Hunter			
4	6.43	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter_Regen	HU817	Low	240
5	151.50	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter_DG	HU817	Moderate/Good	1,546
6	15.11	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	HU818	Moderate/Good	553
<b>TOTAL</b>	<b>611.37</b>				<b>18,933</b>

## 5.7 Species Credits

The land within the BAA contains the species credit species (or their habitat) listed in **Table 5.4**. BCAM requires calculation of species credits for only those species known to occur within the BAA. Species credits have been generated for the Southern Myotis (breeding habitat) (12,685 species credits) and for the Regent Honeyeater (12,249 species credits). The credit requirements are based on preliminary calculations only, as at the time of printing this Biodiversity Assessment Report, the BCAM tool was undergoing another minor revision, (pers comm, David Rudder, OEH).

**Figure 5.4** shows the total species credits which would be required for each polygon assessed generated from the clearing of the BAA. Note that these are interim figures only and that the process of credit and offset calculation will be completed when the Upper Hunter Biodiversity Plan is finalised.

**Table 5.4 Species Credits Generated for Species Credit Species Recorded within BAA**

Scientific Name	Common Name	Area of Habitat (ha)	Credits Required	Red Flagged
<i>Anthochaera phrygia</i>	Regent Honeyeater	459.21	12,249	Yes
<i>Myotis macropus</i>	Southern Myotis	164.89	12,685	Yes

**Table 5.4 Species Credits Generated for Species Credit Species Recorded within BAA**

Scientific Name	Common Name	Area of Habitat (ha)	Credits Required	Red Flagged
(Breeding Habitat) (breeding habitat)				
TOTAL		624.1	24,934	

## 5.8 Total Credits

The total credits which have been generated by the BCAM Assessment for both ecosystem credits and species credits is shown in **Table 5.5**.

**Table 5.5 Total Ecosystem and Species Credits for the BAA**

Total Credits	Credits
Ecosystem Credits	18,933
Species Credits	24,934
<b>GRAND TOTAL</b>	<b>43,867</b>

## 5.9 Financial Contribution

As part of the UHSA it is intended that participating companies can meet their offset commitments by paying an agreed amount into the Upper Hunter Offset Fund. An Offset Program, managed by OEH, will be established under the Offset Fund to purchase the required biodiversity credits on behalf of companies.

The required contribution to the Offset Fund will be calculated using a new tool under development known as the Fund Calculator, which will convert credits into a dollar figure. The Fund Calculator estimates the costs of purchasing biodiversity credits based on the cost of managing an offset site in perpetuity and the land value of the offset site, used as a proxy for the opportunity cost of setting the land aside as a biodiversity offset. The Fund Calculator also includes a small administration fee to cover the costs of managing the biodiversity credit purchases on behalf of the company.

Companies will be able to enter the biodiversity credits calculated through the BCAM into the Fund Calculator and convert these into a financial contribution to the fund. This financial contribution can then form part of the final offset requirements set by the consent authority as part of the mine approval.



- Legend**
- Biodiversity Assessment Area
  - Assessment Circle (3,000ha)
  - Adjacent Remnant Area

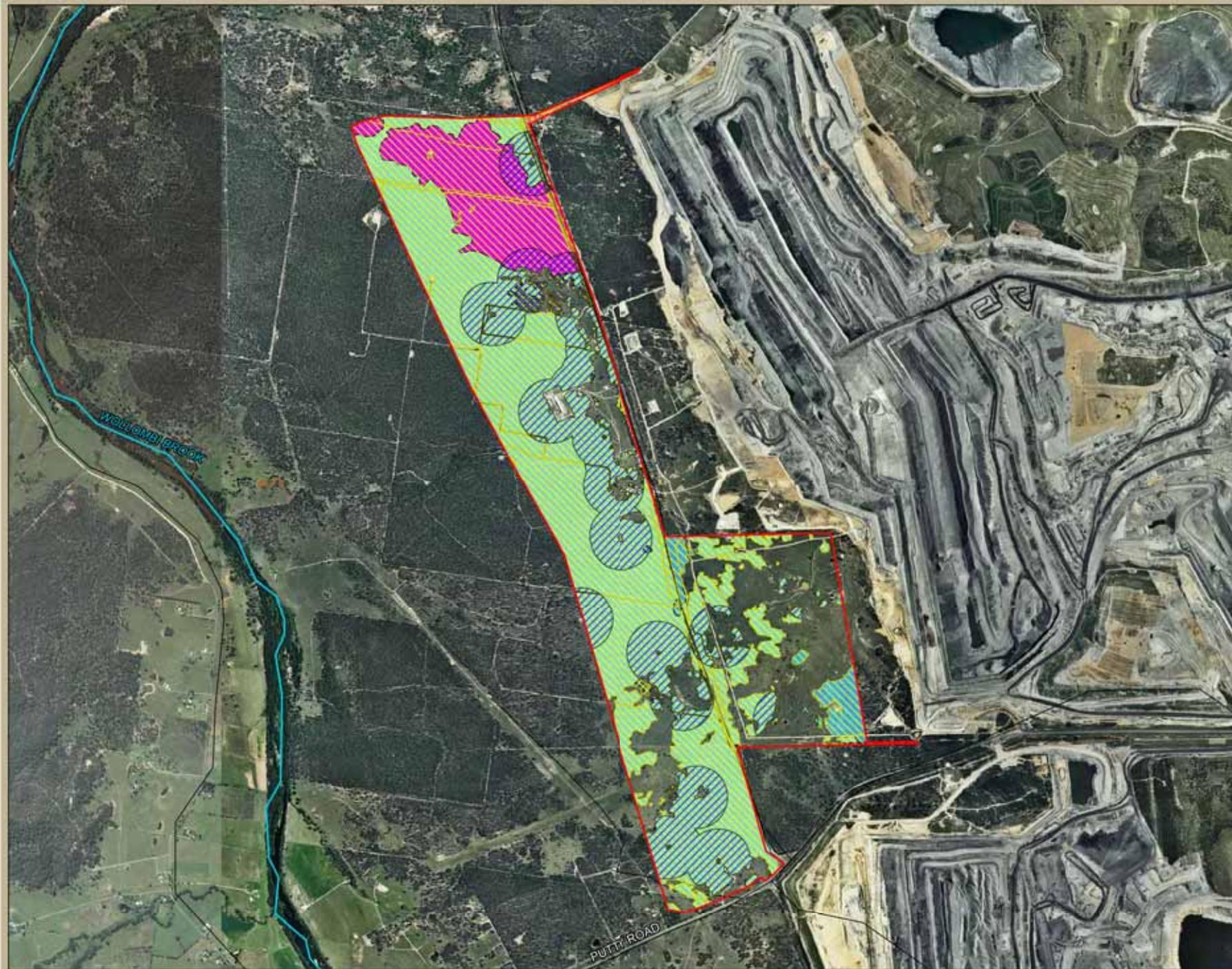
Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:26,340 @ A3 page  
 Date Prepared: 03/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



Figure 5.1. Landscape Value Showing Assessment Circle, Adjacent Remnant Vegetation Area and Connectivity





**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Red Flags**

- Zone 1: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area
- Zone 3: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter
- Zone 4: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter\_Regen
- Zone 6: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter
- Regent Honeyeater Habitat
- Southern Myotis (Breeding Habitat)

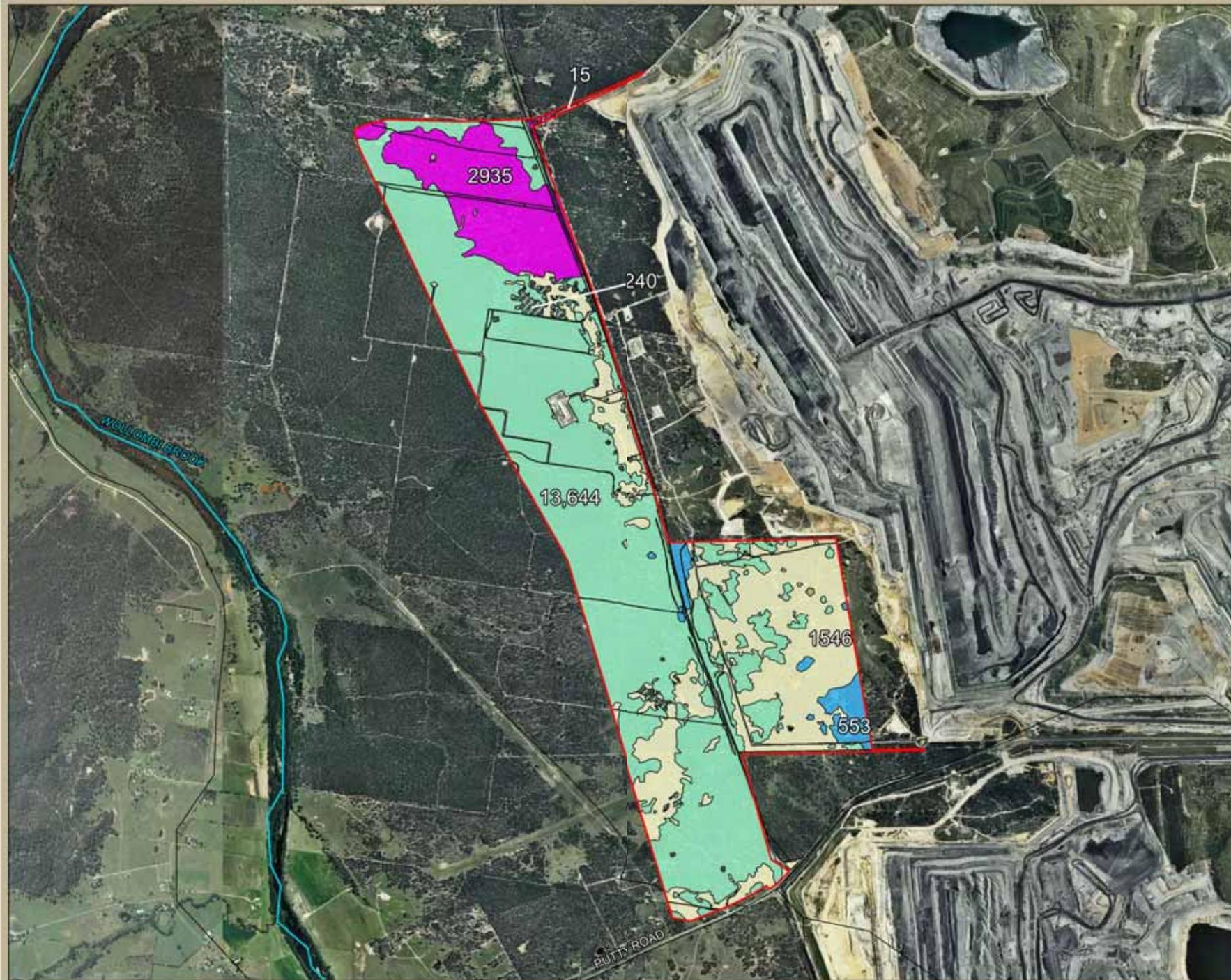
Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



Figure 5.2. Red Flag Areas within the Biodiversity Assessment Area





**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Vegetation Zone**

- Zone 1: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area
- Zone 2: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area\_Grassland
- Zone 3: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter
- Zone 4: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter\_Regen
- Zone 5: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter\_DG
- Zone 6: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



L1\_11-4001\Figures\RP2\_BC\AM\20140603\Figure 5.3. Total Ecosystem Credits

Figure 5.3. Total Ecosystem Credits Required for each Polygon within the Biodiversity Assessment Area





**Legend**

- Biodiversity Assessment Area
- Road
- Minor River/Major Creek

**Species Credit Species Habitat**

- Southern Myotis (Breeding Habitat)
- Regent Honeyeater

Site Name: Warkworth Mine  
 Location: 9km South-west of Singleton, NSW  
 Lot/DP Information:  
 See Appendix H for Lot and DP details  
 Scale: 1:24,900 @ A3 page  
 Date Prepared: 05/06/2014

Image Source:  
 RTCA 2013  
 Data Source:  
 © Copyright Commonwealth of Australia  
 (Geoscience Australia) 2006



Figure 5.4. Total Species Credits Required for each Polygon within the Biodiversity Assessment Area



## Assessment of Indirect Impacts on Biodiversity Values

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### 6.1 Indirect Impacts

This section presents an assessment of the potential indirect impacts the Proposal to species, populations and ecological communities addressed as ecosystem credits or species credit species that are not already identified by the BCAM tool. This is required as part of the BCAM methodology. A full assessment of potential direct and indirect impacts to all threatened ecological communities and species as a result of the proposed extension is provided in the Environmental Assessment for the Project (CE, 2014). Indirect impacts to species, populations and ecological communities addressed as ecosystem credits or species credit species in this report are expected to be minimal as a result of the current proposal.

Potential indirect impacts on ecosystem or species credit species could potentially be from severing movement corridors for species across a broader landscape. However, the Upper Hunter Valley is already highly fragmented, and the potential for this indirect impact to be exacerbated by development of a portion of land within the BAA which will form the Proposal's disturbance boundary is very minimal.

### 6.2 Cumulative Impacts

The Proposal will add to the cumulative loss of native vegetation in the region, as is recognised as part of the UHSA process, which addresses the impacts of potential mine projects in the region. When considered together with the Proposal, a high proportion of the surrounding locality will be subject to extensive mining at various stages within the next two to three decades. However, not all projects will occur concurrently and most will be followed by post-mining rehabilitation and revegetation, which will help to mitigate the impacts of habitat removal across the region as a whole.

## Conclusion

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This Biodiversity Assessment Report has been prepared for the nominated BAA for Warkworth Mine, as required by OEH as part of the UHSA process. Biodiversity Assessment Reports prepared by each participating mining company in the UHSA will form part of the Upper Hunter Biodiversity Plan, to be prepared by OEH, and this plan will comply with the current principles for offsetting set out by DoE (2012) and by OEH (OEH 2013). It will require that the hierarchy of 'avoid, mitigate and offset' is observed and will be developed to manage the impacts of coal mining in the Upper Hunter Valley to improve and maintain the biodiversity values of the region. The Upper Hunter Offset Fund will provide for the opportunity for biodiversity offsets from multiple projects to be consolidated and located strategically to gain greater conservation benefits.

RTCA will participate in the UHSA process and may finance biodiversity offsets for the Proposal, in accordance with the Upper Hunter Biodiversity Plan when it is finalised and approved, by contributing to the Upper Hunter Offset Fund. It is expected that by sourcing biodiversity offsets through the Upper Hunter Biodiversity Plan, RTCA can adequately address any impacts on biodiversity at both the Commonwealth and State levels for the Proposal.

As part of the offsetting process, RTCA can pay for offsets to compensate for the direct removal of native vegetation as part of the Proposal, through contributions to the Upper Hunter Offset Fund based on the credit requirements generated for the clearing of native vegetation within a nominated disturbance boundary. The funds will be calculated based on the generation of 18,933 ecosystem credits for clearance of vegetation, 12,249 species credits for impacts on Regent Honeyeater foraging habitat and 12,685 species credits for impacts on Southern Myotis (Breeding Habitat).

The retiring of ecosystem credits under the Upper Hunter Offset Fund will ensure the conservation of vegetation types (or equivalents) impacted by the Proposal, including the TECs; Warkworth Sands Woodland and Central Hunter Grey Box-Ironbark Woodland. The retiring of species credits for the Southern Myotis (breeding habitat) and the Regent Honeyeater will ensure the protection of habitat for these species. The retiring of ecosystem credits will also ensure maintenance of adequate habitat for threatened birds and mammals that have habitat within the woodland areas of the Upper Hunter Region.

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*Appendix A*

Compliance with Biodiversity Assessment  
Report Requirements

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## A.1 Assessment of Compliance

Information requirements for mine BAA Biodiversity Assessment Reports for the UHSA were provided by OEH (OEH, 2012), and have been replicated in the tables below:

**Table A.1 Biodiversity Assessment Report Requirements**

Inclusion Criteria		Where included/addressed in this report
Introductory chapter which identifies and describes the potential mining project assessment areas nominated by the mining company for inclusion in the strategic assessment (referred to hereafter as 'project areas').	✓	Chapter 1
A description of the applicable sections used in the biodiversity certification assessment methodology (refer to previous advice)	✓	Chapter 2 Section 2.4
A description of targeted threatened species surveys, including survey effort and timing of surveys including any assumptions or limitations	✓	Chapter 2
survey results	✓	Chapter 3
Existing survey data or relevant sections from ecological reports, or previous studies that were used to inform the data values used in the Biodiversity Assessment	✓	Chapter 2 Section 2.1.1
A sequential assessment of the applicable sections used in the biodiversity certification assessment methodology:	✓	Chapter 3 Section 3.4
Section 2.3 Red Flag Areas	✓	Chapter 5 Section 5.5
Section 2.4 Determining That Impacts on Red Flag Areas May be Offset	✓	Chapter 5 Section 5.5
Chapter 3 Assessment and Measurement of General Biodiversity Values	✓	Chapters 2, 3 and 5
Chapter 4 Assessment and Measurement of Threatened Species	✓	Chapters 2, 3 and 5
Chapter 5 Matters of National Environmental Significance	✓	Chapter 4
Chapter 6 Assessment of Indirect Impacts on Biodiversity Values	✓	Chapter 6
Chapter 7 Calculating Ecosystem Credits and Species Credits for Land Where Biodiversity	✓	Chapter 5

**Table A.1 Biodiversity Assessment Report Requirements**

Inclusion Criteria	Where included/addressed in this report
Certification is Conferred	
Appendix 1 Definition of Water Courses and Riparian Buffer Distances	✓ Chapter 5 Section 5.4 Figure 5.1
Appendix 2 Guidelines for the use of Benchmark Data from Local Reference Sites or Published Sources	✓ Chapter 5 Section 5.1
Appendix 3 Survey Design – Stratification and Survey Effort	✓ Chapter 2 Section 2.2.3 (iii)
Description of Matters of National Environmental Significance (MNES) within project areas or potentially impacted upon by development	✓ Chapter 4
For each vegetation zone, include the plot and transect values containing data for each site attribute and the site value score for that vegetation zone	✓ Chapter 3 Section 3.1 Appendix B Appendix D
For each vegetation zone, include a species list containing the dominant indigenous species for over-storey, mid-storey and ground cover for each vegetation type	✓ Chapter 3 Section 3.1 Appendix B

1. Calculation of ecosystem and species credits:

**Table A.2 Calculation of Ecosystem and Species Credits**

Inclusion Criteria	Where included/addressed in this report
the number of ecosystem credits required for each vegetation type on land within the project areas	✓ Chapter 5 Section 5.6
the number of species credits required for each species that requires species credits on land within the project areas	✓ Chapter 5 Section 5.7

2. The Biodiversity Assessment Report should also contain:

**Table A.3 Additional Requirements**

Inclusion Criteria		Where included/addressed in this report
expert reports where they are used	✓	Not Applicable
the reasons and justification for where more appropriate local data has been used for an assessment	✓	Not Applicable

1. A copy of the xml file exported from the Biodiversity Certification Credit Calculator
2. Maps based on digital aerial photography with named:

**Table A.4 Map Inclusions**

Maps to Include	Inclusion Criteria		Where included/addressed in this report
Property boundary	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 1 Figure 1.1
Project areas	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 1 Figure 1.2
Vegetation zones (including asset protection zones or other management zones)	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 3 Figure 3.1

**Table A.4 Map Inclusions**

Maps to Include	Inclusion Criteria	✓	Where included/addressed in this report
Location of any areas of high Biodiversity conservation value (Red flag areas under <b>Section 2.3</b> of the methodology)	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 5 Figure 5.2
Location of any areas of high biodiversity certification value (as defined by <b>Section 2.3</b> that cannot be varied using the variation criteria under Section 2.4 of the methodology.)	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Not Applicable
Map showing the credits required for the clearing of each polygon assessed in the BAA	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 5 Figure 5.3 and Figure 5.4
Landscape value assessment showing assessment circle, adjacent remnant vegetation area and connectivity assessment ( a separate map should be provided for any known offset area that is proposed for the development)	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared A legend.	✓	Chapter 5 Figure 5.1
Threatened species habitat for species that are assessed for species credits	A title (as per the names above) The site's name, location and lot/DP numbers The scale The date it was prepared	✓	Chapter 3 Figure 3.5

**Table A.4 Map Inclusions**

Maps to Include	Inclusion Criteria	Where included/addressed in this report
A legend.		

Note: Boundaries and zones must be confirmed on the site using a GPS. This information should be digitised onto an ortho-rectified aerial photo or SPOT-5 image. Maps must be easily readable and submitted to OEH as a Geographic Information System (GIS) file that is ESRI compatible.

1. Separate shape files should be supplied for the following:

**Table A.5 Shape Files Required**

Inclusion Criteria	Where included/addressed in this report
Property or project area boundary	✓ Enclosed disc or usb
Vegetation zones	✓ Enclosed disc or usb
Asset protection of other management zones (if applicable)	✓ Enclosed disc or usb
Any areas of high biodiversity conservation value (red flag areas) including EEC/TEC, over-cleared vegetation types, threatened species habitat, state or regionally significant biodiversity links	✓ Enclosed disc or usb
Location of assessment circle/s, adjacent remnant vegetation area and connectivity link/s	✓ Enclosed disc or usb
plots and transects	✓ Enclosed disc or usb
assessment circles	✓ Enclosed disc or usb
species polygons	✓ Enclosed disc or usb
polygons for adjacent remnant area	✓ Enclosed disc or usb

Note: Shapefiles must use GDA94 datum.

OEH anticipates that the following outputs from the biodiversity assessment will be included in the Biodiversity Plan. The remaining information will form a background report.

**Table A.6 Background Report Requirements**

Inclusion Criteria		Where included/addressed in this report
Map and supporting text that identifies and describes the mine project areas.	✓	To follow final report, after OEH review
Location of any areas of high biodiversity conservation value (as defined by section 2.3) that cannot be varied using the variation criteria under Section 2.4 of the methodology	✓	To follow final report, after OEH review
Map showing the credits required to offset the clearing for each polygon assessed in the BAA	✓	To follow final report, after OEH review

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*Appendix B*

**Flora Species List / Quadrat Data**

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**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	U		34	x		x	x
	<i>Pseuderanthemum variabile</i>	Pastel Flower	U		11	x			
Adiantaceae	<i>Cheilanthes distans</i>	Bristly Cloak Fern	U		35		x		x
	<i>Cheilanthes sieberi</i>	Rock Fern	U		30			x	x
	<i>Cheilanthes sieberi subsp. sieberi</i>	Rock Fern	U		75		x		
Aizoaceae	<i>Galenia pubescens*</i>	Galenia	U		44			x	x
Amaranthaceae	<i>Alternanthera pungens*</i>	Khaki Weed	U		3		x		
	<i>Alternanthera spp.</i>								x
	<i>Amaranthus spp.</i>								x
	<i>Ptilotus indivisus</i>		U					x	
	<i>Schinus areira*</i>	Pepper Tree	U		20			x	
Anthericaceae	<i>Arthropodium milleflorum</i>	Pale Vanilla-lily	U		13		x		
	<i>Arthropodium minus</i>	Small Vanilla Lily	U		7		x	x	
	<i>Arthropodium spp.</i>		U		9	x		x	x
	<i>Caesia parviflora</i>	Pale Grass-lily	U		6			x	
	<i>Laxmannia gracilis</i>	Slender Wire Lily	U		48	x		x	x
	<i>Tricoryne elatior</i>	Yellow Autumn-lily	U		12	x	x	x	
Apiaceae	<i>Actinotus spp.</i>							x	
	<i>Apiaceae spp.</i>							x	
	<i>Centella asiatica</i>	Indian Pennywort	U		16		x		x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Cyclosporum leptophyllum*</i>	Slender Celery	U		11			x	
	<i>Daucus glochidiatus</i>	Native Carrot	U		9			x	
	<i>Hydrocotyle peduncularis</i>	a Pennywort	U		4		x		
	<i>Hydrocotyle spp.</i>								x
Apocynaceae	<i>Gomphocarpus fruticosus*</i>	Narrow-leaved Cotton Bush	U		40	x	x	x	x
	<i>Gomphocarpus spp.*</i>		U						x
	<i>Parsonsia lanceolata</i>	Rough Silkpod	U		3			x	
	<i>Parsonsia straminea</i>	Common Silkpod	U		16			x	
Arecaceae	<i>Phoenix dactylifera*</i>	Date Palm	U					x	
Asparagaceae	<i>Asparagus officinalis*</i>	Asparagus	U					x	
Asphodelaceae	<i>Bulbine spp.</i>							x	
Asteraceae	<i>Ageratina adenophora*</i>	Crofton Weed	U		3	x			
	<i>Bidens pilosa*</i>	Cobbler's Pegs	U		33	x	x	x	x
	<i>Bidens spp.*</i>							x	
	<i>Bidens subalternans*</i>	Greater Beggar's Ticks	U						x
	<i>Brachyscome multifida var. dilatata</i>	Cut-leaved Daisy	U		2	x			x
	<i>Calocephalus citreus</i>	Lemon Beauty-heads	U						x
	<i>Calotis cuneifolia</i>	Purple Burr-Daisy	U		35	x	x	x	x
	<i>Calotis hispidula</i>	Bogan Flea	U		2		x		

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Calotis lappulacea</i>	Yellow Burr-daisy	U		25	x		x	x
	<i>Carthamus lanatus*</i>	Saffron Thistle	U		9			x	
	<i>Cassinia quinquefaria</i>		U		6	x			
	<i>Cassinia spp.</i>							x	
	<i>Chrysocephalum apiculatum</i>	Common Everlasting	U		50	x	x	x	x
	<i>Chrysocephalum semipapposum</i>	Clustered Everlasting	U						x
	<i>Cirsium vulgare*</i>	Spear Thistle	U		30	x	x		x
	<i>Conyza bonariensis*</i>	Flaxleaf Fleabane	U		27	x	x		x
	<i>Conyza canadensis var. canadensis*</i>	Canadian Fleabane	U		2	x			
	<i>Conyza spp.*</i>							x	x
	<i>Conyza sumatrensis*</i>	Tall fleabane	U		30	x			
	<i>Cotula australis</i>	Common Cotula	U		10		x		
	<i>Cymbonotus lawsonianus</i>	Bear's Ear	U			x			x
	<i>Epaltes australis</i>	Spreading Nut-heads	U		9	x			
	<i>Euchiton involucratus</i>	Star Cudweed	U		4			x	
	<i>Euchiton sphaericus</i>	Star Cudweed	U						x
	<i>Facelis retusa*</i>		U		9		x	x	
	<i>Glossogyne tannensis</i>	Cobbler's Tack	U		18	x		x	x
	<i>Gnaphalium spp.*</i>								x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Hypochaeris microcephala</i> var. <i>albiflora</i> *	White Flatweed	U		7	x			
	<i>Hypochaeris radicata</i> *	Catsear	U		62	x	x	x	x
	<i>Lagenophora gracilis</i>	Slender Lagenophora	U		4	x			
	<i>Olearia elliptica</i>	Sticky Daisy-bush	U		12			x	
	<i>Olearia</i> sp.?								x
	<i>Olearia viscidula</i>	Wallaby Weed	U		3	x			
	<i>Onopordum acanthium</i> *	Scotch Thistle	U					x	
	<i>Ozothamnus diosmifolius</i>	White Dogwood	P13		31	x	x	x	x
	<i>Podolepis</i> spp.		U		1	x		x	
	<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	U		5		x		
	<i>Senecio jacobaea</i> *	Ragwort	U			x			
	<i>Senecio madagascariensis</i> *	Fireweed	U		88	x	x	x	x
	<i>Senecio</i> spp.*		U		6	x			
	<i>Solenogyne bellioides</i>		U		9		x		x
	<i>Soliva sessilis</i> *	Bindyi	U		6		x		
	<i>Sonchus asper</i> subsp. <i>glaucescens</i> *	Prickly Sowthistle	U					x	
	<i>Sonchus oleraceus</i> *	Common Sowthistle	U		24			x	x
	<i>Sonchus</i> spp.*		U		1			x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Taraxacum officinale</i> *	Dandelion	U		11	x	x		
	<i>Vernonia cinerea</i>		U		34	x			x
	<i>Vittadinia cuneata var. cuneata forma minor</i>	A Fuzzweed	U				x		x
	<i>Vittadinia spp.</i>		U		15			x	x
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Wonga Vine	U		24		x	x	
Boraginaceae	<i>Cynoglossum australe</i>		U		3	x		x	
	<i>Echium vulgare</i> *	Viper's Bugloss	U					x	
	<i>Heliotropium amplexicaule</i> *	Blue Heliotrope	U		8			x	x
Brassicaceae	<i>Lepidium africanum</i> *	Common Peppercross	U		9	x			
	<i>Lepidium bonariense</i> *	Argentine Peppercross	U		14			x	
	? <i>Lepidium pseudohyssopifolium</i>	Peppercross	U						x
	<i>Lepidium spp.*</i>	A Peppercross	U		2			x	
Cactaceae	<i>Opuntia aurantiaca</i> *	Tiger Pear	U		20			x	x
	<i>Opuntia stricta</i> *	Prickly Pear	U		34	x	x	x	x
Campanulaceae	<i>Wahlenbergia communis</i>	Tufted Bluebell	U		27	x	x	x	x
	<i>Wahlenbergia gracilis</i>	Sprawling Bluebell	U		52		x	x	x
	<i>Wahlenbergia graniticola</i>	Granite Bluebell	U					x	
	<i>Wahlenbergia luteola</i>		U		1	x		x	
	<i>Wahlenbergia planiflora</i>		U			x			

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Wahlenbergia planiflora</i> subsp. <i>planiflora</i>	Flat Bluebell	U			x			
	<i>Wahlenbergia</i> spp.		U		11			x	
	<i>Wahlenbergia stricta</i>	Tall Bluebell	U						x
Caryophyllaceae	<i>Paronychia brasiliiana</i> *	Chilean Whitlow Wort, Brazilian Whitlow	U		6	x			
	<i>Paronychia brasiliiana</i> *	Chilean Whitlow Wort, Brazilian Whitlow	U		6			x	
	<i>Petrorhagia</i> spp.							x	
	<i>Scleranthus pungens</i>		U					x	
	<i>Spergularia</i> spp.							x	
	<i>Stellaria media</i> *	Common Chickweed	U		3	x			
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-Oak	U		19	x	x	x	x
	<i>Allocasuarina luehmannii</i>	Bulloak	U		66	x	x	x	x
	<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	River Oak	P13		25			x	
	<i>Casuarina glauca</i>		U						x
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush	U		31		x		x
	<i>Einadia nutans</i>	Climbing Saltbush	U		10		x		x
	<i>Einadia nutans</i> subsp. <i>linifolia</i>	Climbing Saltbush	U		16	x			
	<i>Einadia nutans</i> subsp. <i>nutans</i>	Climbing Saltbush	U		5		x		

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Einadia polygonoides</i>	Knotweed Goosefoot	U		11		x		x
	<i>Einadia spp.</i>		U		4			x	
	<i>Einadia trigonos</i>	Fishweed	U		11		x		x
	<i>Enchylaena tomentosa</i>	Ruby Saltbush	U		23	x	x		x
	<i>Maireana microphylla</i>	Small-leaf Bluebush	U		26			x	x
	<i>Maireana spp.</i>							x	
Clusiaceae	<i>Hypericum gramineum</i>	Small St John's Wort	U		29	x		x	x
Commelinaceae	<i>Commelina benghalensis</i> *		U		1		x		
	<i>Commelina cyanea</i>	Native Wandering Jew	U		36	x			x
	<i>Murdannia graminea</i>		U		8	x		x	
	<i>Tradescantia albiflora</i> *	Wandering Jew	U		7	x			
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed	U		86		x		x
	<i>Dichondra sp.</i>					x		x	
	<i>Echium plantagineum</i> *	Patterson's Curse	U		2		x		
	<i>Heliotropium amplexicaule</i> *	Blue Heliotrope	U		8		x		
Crassulaceae	<i>Bryophyllum delagoense</i> *	Mother of millions	U		5		x		x
	<i>Bryophyllum spp.</i>							x	
	<i>Crassula sieberiana</i>	Australian Stonecrop	U		17		x		x
Cunoniaceae	<i>Bauera microphylla</i>		U		1		x		
Cupressaceae	<i>Callitris endlicheri</i>	Black Cypress Pine	U		21		x		

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Cyperaceae	<i>Callitris glaucophylla</i>	White Cypress Pine	U		5	x	x	x	
	<i>Cyperus aggregatus*</i>		U		7	x			
	<i>Cyperus congestus*</i>		U				x		
	<i>Cyperus eragrostis*</i>	Umbrella Sedge	U		4	x			x
	<i>Cyperus gracilis</i>	Slender Flat-sedge	U						x
	<i>Cyperus leiocaulon</i>		U			x			
	<i>Cyperus spp.</i>		U		9	x			x
	<i>Eleocharis sp.</i>								x
	<i>Eleocharis sphacelata</i>	Tall Spike Rush	U						x
	<i>Fimbristylis dichotoma</i>	Common Fringe-sedge	U		27	x			x
	<i>Lepidosperma concavum</i>		U		4		x		
<i>Lepidosperma filiforme</i>		U		2		x			
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken	P13		49	x	x	x	x
Dilleniaceae	<i>Hibbertia empetrifolia subsp. empetrifolia</i>		U		3	x	x		
	<i>Hibbertia linearis</i>		U		10		x	x	x
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	U						x
	<i>Hibbertia spp.</i>		U		5			x	
Dioscoreaceae	<i>Dioscorea transversa</i>	Native Yam	U		6		x		
Droseraceae	<i>Drosera peltata</i>	A Sundew	U		6			x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Ericaceae	<i>Brachyloma daphnoides</i>	Daphne Heath	U		9	x	x	x	
	<i>Leucopogon muticus</i>	Blunt Beard-heath	U		24		x		
	<i>Lissanthe spp.</i>					x			
	<i>Lissanthe strigosa</i>	Peach Heath	U					x	
	<i>Melichrus urceolatus</i>	Urn Heath	U		24	x			
	<i>Sprengelia sprengelioides</i>		U					x	
Euphorbiaceae	<i>Chamaesyce drummondii</i>	Caustic Weed	U						x
	<i>Ricinus communis*</i>	Castor Oil Plant	U					x	
Fabaceae (Caesalpinioideae)	<i>Senna coronilloides</i>		U		4			x	
	<i>Senna form taxon 'zygophylla'</i>		U		4			x	
Fabaceae (Faboideae)	<i>Chorizema parviflorum</i>	Eastern Flame Pea	U		9	x	x		
	<i>Daviesia genistifolia</i>	Broom Bitter Pea	U		15		x	x	
	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea	U		52	x			x
	<i>Desmodium brachypodum</i>	Large Tick-trefoil	U		19	x			x
	<i>Desmodium gunnii</i>	Slender Tick-trefoil	U		1	x			
	<i>Desmodium rhytidophyllum</i>		U		10	x			
	<i>Desmodium spp.</i>		U		1			x	
	<i>Desmodium varians</i>	Slender Tick-trefoil	U		57	x			x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Dillwynia parvifolia</i>		U				x		
	<i>Dillwynia retorta</i>		U		23			x	
	<i>Glycine clandestina</i>	Twining glycine	U		60	x	x		x
	<i>Glycine microphylla</i>	Small-leaf Glycine	U		22	x	x		x
	<i>Glycine spp.</i>		U		5	x		x	
	<i>Glycine tabacina</i>	Variable Glycine	U		49	x	x		x
	<i>Gompholobium spp.</i>					x			
	<i>Hardenbergia violacea</i>	False Sarsaparilla	U		53		x		x
	<i>Hovea linearis</i>		U		20	x	x		x
	<i>Indigofera australis</i>	Australian Indigo	U		31	x		x	x
	<i>Jacksonia scoparia</i>	Dogwood	U		22		x	x	x
	<i>Jacksonia spp.</i>					x			
	<i>Melilotus indicus*</i>	Hexham Scent	U		6		x		
	<i>Trifolium angustifolium*</i>	Narrow-leaved Clover	U		1			x	
	<i>Trifolium arvense*</i>	Haresfoot Clover	U		3			x	
	<i>Zornia dyctiocarpa var. dyctiocarpa</i>	Zornia	U		11	x			x
Fabaceae (Mimosoideae)	<i>Acacia amblygona</i>	Fan Wattle	U		54	x	x	x	x
	<i>Acacia bulgaensis</i>	Bulga Wattle	U		38				x
	<i>Acacia binervia</i>	Coast Myall	P13		31		x	x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Acacia decora</i>	Western Golden Wattle	P13		19			x	x
	<i>Acacia elongata</i>	Swamp Wattle	U		18		x		
	<i>Acacia falcata</i>		U		58	x	x	x	x
	<i>Acacia filicifolia</i>	Fern-leaved Wattle	U		43	x		x	
	<i>Acacia floribunda</i>	White Sally	U		3		x		
	<i>Acacia implexa</i>	Hickory Wattle	U		22	x	x		x
	<i>Acacia mearnsii</i>	Black Wattle	U				x		
	<i>Acacia paradoxa</i>	Kangaroo Thorn	U		9		x	x	
	<i>Acacia parvipinnula</i>	Silver-stemmed Wattle	U		102		x	x	x
	<i>Acacia podalyriifolia</i>	Queensland Silver Wattle	P13		2			x	
	<i>Acacia salicina</i>	Cooba	U		18			x	x
	<i>Acacia saligna*</i>	Golden Wreath Wattle	U		4	x			
	<i>Acacia spp.</i>		U		31			x	
	<i>Acacia suaveolens</i>	Sweet Wattle	U		13		x	x	
Gentianaceae	<i>Centaurium ?tenuiflorum*</i>	Branched Centaury, Slender centaury	U		12			x	
Geraniaceae	<i>Erodium ?crinitum</i>	Blue Storksbill, Blue Crowfoot	U		2			x	
Goodeniaceae	<i>Goodenia bellidifolia subsp. bellidifolia</i>		U			x			

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Goodenia hederacea</i>	Ivy Goodenia; Forest Goodenia	U		23	x			x
	<i>Goodenia hederacea subsp. hederacea</i>		U		14	x	x		
	<i>Goodenia heterophylla subsp. heterophylla</i>		U		3	x			
	<i>Goodenia rotundifolia</i>		U		15			x	x
	<i>Goodenia spp.</i>		U		4	x		x	x
	<i>Scaevola calendulacea</i>		U		2		x		
	<i>Velleia spp.</i>					x			
Haloragaceae	<i>Gonocarpus spp.</i>								x
	<i>Gonocarpus tetragynus</i>	Poverty Raspwort	U		8			x	
	<i>Myriophyllum spp.</i>								x
Iridaceae	<i>Romulea rosea var. australis*</i>	Onion Grass	U		10		x		
	<i>Sisyrinchium sp. A*</i>	Scourweed	U		4			x	
Juncaceae	<i>Juncus spp.</i>	A Rush	U		7	x			
	<i>Juncus usitatus</i>		U		35			x	x
Juncaginaceae	<i>Triglochin procerum</i>	Water Ribbons	U		2				x
Lamiaceae	<i>Ajuga australis</i>	Austral Bugle	U		10	x		x	x
	<i>Scutellaria humilis</i>	Dwarf Skullcap	U		6			x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Spartothamnella juncea</i>		U		16	x	x	x	x
Linaceae	<i>Linum marginale</i>	Native Flax	U		3			x	
Lobeliaceae	<i>Lobelia gracilis</i>	Trailing Lobelia	U		3		x		
	<i>Pratia purpurascens</i>	Whiteroot	U		66	x	x		x
Lomandraceae	<i>Lomandra confertifolia subsp. rubiginosa</i>		U		10	x			
	<i>Lomandra filiformis</i>	Wattle Matt-rush	U		14	x		x	x
	<i>Lomandra filiformis subsp. coriacea</i>	Wattle Matt-rush	U		22	x			
	<i>Lomandra filiformis subsp. filiformis</i>		U		21		x		
	<i>Lomandra glauca</i>	Pale Mat-rush	U		25	x	x	x	
	<i>Lomandra leucocephala subsp. leucocephala</i>	Woolly Mat-rush, Irongrass	U		1			x	
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	U		47	x		x	x
	<i>Lomandra multiflora subsp. multiflora</i>	Many-flowered Mat-rush	U		80	x	x	x	x
	<i>Lomandra obliqua</i>		U		26	x			
	<i>Lomandra sp.</i>								x
Loranthaceae	<i>Amyema linophyllum subsp. orientale</i>		U					x	
	<i>Amyema miquelii</i>	Box Mistletoe	U		6			x	
	<i>Amyema pendulum subsp.</i>		U		1	x			

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>pendulum</i>								
	<i>Amyema spp.</i>		U		3			x	x
	<i>Dendrophthoe vitellina</i>		U		11			x	
	<i>Lysiana spp.</i>							x	
Malaceae	<i>Malus spp.*</i>							x	
Malvaceae	<i>Howittia trilocularis</i>		U					x	
	<i>Pavonia hastata*</i>		U		14		x		
	<i>Sida ?corrugata</i>	Corrugated Sida	U		18	x			
	<i>Sida corrugata</i>	Corrugated Sida	U		18			x	x
	<i>Sida rhombifolia*</i>	Paddy's Lucerne	U		47	x	x	x	x
Meliaceae	<i>Melia azedarach</i>	White Cedar	U		12			x	
Menispermaceae	<i>Stephania japonica</i>	Snake Vine	U					x	
	<i>Stephania japonica var. discolor</i>	Snake Vine	U		12		x		
Moraceae	<i>Ficus macrophylla</i>		U					x	
	<i>Ficus spp.</i>		U		3			x	
Myoporaceae	<i>Eremophila debilis</i>	Amulla	U		50		x	x	x
	<i>Myoporum montanum</i>	Western Boobialla	U		21			x	
	<i>Myoporum parvifolium</i>	Creeping Boobialla	U			x			
Myrsinaceae	<i>Anagallis arvensis*</i>	Scarlet/Blue Pimpernel	U		42	x	x	x	x
Myrtaceae	<i>Angophora bakeri</i>	Narrow-leaved Apple	U		12	x			x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Angophora floribunda</i>	Rough-barked Apple	U		66		x	x	x
	<i>Corymbia ?citriodora</i>	Lemon-scented Gum						x	
	<i>Corymbia maculata</i>	Spotted Gum	U		130	x	x	x	x
	<i>Eucalyptus albens</i>	White Box	U			x		x	
	<i>Eucalyptus albens x moluccana</i>		U					x	x
	<i>Eucalyptus blakelyi</i>	Blakely's Red Gum	U		4	x	x	x	x
	<i>Eucalyptus blakelyi x tereticornis</i>	Blakely's Red Gum/Forest Red Gum						x	x
	<i>Eucalyptus camaldulensis</i>	River Red Gum	U		24			x	
	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	U		125	x	x	x	x
	<i>Eucalyptus melliodora</i>	Yellow Box	U		4		x	x	
	<i>Eucalyptus moluccana</i>	Grey Box	U		72	x	x	x	x
	<i>Eucalyptus stenostoma</i>		U				x		
	<i>Eucalyptus tereticornis</i>	Forest Red Gum	U		71		x	x	x
	<i>Leptospermum polygalifolium</i> <i>subsp. polygalifolium</i>		U		3		x		
	<i>Leptospermum spp.</i>		U		3			x	
	<i>Melaleuca decora</i>		U		16	x	x	x	x
	<i>Melaleuca thymifolia</i>		U		8	x	x	x	x
Nyctaginaceae	<i>Boerhavia dominii</i>	Tarvine	U		3	x		x	x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Oleaceae	<i>Ligustrum sinense*</i>	Small-leaved Privet	U		3			x	
	<i>Notelaea longifolia</i>	Large Mock-olive	U		14		x		x
	<i>Notelaea microcarpa</i>	Native Olive	U		2			x	x
	<i>Notelaea microcarpa var. microcarpa</i>		U		14	x			
	<i>Notelaea neglecta</i>		U				x	x	
	<i>Notelaea spp.</i>							x	
	<i>Olea europaea subsp. cuspidata*</i>		U		41			x	
	<i>Olea europaea subsp. europaea*</i>		U			x	x		
Orchidaceae	<i>Diuris punctata</i>	Purple Donkey Orchid	P13		1			x	
Oxalidaceae	<i>Oxalis corniculata*</i>	Creeping Oxalis	U		12		x		
	<i>Oxalis exilis</i>		U						x
	<i>Oxalis incarnata*</i>		U		1		x		
	<i>Oxalis perennans</i>		U		24	x	x		x
	<i>Oxalis rubens</i>		U					x	
	<i>Oxalis spp.</i>		U		19			x	x
Papaveraceae	<i>Argemone ochroleuca*</i>	Mexican Poppy	U					x	
Phormiaceae	<i>Dianella caerulea var. caerulea</i>		P13		11		x		
	<i>Dianella caerulea var. cinerascens</i>		P13		5		x		
	<i>Dianella longifolia</i>		U						x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Dianella revoluta var. revoluta</i>	A Blue Flax Lily	U		20	x			x
	<i>Dianella spp.</i>		U		6	x		x	
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush	U		63	x	x	x	x
	<i>Phyllanthus hirtellus</i>	Thyme Spurge	U		32	x			
	<i>Phyllanthus virgatus</i>		U						x
	<i>Phyllanthus spp.*</i>		U		4			x	
	<i>Poranthera microphylla</i>	Small Poranthera	U						x
Phytolaccaceae	<i>Phytolacca octandra*</i>	Inkweed	U		2			x	
Pittosporaceae	<i>Bursaria spinosa subsp. spinosa</i>	Native Blackthorn	U		21	x	x	x	
Plantaginaceae	<i>Plantago ?debilis</i>		U		26	x			
	<i>Plantago debilis</i>		U		26		x	x	x
	<i>Plantago lanceolata*</i>	Lamb's Tongues	U		39	x	x	x	x
	<i>Plantago myosuroides subsp. myosuroides*</i>		U		7			x	
Poaceae	<i>Agrostis capillaris*</i>	Browntop Bent	U				x		
	<i>Agrostis spp.</i>							x	
	<i>Ancistrachne maidenii</i>		V				x		
	<i>Andropogon virginicus*</i>	Whisky Grass	U		2	x			
	<i>Aristida calycina</i>		U		2			x	
	<i>Aristida jerichoensis var.</i>	Jericho Wiregrass	U			x			x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>subspinulifera</i>								
	<i>Aristida ramosa</i>	Purple Wiregrass	U		38		x		x
	<i>Aristida ramosa var. ramosa</i>		U		3	x	x		
	<i>Aristida spp.</i>	A Wiregrass	U		30	x		x	
	<i>Aristida vagans</i>	Threeawn Speargrass	U		58	x	x		x
	<i>Aristida warburgii</i>		U		2	x	x		
	<i>Austrodanthonia bipartita</i>	Wallaby Grass	U		11	x	x		
	<i>Austrodanthonia fulva</i>	Wallaby Grass	U		12			x	
	<i>Austrodanthonia monticola</i>	Wallaby Grass	U					x	
	<i>Austrodanthonia racemosa</i>		U						x
	<i>Austrodanthonia racemosa var. racemosa</i>	A Wallaby Grass	U		1		x		
	<i>Austrodanthonia spp.</i>	A Wallaby Grass							x
	<i>Austrostipa ?scabra subsp. scabra</i>	Rough Speargrass	U		2	x			
	<i>Austrostipa scabra</i>	Speargrass	U		10			x	x
	<i>Austrostipa verticillata</i>	Slender Bamboo Grass	U		27	x			x
	<i>Axonopus fissifolius*</i>	Narrow-leafed Carpet Grass	U		16	x			x
	<i>Bothriochloa biloba</i>		U		3				x
	<i>Bothriochloa decipiens</i>	Red-leg Grass	U					x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Bothriochloa decipiens</i> var. <i>decipiens</i>		U		26	x			x
	<i>Bothriochloa macra</i>	Red Grass	U		14				x
	<i>Briza minor</i> *	Shivery Grass	U		10			x	
	<i>Cheilanthes austrotenuifolia</i>	Rock Fern	U		10	x			
	<i>Cheilanthes sieberi</i>	Rock Fern	U		30	x			
	<i>Chloris gayana</i> *	Rhodes Grass	U		20		x		
	<i>Chloris truncata</i>	Windmill Grass	U		19	x	x	x	x
	<i>Chloris ventricosa</i>	Tall Chloris	U		20	x			x
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	U		89	x	x		x
	<i>Cynodon dactylon</i>	Common Couch	U		70	x	x		x
	<i>Dichanthium sericeum</i>	Queensland Bluegrass	U		8				x
	<i>Dichelachne micrantha</i>	Shorthair Plumegrass	U		37	x			
	<i>Dichelanche</i> spp.								x
	<i>Digitaria diffusa</i>	A Finger Grass	U		2	x			
	<i>Digitaria longiflora</i>		U			x			
	<i>Digitaria</i> spp.	A Finger Grass	U		4	x		x	x
	<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>	Tufted Hedgehog Grass	U		19	x			x
	<i>Ehrharta erecta</i> *	Panic Veldtgrass	U						x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Enteropogon acicularis</i>	Curly Windmill Grass	U		11	x		x	
	? <i>Enteropogon sp.</i>							x	
	<i>Entolasia marginata</i>	Bordered Panic	U		41		x		x
	<i>Entolasia stricta</i>	Wiry Panic	U		43	x	x		x
	<i>Eragrostis brownii</i>	Brown's Lovegrass	U		49	x	x		x
	<i>Eragrostis curvula*</i>	African Lovergrass	U						x
	<i>Eragrostis elongata</i>	Clustered Lovegrass	U		5	x			
	<i>Eragrostis leptostachya</i>	Paddock Lovegrass	U		23	x			x
	<i>Eragrostis parviflora</i>	Weeping Lovegrass	U		1	x		x	
	<i>Eragrostis sororia</i>		U			x			
	<i>Eragrostis spp.</i>	A Lovegrass	U		9			x	
	<i>Eulalia aurea</i>	Silky Browntop	U						x
	<i>Imperata cylindrica var. major</i>	Blady Grass	U		38	x	x		x
	<i>Melinis repens*</i>	Red Natal Grass	U		20	x	x		x
	<i>Microlaena stipoides</i>	Weeping Grass	U			x		x	x
	<i>Microlaena stipoides var. stipoides</i>	Weeping Grass	U		34		x		
	<i>Panicum effusum</i>	Poison or Hairy Panic	U		25	x			x
	<i>Panicum simile</i>	Two-colour Panic	U		20	x			
	<i>Paspalidium distans</i>		U						x
	<i>Paspalum dilatatum*</i>	Paspalum	U						x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Pennisetum clandestinum</i> *	Kikuyu Grass	U		16		x		
	<i>Phragmites australis</i>	Common Reed	U		9	x			
	<i>Poa labillardierei</i>		U				x		
	<i>Setaria gracilis</i> *	Slender Pigeon Grass	U		12	x			x
	<i>Setaria pumila</i> *	Pale Pigeon Grass	U		8	x			
	<i>Sporobolus creber</i>	Slender Rat's Tail Grass	U		41	x			x
	<i>Sporobolus elongatus</i>	Slender Rat's Tail Grass	U		6	x			
	<i>Themeda australis</i>	Kangaroo Grass	U		55	x		x	x
	<i>Themeda triandra</i>		U				x		
	<i>Poaceae Sp1</i>	Unknown Grass 1							x
	<i>Poaceae Sp2</i>	Unknown Grass 2							x
Polygonaceae	<i>Acetosella vulgaris</i> *	Sorrel, Sheep Sorrel	U		3		x	x	
Portulacaceae	<i>Calandrinia eremaea</i>	Small Purslane	U					x	
	<i>Calandrinia spp.</i>							x	
	<i>Portulaca oleracea</i>	Pigweed	U		6		x		
	<i>Portulaca spp.</i>								x
Proteaceae	<i>Banksia integrifolia</i>	Coast Banksia	U		10	x		x	x
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	U		7		x		
	<i>Conospermum taxifolium</i>		U		5			x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Grevillea montana</i>		U		79	x	x	x	
	<i>Grevillea robusta</i>	Silky Oak	U		2			x	
	<i>Hakea laevipes</i>		U					x	
	<i>Hakea sp.</i>								x
	<i>Persoonia levis</i>	Broad-leaved Geebung	P13		8	x	x		
	<i>Persoonia linearis</i>	Narrow-leaved Geebung	P13		100	x	x	x	x
Ranunculaceae	<i>Clematis aristata</i>	Old Man's Beard	U		14	x	x		x
	<i>Clematis glycinoides</i>	Headache Vine	U		17		x	x	
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash	U		11			x	
	<i>Cryptandra amara</i>	Bitter cryptandra	U		3	x			
Rosaceae	<i>Cydonia oblonga*</i>	Quince	U					x	
Rubiaceae	<i>Asperula conferta</i>	Common Woodruff	U		12	x		x	x
	<i>Canthium spp.</i>							x	
	<i>Opercularia spp.</i>					x			
	<i>Opercularia varia</i>	Variable Stinkweed	U						x
	<i>Pomax umbellata</i>	Pomax	U		66	x	x	x	x
	<i>Psydrax odorata</i>		U		5			x	
	<i>Richardia ?humistrata*</i>		U		2			x	
	<i>Richardia humistrata*</i>		U		2	x			
	<i>Richardia stellaris*</i>		U		14	x			x

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Rutaceae	<i>Geijera salicifolia</i>	Brush Wilga	U		7			x	
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry/Cherry Ballart	U		32	x	x	x	x
	<i>Exocarpos strictus</i>	Dwarf Cherry	U		35		x	x	
Sapindaceae	<i>Dodonaea viscosa subsp. cuneata</i>	Broad-leaf Hopbush	U		11	x		x	
Scrophulariaceae	<i>Linaria pelisseriana*</i>	Pelisser's Toadflax	U		2			x	
	<i>Verbascum thapsus subsp. thapsus*</i>	Blanket Weed	U		1			x	
	<i>Verbascum virgatum*</i>	Twiggy Mullein, Green Mullein	U		2	x		x	
	<i>Veronica plebeia</i>	Trailing Speedwell	U		39	x	x	x	x
Solanaceae	<i>Cestrum parqui*</i>	Green Cestrum	U		7		x	x	
	<i>Lycium ferocissimum*</i>	African Boxthorn	U		22		x	x	
	<i>Nicotiana forsteri</i>		U					x	
	<i>Solanum cinereum</i>	Narrawa Burr	U						x
	<i>Solanum nigrum*</i>	Black-berry Nightshade	U						x
	<i>Solanum prinophyllum</i>	Forest Nightshade	U		37	x	x		x
	<i>Solanum pungetium</i>	Eastern Nightshade	U		2		x	x	
	<i>Solanum spp.</i>		U		5			x	x
	<i>Withania somnifera*</i>	Winter Cherry	U		2			x	

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
Stackhousiaceae	<i>Stackhousia ?monogyna</i>	Creamy Candles	U		2			x	
	<i>Stackhousia muricata</i>		U		2	x			
	<i>Stackhousia viminea</i>	Slender Stackhousia	U		32	x			x
Sterculiaceae	<i>Brachychiton populneus</i>	Kurrajong	U		14	x		x	x
Stylidiaceae	<i>Stylidium eglandulosum</i>	Woolly-stemmed Triggerplant	U		1	x		x	
	<i>Stylidium graminifolium</i>	Grass Triggerplant	U		8			x	
	<i>Stylidium laricifolium</i>	Tree Triggerplant	U		2	x			
Thymelaeaceae	<i>Pimelea linifolia</i>	Slender Rice Flower	U		11		x	x	x
	<i>Pimelea linifolia subsp. linifolia</i>		U		10	x	x		
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi	U		12	x			
Urticaceae	<i>Pipturus argenteus</i>	White Nettle	U					x	
Verbenaceae	<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum	U					x	
	<i>Lantana camara*</i>	Lantana	U		25		x	x	x
	<i>Verbena rigida*</i>	Veined Verbena	U		14		x	x	
	<i>Verbena bonariensis*</i>	Purpletop	U		32				x
	<i>Verbena hispida*</i>	Rough Verbena	U		5		x		
	<i>Verbena spp.*</i>								
Violaceae	<i>Viola sieberiana</i>		U				x		
Vitaceae	<i>Cayratia clematidea</i>	Slender Grape	U		17	x			

**Table B.1 Flora Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	LGA Count	ERM (2002)	Andrews.Neil (2006)	UNE (2007)	CE (2009)
	<i>Macrozamia pauli-guilielmi</i>		P13					x	
	<i>Parthenocissus quinquefolia</i> *	Virginia Creeper	U					x	
Xanthorrhoeaceae	<i>Xanthorrhoea</i> spp.								x

\* denotes exotic species









Table B.2 Flora Quadrat Data (2009)

Family	* Scientific Name	Common Name	MTW1	MTW2	MTW3	MTW4	MTW5	MTW6	MTW7	MTW8	MTW9	MTW10	MTW11	MTW12	MTW13	MTW14	MTW15	MTW16	MTW17	MTW18	MTW19	MTW20	MTW21	MTW22	MTW23	MTW24	MTW25	MTW26	MTW27	MTW28	MTW29	MTW30	MTW31	MTW32	MTW33	MTW34	MTW35	A	B	C	D	E	F	G	H					
Poaceae	Panicum effusum	Poison or Hairy Panic			X	X	X	X	X	X			X		X	X			X				X	X	X	X	X	X	X			X	X							X	X	X	X							
Poaceae	Paspalidium distans		X	X	X	X		X	X					X	X	X						X	X								X	X											X	X						
Poaceae	* Paspalum dilatatum	Paspalum																																										X						
Poaceae	* Setaria gracilis	Slender Pigeon Grass																										X			X								X	X										
Poaceae	Sporobolus creber	Slender Rat's Tail Grass	X														X	X				X																						X						
Poaceae	Themeda australis	Kangaroo Grass										X												X																										
<b>Herbs - Monocots (Other)</b>																																																		
Anthericaceae	Arthropodium sp.										X					X						X	X					X																						
Anthericaceae	Laxmannia gracilis	Slender Wire Lily			X	X		X	X	X											X			X																			X	X		X				
Cyperaceae	Cyperus gracilis	Slender Flat-sedge											X			X	X							X	X						X	X																		
Cyperaceae	Cyperus sp.																											X	X															X	X	X	X			
Cyperaceae	Eleocharis sp.																X	X	X												X																			
Cyperaceae	Eleocharis sphacelata	Tall Spike Rush																										X																						
Cyperaceae	Fimbristylis dichotoma	Common Fringe-sedge	X	X	X	X	X	X	X	X					X	X						X		X	X	X			X	X														X	X					
Elaeocarpaceae	Elaeocarpus sp.																																																	
Juncaceae	Juncus usitatus																										X	X																				X		
Juncaginaceae	Triglochin procerum	Water Ribbons																	X											X																				
Lomandraceae	Lomandra filiformis	Wattle Matt-rush		X	X	X	X	X	X	X	X	X	X		X							X	X	X	X	X		X	X	X																		X		
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush		X	X					X		X					X																															X		
Lomandraceae	Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush		X	X	X	X	X	X	X			X	X							X	X		X	X	X	X		X	X	X																	X		
Lomandraceae	Lomandra sp.													X																																				
Phormiaceae	Dianella longifolia	A Blue Flax-Lily	X	X		X		X					X	X	X	X	X	X	X	X	X	X	X			X	X																					X		
Phormiaceae	Dianella revoluta	Blueberry Lily, Blue Flax-Lily																					X	X	X							X																		
<b>Herbs - Ferns</b>																																																		
Adiantaceae	Cheilanthes distans	Bristly Cloak Fern																																																
Adiantaceae	Cheilanthes sieberi	Rock Fern	X	X	X	X	X	X	X	X				X	X	X																																		
Dennstaedtiaceae	Pteridium esculentum	Bracken										X	X		X																																			
<b>Climbers/Vines</b>																																																		
Commelinaceae	Commelina cyanea	Native Wandering Jew				X						X																																						
Fabaceae (Faboideae)	Glycine clandestina	Twining glycine		X	X	X		X	X									X	X			X	X	X					X	X																				
Fabaceae (Faboideae)	Glycine microphylla	Small-leaf Glycine	X					X					X	X								X					X	X																						
Fabaceae (Faboideae)	Glycine tabacina	Variable Glycine	X	X	X		X		X	X		X		X			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X												
Fabaceae (Faboideae)	Hardenbergia violacea	False Sarsaparilla						X															X																											
Nyctaginaceae	Boerhavia dominii	Tarvine	X																																															
Ranunculaceae	Clematis aristata	Old Man's Beard												X																																				

\* denotes exotic species

Table B.3 Flora Quadrat Data (2013)

Family	Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23		
<b>Trees</b>																											
Casuarinaceae	* Allocasuarina leuhmannii	Buloak					5				4		3												2		
Casuarinaceae	Casuarina cunninghamiana	River Oak						6																			
Casuarinaceae	Casuarina glauca	Swamp Oak								6													6	5	6		
Myrtaceae	Angophora floribunda	Rough-barked Apple								5																	
Myrtaceae	Eucalyptus crebra	Narrow-leaved Ironbark	6	3	5	X	2			X			5	3													
Myrtaceae	Eucalyptus moluccana	Grey Box			5																						
Myrtaceae	Eucalyptus tereticornis	Forest Red Gum																					2	3			
<b>Small Trees</b>																											
Anacardiaceae	* Schinus terebinthifolius	Brazilian Pepper Tree								2														1			
Casuarinaceae	Allocasuarina leuhmannii	Buloak		4		X	2				5		3	2													
Casuarinaceae	Casuarina cunninghamiana	River Oak							4																		
Casuarinaceae	Casuarina glauca	Swamp Oak								5													4	6	6		
Cupressaceae	Callitris ?endlicheri	Black Cypress Pine		5									X														
Fabaceae - Mimosoideae	Acacia mearnsii	Blach Wattle							5		6																
Fabaceae - Mimosoideae	Acacia parramattensis	Parramatta Wattle							6																		
Meliaceae	Melia azedarach	White Cedar								3																	
Myrtaceae	Angophora floribunda	Rough-barked Apple																X					3	X			
Myrtaceae	Eucalyptus crebra	Narrow-leaved Ironbark	4	6	3	5								6													
Myrtaceae	Eucalyptus moluccana	Grey Box			3								1														
Myrtaceae	Eucalyptus tereticornis	Forest Red Gum											3														
Myrtaceae	Melaleuca thymifolia	Thyme Honey-myrtle											5														
<b>Shrubs</b>																											
Amygdalaceae	* Prunus sp.							2																			
Araliaceae	Polyscias elegans	Celery Wood			X																						
Asclepidaceae	* Gomphocarpus fruticosus	Narrow-leaved Cotton Bush			2																						
Asteraceae	Cassinia arcuata	Sifton Bush				1																					
Asteraceae	Olearia elliptica	Sticky Daisy-bush			2																						
Casuarinaceae	Allocasuarina leuhmannii	Buloak	3	2	1	1	3				2			4				1									
Casuarinaceae	Casuarina glauca	Swamp Oak																					4	4			
Chenopodiaceae	Enchylaena tomentosa	Ruby Saltbush																				X		X	2		
Chenopodiaceae	Maireana ?microphylla	Small-leaf Bluebush, Bluebush					1																				
Chenopodiaceae	Maireana microphylla	Small-leaf Bluebush, Bluebush			X										1	2	1				X	1					
Cupressaceae	Callitris ?endlicheri	Black Cypress Pine		2																							
Ericaceae - Styphelioideae	Brachyloma daphnoides	Daphne Heath									5																
Fabaceae - Faboideae	Indigofera australis	Australian Indigo																							1		
Fabaceae - Mimosoideae	Acacia ?elongata	Swamp Wattle																			1						
Fabaceae - Mimosoideae	Acacia ?gunnii	Ploughshare Wattle		X	2																						
Fabaceae - Mimosoideae	Acacia decora	Western Golden Wattle			3																						
Fabaceae - Mimosoideae	Acacia falcata		1										1							X							
Fabaceae - Mimosoideae	Acacia implexa	Hickory Wattle	3																								
Fabaceae - Mimosoideae	Acacia mearnsii	Black Wattle							5		3	1															
Fabaceae - Mimosoideae	Acacia parramattensis	Parramatta Wattle						2																			
Goodeniaceae	Goodenia ovata	Hop Goodenia																								3	
Meliaceae	* Melia azedarach	White Cedar						1																			

Table B.3 Flora Quadrat Data (2013)

Family	Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23		
Myrtaceae	Angophora floribunda	Rough-barked Apple	2																					2			
Myrtaceae	Eucalyptus crebra	Narrow-leaved Ironbark	3	3	2	5							2	3		4											
Myrtaceae	Eucalyptus moluccana	Grey Box			2																						
Myrtaceae	Eucalyptus tereticornis	Forest Red Gum											2														
Myrtaceae	Leptospermum polygalifolium subsp. polygalifolium	Tantoon						X	1																		
Myrtaceae	Melaleuca thymifolia	Thyme Honey-myrtle	1																								
Oleaceae	Notolaea												1														
Oleaceae	Notolaea microcarpa	Native Olive																							1		
Pittosporaceae	Bursaria spinosa	Blackthorn												1										2			
Santalaceae	Exocarpos cupressiformis	Cherry Ballart											X														
Sapindaceae	Dodonaea viscosa		1			1																					
Scrophulariaceae	Myoporum montanum	Western Boobialla			3																						
Solanaceae	* Cestrum parqui	Green Cestrum						3		1													5				
Solanaceae	* Lycium ferocissimum	African Boxthorn			1																						
Solanaceae	* Lycium ferocissimum	African Boxthorn					1			3																	
Solanaceae	Solanum ?brownii	Violet Nightshade																						X			
Thymelaceae	Pimelea linifolia	Slender Rice Flower									3																
Thymelaceae	Pimelea linifolia subsp. linifolia											X															
Verbenaceae	* Lantana camara	Lantana				2	1			4													3	5			
<b>Herbs - Dicots</b>																											
Acanthaceae	Brunoniella australis	Blue Trumpet	1		2	X				2			2	3											2		
Aizoaceae	* Galenia pubescens	Galenia					1	4		3						2	2	1		3	2	3	3	2	5		
Aizoaceae	Tetragonia tetragonioides	New Zealand Spinach						2																			
Apiaceae	* Centella asiatica	Indian Pennywort							X						X												
Apiaceae	* Cyclospermum leptophyllum	Slender Celery							2				1			2	1	1	2	1		1	1				
Apiaceae	Daucus glochidiatus	Native Carrot																		1							
Apocynaceae	* Gomphocarpus fruticosus	Narrow-leaved Cotton Bush					2									1				1							
Asteraceae	* Aster subulatus	Wild Aster							1																		
Asteraceae	* Bidens pilosa	Farmers Friend					1	1		1			2											1			
Asteraceae	Calotis ?cuneifolia	Purple Burr-daisy														1											
Asteraceae	Calotis cuneifolia	Purple Burr-daisy	2	2													X							2			
Asteraceae	Calotis lappulacea	Yellow Burr-daisy			2	2	2						1				X										
Asteraceae	* Carthamus lanatus	Saffron Thistle															3										
Asteraceae	Cassinia quinquefaria	Cough bush			1																						
Asteraceae	Chrysocephalum apiculatum	Common Everlasting	1		1	X	1					2	5		1		2	2	4	2		2	4				
Asteraceae	* Cirsium vulgare	Spear Thistle						2	2	1													2	2			
Asteraceae	* Conyza bonariensis	Flaxleaf Fleabane						3	4											1				1			
Asteraceae	* Conyza sp.																							1			
Asteraceae	* Conyza sumatrensis	Tall Fleabane						3	1																		
Asteraceae	Euchiton sphaericus									X			2	1													
Asteraceae	* Gamochaeta sp.							2	4						1		2						2				
Asteraceae	* Hypochaeris glabra	Smooth Catsear							4	1					2	2		3					1				
Asteraceae	* Hypochaeris microcephala	White Flat Weed															2		1								
Asteraceae	* Hypochaeris radicata	Catsear						1	2	1	3	4	1		3			2				2	2				
Asteraceae	* Lactuca serriola	Prickly Lettuce						1																			

Table B.3 Flora Quadrat Data (2013)

Family	* Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23
Asteraceae	Lagenophora stipitata	Blue Bottle-daisy											1												
Asteraceae	Senecio ?quadridentatus	Cotton Fireweed																	X		1				
Asteraceae	* Senecio madagascariensis	Fireweed	1	2	2	2	1	1	3	1		2	1	2	2	3	2	3	2	3		3	3	1	
Asteraceae	Senecio quadridentatus	Cotton Fireweed							1									1							
Asteraceae	Sigesbeckia orientalis								X																
Asteraceae	* Sonchus oleraceus	Common Sowthistle						2															2		
Asteraceae	* Sonchus sp.							3	2	1							1								
Asteraceae	* Tagetes minuta	Stinking Roger						1																	
Asteraceae	Unknown sp.											X													
Asteraceae	* Vellereophyton dealbatum	White Cudweed						2	4																
Asteraceae	Vernonia cinerea												2	1											
Asteraceae	Vittadinia cuneata	Fuzzweed																	1						
Asteraceae	Vittadinia cuneata var. cuneata				21																				
Boragaceae	* ?Heliotropium amplexicaule	Blue Heliotrope								1															
Boragaceae	* Heliotropium amplexicaule	Blue Heliotrope						3			1												1		
Cactaceae	* Opuntia aurantiaca	Tiger Pear									1			2											
Cactaceae	* Opuntia stricta	Common Prickly Pear			2							1		2		1									
Campanulaceae	Wahlenbergia communis	Tufted Bluebell									2														2
Campanulaceae	Wahlenbergia gracilis	Sprawling Bluebell			X																				
Campanulaceae	Wahlenbergia sp.																	X							
Campanulaceae	Wahlenbergia stricta	Australian Bluebell																	2						
Caryophyllaceae	* Paronychia brasiliiana	Chilean Whitlow Wort										2			3	1	3	1							
Caryophyllaceae	* Petrorhagia dubia														2		3								
Caryophyllaceae	* Petrorhagia sp.											3						1	2		2	2			
Caryophyllaceae	* Silene sp.											2					1	2							
Chenopodiaceae	Atriplex semibaccata	Creeping Saltbush			X												X								
Chenopodiaceae	Einadia nutans subsp. linifolia									X														X	
Chenopodiaceae	Einadia nutans subsp. nutans	Climbing Saltbush																		1					
Chenopodiaceae	Einadia polygonoides																	X							1
Chenopodiaceae	Einadia trigonos	Fishweed				X																	1		
Chenopodiaceae	Enchylaena tomentosa	Ruby Saltbush			2		1			1															
Chenopodiaceae	Maireana microphylla	Small-leaf Bluebush, Bluebush								2				1										2	
Clusiaceae	Hypericum gramineum	Small St. John's Wort													1										X
Clusiaceae	* Hypericum perforatum	St. John's Wort							1							2	2				6	1			
Commelinaceae	* Tradescantia fluminensis	Wandering Jew						6																	
Convolvulaceae	Dichondra repens	Kidney Weed			2	1				2			1					1					X	2	
Dilleniaceae	Hibbertia diffusa	Wedge Guinea Flower									5														
Ericaceae - Styphelioideae	Astroloma humifusum	Native Cranberry									1	X													
Ericaceae - Styphelioideae	Brachyloma daphnoides	Daphne Heath										X													
Euphorbiaceae	Chamaesyce drummondii	Caustic Weed				1				X															
Euphorbiaceae	Phyllanthus ?virgatus														1										
Euphorbiaceae	Phyllanthus virgatus																1	1					X		
Fabaceae - Faboideae	Daviesia ulicifolia	Gorse Bitter Pea		1																					
Fabaceae - Faboideae	Desmodium brachypodum	Large Tick-trefoil				2																			
Fabaceae - Faboideae	Desmodium varians	Slender Tick-trefoil				1	2			1								X						2	
Fabaceae - Faboideae	Indigofera australis	Australian Indigo			1																				
Fabaceae - Faboideae	Templetonia stenophylla	Leafy Templetonia												X											

Table B.3 Flora Quadrat Data (2013)

Family	Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23
Fabaceae - Faboideae	* Trifolium arvense	Haresfoot Clover										1													
Fabaceae - Faboideae	* Trifolium sp.																2								
Fabaceae - Faboideae	* Trifolium sp.											2			1	1	3		1		1				
Gentianaceae	* Centaurium erythraea	Common Centaury													1		1								
Gentianaceae	* Centaurium sp.																	1				2			
Geraniaceae	Erodium crinitum	Blue Storksbill					1																		
Geraniaceae	Geranium solanderi	Native Geranium																				X			
Geraniaceae	Goodenia hederacea subsp. hederacea	Ivy Goodenia		1																					
Lamiaceae	Mentha satureioides	Creeping Mint												1				X	3			2			
Linaceae	Linum marginale	Native Flax																	2						
Linaceae	* Linum trigynum	French Flax																	1			1			
Lobeliaceae	Pratia purpurascens	Whiteroot									2		1												
Loranthaceae	Amyema											3													
Malvaceae	* Malvastrum americanum	Spiked Malvastrum					2														4				
Malvaceae	* Modiola caroliniana	Red-flowered Mallow															1								
Malvaceae	* Pavonia hastata				1																			2	
Malvaceae	Sida corrugata													1								X	1		
Malvaceae	* Sida rhombifolia	Paddy's Lucerne				1	1	2		1		1				1			2				4		
Myoporaceae	Eremophila debilis	Winter Apple			2	X	2			2				2						2		2	2	2	
Myrsinaceae	* Anagallis arvensis	Scarlet Pimpernel			2		1	2	2				2		3	3		3	3	5	3	4	2		
Oleaceae	* Olea europea ssp cuspidata	African Olive			1					1															
Oxalidaceae	Oxalis perennans						X				2	1						1				X		1	
Oxalidaceae	Oxalis sp.																								1
Plantaginaceae	Plantago debilis												2		1										
Plantaginaceae	* Plantago lanceolata	Lamb's Tongues	1			2				1						3	2	2	3		3	3		1	
Plantaginaceae	* Plantago myosuroides								2																
Plantaginaceae	* Plantago myosuroides subsp. myosuroides																					1			
Plantaginaceae	Plantago sp.														1	1			X						
Plantaginaceae	Veronica plebeia	Trailing Speedwell					2	1																1	
Polygonaceae	* Acetosella vulgaris	Sorrel										2													
Polygonaceae	Rumex brownii	Swamp Dock										1							X	1	1	1			
Rubiaceae	Asperula conferta	Common Woodruff											1	2				X	2			2			
Rubiaceae	Opercularia diphylla		1																						
Rubiaceae	* Richardia humistrata										4														
Rubiaceae	* Richardia stellaris		1			1							1		3		1								
Scrophulariaceae	* Verbascum sp.																				1				
Solanaceae	* Cestrum parqui	Green Cestrum						2																	
Solanaceae	Solanum brownii	Violet Nightshade			X																				
Solanaceae	* Solanum chenopodioides	Whitewort Nightshade						2																	
Solanaceae	* Solanum nigrum	Black-berry Nightshade						1																	
Solanaceae	Solanum prinophyllum	Forest Nightshade										1											X		
Solanaceae	Solanum sp.																							1	
Stackhousiaceae	Stackhousia viminea	Slender Stackhousia																						1	
Unknown	?Minusia sp.																1								
Unknown	* Aster sp.														1										
Unknown	Unknown sp.													2											
Verbenaceae	* Verbena bonariensis	Purpletop							2							1	1	1		2	2	2	2		

Table B.3 Flora Quadrat Data (2013)

Family	Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23		
Verbenaceae	* <i>Verbena rigida</i>	Veined Verbena			2	3	3								1	2	3	2		5	5	3		1			
<b>Herbs - Monocots (Grasses)</b>																											
Poaceae	<i>Aristida ramosa</i>	Purple Wiregrass	5	3	5	5	3			2	2		4	4	5	5	2	3	3	5	3	3	X	2			
Poaceae	<i>Aristida vagans</i>	Threeawn Speargrass	4	3	3	2	X				4		3	4				3					X	1			
Poaceae	<i>Austrodanthonia setacea</i>	Smallflower Wallaby Grass		1						X																	
Poaceae	<i>Austrodanthonia</i> sp.			1																							
Poaceae	<i>Austrostipa ramosissima</i>	Stout Bamboo Grass					3																				
Poaceae	<i>Austrostipa scabra</i>	Speargrass			3		3						3			3				4					3		
Poaceae	<i>Austrostipa verticillata</i>	Slender Bamboo Grass				X	4	1		4										2			4	6			
Poaceae	* <i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass													5												
Poaceae	<i>Bothriochloa decipiens</i>	Redleg Grass		X	4		3				2	X	2		5	5	5	4	5	2	3	6	X				
Poaceae	<i>Bothriochloa macra</i>	Red-leg Grass			5												3				3			X			
Poaceae	* <i>Briza minor</i>	Shivery Grass											2			2	2	1	1		1	2	2				
Poaceae	* <i>Bromus catharticus</i>	Prairie Grass						4																			
Poaceae	* <i>Chloris gayana</i>	Rhodes Grass			2					2										4			4	2			
Poaceae	<i>Chloris truncata</i>	Windmill Grass																		2							
Poaceae	<i>Chloris ventricosa</i>	Plump Windmill Grass			2					X			1	3											2		
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass	5	X	4	4	2			1	2	3	2	5	3	3		3	4		3		X	1			
Poaceae	<i>Cynodon dactylon</i>	Couch	4			2	3	2	6	2		6	2		5	4	5	7	5	3	4		5				
Poaceae	<i>Dichanthium sericeum</i>	Queensland Bluegrass								2										3							
Poaceae	<i>Dichelachne crinita</i>	Longhair Plumegrass																								3	
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass									1						1					1					
Poaceae	<i>Digitaria brownii</i>	Cotton Panic Grass																								1	
Poaceae	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass											1														
Poaceae	* <i>Ehrharta erecta</i>	Panic Veldtgrass						4																3	3		
Poaceae	<i>Enteropogon acicularis</i>			2	1											4											
Poaceae	<i>Eragrostis brownii</i>	Brown's Lovegrass	4	4		3	3				4	2	1					X		2		1		3			
Poaceae	* <i>Eragrostis curvula</i>	African Lovegrass									1	5	1	3			4										
Poaceae	<i>Eragrostis leptostachya</i>	Paddock Lovegrass	2	X	2	2	4						X									3	X	4			
Poaceae	<i>Eragrostis</i> sp.										3																
Poaceae	* <i>Hordeum</i> sp.															2	2										
Poaceae	* <i>Hordeum</i> sp. 2																				2						
Poaceae	<i>Imperata cylindrica</i>	Blady Grass																						3			
Poaceae	<i>Lachnagrostis filiformis</i>								5													1					
Poaceae	* <i>Lolium perenne</i>	Perennial Ryegrass						2	1							2											
Poaceae	* <i>Lolium</i> sp.																							2			
Poaceae	<i>Microlaena stipoides</i>	Weeping Meadow Grass	3			3		3		3	5	3										1	5				
Poaceae	<i>Oplismenus aemulus</i>	Australian Basket Grass						2					3														
Poaceae	<i>Panicum effusum</i>	Hairy Panic	2	2	2	1	2							2	4	2	4			2	3	2	2	1			
Poaceae	<i>Panicum</i> sp.												X														
Poaceae	<i>Paspalidium distans</i>		3		2	2					2			4			2					2		2			
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum									1																
Poaceae	* <i>Paspalum</i> sp.																	1	2		2	1					
Poaceae	<i>Phragmites australis</i>	Common Reed						4	3	2														2			
Poaceae	* <i>Setaria</i> sp.									3														2			
Poaceae	* <i>Setaria parviflora</i>					1						1	1							1			1	3	1		

Table B.3 Flora Quadrat Data (2013)

Family	Scientific Name	Common Name	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23
Poaceae	Sporobolus creber	Slender Rat's Tail Grass										3				1									
Poaceae	Sporobolus elongata	Slender Rat's Tail Grass																2							
Poaceae	Themeda australis	Kangaroo Grass			2																				
Poaceae	* Unknown				2															3					
<b>Herbs - Monocots (Other)</b>																									
Anthericaceae	?Tricoryne elatior	Yellow Autumn-lily				1																			
Anthericaceae	Arthropodium sp.				X					1															
Anthericaceae	Laxmannia gracilis	Slender Wire Lily	1	3		3																		2	
Commelinaceae	Commelina cyanea	Native Wandering Jew																		2					
Cyperaceae	Carex inversa												2												
Cyperaceae	Cyperus gracilis	Slender Flat-sedge			1											1					X				
Cyperaceae	Cyperus sp.																			1					
Cyperaceae	Fimbristylis dichotoma	Common Fringe-sedge												X								1			
Cyperaceae	Scleria mackaviensis				2																				
Hypoxidaceae	Hypoxis hygrometrica	Golden Weather-grass									1														
Iridaceae	* Romulea rosea	Onion Grass										2			1				1		2				
Juncaceae	Juncus ?subsecundus													1	1						1				
Juncaceae	* Juncus acutus	Sharp Rush								3													3		
Juncaceae	Juncus sp.										1														
Juncaceae	Juncus subsecundus																	1				2			
Lomandraceae	Lomandra filiformis subsp. coriacea										X														
Lomandraceae	Lomandra filiformis subsp. filiformis	Wattle Mat-rush	1	3	2	3	3			2				2							2			1	
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush								X			2												
Lomandraceae	Lomandra multiflora	Many-flowered Mat-rush	1		3		2		3	2			2	3									2	2	
Phormiaceae	Dianella longifolia	Blue Flax-Lily	1			2	X			1	X			X					X				X	1	
Phormiaceae	Dianella revoluta	Blueberry Lily	1	2	3								2	2					1						
<b>Herbs - Ferns and Allies</b>																									
Adiantaceae	Cheilanthes sieberi	Poison Rock Fern	2	2	2	2	4				3	X	2		X		2	2		4	1	2	2	2	
Dennstaedtiaceae	Pteridium esculentum	Common Bracken									6														
<b>Climbers/Vines</b>																									
Apocynaceae	* Araujia sericifera	Moth Vine						3																	
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine																							X
Convolvulaceae	Convolvulus erubescens	Blushing Bindweed								X							1						X		
Fabaceae - Faboideae	Glycine clandestina						1			1						1							X		
Fabaceae - Faboideae	Glycine microphylla	Small-leaf glycine	X		1	1	1				1									X					
Fabaceae - Faboideae	Glycine sp.																				1				
Fabaceae - Faboideae	Glycine tabacina						1			2			2	X		1	1	1	2			X	1	1	
Polygonaceae	* Acetosa sagittata	Rambling Dock						4																	
Ranunculaceae	Clematis glycinoides	Headache Vine								3														3	
Rosaceae	Rubus parvifolius	Native Raspberry						X																	
Sapindaceae	* Cardiospermum grandiflorum	Balloon Vine						2																	
Unknown	sp.																						1		
Vitaceae	Cayratia clematidea	Native Grape																							1

\* denotes exotic species

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*Appendix C*

# Fauna Species List

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**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
<b>Amphibians</b>					26							
Hylidae	<i>Litoria caerulea</i>	Green Tree Frog	P		74	x						
		Eastern Dwarf Tree Frog										
	<i>Litoria fallax</i>	Frog	P			x			x			
	<i>Litoria freycineti</i>	Freycinet's Frog	P		71	x						
	<i>Litoria latopalmata</i>	Broad-palmed Frog	P		82				x			
	<i>Litoria peronii</i>	Peron's Tree Frog	P		22				x			
	<i>Litoria verreauxi</i>	Whistling Tree Frog	P		232	x						x
Myobatrachidae	<i>Crinia signifera</i>	Common Eastern Froglet										
		Froglet	P		58				x			x
	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	P		19				x	x		x
	<i>Limnodynastes peronii</i>	Brown-striped Frog	P		268				x			
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	P		16	x			x			x
	<i>Pseudophryne bibronii</i>	Bibron's Toadlet	P		1					x		x
	<i>Uperoleia rugosa</i>	Wrinkled Toadlet	P		74							x
	<i>Uperoleia laevigata</i>	Smooth Toadlet	P						x	x		
<b>Birds</b>					91							

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	P		174		x	x	x	x	x	x
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill	P		91	x				x		
	<i>Acanthiza nana</i>	Yellow Thornbill	P		248		x	x	x	x	x	x
	<i>Acanthiza pusilla</i>	Brown Thornbill	P		79		x	x	x	x		
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	P		10		x	x	x	x	x	x
	<i>Gerygone fusca</i>	Western Gerygone	P		50		x	x	x			
		White-throated										
	<i>Gerygone olivacea</i>	Gerygone	P		106		x	x		x		
	<i>Pyrholaemus saggitatus</i>	Speckled Warbler	V		203		x	x	x	x	x	x
		White-browed										
	<i>Sericornis frontalis</i>	Scrubwren	P		84		x	x		x		
	<i>Smicromnis brevirostris</i>	Weebill	P		29	x	x	x	x	x	x	x
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk	P		104			x		x		x
	<i>Aquila audax</i>	Wedge-tailed Eagle	P		6		x	x	x	x	x	x
	<i>Aviceda subcristata</i>	Pacific Baza	P		5		x					
	<i>Circus assimilis</i>	Spotted Harrier	P (V)		36				x		x	
	<i>Elanus axillaris</i>	Black-shouldered Kite	P		11	x						
		White-bellied Sea-										
	<i>Haliaeetus leucogaster</i>	Eagle	P	M	19					x		

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>Haliastur sphenurus</i>	Whistling Kite	P		1				x		x	
		Black-breasted										
	<i>Hamirostra melanosternon</i>	Buzzard	V		13					x		
	<i>Hieraaetus morphnoides</i>	Little Eagle	P (V)		145		x				x	
		Australian Owlet-										
Aegothelidae	<i>Aegotheles cristatus</i>	nightjar	P		211	x		x	x		x	
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	P		57		x	x	x	x	x	x
	<i>Todiramphus sanctus</i>	Sacred Kingfisher	P		46	x	x	x	x	x		
Anatidae	<i>Anas gracilis</i>	Grey Teal	P		89				x	x		
	<i>Anas superciliosa</i>	Pacific Black Duck	P		85		x	x	x	x	x	x
	<i>Chenonetta jubata</i>	Australian Wood Duck	P		25		x	x	x		x	x
		White-throated										
Apodidae	<i>Hirundapus caudacutus</i>	Needletail	P	M	8		x		x			
Ardeidae	<i>Ardea alba</i>	Great Egret	P	M	22				x			
	<i>Ardea pacifica</i>	White-necked Heron	P		61	x		x				
	<i>Egretta novaehollandiae</i>	White-faced Heron	P		4			x	x		x	x
	<i>Nycticorax caledonicus</i>	Nankeen Night Heron	P		57				x			
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow	P		126	x	x	x	x		x	x
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	P		144		x	x	x		x	x
	<i>Cracticus torquatus</i>	Grey Butcherbird	P		297		x	x	x	x	x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
	<i>Gymnorhina tibicen</i>	Australian Magpie	P		304		x	x	x	x	x	x
	<i>Strepera graculina</i>	Pied Currawong	P		138	x	x	x	x	x	x	
Cacatuidae		Sulphur-crested Cockatoo	P		72		x	x	x			x
		Yellow-tailed Black- Cockatoo	P		122					x		
		Glossy Black Cockatoo	V		113		x	x			x	x
	<i>Eolophus roseicapillus</i>	Galah	P		177		x	x	x	x	x	
Campephagidae		Black-faced Cuckoo- shrike	P		14		x	x	x	x	x	
		White-bellied Cuckoo- shrike	P		90							x
		Cicadabird	P		18			x				
Charadriidae		White-winged Triller	P		15	x		x				
		Black-fronted Dotterel	P		101	x						
		Masked Lapwing	P		5			x	x	x	x	x
	<i>Vanellus miles</i>	Masked Lapwing	P		5			x	x	x	x	x
	<i>Vanellus tricolor</i>	Banded Lapwing	P		63					x		
Climacteridae		Brown Treecreeper										
		(eastern subspecies)	V		348		x	x	x	x	x	x
	<i>Cormobates leucophaea</i>	White-throated	P		3		x	x	x	x	x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
		Treecreeper										
Columbidae	<i>Columba livia*</i>	Rock Dove	U		20	x						
	<i>Geopelia humeralis</i>	Bar-shouldered Dove	P		17			x			x	x
	<i>Geopelia placida</i>	Peaceful Dove	P		103		x	x			x	
	<i>Ocyphaps lophotes</i>	Crested Pigeon	P		65		x	x	x	x	x	
	<i>Phaps chalcoptera</i>	Common Bronzewing	P		9		x	x	x	x		x
	<i>Streptopelia chinensis*</i>	Spotted Turtle-Dove	U		46				x			
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird	P		158			x	x			
Corcoracidae	<i>Corcorax melanorhamphos</i>	White-winged Chough	P		242		x	x	x	x	x	x
Corvidae	<i>Corvus coronoides</i>	Australian Raven	P		3		x	x	x	x	x	x
	<i>Corvus mellori</i>	Little Raven	P		94				x			
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	P		25				x	x	x	x
		Horsfield's Bronze-										
	<i>Chalcites basalis</i>	Cuckoo	P		37			x	x	x		
		Shining Bronze-										
	<i>Chalcites lucidus</i>	Cuckoo	P		2			x	x			
	<i>Chalcites osculans</i>	Black-eared Cuckoo	P		19		x					
	<i>Cuculus pallidus</i>	Pallid Cuckoo	P		27			x		x		
	<i>Eudynamys orientalis</i>	Pacific Koel	P		46			x				
	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	P		155			x		x		

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status									
Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird	P					x	x	x	x	x	x
	<i>Dicrurus bracteatus</i>	Spangled Drongo	P		117					x			
	<i>Grallina cyanoleuca</i>	Magpie-lark	P		31			x	x	x	x	x	x
	<i>Myiagra inquieta</i>	Restless Flycatcher	P		79					x	x	x	x
	<i>Myiagra rubecula</i>	Leaden Flycatcher	P		306	x	x			x			
	<i>Rhipidura albiscapa</i>	Grey Fantail	P		181			x	x	x	x	x	x
	<i>Rhipidura leucophrys</i>	Willie Wagtail	P		84			x	x	x	x	x	x
	<i>Rhipidura rufifrons</i>	Rufous Fantail	P	M	1			x	x	x			
Estrildidae	<i>Neochmia modesta</i>	Plum-headed Finch	P		179								x
	<i>Neochmia temporalis</i>	Red-browed Finch	P		32					x			x
	<i>Stagonopleura guttata</i>	Diamond Firetail	V		96	x				x			x
	<i>Taeniopygia bichenovii</i>	Double-barred Finch	P		213			x	x	x	x	x	x
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	P		35						x		
Falconidae	<i>Falco berigora</i>	Brown Falcon	P		87	x	x	x	x				x
	<i>Falco cenchroides</i>	Nankeen Kestrel	P		18			x	x	x		x	x
	<i>Falco longipennis</i>	Australian Hobby	P		120	x	x				x		
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	P		20	x	x			x	x	x	x
	<i>Petrochelidon ariel</i>	Fairy Martin	P		22					x	x		
	<i>Petrochelidon nigricans</i>	Tree Martin	P		206			x	x				x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	P		96		x	x	x	x	x	x
	<i>Malurus lamberti</i>	Variigated Fairy-wren	P		417		x	x	x	x		x
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	P		60			x	x	x	x	x
	<i>Anthochaera carunculata</i>	Red Wattlebird	P		379				x	x	x	x
		Yellow-faced Honeyeater	P		16	x	x	x	x		x	x
	<i>Lichenostomus chrysops</i>	Fuscous Honeyeater	P		152							x
		White-eared Honeyeater	P		113		x	x	x		x	x
	<i>Lichenostomus leucotis</i>	Yellow-tufted Honeyeater	P		107				x			
		White-plumed Honeyeater	P		212	x	x	x	x	x	x	x
	<i>Lichenostomus penicillatus</i>	Noisy Miner	P		196		x	x	x	x	x	x
	<i>Manorina melanocephala</i>	Lewin's Honeyeater	P		36					x		
	<i>Meliphaga lewinii</i>	Brown-headed Honeyeater	P		154	x	x	x	x		x	x
	<i>Melithreptus brevirostris</i>	White-naped Honeyeater	P		90	x			x		x	x
	<i>Melithreptus lunatus</i>											

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	P		19		x	x	x			
	<i>Philemon citreogularis</i>	Little Friarbird	P		336					x		
	<i>Philemon corniculatus</i>	Noisy Friarbird	P		20	x	x	x	x	x	x	
		White-cheeked										
	<i>Phylidonyris niger</i>	Honeyeater	P		70				x			
	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	P		83	x	x	x	x			x
	<i>Anthochaera phrygia</i>	Regent Honeyeater	E1	E, M	84				x			
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	P	M	58	x	x	x	x	x		
Motacillidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit	P		57						x	x
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	P (V)		107	x	x	x	x		x	
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole	P		286		x	x	x	x		
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	P		269	x	x	x	x	x	x	x
	<i>Pachycephala pectoralis</i>	Golden Whistler	P		264		x	x	x	x	x	x
	<i>Pachycephala rufiventris</i>	Rufous Whistler	P		358	x	x	x	x			
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	P		100		x	x	x	x	x	x
	<i>Pardalotus striatus</i>	Striated Pardalote	P		26		x	x	x	x	x	x
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican	P		254				x			
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	P		21		x	x	x		x	x
	<i>Melanodryas cucullata</i>	Hooded Robin (south-	V		73				x		x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>cucullata</i>	eastern form)										
	<i>Microeca fascinans</i>	Jacky Winter	P		31		x	x	x		x	x
	<i>Petroica boodang</i>	Scarlet Robin	P (V)		21				x		x	
	<i>Petroica goodenovii</i>	Red-capped Robin	P		56		x	x	x		x	x
	<i>Petroica rosea</i>	Rose Robin	P		13				x		x	x
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant	P		26	x	x					
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	P		20	x	x				x	
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	P		8				x			
	<i>Phalacrocorax varius</i>	Pied Cormorant	P		25				x			
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail	P		141				x		x	
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth	P		9	x	x		x	x	x	
	<i>Poliiocephalus</i>											
Podicipedidae	<i>poliocephalus</i>	Hoary-headed Grebe	P		40	x						
	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	P		195				x	x	x	
	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler										
Pomatostomidae	<i>temporalis</i>	(eastern subspecies)	V		148		x	x	x	x	x	x
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot	P		8		x		x		x	x
	<i>Glossopsitta concinna</i>	Musk Lorikeet	P		74						x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
	<i>Glossopsitta pusilla</i>	Little Lorikeet	V		10		x			x	x	
	<i>Lathamus discolor</i>	Swift Parrot	E1	E	186				x			
	<i>Platycercus adscitus eximius</i>	Eastern Rosella	P		172		x	x	x	x	x	x
	<i>Platycercus elegans</i>	Crimson Rosella	P		44				x			
	<i>Psephotus haematonotus</i>	Red-rumped Parrot	P		9						x	x
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	P		104					x	x	x
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	P		22							x
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	P		200				x	x	x	x
Strigidae	<i>Ninox boobook</i>	Southern Boobook	P		7				x			
	<i>Tyto alba</i>	Barn Owl	P		14					x		
		Australian Reed-										
Sylviidae	<i>Acrocephalus australis</i>	Warbler	P		11					x		
	<i>Cincloramphus mathewsi</i>	Rufous Songlark	P		4	x				x		
Threskiornithidae	<i>Platalea regia</i>	Royal Spoonbill	P		44					x		
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	P		40					x		
Turnicidae	<i>Turnix varia</i>	Painted Button-quail	P		172	x	x	x				
Zosteropidae	<i>Zosterops lateralis</i>	Silvereye	P				x	x	x	x	x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status							(2006)	(2009)	(2009)
<b>Mammals</b>					51								
Bovidae	<i>Bos taurus*</i>	Cattle	U		12	x							
Canidae	<i>Canis lupus familiaris*</i>	Dog	U		303	x			x			x	
	<i>Vulpes vulpes*</i>	Fox	U		175	x			x	x		x	
Dasyuridae		Yellow-footed											
	<i>Antechinus flavipes</i>	Antechinus	P		112				x				
	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V		186	unconfirmed scat from 1979							
	<i>Sminthopsis murina</i>	Common Dunnart	P		12	x						x	
Equidae	<i>Equus caballus*</i>	Horse	U		26	x							
Felidae	<i>Felis catus*</i>	Cat	U		56	x			x	x		x	
Leporidae	<i>Lepus capensis*</i>	Brown Hare	U		125				x	x		x	
	<i>Oryctolagus cuniculus*</i>	Rabbit	U		219	x			x	x		x	
Macropodidae		Eastern Grey											
	<i>Macropus giganteus</i>	Kangaroo	P		181	x			x	x		x	
	<i>Macropus rufogriseus</i>	Red-necked Wallaby	P		63	x			x	x		x	
	<i>Macropus robustus</i>	Common Wallaroo	P		196	x							
	<i>Wallabia bicolor</i>	Swamp Wallaby	P		8				x	x		x	
		Undescribed Freetail											
Molossidae	<i>Mormopterus "Species 2"</i>	Bat	P		86				x			x	
	<i>Mormopterus "Species 4"</i>	Undescribed Freetail										x	

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
		Bat										
	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V		5	x			x			x
	<i>Mormopterus planiceps</i>	Little Mastiff-bat	P		171	x						
		White-striped Freetail-										
	<i>Tadarida australis</i>	bat	P		3	x			x			x
Muridae	<i>Hydromys chrysogaster</i>	Water-rat	P		462					x		
	<i>Mus musculus*</i>	House Mouse	U		123				x	x		x
	<i>Rattus fuscipes</i>	Bush Rat	P		23	x			x			
	<i>Rattus rattus*</i>	Black Rat	U		17				x			x
Peramelidae	<i>Perameles nasuta</i>	Long-nosed Bandicoot	P		167					x		
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider	P		38	x						
	<i>Petaurus norfolcensis</i>	Squirrel Glider	V		305				x			x
		Common Brushtail										
Phalangeridae	<i>Trichosurus vulpecula</i>	Possum	P		59	x			x	x		x
		Common Ringtail										
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	Possum	P		49							
		Grey-headed Flying-										
Pteropodidae	<i>Pteropus pliocephalus</i>	fox	V	V								X
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	P		183				x			x
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	P		46	x				x		x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status								
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V		118	x						
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	P		226				x		x	
	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	P		5				x		x	
	<i>Miniopterus australis</i>	Little Bent-wing Bat	V		60				x			
	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V		8	x			x		x	
	<i>Myotis macropus</i>	Southern Myotis	V		64				x		x	
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	P		158	x			x		x	
	<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	P		59	x			x		x	
	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat										x
	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	P		216				x			
	<i>Vespadelus darlingtoni</i>	Large Forest Bat	P		41				x			
	<i>Vespadelus regulus</i>	Southern Forest Bat	P		11				x		x	
	<i>Vespadelus sp.</i>		P		525				x			
	<i>Vespadelus vulturnus</i>	Little Forest Bat	P		369	x			x		x	
	Vombatidae	<i>Vombatus ursinus</i>	Common Wombat	P			x			x	x	x

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews		
			Act	Act						Count	(1995)	(2008a)
			Status	Status						(2006)	(2009)	(2009)
<b>Reptiles</b>					51							
Agamidae	<i>Amphibolurus muricatus</i>	Jacky Lizard	P		46				x	x		
	<i>Pogona barbata</i>	Bearded Dragon	P		44	x			x	x		
	<i>Physignathus lesueurii</i>	Eastern Water Dragon	P		46	x						
		Eastern Snake-necked										
Chelidae	<i>Chelodina longicollis</i>	Turtle	P		4				x	x		
Colubridae	<i>Dendrelaphis punctulatus</i>	Common Tree Snake	P		45						x	
		Red-bellied Black										
Elapidae	<i>Pseudechis porphyriacus</i>	Snake	P		18	x				x		
	<i>Pseudonaja textilis</i>	Eastern Brown Snake	P		27	x			x			
Gekkonidae	<i>Diplodactylus vittatus</i>	Wood Gecko	P		84				x		x	
		Southern Rainbow-										
Scincidae	<i>Carlia tetradactyla</i>	skink	P		72				x	x		
	<i>Ctenotus robustus</i>	Robust Ctenotus	P		126				x	x	x	
	<i>Ctenotus taeniolatus</i>	Copper-tailed Skink	P		86	x						
	<i>Egernia striolata</i>	Tree Skink	P		154	x			x	x	x	
		Dark-flecked Garden										
	<i>Lampropholis delicata</i>	Sunsink	P		76				x			
		Pale-flecked Garden										
	<i>Lampropholis guichenoti</i>	Sunsink	P		15					x		

**Table C.1 Fauna Species Recorded within the BAA and Surrounds**

Family	Scientific Name	Common Name	TSC	EPBC	LGA	ERM	Debus	Debus	ERM	Andrews			
			Act	Act						Count	(1995)	(2008a)	(2008b)
			Status	Status									
		South-eastern											
	<i>Morethia boulengeri</i>	Morethia Skink	P		15						x		x
	<i>Tiliqua scincoides</i>	Eastern Blue-tongue	P		5						x		
	<i>Ramphotyphlops</i>												
Typhlopidae	<i>nigrescens</i>	Blackish Blind Snake	P		99						x		
Varanidae	<i>Varanus varius</i>	Lace Monitor	P				x			x	x		

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*Appendix D*

## BCAM Plot and Transect Data

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**Table D.1 Data for BCAM Assessment Plots and Transects**

Zone	Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Latitude	Longitude	Zone
1	THE PROPOSAL10	27	17.5	39	24	4	22	2.61	0	1	6	315230	6391834	56
1	THE PROPOSAL12	38	50	0	32	8	10	0	1	1	60	314938	6391542	56
1	THE PROPOSAL13	37	44	6.5	24	16	6	0	0	1	9	315714	6391186	56
1	THE PROPOSAL33	25	6	15	44	6	16	0	0	1	43.3	315201	6391956	56
1	THE PROPOSAL26	25	8	8.5	22	20	6	0	0	1	16.7	316820	6393830	56
1	THE PROPOSAL32	25	11	13	36	2	4	6	1	1	63.2	314664	6392715	56
2	THE PROPOSALA	23	0	7.5	4	14	50	3.33	0	1	0	315672.3	6391946.3	56
3&4	THE PROPOSAL1	35	40.5	0	74	2	72	5.33	0	1	24	316425	6388530	56
3&4	THE PROPOSAL2	31	11.5	17	52	0	32	0.66	0	1	21.5	316067	6388800	56
3&4	THE PROPOSAL3	41	7	22	42	0	9	0	1	1	39	316067	6388915	56
3&4	THE PROPOSAL7	30	22	8.5	32	0	18	0	0	1	24	316752	6387131	56
3&4	THE PROPOSAL8	33	3	14	40	2	34	1.33	0	1	5	316807	6386927	56
3&4	THE PROPOSAL9	38	19.5	31.5	14	18	22	0.67	0	1	54.5	315143	6392658	56
3&4	THE PROPOSAL14	38	1	26.5	14	6	6	0	0	1	76	314585	6389881	56
3&4	THE PROPOSAL17	34	11	28	30	0	10	12.6	0	1	47.5	314059	6389474	56
3&4	THE PROPOSAL20	36	13	11	26	0	20	0	7	1	85.2	315423.1	6389346.2	56
3&4	THE PROPOSAL22	33	21	4	8	6	12	0	0	1	18.6	316087.2	6392360.7	56
3&4	THE PROPOSAL23	30	16	5.5	4	2	12	0.67	0	1	0	316108.5	6394006.4	56
3&4	THE PROPOSAL34	32	25	2.5	16	0	4	0	0	1	165	315,134.70	6,388,026.50	56
3&4	THE PROPOSAL35	31	23	3	10	2	2	0	0	1	41.8	314,691.30	6,388,615.90	56

**Table D.1 Data for BCAM Assessment Plots and Transects**

Zone	Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Latitude	Longitude	Zone
3&4	Q1	26	22	7.5	88	2	8	0	0	1	21	317201.53	6386311.3	56
3&4	Q2	24	7.5	4.5	44	0	22	0	1	1	5	315923.19	6387127.26	56
3&4	Q3	38	14.5	4.5	84	10	38	1.33	3	1	16	321730.16	6388868	56
3&4	Q4	23	10.5	1.5	68	0	36	7.33	0	1	16	322994.91	6385386.53	56
3&4	Q5	29	9.5	4.5	72	0	32	3.33	0	1	29	322906.51	6387834.44	56
3&4	Q12	21	11.5	4.5	78	0	26	0.67	1	1	0	314774.03	6388840.79	56
5	Q13	10	0	0	64	0	6	29.33	0	0.33	0	315610.39	6387637.25	56
5	Q14	15	0	0	62	0	8	26.7	0	0.33	0	316596.35	6386141.3	56
5	Q15	15	0	0	90	0	24	11.33	0	0.33	0	317208.33	6385352.53	56
5	Q16	15	0	0	46	0	12	30	0	0.33	0	323056.1	6385760.52	56
5	Q17	14	0	0	58	0	4	22	0	0.33	0	321485.36	6388915.59	56
5	Q20	21	0	0	90	0	34	23.33	0	0.33	0	322474.72	6385413.73	56
6	THE PROPOSAL5	21	32	2	30	2	18	0.67	0	1	6.5	317722	6387994	56
6	THE PROPOSAL6	30	25	1.5	10	6	4	0	0	1	17.5	317635	6388046	56
6	THE PROPOSAL21	35	35	10.5	10	12	4	0	7	1	46.9	316461.4	6389034.5	56

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*Appendix E*

# Vegetation Classification

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**Table E.1 Vegetation Classification**

<b>Vegetation Zone Number</b>	<b>Cumberland Ecology Vegetation Type/Zone Name</b>	<b>Best fit Peake (2006) veg type</b>	<b>Best Fit Greater Hunter Native Vegetation Mapping Project (Silverton et al. 2011)</b>	<b>Best fit Biometric Veg Type (OEH 2013)</b>	<b>Code (2013)</b>	<b>TSC Act and EPBC Act Status</b>
1	Warkworth Sands Woodland	Warkworth Sands Woodland (MU 14)	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area (MU 140)	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	HU872	Warkworth Sands Woodland (TSC Act EEC)
2	Warkworth Sands Grassland	N/A	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area (MU 140)	Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	HU872	Not an EEC
3	Central Hunter Grey Box - Ironbark Woodland	Central Hunter Box – Ironbark Woodland (MU 10)	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (MU 173)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	HU817	Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (TSC Act EEC)
4	Regenerating Central Hunter Grey Box - Ironbark Woodland	Central Hunter Box – Ironbark Woodland (MU 10)	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (MU 173)	Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower	HU817	Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (TSC Act EEC)

**Table E.1 Vegetation Classification**

Vegetation Zone Number	Cumberland Ecology Vegetation Type/Zone Name	Best fit Peake (2006) veg type	Best Fit Greater Hunter Native Vegetation Mapping Project (Silverton et al. 2011)	Best fit Biometric Veg Type (OEH 2013)	Code (2013)	TSC Act and EPBC Act Status
5	Central Hunter Grey Box - Ironbark Derived Grassland	N/A	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (MU 173)	Hunter Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	HU817	Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (TSC Act EEC)
6	Central Hunter Ironbark - Spotted Gum - Grey Box Forest	Central Hunter Ironbark - Spotted Gum - Grey Box Forest (MU 27)	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter (MU 86)	Hunter Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	HU818	Not an EEC

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*Appendix F*

Likelihood of Occurrence of Threatened  
Flora Species Credit Species in the BAA

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**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Apocynaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	6	E1	E	Usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and Bracelet Honey-myrtle <i>Melaleuca armillaris</i> scrub to open scrub.	Possible. Nearest OEH record is 12km to south east of the BAA within the Singleton Military Training Area. Not detected in previous targeted flora surveys.
Asteraceae	<i>Olearia cordata</i>		9	V	V	Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges.	Possible. Records from 2001 occur within Yengo National Park. Not detected in previous targeted threatened flora surveys.
	<i>Ozothamnus tessellatus</i>		1	V	V	Grows in eucalypt woodland. Restricted to a few locations north of Rylstone.	Unlikely. One record within the Singleton LGA from 2003 to the north of the BAA. Not detected in previous targeted flora surveys.

**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Fabaceae (Faboideae)	<i>Dillwynia tenuifolia</i>		9	V	V	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. In the disjunct locality in Yengo, this species occurs in disturbed escarpment woodland on Narrabeen sandstone.	Unlikely. OEH record 5km south of the BAA from 1998. Not detected in previous targeted threatened flora surveys
Fabaceae (Mimosoideae)	<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	5	E2		Typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations.	Possible. Records from 2006 occur 14km to the north of the BAA. Not detected in previous targeted threatened flora surveys.
Lamiaceae	<i>Prostanthera cineolifera</i>	Singleton Mint Bush	4	V	V	Grows in open woodlands on exposed sandstone ridges. Known occurrences are in Walcha; Scone and St Albans.	Unlikely. Records from 1987, 12km south east of BAA. Not detected in previous targeted threatened flora surveys.
Myrtaceae	<i>Callistemon linearifolius</i>	Netted Bottle Brush	1	V		Grows in dry sclerophyll forest on the coast and adjacent ranges. In northern distribution it has been recorded from Yengo National Park.	Possible. Nearest OEH record is 16km to the north of the BAA from 1992. Not detected in previous targeted threatened

**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
	<i>Darwinia biflora</i>		2	V	V	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas.	flora surveys. Unlikely. Records from 1998, 8km south of the BAA. Not detected in previous targeted flora surveys.
	<i>Darwinia peduncularis</i>		3	V		Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone.	Possible. Recorded in Wollemi National Park from 1998 to the south west of the BAA. Not detected in previous targeted flora surveys.
	<i>Eucalyptus camaldulensis</i>	<i>Eucalyptus camaldulensis</i> population in the Hunter catchment	24	E2		Forms stands of woodland and open woodland on the major floodplains of the Hunter and Goulburn rivers, especially in areas where water impoundment occurs after flood. May occur with <i>Eucalyptus tereticornis</i> , <i>Eucalyptus melliodora</i> ; <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> and <i>Angophora floribunda</i> .	Present within areas adjacent to the BAA. Verified records along Wollombi Brook and the Hunter River.

**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
	<i>Eucalyptus fracta</i>	Broken Back Ironbark	22	V		Occurs in dry eucalypt woodland in shallow soils. Locally common but restricted to the northern Broken Back Range near Cessnock. Dominant tree in a narrow band along the upper edge of a sandstone escarpment.	Unlikely. OEH records from 2004 occur 22km south west of the BAA. Not detected in previous targeted flora surveys. Study area is outside known distribution. Not likely to occur.
	<i>Eucalyptus glaucina</i>	Slaty Red Gum	159	V	V	Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils.	Possible. OEH records from 1998 occur to the west of the BAA. Presence not confirmed in numerous surveys. Potential to occur.
	<i>Melaleuca groveana</i>	Grove's Paperbark	15	V		Grows in heath and shrubland, often in exposed sites, at high elevations, on rocky outcrops and cliffs. It also occurs in dry woodlands.	Possible. Nearest OEH record is 10km to the south of the BAA from 2006. Not detected in previous targeted flora surveys.
Orchidaceae	<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum in the Hunter Catchment	1	E2		Grows in the hollows of trees in dry sclerophyll forest or woodland; north from the Hunter Valley, chiefly in inland districts, west to New Angledool.	Possible. Recorded at the NBA by Cumberland Ecology (2009) approximately 8km north of the BAA.
	<i>Pterostylis gibbosa</i>	Illawarra Greenhood	6	E1	E	All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the	Likely. OEH records 8km south of the BAA from 2001. Not detected in previous targeted

**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
						Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	flora surveys.
Proteaceae	<i>Grevillea evansiana</i>	Evans Grevillea	6	V	V	Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone. Known populations occur on the western side of Wollemi National Park and nearby private lands, within the Rylstone Local Government Area.	Possible. Nearest record is approximately 45km south west of the BAA within Wollemi National Park. Not detected in previous targeted flora surveys. The BAA is outside known distribution.
	<i>Persoonia hirsuta</i>	Hairy Geebung	7	E1	E	Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	Unlikely. Records from 2006 in Yengo National Park, approximately 45km from BAA. Not detected in previous targeted flora surveys. Has potential to occur, but potential is low.
Rutaceae	<i>Leionema lamprophyllum</i> subsp. <i>obovatum</i>	Leionema lamprophyllum subsp. obovatum in the Hunter	1	E2		Occurs in dry eucalypt forest on exposed rocky terrain. The Hunter Catchment population of <i>L. lamprophyllum</i> subsp. <i>obovatum</i> occurs	Unlikely. Nearest record is 22km south east of the BAA from 1993. Not detected in previous targeted flora surveys.

**Table F.1 Assessment of the Likelihood of Occurrence of Threatened Flora Species in the BAA**

Family	Scientific Name	Common Name	LGA Count	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
		Catchment				east of Maitland near Pokolbin in the Hunter Valley.	Proposed disturbance boundary is outside known distribution.
	<i>Leionema sympetalum</i>	Rylstone Bell	3	V	V	Restricted to exposed rocky sandstone formations known as pagodas. The species occurs in dry sclerophyll forest and probably also occurs in open or closed heathland communities.	Unlikely. Recent records from the south western corner of Wollemi National Park. Not detected in previous targeted flora surveys.

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*Appendix G*

Likelihood of Occurrence of Threatened  
Fauna Species Credit Species in the BAA

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**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Green and Golden Bell Frog	<i>Litoria aurea</i>	E	V	Inhabits marshes, dams and stream-sides, particularly those containing bulrushes ( <i>Typha</i> spp.) and Spikerushes ( <i>Eleocharis</i> spp.). Optimal habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow ( <i>Gambusia holbrooki</i> ), have a grassy area nearby and sheltering sites available. Can occur in highly disturbed areas.	Possible. Nearest recent OEH records (1997 and 2000) from near Ravensworth, approximately 20km north of the BAA. Suitable habitat within the BAA.
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	V	V	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. Breeds from August to March, laying eggs under vegetation in creeks or in yabby holes.	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Suitable foraging habitat within the BAA; particularly the Warkworth Sands Woodland vegetation and the vegetation along sandy drainage lines. Nearest OEH records from upstream areas of Wollombi Brook. Suitable habitat within the BAA but unlikely to occur due to scarcity of records and previous intensive agricultural land use.
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V		Occurs in open forests, mostly on Hawkesbury or Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of the tadpoles takes place in the egg. Disperses outside the breeding period, when they are	Unlikely. Not recorded within the BAA and surrounds during current or previous surveys. No suitable habitat within the study land. Nearest OEH records and habitat within Wollemi National Park on different geology and topography to the BAA

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Red Goshawk	<i>Erythrotriorchis radiatus</i>	E	V	found under rocks and logs on sandstone ridges and forage amongst leaf-litter. Mainly found along or near watercourses, in swamp forest and woodlands on the coastal plain. It favours patches of dense forest interspersed with open woodland or cleared land and often frequents forest edges.	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Sub-optimal forage habitat. No recent records from wider locality.
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	V		Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Breeds from August to October near water in tall trees.	Likely. Recorded opportunistically in the to the south of the BAA during 2006 surveys.
Square-tailed Kite	<i>Lophoictinia isura</i>	V		Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses and is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Appears to occupy large hunting ranges of more than 100km <sup>2</sup> .	Likely. Not recorded during the current or previous surveys within the BAA and surrounds. Recorded during previous surveys at Wambo (ERM, 2008). No OEH records for the Singleton LGA. Suitable forage habitat within the BAA which may form a component of a much larger home-range.
Black Bittern	<i>Ixobrychus flavicollis</i>	V		Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Recorded during previous surveys at Wambo (ERM, 2008) in vegetation along Wollombi Brook, similar to that which occurs adjacent to the BAA. Suitable habitat occurs in Wollombi Brook and

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				amongst dense reeds. Generally solitary, but occurs in pairs during the breeding season, from December to March. Nests, built in spring are located on a branch overhanging water.	other drainage lines within the wider area.
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E		Inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey items including fish, frogs, eels, turtles, snakes and crabs.	Unlikely. Not recorded within the BAA and surrounds during current or previous surveys. OEH records within the 10km buffer area surrounding the study area. No suitable habitat within the BAA.
Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	V		Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1,000 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 (Casuarina and Allocasuarina species). Dependent on large hollow-bearing eucalypts for nest sites.	Present. Recorded during current surveys from within portions of the BAA and surrounds to the west of Wallaby Scrub Road, and from feeding signs during previous surveys.
Gang Gang Cockatoo	<i>Callocephalon fimbriatum</i>	V		In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet eucalypt forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Often found in urban areas. Favours old-growth attributes for nesting and roosting.	Possible. Not recorded within the BAA and surrounds during current or previous surveys. OEH records within the 10km buffer area surrounding the BAA. Suitable winter forage habitat within the BAA.
Speckled Warbler	<i>Chthonicola sagittata</i>	V		Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or gullies. Typical habitat would	Present. Recorded commonly during current and previous surveys throughout the BAA. Common

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary, occupying a breeding territory of about 10ha; with a slightly larger home-range when not breeding.	throughout the locality.
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus victoriae</i>	V		Found in eucalypt woodlands and dry open forests of the inland slopes and plains inland of the Great Dividing Range. Also occasionally occurs in suitable habitat in coastal areas. Mainly inhabits woodlands dominated by stringybarks and other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. Usually not found in woodland with a dense shrub understorey. Fallen timber is an important habitat component for foraging. Sedentary, with home-ranges from 1.1ha to 10.7ha. Hollows in standing dead or living trees and tree stumps are essential for nesting.	Present. Recorded during current and previous surveys throughout the BAA.
Diamond Firetail	<i>Stagonopleura guttata</i>	V		Found in grassy eucalypt woodlands, including Box-Gum Woodlands. Also occurs in open forest, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas, and sometimes in lightly wooded farmland. Feeds exclusively on the ground, primarily on grass and herb seed. Nests and roosts mainly in dense shrubs.	Present. Recorded during surveys.
Regent	<i>Anthochaera</i>	E	E	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland,	Possible. Not recorded during current surveys.

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Honeyeater	<i>phrygia</i>			and riparian forests of River She-oak. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include: Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany.	Recorded during previous surveys (ERM, 2002a) adjacent to the BAA. Suitable forage habitat within the BAA.
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	V		Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark ( <i>Eucalyptus sideroxylon</i> ), 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> ). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees. Feeding territories are large making the species locally nomadic. The Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearby OEH records from within 10km of the study land boundaries. Suitable habitat within the BAA; which may form a component of a much larger home-range.
Painted Honeyeater	<i>Grantiella picta</i>	V		Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearby OEH records within several kilometres to the south of the study area. Suitable habitat within the BAA.

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis</i>	V		Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. Build and maintain several dome-shaped stick nests used for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts.	Present. Recorded commonly during current and previous surveys (Andrews Neil, 2006, Debus, 2008a, Debus, 2008b, ERM, 1995, ERM, 2002a) throughout the BAA and surrounds. Common in the locality.
Swift Parrot	<i>Lathamus discolor</i>	E	E	Migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany ( <i>Eucalyptus robusta</i> ), Spotted Gum ( <i>Corymbia maculate</i> ), Red Bloodwood ( <i>Corymbia gummifera</i> ), Mugga Ironbark ( <i>Eucalyptus sideroxylon</i> ), and White Box ( <i>Eucalyptus albens</i> ). Commonly used lerp infested trees include Grey Box ( <i>Eucalyptus microcarpa</i> ), Grey Box ( <i>Eucalyptus moluccana</i> ) and Blackbutt ( <i>Eucalyptus pilularis</i> ). Return to some foraging sites on a cyclic basis depending on food availability.	Possible. Not recorded during current surveys. Recorded during previous surveys (ERM, 2002a) adjacent to the BAA. Suitable forage habitat within the BAA.
Little Lorikeet	<i>Glossopsitta pusilla</i>	V		Mostly occur in dry, open eucalypt forests and woodlands. Gregarious, usually foraging in small flocks, often with other species of lorikeet. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including Melaleuca and mistletoes. Nest hollows are located at heights of between 2m and 15m, mostly in living, smooth-barked eucalypts. . Nest-	Present. Recorded during current and previous surveys (Andrews Neil, 2006, Debus, 2008a) within the BAA and surrounds.

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Turquoise Parrot	<i>Neophema pulchella</i>	V		<p>hollows are used “traditionally”, with the same hollow known to be occupied for at least 29 years. Breeding season extends from May to September.</p> <p>Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. 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. Nests in tree hollows, logs or posts, from August to December.</p>	Likely. Not recorded during the current or previous surveys within the BAA and surrounds. Recorded during previous surveys at Wambo (ERM, 2008) and from nearby OEH records with 10km of the BAA. Suitable forage habitat within the BAA.
Hooded Robin (south-eastern form)	<i>Melanodryas cucullata cucullata</i>	V		<p>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.</p> <p>Territories range from around 10ha during the breeding season, to 30ha in the non-breeding season.</p>	Present. Recorded during current surveys from two locations within and adjacent to the BAA. Also recorded during previous surveys (ERM, 2002a).
Blue-billed Duck	<i>Oxyura australis</i>	V		<p>Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes.</p>	Unlikely. Not recorded within the BAA and surrounds during current or previous surveys. Nearest OEH records for the Singleton LGA are approximately 20km to the north of the BAA. No suitable habitat within the BAA.

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Powerful Owl	<i>Ninox strenua</i>	V		Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation. Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. Powerful Owls nest in large tree hollows (at least 0.5m deep), in large eucalypts (diameter at breast height of 80-240cm) that are at least 150 years old.	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearest OEH records are within the 10km buffer surrounding the BAA; to the south. Sub-optimal forage habitat within the BAA; which may form a component of a much larger home-range. No suitable roosting or nesting habitat.
Barking Owl	<i>Ninox connivens</i>	V		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 Acacia and Casuarina species, or the dense clumps of canopy leaves in large Eucalypts. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Live alone or in pairs. Territories range from 30 to 200ha and birds are present all year. Breeding occurs during late winter and early spring.	Likely. Not recorded during current or previous surveys. Nearest OEH records are near Bulga; within 10km of the BAA and surrounds. Suitable habitat within the BAA.
Masked Owl	<i>Tyto novaehollandiae</i>	V		Lives in dry eucalypt forests and woodlands from sea level to 1,100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearest OEH records are within 10km of the

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				rats. Pairs have a large home-range of 500 to 1,000ha. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	boundary of the BAA; to the south and west. Suitable forage habitat within the BAA; which may form a component of a much larger home-range. Potential roosting or nesting habitat adjacent to Wollombi Brook.
Sooty Owl	<i>Tyto tenebricosa</i>	V		Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) or Sugar Glider ( <i>Petaurus breviceps</i> ). Nests in very large tree-hollows.	Unlikely. Not recorded within the BAA and surrounds during current or previous surveys. No suitable habitat or nearby OEH records.
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia; and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	Present. Recorded during Spring surveys by Cumberland Ecology. Suitable forage habitat within the BAA. No known roost or breeding habitat. Large roosting colony in Singleton, individuals from which are likely to forage within the BAA during blossom periods of the dominant trees.
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	V		Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats, with and without trees.	Likely. Not recorded within the BAA and surrounds during current or previous surveys. Recorded during previous surveys at both HVO South and Wambo (ERM, 2008). Nearest OEH records are

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V		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.	within 10km from the boundary of the BAA. Suitable forage habitat within the BAA. No significant roost or breeding habitat present. Present. Recorded in the BAA and surrounds. Recorded during previous surveys (ERM, 1995, ERM, 2002a). Suitable habitat throughout the BAA and surrounds.
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	V	V	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.	Possible. Recorded adjacent to the BAA. Recorded during previous surveys at Mt Thorley Mine (ERM, 1995). Also recorded during previous surveys at Wambo (ERM, 2008) at several locations. Suitable forage habitat within the BAA. No suitable roosting or breeding habitat within areas surveyed. Chartlon Ridge may provide potential roosting habitat.
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V		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.	Possible. Not recorded during current or previous surveys. Nearby OEH records from within 10km of the BAA. Limited suitable habitat within the BAA; mainly adjacent to Wollombi Brook and along drainage lines.
Little Bentwing-	<i>Miniopterus australis</i>	V		Prefer moist eucalypt forest, rainforest or dense coastal banksia scrub. Roost in caves, tunnels and sometimes tree hollows during the day, and at	Likely. Recorded adjacent the BAA during previous (ERM, 2002a) surveys. Suitable forage

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
bat				night forage beneath the canopy of densely vegetated habitats.	habitat within the BAA. No suitable roost or breeding habitat present.
Eastern Bentwing-bat	<i>Miniopterus schreibersii</i>	V		Hunt in forested areas, catching moths and other flying insects above the tree tops. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centered on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300km range of maternity caves. Cold caves are used for hibernation in southern Australia.	Present . Recorded during Cumberland Ecology Spring surveys Recorded during previous surveys (ERM, 1995, ERM, 2002a). Suitable foraging but no suitable roosting habitat within the BAA.
Southern Myotis	<i>Myotis adversus</i>	V		Most habitats near water, including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland. Forage over streams and pools catching insects and small fish. Generally roost close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.	Present. Possible records from within the BAA during the current surveys. Recorded within adjacent land during previous surveys (ERM, 2002a). Suitable habitat within the BAA; particularly adjacent to dams and other water bodies.
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	V	V	Inhabits a variety of vegetation types, including mallee, buloke <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 NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark. Slow flying agile bat, utilising the understorey to hunt non-	Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearest OEH records within the Singleton LGA are from west of Jerry's Plains. Suitable habitat within the BAA.

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V		<p>flying prey. Mating takes place in autumn with one or two young born in late spring to early summer.</p> <p>Utilises 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. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6m. Although this species usually roosts in tree hollows, it has also been found in buildings. Females congregate at maternity sites located in suitable trees.</p>	<p>Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearby OEH records from within 10km of the boundary of the BAA. Limited suitable habitat within the BAA; mainly adjacent to Wollombi Brook and along drainage lines.</p>
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	V		<p>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. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.</p>	<p>Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearby OEH records from within 10km of the boundary of the BAA. Suitable habitat within the BAA.</p>
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V		<p>Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) dreys or thickets of vegetation, (e.g. grass-tree</p>	<p>Possible. Not recorded within the BAA and surrounds during current or previous surveys. Nearest OEH records are from within 10km of the boundaries of the BAA; from Wollemi National Park. Suitable habitat occurs within the BAA; particularly the Warkworth Sands Woodland but the species is considered unlikely to occur.</p>

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	V	E	skirts); tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68ha and females about 0.35ha 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. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Females occupy home ranges up to about 750ha and males up to 3500ha; usually traverse their ranges along densely vegetated creek lines.	Possible. Not recorded during current surveys. Unconfirmed record from old scats found within the wider area in 1979 (ERM, 1995). Nearby recent OEH records from Warkworth locality, and other areas within 10km of the boundaries of the BAA. Suitable forage habitat in the BAA; which may form a component of a much larger home-range. Den habitat limited to fallen logs.
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	V		Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25cm diameter or greater. Females have exclusive territories of approximately 20 - 60ha; while males have overlapping territories of up to 100ha. Nest and shelter in tree hollows with entrances 2.5-4cm wide and use many different hollows over a short time span.	Possible. No records from within the BAA and surrounds during current or previous surveys. Recorded during previous surveys from Jerry's Plains Road at HVO South (ERM, 2008). Suitable habitat within the BAA.
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	E	V	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during	Unlikely. Not recorded during current or previous surveys. Nearest recent OEH records are within 10km from the boundary of the BAA to the south and west, mostly from within Wollemi National

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15ha.	Park. No suitable intact habitat within the BAA. Large number of feral predators within the BAA and surrounds known to heavily impact on this species.
Koala	<i>Phascolarctos cinereus</i>	V		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. Home range size varies with quality of habitat, ranging from less than 2ha to several hundred hectares in size.	Possible. Not recorded during current or previous surveys. Nearest recent (2006) OEH records are within 10km from the boundary of the BAA. Most suitable habitat for Koala within the wider area occurs adjacent to Wollombi Brook; some suitable habitat within the BAA.
Yellow-bellied Glider	<i>Petaurus australis</i>	V		Den, often in family groups, in hollows of large trees. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Very mobile and occupy large home ranges of 20-85ha to encompass dispersed and seasonally variable food resources.	Unlikely. Not recorded during current or previous surveys. Nearest OEH records are within 10km from the boundary of the BAA; within Wollemi National Park. No suitable habitat within the BAA.
Squirrel Glider	<i>Petaurus norfolcensis</i>	V		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	Present. Recorded within the south-eastern portion of the BAA during surveys. Also recorded in other portions of the BAA and surrounds during

**Table G.1 Assessment of the Likelihood of Occurrence of Threatened Fauna Species in the BAA**

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Habitat Requirements	Likelihood of Occurrence
				stands with a shrub or Acacia mid-storey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna; with invertebrates and pollen providing protein.	previous surveys (ERM, 2002a). Suitable habitat throughout the BAA and surrounds.

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*Appendix H*

Lot and DP References Land Within the  
BAA

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**Table H.1 Lot and DP Numbers of the BAA**

<b>Lot</b>	<b>DP</b>
A	182301
99	755270
551	569597
129	755267
166	657481
16	755267
137	755267
6	587986
61	755270
165	755267
144	755267
63	755267
95	755267
93	755267
1	610376
164	755267
2	804245
191	755267
97	755267
2	610376
161	755267
1	804245
9	246201
8	1026900
96	755267
94	755267
87	755267
10	246201
341	612684





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