

APPENDIX C

Ecological Impact Assessment

ECOLOGICAL ASSESSMENT

Cullen Valley Modification and Invincible Colliery Modification

For:

Hansen Bailey

February 2014

Final



**PO Box 2474
Carlingford Court 2118**

Report No. 13007RP3

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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Executive Summary

S1 Introduction

Cumberland Ecology has been commissioned by Hansen Bailey to prepare an ecological impact assessment for Modifications proposed for the existing development approvals for each of Invincible Colliery and Cullen Valley Mine. Invincible Colliery and Cullen Valley Mine are two adjacent operations near the town of Cullen Bullen, on the western slopes of the Great Dividing Range on the western edge of the Sydney Basin bioregion, and in the Central West Catchment Management Management Authority, NSW.

Coalpac seeks two separate modifications to Development Consent and Project Approval to Cullen Valley Mine and Invincible Colliery respectively, under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to continue mining operations in additional extension areas adjacent to the approved Invincible Colliery and Cullen Valley Mine. This extension will allow open cut mining at Invincible Colliery and Cullen Valley Mine for an additional four years following exhaustion of coal resources within the current approved footprint.

The land that has been considered by this report (the study area) is under investigation for the Invincible Colliery Modification and Cullen Valley Mine Modification (the Modifications). The study area (see **Figure 1.1**) is approximately 2,706 ha and includes the existing Invincible Colliery and Cullen Valley Mine, the Modification Boundaries and surrounding lands and parts of Ben Bullen State Forest that have been the subject of numerous ecological investigations over several years.

The Modification Boundary for each site is shown on **Figure 1.2** and is composed of:

- **Cullen Valley Mine:** an opencut single direct 'modification area' comprised of 'disturbance boundary of 62 ha and an additional 'highwall mining area' of 79 ha (resulting in no surface disturbance); and
- **Invincible Colliery:** three opencut 'modification areas' are described as Northern, Eastern and Southern Mining Areas (the Invincible Modification Disturbance Boundary), with additional 'disturbance areas' of 25.9 ha, 7.2 ha and 53.3 ha respectively. A pipeline will disturb an additional approximately 2.1 ha to the north of Invincible Colliery. The Invincible Colliery Modification Boundary includes additional 'highwall mining areas' of 86 ha (resulting in no surface disturbance).

Although some areas to be disturbed are within the boundary of the existing consent, however for the purposes of this report, the Modification Boundaries only consists of land that is outside the current approval.

The purpose of this report is to describe the ecological values of each Modification and to assess the potential impacts of the proposed developments on ecological communities as well as flora and fauna species protected under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This report will be incorporated into an Environmental Assessment (EA) prepared by Hansen Bailey.

Specifically, the objectives of the assessment are to:

- Describe and map vegetation communities within each Modification Disturbance Boundary, 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 each of the Modification Disturbance Boundaries;
- Describe the types and extent of potential impacts on threatened communities and species arising from the Modifications;
- Where relevant, recommend measures for mitigation in order to manage potential impacts on threatened communities and species under the EPBC Act and TSC Act; and
- Provide a summary of the ecological values of the areas considered appropriate to offset the potential impacts of the Modifications.

The ecological assessment examines the terrestrial and aquatic flora and fauna assemblages and their habitats within the Modification Disturbance Boundary for each site and determines the biological impacts of the construction and operational activities proposed. It also describes the proposed ameliorative measures as well as the assessments of impacts required under Part 3A of the *Environmental Planning and Assessment Act 1979*.

S2 Methodology

S2.1 Literature Review

Relevant literature from previous studies conducted for the existing Invincible Colliery and Cullen Valley Mine operations and for other mines in the area was reviewed for each Modification. Information from previous studies has been incorporated into this report. Additionally, the “*Vegetation of the Western Blue Mountains*” DEC (2006) mapping project has been used to assist with identifying and describing vegetation communities.

Database analysis was also conducted for the locality using the (then) Department of Environment, Climate Change and Water Atlas of NSW Wildlife Database and the Department of Sustainability, Environment, Water Population and Communities EPBC Protected Matters Search Tool.

S2.2 Surveys within the Study Area

The study area is approximately 2,706 ha and comprises the area within which surveys have been conducted, including the Modification Boundaries. This is a much larger area than the Modification Boundaries themselves (total 757 ha), but is included in order to capture the large number of detailed surveys that have been conducted in the study area between 2009 and 2013. Surveys aimed to update flora and fauna baseline data in compliance with the Office of Environment & Heritage (OEH) guidelines for flora and fauna survey (DEC (NSW), 2005). The data obtained from these surveys has been used in the assessment of the Modifications. Floristic sampling was designed to meet Department of the Environment (DoE) (formerly the Department of the Sustainability, Environment, Water, Populations and Communities) guidelines for identifying the Critically Endangered Box Gum Woodland and Derived Grasslands (DEH, 2006).

Vegetation sampling conducted within the study area involved the following procedures:

- Quadrat sampling (20m x 20m);
- Quadrat sampling (20m x 50m in Box Gum Woodland);
- Quadrat sampling (100m x 20m);
- Targeted searches for threatened species; and
- Random meander surveys.

Detailed fauna surveys by Cumberland Ecology were conducted over three periods in autumn and spring to cover a range of seasonal conditions, specifically from 6-8 April 2009 (preliminary survey), 7-11 September 2009 and 19-23 October 2009. The following targeted surveys for fauna were conducted:

- Amphibians: habitat assessment, diurnal and nocturnal active searches, spotlighting, call playback;
- Birds: habitat assessment, bird census surveys, visual observation and call identification, nocturnal spotlighting, nocturnal call playback, diurnal call playback;
- Mammals: habitat assessment, trapping (ground and arboreal trapping), harp trapping, trip-lining, hair tubes, Anabat call recording, spotlighting, nocturnal call playback, infra-red cameras;
- Reptiles: habitat assessment, diurnal and nocturnal active searches; and
- Threatened insects: habitat assessment, diurnal searches, and nocturnal searches.

In addition to these surveys, targeted reptile searches for the Broad-headed Snake were conducted by Biosphere Consultants and Cumberland Ecology on the 6th February 2013.

S2.3 Surveys for Potential Offset Sites

The Modifications will impact native forests and woodlands, including habitats of threatened flora and fauna. No threatened ecological communities will be impacted. For this reason, it was apparent that land to be designated as compensatory offsets would be required to address the ecological impacts of each Modification. Offset surveys were conducted during late 2010 and throughout 2011, 2012 and 2013. The information collected from these surveys has been used to construct an appropriate offset strategy for the Modifications. The latter part of the methods chapter of this report provides details regarding proposed offset land assessment procedures and the methods used to derive a final offset package, including criteria for the survey and selection of offsets.

S3 Results

S3.1 Vegetation Communities

The study area is generally forested outside of existing mined areas and occurs across a landscape which includes sandstone plateaus and rocky out-crops; the latter have been included in the study area, even though they are outside of the proposed mining areas and will not be disturbed by any mining activities. The study area sits relatively high in the landscape with very few drainage lines. A wide variety of woodland and open forest flora and fauna are known to occur in the Lithgow Local Government Area (LGA) and a considerable diversity of species has been identified in previous environmental surveys for the approved mines. The vegetation of the study area is generally in good condition, with few exotic species occurring.

The following vegetation communities were recorded in the Modification Boundaries:

1. Tableland Gully Ribbon Gum Blackwood Applebox Forest;
2. Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland;
3. Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy;
4. Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland;
5. Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest;
6. Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest;
7. Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest;
8. Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest Derived Native Grassland; and
9. Cox's Permian Red Stringybark - Brittle Gum Woodland

Of these communities, Capertee Rough-barked Apple Red Gum Yellow Box Grassy Woodland and Derived Native Grasslands represents a form of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) endangered ecological community (EEC) as listed under the *Threatened Species Conservation Act 1995*, and critically endangered ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*.

This community does not however occur in the Modification Disturbance Boundaries and will not be disturbed by either Modification as it only occurs above an area proposed for underground highwall mining.

The table below provides a summary of the vegetation within the Modification Boundaries and areas to be disturbed within the Modification Disturbance Boundaries.

Table S.1 Vegetation Communities within the Modification Boundaries and Area of Vegetation Impacted within the Modification Disturbance Boundaries.

Code	Vegetation Community	Area of Vegetation within Modification Boundaries (ha)	Area of Vegetation Impacted (ha)			Total
			Cullen Valley Modification Disturbance Boundary	Invincible Modification Disturbance Boundary	Pipeline Corridor*	
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland	0.6				
MU20a	Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy	0.1	0.1			0.1
MU13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	21.6		7.0	0.9	7.9
MU32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	87.5	34.8	0.1	0.3	35.2
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	80.9	21.7	37.3	0.4	59.4
MU35	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	10.6		8.0		8.0
MGBIP DNG	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest Derived Native Grassland	4.0		2.4		2.4

Table S.1 Vegetation Communities within the Modification Boundaries and Area of Vegetation Impacted within the Modification Disturbance Boundaries.

Code	Vegetation Community	Area of	Area of Vegetation Impacted (ha)			
MU37	Cox's Permian Red Stringybark - Brittle Gum Woodland	9.2		0.1		0.1
MU30	Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	140.9	5.2	31.6	0.6	37.5
Total		355.4	61.8	86.5	2.1	150.5

* Note that this is a conservative assessment as the pipeline will be following an existing track and additional disturbance will be kept to a minimum.

S3.2 Flora

One threatened flora species was recorded within the study area, *Eucalyptus cannonii* (Capertee Stringybark), listed as Vulnerable under the TSC Act. This species was de-listed from the EPBC Act in December 2013.

S3.3 Fauna

The study area contains a variety of fauna habitats including forested steep slopes and gullies, woodlands on slopes and flatter topography, and sandstone outcropping with heath and woodland. This outcropping sandstone contains caves and crevices that are used as refugia by some fauna species. There are very few aquatic habitats present in the study area, limited to small farm dams, and ephemeral drainage lines. Generally there are no permanent or reliable freshwater sources within the study area.

A large number of bird species, several common reptile species and eight amphibian species have been recorded from within the study area. Mammal species recorded included macropods, microchiropteran bats and arboreal mammals; although very few small ground-dwelling mammals were recorded. Although no threatened fauna species were recorded within the Modification Boundaries, the following threatened fauna species have been recorded from the study area and are considered to have potential to occur in the Invincible Colliery and Cullen Valley Modification Boundaries:

- Satin Flycatcher (*Myiagra cyanoleuca*) is listed as Migratory under the EPBC Act;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act and TSC Act;
- Brown Treecreeper (*Climacteris picumnus*) is listed as Vulnerable under the TSC Act;

- Scarlet Robin (*Petroica boodang*) is listed as Vulnerable under the TSC Act;
- Speckled Warbler (*Chthonicola sagittata*) is listed as Vulnerable under the TSC Act;
- Varied Sittella (*Daphoenositta chrysoptera*) is listed as Vulnerable under the TSC Act;
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) is listed as Vulnerable under the TSC Act;
- Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act;
- Powerful Owl (*Ninox strenua*) is listed as Vulnerable under the TSC Act;
- Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act;
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) is listed as Vulnerable under the TSC Act;
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), listed as Vulnerable under the TSC Act;
- The Eastern Freetail-bat (*Mormopterus norfolkensis*) is listed as Vulnerable under the TSC Act; and
- The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as Vulnerable under the TSC Act.

The following threatened fauna species have been recorded within the Lithgow LGA and are considered to have potential to occur in the study area. These species have potential habitat in the study area but have not been recorded from this area and for this reason were not listed above:

- Brush-tailed Rock-wallaby (*Petrogale penicillata*) listed as Vulnerable under the EPBC Act and Endangered under the TSC Act;
- Spotted-tail Quoll (*Dasyurus maculatus*) listed as Endangered under the EPBC Act and Vulnerable under the TSC Act;
- Rosenberg's Goanna (*Varanus rosenbergi*) listed as Vulnerable under the TSC Act;
- Broad-headed Snake (*Hoplocephalus bungaroides*) listed as Endangered under the TSC Act and Vulnerable under the EPBC Act;
- Regent Honeyeater (*Anthochaera phrygia*) listed as Critically Endangered under the EPBC and TSC Act;
- The Swift Parrot (*Lathamus discolor*) listed as Endangered under the EPBC Act and TSC Act

- White-throated Needletail (*Hirundapus caudacutus*) listed as Migratory under the EPBC Act;
- Rainbow Bee-eater (*Merops ornatus*) listed as Migratory under the EPBC Act;
- Black-faced Monarch (*Monarcha melanopsis*) is listed as Migratory under the EPBC Act);
- Rufous Fantail (*Rhipidura rufifrons*) listed as Migratory under the EPBC Act;
- Little Lorikeet (*Glossopsitta pusilla*) listed as Vulnerable under the TSC Act;
- Black-chinned Honeyeater (*Melithreptus gularis*) listed as Vulnerable under the TSC Act;
- Painted Honeyeater (*Grantiella picta*) listed as Vulnerable under the TSC Act;
- Grey-crowned Babbler (*Pomatostomus temporalis*) listed as Vulnerable under the TSC Act;
- Turquoise Parrot (*Neophema pulchella*) listed as Vulnerable under the TSC Act;
- Hooded Robin (*Melanodryas cucullata*) listed as Vulnerable under the TSC Act;
- Diamond Firetail (*Stagonopleura guttata*) listed as Vulnerable under the TSC Act;
- Black Cockatoo (*Calyptorhynchus lathami*) listed as Vulnerable under the TSC Act;
- Eastern Pygmy-possum (*Petaurus norfolcensis*) listed as Vulnerable under the TSC Act;
- Koala (*Phascolarctos cinereus*) listed as Vulnerable under the TSC Act;
- Yellow-bellied Glider (*Petaurus australis*) listed Vulnerable under the TSC Act;
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) listed Vulnerable under the TSC Act; and
- Little Bent-wing Bat (*Miniopterus australis*) listed Vulnerable under the TSC Act.

S4 Impact Assessment

The Modification Disturbance Boundaries cover a combined area of approximately 151 ha within the study area. The following is a summary of the impacts of the Modifications on the threatened biodiversity within the Modification Disturbance Boundaries:

- 148 ha of known and potential *Eucalyptus cannonii* habitat constituting an estimated 2,302 individuals. This excludes approximately 2 ha of grassland and comprises 62 ha and 84 ha in the Cullen Valley Mine and Invincible Colliery Modification Disturbance Boundaries respectively, plus another 2 ha in the pipeline; and

- 148 ha (excluding grassland) of non-listed native forest and woodland, habitat for various fauna species known to occur or considered potentially occurring. This comprises 62 ha and 84 ha in the Cullen Valley Mine and Invincible Colliery Modification Disturbance Boundaries respectively, plus another 2 ha in the pipeline.

The two Modification Disturbance Boundaries will remove a combined area of approximately 148 ha of woodland and forest providing foraging, shelter and breeding habitat for a suite of woodland birds including: the Varied Sittella, Scarlet Robin, Speckled Warbler and Brown Treecreeper. Other bird species with a potential to utilise this habitat include the Little Lorikeet, Diamond Firetail, Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater and the Swift Parrot. Some migratory species also have potential to be affected by the removal of these treed habitats. Other threatened birds expected to be impacted by habitat removal for the Modifications include the Gang-gang Cockatoo, Powerful Owl and Masked Owl.

Additionally, the following threatened mammals are expected to be impacted by habitat removal for the two Modification Disturbance Boundaries: Yellow-bellied Glider, Squirrel Glider, Brush-tailed Rock Wallaby and Spotted-tailed Quoll. A suite of threatened microbats including the hollow dependant Eastern False Pipistrelle, Eastern Freetail-bat, Yellow-bellied Sheath-tail-bat and Greater Broad-nosed Bat and cave dwelling Large-eared Pied Bat and Eastern Bent-wing Bat are also expected to be impacted by the removal of vegetation.

Notwithstanding the impacts of 148 ha of vegetation removal, large areas of habitat will remain in the study area and in the wider locality within protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other large remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and other parts of Ben Bullen State Forest. In addition, a range of mitigation measures are proposed to be implemented, including protecting and conserving habitat for these species via establishing and conserving offsets, and progressively rehabilitating impacted land to develop high quality habitat within the Modification Boundaries.

S5 Amelioration Measures

A number of amelioration measures have been designed to minimise the ecological impacts of the Modifications. The approach is consistent with the principles of avoidance, mitigation and compensation described within the Draft Discussion Paper for the use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999*, and the NSW Offset Principles for Major Projects (State Significant Development and State Significant Infrastructure). These are:

- Avoid: developments should be designed to avoid or minimise ecological impacts, where possible;
- Mitigate: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development; and

- Compensate: the residual impacts of the Modifications, following the implementation of mitigation measures, should be compensated for in some way to offset what would otherwise be a net loss of habitat.

These are described in more detail below.

S5.1 Avoidance

Avoiding environmental impacts has been considered throughout the Modifications planning and design phases. The Modifications have been devised through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened communities and species.

Altering disturbance footprints for the Modifications through mine plan design has avoided:

- All individuals, population and habitat for *Persoonia marginata*;
- Large numbers of *E. cannoni* (approximately 2,180 individuals) through the use of highwall mining instead of open cut mining at Invincible Colliery;
- Pagoda and rocky escarpment, potential habitat for the following threatened species:
 - Potential Brush-tailed Rock Wallaby habitat;
 - Summer and winter habitat for the Broad-headed Snake; and
 - Roost habitat for the Large-eared Pied Bat and Eastern Bent-wing Bat.
- Complete avoidance of Box Gum Woodland.

Furthermore, the use of highwall mining has avoided potential subsidence impacts associated with other kinds of underground mining. While it generates a lower yield of coal extracted, it ensures that subsidence will not impact areas of vegetation and habitat above extraction areas.

S5.2 Mitigation Measures

The following mitigation measures are recommended for the Modifications:

- Minimise disturbance of native vegetation during construction and ahead of mining operations;
- Maintain & extend successful rehabilitation practices;
- Update all existing management plans to cover land disturbed by the Modifications. These include the current Flora and Fauna Management Plan for Cullen Valley Mine and the Landscape Management Plan for Invincible Colliery. This will include updating plans to incorporate best practice guidelines and current industry standards. The plans will include (but not be limited to) information such as

protocols for vegetation clearing (including inspection of hollows), feral animal and pest control, rehabilitation objectives and further detailed design measures;

- Prepare and implement a nest box management procedure;
- Implement a two stage clearing protocol for all hollow-bearing trees. All hollow-bearing trees to be felled should be marked and a catalogue of their species and approximate dimensions recorded so that hollows and nest boxes can be affixed to similar standing trees located in offsets and mine rehabilitation areas.
- Undertake ongoing weed and feral animal management and monitoring; and
- Review and continue existing flora and fauna monitoring program and extend to include the Modification Boundaries. This plan should also include monitoring and control of exotic weeds and feral animals.

S5.3 Compensatory Habitat

S5.3.1 Existing Biodiversity Offsets and Compensatory Habitat

i. Invincible Colliery

Coalpac is currently managing land totalling approximately 166 ha of woodland, open forest and grassland, as long-term compensatory conservation areas for residual impacts associated with the existing Invincible Colliery. In Coalpac's existing habitat compensation areas for Invincible Colliery, two threatened plants have been recorded and another threatened species has been planted during rehabilitation. These include the following:

- Lot 112 DP 877190, part of Invincible Colliery's 2008 offset, contains approximately 20 *Eucalyptus aggregata* individuals; and
- *Eucalyptus cannonii* is recolonising Lot 112, and Lot 113 which forms part of the Invincible Colliery's 2008 offset (GSS 2013).

A vegetation survey of Lot 112 and Lot 113 biodiversity offset areas by Global Soil Systems in 2013 found evidence of natural regeneration of *Eucalyptus cannonii* individuals which were spreading throughout these areas. Younger trees were predominantly located in close proximity to existing mature *Eucalyptus cannonii* individuals. This demonstrates the resilience of the species and its potential to recolonise a previously cleared landscape. There is evidence of *Eucalyptus* species migrating into rehabilitated areas as part of natural regeneration from adjacent native vegetation communities in the Ben Bullen State Forest. Due to the connectivity of rehabilitated areas with mature native woodland and biodiversity offset areas which contain self-seeding adult *Eucalyptus cannonii* individuals, it is likely that the species will infiltrate rehabilitated areas given time and suitable environmental conditions. The NSW National Parks and Wildlife Service note that *Eucalyptus cannonii* can be easily propagated from seed (NSW NPWS 2000). As such the species could be readily introduced to rehabilitated areas as seedlings or included in the rehabilitation seed mix if available.

Collectively, in the long term, these existing habitat compensation and ecological offset areas will complement the surrounding remnant vegetation by adding to existing forest and woodland, create new corridors through the rehabilitation of grasslands and conserve known habitat of *Eucalyptus aggregata* and *Eucalyptus cannonii*.

ii. Cullen Valley Mine

As required by DA 200-5-2003, Coalpac has established and maintained Compensatory Habitat Areas of approximately 51 hectares to offset the environmental impacts from land disturbance associated with the approved operations of Cullen Valley Mine. The Cullen Valley Mine Compensatory Habitat Areas are located adjacent to existing rehabilitation areas at the mine and the adjacent to the Ben Bullen State Forest. These areas are managed to conserve and enhance the ecological communities present, which include Sandstone Dry Ridgetop Woodland, Tablelands Sheltered Valley Forest, and Tablelands Dry Woodland.

S5.4 Modifications Compensatory Habitat

Coalpac has developed a Biodiversity Offset Strategy for the two Modifications with the objective of offsetting the residual impacts on biodiversity. The Biodiversity Offset Strategy entails the provision of offset properties for the permanent conservation of flora and fauna, including threatened flora and fauna predicted to be impacted by the Modifications. The protection of native vegetation occurring on these properties will contribute to increasing and improving the amount of forest and woodland under conservation tenure within the locality, and will complement Coalpac's existing offsetting arrangements.

The properties that form the Biodiversity Offset Strategy for the Modifications comprise the Hillview/Billabong properties, part of the Gulf Mountain property and several smaller properties near the Cullen Valley Mine that are referred to here together as the 'Additional Offset Areas.

In addition to the offsetting principles set out by DoE and OEH, the development of the Biodiversity Offset Strategy has been guided by the following key design concepts:

- Secure land for permanent conservation;
- Increase the area of forest and woodland under conservation above what will be lost through the Modifications;
- Improve the biodiversity values of the offset properties through changing land use (i.e. deliver conservation gains to offset properties that would otherwise not have taken place under current use);
- Improve the biodiversity values of the offset properties through the implementation of positive management interventions to actively stop degradation and to increase the area of native vegetation and habitat for native flora and fauna; and
- Time the offsets to minimise the lags between the impacts of the Modifications and the offset achieving its objectives.

Under the Biodiversity Offset Strategy a total of approximately 645 ha of forest, woodland and derived native grassland vegetation are proposed to be conserved and will create an offset ratio for these communities of approximately 4.3:1 for the impacts of the two Modifications (refer to **Table S.2**).

Table S.2 provides the areas of vegetation on Hillview/Billabong, Gulf Mountain and the Additional Offset Areas that will be provided to offset potential ecological impacts of the Modifications.

Table S.2 Vegetation Communities within the Offset Properties

Unit	Vegetation Community	Disturbance Boundary (ha)	Hillview/ Billabong Offset Area (ha)	Gulf Mountain Offset Area* (ha)	Additional Offset Areas (ha)	Total Offset (ha)	RATIO
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC C/EEC)	0.0	5.5	0.0	0.0	5.5	
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC C/EEC) DNG	0.0	29.3	0.0	0.0	29.3	
MU20a	Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy	0.1	0.0	0.0	0.0	0.0	
MU13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	7.9	0.0	36.0	0.0	36.0	
MU13 DNG	Tableland Gully Ribbon Gum Blackwood Applebox Forest Derived Native Grassland	0.0	0.0	0.0	2.0	2.0	
MU32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	35.2	0.0	405.3	0.0	405.3	
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	59.4	41.3	84.9	4.3	130.5	
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	0.0	7.2	0.0	4.5	11.7	

Table S.2 Vegetation Communities within the Offset Properties

Unit	Vegetation Community	Disturbance Boundary (ha)	Hillview/ Billabong Offset Area (ha)	Gulf Mountain Offset Area* (ha)	Additional Offset Areas (ha)	Total Offset (ha)	RATIO
MU35	Derived Native Grassland						
	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	8.0	0.0	0.0	17.8	17.8	
MU35 DNG	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest						
	Derived Native Grassland	2.4	0.0	0.0	0.0	0.0	
MU37	Cox's Permian Red Stringybark - Brittle Gum Woodland	0.1	0.0	0.0	0.0	0.0	
MU30	Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	37.5	0.0	0.0	1.2	1.2	
	Riparian River Oak Forest	0.0	0.0	5.6		5.6	
	TOTAL	150.5	83.4	531.7	29.7	644.8	4.3

** A 20% discount has been included in the area of vegetation within Gulf Mountain Offset Area as a pre-existing covenant on native vegetation exists in this area that prevents clearing of trees.*

S6 Conclusion

The Modifications will remove approximately 151 ha of native vegetation, including potential and known *Eucalyptus cannonii* habitat. The vegetation that is proposed to be cleared provides habitat for a range of threatened species. At least 35 threatened species listed by the TSC Act and/or the EPBC Act, have potential to occur within the study area.

In recognition of the potential ecological impacts of the Modifications, a substantial rehabilitation and offsetting package is proposed and will be implemented by Coalpac. All forest and woodland areas to be cleared by mining operations for the Modifications will be rehabilitated to forest and woodland in the long term using local native species, redeveloping treed habitat in the locality. Coalpac is committed to maintaining the high quality rehabilitation carried out to date and focus on re-population of *Eucalyptus cannonii*, which has been successfully cultivated in mine rehabilitation and in existing offsets.

In addition to this, 645 ha of forest, woodland, and grassland will be permanently conserved under the offset package, including approximately 34 ha of CEEC Box Gum Woodland and Derived Native Grassland and 101 ha of known *Eucalyptus cannonii* habitat.

Introduction

Coalpac Pty Ltd (Coalpac) owns and operates the existing operations of Invincible Colliery and Cullen Valley Mine. Invincible Colliery has been owned and operated by Coalpac since 1988 and Cullen Valley Mine was acquired by Coalpac in 2007. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act (the Modifications). These modifications are sought to facilitate the extension to the respective approved mining areas via open cut and highwall coal mining methods at each site as well as the orderly rehabilitation of the final landform in the area.

Cumberland Ecology has been commissioned by Hansen Bailey to prepare an ecological assessment of vegetated land proposed to be impacted by the Modifications. The land considered by this report is under investigation for the Invincible Colliery Modification and Cullen Valley Mine Modification (the Modifications).

The purpose of this report is to describe the ecological values in the Modification Boundaries and to assess the potential impacts of the proposed Modifications on ecological communities as well as flora and fauna species protected under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This report will be incorporated into an Environmental Assessment (EA) prepared by Hansen Bailey for submission to the NSW Minister for Planning for assessment under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

Specifically, the objectives of the assessment are to:

- Describe and map vegetation communities within each Modification Boundary, 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 each Modifications Boundary;
- Describe the types and extent of potential impacts on threatened communities and species arising from the Modifications;

- Where relevant, recommend measures for mitigation in order to manage potential impacts on threatened communities and species under the EPBC Act and TSC Act; and
- Provide a summary of the ecological values of the areas considered appropriate to offset the potential impacts of the Modifications.

1.1 Background

1.1.1 Modifications Overview

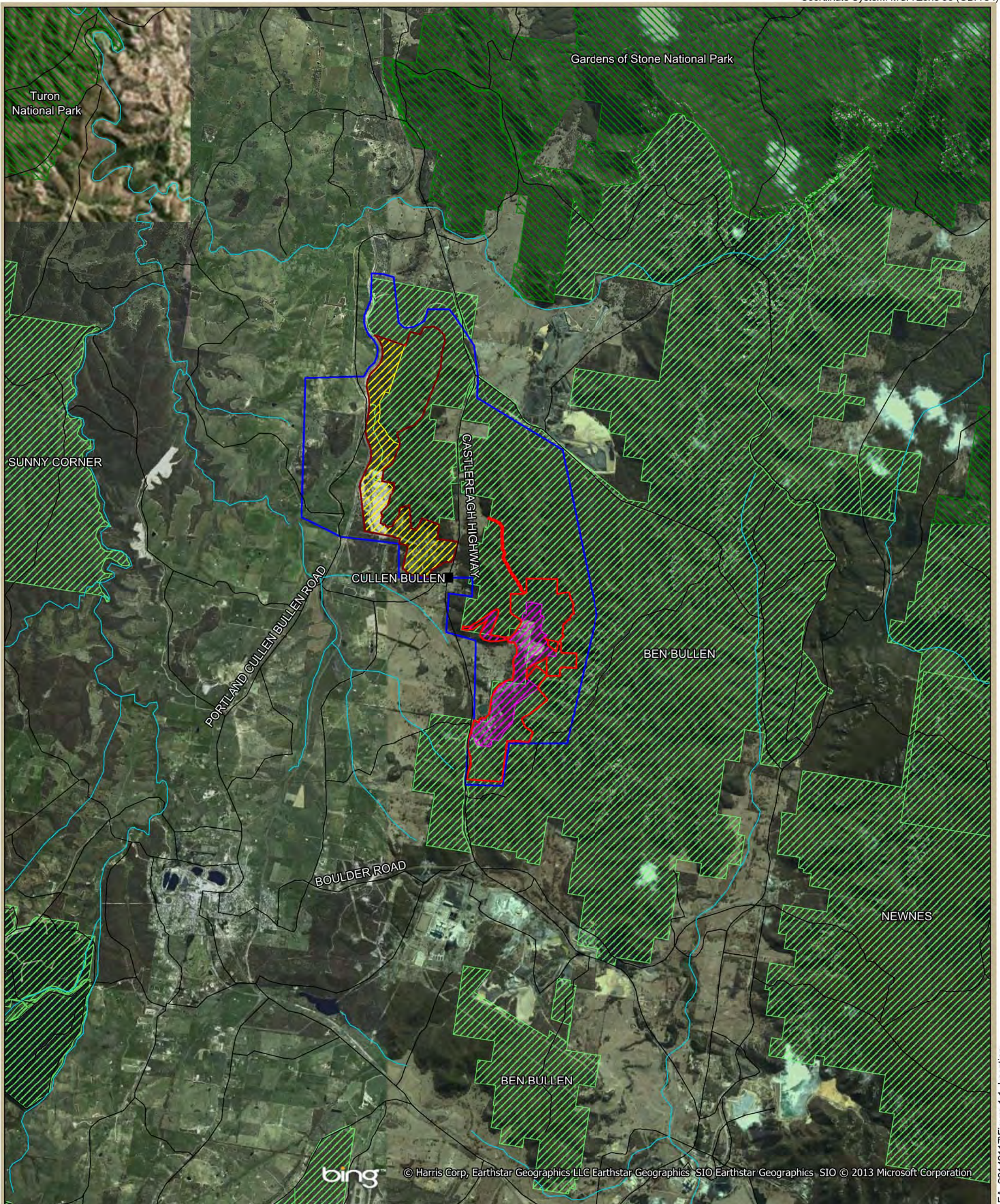
Coalpac seeks to modify the existing planning approvals of each of Invincible Colliery and Cullen Valley Mine under Section 75W of the EP&A Act to extend mining operations in additional mine extension areas adjacent to the currently approved footprints. **Figure 1.1.** illustrates the study area within the region and **Figure 1.2** illustrates the approved mining areas at Invincible Colliery and Cullen Valley Mine, the modification boundaries and the disturbance boundaries of each Modification.

i. *Invincible Colliery Modification*

The Invincible Colliery Modification will seek approval for the following activities that are not approved changes to its current Project Approval (PA 07_0127):

- Extension to PA 07_0127 for four years from December 2016 to December 2020;
- Extension of 88 ha to areas approved for open cut mining;
- Extension of 86 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance; and
- Installation and use of a water pipeline from Invincible Colliery to benefit from the transfer of mine water to and from the adjacent Cullen Valley Mine for operational use. The pipeline alignment will largely remain on or adjacent to existing access tracks within the Ben Bullen State Forest.

All other aspects of operations on site, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that currently approved under PA 07_0127.



Legend

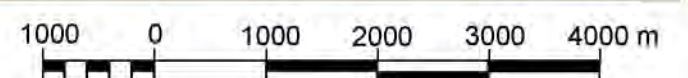
Cullen Valley Modification Boundary	National Parks and Reserves
Invincible Colliery Modification Boundary	State Forest
Study Area	Road
Existing Cullen Valley Mine	Waterway
Existing Invincible Colliery	Town

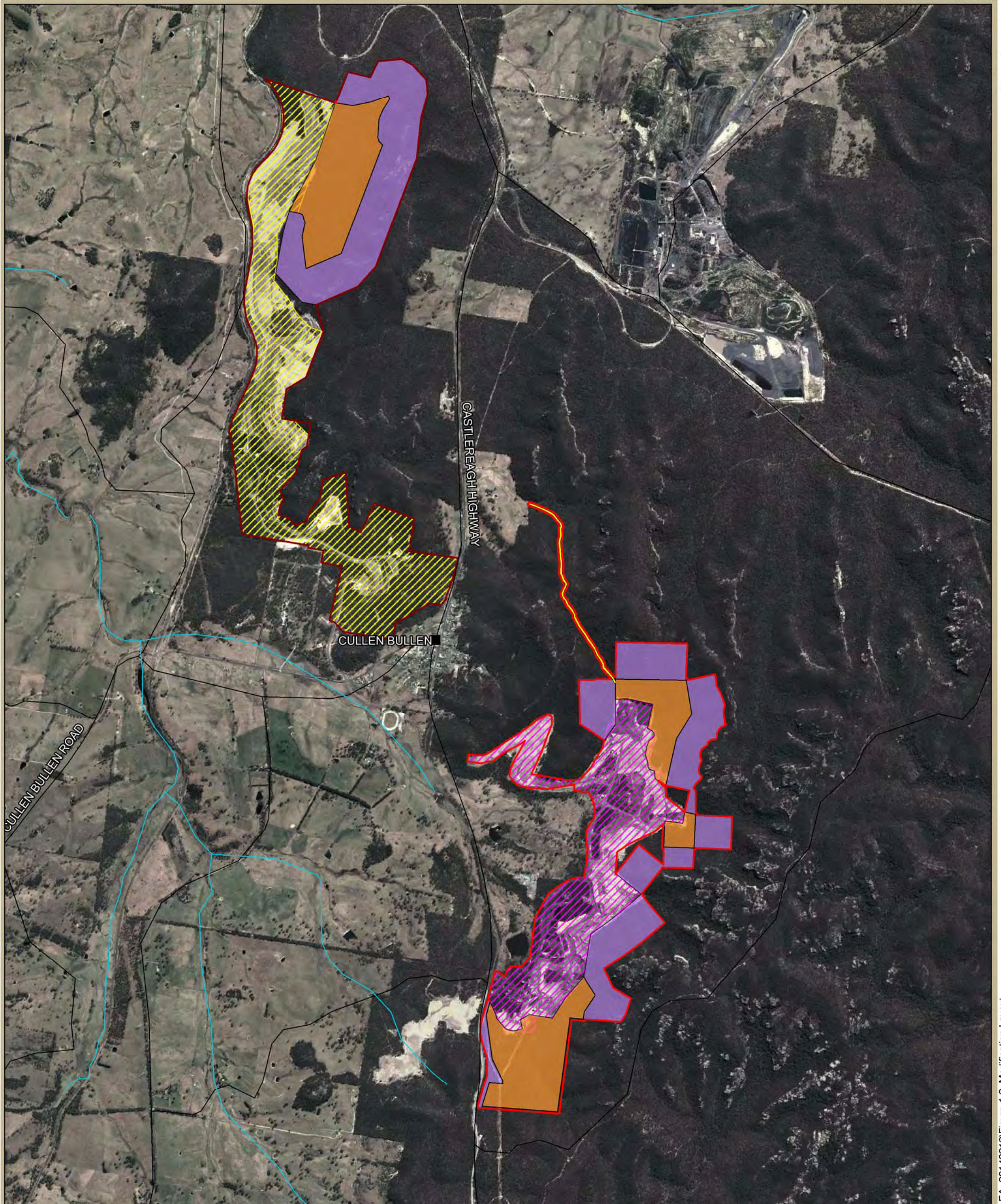
Image Source:
Image © 2010 Sinclair Knight Merz
Image © 2010 DigitalGlobe
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Data Source:
NPWS Estate 2012
Forests NSW, 2010
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Figure 1.1. Location of the Study Area





Legend

	Cullen Valley Modification Boundary		Highwall Mining
	Invincible Colliery Modification Boundary		Pipeline Corridor
	Existing Cullen Valley Mine		Road
	Existing Invincible Colliery		Waterway
	Open Cut Mining		Town

Image Source:
Image © 2013 DigitalGlobe
© 2013 Google

Data Source:
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(Geoscience Australia) 2006



Figure 1.2. Modification Layout



ii. Cullen Valley Mine Modification

The Cullen Valley Mine Modification (CV MOD2) is seeking approval for the following activities that are not approved changes to its current Development Consent (DA 200-5-2003):

- Extension of 62 ha to areas approved for open cut mining;
- Extension of 79 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance; and
- Ability to benefit from the transfer of water to and from Invincible Colliery.

All other aspects of operations, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that approved under DA 200-5-2003.

1.1.2 Site Description

The Modifications are located near the town of Cullen Bullen, on the western slopes of the Great Dividing Range on the western edge of the Sydney Basin Bioregion, and in the Central West Catchment Management Authority (CWCMA), NSW.

The Modification Boundaries include the existing Cullen Valley Mine and the Invincible Colliery as well as four proposed extension areas and a pipeline which are located in Ben Bullen State Forest (**Figure 1.1**). The Modification Boundaries are within and adjoin Ben Bullen State Forest: to the north, south and east. The Castlereagh Highway runs between the Modification Boundaries (**Figure 1.1**). There are several significant conservation reserves in the region, including the Gardens of Stone National Park.

i. Climate

The climate is cool temperate, characterised by relatively mild summers and cold winters, typical of the western slopes of the Great Dividing Range. Fog and frost are common in cooler months, although a range of factors including the ridge and valley topography, altitude, aspect and exposure result in small localised microclimates. These variables provide a diverse range of habitat for both flora and fauna.

ii. Topography, Soil and Geology

The Sydney Basin consists of a series of shale and sandstone of Permo-Carboniferous age capped by massive sandstones of Triassic Age beneath which coal seams form the Upper Coal Measures.

The landscape within the Modification Boundaries and study area ranges from steep hills and gullies associated with the Great Dividing Range to more moderately undulating and gentle slopes around the township of Cullen Bullen.

The areas adjacent to the Modification Boundaries have been found to contain rock outcrops locally referred to as “pagoda landforms”. These outcrops may exhibit geomorphological features such as cliffs, caves, rock towers and isolated rock towers that do not form an aggregate or have deeply dissected wet gullies.

iii. Land use

The main existing land uses within the Modification Boundaries are mining and forestry. Ben Bullen State Forest is also currently regularly used for recreation activities including four-wheel driving, motorbike riding and conservation hunting. Numerous informal tracks and trails have been created through the Ben Bullen State Forest lands within the Modification Boundaries. This part of Ben Bullen State Forest has been historically logged for the local underground mines. It also continues to be logged on a non-commercial basis. As a result numerous, and tree stumps and coppiced trees are present in more accessible areas.

The Modification Boundaries are classified as Zone No 1 (f) Rural (Forestry) under the Lithgow Draft LEP 2013 which permits the development of extractive industries (mining).

1.2 Assessment Approach

The information obtained during surveys of flora and fauna of the study area has been used in the ecological assessment of these Modifications. This section outlines the surveys undertaken on and adjacent to the Modification Boundaries within the study area as well as surveys of prospective biodiversity offset sites.

1.2.1 Surveys within the Study Area

Detailed surveys of vegetation within and adjacent to the study area were completed between 2009 and 2013 to provide flora and fauna baseline data for compliance with the OEH survey guidelines for the assessment of developments (DEC (NSW), 2005).

1.2.2 Surveys of Prospective Offset Properties

The study area is almost completely wooded and it is not possible for open cut coal mining to occur without incurring ecological impacts to native forests and woodlands, including habitats of threatened flora and fauna. For this reason, it was apparent that compensatory offsets would be required in order to address the ecological impacts of the Modifications. Detailed surveys were completed between 2010 and 2013 to investigate potential offset sites. **Section 2.7** provides details about how proposed offset land was screened and how a final offset package was derived, including criteria for the survey and selection of offsets.

1.3 Terms and Abbreviations

This report uses the following terms and abbreviations:

Box Gum Woodland: White Box Yellow Box Blakely's Red Gum Grassy Woodland listed under the EPBC Act and TSC Act;

BVT: Broad vegetation type;

DNG: Box Gum Woodland Derived Native Grassland;

DoE: Commonwealth Department of Environment;

EEC: Endangered Ecological Community;

CEEC: Critically Endangered Ecological Community;

C/EEC: Critically Endangered Ecological Community and Endangered Ecological Community;

Current Survey refers to the survey work by Cumberland Ecology conducted in 2009, 2010, 2011 and 2013;

EP&A Act: NSW *Environmental Planning and Assessment Act 1979*;

EPBC Act: Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*;

KTP: Key Threatening Process, listed under the TSC and EPBC Acts as a process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities.

LGA: Local Government Area;

Locality: is the area within a 10 km radius of the study area;

Mining Lease: means the land within the Coalpac mining tenements;

Modification Boundaries: refers to the land which is the subject of the proposed modifications including both highwall mining and the open -cut mining components of the Modifications;

Modification Disturbance Boundaries; refers to land which will be physically disturbed by open cut mining in the Modification Boundaries. Land to be subject to underground highwall mining will not be directly impacted;

OEH: Office of Environment and Heritage, formerly DECCW;

Previous Surveys: refer to all previous flora and/or fauna surveys conducted within the study area and reviewed by Cumberland Ecology;

Study Area: refers to land surveyed for this EA and previous reports from 2009 until 2013. This includes the existing Invincible Colliery and Cullen Valley Mine and land surrounding them and the Modification Boundaries;

SEWPaC: previous Commonwealth Department of Sustainability, Environment, Water, Population and Communities;

Threatened flora and fauna: refers to communities, populations and species listed as threatened under the EPBC Act, the TSC Act and the *Fisheries Management Act 1994*; and

TSC Act: NSW *Threatened Species Conservation Act 1995*.

Methodology

2.1 Literature Review

Relevant literature from previous studies conducted within and adjacent to the study area and the locality were reviewed for the Modifications and incorporated into this report. Relevant studies include:

- Coalpac Consolidation Project Ecological Impact Assessment (Cumberland Ecology 2012a)
- Cullen Valley Lease Extension Project Flora Survey (Lembit, 2003);
- Fauna Assessment Cullen Valley Mine Extension (AES, 2003);
- Flora Survey for Feldmast Coal Project (Lembit, 1997);
- Fauna Survey Proposed Feldmast Coal Project Cullen Bullen, NSW (Wildsearch, 1997);
- Environmental Assessment of the Proposed Extension to the Invincible Colliery Open Cut Mine and Production Increase (R.W. Corkery & Co, 2008b);
- Augmented Biodiversity Offset Strategy for the Invincible Colliery Open Cut Mine Extension (R.W. Corkery & Co, 2008a);
- Environmental Assessment – Baal Bone Colliery (AECOM, 2010);
- Environmental Assessment – Pine Dale Coal Mine Yarraboldy Extension (R.W. Corkery & Co, 2010); and
- Environmental Assessment – Ivanhoe North Rehabilitation Project (R.W. Corkery & Co 2006).

Additionally, the “*Vegetation of the Western Blue Mountains*” mapping project (DEC (NSW), 2006b) has been used to assist with identifying and describing vegetation communities. Although the study area is not covered by the mapping for the Modifications, the vegetation of the study area is contiguous with the north western section of the map of the Cox’s Valley and contains similar species and habitats.

2.2 Database Analysis

Database analysis was conducted for the Lithgow LGA using both the OEH Atlas of NSW Wildlife (OEH, 2012) and the DoE Protected Matters Search Tool (SEWPaC, 2012a). The Atlas of NSW Wildlife search (last accessed 10th December 2013) was used to generate records of threatened flora and fauna species listed under the TSC Act within the Lithgow LGA. The Protected Matters search (last accessed 10th December 2013) generated a list of flora, fauna and ecological communities listed under the EPBC Act that were predicted to occur within the locality (i.e. a 10 km radius of the Modification Boundaries). The lists generated from these databases identified threatened species with potential to occur in the Modification Boundaries.

2.3 Flora Survey

2.3.1 Vegetation Community Mapping

Vegetation communities were mapped using GPS during flora field surveys. In addition, aerial photographs and satellite imagery, as available from SIX Viewer (<http://impagery.maps.nsw.gov.au/>), Google Earth 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 (20m x 20m, 20m x 50m) 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 Geographical Positioning System (GPS) unit.

Plant communities were described based on the dominant canopies species and community structure according to Specht (1970). The “*Vegetation of the Western Blue Mountains*” (DEC (NSW), 2006) was used to predict the identity of the main vegetation communities present in the Modification Boundaries by identifying the communities that had been mapped on sandstone ridges and pagoda outcrops, upper slopes, mid slopes, steep gullies, lower slopes and valley floors within neighbouring parts of Ben Bullen State Forest and other nearby areas previously studied by Cumberland Ecology.

2.3.2 Criteria for the Identification of Box Gum Woodland and Derived Grasslands

White Box, Yellow Box, Blakely’s Red Gum Woodland is listed as an EEC under the TSC Act, and is listed as a CEEC under the EPBC Act. The definitions of this community under these two acts vary slightly, and therefore the relevant identification guidelines for each Act are explained below.

i. EPBC Act

The EPBC Act Policy Statement for assessing Box Gum Woodland and Derived Grasslands (DEH, 2006) provides a prescriptive, detailed methodology for determining the presence of the CEEC.

To confirm the presence of this CEEC as listed under the EPBC Act, it is firstly necessary to confirm the presence or historical presence of *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) or *E. blakelyi* (Blakely's Red Gum) within the area of interest. Then, if one or more of these trees are present or were historically present as dominants, a quadrat should be completed within a plot of 1,000m² (0.1 ha). If the survey plot contains 12 native non-grassy understorey species (including sedges, forbs, monocots, shrubs and excluding native grasses) and should have at least one "important" species as contained in the list of characteristic species published by DoE, then it is considered to comprise Box Gum Woodland and Derived Native Grasslands.

ii. TSC Act

There is no such prescriptive methodology to identify Box Gum Woodland and Derived Native Grasslands under the TSC Act. A detailed description that defines the Box Gum Woodland and Derived Native Grasslands is included in the Final Determination made in 2004 by the NSW Scientific Committee to list Box Gum Woodland and Derived Native Grasslands as a EEC under the TSC Act. The presence of the community is determined on the basis of its consistency with the community described within the Final Determination (NSW Scientific Committee, 2004g) and Identification Guidelines (NSW NPWS, 2005) provided below:

- Is the site on the tablelands or western slopes of NSW?
- Does the site contain, or would be likely to contain, White Box, Yellow Box or Blakely's Red Gum?
- Is the ground layer mainly grassy? [assuming mainly native grasses]
- If the site has been degraded, is there potential for assisted natural regeneration of the tree layer or the understorey (e.g. by removing grazing, weeds, etc.)?

2.3.3 Quadrat Survey

Quadrats of 20 x 20 m were surveyed in representative areas of vegetation in order to characterise each of the vegetation communities that occur in the study area and to identify the plant species present. Quadrats of 20 x 50 m were used in areas considered likely to conform to Box Gum Woodland and Derived Native Grassland to aid in the identification of this community. Each flora species observed within each quadrat was recorded and allocated an abundance rating according to a modified Braun-Blanquet scale (Mueller-Dombois and Ellenberg, 1974). The average height and projective foliage cover (PFC) for each stratum was also recorded. Forty-four quadrats were surveyed throughout the study area. The locations of quadrats located within the study area are shown in **Figure 2.1**.

The quadrat survey was supplemented with random meander searches. These involved walking or driving an irregular line through vegetated areas to determine where vegetation communities intergrade, to ascertain how communities are distributed in the study area, and to search for threatened plants. All plant species detected in the study area during these random meander searches were also recorded.

All vascular plants were collected if not readily identifiable in the field and were identified using keys and nomenclature provided in Harden (Harden, 1990, Harden, 1991, Harden, 1992, Harden, 1993). Other references were used to assist identification, particularly for, difficult specimens (Law, 2000, Harden, 1990-1993). Eucalypt samples were identified by Van Klaphake from the Royal Botanic Gardens. Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from PlantNET [Botanic Gardens Trust 2010 #4568].

2.3.4 Threatened Species Searches

Targeted threatened species searches have been undertaken for threatened plants recorded in the Lithgow LGA with the potential to occur in the study area. Random meander surveys were employed within areas considered to provide suitable habitat for these species. All plants found sharing the same genus as threatened species known to occur in the Lithgow LGA that could not be accurately identified in the field were collected for later identification by the Royal Botanic Gardens Sydney.

The following threatened plant species were specifically targeted during threatened flora searches as these were considered to have the potential to occur within the Modification Boundaries:

- *Eucalyptus cannonii*;
- *Persoonia marginata*;
- *Eucalyptus pulverulenta*;
- *Grevillea evansiana*;
- *Grevillea obtusiflora*;
- *Prostanthera cryptandroides* subsp. *cryptandroides*;
- *Derwentia blakelyi*; and
- *Eucalyptus aggregata*.

2.3.5 Threatened Species Population Estimates

i. *Eucalyptus cannonii*

One threatened tree species listed as Vulnerable under both the TSC Act, *Eucalyptus cannonii* (Capertee Stringybark), has previously been recorded in the study area (Lembit 1997; Cumberland Ecology 2012). As Stringybarks occur in almost every community in the study area, and because they occur so frequently within those communities, it was not possible to map or count every individual of *Eucalyptus cannonii*. Waypoints were recorded at random sites where either *Eucalyptus cannonii* or hybrids *Eucalyptus macrorhyncha subsp. cannonii* were recorded. These were plotted, as well as locations of either species within vegetation quadrats.

Fifteen quadrats of 100m x 20m were surveyed to estimate the density of *Eucalyptus cannonii* across its distribution in the study area. All *Eucalyptus cannonii* and *Eucalyptus macrorhyncha subsp. cannonii* recorded within these quadrats were counted and the total multiplied by five to give a density per hectare. This was then extrapolated over the extent of the community by multiplying the area of each vegetation community and the average density per hectare. Juvenile saplings were not included in this count.

Eucalyptus cannonii (Capertee Stringybark) was previously listed as Vulnerable under the EPBC Act; however it was de-listed on the 14th December 2013 and is not currently listed under any category of threat under the EPBC Act.

2.3.6 Flora Survey Effort

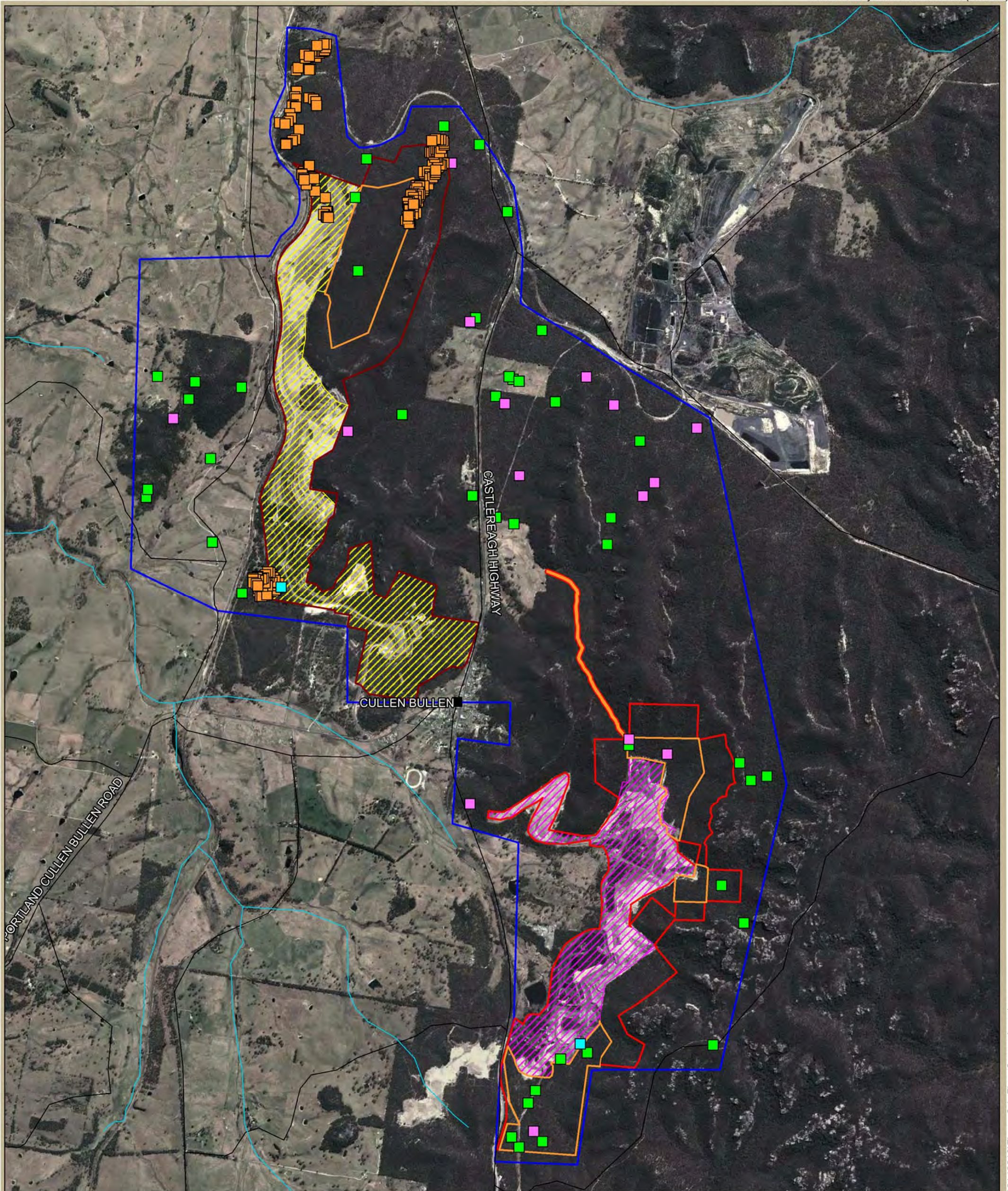
A summary of flora surveys and sampling effort during the Cumberland Ecology surveys is provided in **Table 2.1** and field survey locations are shown in **Figure 2.1**.

Table 2.1 Flora Survey Effort in the Study Area

Survey Technique	Dates	Effort
Vegetation Mapping,	21-25 September 2009 19-23 October 2009 28 January 2010 2-3 February 2010 14-19 October 2010 12-16 September 2011 11-12 October 2011 10-11 December 2013 and throughout flora survey period	Minimum 24 days two people plus throughout entire survey period.

Table 2.1 Flora Survey Effort in the Study Area

Survey Technique	Dates	Effort
Quadrat sampling	21-25 September 2009 19-23 October 2009 28 January 2010 2-3 February 2010 14-19 October 2010 12-16 September 2011	44 quadrats
Random meanders	Throughout flora survey period during vegetation mapping, quadrat sampling and threatened species searches. 10-11 December 2013	Throughout survey period
Threatened flora searches and population estimates	Surveys undertaken concurrently with vegetation community mapping, random meanders and quadrat sampling with counts and additional searches undertaken on 20 April 2011 6 and 12 May 2011 16 and 22 June 2011 12-16 September 2011 11-12 October 2011 3 – 6 November 2011	Minimum 16 days for 2 people targeted and throughout survey period



Legend

- Cullen Valley Modification Boundary
- Invincible Colliery Modification Boundary
- Study Area
- Modification Disturbance Boundary
- Existing Cullen Valley Mine
- Existing Invincible Colliery

- Road
- Waterway
- Town

Flora Survey Location

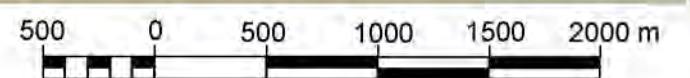
- Flora Quadrat Location
- Capertee Stringybark/Tree Hollow Quadrat Location
- Persoonia marginata Quadrat Location
- Rehabilitation reference site (Ecobiological, 2011)

Image Source:
Image © 2013 DigitalGlobe
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Data Source:
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(Geoscience Australia) 2006



Figure 2.1. Flora Survey Locations within the Study Area



2.4 Fauna Survey

2.4.1 Introduction

Detailed fauna surveys were conducted by Cumberland Ecology within the study area in three periods. The first survey (Survey period 1) was conducted between 6 and 8 April 2009. The second (Survey period 2) and third (Survey period 3) surveys were each one week in duration and were conducted between 14 – 18 September and 19 to 23 October 2009. Fauna surveys were conducted, where possible, in accordance with the DEC Threatened Biodiversity Survey and Assessment Guidelines (DEC (NSW), 2004a).

Additional surveys were undertaken by Biosphere Environmental Consultants and Cumberland Ecology in 2013 to identify and map habitat for the Broad-headed Snake within the pagodas to the east of the study area.

2.4.2 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 arboreal fauna; and
- Elliot A traps for small terrestrial fauna.

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

Terrestrial trap lines were established using Elliot A and cage traps. Elliot A traps were placed approximately 10m apart along each trapping transect while cage traps were placed at the beginning, middle and end of each transect. Twenty-five Elliot A and three cage traps were placed along each of the trapping transects. The Elliot A traps were baited with peanut butter, honey and rolled oats to target small mammals. Cage traps were baited with chicken necks. Traps were left out for a period of four nights along each of 12 transect.

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

2.4.3 Hair Tubes

‘Faunatech’ hair tubes were used during the survey period to detect arboreal and terrestrial mammals. Two 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 transect. All hair tubes were baited with rolled oats, peanut butter and honey. A total of 80 hair tubes were deployed for a

period of 35 nights, giving a survey effort of 2,800 trap nights. Hair samples were analysed by Georgeanna Story of 'Scats About', Majors Creek, NSW.

2.4.4 Bat Surveys

Harp traps were erected at several locations throughout the study area to survey for bats. Harp traps were located in narrow areas (e.g. tracks and gullies) that microbats typically use as fly-ways. On some occasions harp traps were also located near to potential bat roost sites. Bats were captured as they flew into the tight wires of the harp trap and were forced into a capture bag. Harp traps were checked early each day. Captured bats were kept in cloth bags in the shade during the day, and were released at the point of capture the following night.

Anabat ZCAIM (Zero Crossing Analysis Interface Module) units were employed on most survey nights, depending upon weather conditions, to record calls of microbats. Anabats were set at dusk and collected the following morning after nocturnal surveys each night. Calls recorded on each Anabat were analysed to determine which species were present within the study area.

2.4.5 Diurnal Bird Surveys

Bird census surveys were conducted at several points throughout the study area. Bird census surveys involved looking and listening for birds from a central point for a period of 30 minutes, and recording all birds that were detected during these surveys. Diurnal birds were also identified and recorded as they were encountered incidentally throughout the study area during the survey periods. In addition, call playback was used to elicit a response from threatened diurnal bird species at several points throughout the adjacent vegetation.

2.4.6 Nocturnal Bird Surveys

Nocturnal bird surveys were undertaken over several nights during each survey period for threatened bird species detected within the Lithgow LGA and for which suitable habitat occurs within the study area. Surveys were precluded by a period of quiet listening prior to call playback. Surveys targeting the presence of Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Sooty Owl (*Tyto tenebrosa*) and Bush Stone-curlew (*Burhinus grallarius*) were then undertaken by broadcasting taped calls through an amplifier. Calls were played for 2-minute periods at 5-minute intervals. This was followed with quiet listening and spotlighting.

2.4.7 Spotlight Surveys and Call Playback

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

During spotlighting surveys, call playback of nocturnal mammal calls were broadcast using a megaphone to illicit a response from targeted threatened nocturnal species. Koala

(*Phascolarctos cinereus*), Spotted-tail Quoll (*Dasyurus maculatus*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*) were targeted by broadcasting taped calls through an amplifier. Calls were played for 2-minute periods at 5-minute intervals. This was followed with quiet listening and spotlighting.

2.4.8 Infrared (IR) Cameras

Infrared (IR) cameras were set up at four locations throughout the study area. The cameras were attached to trees and focused on apparent fauna pathways or runways such as at the bases of cliffs and at the top of gullies. Cameras 1, 2 and 3 were left for 10 nights each and Camera 4 for 4 nights (**Figure 2.2**).

2.4.9 Amphibian and Reptile Surveys

Diurnal and nocturnal active searches were conducted in suitable habitat for amphibians and reptiles throughout vegetation adjacent to 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 bushrock and the scraping of top soil. Caught animals were identified and then released.

In addition to the surveys conducted during the detailed surveys, one day of targeted surveys for the Broad-headed Snake were conducted by Biosphere Consultants and Cumberland Ecology on the 6th of February 2013. This involved active searches for the snake in areas of potential habitat within the study area such as under rocks and sandstone overhangs.

2.4.10 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 threatened flora and fauna recorded from areas adjacent to the study area during the survey period have also been included.

2.4.11 Habitat Assessment

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

Habitat condition 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.

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

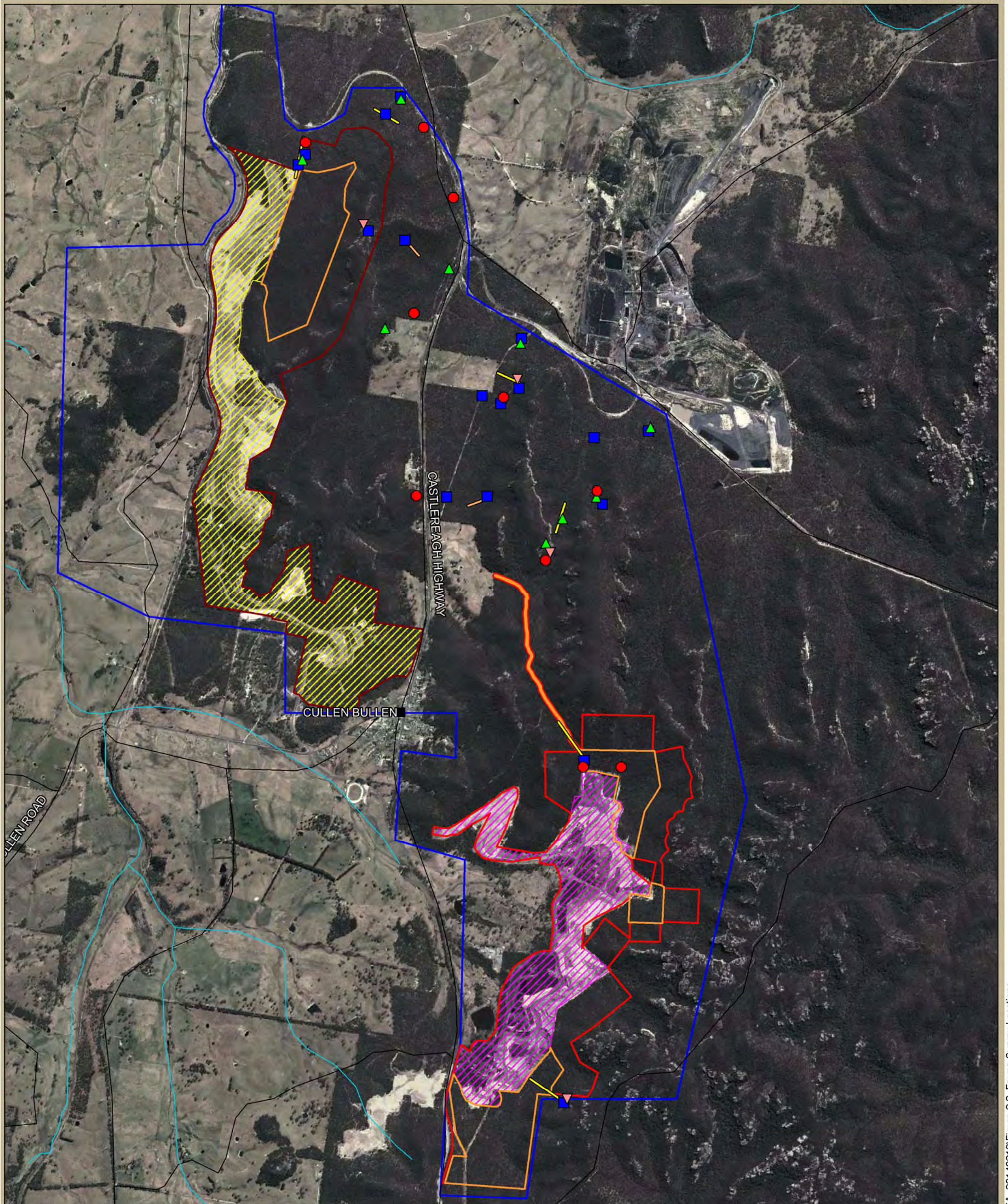
2.4.12 Fauna Survey Effort

A summary of trapping and sampling effort during the detailed Cumberland Ecology surveys is provided in **Table 2.2** and field survey locations are shown in **Figure 2.2**.

Table 2.2 Detailed Fauna Survey Effort within the Study Area			
Survey Technique	Survey Effort 6-8 April 2009 (Survey period 1)	Survey Effort 14-18 Sept 2009 (Survey period 2)	Survey Effort 19-23 Oct 2009 (Survey period 3)
Amphibians			
Systematic day habitat search	1 hour	1 hour	1 hour
Night habitat search of damp and watery sites	1 hour	1 hour	1 hour
Night watercourse search	1 hour	1 hour	1 hour
Reptiles			
Habitat search	2 x 30 minutes (across 2 separate days)	2 x 30 minutes (across 2 separate days)	8 x 30 minutes (across 5 separate days)
Spotlighting	3 hours (across two separate nights)	4.5 hours (across three separate nights)	4.5 hours (across three separate nights)
Diurnal Birds			
Incidental searches	Throughout survey periods	Throughout survey periods	Throughout survey periods
Bird census surveys	Visual and auditory searches totalling 6 hours over 2 days across the study area	Visual and auditory searches totalling 10 hours over 5 days across the study area	Visual and auditory searches totalling 15 hours over 5 days across the study area
Nocturnal Birds			
Call playback	2 nights (30 minutes each night)	3 nights (30 minutes each night)	3 nights (30 minutes each night)
Day habitat search	Throughout survey period	Throughout survey period	Throughout survey period
Spotlighting on foot	2 nights (30 minutes each night)	3 nights (30 minutes each night)	3 nights (30 minutes each night)
Non-flying Mammals			
Small Elliott traps		300 trap nights	300 trap nights

Table 2.2 Detailed Fauna Survey Effort within the Study Area

Survey Technique	Survey Effort 6-8 April 2009 (Survey period 1)	Survey Effort 14-18 Sept 2009 (Survey period 2)	Survey Effort 19-23 Oct 2009 (Survey period 3)
Large Elliott traps (arboreal)		120 trap nights	120 trap nights
Cage traps		36 trap nights	36 trap nights
Terrestrial Hair tubes		1400 trap nights	1400 trap nights
Arboreal hair tubes		1400 trap nights	1400 trap nights
Spotlighting on foot	2 nights (30 minutes each night)	3 nights (30 minutes each night)	3 nights (30 minutes each night)
Call playback	2 nights (30 minutes each night)	3 nights (30 minutes each night)	3 nights (30 minutes each night)
Search for scats and signs	2 hours	3 hour	3 hour
IR cameras		30 survey nights (3 camera over 10 nights)	4 survey nights (1 camera over 4 nights)
Collection of predator scats	Throughout survey period	Throughout survey period	Throughout survey period
Bats			
Harp trapping	3 nights	8 night	8 night
Ultrasonic call recording	8 nights	12 nights	12 nights



Legend

- Cullen Valley Modification Boundary
- Invincible Colliery Modification Boundary
- Study Area
- Modification Disturbance Boundary
- Existing Cullen Valley Mine
- Existing Invincible Colliery

- Road
- Waterway
- Town

Fauna Survey Locations

- Anabat
- IR Camera
- Active bird and reptile search
- Harp trap
- Hairtube
- Trap Line

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Data Source:
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Figure 2.2. Fauna Survey Locations within the Study Area



2.5 Weather Conditions

A summary of weather conditions in the locality of the study area during fauna surveys of the study area are provided in **Table 2.3**. Weather conditions for all survey periods were relatively mild with no prolonged cold or hot periods experienced prior to or during the surveys. Daily temperatures during these periods ranged from -3.2°C to 25.9°C . No significant rainfall was experienced immediately prior to or during any of the fauna surveys.

Table 2.3 Summary of Weather Conditions during Fauna Survey

Date	Min. Temp. ($^{\circ}\text{C}$)	Max. Temp. ($^{\circ}\text{C}$)	Rainfall (mm)
6/04/2009	3	18	0
7/04/2009	10.3	17.3	0
8/04/2009	7	18.4	0
14/09/2009	12.8	24.4	0
15/09/2009	10.1	20.3	0
16/09/2009	4.4	19	0
17/09/2009	9.8	24.3	0
18/09/2009	10.4	18.8	2.2
19/10/2009	1.7	20.2	0
20/10/2009	4.1	23.2	0
21/10/2009	4	25.9	0
22/10/2009	8.7	24.9	0
23/10/2009	8.9	25.7	0
06/02/2013	10.8	23.8	0

Notes: Source for weather data was Bureau of Meteorology Daily Weather Observations for Lithgow.

2.6 Limitations

2.6.1 Flora

It is considered that the survey of the study area represents an accurate baseline of ecological information for the study area. Although it is impossible to record the entirety of the flora species present within the study area, it is considered that the surveys were comprehensive enough for the majority of species present to have been recorded, including threatened species. Cumberland Ecology is satisfied that the conservation significance of the flora, condition and viability of vegetation communities and likely impacts of the Modifications on native vegetation has been satisfactorily assessed.

The topography of the study area poses difficulties of access to many areas due to steep slopes and a lack of good tracks to some areas. Mapping of inaccessible areas was conducted by extrapolating from the mapping undertaken in more accessible parts of the study area and using our knowledge of the local environment.

Some of the boundaries between non-listed vegetation communities are gradual and transitional zones (ecotones) of variable width occur between communities. In these transitional zones the vegetation comprises an assortment of species from each adjacent vegetation community. This makes mapping of such communities difficult.

While extensive field surveys were undertaken, there is some potential for species that were not recorded during field surveys to occur in parts of the study area due to the large areas requiring surveys. It is possible that some orchid species were undetected because of their cryptic habit even though surveys were conducted during known flowering times. For this reason a precautionary approach was taken, and threatened species that were not actually detected, but which had potential to occur, were still assessed as occurring in the site.

2.6.2 Fauna

It is considered that the fauna surveys of the study area were comprehensive enough to record the majority of the vertebrate species that occur in the study area, and to allow the suitability of the habitat within the study area for fauna species to be adequately assessed.

The three detailed fauna survey periods were timed to survey for both winter migrant species as well as those groups that become more active during the warmer months (e.g. reptiles and microbats). Both the April and September 2009 surveys were suitable to detect winter migrants, particularly the Swift Parrot (*Lathamus discolor*).

The surveys were conducted at the appropriate time of year 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*). Despite surveying during appropriate flowering seasons, the absence of significant forage for blossom-dependent species may have resulted in the under-representation of blossom-dependent species during the surveys. To overcome this limitation, habitat assessment was conducted during all surveys. This provides an adequate indication of the likelihood of occurrence for all threatened blossom-dependent species within the study area.

The detailed surveys were conducted in the autumn and spring months, providing optimal conditions for detecting mixed flocks of non-breeding resident and winter-migratory species. Several summer migrant bird species were recorded during the October 2009 survey indicating that the timing of this survey was appropriate for detecting summer migrants.

Weather conditions during all survey periods were mild and dry which are typically unsuitable to detect most amphibian species that are likely to occur within the study area. The location of the study area, on the western side of the Great Dividing Range is typically temperate and dry, and results from the habitat assessment indicated that suitable amphibian habitat is rare. For this reason detailed targeted searches for amphibians were not warranted. The

combination of results from habitat assessment, targeted searches, literature review from previous surveys from 1997 and OEH records was considered to be adequate.

The timing of the detailed surveys were not optimal for detecting reptiles as they are known to enter a state of aestivation (short-term hibernation) during periods of cold weather (Wilson and Swan, 2003) and it is likely that reptile activity would increase with warmer weather following the third survey period. Reptile activity was low during the April and September 2009 surveys, with more activity noted during the October 2009 survey. Habitat assessment and active searches of shelter habitat were employed to compensate for the sub-optimal timing of surveys for this group, and it is considered that the survey effort for reptiles was adequate to detect the majority of the reptiles that could occur in the study area. The additional surveys of the Broad-headed Snake in February 2013 were conducted in summer when conditions were optimal for the detection of this species.

As with reptiles, many microchiropteran bats enter a state of limited activity during the winter months, and it is likely that later surveys conducted during the summer months may record higher diversity and abundance of bats within the study area. Nevertheless, the combination of field survey results, habitat assessment and database analysis is considered to be sufficient to have adequately assessed the majority of species that may occur.

During the April 2009 survey, access was the primary limitation to survey effort. However, the survey sites able to be accessed were indicative of the natural habitats available for fauna throughout the study area. Surveys in September and October 2009 were conducted in other parts of the study area, providing a thorough coverage of all habitat types that occur.

2.7 Surveys of Potential Offset Sites

At the time of preparing the Ecological Assessment, it was apparent that some areas of forest, woodland and threatened species habitat would be cleared as a result of the Modifications. For this reason, surveys were undertaken for land that could provide suitable offsets, to compensate for the clearance of flora and fauna habitats within the Modification Boundaries. The objectives of the offsets work therefore included:

- Identifying land that contains or could be regenerated to similar vegetation to that occurring within the study area;
- Providing land that includes habitat for all relevant threatened flora and fauna species that could be impacted by the Modifications;
- Providing land that contributes to an existing regional biodiversity conservation strategy;
- Obtain data on all offset lands to demonstrate that they contain suitable vegetation and other habitat, and to assist with future land management; and
- Prepare an Offsets Strategy, for inclusion in the Ecological Impact Assessment and the EA.

The highest priorities for consideration as offsets were the closest properties with similar vegetation to that in the Modification Boundaries.

i. Prioritised List of Properties for Investigation

Cumberland Ecology completed the following tasks to obtain a list of candidate properties for investigation to purchase:

1. Mapping of candidate habitats in the locality;
2. Overlaying potential vegetation areas with cadastral maps to show ownership (Lot and DP numbers);
3. Desktop estimation of broad areas of like for like vegetation; and
4. Prioritising a list of properties for investigation.

Once Coalpac investigated potential vendors and short listed properties for purchase, limited field studies were made to validate the vegetation present on the short listed properties.

ii. Field Studies

Cumberland Ecology sent teams consisting of one ecologist and one botanist to investigate properties with reasonable prospects for offsets. Firstly, the investigation entailed a general reconnaissance and drive across (or around) the properties to gain a general understanding of the local ecology.

During the initial visit of a potential offset site, preliminary mapping of vegetation types was created, habitat values identified and initial Rapid Condition Assessments (RCA) were conducted. If the property was found to provide suitable offsets to compensate for the clearance of flora and fauna habitats within the study area, a more detailed follow up survey was conducted. Follow up surveys involved fine tuning vegetation boundaries, particularly of any threatened ecological community (if present) and conducting quadrat surveys (20 m x 50 m) to assess whether vegetation conformed to the EPBC Act definition of Box Gum Woodland. Additional notes about vegetation condition, threatened species and habitat, key habitat features (rock outcrops, streams, etc.), weed infestations etc. were also recorded.

Quadrat sampling of *Eucalyptus cannonii* was also undertaken in offset properties where the species was recorded in order to estimate density and abundance of this species in the offset site.

Results

3.1 Introduction

This chapter presents the findings of all flora and fauna surveys across the study area, with particular focus on the Modification Boundaries.

The diversity of natural relief within the study area supports a variety of native vegetation communities including shrubland, woodland and open forest. A wide variety of woodland and open forest flora and fauna are known to occur in the locality and a considerable diversity of species has been identified in previous environmental surveys for the already approved mining projects. Total flora and fauna species lists from previous surveys (as available to Cumberland Ecology) and current surveys of the study area are provided in **Appendix A** and **Appendix B** respectively.

3.2 Vegetation Communities

Nine vegetation communities occur within the Modification Boundaries. These vegetation communities have been named in accordance with the DECCW (2006) Western Blue Mountains mapping, however contain some differences in species composition and vegetative structure. Communities found within the Modification Boundaries include:

1. Tableland Gully Ribbon Gum Blackwood Applebox Forest;
2. Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland;
3. Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy;
4. Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland;
5. Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest;
6. Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest;
7. Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest;
8. Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest Derived Native Grassland; and

9. Cox's Permian Red Stringybark - Brittle Gum Woodland.

.**Table 3.1** below details the vegetation classification of each vegetation type. This includes the corresponding Revised Biometric Vegetation Type (RBVT) and RBVT Code, as well as the Class and Formation that each community corresponds to as mapped by Keith (2004) (here termed Keith Class and Keith Formation). The distribution of each community across the Modification Boundaries is shown in **Figure 3.1**.

Table 3.1 Vegetation Communities Within the Modification Boundaries

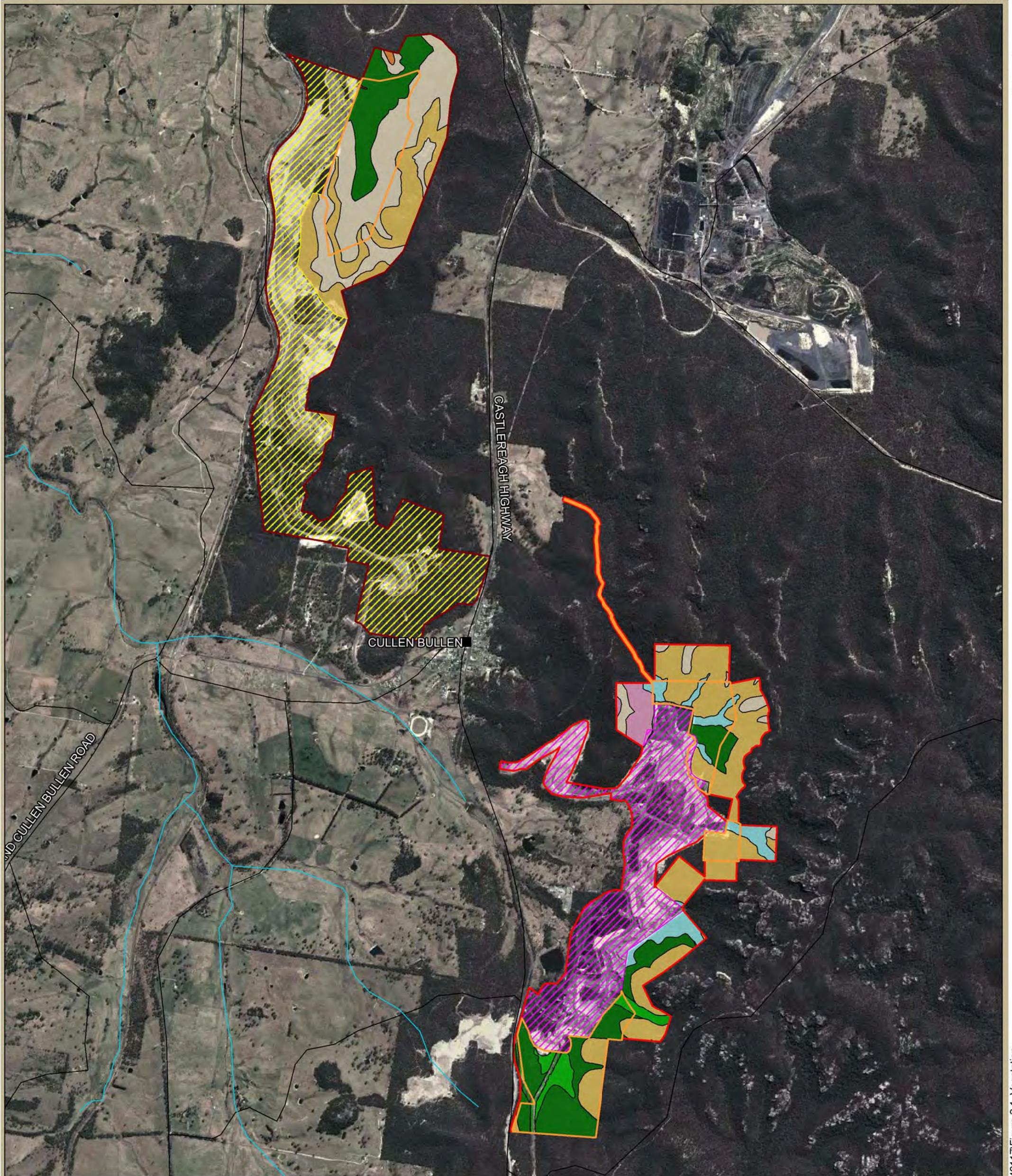
Code	Vegetation Community	Conservation Status	RBVT Code	RBVT	Keith Class	Keith Formation	Area (ha)
MU13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	Not listed	CW154	Mountain Gum - Manna Gum open forest of the South Eastern Highlands	Southern Tableland Grassy Woodland	Grassy Woodlands	21.6
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland	CEEC (EPBC Act)	CW102	Apple Box - Yellow Box dry grassy woodland of the South Eastern Highlands	Southern Tableland Grassy Woodlands	Grassy Woodlands	0.6
MU20a	Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland – non grassy	Not listed	CW102	Apple Box - Yellow Box dry grassy woodland of the South Eastern Highlands	Southern Tableland Grassy Woodlands	Grassy Woodlands	0.1
MU30	Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	Not listed	CW228	Sydney Peppermint - Silvertop Ash shrubby low open forest of the upper Blue Mountains	Sydney Montane Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	140.9

Table 3.1 Vegetation Communities Within the Modification Boundaries

Code	Vegetation Community	Conservation Status	RBVT Code	RBVT	Keith Class	Keith Formation	Area (ha)
MU32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	Not listed	CW176	Red Stringybark - Scribbly Gum - Red Box - Long- leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Upper Riverina Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrub/grass subformation)	87.5
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	Not listed	CW117	Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	Southern Tableland Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	80.9
MU35	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	Not listed	CW154	Mountain Gum - Manna Gum open forest of the South Eastern Highlands	Southern Tableland Wet Sclerophyll Forests	Wet Sclerophyll Forests (Grassy subformation)	10.6

Table 3.1 Vegetation Communities Within the Modification Boundaries

Code	Vegetation Community	Conservation Status	RBVT Code	RBVT	Keith Class	Keith Formation	Area (ha)
MU35 DNG	Tableland Gully Mountain Gum Broad-leaved Peppermint Grassy Forest Derived Native Grassland	Not listed	CW154	Mountain Gum - Manna Gum open forest of the South Eastern Highlands	Western Slopes Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	4.0
MU37	Cox's Permian Red Stringybark - Brittle Gum Woodland	Not listed	CW117	Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	Southern Tableland Dry Sclerophyll Forests	Dry Sclerophyll Forests (Shrubby subformation)	9.2



Legend

- Cullen Valley Modification Boundary
- Invincible Colliery Modification Boundary
- Modification Disturbance Boundary
- Existing Cullen Valley Mine
- Existing Invincible Colliery
- Road
- Waterway
- Town

Vegetation Community

- Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC)
- Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy
- Tableland Gully Ribbon Gum Blackwood Applebox Forest
- Tableland Scribbly Gum - Narrow-leaved Stringybark Shrubby Open Forest
- Tableland Slopes Brittle Gum - Broad-leaved Peppermint Grassy Forest
- Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest
- Tableland Gully Mountain Gum Broad-leaved Peppermint Grassy Forest Derived Native Grassland
- Pagoda Rock Sparse Shrubland
- Cox's Permian Red Stringybark - Brittle Gum Woodland
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland

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Figure 3.1. Vegetation Communities in the Modification Boundaries



3.3 Community Descriptions

3.3.1 *MU20 - Capertee Rough-barked Apple – Red Gum –Yellow Box Grassy Woodland*



Photograph 3.1 Scattered Yellow Box amid Derived Native Grassland



Photograph 3.2 Capertee Rough-barked Apple Red Gum Yellow Box Grassy Woodland

i. Corresponding Classifications

EPBC Act: CEEC White Box – Yellow Box – Blakely's Red gum Grassy Woodland and Derived Native Grassland

TSC Act: EEC White Box – Yellow Box – Blakely's Red gum Grassy Woodland and Derived Native Grassland

DEC (NSW) (2006): MU 20 Capertee Rough-barked Apple Red Gum Yellow Box Grassy Woodland

BioMetric Vegetation Type: CW102 - Apple Box - Yellow Box dry grassy woodland of the South Eastern Highlands

DEC (2006): BVT 41 Stringybark – Box – Gum Woodland

Keith (2004): Western Slopes Grassy Woodland

ii. Description

Capertee Rough-barked Apple Red Gum Yellow Box Grassy Woodland is a form of grassy woodland that occurs on the valley floor and some lower hillsides in the northern portion of the Modification Boundaries (**Photograph 3.1** and **Photograph 3.2**). Typically this

community occurs low in the landscape, in broad, flat areas and is dominated by Blakelys Red Gum (*Eucalyptus blakelyi*), Apple Box (*E. bridgesiana*) and to a lesser extent, Yellow Box (*E. melliodora*). Other species that may occur include *E. dalrympleana*, *E. rubida*, *E. praecox* and *E. mannifera*. The canopy has a height of 10-22m and Projective Foliage Cover (PFC) of 20-40%.

A variety of shrubs occur, including *Acacia buxifolia*, *A. falciformis*, *Podolobium ilicifolium*, *Leucopogon muticus* and *L. virgatus*, with a shrub layer height of approximately 0.5-2m and PFC of 2-25%. Ground cover varies between patches of this woodland type. In some places it is dominated by Wallaby Grasses (*Austrodanthonia* spp), *Austrostipa scabra*, *Poa sieberi*, *Themeda australis* and *Echinopogon ovatus*. In other drier places it is dominated by *Lomandra filiformis*, *Joycea pallida* and *Poa sieberiana*. In some patches herb species are very diverse and species with high coverage include *Hydrocotyle laxiflora* and *Dichondra repens*. The ground cover has a height of 0.1-0.3m and PFC of 30-50%.

This community conforms to EEC listed under the TSC Act and CEEC listed under the EPBC Act.

3.3.2 MU20a – Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland – non grassy



Photograph 3.3 Capertee Rough-barked Apple, Red Gum, Yellow Box Woodland – non grassy. Grass-like plants in the understorey are *Lomandra* spp.

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 20 Capertee Rough-barked Apple Red Gum Yellow Box Woodland – non grassy

BioMetric Vegetation Type: CW102 - Apple Box - Yellow Box dry grassy woodland of the South Eastern Highlands

DEC (2006): BVT 41 Stringybark – Box – Gum Woodland

Keith (2004): Western Slopes Grassy Woodland

ii. Description

This vegetation community is very similar to the Capertee Rough-barked Apple – Red Gum – Yellow Box Grassy Woodland. However, it lacks Yellow Box, the ground stratum is relatively bare and it is not dominated by perennial grasses. Rather it is dominated by matt rushes (*Lomandra* spp) as shown in **Photograph 3.3**. Owing to the lack of a native perennial grassy ground stratum this community does not classify as the CEEC for Box Gum Woodland. It is found in drier sites than the CEEC and is found solely in the north western portion of the Modification Boundaries.

3.3.3 MU13 - Tableland Gully Ribbon Gum – Blackwood – Apple Box Forest



Photograph 3.4 **Tableland Gully Ribbon Gum, Blackwood Apple Box Forest**

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 13 Tableland Gully Ribbon Gum Blackwood Apple Box Forest

BioMetric Vegetation Type: CW154 Mountain Gum - Manna Gum open forest of the South Eastern Highlands

DEC (2006): BVT 1 Mountain Gum – Peppermint Forest at High Altitudes

Keith (2004): Southern Tableland Grassy Woodland

ii. *Description*

This tall open forest community occurs in the low points of steep-sided gullies and on some steep eastern slopes (see **Photograph 3.4**). The dominant canopy species are Ribbon Gum (*E. viminalis*) and often Applebox (*E. bridgesiana*). However, this is a variable and widespread community. Other co-dominants variously include the threatened Stringybark Capertee Stringybark (*Eucalyptus cannonii*) and Silvertop Ash (*E. sieberi*). In some gullies, *E. cannonii* is replaced with Blaxlands Stringybark (*E. blaxlandii*).

The canopy height is approximately 20-30m with approximately 20% projective foliage cover (PFC). There is a small tree layer present of approximately 15m in height comprising younger eucalypts and *Acacia falciformis*. The shrub layer is sparse, with a projective foliage cover (PFC) of approximately 5% and a height range of 0.5-2m. Frequent shrub species include *Hibbertia obtusifolia*, *Styphelia triflora*, *Acacia dealbata*, *Pomaderris* sp, *Leucopogon lanceolata*, *L. muticus* and *Podolobium ilicifolium*.

The low herbaceous ground cover is maintained as a “macropod lawn” by wallabies and kangaroos to approximately 0.05m and PFC of approximately 40%. Dominant species include native grasses and graminoids *Poa sieberiana*, *Lomandra filiformis*, *Microlaena stipoides* and *Echinopogon caespitosus*. Bracken (*Pteridium esculentum*) forms dense patches over approximately 10% of this community with a height of approximately 0.6m.

3.3.4 MU30 - Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland



Photograph 3.5 Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 30, Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland

BioMetric Vegetation Type: CW228 Sydney Peppermint - Silvertop Ash shrubby low open forest of the upper Blue Mountains

DEC (2006): BVT 2 Sydney Sandstone Woodland/Open Forest

Keith (2004): part of Sydney Montane Dry Sclerophyll Forest

ii. Description

This woodland (and sometimes open forest) community occurs at the top of gullies, immediately under pagodas and is a wetter, sheltered forest (**Photograph 3.5**). It is dominated by *E. piperita* and *E. sieberi* and also contains *E. cannonii*, with a canopy height of 25-30m and PFC of approximately 25%. A small tree layer occurs including *Acacia falciformis*, *A. obtusifolia* and *Leptospermum polygalifolium* occurring in the drainage line. Shrubs are rare. The ground cover is typified by a dense covering of Bracken (*Pteridium esculentum*) and False Bracken Fern (*Calochlaena dubia*).

This community is similar to Stringybark – Ribbon Gum – Sydney Peppermint – Silvertop Ash Open Forest and Sydney Peppermint – Silvertop Ash – Stringybark Open Forest.

3.3.5 MU 32 - Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest and Woodland



Photograph 3.6 Tableland Scribbly Gum – Narrow –leaved Stringybark Shrubby Woodland



Photograph 3.7 **Tableland Scribbly Gum – Narrow –Leaved Stringybark Shrubby Open Forest**

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 32, Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest

BioMetric Vegetation Type: CW176 Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion

DEC (2006): BVT 6 Inland Scribbly Gum Woodland

Keith (2004): Southern Tableland Dry Sclerophyll Forests

ii. *Description*

This community varies from open forest to woodland as shown in **Photographs 3.6** and **3.7**. It largely occurs in the highest points of the landscape and where there are locally very low fertility soils. *Eucalyptus rossii* occurs as the only tree species in this community. No quadrat data was collected from this community but it is a shrubby woodland with low forb diversity and high litter coverage. The understorey is similar to that of the Scribbly Gum – Stringybark Woodland community. Typical shrub species include *Leptospermum polygalifolium*, *Monotoca scoparia*, *Brachyloma daphnoides* and *Leucopogon muticus*. A variety of orchids also occur in this community.

3.3.6 MU 34 - Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest



Photograph 3.8 Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 34 Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest

BioMetric Vegetation Type: CW117 Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands

DEC (2006): BVT 4 Mountain Gum – Red Stringybark Open Forest at High Altitudes

Keith (2004): Southern Tableland Dry Sclerophyll Forest

This community occurs mainly on the metamorphic slopes of west Lithgow (DEC (NSW), 2006). The canopy comprises of *Eucalyptus mannifera*, *E. rossii* and *E. dives* at heights 20-25m. On more exposed sites *E. mannifera* and *E. rossii* tend to dominant the canopy. On lower slopes occasional *E. bridgesiana* are found amongst the canopy. This community occurs largely on gentle foot slopes with a westerly or northerly aspect and acts as a transitional forest between grassy gully forests and mid and upper slope shrubby forests (see **Figure 3.1**). The varying species composition exemplifies this with an incursion of species from neighbouring communities.

The shrub layer contains *Hibbertia obtusifolia*, *Leucopogon muticus*, *Persoonia linearis*, *Indigofera australis* and *Acacia buxifolia*. The ground layer is made of largely of dense clumps of tussock grasses including *Joycea palida* or *Lomandra filiformis* (see **Photograph 3.8**). Other species found in the ground layer include; *Lagenifera stipitata*, *Wahlenbergia gracilis*, *Galium propinquum* and *Plantago debilis*.

3.3.7 MU 35 - Tableland Gully Mountain Gum – Broadleaved Peppermint Grassy Forest



Photograph 3.9 Tableland Gully Mountain Gum – Broadleaved Peppermint Grassy Forest

i. Corresponding Classifications

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 35 Tableland Gully Mountain Gum – Broadleaved Peppermint Grassy Forest

BioMetric Vegetation Type: CW154 Mountain Gum - Manna Gum open forest of the South Eastern Highlands

DEC (2006): BVT 1 Mountain Gum – Peppermint Forest at High Altitudes

Keith (2004): Southern Tableland Dry Sclerophyll Forest

ii. *Description*

This open forest community has somewhat varied tree composition (**Photograph 3.9**). It is dominated by Mountain Gum (*E. dalrympleana*), and co-dominated by a suite of other species including Broadleaved Peppermint (*E. dives*), Narrow-leaved Stringybark (*E. sparsifolia*), Scribbly Gum (*E. rossii*) and Brittle Gum (*E. mannifera*). Other eucalypts that also occur in this community, generally infrequently and in localised patches, include *E. praecox* and Ribbon Gum (*E. viminalis*). The canopy has a height of 15-22m and a PFC of 30%.

This is a forest with sparse to mid dense shrubs with typical shrub species including *Persoonia myrtilloides*, *Acacia ulicifolia*, *Hakea dactyloides*, *Acacia terminalis* and *Podolobium ilicifolium*. Ground cover species are dominated by *Joycea pallida*, *Poa sieberiana* and *Lomandra filiformis*. The average ground cover height here is 0.5m as there is less grazing and PFC is 40%.

3.3.8 MU37 - Cox's Permian Red Stringybark – Brittle Gum Woodland



Photograph 3.10 **Cox's Permian Red Stringybark – Brittle Gum Woodland**

i. *Corresponding Classifications*

TSC Act: not listed

EPBC Act: not listed

DEC (NSW) (2006): MU 37 Cox's Permian Red Stringybark – Brittle Gum Woodland

DEC (2006): BVT 4 Mountain Gum – Red Stringybark Open Forest at High Altitudes

BioMetric Vegetation Type: CW117 Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands

Keith (2004): Southern Tableland Dry Sclerophyll Forests

ii. *Description*

This community occurs on exposed escarpment slopes and ridges of the Upper Cox's catchment and is defined by low growing and open woodland with an inconsistent understorey (see **Photograph 3.10**). The dominant tree species include *Eucalyptus macrorhyncha* and *E. mannifera*; however several other species may appear in combination or at localised sites including *E. rossii* and *E. dives*. The shrub layer if present consists of *Lissanthe strigosa*. The groundcover retains a sparse though consistent cover of forbs and occasional grasses, *Acaena novae-zelandiae*, *Galium gudichaudii*, *Geranium solanderi*, *Hibbertia obtusifolia*, *Hypericum gramineum* and *Lomandra filiformis*.

3.4 Flora

An extensive amount of flora survey has been conducted within the study area over several years. A combined species list has been compiled from the flora surveys previously conducted in the study area (AES, 2003; Lembit, 2003) and the species identified during surveys by Cumberland Ecology (2012a) of the study area. Extra species detected during random meanders not previously on the list were also added to this list (**Appendix A**).

The dominant plant families encountered in the open forest and woodland have been consistently represented by the Myrtaceae, Fabaceae, Asteraceae and Poaceae families. The most common genera encountered are *Eucalyptus* and *Acacia*.

3.4.1 Threatened Flora Species

One threatened flora species, *Eucalyptus cannonii* (Capertee Stringybark), listed as Vulnerable under the TSC Act has been recorded within the Modification Boundaries and study area.

Although not recorded from the study area, a number of additional threatened flora species have been recorded in the Lithgow LGA. **Table D.1** in **Appendix D** analyses the likelihood of occurrence within the study area of threatened species known to occur within the Lithgow

LGA. Threatened flora species known to occur or that have the potential to occur within the Modification Boundaries are discussed further below.

i. Eucalyptus cannonii

Eucalyptus cannonii (Capertee Stringybark) [syn. Cannon's Stringybark, *Eucalyptus macrorhynca* subsp. *cannonii*] was recorded within the Modification Boundaries. This species is listed as Vulnerable under the TSC Act. *Eucalyptus cannonii* is also listed as Rare or Threatened Plant (ROTAP) as 2Vci. *Eucalyptus cannonii* is restricted to an area of approximately 100 km by 60 km in the central tablelands of NSW. The western border generally aligns between Bathurst and Mudgee, while the eastern locations occur approximately between Lithgow and the town of Bylong. Within this area the species is often locally frequent (DEC (NSW), 2005c).

The altitude range of *Eucalyptus cannonii* is from about 460 m to 1040 m (DEC (NSW), 2005a). The species mostly occurs on rocky, usually poor, steep ridges in dry sclerophyll forest, although it can also be found in valleys and on gentle slopes (NSW Scientific Committee, 2004b) but less commonly on valley floors (DEC (NSW), 2005a). Associated tree species include Red Stringybark (*E. macrorhynca*), Thin-leaved Stringybark (*E. eugenoides*), Red Box (*E. polyanthemos*) and Scribbly Gum (*E. rossii*). On the intermediate slopes there may also be Narrow-leaved Red Ironbark (*E. crebra*), *E. blakelyi*, *E. melliodora*, *E. bridgesiana*, *E. dalrympleana* and *E. viminalis*, whilst on the on lower slopes it may occur with *E. mannifera* subsp. *praecox*, *E. laevopinea*, *E. oblonga*, *E. sparsifolia*, *E. dives* and *E. goniocalyx*. On rocky areas *Angophora intermedia* has been recorded co-existing. *E. cannonii* is also known to hybridise with *E. macrorhynca* (NSW Scientific Committee, 2004b).

From observations, the species was found to occur sporadically over much of the study area in a diversity of habitats. For this reason its habitat cannot be accurately mapped, unlike *Persoonia marginata* which has a specific, niche tangible habitat. Where recorded, the species seemed to form localised patches, sometimes forming monotypic stands. The densities varied from vegetation community to vegetation community (**Table 3.2**). Generally, the species was commonly found within the mid to lower slopes and the valley floors, particularly within Tableland Gully Ribbon Gum Blackwood – Apple Box Forest and Cox's Permian Red Stringybark – Brittle Gum Woodland. Densities within Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland were variably different. The species was not recorded within Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland and was rarely found in Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest, usually close to community transitional zones. As topography steepened in the study area and the vegetation changed into Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland or Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest *Eucalyptus cannonii* ceased to occur and *Eucalyptus sparsifolia* became the dominant Stringybark.

The results of the *Eucalyptus cannonii* quadrats in the study area have been used to attempt to estimate the number of individuals within the Modification Boundaries and are shown in **Appendix C**. The average numbers of the individuals recorded in each quadrat has been

extrapolated to a density per hectare estimate for each vegetation community. This has then be used to provide an estimate of the number of *Eucalyptus cannonii* individuals occurring in each vegetation community within the Modification Boundaries. Approximately 4,500 individuals are predicted to occur in the Modification Boundaries and in excess of 16,800 individuals are predicted within the study area. These were calculated by extrapolating average densities of *Eucalyptus cannonii* found in quadrats located in each vegetation community across the Modification Boundaries and study area.

Of these, approximately 2,300 individuals are predicted to be removed from the Modification Disturbance Boundaries; 470 and 1,830 individuals are predicted to occur in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively.

These calculations are summarised in **Table 3.2** below.

Table 3.2 Eucalyptus cannonii Impact Calculations

MU	Vegetation Community	Average Density per hectare	Extent of Community in Modification Boundaries (ha)	Estimated Number of Individuals in Modification Boundaries	Extent of Community in Cullen Valley Modification Disturbance Boundary	Extent of Community in Invincible Modification Disturbance Boundary	Estimated Number of Individuals to be removed from the Cullen Valley Modification Disturbance Boundary	Estimated Number of Individuals to be removed from the Invincible Modification Disturbance Boundary	Estimated Number of Individuals remaining in the Modification Boundaries
13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	105	22	2,310		7.9	0	828	1,482
20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland	65	1	65		0	0	0	65
30	Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	0	141	0	5.2	32.2	0	0	0
32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	3	87	261	34.8	0.4	104	1	156
34	Tableland Slopes Brittle	17	81	1,377	21.7	37.7	369	640	368

Table 3.2 Eucalyptus cannonii Impact Calculations

MU	Vegetation Community	Average Density per hectare	Extent of Community in Modification Boundaries (ha)	Estimated Number of Individuals in Modification Boundaries	Extent of Community in Cullen Valley Modification Disturbance Boundary	Extent of Community in Invincible Modification Disturbance Boundary	Estimated Number of Individuals to be removed from the Cullen Valley Modification Disturbance Boundary	Estimated Number of Individuals to be removed from the Invincible Modification Disturbance Boundary	Estimated Number of Individuals remaining in the Modification Boundaries
35	Gum – Broad-leaved Peppermint Grassy Forest Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	45	11	495		8	0	359	136
TOTAL				4,508			474	1,828	2,207

**Note that the calculations for the Invincible Modification also include the pipeline and it is unlikely that any individuals will need to be removed. These calculations are therefore conservative.*

ii. *Persoonia marginata*

Persoonia marginata (Clandulla Geebung) is listed as Vulnerable under both the TSC Act and the EPBC Act and was recorded outside the study area.

Persoonia marginata is known from only four disjunct locations on the Central Tablelands and Central Coast (DEC (NSW), 2005j). The core of the species' distribution is within Clandulla State Forest, west of Kandos. Disjunct populations occur to the north at Dingo Creek and Mount Dangar within the Wollemi and Goulburn River National Parks; to the south within Ben Bullen State Forest, south-east of Capertee; and to the south-east at Devils Hole, north of Colo Heights within Parr State Recreation Area (DEC (NSW), 2005j). Two of these disjunct populations occur close to the study area, within the Wollemi National Park and within Ben Bullen State Forest (DEC (NSW), 2005j) (DEC (NSW), 2005c). Known populations have been recorded to date on flat ground within dry sclerophyll forest and woodland on sandy loam, clayey and/or rocky soils derived from Permian rock (Threatened Species Scientific Committee, 2008b).

This species was recorded at three locations outside the study area:

1. To the north of the approved disturbance area of Cullen Valley Mine (but within the Cullen Valley Mining Exclusion Zone), and also extending north beyond the study area into Ben Bullen State Forest;
2. Within Cullen Valley Mine's existing Habitat Compensation Area no. 5; and
3. In the northern extent of the study area to the east of occurrence found within the approved Cullen Valley Mine disturbance area.

Examination of the geological profile at each sub-population occurrence suggests that this population is closely associated with the Upper Irondale Seam, which is comprised of coal, oil shale, minor shale and sandstone; and the Irondale Seam, which contains coal and minor shale. The populations were rarely found above these seams within the skeletal sandstone soil along the plateaus or at lower landscape positions in gullies containing deeper wetter soils and a denser grassier ground layer. The population may also be strongly influenced by aspect, as the population was recorded exclusively on western slopes and none on eastern slopes. All three subpopulations were also recorded on sloping and relatively flat land facing west in dry sclerophyll forest or woodland with a sparse understorey. The vegetation in which these subpopulations have been recorded has been classified as Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest.

Very little is known about this species as a result of its restricted distribution. It is possible that suitable habitat occurs in other areas of dry sclerophyll forest and woodland communities within the study area; although no other individuals were detected in this area during targeted surveys or previous surveys for the species.

iii. *Eucalyptus pulverulenta*

Eucalyptus pulverulenta (Silver-leaved Mountain Gum) is listed as Vulnerable under the EPBC Act and TSC Act. Silver-leaved Mountain Gum has a highly disjunct distribution and is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro area (DEC (NSW), 2005e). Silver-leaved Mountain Gum grows in shallow soils as an understorey plant in open forest, typically dominated by *Eucalyptus mannifera* (Brittle Gum), *E. macrorhynca* (Red Stringybark), *E. dives* (Broad-leaved Peppermint), *E. sieberi* (Silvertop Ash) and *E. bridgesiana* (Apple Box). Silver-leaved Mountain Gum occurs on the crests or upper slopes of moderately steep hillsides or mountains, at altitudes of 800–1,000 m, usually on well-drained skeletal soils with frequent rock outcrops (DEC (NSW), 2005e).

The Atlas of NSW Wildlife holds 12 records of *Eucalyptus pulverulenta* within the Lithgow LGA. The closest record occurs approximately 6 km (dated 1974) from the study area. Additional records of this species occur within the Central Tableland bioregion. *Eucalyptus pulverulenta* is not known from any conservation reserves within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries in areas mapped as Exposed Blue Mountains Sydney Peppermint, Silvertop Ash Shrubby Woodland and Tableland Scribbly Gum Narrow-leaved Stringybark Shrubby Open Forest. The Modification Boundaries occurs at similar altitudes (800-1,020m above sea level (ASL)). Other species generally associated with this species are found within the upper and mid slopes within the study area. However, repeated targeted surveys during flowering times within these communities have failed to locate the species.

The Atlas of NSW Wildlife holds 12 records of *Eucalyptus pulverulenta* within the Lithgow LGA. The closest record occurs approximately 6 km (dated 1974) from the study area. Additional records of this species occur within the Central Tableland bioregion. *Eucalyptus pulverulenta* is not known from any conservation reserves within Lithgow LGA.

iv. *Grevillea evansiana*

Grevillea evansiana is listed as Vulnerable under the EPBC Act and TSC Act. It is restricted to a small area east of Olinda in the Kandos-Rylstone district, mostly on the western catchment, but also extending into the Colo River catchment (Threatened Species Scientific Committee, 2008a). The species inhabits dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone (DEC (NSW), 2005h).

The Atlas of NSW Wildlife holds 17 records of *Grevillea evansiana* within the Lithgow LGA. The closest records occur approximately 15 km from the study area within the Gardens of Stone National Park. Additional records of this species occur within the western side of Wollemi National Park within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries in areas mapped as Pagoda Rock Sparse Shrubland and Sydney Peppermint, Silvertop Ash Shrubby Woodland. DEC (2006) has identified these two communities as providing possible habitat for the species, while Benson & Keith (1990) have identified Scribbly Gum Stringybark Woodland mapped as Tableland Scribbly Gum Narrow-leaved Stringybark Shrubby Open Forest within the study area. However, repeated targeted surveys during flowering periods in these communities failed to locate the species within Pagoda Rock Sparse Shrubland NSW NPWS, 2000a).

v. *Grevillea obtusiflora ssp. obtusiflora*

Grevillea obtusiflora ssp. obtusiflora is listed as Endangered under the EPBC Act and TSC Act. *Grevillea obtusiflora ssp. obtusiflora* is known to occur near Rylstone in the Central Tablelands bioregion (NSW NPWS, 2000c). *G. obtusiflora* subsp. *obtusiflora* occurs in the understorey of low open eucalypt forest at an altitude of 730 metres ASL (NSW NPWS, 2000c).

The Atlas of NSW Wildlife holds 43 records of *Grevillea obtusiflora* within the Lithgow LGA. Numerous records are found within the nearby Gardens of Stone National Park. Additional records of this species occur within the western side of Wollemi National Park within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries, albeit above the altitude of known populations. The study area's elevation ranges between 800-1,020 m above sea level, considerably higher than what is documented as suitable habitat. Species generally associated with this species found within the mid and upper slopes and exposed plateaus within the study area include *Acacia buxifolia*, *Leucopogon spp.*, *Caustis flexulosa*, *Dianella spp.* and *Patersonia spp.* Repeated targeted surveys during flowering periods within these communities on mid and upper slopes have failed to locate the species.

vi. *Grevillea obtusiflora ssp. fecunda*

Grevillea obtusiflora ssp. fecunda is listed as Endangered under the EPBC Act and TSC Act. *G. obtusiflora ssp. fecunda* is known to occur in the Capertee Valley, west of Lithgow, and in the Gardens of Stone National Park (NSW NPWS, 2000c). Both sites are in the Central Tablelands botanical division. *G. obtusiflora* subsp. *fecunda* occurs on orange sandy loam soils with sandstone boulders in low open scrub beneath open dry sclerophyll forest, at an altitude of 570 m (NSW NPWS, 2000c). Species found growing alongside include *Eucalyptus tenella*, *E. fibrosa*, *E. macrorhyncha*, *E. punctata*, *Callitris endlicheri*, *Acacia buxifolia*, *Leptospermum continentale*, *Monotoca elliptica.*, *Persoonia linearis*, *Indigofera sp.*, and *Pomax umbellata* (NSW NPWS, 2000c).

The Atlas of NSW Wildlife holds 43 records of *Grevillea obtusiflora* within the Lithgow LGA. Numerous records are found within the nearby Gardens of Stone National Park. Additional records of this species occur within the western side of Wollemi National Park within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries within the drier woodland and forest communities. Common species generally associated with habitat for this species are found within the mid and upper slopes and exposed plateaus within the study area; however these habitats occur around 900 m above sea level, far beyond known populations of *Grevillea obtusiflora* ssp. *Fecunda*. Repeated targeted surveys during flowering periods on mid and upper slopes and exposed plateaus have failed to locate the species.

vii. *Prostanthera cryptandroides* subsp. *cryptandroides*

Prostanthera cryptandroides subsp. *cryptandroides* is listed as Vulnerable under the EPBC Act and TSC Act. *Prostanthera cryptandroides* is known from Glen Davis to Capertee and extends to the Goulburn River Valley, NSW (Threatened Species Scientific Committee, 2008c). *Prostanthera cryptandroides* occurs in dry sclerophyll forested slopes and gullies, in rocky ridgelines and rocky areas especially at the base of scree slopes and sandstone boulders, and in shallow sandy loam, as an understorey species (Threatened Species Scientific Committee, 2008c).

The Atlas of NSW Wildlife holds 22 records of *Prostanthera cryptandroides* subsp. *cryptandroides* within the Lithgow LGA. The closest record occurs within Ben Bullen State Forest near Baal Bone Colliery. Additional records of this species occur within the Central Tableland bioregion. *Prostanthera cryptandroides* subsp. *cryptandroides* is conserved in Wollemi National Park and Gardens of Stone National Park within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries within open forest and woodland communities. Pagoda Rock Sparse Shrubland, Tableland Scribbly Gum Narrow-leaved Stringybark Shrubby Open Forest and Capertee Rough-barked Apple Red Gum Yellow Box Woodland has been identified as providing possible habitat for the species (DEC 2006), and these communities occur within the Modification Boundaries. One record of the species has been found within Pagoda Rock Complex at Glen Davis (NSW NPWS, 2000b). However, repeated targeted surveys during flowering periods in dry sclerophyll forested slopes and gullies, in rocky ridgelines and rocky areas especially at the base of scree slopes and sandstone boulders, and in shallow sandy loam have failed to locate the species.

viii. *Eucalyptus aggregata*

Eucalyptus aggregata (Black Gum) is listed as Vulnerable under the TSC Act and was recorded outside of the study area. Black Gum is found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT (NSW Scientific Committee, 2010). In NSW it occurs in the South Eastern Highlands Bioregion and on the western fringe of the Sydney Basin Bioregion (NSW Scientific Committee, 2010). Black Gum has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands (NSW Scientific Committee, 2010). It grows in the lowest parts of the landscape on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers (NSW Scientific Committee, 2010).

The Atlas of NSW Wildlife holds 9 records (post 1980) of *E. aggregata* within the Lithgow LGA. The two previously known records occur within 5 km from the study area, in the Gardens of Stone National Park to the north, and in Blackmans Flats to the south. Additional records of this species occur within the Central Tableland bioregion. Black Gum is not known from any conservation reserves within Lithgow LGA.

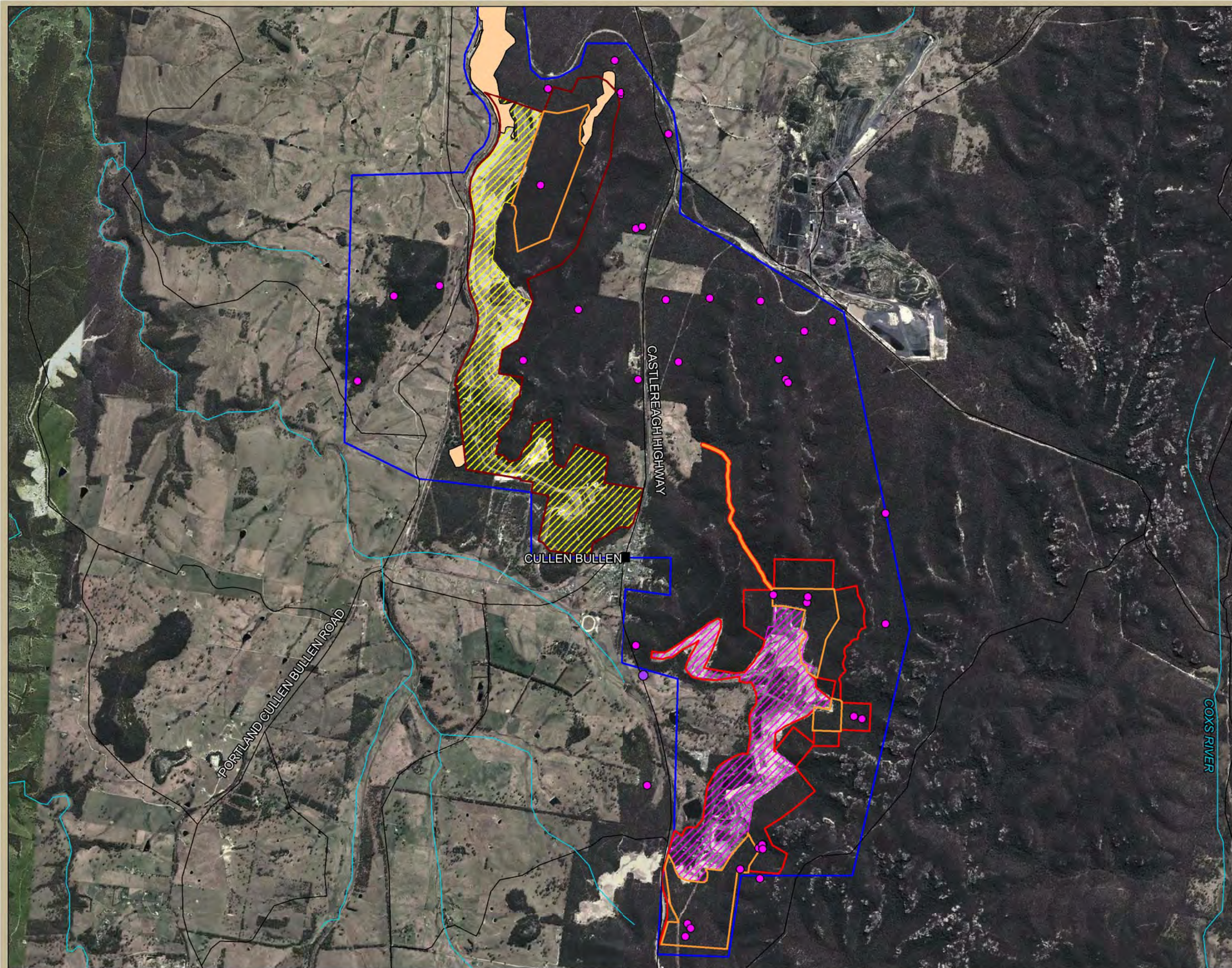
This species was recorded in Lot 112, DP 877190, Invincible Colliery's 2008 Offset. Approximately 20 trees were recorded within a cleared valley floor pasture (**Figure 3.2**).

ix. *Derwentia blakelyi*

Derwentia blakelyi is listed as Vulnerable under the TSC Act. This species is known to be restricted to the western Blue Mountains, near Clarence, near Mt Horrible, on Nullo Mountain and in the Coricudgy Range (NSW Scientific Committee, 2000). It grows in eucalypt forest often in moist areas (NSW Scientific Committee, 2000).

The Atlas of NSW Wildlife holds 50 records of *Derwentia blakelyi* within the Lithgow LGA. The distribution within Lithgow LGA largely occupies Newnes Plateau, less than 5km away. Additional records of this species occur within the Central Tableland bioregion. *D. blakelyi* is not known from any conservation reserves within Lithgow LGA.

Potential habitat for this species occurs within the Modification Boundaries within areas mapped as Tableland Gully Mountain Gum Broad-leaved Peppermint Forest, Tableland Gully Ribbon Gum Blackwood Apple Box Forest and Capertee Rough-barked Apple Red Gum Yellow Box Woodland, particularly in the lowest areas or floors of these communities. DEC (NSW) (2006) has found the species within Gully Ribbon Gum Blackwood Apple Box Forest and have identified Tableland Gully Mountain Gum Broad-leaved Peppermint Forest as providing possible habitat. However, repeated targeted surveys during flowering periods in the aforementioned vegetation communities have failed to locate the species.



Legend

- Cullen Valley Modification Boundary
- Invincible Colliery Modification Boundary
- Study Area
- Existing Cullen Valley Mine
- Existing Invincible Colliery
- Modification Disturbance Boundaries
- Road
- Waterway
- Town

Threatened Flora

- Persoonia marginata* habitat
- Eucalyptus cannonii* (TSC Act)
- Eucalyptus aggregata* (TSC Act)

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Data Source:
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(Geoscience Australia) 2006



Figure 3.2. Locations of Threatened Flora Species in the Study Area



3.4.2 ROTAP Species

Although not listed under State or Commonwealth conservation legislation, several Rare or Threatened Australian Plant (ROTAP) species have been recorded from the study area by Cumberland Ecology or by others. These include the following species:

- *Gonocarpus longifolius*;
- *Acacia asparagoides*;
- *Leonema lamprophyllum* subsp. *orbiculare*;
- *Laucochrysum graminifolium*; and
- *Philotheca obovalis*.

3.5 Fauna

Extensive fauna surveys have been conducted throughout the study area over several years (Wildsearch, 1997, AES, 2003). Current fauna surveys were designed to provide additional information for particular fauna groups as well as to address current listings of species under State and Commonwealth legislation. A list of all fauna species recorded in the study area is presented in **Appendix B**.

This section first considers the fauna habitats present in the study area and then assesses the threatened species with potential to occur.

3.5.1 *Fauna Habitat Assessment*

The primary fauna habitats located within the study area are:

- Open forest communities;
- Woodland communities;
- Cliffs and caves; and
- Permanent and ephemeral water bodies such as dams.

Forest and woodland communities occur extensively throughout the study area and provide suitable habitat for a range of fauna types including: amphibians, reptiles, birds, bats and arboreal and terrestrial mammals. Key habitat features recorded in the study area included:

- Woodland and forest vegetation – shelter and forage for birds including raptors and microbats;
- 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 terrestrial mammals and cave dwelling microbats;
- 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 limited aquatic vegetation – foraging and breeding habitat for amphibians, aquatic reptiles and wetland birds.

There are no wetlands or permanent streams within the study area. However, there are a small number of ephemeral streams and farm dams. The network of intermittent drainage lines present in the study area would create temporary pools following heavy rain and provide suitable foraging and breeding habitat for a number of amphibian species. The dams within the study area do not generally support aquatic vegetation and are typically small, however they do provide limited habitat for some wetland-dependent species such as wetland birds and amphibians. The water contained within dams and temporary pools also provides a drinking source for terrestrial and arboreal mammals, birds and reptiles.

Features such as rock outcrops, 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 abundant within the forest and woodland communities of the study area. However, the results of numerous surveys indicate that the study area supports a low abundance and diversity of small terrestrial fauna when compared to more intact areas. This may be a result of past land use (logging) and inappropriate fire regimes, combined with the presence of feral predators (e.g. foxes) which are abundant throughout the study area despite baiting efforts. 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 forest and woodland 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 dependent on this resource as shelter and breeding habitat. Large hollows in tall trees that provide breeding and shelter habitat, particularly for large forest owls and large gliders, are relatively abundant in the taller forest communities of the study area.

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. It is likely that a number of nectar-dependent bird species would be attracted to the study area during the blossoming periods of dominant trees.

Habitat assessments during the field surveys indicated that the sandstone escarpments of the study area support suitable habitat for cave-dependent fauna, particularly various Microchiropteran bats. Records of cave-dependent microbats indicate that the study area provides suitable forage, roosting and breeding habitat for these species.

3.5.2 Threatened Fauna Species

No threatened fauna species have been recorded within the Modification Boundaries. A number of threatened species are known in the Lithgow LGA or have been recorded in the study area and some have potential to occur in the Modification Boundaries.

Table E.1 in **Appendix E** presents an analysis of the likelihood of occurrence within the study area of threatened species known to occur within the Lithgow LGA. Those considered likely to occur or with potential to occur within the study area are discussed below.

i. Invertebrates

No threatened invertebrates listed under the EPBC Act or TSC Act were recorded within the study area, however the Bathurst Copper Butterfly listed as Vulnerable under the EPBC Act and Endangered under the TSC Act has the potential to occur within the study area.

It is recommended by NSW NPWS (2001a) that potential habitat for Bathurst Copper Butterfly be identified by the presence of *Bursaria spinosa* subsp. *lasiophylla* at locations above approximately 900 metres in altitude. NSW NPWS (2001a) further explain that aspect, geology, vegetation overstorey species are sufficiently variable at known locations of the butterfly to preclude their use as factors in identifying potential habitat. Nevertheless, the reliance on *Bursaria spinosa* subsp. *lasiophylla* further constrains potential habitat to forest and woodlands on heavier soils. Further, the species requires vegetation structure so that it is exposed to sun all day (NSW NPWS 2001a). The majority of the vegetation above 900m in the study area is situated on sandstone soils unsuitable for the host plant. Some small areas of Tableland Gully Ribbon Gum – Blackwood – Applebox Open Forest and Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland above 900m were targeted within the study area as these communities contain clay soils and could support the host plant. However, no sparse understorey dominated by *Bursaria spinosa* subsp. *lasiophylla* was recorded. Additionally, there may be other biotic factors dictating the distribution of the species, as some potential habitat may contain both the host plant and the attendant ant, but not the Bathurst Copper Butterfly (NSW NPWS 2001b).

Surveys failed to locate these habitat requirements within the study area. A single individual of *Bursaria spinosa* subsp. *lasiophylla* has been identified as occurring within the study area by OEH within plants. For this reason, the occurrence of this species within the Modification Boundaries cannot be completely discounted. The potential impacts to this species are discussed in **Chapter 4**.

ii. Amphibians

The lack of natural pools and streams, and the relatively dry conditions experienced throughout the survey period means that the study area provided limited habitat for amphibians. The small dams within the study area provide some habitat for a number of common amphibian species. No threatened amphibians listed under the EPBC Act or TSC Act were recorded during surveys and none are likely to occur within the Modification Boundaries as no suitable habitat for any amphibian other than common widespread species was recorded during field surveys.

iii. Reptiles

No threatened reptiles listed under the EPBC Act or TSC Act were recorded within the study area.

The Broad-headed Snake (*Hoplocephalus bungaroides*) listed as Vulnerable under the EPBC Act and Endangered under the TSC Act is considered to have potential to occur. The Broad-headed Snake occurs from the coast to ranges of south-eastern Australia, where it is largely confined within an area approximately 250 km west of Sydney where Triassic and Permian sandstones (including the Hawkesbury, Narrabeen and Shoalhaven groups) occur. This nocturnal species inhabits rock crevices and shelters under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. During summer the species typically migrates about 200m from the sandstone escarpments to hollows in large trees (DEC (NSW), 2005b). Preferred prey species (geckos and small skinks) were recorded during surveys of the study area. The Broad-headed Snake centres its habitat around vegetation communities (mainly woodland, open woodland and/or heath) on exposed sandstone outcrops and benching (DEC (NSW), 2005b). They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer within 200 m of their winter habitat (DEC (NSW), 2005b). These habitats exist within the study area as rocky escarpments (winter habitat) as well as valley forests directly beneath these winter habitats. Given the proximity of a nearby recent record (less than 1km), the extent of suitable winter and summer habitat recorded in the study area and ample connectivity to other areas of extensive high quality habitat in Ben Bullen State Forest, Newnes State Forest and Wollemi National Park to the east, the Broad-headed Snake is considered to have potential to occur, despite the absence of detection during the survey periods.

Rosenberg's Goanna (*Varanus rosenbergi*); listed as Vulnerable under the TSC Act has the potential occur in the study area. Rosenberg's Goanna occurs in heath, open forest and woodland. There are very few records within the Lithgow LGA, which occur predominately in the Wollemi National Park. The species requires large tracts of habitat in which termite mounds are critical for the species' life cycle. For this reason it is possible that this species may utilise habitat within the study area from time to time. The habitat with potential to be used would include the woodland of the mid to upper slopes and heath within the ridgelines and rocky escarpments more so than the taller gully forests. Given the extent of suitable habitat, and ample connectivity to even more extensive habitat in other areas of Ben Bullen State Forest and Wollemi National Park to the east, it is possible that the Modification Boundaries could support the Rosenberg's Goanna, despite the absence of detection during the survey periods.

iv. Birds

No threatened birds listed under the EPBC Act or TSC Act were recorded within the Modification Boundaries, however several have been recorded within and have potential to occur in the study area. These are:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*);

- Brown Treecreeper (*Climacteris picumnus*);
- Scarlet Robin (*Petroica boodang*);
- Speckled Warbler (*Chthonicola sagittata*);
- Square-tailed Kite (*Lophoictinia isura*);
- Powerful Owl (*Ninox strenua*); and
- Varied Sittella (*Daphoenositta chrysoptera*).

In addition, several threatened birds have been recorded from the locality and are considered to have potential to occur. A more detailed discussion of the threatened birds species recorded within the study area are included below as well as those threatened species that were not recorded but have potential to occur. The locations of all threatened species identified in the study area are provided in **Figure 3.3**.

a. Blossom-dependant Birds

All of the open forest and woodland communities within the study area would provide some foraging habitat for the range of threatened blossom-dependent birds known from the Lithgow LGA, especially during the blossom periods of dominant trees within these communities. The blossoming periods of eucalypt species recorded from the study area are presented in **Table 3.3**. Blossom-dependant threatened bird species with potential to occur in the study area include the following:

- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Black-chinned Honeyeater (*Melithreptus gularis*); and
- Painted Honeyeater (*Grantiella picta*)

These are considered in more detail below.

The Regent Honeyeater (*Anthochaera phrygia*) is listed as Critically Endangered under the EPBC and TSC Act and was not recorded within the study area. Regent Honeyeaters are a nomadic species that will move to areas where food is abundant, however, the exact nature of these movements is still poorly understood. The majority of records within the Lithgow LGA are confined to areas of low relief in the Capertee and Wolgan Valleys to the north and northeast of the study area. These valleys are known breeding locations for this species. The species prefers box-ironbark eucalypt associations and it seems to prefer wetter, more fertile sites within these associations, such as along creek flats, broad river valleys and lower slopes (Department of Environment and Conservation NSW, 2004). This is manifested through the location of records within the Lithgow LGA. Among the documented tree

species favoured by the species, *Eucalyptus melliodora* and *Eucalyptus blakelyi* have been recorded in low densities in the study area. These trees occur within isolated pockets along drainage lines within the community Tableland Gully Mountain Gum – Broad Leaved Peppermint Grassy Forest and within the Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland – non grassy. The study area also provides insect forage which is an important diet for nestlings and during times when nectar is scarce (DEC (NSW), 2005k). It is likely that the species may utilise habitat within study area irregularly. It is also likely areas of non-preferred vegetation may be relied on when primary forage habitats occur further north are scarce.

The Swift Parrot (*Lathamus discolor*) is listed as Endangered and Migratory under the EPBC Act and Endangered under the TSC Act. It was not recorded within the study area. This species breeds in Tasmania during spring and summer, migrating between March and September to south-eastern Australia (Swift Parrot Recovery Team, 2000). They will return to some foraging sites on a cyclic basis depending on food availability. Their principal habitat is box-ironbark forest including grassy white box and grassy grey box communities. Principal food trees include *Eucalyptus sideroxylon*, *E. microcapra* and *E. albens* (Swift Parrot Recovery Team, 2001). This is manifested through the distribution of the species in the Lithgow LGA, as all records are confined to areas of low relief in the Capertee Valley. The study area does not contain principal forage habitat for the Swift Parrot. Eucalypts recorded in the study area and their known flowering times are provided in the table below. The months in which the Swift Parrot migrates to Australia are italicised. As highlighted in the table below, the dominant eucalypts within the study area do not convincingly cover the months of March to September when compared to principal food trees. Under the assumption that the species chooses principal food trees over other trees, unless nectar is scarce, the Swift Parrot may utilise flowering eucalypts within the study area irregularly or to supplement their diet, particularly when the dominant trees are not profusely flowering during winter months.

The Little Lorikeet (*Glossopsitta pusilla*) is listed as Vulnerable under the TSC Act. This species prefers flowering eucalypts on fertile soils and will also try to nest in proximity to feeding areas (DECCW (NSW), 2010a). The species is likely to forage in the Capertee Valley and nest in the surrounding landscapes. This is illustrated by the amount and distribution of records in the Lithgow LGA. Although not recorded from the study area, this blossom dependent nomad could potentially forage in open forest and woodland communities within the study area at any time of year, providing there is substantial blossoming of the dominant trees. Eucalypts recorded in the study area and their known flowering times are provided in the table below. The study area supports a diverse range of eucalypts with varying flowering times, with the majority of dominant trees flowering in summer. Although the study area does provide suitable breeding habitat for this species, it seems to prefer habitats closer to the Capertee Valley. It is unlikely that study area forms critical breeding habitat due to the distance to feeding habitats. It is likely that the study area could provide nesting and foraging habitat during times when closer habitats are used for feeding.

The Black-chinned Honeyeater (*Melithreptus gularis*) is listed as Vulnerable under the TSC Act. The species occupies mostly the upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), *E. microcarpa* (Inland Grey Box), *E. melliodora* (Yellow Box) and *E. tereticornis* (Forest Red Gum) (DEC (NSW), 2005a). As indicated in the table below *Eucalyptus melliodora* may provide some forage; however these are in very low numbers and occur within a small area (0.69 ha) within the study area. The study area provides an abundance of upper level woodland and forests; however their preference to other flowering eucalypts is not well documented. The known occurrence within the Lithgow LGA suggests the species may prefer habitats further north. Two records (dated 2004) are located in similar habitat in Newnes State Forest approximately 10km away. It is unlikely that study area forms critical breeding habitat as indicated by a lack of records in the immediate area. It is likely that the study area could provide nesting and foraging habitat.

The Painted Honeyeater (*Grantiella picta*) is listed as Vulnerable under the TSC Act. This species is known to occupy a range of habitats, including Box-Gum 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 as *Amyema pendulum* within the study area (DEC (NSW), 2006a). Nectar from this mistletoe and insects present on them are also consumed (DEC (NSW), 2006a). Given the abundance of *Amyema* sp. mistletoes it is likely that the Painted Honeyeater could occur within the study area at various times.

Table 3.3 Flowering Times of Principal Eucalypts Recorded in the Study Area

Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Principal Food Trees for Swift Parrot												
<i>Eucalyptus albens</i> (White Box)												
<i>Eucalyptus microcarpa</i> (Inland Grey Box)												
<i>Eucalyptus sideroxylon</i> (Mugga Ironbark)												
Eucalypts in the study area												
<i>Eucalyptus aggregata</i> (Black Gum)												
<i>Eucalyptus blakelyi</i> (Blakely's Red Gum)												
<i>Eucalyptus blaxlandii</i> (Blaxland's Stringybark)												
<i>Eucalyptus bridgesiana</i> (Apple Box)												
<i>Eucalyptus cannonii</i> (Capertee Stringybark)												

Table 3.3 Flowering Times of Principal Eucalypts Recorded in the Study Area

Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Eucalyptus dives</i> (Broad-leaved Peppermint)												
<i>Eucalyptus macrorhyncha</i> (Red Stringybark)												
<i>Eucalyptus dalrympleana</i> (Mountain Gum)												
<i>Eucalyptus goniocalyx</i>												
<i>Eucalyptus mannifera</i> (Brittle Gum)*												
<i>Eucalyptus melliodora</i> (Yellow Box)												
<i>Eucalyptus piperita</i> (Sydney Peppermint)												
<i>Eucalyptus rossii</i> (Inland Scribbly Gum)*												
<i>Eucalyptus sieberi</i> (Silvertop Ash)*												

Table 3.3 Flowering Times of Principal Eucalypts Recorded in the Study Area

Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Eucalyptus stricta</i>												
<i>Eucalyptus sparsifolia</i> (Narrow-leaved Stringybark)												
➤ <i>Eucalyptus viminalis</i> (Ribbon Gum)												

b. Migratory Birds

One EPBC Act listed Migratory species has been recorded in the study area; the Satin Flycatcher (*Myiagra cyanoleuca*).

The Satin Flycatcher is a migratory species that has been recorded approximately 2 km north and 1 km east of the study area (Cumberland Ecology 2012a) and previous surveys (Wildsearch 1996; AES 2003). The species is a warm season migrant that forages and nests within forest and woodland. The Satin Flycatcher was recorded in similar vegetation approximately 2 km north of the study area (Cumberland Ecology 2012a). It is likely that the study area provides breeding habitat for the species based on the following information:

- A nearby recent sighting approximately 2 km north of the study area during their breeding season in November;
- The presence of preferred nesting trees and vegetation complexes; and
- Satin Flycatchers have been recorded at densities of 1.25 birds/ha near Bathurst, [approximately 56 km away] (SEWPaC, 2012b). This is the highest recorded density in NSW described by SEWPaC (2012b).

Although not recorded, a number of other birds listed as migratory under the EPBC Act have potential to occur within the study area. These include:

- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Black-faced Monarch (*Monarcha melanopsis*);
- Rufous Fantail (*Rhipidura rufifrons*); and
- Swift Parrot (*Lathamus discolor*).

The White-throated Needletail is a summer migrant that forages over the canopy of forest and woodland communities for small flying insects. This is a wide-ranging species and is almost exclusively aerial (DEWHA, 2009). Records within the Lithgow LGA are located in Wollemi National Park, Gardens of Stone National Park and Newnes State Forest and share similar habitat to that provided in the study area. It is likely that the White-throated Needletail may utilise the study area for forage.

The Rainbow Bee-eater usually occurs in open or lightly timbered areas, often near water (SEWPaC, 2011b). They breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands (SEWPaC, 2011b). Their nests have been found in embankments including creeks, rivers and sand dunes (SEWPaC, 2011b). The species is insectivorous and most foraging is aerial and in clearings. Records within the Lithgow LGA coincide with valleys and cleared lands north of the study area in the Capertee Valley. One nearby recent record (dated 2009) occurs within Wolgan Valley. Open areas

exists in lower parts of the study area in lower parts of the landscape, particularly in existing Invincible Offset areas.

Very little is documented on the ecology of the Black-faced Monarch. It is found along the coast of eastern Australia, becoming less common further south. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. According to known records within the Lithgow LGA the species is distributed within Wollemi National Park. The Ben Bullen State Forest (including the study area) shares similar forest and woodland habitats, particularly in gullies.

Very little is documented on the ecology of the Rufous Fantail. This species has been found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas. Strongly migratory in the south of its range, it moves northwards in winter, and virtually disappears from New South Wales at this time. The majority of records within the Lithgow LGA are distributed in Wollemi National Park. Other records occur in Gardens of Stone National Park and the Newnes State Forest with a recent record (dated 2009) in to the north east in Wolgan State Forest, approximately 8 km from the study area. No dense wet forests, swamp woodland or mangroves were recorded within the study area. The study area may provide some potential forage habitat and potential habitat during migration.

The Swift Parrot has been discussed in **Section 3.5.2.iv.a**; Blossom dependant birds.

c. Wetland Birds

The study area supports a small number of farm dams and ephemeral water courses. These water features do not generally support aquatic vegetation, and habitat assessment and the results of fauna surveys indicate that the study area does not provide suitable habitat for the majority of bird species dependent on wetland habitats. Only common, adaptable wetland birds are likely to occur.

d. Woodland Birds

No threatened woodland birds listed under the EPBC Act or TSC Act have been recorded within the Modification Boundaries. A number of species listed as Vulnerable under the TSC Act have been recorded in the study area (Cumberland Ecology 2012a; AES 2003) and are considered likely to likely occur within the Modification Boundaries:

- Brown Treecreeper (*Climacteris picumnus*) recorded by Cumberland Ecology (2012a)
- Speckled Warbler (*Chthonicola sagittata*) recorded by Cumberland Ecology (2012a);
- Varied Sittella (*Daphoenositta chrysoptera*) recorded by AES in 2003; and
- Scarlet Robin (*Petroica boodang*) recorded by Cumberland Ecology (2012a).

Although not recorded in the study area, NSW Atlas database records indicate that four additional woodland birds listed as Vulnerable under the TSC Act have been recorded from the Lithgow LGA and these have potential to occur in the study area. These species are:

- Grey-crowned Babbler (*Pomatostomus temporalis*);
- Turquoise Parrot (*Neophema pulchella*);
- Hooded Robin (*Melanodryas cucullata*); and
- Diamond Firetail (*Stagonopleura guttata*).

e. Cockatoos, Raptors and Large Forest Owls

The following threatened species listed as Vulnerable under the TSC Act have been recorded in the study area and have potential to occur in the Modification Boundaries:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*) – recorded by Wildsearch (1996) and Cumberland Ecology (2012a)
- Powerful Owl (*Ninox strenua*) recorded (Wildsearch, 1996); and
- Square-tailed Kite (*Lophoictinia isura*) recorded foraging by Cumberland Ecology (2012a).

The Gang-gang Cockatoo (*Callocephalon fimbriatum*) is listed as Vulnerable under the TSC Act and was frequently recorded in the study area by Cumberland Ecology (2012a). This species was also detected during previous surveys (Wildsearch, 1997). The majority of records were recorded during October 2009, suggesting that this species may occupy the study area primarily in spring and summer. Individuals were observed examining hollows in tall trees during this period, indicating that suitable breeding habitat is present and that breeding may occur within the study area in spring/summer.

The Powerful Owl (*Ninox strenua*) is listed as Vulnerable under the TSC Act and was recorded in the study area by Wildsearch (1996). This owl has a very large foraging range and requires tall hollow-bearing trees as nesting habitat. Suitable roost and to a lesser extent nest habitat for this species occurs primarily in the taller forest communities of the study area. The more open grassy woodland of the study area would also provide foraging habitat. It is likely that the study area may form a component of a much larger home range for this species.

The Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act and was recorded by Cumberland Ecology (2012a) in 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. It is likely that the Square-tailed Kite utilises the study area for foraging and that it is a component of a much larger home range.

Although not recorded in the study area, NSW Atlas database records indicate that three additional threatened birds listed as Vulnerable under the TSC Act have been recorded from the Lithgow LGA. These are:

- Glossy Black Cockatoo (*Calyptorhynchus lathami*);
- Masked Owl (*Tyto novaehollandiae*); and
- Barking Owl (*Ninox connivens*).

The Glossy Black Cockatoo (*Calyptorhynchus lathami*) is listed as Vulnerable under the TSC Act and occupies a range of forest and woodland communities. This species requires productive specimens of *Allocasuarina spp.* for forage, and nests in tall hollow-bearing trees. Although not recorded from the study area, it is possible that the Glossy Black Cockatoo may nest within the study area, given the extent of suitable habitat present, although suitable foraging habitat is rare in the study area.

The Masked Owl and Barking Owl have very large foraging ranges and require tall hollow-bearing trees as nesting habitat. Suitable roost and nest habitat for all of these species occurs primarily in the taller forest communities of the study area. The more open grassy woodland of the study area would also provide foraging habitat for both the Masked and Barking Owls. Although the Masked Owl or Barking Owl were not recorded it is possible that suitable habitat within the study area may form a component of a much larger home range for either or both of these species.

v. *Mammals*

No threatened mammal species listed under the EPBC Act or TSC Act have been recorded within the study area.

The large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act and TSC Act was possibly recorded in the wider study and is considered likely to occur.

Two additional species listed as Vulnerable under the TSC Act have been recorded from the study area by Cumberland Ecology and are considered likely to occur within the Modification Boundaries. These are:

- Squirrel Glider (*Petaurus norfolcensis*) recorded by Cumberland Ecology (2012a); and
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) (recorded by Cumberland Ecology (2012a).

Although not recorded during current or previous surveys, the study area also provides suitable habitat for the Yellow-bellied Glider (*Petaurus australis*), listed Vulnerable under the TSC Act.

A number of additional species have either been recorded in the study area or are known within the Lithgow LGA and have potential to occur. These are discussed below in more detail.

a. Spotted-tail Quoll

The Spotted-tail Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act and Vulnerable under the TSC Act. A number of records exist for this species within the Lithgow LGA including some near to the study area; however this species has not been recorded within the study area or Modification Boundaries. This 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 3500 ha. The study area provides an abundance of suitable forage, den and breeding habitat for the Spotted-tail Quoll. Despite the absence of records during current and previous surveys, this species could potentially occur within the Modification Boundaries.

b. Brush-tailed Rock Wallaby

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) is listed as Vulnerable under the EPBC Act and Endangered under the TSC Act. Despite targeted survey efforts, including the deployment of several infra-red remote cameras, no Brush-tailed Rock-wallabies were recorded within the study area. Habitat assessment indicates that the sandstone escarpments including vegetation above and below provide an abundance of suitable shelter habitat for the Brush-tailed Rock-wallaby. It is likely that this species historically occurred within the study area, and may still potentially occur here, albeit in low densities.

c. Squirrel Glider

Two individual Squirrel Gliders (*Petaurus norfolcensis*) were detected in the study area. Although these were the only individuals recorded, habitat assessment indicates that suitable habitat for the Squirrel Glider occurs in the study area. It is therefore likely that this species would occur in other portions of the study area where suitable habitat occurs.

d. Yellow-bellied Glider

The Yellow-bellied Glider (*Petaurus australis*) is listed as Vulnerable under the TSC Act. This species was not recorded during current or previous surveys. The Yellow-bellied Glider is found in a broad range of habitats, including forest and woodland communities similar to those occurring within the study area. Although not recorded during surveys, nearby records combined with habitat assessments indicate that the species could possibly occupy suitable habitat within the study area.

e. Eastern Pygmy-possum

The Eastern Pygmy-possum (*Ceratus nanus*) is listed as Vulnerable under the TSC Act. This species was not recorded during current or previous surveys. The Eastern Pygmy-possum is found in a broad range of habitats, including forest and woodland communities

similar to those occurring within the study area. Although not recorded during surveys, nearby records combined with habitat assessments indicate that this sometimes cryptic species could possibly occupy suitable habitat within the study area.

f. Koala

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the TSC Act. No Koalas were detected during current or previous surveys. Habitat assessment indicated that some portions of the study area support primary and secondary food trees (*Eucalyptus viminalis*) for the Koala. Known records indicate that their distribution within the Lithgow LGA is scattered and restricted to Newnes State Forest and Wollemi National Park. The closest record (dated 1994) occurs at Wolgan State Forest, around 8 km north-east of the study area. Although Koalas have the potential to occur within some the grassy forests of the study area; however as indicated by their distribution in the LGA they are more common to the east on better soil.

g. Microchiropteran Bats

Habitat assessments indicated that a number of hollow-bearing dead and living trees within the study area would provide suitable roosting and breeding habitat for hollow dwelling species known to occur in the Lithgow LGA. The sandstone escarpments of the study area also provide suitable roosting or breeding habitat for cave-dependent microbats, recorded in the study area or known in the Lithgow LGA. Although each of these bat species has specific habitat requirements for roosting and breeding, many utilise a variety of forest, woodland and grassland communities as foraging habitat. Given the extent of these habitats within the study area, microbats known to occur in the LGA could potentially forage within the study area on occasion.

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under the EPBC Act and TSC Act. Several Anabat records during surveys of the study area demonstrate some of the characteristics of calls emitted by the Large-eared Pied Bat. However the few calls recorded were not substantial enough to conclusively identify this bat as the Large-eared Pied Bat, and no individuals of this species were captured during harp trapping. The sandstone escarpments provide an abundance of shelter habitat for cave-dependant bats such as the Large-eared Pied Bat, and records within the LGA indicate that this species occurs in the locality. It is therefore likely that the Large-eared Pied Bat forages and roosts within the study area.

One individual Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) listed as Vulnerable under the TSC Act was captured and others detected using Anabat bat call in the study area by Cumberland Ecology (2012a). The Eastern Bent-wing Bat breeds annually in spring and summer in maternity caves, with populations dispersing within about 300 km range of maternity caves when not breeding. At these times this species will roost predominantly in caves but may also utilise culverts, mine shafts and the roofs of artificial structures. The sandstone escarpments of the study area are likely to support suitable roosting and breeding habitat while the forests, woodlands and to a lesser extent semi-cleared grasslands could provide forage for the Eastern Bent-wing Bat.

Although not recorded within the study area the following threatened microbats listed as Vulnerable under the TSC Act known to occur within the Lithgow LGA and considered likely to occur in the study area. These are:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- The Eastern Freetail-bat (*Mormopterus norfolkensis*);
- The Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*); and
- Little Bent-wing Bat (*Miniopterus australis*).

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), listed as Vulnerable under the TSC Act was not recorded within the study area during the current surveys; however previous surveys (Wildsearch 1996) indicate one probable record of this species outside the study area. Further, a record (dated 2003) is located near the existing Cullen Valley Mine. This species utilises tree hollows as roosting and breeding habitat and, unlike the previously discussed species, is not cave-dependant. The forest and woodland communities within the study area provide an abundance of suitable roosting, breeding and foraging habitat for this species.

The Eastern Freetail-bat (*Mormopterus norfolkensis*) is listed as Vulnerable under the TSC Act and has not been recorded within the study area during current or previous surveys. There is however, a recent record (dated 2003) at the same location as the Eastern False Pipistrelle record near the existing Cullen Valley Mine. This species utilises tree hollows as roosting and breeding habitat. The forest and woodland communities within the study area provide an abundance of suitable roosting, breeding and foraging habitat for this species.

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as Vulnerable under the TSC Act and has not been recorded within the study area during current or previous surveys. There is however, a recent record (dated 2003) located at the same location as the Eastern False Pipistrelle and Eastern Freetail-bat near the existing Cullen Valley Mine. This species utilises predominantly tree hollows as roosting and breeding habitat. The forest and woodland communities within the study area provide an abundance of suitable roosting, breeding and foraging habitat for this species.

In addition, the study area may also provide potential foraging and roosting habitat for the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Little Bent-wing Bat (*Miniopterus australis*) listed Vulnerable under the TSC Act; however only one record is known within the Lithgow LGA.

3.5.3 Common Species

i. Amphibians

The small dams within the study area provide permanent water sources constituting habitat for a number of common amphibian species including *Crinia signifera*, *Limnodynastes peronii*, *Limnodynastes tasmaniensis* and *Litoria peronii*. A total of eight amphibian species were recorded within the study area during surveys of the study area (refer to **Appendix B**).

ii. Reptiles

A total of 13 common reptile species including six skinks, five lizards and monitors, one snake and one gecko were recorded during active searches of various sites throughout the study area (refer to **Appendix B**). It is likely that a number of additional common species would also occur as indicated by previous surveys (Wildsearch 1996), as the study area provides suitable forest and woodland habitat for many of the reptiles known to occur in the wider locality.

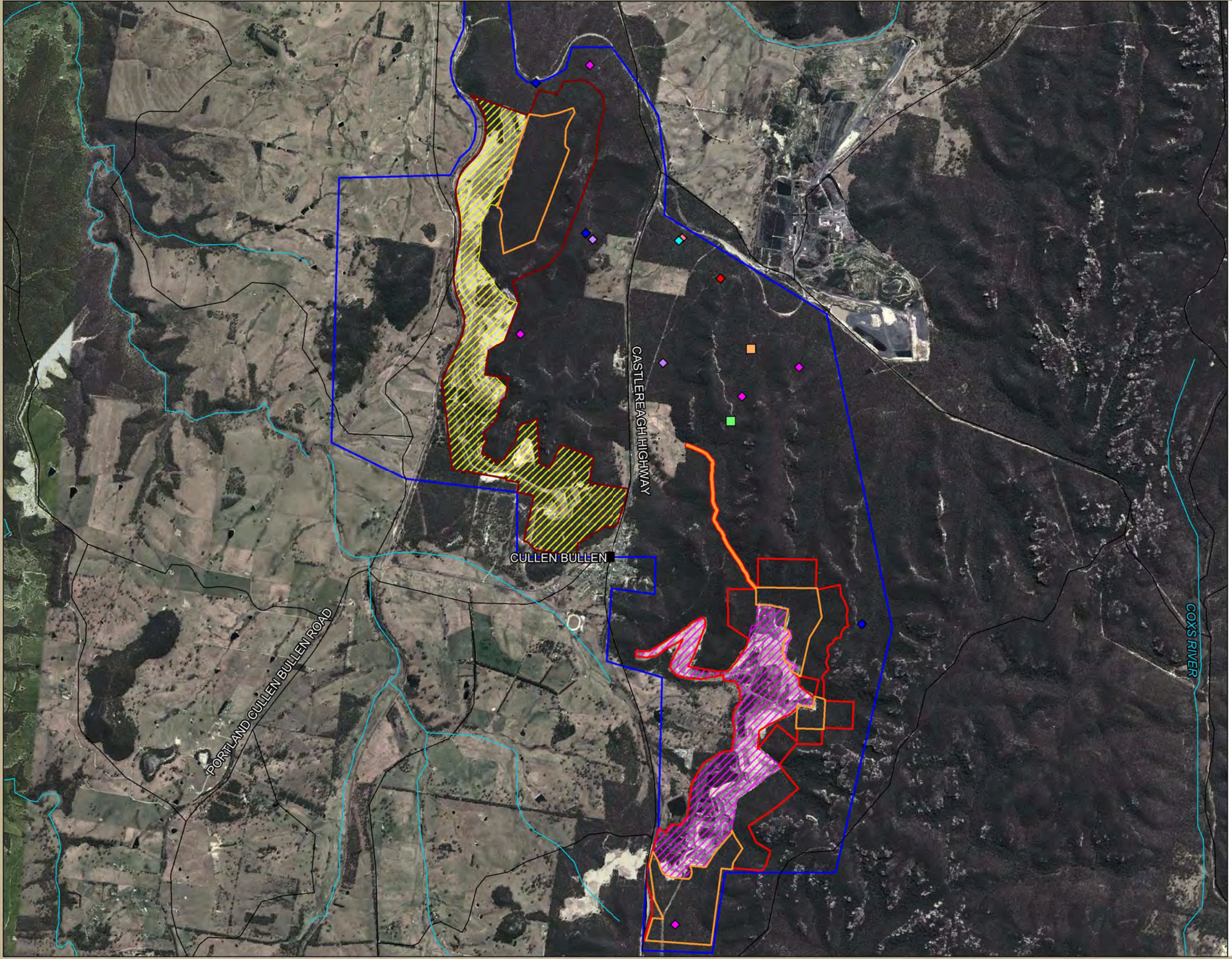
iii. Birds

Habitat assessment and fauna survey results indicate that the study area provides suitable foraging habitat for a range of common diurnal raptors, cockatoos, owls and small woodland birds and potential foraging habitat for some threatened species. However, the large trees within riparian habitats required by some raptors for nesting were largely absent from within the study area. The area also provides suitable foraging habitat for a range of forest and woodland-dependent owls. The tall forest communities within the study area provide abundant forage, roosting and nesting opportunities for these species.

iv. Mammals

Despite the presence of relatively good habitat for terrestrial mammals, the results of the current and previous surveys indicate that the study area supports only a low abundance and diversity of small terrestrial mammals. Only two native small terrestrial mammal species were recorded during the current and previous surveys. Surprisingly, introduced species that are commonly recorded in disturbed habitats (e.g. House Mouse and Black Rat) were absent during the surveys. The low diversity and abundance of small terrestrial mammals is likely to be a result an abundance of introduced (feral) predators such as the European Red Fox (*Vulpes vulpes*).

Records of native terrestrial fauna within the study area during the current and previous surveys 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 predation, and are able to traverse larger areas of cleared land to migrate back into regenerating communities such as those within the study area.



- Legend**
- Cullen Valley Modification Boundary
 - Invincible Colliery Modification Boundary
 - Study Area
 - Existing Cullen Valley Mine
 - Existing Invincible Colliery
 - Modification Disturbance Boundaries
 - Road
 - Waterway
 - Town
- Threatened Fauna**
- Satin Flycatcher (EPBC & TSC)
 - Speckled Warbler (TSC)
 - Gang-gang Cockatoo (TSC)
 - Brown Treecreeper (TSC)
 - Square-tailed Kite (TSC)
 - Scarlet Robin (TSC)
 - Squirrel Glider (TSC)
 - Eastern Bentwing Bat (TSC)

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Figure 3.3. Locations of Threatened Fauna Species in the Study Area



Impact Assessment

4.1 Introduction

The ecological impacts of the Modifications on the biodiversity values are entirely related to habitat removal and fragmentation within the open cut disturbance footprint of both Modification Boundaries. Highwall mining proposed by both Modifications is not considered to constitute an impact, as surface subsidence in highwall areas will be less than 20mm (GEONET, 2011), thus has not been included within the impact assessment or calculations.

The primary impact will be the removal of forest and woodland vegetation communities. These communities contain suitable habitat for several threatened flora and fauna species. Despite some area of forest and woodland in the Modification Boundaries being subject to some ongoing logging, and partial clearing and recreation activities including four-wheel driving, motorbike riding and conservation hunting, much of it is still in good ecological condition.

4.2 Direct Impacts

The largest direct impact of the Modifications is the removal of habitat for flora and fauna.

4.2.1 *Vegetation Communities*

i. Threatened Ecological Communities

No threatened ecological communities occur within either the Invincible Modification Disturbance Boundary or the Cullen Valley Modification Disturbance Boundary.

Previous mapping undertaken by Cumberland Ecology identified Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland within the Invincible Colliery Modification Boundary. This community conforms to the critically endangered ecological community (CEEC), Box Gum Woodland. The community is now not considered to occur within the Invincible Colliery Modification Boundary. The community within this area was previously mapped by Cumberland Ecology as the CEEC, however further analysis has determined that the vegetation better conforms to a variant of the dominant surrounding community, Tableland Gully Mountain Gum - Broad Leaved Peppermint Grassy Forest. The re-mapping of this community is supported by the NSW Office of Environment and Heritage in their

submission to the NSW Planning Assessment Commission Coalpac Consolidation Review (OEH, 2012). Within their submission, they state that:

“...Cumberland Ecology has identified areas with Blakely’s Red Gum as the White Box Blakely’s Red Gum Yellow Box Endangered Ecological Community.....However OEH reached a different conclusion after sampling a number of sites....The consistent presence of Mountain Gum, and more occasional presence of Blakely’s Red Gum suggests that this is a tableland grassy forest.” (OEH, 2012).

A small area (approximately 0.6 ha) of Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland – non grassy variant occurs in the Cullen Valley Modification Boundary, however the non-grassy variant of this community is not listed as a C/EEC under either the EPBC Act or the TSC Act. It has a shrubby understorey and not the grassy understorey which defines the C/EEC. Furthermore, this area is outside of the Modification Disturbance Boundary and will not be impacted.

ii. *Non-threatened Ecological Communities*

A total of approximately 151 ha of non-listed vegetation will be removed from the Invincible and the Cullen Valley Modification Disturbance Boundaries and the pipeline, comprising a suite of communities as shown in **Table 4.1** and **Figure 4.1**. These vegetation communities provide habitat for a range of flora and fauna, including species listed as threatened or migratory under the EPBC Act and/or TSC Act.

The vegetation communities that would be most significantly impacted by the Modifications includes: Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Forest, Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest and Tableland Gully Ribbon Gum – Blackwood Apple Box Forest. These communities occur in the valley and lower to mid slopes. The least impacted communities are the ones which grow on the plateaus and upper slopes.

Table 4.1 provides a summary of the area of each vegetation community to be removed in the Modification Disturbance Boundaries, and the area of each community being retained within the Modification Boundaries.

Table 4.1 Summary of Vegetation Areas within the Modification Boundaries

Code	Vegetation Community	Area of Vegetation within Modification Boundaries (ha)	Area of Vegetation Impacted (ha)				Area (ha) being retained
			Cullen Valley Disturbance Boundary	Invincible Disturbance Boundary	Pipeline Corridor	Total	
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC)	0.6					0.6
MU20a	Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy	0.1	0.1			0.1	0.0
MU13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	21.6		7.0	0.9	7.9	13.7
MU32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	87.5	34.8	0.1	0.3	35.2	52.3
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	80.9	21.7	37.3	0.4	59.4	21.5
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native						
DNG	Grassland	0.0				0.0	0.0
MU35	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	10.6		8.0		8.0	2.6
MGBIP	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest Derived						
DNG	Native Grassland	4.0		2.4		2.4	1.6

Table 4.1 Summary of Vegetation Areas within the Modification Boundaries

Code	Vegetation Community	Area of Vegetation within Modification Boundaries (ha)				Area of Vegetation Impacted (ha)		Area (ha) being retained
MU37	Cox's Permian Red							
	Stringybark - Brittle Gum							
	Woodland	9.2		0.1		0.1		9.1
MU30	Exposed Blue Mountains							
	Sydney Peppermint -							
	Silvertop Ash Shrubby							
	Woodland	140.9	5.2	31.6	0.6	37.5		103.4
TOTAL		355.4	61.8	86.5	2.1	150.5		204.9



Legend

- Cullen Valley Modification Boundary
- Modification Disturbance Boundary
- Highwall Mining
- Existing Cullen Valley Mine

Vegetation Community

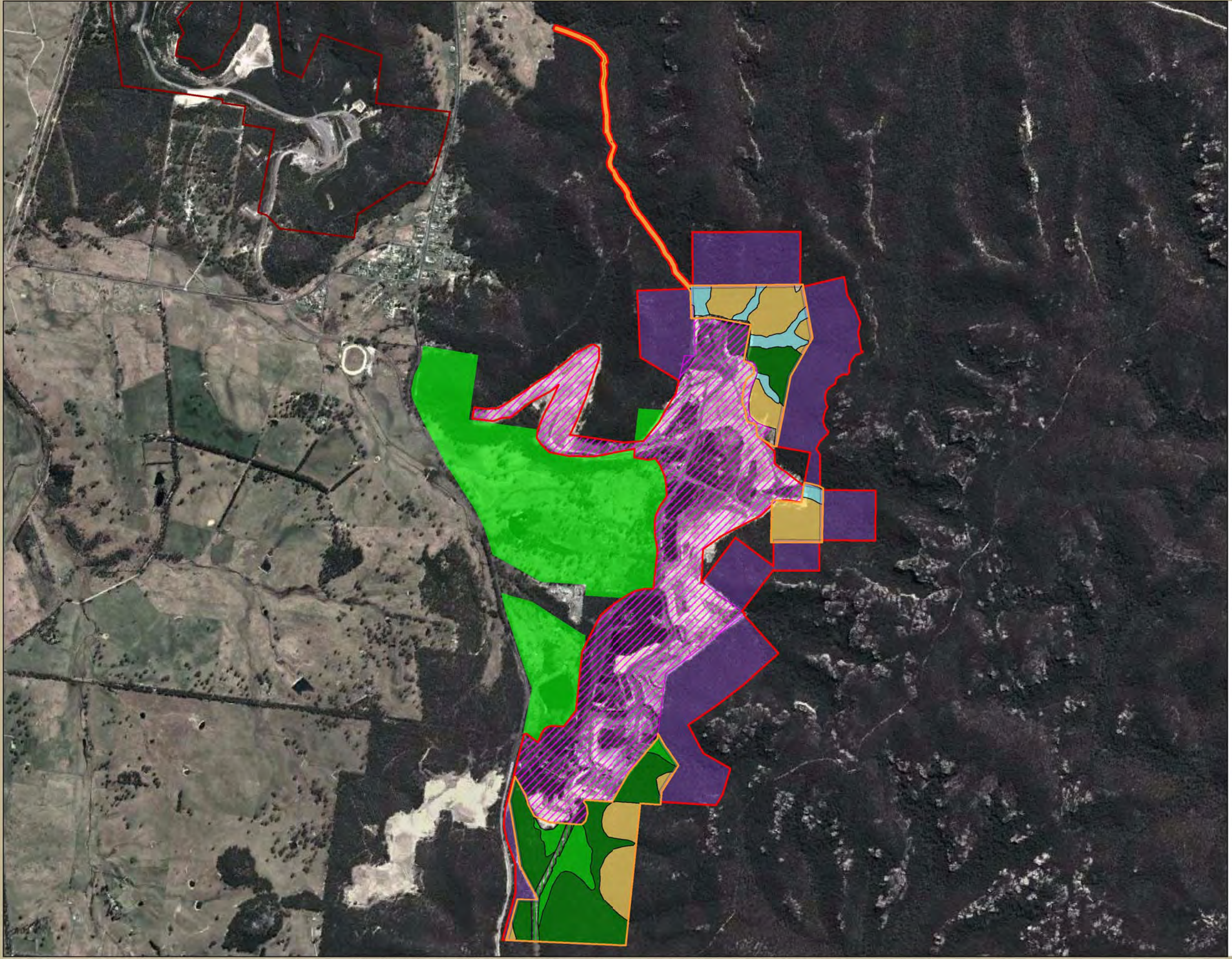
- Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy
- Tableland Slopes Brittle Gum - Broad-leaved Peppermint Grassy Forest
- Tableland Scribbly Gum - Narrow-leaved Stringybark Shrubby Open Forest
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland

Image Source:
Image © 2013 DigitalGlobe



Figure 4.1. Impacts on Vegetation within the Cullen Valley Modification Disturbance Boundary



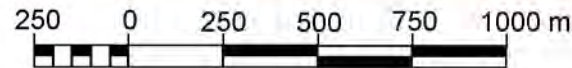


- Legend**
- Invincible Colliery Modification Boundary
 - Modification Disturbance Boundary
 - Highwall Mining
 - Existing Invincible Colliery
 - Existing Invincible Colliery Offset Area
- Vegetation Community**
- Tableland Gully Ribbon Gum Blackwood Applebox Forest
 - Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest
 - Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest
 - Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest
 - Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest Derived Native Grassland
 - Cox's Permian Red Stringybark - Brittle Gum Woodland
 - Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland

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Figure 4.2. Impacts on Vegetation within the Invincible Colliery Modification Disturbance Boundary



4.2.2 *Threatened Flora Species*

The potential impacts upon threatened flora species discussed below focus upon flora species known to occur in the study area. It does not include species discussed in **Chapter 3** that have not been verified to occur in the study area.

i. *Eucalyptus cannonii*

Eucalyptus cannonii, listed as Vulnerable under the TSC Act has been found throughout the study area (see **Figure 3.2**). This species was previously listed as Vulnerable under the EPBC Act; however it was delisted on 14th December 2013.

Approximately 335 ha of potential and known habitat estimated to support approximately 4,500 individuals occurs within the Modification Boundaries (see **Table 3.2**). The wider Study Area has been estimated to support in excess of 16,800 individuals. The Modifications will remove approximately 148 ha of potential and known habitat, estimated to support approximately 2,300 individuals (approximately 470 from the Cullen Valley Modification Disturbance Boundary and 1,830 from the Invincible Modification Disturbance Boundary).

Approximately 180 ha of potential and known *Eucalyptus cannonii* habitat will remain in the Modification Boundaries (estimated to support over 2,200 individuals) and over 14,500 individuals are estimated to remain within the study area. It is expected that 10,000s of *Eucalyptus cannonii* individuals occur in other areas of Ben Bullen State Forest (Cumberland Ecology 2012a).

A vegetation survey of Lot 112 and Lot 113 biodiversity offset areas by Global Soil Systems in 2013 found evidence of natural regeneration of *Eucalyptus cannonii* individuals which were spreading throughout these areas. Younger trees were predominantly located in close proximity to existing mature *Eucalyptus cannonii* individuals. This demonstrates the resilience of the species and its potential to recolonise a previously cleared landscape. There is evidence of *Eucalyptus* species migrating into rehabilitated areas as part of natural regeneration from adjacent native vegetation communities in the Ben Bullen State Forest. Due to the connectivity of rehabilitated areas with mature native woodland and biodiversity offset areas which contain self-seeding adult *Eucalyptus cannonii* individuals, it is likely that the species will infiltrate rehabilitated areas given time and suitable environmental conditions. The NSW National Parks and Wildlife Service note that *Eucalyptus cannonii* can be easily propagated from seed (NSW NPWS 2000). As such the species could be readily introduced to rehabilitated areas as seedlings or included in the rehabilitation seed mix if available.

The Biodiversity offset package proposed for the Modifications contains at least 101 ha of known and potential habitat for this species which can be conserved and rehabilitated respectively. When considering the above information the Modifications are unlikely to result in a significant impact to *Eucalyptus cannonii* and it has been demonstrated that it can be successfully regenerated in biodiversity offset areas.

ii. *Eucalyptus aggregata*

Eucalyptus aggregata, listed as Vulnerable under the TSC Act was found adjacent to the study area and outside the Modification Disturbance Boundaries within an existing adjoining offset acquired by Invincible Colliery in 2008 (Lot 112, DP 877190).

No impact is expected to occur to *Eucalyptus aggregata* by the Modifications and it is not considered further.

4.2.3 Threatened Fauna Species

The potential impacts upon threatened fauna species discussed below focus upon fauna species recorded from or with potential to occur in the Modification Boundaries. It does not include species with a low likelihood of occurrence as discussed in **Appendix E**.

i. *Invertebrates*

The Bathurst Copper Butterfly (*Paralucia spinifera*) is listed as Vulnerable under the EPBC Act and Endangered under the TSC Act. This species has quite a specific set of habitat requirements (previously discussed in **Chapter 3**), which renders large areas of the Modification Boundaries unsuitable. According to NSW Atlas of Wildlife records, the closest records to the study area occur at Pinedale Mine, Blackmans Flat, approximately 5km away.

Surveys failed to locate significant areas of habitat for the species, though one individual of *Bursaria spinosa* subsp. *lasiophylla* has been identified as occurring within the Invincible Modification Disturbance Area by OEH. Additionally, an individual of *Bursaria spinosa* subsp. *lasiophylla* was detected to the north of the Modification Boundaries. There is potential for additional specimens to be present, but as no others have been recorded they are not likely to be present in high numbers and are unlikely to provide extensive habitat for the Bathurst Copper Butterfly.

No *Bursaria spinosa* subsp. *lasiophylla* plants have been recorded from the Cullen Valley Modification Disturbance Boundary. The removal of an individual habitat plant is not considered likely to constitute a significant impact to the Bathurst Copper Butterfly, when the species requires expansive areas of suitable habitat to form breeding colonies.

ii. *Amphibians*

No amphibians listed under the EPBC Act or TSC Act were recorded within the study area or are considered likely to occur. The likelihood of these species occurring has been discussed in **Chapter 3**. Therefore no impact to threatened amphibian species will occur as a result of the two proposed Modifications.

iii. *Reptiles*

Two threatened reptiles have the potential to occur within the Modification Boundaries. These are:

- Broad-headed Snake (*Hoplocephalus bungaroides*); and

➤ Rosenberg's Goanna (*Varanus rosenbergi*)

The Broad-headed Snake is listed under as Endangered under the EPBC Act and Vulnerable under the TSC Act. As a result of suitable summer foraging habitat available, this species is considered to have potential to occur within the Modification Disturbance Boundaries. The Modifications will not remove any winter habitats for this species as no pagodas or cliff lines will be impacted by open cut or highwall mining. The Modifications may remove some of the available summer habitat occurring below the cliff lines in the form of Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland in some localised areas.

A total of 37 ha of this community occurs within both the combined Modification Disturbance Boundaries and the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the modifications Modifications and these are presented in **Chapter 5** and **Chapter 6**. This includes pre-clearance surveys and rehabilitation of vegetation within the two Modification Disturbance Boundaries. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the two proposed Modifications will result in a significant impact to the Broad-headed Snake.

Rosenberg's Goanna is listed as Vulnerable under the TSC Act. This species was not recorded within either Modification Disturbance Boundary; however potential foraging, shelter and breeding habitat occur within both Modification Disturbance Boundaries. The Modifications will remove approximately 148 ha of potential open forest and woodland habitat; 62 ha from Cullen Valley, 84 ha from the Invincible Modification Disturbance Boundaries and 2 ha from the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the proposed removal of vegetation as a result of the two Modifications will result in a significant impact to the Rosenberg's Goanna.

iv. *Birds*

The following threatened species listed under the TSC Act are considered to have potential to occur in the two Modification Disturbance Boundaries. These are:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Brown Treecreeper (*Climacteris picumnus*);
- Scarlet Robin (*Petroica boodang*);
- Speckled Warbler (*Chthonicola sagittata*);
- Square-tailed Kite (*Lophoictinia isura*);
- Powerful Owl (*Ninox strenua*); and

- Varied Sittella (*Daphoenositta chrysoptera*).

All bird species listed under either the EPBC Act or the TSC Act that are likely to occur or considered to have potential habitat on the Modification Disturbance Boundaries are considered in more detail in subsections below, based on their preferred habitat types.

a. Blossom-dependent birds

A suite of threatened blossom-dependant birds have potential to occur. These are:

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

The Modifications will remove approximately 0.1 ha of Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland (non grassy) from the Cullen Valley Modification Disturbance Boundary which contains favoured food trees of the Regent Honeyeater (refer to discussion of species in **Chapter 3**). None of this community will be removed from the Invincible Modification Disturbance Boundary.

The Modifications will also remove approximately 62 ha of other woodland non-preferred forage habitat for the Regent Honeyeater from the Cullen Valley Modification Disturbance Boundary and 84 ha (not including grassland) from the Invincible Modification Disturbance Boundary as well as 2 ha from the pipeline corridor. Neither of the Modification Disturbance Boundaries are considered to support breeding or nesting habitat as the species prefers to breed and nest in areas of low relief e.g. Capertee Valley, as illustrated by the distribution of records within the LGA.

The Modifications will remove approximately 148 ha of woodland foraging habitat for the Swift Parrot (refer to discussion of species in **Chapter 3**) as many of the eucalypts are not documented favoured trees (winter flowering species) on fertile soils. The Modification Disturbance Boundaries do not contain breeding or nesting habitat as the species breeds in Tasmania. Principle foraging habitat occurs in areas of low relief (e.g. Capertee Valley as illustrated by the distribution of records within the LGA).

The Modifications will remove approximately 62 ha and 84 ha of potential foraging, shelter and breeding woodland habitat for the Little Lorikeet, Painted Honeyeater and Black-chinned Honeyeater from the Cullen Valley and Invincible Modification Boundaries respectively, as well as a further removal of 2 ha from the pipeline corridor.

A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the removal of habitat as a result of the two Modifications will result in a significant impact to these blossom dependant birds.

b. Migratory birds

The Satin Fly Catcher (*Myiagra cyanoleuca*) is considered likely to breed and forage in the Modification Disturbance Boundaries as it was recorded within the study area. The Modifications will remove approximately 62 ha and 84 ha of foraging, shelter and breeding woodland habitat for the Satin Flycatcher from the Cullen Valley and Invincible Modification Disturbance Boundaries respectively, as well as a further removal of 2 ha from the pipeline corridor which is considered important habitat (refer to discussion of species in **Chapter 3**).

A number of EPBC Act listed Migratory species have the potential to occur within the Modification Disturbance Boundaries. These include:

- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Black-faced Monarch (*Monarcha melanopsis*);
- Rufous Fantail (*Rhipidura rufifrons*); and
- Satin Flycatcher (*Myiagra cyanoleuca*).

The White-throated Needletail, Rainbow Bee-eater, Black-faced Monarch and Rufous Fantail are considered to potentially utilise the Modification Disturbance Boundaries to forage and nesting. The Modifications will remove approximately 62 ha and 84 ha of woodland habitat from the Cullen Valley and Invincible Modification Disturbance Boundaries respectively as well as a further removal of 2 ha from the pipeline corridor that provides potential forage and breeding habitat for these species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the proposed removal of habitat from the two Modifications will result in a significant impact to the migratory species.

c. Woodland Birds

The following threatened woodland birds listed as Vulnerable under the TSC Act are considered likely to occur in the Modification Disturbance Boundaries or considered to have potential to occur. These include:

- Varied Sittella (*Daphoenositta chrysoptera*);

- Speckled Warbler (*Pyrrholaemus saggitatus*);
- Brown Treecreeper (*Climacteris picumnus victoriae*); and
- Scarlet Robin (*Petroica boodang*)
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*);
- Turquoise parrot (*Neophema pulchella*);
- Hooded Robin (*Melanodryas cucullata cucullata*);
- Flame Robin (*Petroica phoenicea*); and
- Diamond Firetail (*Stagonopleura guttata*)

These birds are dependent on woodland and open forest for their survival and although they may forage in areas of grassland, they seek shelter and breed in woodland and open forest. Woodland birds in NSW are declining, and some of the processes that are perceived to be most responsible for the decline are (a) increasing fragmentation, and (b) diminishing sizes of woodland patches in the fertile wheat belt of western NSW (Reid, 1999). The species that are most at risk appear to be mainly ground-feeding, insectivorous, and sedentary passerine species (Reid, 1999).

These characteristics likely render these woodland birds more susceptible to direct habitat loss and landscape fragmentation because they are less able to disperse to other patches of remnant woodland. Many woodland birds have limited capacity for dispersal, and it has been shown that the Brown Treecreeper has a maximum gap-crossing threshold of less than 100m (Cooper et al., 2002); (Doerr et al., 2011)) and Grey-crowned Babbler were recorded in a recent study moving less than 900m (Blackmore et al., 2011).

Reduction of woodland patches below a critical size can eliminate or significantly reduce the population of some species. Research into the capacity of Speckled Warblers to persist in fragmented habitat suggests that small isolated populations are most at risk of extinction in the long term; a study undertaken in Canberra suggested that the species was more likely to decrease in numbers in patches below 200 to 400 ha (Gardner and Heinsohn, 2007).

Where populations are able to disperse to nearby patches, increasing intraspecific and interspecific competition for space and resources (e.g. (Maron et al., 2011) and increased exposure to predation (Ford, 2011) can be significant factors contributing to continuing decline. Equally important to direct loss is the degradation of remaining patches of habitat from key threatening processes that facilitates further decline, including:

- Land degradation, particularly salinity, dieback and decreasing fertility (Watson, 2011);
- Collection of timber for fuel wood;
- Grazing by feral herbivores and agricultural stock;

- Weed invasions;
- Loss of and competition for hollows;
- Lack of or limited regeneration in remnants; and
- Predation by feral carnivores.

Many woodland bird species are dependent on tree hollows for nesting. Such holes take many decades to develop, with the largest hollows taking over 150 years on average to form (Mackowski, 1984). In a closely related species to the Brown Treecreeper (i.e. the Rufous Treecreeper), the availability of nesting sites exerted a strong influence on habitat use (Luck, 2002).

Many of the larger trees in woodland communities of the Modification Disturbance Boundaries contain tree hollows. These are likely to represent a significant nesting resource for local woodland birds, including the Brown Treecreeper.

The Modifications will remove approximately 148 ha of potential woodland and forest breeding and foraging habitat for the following bird species; Scarlet Robin, Brown Treecreeper, Speckled Warbler, Varied Sittella, Grey-crowned Babbler, Turquoise parrot, Hooded Robin, Flame Robin and Diamond Firetail. This is approximately 62 ha and 84 ha of potential habitat from the Cullen Valley and Invincible Modification Disturbance Boundaries respectively as well as a further removal of 2 ha from the pipeline corridor. The proposed Modifications will not fragment habitat however, and will only excise some additional habitat from the edge of a larger area. The birds are expected to be able to continue using habitat in the retained vegetation in Ben Bullen State Forest, and are expected to return once the land disturbed by the mine has been rehabilitated to woodland.

A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the proposed removal of habitat from the two Modifications and the pipeline will result in a significant impact to the woodland birds.

d. Cockatoos, Raptors and Large Forest Owls

No threatened Cockatoos, Raptors or Large Forest Owls listed under the EPBC Act or TSC Act were recorded in either of the Modification Disturbance Boundaries.

The following threatened Cockatoos, Raptors and Forest Owls, listed Vulnerable under the TSC Act are considered likely to occur or have potential to occur in the two Modification Disturbance Boundaries. These include:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*) recorded in the study area;
- Glossy Black Cockatoo (*Calyptorhynchus lathami*) – potential to occur;
- Square-tailed Kite (*Lophoictinia isura*) recorded in the study area;

- Powerful Owl (*Ninox strenua*) recorded in the study area;
- Masked Owl (*Tyto novaehollandiae*) – potential to occur; and
- Barking Owl (*Ninox connivens*) – potential to occur.

The Gang-gang Cockatoo was recorded inspecting hollows in the study area during breeding season, indicating that breeding may occur in the Modification Disturbance Boundaries. The Glossy Black Cockatoo requires productive specimens of *Allocasuarina* sp. for forage and nests in tall hollow-bearing trees. Suitable foraging habitat is rare in the Modification Disturbance Boundaries. The lack of suitable forage reduces the likelihood of the species nesting in suitable sized hollows in the Modification Disturbance Boundaries.

Raptors are typically reliant on very large territories for foraging and nesting. Many species occupy a large home range that include both remnant forest/woodland and grassland habitats and are generally tolerant of agricultural landscapes providing there is some woodland habitat available for nesting (Marchant, 1993).

The Masked Owl and Barking Owl are also tolerant of disturbed areas and have a close association with drier, unlogged, or selectively logged forests (Newton, 2002). Thus, the vegetation within the Modification Disturbance Boundaries is likely to support both potential breeding sites (tall remnant trees) and foraging resources (abundant mammal and bird prey) for these species. Owl species are typically reliant on large tree hollows for nesting, which occur within the Modification Disturbance Boundaries.

The Modifications will remove approximately 148 ha of breeding and foraging habitat for the Gang-gang Cockatoo and Powerful Owl. The Modifications will also remove approximately 148 ha of woodland forage habitat for the Square-tailed Kite and potential woodland nesting and foraging habitat for the Masked Owl and Barking Owl. This represents a removal of 62 ha and 84 ha of woodland habitat from the Cullen Valley and Invincible Modification Disturbance Boundaries respectively as well as a further removal of 2 ha from the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the proposed removal of the two Modifications and the pipeline will result in a significant impact to the Cockatoos, raptors and large forest owls.

v. *Mammals*

No threatened mammals listed under the EPBC Act or TSC Act have been recorded in either of the Modification Disturbance Boundaries.

The following threatened mammals are considered likely to occur or have potential to occur in the two Modification Disturbance Boundaries. These include:

- Spotted-tail Quoll (*Dasyurus maculatus*), listed Endangered under the EPBC Act and Endangered under the TSC Act – potential to occur;

- Brush-tailed Rock-wallaby (*Petrogale penicillata*) is listed as Vulnerable under the EPBC Act and Endangered under the TSC Act – potential to occur;
- Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act – recorded in the study area;
- Yellow-bellied Glider (*Petaurus australis*) listed as Vulnerable under the TSC Act – potential to occur;
- Eastern Pygmy Possum (*Cercartetus nanus*) listed as Vulnerable under the TSC Act – potential to occur;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) listed as Vulnerable under the EPBC Act and TSC Act – possible record in study area;
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) listed as Vulnerable under the TSC Act – possible record in study area
- Eastern Freetail-bat (*Mormopterus norfolkensis*) listed as Vulnerable under the TSC Act – possible record in study area;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) listed as Vulnerable under the TSC Act – possible record in study area;
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) listed as Vulnerable under the TSC Act – recorded in study area.
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) listed as Vulnerable under the TSC Act – potential to occur; and
- Little Bent-wing Bat (*Miniopterus australis*) listed as Vulnerable under the TSC Act – potential to occur.

These are discussed in more detail in the subsections below.

a. Spotted-tailed Quoll

The Spotted-tailed Quoll was not detected within the Modification Disturbance Boundaries; however it is considered to potentially occur due to the presence of suitable habitat, connection to large intact areas of habitat in Ben Bullen State Forest and because the species is known in the LGA (refer to species discussion in **Chapter 3**).

The Modifications will remove approximately 148 ha of potential woodland forage, den and breeding habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively) as well as a further removal of 2 ha from the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not

expected that the two proposed Modifications will result in a significant impact to the Spotted-tail Quoll.

b. Brush-tailed Rock Wallaby

The Brush-tailed Rock-wallaby was not detected within the Modification Disturbance Boundaries; however it is considered to potentially occur within the Modification Boundaries due to the presence of suitable habitat and known records in the LGA (refer to species discussion in **Chapter 3**).

The Modifications will not directly impact the plateaus, ridges and upper slopes, which contain the sandstone outcropping and the pagoda landscapes suitable for the Brush-tailed Rock-wallaby. The Modifications will remove approximately 148 ha of potential woodland shelter and forage habitat occurring below these rocky escarpments (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively) as well as a further removal of 2 ha from the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. This includes avoidance of 200 ha of habitat within the Modification Boundaries, pre-clearance surveys and rehabilitation of vegetation within the Modification Disturbance Boundaries. Tens of thousands of hectares of suitable habitat also remain in the wider locality within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

Short term loss of potential resources will be addressed with the retention of suitable habitat in off-site offset areas. An offset strategy has been developed for Modifications that will result in the protection of 645 ha of land for conservation that provides suitable habitat for this species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the two proposed Modifications will result in a significant impact to the Brush-tailed Rock Wallaby.

c. Arboreal Fauna

Two species of glider have been recorded from the study area or have potential to occur; the Squirrel Glider the Yellow-bellied Glider and the Eastern Pygmy Possum.

The Squirrel Glider was recorded in the study area by Cumberland Ecology (2012a). Habitat assessment indicates that suitable habitat for the Squirrel Glider occurs throughout the Modification Disturbance Boundaries (refer to species discussion in **Chapter 3**).

The Yellow-bellied Glider has not been detected within the study area, however suitable habitat in the form of large flowering eucalypts containing hollows were recorded in the study area by Cumberland Ecology (2012a). Habitat assessment indicates that suitable habitat for the Yellow-bellied Glider occurs throughout the Modification Disturbance Boundaries (refer to species discussion in **Chapter 3**).

The Eastern Pygmy Possum has not been detected within the study area, however suitable habitat in the form of nectar-producing plants, heath and tree hollows were recorded in the study area by Cumberland Ecology (2012a). Habitat assessment indicates that suitable habitat for the Eastern Pygmy Possum occurs throughout the Modification Disturbance Boundaries (refer to species discussion in **Chapter 3**).

The Modifications will remove approximately 148 ha of potential woodland shelter habitat containing large trees, and woodland forage habitat containing flowering eucalypts (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively) as well as a further removal of 2 ha from the pipeline corridor. A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications and these are presented in **Chapter 5** and **Chapter 6**. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the removal of the Modifications will result in a significant impact to the Squirrel Glider, Yellow-bellied Glider or the Eastern Pygmy Possum.

d. Microchiropteran Bats

The Large-eared Pied Bat (*Chalinolobus dwyeri*) was not recorded within the study area; however is considered to occur due to the multiple possible call detections within the study area, presence of suitable habitat, and known records in the LGA. The Modifications will not disturb or remove rocky escarpments or rock formations which provide critical habitat features for this species. The only impact to this species will be from the removal of foraging habitat (see discussion below).

The following threatened microbats listed as Vulnerable under the TSC Act are considered likely to occur in the Modification Disturbance Boundaries. These include:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*); and
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*).

The above list of microbats have been separated and discussed with respect to their roosting requirements.

Of these species, the Eastern False Pipistrelle, Eastern Freetail-bat and Greater Broad-nosed Bat are hollow dependant species which rely on tree hollows to roost and breed. The Modifications will remove 148 ha of woodland roosting habitat and foraging habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively) and 2 ha from the pipeline corridor. These areas contain hollows that are likely to be suitable for this species to utilise for roosting and breeding.

The Eastern Bent-wing Bat is a cave dependant microbat that utilises caves to roost and breed. The Modifications will not directly impacts rocky escarpments or caves which provide critical habitat features for this species, however they will remove 148 ha of potential

woodland foraging habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively) and 2 ha from the pipeline corridor.

The following threatened microbats listed Vulnerable under the TSC Act are considered to have potential to occur in the Modification Disturbance Boundaries. These include:

- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*); and
- Little Bent-wing Bat (*Miniopterus australis*)

The Yellow-bellied Sheath-tail-bat is a hollow dependant species which relies on tree hollows to roost and breed. The Modifications will remove 148 ha of potential woodland roosting habitat and foraging habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively and 2 ha from the pipeline corridor). The Little Bent-wing Bat roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day (DEC (NSW), 2005i), and forages over woodland. No suitable roosting habitat for this species will be removed, however the Modifications will remove approximately 148 ha of potential woodland foraging habitat).

The Modifications will remove 148 ha of woodland and forage habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively and 2 ha from the pipeline corridor). The removal of this habitat is not expected to cause a significant impact to microbats as further larger areas (200 ha) of forage habitat will remain in the Modification Boundaries and vast areas of habitat remain in the wider locality within the protected Wollemi National Park, Gardens of Stone National Park, and other remnants including Newnes State Forest, Wollang State Forest and some parts of Ben Bullen State Forest. Further, a suite of mitigation and compensatory measures will be implemented including conserving 645 ha of native vegetation, which includes 35 ha of Box Gum Woodland. These are outlined in **Chapter 5** and **6**.

4.2.4 Impacts to Common Species

i. Amphibians

All amphibian habitats described as occurring within the Modification Disturbance Boundaries are also commonly represented in the wider locality, including nearby protected areas. The Modifications will result in the removal of foraging and breeding habitat for common amphibians.

ii. Reptiles

A total of 13 common reptile species have been recorded within the study area. All reptile habitats described as occurring within the Modification Boundaries are also commonly represented in the wider locality, including nearby protected areas. As with amphibians, the Modifications will result in the removal of foraging and breeding habitat for common reptiles.

iii. *Birds*

The Modifications will result in the removal of approximately 148 ha of woodland foraging and/or breeding habitat for birds (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively and 2 ha from the pipeline corridor). Given the extent of woodland habitat to be removed, it is likely that this will result in impacts on common woodland-dependant birds that currently occupy the study area. Pre-clearing surveys and clearing supervision will assist in the minimisation of impacts. Large areas of adjacent woodland habitat also remain in the wider locality.

iv. *Mammals*

A number of mammal species have been recorded from within the study area during current and previous surveys conducted since 1996. The Modifications will result in the removal of approximately 148 ha of woodland foraging, breeding and shelter habitat for common mammals (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively and 2 ha from the pipeline corridor). A few of the common mammals occurring within the study area are woodland-dependant species. It is likely that this will result in impacts on common woodland-dependant mammals that currently occupy the study area. Large areas of woodland habitat also remain in the wider locality.

4.2.5 *Summary of Impacts to EPBC Act Listed Species*

i. *Threatened Ecological Communities*

No C/EECs listed under the EPBC Act will be removed or impacted by the Modifications.

ii. *Flora Species*

Eucalyptus cannonii is listed as Vulnerable under the TSC Act and was recorded from the Modification Boundaries. This species was previously listed as Vulnerable under the EPBC Act; however it was delisted on 14th December 2013.

Although not recorded from the Modification Boundaries, the following threatened flora species have potential to occur due to the presence of suitable habitat:

- *Grevillea obtusiflora* ssp. *obtusiflora* listed as Endangered under the EPBC Act;
- *Grevillea obtusiflora* ssp. *fecunda* listed as Endangered under the EPBC Act;
- *Persoonia marginata* (Clandulla Geebung) listed as Vulnerable under the EPBC Act;
- *Eucalyptus pulverulenta* (Silver-leaved Mountain Gum) listed as Vulnerable under the EPBC Act;
- *Grevillea evansiana* listed as Vulnerable under the EPBC Act;

- *Prostanthera cryptandroides subsp. cryptandroides* listed as Vulnerable under the EPBC Act; and

Persoonia marginata was recorded outside the study area; however no records have been made from the study area or the Modification Boundaries.

Potential habitat for these species occurs within the study area and within the Modification Boundaries in woodland and forest communities. Repeated targeted surveys during flowering periods have failed to locate these species. Accordingly, no impact is predicted to occur to these species as a result of the proposed Modifications.

No other threatened flora species listed under the EPBC Act have been recorded or are considered to have potential to occur.

iii. Fauna Species

Several threatened fauna species listed under the EPBC Act have been recorded or have potential to occur in the study area and Modification Boundaries. These include the following:

- The Broad-headed Snake (*Hoplocephalus bungaroides*) listed as Endangered;
- Regent Honeyeater (*Anthochaera phrygia*) listed as Endangered;
- Swift Parrot (*Lathamus discolor*) listed as Endangered and Migratory;
- Spotted-tail Quoll (*Dasyurus maculatus*), listed as Endangered;
- Brush-tailed Rock-wallaby (*Petrogale penicillata*) listed as Vulnerable;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) listed as Vulnerable;
- Bathurst Copper Butterfly (*Paralucia spinifera*) listed as Vulnerable;
- White-throated Needletail (*Hirundapus caudacutus*) listed Migratory;
- Rainbow Bee-eater (*Merops ornatus*) listed as Migratory;
- Black-faced Monarch (*Monarcha melanopsis*) listed as Migratory;
- Rufous Fantail (*Rhipidura rufifrons*) listed as Migratory; and
- Satin Flycatcher (*Myiagra cyanoleuca*) listed as Migratory;

No amphibians listed under the EPBC Act were recorded within the Modification Boundaries or are considered likely to occur.

The Broad-headed Snake is considered to have potential to occur within the Modification Disturbance Boundaries. The Modifications will not remove any winter habitats for this species as no rocky outcrops will be impacted by open cut or highwall mining. The

Modifications may remove some of the potential available summer habitat occurring below the cliff lines in the form of Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland. A total of 37 ha of this community occurs within both Modification Disturbance Boundaries. Over 100 ha of this community will be retained within the Modification Boundary.

Neither the Swift Parrot nor the Regent Honeyeater have been recorded from the Modification Boundaries or the study area, but are considered to have potential to occur. The Modifications will remove approximately 148 ha of woodland forage habitat for these species; approximately 62 ha from the Cullen Valley Modification Disturbance Boundary and 84 ha from the Invincible Modification Disturbance Boundary and 2 ha from the pipeline corridor. Neither of the Modification Disturbance Boundaries is considered to support breeding or nesting habitat for either species as the Regent Honeyeater prefers to breed and nest in areas of low relief (e.g. Capertee Valley and the Swift Parrot breeds in Tasmania). Principle foraging habitat for both species occurs in areas of low relief (e.g. Capertee Valley as illustrated by the distribution of records within the Lithgow LGA).

The Spotted-tailed Quoll was not detected within the Modification Boundaries; however it is considered to potentially occur due to the presence of suitable habitat and records from the LGA. The Modifications will remove approximately 148 ha of potential woodland forage, den and breeding habitat (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries, respectively and 2 ha from the pipeline corridor).

The Large-eared Pied Bat (*Chalinolobus dwyeri*) was not recorded within the Modification Disturbance Boundaries; however it is considered to occur due to the multiple possible call detections within the study area, presence of suitable habitat, and known records in the LGA. The Modifications will not remove rocky escarpments which provide critical habitat features for this species. Approximately 148 ha of woodland and forest foraging habitat will be removed.

The Brush-tailed Rock-wallaby was not detected within the study area; however it is considered to have potential to occur due to the presence of suitable habitat and known records in the LGA. However, the Modifications will not impact the plateaus, ridges and upper slopes, which contain the sandstone outcropping suitable for the Brush-tailed Rock-wallaby. The Modifications will remove approximately 148 ha of potential woodland shelter and forage habitat occurring below these rocky escarpments (62 ha and 84 ha in the Cullen Valley and Invincible Modification Disturbance Boundaries respectively and 2 ha from the pipeline corridor).

The Bathurst Copper Butterfly was not detected within the Modification Boundaries and is considered unlikely to occur. This species has quite a specific set of habitat requirements, namely *Bursaria spinosa* subsp. *lasiophylla* plants, which renders large areas of the study area unsuitable. Surveys failed to locate significant areas of habitat for the species, though one individual of *Bursaria spinosa* subsp. *lasiophylla* has been identified as occurring within the Invincible Modification Disturbance Area by OEH. There is potential for additional specimens to be recorded, however as they have not been recorded during previous surveys, large numbers are unlikely to be present. The removal of an individual plant (or potentially several isolated plants) of suitable habitat is not considered likely to constitute a

significant impact to the Bathurst Copper Butterfly, when the species requires expansive areas of suitable habitat to form breeding colonies.

The Migratory species that have the potential to occur within the Modification Disturbance Boundaries (White-throated Needletail, Rainbow Bee-eater, Black-faced Monarch, Rufous Fantail and Satin Flycatcher) are widespread and relatively abundant species. The Modifications will remove approximately 62 ha and 84 ha of forest and woodland habitat from the Cullen Valley and Invincible Modification Disturbance Boundaries respectively that provides potential forage and breeding habitat for these species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Modifications including pre-clearance surveys and rehabilitation of vegetation within the Modification Disturbance Boundaries. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the two proposed Modifications will result in a significant impact to species listed under the EPBC Act.

4.2.6 *Reduction in the Availability of Important Habitat Features*

The distribution and abundance of flora and fauna varies on temporal and spatial scales and in relation to the ability of each species to exploit a set of environmental resources to maintain a viable population. Habitat selection and the value of a site are generally based on a bio-geographic range in which critical resources can be acquired. These include sufficient territory for a home range, macro and micro-physical habitat features and the availability of food, water, nest and/or den sites (Bookhout, 1996).

Within these vegetation communities, a range of habitat features provide forage, shelter and breeding opportunities for fauna, the quality of which is dependent upon location and past land use. Remnant woodland patches support a higher diversity and abundance of habitat features, than regrowth areas which generally lack many habitat features. This is mainly because features such as ground debris and hollows have not had the opportunity to form because the trees are still young, or because they occur in areas that were, until recently, regularly cleared of ground habitat.

Important fauna habitat features that will be removed by the Modifications are:

- Structural diversity – as more vegetation layers support more niche habitats for various animals to shelter, forage and nest;
- Understorey vegetation – shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- Fallen logs, woody debris and leaf litter – shelter habitat for amphibians, reptiles and terrestrial mammals, and forage habitat for woodland bird species;
- Hollow-bearing living trees and stags – essential habitat resources for range of fauna species which may rely on them for shelter, breeding or roosting. Loss of mature remnant hollow-bearing trees will have important implications for threatened species such as 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 a range of passerine birds and herbivorous mammals;
- Ecotonal (edge) communities – foraging habitat for many species, particularly birds such as raptors; and
- Ephemeral drainage lines - foraging, shelter and breeding habitat for amphibians, aquatic reptiles, wetland birds and aquatic mammals.

The impact of mining on fauna habitat results in the clearance of vegetation and removal of fauna habitat features. This process results in several actions considered to be Key Threatening Processes by OEH such as the Clearing of Native Vegetation (NSW Scientific Committee, 2004c), Loss of Hollow-bearing Trees (NSW Scientific Committee, 2006a), Removal of Dead Wood and Dead Trees (NSW Scientific Committee, 2004i) Bushrock Removal (NSW Scientific Committee, 2004b).

i. Loss of Tree Hollows

Tree hollows are an essential resource for a number of fauna species that rely on them for refuge and nesting (Cockle et al., 2010, Newton, 1994, Heinsohn et al., 2003, Gibbons and Lindenmayer, 2002). Tree hollows have been shown to be a key limiting resource for hollow-dependent fauna (Lindenmayer et al., 1990, Newton, 1994, Heinsohn et al., 2003, Gibbons and Lindenmayer, 2002, Brawn and Balda, 1988, Cameron, 2006, Gibbons et al., 2002), especially considering the processes of natural decay and primary excavation that produce hollows are time-consuming (Aitken and Martin, 2007, Aitken and Martin, 2008, Marsden and Pilgrim, 2003, Murphy and Legge, 2007). Furthermore, many hollow-dependent species such as the Swift Parrot (*Lathamus discolor*) are hollow specialists (as opposed to hollow generalists) and will only occupy hollows with specific hollow characteristics (Gibbons et al., 2002); this means that many of the available number of hollows in an area of habitat are unlikely to be usable or 'functional', which increases the demand on the remaining suitable hollows.

In spite of the history of logging and gathering of timber for firewood within Ben Bullen State Forest, many trees remaining within the forest have hollows; particularly within the gully and slopes vegetation communities. Of these, it is possible that only a small proportion of available hollows are likely to be functional (Cockle et al., 2008) and so the importance of this limited resource in the study area is likely to be high.

Hollow formation generally develops as a tree ages and is exposed for longer, and eventually becomes vulnerable to natural decay and weakening processes (Gibbons and Lindenmayer, 2002). The likelihood of a tree being hollow-bearing is strongly associated with trunk diameter at breast height (DBH) and as a result of age and habit of the tree species (Gibbons and Lindenmayer, 2002, Harper et al., 2004). In box-ironbark communities, this corresponds to old trees with a DBH of at least 60 cm, which is generally equivalent to at least 120-150 years old, or pre-European settlement ages (Gibbons et al., 2008, ECC, 2001).

Over 300 Australian fauna species are reliant on hollows, and at least 40 species are commonly found within a given geographical region (Gibbons et al., 2002). As such, hollows are a resource in disproportionately high demand compared to the availability of suitable cavities (Lindenmayer et al., 1990, Newton, 1994, Heinsohn et al., 2003, Gibbons and Lindenmayer, 2002); a consequence of the low occurrence of remnant trees, age requirements, and the prolonged and energy intensive processes of natural decay and primary excavation that produce hollows (Aitken and Martin, 2008, Aitken and Martin, 2007, Murphy and Legge, 2007). The distribution, diversity and abundance of hollow-dependent fauna is constrained by hollow density and specific characteristics of cavities (Remm et al., 2008).

Many available hollows in an area are unlikely to be usable or 'functional' for many species, which increases the demand on remaining suitable hollows (Cockle et al., 2010, Newton, 1994).

Much of this resource will be lost in the short term and medium term from within the Modification Disturbance Boundaries. Furthermore, fragmentation and edge effects will have consequences for the integrity of the remaining hollow-bearing forest (e.g. susceptibility to wind blow). The loss of tree hollows will have important implications for threatened species such as bats, owls and some diurnal birds, as discussed below.

The recommended mitigation measures to minimise adverse impacts on tree hollows resulting from the mining process are described in detail in **Chapter 5**.

4.3 Indirect Impacts

The direct impacts of the Modifications on flora, fauna and vegetation communities are mostly related to the removal of native vegetation which provides direct habitat for a wide diversity of species (see preceding sections). However, the Modifications will also have indirect impacts on the ecological values of the study area, including subsidence, edge effects, noise, dust, and erosion. These indirect impacts of the Modifications are considered in more detail below.

4.3.1 Subsidence

As discussed previously, the use of a highwall mining methodology will ensure that no surface subsidence of greater than 20 mm occurs within areas mined. As a result, no impacts to surface topography, landform or hydrology will occur. Moreover, subsidence is not considered likely to adversely impact any species occurring within the Modification Boundaries.

4.3.2 Edge Effects

The Modifications will result in habitat clearing which leads to "edge effects". This refers to changes in physical and biological conditions at an ecosystem boundary or interface between adjacent ecosystems (Fischer and Lindenmayer, 2007), particularly between natural habitats such as forests and disturbed or developed land (Yahner, 1988).

Edge effects can refer to abiotic microhabitat changes in light, temperature, moisture and nutrient levels; and biotic changes such as alterations in the composition and relationships between various flora and fauna species (Fischer and Lindenmayer, 2007, Chen et al., 1990). The depth of penetration of edge effects within vegetation varies depending on the structural contrast between ecosystems, but can extend from between tens to hundreds of metres from the edge (Yahner, 1988). These include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species, including exotics, and therefore cause significant changes to the ecology of the patch (Lindenmayer and Fischer, 2006).

Impacts will occur at edges created between the Modification Disturbance Boundaries and areas of retained forest and woodland (Peake, 2006). The measure of penetration is also correlated to slope, soil type and adjoining land use. For example, dry sclerophyll sandstone forest and other exposed habitats upslope of clearing will remain relatively intact. Conversely, edge effects of down slope habitats, particularly wetter environments are far more extensive if not well managed.

The potential ecological impacts of the open cut could extend beyond the areas to be cleared and into areas of forest and woodland that are being retained. The edge effects could include changes in sunlight, humidity, water runoff and wind and erosion. There is a low potential for edge effects to occur in upslope or midslope areas as the highest risk of edge effects is from unmitigated erosion and surface water runoff. Therefore edge effects within the drier habitats are expected to be minimal and confined close to the edge of clearing.

Such habitats include the following vegetation communities: Exposed Blue Mountains Sydney Peppermint Silvertop Ash Shrubby Woodland and Tableland Scribbly Gum Narrow-leaved Stringybark Shrubby Open Forest. Impacts down slope of clearing have the potential to be more widespread and penetrate significantly further from the cleared areas.

4.3.3 *Habitat Degradation*

Habitat loss rarely occurs in isolation from other threats (Fischer and Lindenmayer, 2007). While the Modifications will directly remove large areas of vegetation, a range of other indirect threatening processes will result from the clearance which will further increase the loss of habitat for a range of flora and fauna.

Habitat degradation refers to the gradual deterioration of habitat quality over various spatial and temporal scales (Fischer and Lindenmayer, 2002, Maron et al., 2011). In some instances it can be difficult to detect due to a long manifestation time. The woodland areas to be cleared predominantly consist of trees that have been cleared and have since regrown, although remnant trees are scattered across the Modification Boundaries. Portions of forest and woodland within the Modification Disturbance Boundaries are made up of relatively young trees that are not of hollow-bearing age. Notwithstanding the importance of these trees in providing hollows once matured, the removal of these trees will significantly reduce the short to mid-term availability of hollow habitat for native fauna.

The main consequences of habitat degradation are the decline or complete loss of a species from a geographic area. The loss of critical habitat features may force some mobile species to emigrate, however species unable to relocate to other habitat will be vulnerable to genetic isolation and an inability to breed or a slow life cycle which may result in low population density and potentially local extinction (refer to **Figure 4.2**).

4.3.4 Competition for Resources

Removal of habitat and forced emigration from the Modification Disturbance Boundaries will impact on the successful relocation of a range of fauna. Dispersal into new areas of habitat can significantly increase con-specific competition and alter population dynamics with existing occupants (Maron et al., 2011, Amarasekare, 2002, Rappole and McDonald, 1994, Dickman, 1991). Overcrowding has the potential to create conflict over territoriality, viable home ranges and overlap of structural niches (Lawlor, 1980); restrict accessibility to limiting forage, roosting and breeding resources; alter predator-prey interactions; potentially increase the incidence and spread of diseases; and affect the availability of mates (Nelson et al., 1960). Competition for such resources may lead to injury and death for various fauna, or push those unable to settle out of suitable habitat.

4.3.5 Noise

Fauna species are sensitive to elevated levels of noise in their environment, which generally result from anthropogenic sources (Fletcher and Busnel, 1978). Persistent noise can affect an animal's physiology by impacting on its hearing and energy budget, interrupting foraging and reducing reproductive success and long-term survival. Behavioural impacts include habitat loss through avoidance and a retreat away from favourable habitats (AMEC Americas Limited, 2005). While some species will habituate and become accustomed to periodic noise disturbance (Fletcher and Busnel, 1978), other species may be forced to relocate, which again will be restricted by habitat degradation.

Anthropogenic noise can adversely impact an individual or species' reproductive success and mortality (AMEC Americas Limited, 2005) by affecting signal production, deployment, perception and response. Interference can distort or mask social, warning, mating or territorial calls and how they are heard and interpreted by other animals (Chan et al., 2010). It can indirectly change population dynamics by disrupting navigation, impacting on predator-prey interactions, changing habitat use and affecting courtship and parental care (Chan et al., 2010, Rabin et al., 2003, Owings and Morton, 1998).

The Modifications will continue to generate noise through routine mining operations, which may increase as mining advances towards retained habitats. Traffic, particularly from large mining trucks and excavation machinery; blasting during the mining phase; and noise from generators and machinery will elevate noise levels in the environment and potentially impact on various fauna species and affect the value of the habitats that remain (AMEC Americas Limited, 2005).

Noise will diminish within areas that are progressively rehabilitated and, in the long term, noise levels will return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.6 Light

Increased 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, Longcore and Rich, 2004). The Modifications will continue to generate light through routine mining operations, which may increase as mining advances towards retained habitats.

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

- Disorientation and/or temporary blindness;
- Changes in foraging behaviour, such as when diurnal species extend foraging into the night-time (Longcore and Rich, 2010);
- A disruption of seasonal day length cues which trigger critical behaviours (Longcore and Rich, 2010, Saleh, 2007, Longcore and Rich, 2004);
- Suppression of the immune function (Bedrosian et al., 2011);
- Alteration in the timing of reproduction which can decrease successful breeding and reduce fitness (Bedrosian et al., 2011); and
- Interference with predator-prey relationships.

While the operational phases of the Modifications will have some effect on the surrounding forest and woodland environment, the impacts from light pollution are likely to remain close to the immediate Modification Disturbance Boundaries of the operational open cut pit, with only limited glare into the surrounding natural vegetation. It is likely that most fauna species would habituate to the periodic disturbance and that light pollution from the mine is unlikely to have a significant or long-term impact on any fauna species.

Artificial light will diminish within areas that are progressively rehabilitated and, in the long term, light levels will return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.7 Dust

The Modifications will generate dust during the removal of vegetation, construction and mining phases. As with the impacts caused by anthropogenic noise, dust pollution can lead to a decrease in habitat quality by affecting the health of trees and leading to altered community structure, reducing the overall amount of available habitat. It also has the potential to extend the area of impact beyond the mine footprint.

Plants will be most affected by dust, as it can settle and accumulate on leaf surfaces and impair essential physiological processes including photosynthesis, respiration, and transpiration by shading or clogging stomata and reducing light penetration through leaves (Spencer and Tinnin, 1997, Ministry for the Environment (NZ), 2001). Dust can also abrade

the leaf surface and cuticle, increasing the plant's susceptibility to pathogens, fungal disease, and toxic gaseous pollutants (Farmer, 1993). These impacts increase mortality and decrease productivity which can result in changes in vegetation and community structure (Farmer, 1993).

The effect of dust deposition could affect animals that rely on plants, either as a source of food or habitat. Physiological impacts may result in a reduction in the size and abundance of fruits and sugar levels, while dust on the foliage and fruit may affect palatability to animals (Ministry for the Environment (NZ), 2001).

Dust will diminish within areas that are progressively rehabilitated and, in the long term, dust levels will return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.8 Erosion

The Modifications will increase the current extent of erosion in the Modification Disturbance Boundaries, impacting on the landscape and key areas of habitat. Soil erosion typically results in a loss of water, organic matter, nutrients and biota important for the health and productivity of soil landscapes (Pimentel and Kounang, 1998). Disregarding the direct, large-scale clearance of vegetation and soil in the mine footprint, erosion will predominantly result from the construction and use of hard-surfaces such as roads, tracks, and infrastructure for general mining operations.

Erosion most relevant to the Modification Disturbance Boundaries is water erosion of soil; sheet, rill, gully, and tunnel (Harpstead et al., 2001). Sheet erosion is the uniform removal of soil without the development of visible water channels and is the least apparent of the four erosion types. Rill erosion is soil removal through the cutting of many small, but conspicuous, channels. Gully erosion is the consequence of water that cuts down into the soil along the line of flow and this type of erosion develops more quickly in places like tracks and animal trails. Tunnel erosion may occur in soils with sub layers that have a greater tendency to transport flowing water than does the surface layer.

The effects of erosion can already be seen within the Modification Disturbance Boundaries, particularly gully erosion along access roads and banks of dry creek lines. The soils of the Modification Disturbance Boundaries have a moderate soil erosion and dispersion potential (EcoBiological 2011). Once these soils are disturbed, the potential for erosion is increased (EcoBiological 2011). As indicated, this characteristic of soil is worsened by the removal of ground vegetation that would otherwise stabilise the banks.

Sheet and rill erosion may occur where large areas are cleared, particularly on hillsides. Where there is no obvious existing channel for the water to follow, it will form rills or flow overland. This kind of erosion is likely to be exacerbated by any kind of clearance for the mine and infrastructure. Appropriate surface water management practices will be implemented to minimise these risks.

4.3.9 Vehicle Strike

Vegetation clearance and increased traffic associated with the Modifications may impact fauna through increased vehicle strike, injury and mortality. The Modifications will result in the construction of additional roads and tracks which means an increased length of road for animals to cross and negotiate, as well as an increase in the number of vehicles operating in the Modification Boundaries. Vehicle strike can pose a significant risk to some wildlife, particularly (but not exclusively) ground dwelling species (Taylor and Goldingay, 2010).

This may occur during the operation of the mine as a result of collision with vehicles entering and leaving the pit as well as during the normal daily movements of workers and vehicles throughout the site. Although some mortality of animals as a result of vehicle strike is likely, it is not expected to be significant. Mine speed limits are enforced limiting speed across all operations to 60kph or less with most traffic in daylight hours. Animals are expected to mostly be able to avoid vehicles on this basis.

Site induction that entails instructions to be aware of fauna on haul roads will decrease the risk. The risk of vehicle strike will diminish as areas that are progressively rehabilitated will return to current levels following rehabilitation of the total mined area and cessation of mining.

4.3.10 Weeds, Feral Animals and Overabundant Native Species

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions. Habitat fragmentation and associated edge effects reduce the availability and quality of refugia for native fauna and increase feral access to resources, thus increasing the risk of predation and competition for resources for local native fauna (Dickman, 1996, Fitzgerald and Wilkinson, 2009, Doak, 2002). It can also increase native flora susceptibility to infection from pathogens (Dale et al., 2001, Garkaklis et al., 2004) such as the fungus *Phytophthora cinnamoni* which causes dieback (NSW Scientific Committee, 2004e).

Invasive weed and feral animal infestation are already evident within the study area and are threats whose impacts are well established in the nearby Hunter region (West and Saunders, 2007, Gong et al., 2009). Invasive species compete with natives for resources and can aggressively invade areas, displacing native plants and animals. Feral animals such as rabbits, hares, pigs, goats, wild dogs, cats, foxes, aggressive birds such as mynas, and feral honey bees (Oldroyd et al., 1997) pose a major threat to many native and threatened species (West and Saunders, 2007, Fitzgerald and Wilkinson, 2009). They compete for food and nest or roost sites; breed in more open areas following clearance of forest and woodland; prey on adults, juveniles and eggs; and damage and degrade natural habitats and breeding sites.

As previously mentioned, the presence of the feral fox may be a key factor in the low numbers and diversity of ground-dwelling fauna in the study area and surrounds as they have long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC, 2010, DECC (NSW), 2007). Regular baiting programs are undertaken in the study area to manage the risks of this species.

Generally, the proportion of exotic plants found within the study area is highest around the lower slopes and valley floors where the land has been used for more intensive agriculture and livestock can facilitate weed dispersal. The upland areas tend to have a more intact understorey that has fewer serious weeds. The control of weeds can help recover threatened species (Hunter-Central Rivers Catchment Management Authority, 2010, West and Saunders, 2007, Fitzgerald and Wilkinson, 2009).

These processes are well established in the study area and region by Forests NSW and the Modifications are not considered likely to exacerbate them. A weed and feral animals control program will be prepared for implementation by Coalpac as part of the Biodiversity Management Plan (BMP). With the implementation of this plan, the Modifications are not likely to increase the presence of effects of feral species.

4.4 Duration and Timing of Impacts

The duration and timing of the impacts of the Modifications have important effects on the magnitude of the overall impacts on the ecology of the Modification Boundaries at any given time.

Ben Bullen State Forest is approximately 6,783 ha in size and of this, 148 ha of forest and woodland will be progressively cleared by the two Modification Disturbance Boundaries (2 ha comprises grassland). However, land within the Modification Disturbance Boundaries will be revegetated to forest and woodland in accordance with a Biodiversity Management Plan (BMP; see **Chapter 5**) and added to the BOMP (see **Chapter 6**). Thus the *net loss* of vegetation at a given stage of the Modifications time will be minimised through the progressive clearance and concurrent rehabilitation of the land within the Modification Boundaries. In the final years of mining some of the rehabilitation will be at least four years old and will already provide some habitat to replace that which will be removed. Existing rehabilitation areas will be up to 18 years old. Moreover, the mines have 193 ha of existing successful rehabilitation and adjoining biodiversity offset which will be linked to the Ben Bullen State Forest at the same time.

4.5 Permanence and Reversibility of Impacts

Although impacts will occur on a local scale, not all of these are irreversible, and with appropriate management and the implementation of mitigation measures, the impact of these can be considerably reduced.

Apart from the open cut components of the mines that will alter the topography of the site, other aspects of the development are likely to have reversible impacts, and flora and fauna are likely to recover well with appropriate rehabilitation measures. Not all areas will be permanently cleared and disturbed. Areas to be used for buildings and other mine infrastructure will be returned to forest and woodland in the long term once mining has ceased. Moreover, all of the disturbed areas will be reshaped and revegetated post-mining to forest and woodland using local provenance species in the long term.

If appropriate effort is put into the subsequent rehabilitation of disturbed areas, it is possible to recreate the communities that previously existed in these areas in the long term. This is evident in the results from the monitoring of Coalpac rehabilitation areas, some of which are up to twelve years old. Through the ongoing implementation of management and maintenance works, rehabilitation areas are progressing well against long term performance targets for biodiversity, vegetation community structure and development, fauna habitat and landform sustainability. Rehabilitation and regeneration of forest and woodland has the potential to reduce the impacts of habitat removal on threatened species. The planting of threatened plant species which are known to occur in the Modification Disturbance Boundaries would reduce impacts on these species and enable recovery of populations in the Modification Disturbance Boundaries.

Impact Mitigation Measures

5.1 Introduction

The purpose of this chapter is to outline the mitigation measures proposed to ameliorate the impacts of the Invincible and Cullen Valley Modifications on flora and fauna. As demonstrated in previous chapters, the study area is biodiverse and provides habitat for a wide range of flora and fauna, including species listed under State and Commonwealth threatened species legislation. Accordingly a suite of substantial mitigation measures has been prepared to mitigate these impacts.

The considerations for reducing the ecological impacts are according to the following hierarchy of principles:

- Avoid – to the extent possible, developments should be designed to avoid or minimise ecological impacts;
- Mitigate – where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the Modifications; and
- Compensate – the residual impacts of the Modifications, following the implementation of mitigation measures, should be compensated to offset what would otherwise be a net loss of habitat.

Further to these considerations, it is essential to monitor the ongoing status and health of flora and fauna communities that will be retained within the Modification Boundaries in order to assess the success of the mitigation and compensation measures. This will be achieved through the continuation and refinement of the existing ecological monitoring program for the Modifications.

A Biodiversity Management Plan (BMP) will be prepared for Invincible Colliery and Cullen Valley Mine to guide the implementation of the mitigation strategy incorporating detailed specifications for the implementation of all the impact mitigation measures described below for the existing offsets and the Modifications. The BMP will be the key document to ensure that the conservation objectives of the Modifications are met and that impacts to biodiversity are adequately managed for the life of the Modifications. This is explained further in **Section 5.2**.

The BMP will also include a Biodiversity Offsets Management Plan (BOMP) that covers all offsets for each Modification (including existing offsets) and provides specifications for the restoration and management of biodiversity offset areas. This will be finalised prior to the commencement of mining operations. This is explained in further detail in **Chapter 6**.

5.2 Measures to Avoid Impacts

Open cut mining operations cannot readily avoid impacts where mineral resources are beneath flora and fauna habitats. However, avoidance can be achieved to varying degrees by modification of the design and location of mine associated infrastructure away from more sensitive natural habitats, where feasible. Wherever possible, risks of environmental impacts have been avoided through the overall design of the Modifications. Some local scale avoidance measures are discussed below.

Avoidance of environmental impacts has been a consideration throughout the Modifications planning and design phases. The Modifications have been devised through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened communities and species.

Altering disturbance footprints for the Modifications through mine plan design also avoided:

- Significant potential and known *Eucalyptus cannonii* habitat;
- All known habitat for *Persoonia marginata*;
- Rocky escarpments and formations, potential habitat for the following threatened species:
 - Potential Brush-tailed Rock Wallaby habitat;
 - Summer habitat for the Broad-headed Snake;
 - Roost habitat for the Large-eared Pied Bat and Eastern Bent-wing Bat;

These avoidance measures are explained in more detail below.

The Modifications have avoided significant disturbance of surface habitat including that of *Eucalyptus cannonii* by the use of underground highwall mining instead of open cut mining. A total of 179 ha of habitat for *E. cannonii* is present within the highwall mining areas that would have been removed if open cut mining methods were used. This habitat supports an estimated 2,180 individuals of *E. cannonii*.

Furthermore, Coalpac will implement mitigation measures and compensatory measures to further reduce impacts to *Eucalyptus cannonii* (refer to **Section 5.3** and **Chapter 6**).

The Modifications have avoided all known individuals, population and habitat for *Persoonia marginata*. The open cut footprint of the Cullen Valley Mine Modification Disturbance

Boundary has specifically been designed around habitat and known populations of the species so as to avoid impacts. The species is not considered to be significantly impacted by the Modifications. The implementation of open cut mining proposed for the Modifications will not impact sandstone escarpments and plateaus, critical habitat for numerous threatened species.

The above measures will reduce the impacts of the Modifications as much as is practically possible. The residual impacts of the Modifications that cannot be avoided will be compensated for via substantial mitigation and offset measures, as described below. Further avoidance, where practical will be a key aim during the detailed design phase for the Modifications.

5.3 Measures to Mitigate Impacts

During implementation of the Modifications, measures will be established to mitigate some of the direct and indirect impacts of the construction and operation. This section summarises the recommended mitigation measures.

5.3.1 Minimising Vegetation Clearance and Habitat Loss

Disturbance to areas of native vegetation and habitat will be unavoidable during the construction process. However, in order to minimise clearing impacts and avoid unnecessary disturbance outside of the Modification Disturbance Boundaries, 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 areas as far as practically possible. During the detailed design stage, opportunities to further minimise vegetation disturbance will be considered.

5.3.2 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. Pre-clearing surveys will also include documentation of *Eucalyptus cannonii* counts within designated clearing areas to ensure that mitigation for the Modifications includes re-planting of the appropriate number of individuals to compensate for those lost.

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.

Coalpac will implement an updated Land Disturbance Protocol (LDP) for the Modifications, to be included in the BMP, which requires the Environmental Manager (or delegate) to carry out an inspection of proposed disturbance areas prior to any disturbance activities occurring. This LDP also provides a process to ensure compliance with the relevant licences and approvals is met, that vegetation clearance does not impact on areas outside of the disturbance boundary and that appropriate mitigation is put in place prior to any disturbance taking place.

5.3.3 Mine Rehabilitation

One of the key mitigation strategies for the Modifications is the continued progressive rehabilitation of mining areas to maximise conservation values and biodiversity. This includes maximising the biodiversity and connectivity within the landscape, through management of existing rehabilitation sites and the establishment of new rehabilitation sites.

Mine rehabilitation has an important role to play in mitigating impacts and restoring biodiversity and connectivity post-mining.

High quality mine rehabilitation for the Modifications is paramount. Coalpac is committed to continuing their existing high quality rehabilitation and will rehabilitate 151 ha (the entirety of both Modification Disturbance Boundaries) back to woodland. These areas will be rehabilitated to a similar standard as that of the undisturbed vegetation.

Rehabilitation of threatened plant habitats will aim to achieve similar densities of pre-disturbed *Eucalyptus cannonii* densities (refer to **Table 3.2** for extrapolated densities). Rehabilitation of *Eucalyptus cannonii* habitat is not expected to be difficult as seed viability appears to be high as the species can be easily propagated from seed (NSW NPWS 2000).

All areas disturbed by mining activities of the Modifications will be progressively rehabilitated over the life of the Modifications (>4 years) and will be covered by a revised Flora and Fauna Management Plan for Cullen Valley Mine and Landscape Management Plan for Invincible Colliery. These Management Plans will prescribe the progressive rehabilitation of all mine disturbed areas. The key objectives of this plan are to restore, where possible, the pre-mining biodiversity within a safe and stable landform. Replanting of mine rehabilitation areas will use local, native plant species.

In order to measure the effectiveness of the rehabilitation and its effect on threatened species, the existing monitoring strategy will continue to be implemented and revised as required. This will comprise detailed and replicated flora and fauna surveys in rehabilitated areas to quantify the change in species diversity and vegetation communities over time. Further details of the monitoring strategy to be implemented in areas of rehabilitation are provided in the **Section 5.3.10**.

5.3.4 Weeds and Feral Animal Control

A weed and feral animal control program will continue for the Modifications, with a focus on weed and feral animal species that have the capacity to significantly impact on the habitat value of the retained native vegetation and native fauna populations. Some exotic plant species pose serious threats to native vegetation communities. These introduced species typically invade, out compete and eventually modify ecosystems so that native plants cannot survive. Priority will be given to the removal of such species. Weed control methods include hand weeding, foliar spraying, cut-and-paste, and stem injection.

Feral animals that have the capacity to significantly impact on the environment include the European Red Fox that can impact on the Spotted-tailed Quoll through predation, and the European Rabbit, that can affect vegetation communities through grazing. These will be controlled through appropriate management strategies.

5.3.5 Dust Minimisation Measures

A suite of dust minimisation measures will be implemented during construction and operation of the Modifications. These measures would comprise a monitoring network and management procedures to proactively manage the day-to-day generation of dust and fine particles due to the Modifications.

The management of dust generation from the Modifications will focus on key identified areas of construction and operational activities. Mitigation activities are listed below and will be implemented to minimise dust impacts on-site and off-site:

- Disturbed areas – mitigation measures are targeted at design measures as well as operational techniques, such as the design and reshaping of overburden emplacement areas and the regular watering of trafficked surfaces in order to minimise dust generation.
- Handling of materials – mitigation measures are focused on materials being handled (i.e. ROM coal, overburden, topsoil) to minimise dust generation, as well as an awareness of adverse weather and relocating/rescheduling activities in periods of high wind where dust impacts can be expected.
- Haul roads – mitigation measures are targeted at minimising the volume of trucks where practical and minimising dry exposed surfaces as well as the type of surface of the haul roads themselves.
- Blasting – mitigation measures such as the consideration of weather conditions and sensitive features will be incorporated into the design of the blasts for the Modifications.

A key component of dust minimisation for on-site and off-site impacts is the monitoring of adverse weather conditions. Adverse dispersion conditions may include prolonged periods of calm or strong wind speeds and a range of conditions in between. Under light winds and stable conditions the dispersion potential of the atmosphere is limited and emissions

sources, such as dozers, excavators, draglines and trucks are likely to be the largest contributor to impacts and should be managed accordingly. Conversely, wind erosion and wind dependent sources are likely to contribute most significantly when strong winds are experienced.

The implementation of the above mitigation measures are expected to provide sufficient management of dust generation to minimise the on-site and off-site impacts.

5.3.6 Noise Minimisation Measures

Noise generation from the Modifications will be managed through design, noise mitigation of the plant and equipment fleet (such as attenuating haul trucks noise via bunds or shielding of site infrastructure), and prescribing protocols and procedures for construction and operational activities.

The implementation of the above management and mitigation measures is expected to provide sufficient management of noise generation to minimise the on-site and off-site impacts.

5.3.7 Management of Surface Water, Erosion and Sedimentation

The operation of the Modifications will manage the potential on-site and off-site impacts from surface water and erosion and sedimentation through the implementation of a range of prescribed mitigation measures. These measures will target the design of both construction and operational activities where practical. Key aspects include:

- Maintaining flows in receiving waters – where practical, diverting runoff from undisturbed areas into natural drainage network via diversion drains and banks;
- Maintaining receiving water quality – directing surface water flows and stormwater runoff from disturbed areas to the water management system;
- Minimising on-site erosion – temporary erosion and sediment control measures to include silt fences, hay bales, jute mesh, cross banks, contour banks, armouring and straw mulching; and
- Developing an updated Water Management System for the Modifications, to reflect the operations proposed.

The implementation of the above mitigation measures and construction of the water supply pipeline to link both sites are expected to provide sufficient management of water on-site to minimise the potential direct and indirect impacts from water through erosion and sedimentation.

5.3.8 Ecological Monitoring

An ecological monitoring program will be implemented within the offsets and areas of remnant vegetation and mine rehabilitation within the Modification Disturbance Boundaries. The monitoring program aims to incorporate a range of methodologies that will provide

various levels of information about the existing flora and fauna species and their habitats and quantify ecological changes occurring within these populations and habitats as a result of improved management, habitat re-establishment and enhancement and rehabilitation programs being implemented throughout the life of the Modifications. The monitoring program will include:

- Establishing permanent monitoring quadrats and photo-points in various habitat types and in various health conditions in the Biodiversity Offset Properties and remnant vegetation within the study area;
- Undertaking on-going ecological monitoring in these areas for the duration of the Modifications to assess changes occurring within these communities as a result of improved management or habitat enhancement programs;
- Undertaking annual ecological monitoring of rehabilitation, habitat re-establishment and active management areas within the Modification Disturbance Boundaries for the duration of the Modifications to measure changes in ecological function and sustainability and ensure these areas are comparable with a range of reference sites or trending in the right direction;
- Undertake monitoring of threatened species and communities particularly adjacent to the Modification Disturbance Boundaries for the duration of the Modifications to measure changes in habitat quality, potential threatening processes and overall population health;
- Identify and address key threatening processes, such as limited recruitment, weed or feral animal invasion or poor rehabilitation progress based on the data, which can be used as a guide for adaptive management strategies; and
- Demonstrating that the monitoring methodology is sufficient to satisfy regulatory reporting requirements and assist and guide management intervention required to complete the desired objectives.

5.3.9 Summary of Mitigation Measures

A suite of environmental control measures will be implemented for the Modifications which will have indirect benefits that will help to minimise impacts to ecology.

Table 5.2 provides a summary of the specific ecological mitigation measures to be implemented. Since the proposed Modifications are a continuation of mining, some of the following measures are currently being undertaken in which case existing management systems will be amalgamated and updated to cover the Modifications.

Table 5.1 Summary of Specific Ecological Mitigation Measures for the Modifications

Impact	Mitigation
Vegetation and habitat loss	Disturbance of vegetation will be limited to the minimum necessary for each stage of the pre strip clearing. Limits of clearing will be marked and fencing installed where appropriate around the construction footprint area prior to construction activities commencing to avoid unnecessary vegetation and habitat removal.
	A pre-clearing Land Disturbance protocol will be extended and refined for all vegetation clearing to minimise impacts to threatened flora and fauna and resident fauna.
	An updated flora and fauna management plan will be developed as part of the BMP.
	Clearing of vegetation will be scheduled where possible to optimise seed collection.
	Transportable habitat features such as large logs and boulders will be retained post-clearing and placed in available rehabilitation areas, where safe and practicable, to allow their continuation as potential fauna refuge sites.
	Native seed will be collected and propagated for use in rehabilitation areas and other disturbed areas including <i>Eucalyptus cannonii</i> .
	Appropriate regeneration methodologies and strategies will be developed for the Modifications. As part of these methodologies, there will be a focus on optimising revegetation efforts and offsetting areas for threatened species.
	Mining areas will be progressively revegetated.
	Retained vegetation and revegetated/regenerated. Vegetation will be managed for conservation including access restrictions, weed control and feral animal management.
	A substantial offset strategy will be developed and implemented (see Chapter 6).
	A terrestrial ecology monitoring program for the Modifications will be extended and refined to better understand impacts and guide rehabilitation actions for flora and fauna throughout the study area.
	Threatened species monitoring will be undertaken.
	Monitoring will be undertaken for exotic weeds and feral animals to determine management actions required.
	Detailed management strategies will be contained in the BMP.

Table 5.1 Summary of Specific Ecological Mitigation Measures for the Modifications	
Impact	Mitigation
Vehicle strike and direct mortality	Vehicle driving policies will continue to be implemented and speed on interior roads restricted to minimise the risk to fauna.

Biodiversity Offset Package

6.1 Introduction

In a regional context, it is recognised that the proposed Modifications will take place on land classified under the Lithgow Draft LEP 2013 as Zone No 1 (f) Rural (Forestry) which permits the development of extractive industries (mining). Notwithstanding, Coalpac has developed a Biodiversity Offset Strategy for the Modifications with the objective of offsetting the residual impacts on biodiversity, particularly on threatened ecological communities and habitat for threatened species. The Biodiversity Offset Strategy has been devised to comply with the current principles for offsetting set out by DoE (DEWR, 2007) and by OEH (DECC (NSW), 2008a).

The Modifications will require the provision of a Biodiversity Offset to compensate for the predicted residual ecological impacts of the proposed open cut mine and associated infrastructure after avoidance and mitigation measures have been implemented. The Biodiversity Offset addresses the impacts of the Modifications in a strategic and meaningful way that will deliver a real biodiversity outcome. It will ensure that the Modifications are not conducted at the cost of biodiversity conservation. A “maintain or improve” approach is to be undertaken that retains the ecological condition of the landscape within the locality by conserving, where practically possible, and increasing representative woodland and forest communities within designated areas.

Maintain or improve is defined as increasing the net area and condition of ecological communities within the locality of the proposed development in the medium to long term by permanently conserving and improving the condition of representative examples of vegetation communities and habitats for threatened species that are to be impacted by the proposed development. This definition has been based upon the key principles of offsetting, and particularly that:

- Offsets should be targeted to the ecological communities and threatened species that will be impacted by the Modifications;
- Offsets should be commensurate with the magnitude of the impacts; that is, there should be a net increase in the size and condition of the community types, populations or habitat types that will be impacted by the Modifications; and
- Offsets should be lasting; that is, there should be a level of legal protection for offset areas.

The Biodiversity Offset will ensure the best compensatory outcomes are achieved for the predicted ecological impacts of the Modifications and will protect and improve biodiversity within the locality with the most efficient utilisation of resources.

6.2 Legal Requirements

The provision of Biodiversity Offsets to compensate for impacts of the Modifications is not currently a formal legal requirement. Notwithstanding this, offset policy documents exist for both Commonwealth and State Agencies (DECCW, 2010, DEWR, 2007). Proponents generally must demonstrate that their project can address the principles outlined in these policy documents in order for their project to be considered compliant with the objectives of the relevant environmental legislation (i.e. the Commonwealth EPBC Act and State EP&A Act and TSC Act).

6.3 Approach to Biodiversity Offsetting

The Biodiversity Offset entails acquisition of offset properties for permanent conservation of native flora and fauna, including threatened flora and fauna predicted to be impacted by the proposed Modifications, supported by ongoing land management to improve the biodiversity values of the offsets. In addition to the principles set out by DoE and OEH, the development of the Biodiversity Offset Strategy has been guided by the following key design concepts (adapted from Business and Biodiversity Offsets Programme (BBOP), 2009):

- Secure land for permanent conservation;
- Increase the area of forest and woodland under conservation above what will be lost through the Modifications;
- Improve the biodiversity values of the offset properties through changing land use (i.e. deliver conservation gains to offset properties that would otherwise not have taken place under current use);
- Improve the biodiversity values of the offset property through the implementation of positive management interventions to actively stop degradation and to increase the area of native vegetation and habitat for native flora and fauna; and
- Time the offsets to minimise the lags between the Modifications' impacts and the offset achieving its objectives.

Research has highlighted the importance of maintaining treed habitats in the intervening disturbed landscape, as these patches or corridors are important for fauna movement and seed dispersal (Cooper *et al.*, 2002; Fischer and Lindenmayer, 2002; DSE (VIC), 2008; Goldingay and Taylor, 2009).

Remnant patches also serve as stepping stone corridors that facilitate the movement of fauna in the landscape (DSE (VIC), 2008). Stepping stones have been shown to be important in maintaining landscape connectivity and maintaining gene flow between

separate populations because of the movement of pollen and seed vectors such as animals and insects (Lindenmayer, 2006).

6.3.1 Existing Biodiversity Offset Properties

Coalpac is currently managing land totalling approximately 166 ha of forest, woodland and grassland for Invincible Colliery and a further 51 ha for Cullen Valley Mine, which will continue to be included as long-term compensatory conservation areas. All of this land adjoins the Modification Boundaries (see **Figure 1.2**). These properties will provide additional habitat for resident fauna and threatened flora species during the implementation of the Modifications.

A breakdown of these properties has been provided below.

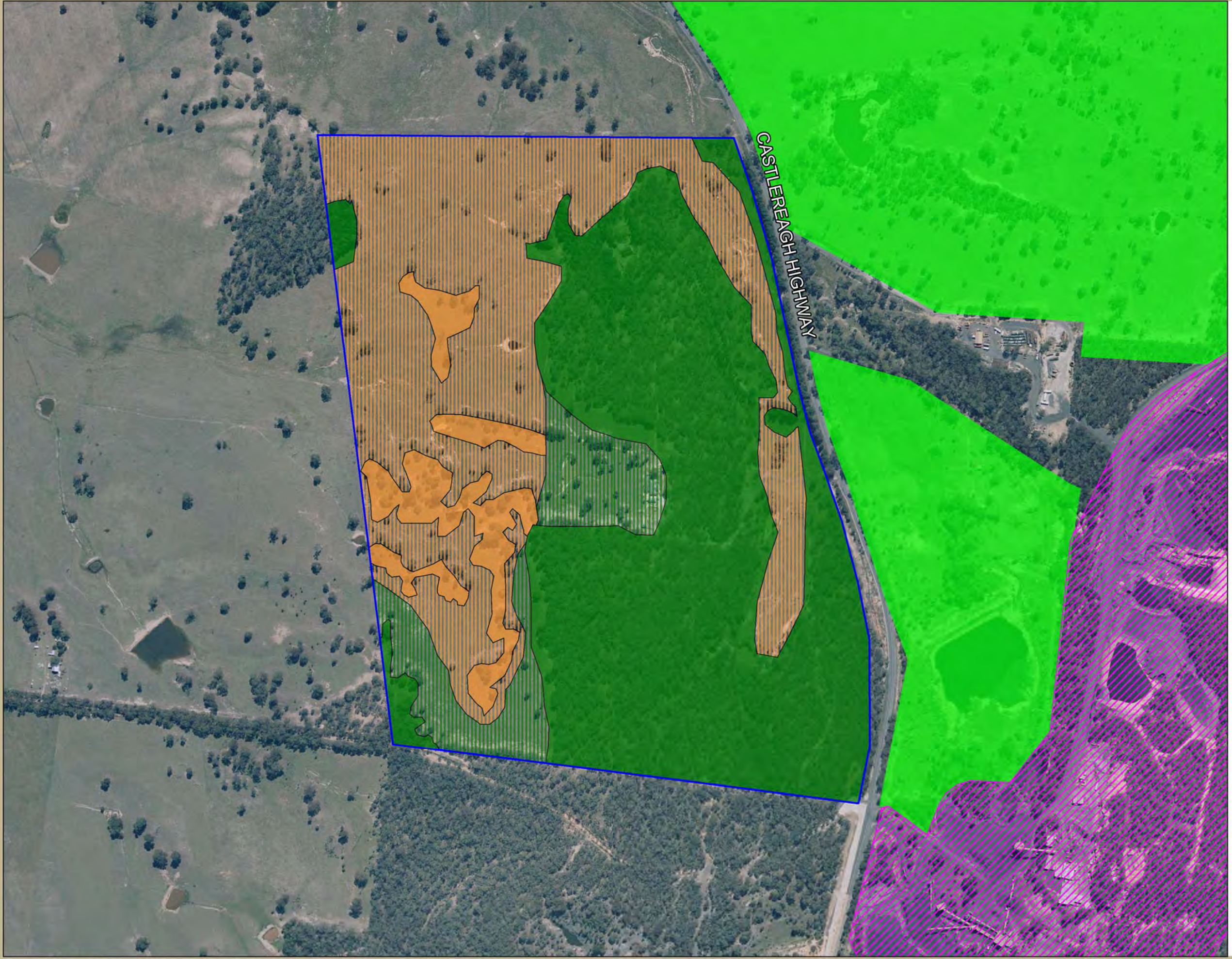
- Lot 1, DP 180294 ("Renown Farm"), an 18 ha property containing approximately 5 ha, of degraded woodland vegetation, and 13 ha of degraded grassland and water storage;
- Lot 112, DP 877190, an 82 ha property containing Tableland Gully Snow Gum, Ribbon Gum Grassy Forest vegetation community, Cox's Permian Red Stringybark Brittle Gum Woodland and Tableland Gully Mountain Gum Broad-leaved Peppermint Grassy Forest which is being rehabilitated and managed. This property also contains *Eucalyptus aggregata* with approximately 55 ha of suitable habitat. ;
- Lot 113, DP 877190, which is linked to Ben Bullen State Forest and contains 14.5 ha dominated by Tableland Gully Snow Gum – Ribbon Gum Grassy Forest vegetation community and grassland; and
- Cullen Valley Mine Compensatory Habitat Areas, which contain a total of 51 ha of forest and woodland vegetation and habitat for *Persoonia marginata*.

In addition to the existing offsets, Coalpac have developed a Biodiversity Offset Strategy with the objective of further offsetting the residual impacts from the Modifications on biodiversity, particularly on threatened ecological communities and habitat for threatened species.

6.4 Biodiversity Offset

Impacts to forest and woodland communities will be comprehensively offset through the provision of a Biodiversity Offset. This involves setting aside large areas of native forest and woodland for conservation as well as rehabilitating cleared and disturbed areas to forest and woodland habitats. The rehabilitation of disturbed areas under existing Coalpac operations is progressing well and is of high quality. There is therefore a relatively high degree of confidence that future rehabilitation will succeed and will be able to replace local native forest and woodland species on rehabilitated land.

The Biodiversity Offset comprises the Hillview/Billabong and Gulf Mountain properties as well as several smaller properties in the vicinity of Cullen Valley Mine that are referred to here as the Additional Offset Areas (see **Figures 6.1, 6.2 and 6.3.**). Each has been selected for the similarity of its flora and fauna attributes and ability to offset the Modifications' residual impacts. **Table 6.1** provides the extent of vegetation being disturbed within the Modification Disturbance Boundaries and the amount of vegetation being conserved within Hillview/Billabong, Gulf Mountain, and the Additional Offset Properties. Hillview and Billabong are adjoining properties and are considered as a single combined biodiversity offset area for the purposes of this report. Similarly, the several smaller properties that make up the Additional Offset Areas are considered together. In total, a 4.3:1 offset ratio of vegetation has been provided in the Biodiversity Offset to that being disturbed in the Modification Disturbance Boundaries (refer to **Table 6.1**). The attributes of each property being used to provide the Biodiversity Offset are discussed in detail below.



Legend

- Hillview/Billabong Offset Area
- Existing Invincible Colliery
- Existing Invincible Colliery Offset Area

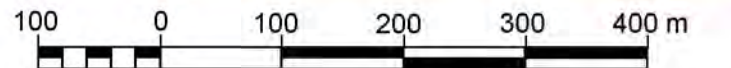
Vegetation Community

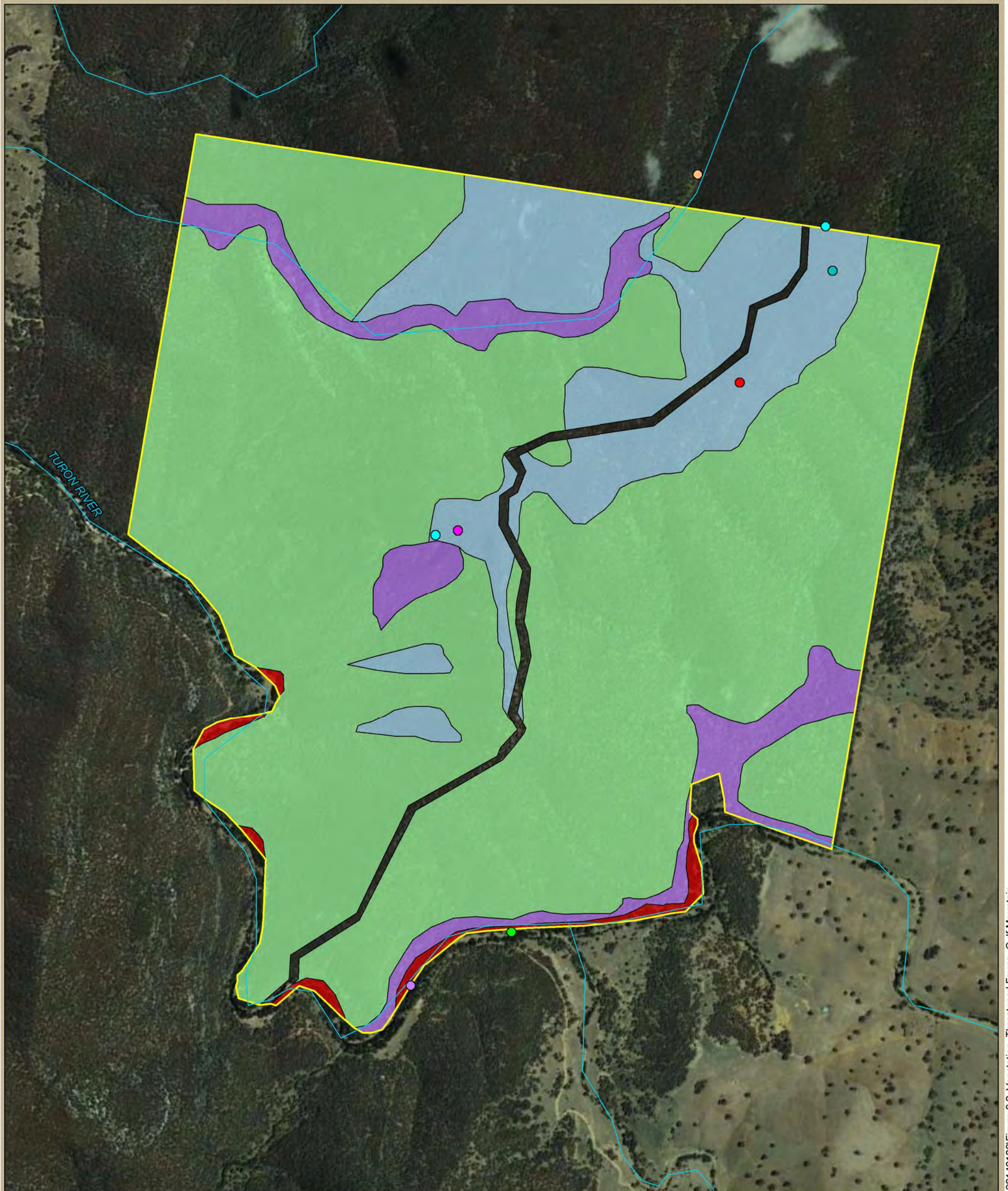
- Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC CEEC)
- Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland Derived Native Grassland (EPBC CEEC)
- Tableland Slopes Brittle Gum - Broad-leaved Peppermint Grassy Forest
- Tableland Slopes Brittle Gum - Broad-leaved Peppermint Grassy Forest Derived Native Grassland

Image Source:
Coalpac 2009



Figure 6.1. Vegetation Communities within the Hillview/Billabong Offset Area





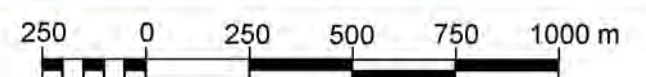
- Legend**
- Gulf Mountain Offset Area
 - Waterway
- Vegetation Community**
- Sheltered Gully Ribbon Gum Woodland
 - Broadleaved Peppermint - Brittle Gum Woodland
 - Scribbly Gum Woodland
 - Riparian River Oak Forest

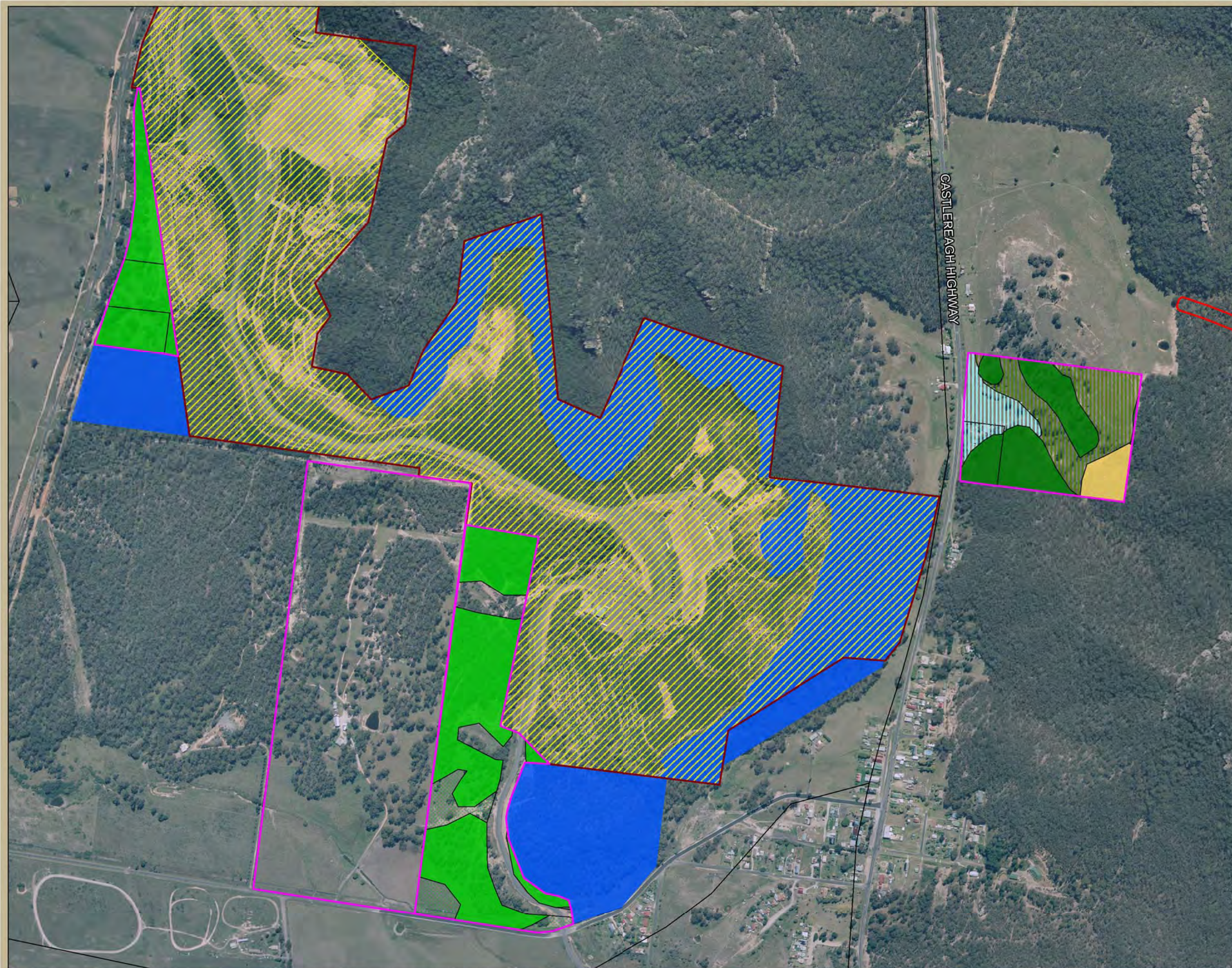
- Threatened Fauna**
- Booroolong Frog (EPBC & TSC)
 - Satin Flycatcher (EPBC & TSC)
 - Rainbow Bee-eater (EPBC)
 - Gang-gang Cockatoo (TSC)
 - Varied Sittella (TSC)
 - Scarlet Robin (TSC)
 - Powerful Owl (TSC)
 - Squirrel Glider (TSC)

Image Source:
© 2012 Cnes/Spot Image
Image © 2012 GeoEye



Figure 6.2. Vegetation Communities and Threatened Fauna within the Gulf Mountain Offset Area





- Legend**
- Cullen Valley Modification Boundary
 - Invincible Modification Boundary
 - Existing Cullen Valley Mine
 - Existing Cullen Valley Compensatory Habitat Area
 - Additional Offset Area
- Vegetation Community**
- Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest
 - Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native Grassland
 - Tableland Gully Ribbon Gum Blackwood Applebox Forest Derived Native Grassland
 - Tableland Gully Mountain Gum – Broad-leaved Peppermint Grassy Forest
 - Tableland Gully Mountain Gum – Broad-leaved Peppermint Grassy Forest
 - Low Diversity Derived Native Grassland
 - Exposed Blue Mountains Sydney Peppermint – Silvertop Ash Shrubby Woodland

Image Source:
Coalpac 2011

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



Figure 6.3. Vegetation Communities within the Additional Offset Area

Table 6.1 Vegetation Communities within the Proposed Biodiversity Offset

Unit	Vegetation Community	Disturbance Boundary (ha)	Hillview/ Billabong Offset Area (ha)	Gulf Mountain Offset Area* (ha)	Additional Offset Areas (ha)*	Total Offset (ha)	RATIO
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC C/EEC)	0.0	5.5	0.0	0.0	5.5	
MU20	Capertee Rough-barked Apple - Red Gum - Yellow Box Grassy Woodland (EPBC C/EEC) DNG	0.0	29.3	0.0	0.0	29.3	
MU20a	Capertee Rough-barked Apple - Red Gum - Yellow Box Woodland: non grassy	0.1	0.0	0.0	0.0	0.0	
MU13	Tableland Gully Ribbon Gum Blackwood Applebox Forest	7.9	0.0	36.0	0.0	36.0	
MU13 DNG	Tableland Gully Ribbon Gum Blackwood Applebox Forest Derived Native Grassland	0.0	0.0	0.0	2.0	2.0	
MU32	Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	35.2	0.0	405.3	0.0	405.3	
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	59.4	41.3	84.9	4.3	130.5	
MU34	Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native Grassland	0.0	7.2	0.0	4.5	11.7	
MU35	Tableland Gully Mountain Gum - Broad-	8.0	0.0	0.0	17.8	17.8	

Table 6.1 Vegetation Communities within the Proposed Biodiversity Offset

Unit	Vegetation Community	Disturbance Boundary (ha)	Hillview/ Billabong Offset Area (ha)	Gulf Mountain Offset Area* (ha)	Additional Offset Areas (ha)*	Total Offset (ha)	RATIO
MU35 DNG	leaved Peppermint Grassy Forest						
	Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest						
	Derived Native Grassland	2.4	0.0	0.0	0.0	0.0	
MU37	Cox's Permian Red Stringybark - Brittle Gum Woodland	0.1	0.0	0.0	0.0	0.0	
	Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	37.5	0.0	0.0	1.2	1.2	
MU30	Riparian River Oak Forest	0.0	0.0	5.6		5.6	
	TOTAL	150.5	83.4	531.7	29.7	644.8	4.3

* Note that the calculations for the Additional Offset Areas exclude lands within approved mining or rehabilitation areas at Cullen Valley Mine, or the vegetation provided by Block 211 (Lot 3, DP 249955). Block 211 provides a further area of 40.3 ha that will be included in the Biodiversity Offset Strategy following completion of vegetation mapping surveys.

6.4.1 Hillview/ Billabong Properties

i. Purpose

The primary objective for the inclusion of Hillview/Billabong in the Biodiversity Offset is to:

- Conserve and rehabilitate similar vegetation to that located within the Modification Disturbance Boundaries;
- Conserve and rehabilitate similar habitat for birds and bats to that located within the Modification Disturbance Boundaries; and
- Conserve and rehabilitate known and potential *Eucalyptus cannonii* habitat.

ii. Background

The Hillview/ Billabong properties cover a combined area of approximately 83 ha and are situated on the western side of the Castlereagh Highway, west of the Invincible Colliery and existing Invincible Colliery Offsets (see **Figure 6.1**).

Coalpac confirms that there has been no cultivation on Hillview or Billabong. There has been partial clearing for sheep and cattle grazing purposes which has since ceased. Coalpac is unsure of whether any fertiliser was applied by the previous landholder.

iii. Vegetation

The property contains Tableland Slopes Brittle Gum Broad-leaved Peppermint Grassy Forest and derived native grasslands on the upper slopes and plateaus (see **Photograph 6.1**). *Eucalyptus cannonii* was also found in this community, albeit in low abundance. This community observed on the property varied in species composition, which seemed to relate to aspect or exposure. Along the drier western aspects and exposed ridgelines, the community appeared to be dominated by *Eucalyptus rossii* (Scribbly Gum). The eastern aspect appeared to shift in dominance towards *Eucalyptus dives* (Broad-leaved Peppermint) and *E. mannifera* (Brittle Gum).

The lower areas would once have supported Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland (see **Photograph 6.2**) but have been cleared and grazed. As a result, the diversity of native herbs is low and the ground cover is dominated by native grasses. Notwithstanding the disturbed nature of the community, native species account for approximately 80% of the groundcover. Furthermore, there is widespread regeneration of Eucalypts, indicating that these areas show high resilience and are likely to be able to be restored to Capertee Rough-barked Apple Red Gum Yellow Box Woodland.



Photograph 6.1 Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest



Photograph 6.2 Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland

Table 6.2 provides an approximation of the area of each vegetation community on the Hillview/Billabong property.

Table 6.2 Approximate Areas of Vegetation in the Hillview/Billabong Offset	
Vegetation Community	Area (ha)
Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	41
Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native Grassland	7
Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland (CEEC)	6
Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland Derived Native Grassland (CEEC)	29
TOTAL	83

iv. *Connectivity*

The southern boundary of the Hillview/ Billabong property adjoins Ben Bullen State Forest and immediately to the east is the existing Invincible Colliery Offset, although dissected by the Castlereagh Highway. Once the property is fully rehabilitated it will increase the extent of woodland and forest habitat adjacent to the Ben Bullen State Forest.

v. *Threatened Species Habitat*

a. Flora

Eucalyptus cannonii was recorded during quadrat survey of the Hillview/Billabong properties. The species was found in Tableland Slopes Brittle Gum Broad-leaved Peppermint Grassy Forest.

b. Fauna

No threatened fauna species were recorded within Hillview/Billabong property during surveys, however it is understood that the following species listed as Vulnerable under the TSC Act have been recorded by mine personnel; Gang Gang Cockatoo (*Callocephalon fimbriatum*), the Powerful Owl (*Ninox strenua*) and the Scarlet Robin (*Petroica boodang*). Furthermore, like the study area many species are considered to occur or have potential to occur. Considering the proximity of the property to the study area and the similarity of habitats between the two areas, Hillview/Billabong provides potential habitat for the majority of impacted fauna, with the exception of the Brush-tailed Rock Wallaby and Broad-headed Snake, which utilise various habitats associated with rocky escarpments.

vi. *Rehabilitation*

The rehabilitation of grasslands also provides scope to re-introduce *Eucalyptus cannonii*. The density of *E. cannonii* in Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland Derived Native Grassland on the property is unknown; however using data obtained from surveys of *Eucalyptus cannonii* by Cumberland Ecology (2012a) in the study area within intact areas of Capertee Rough-barked Apple – Red Gum – Yellow Box Woodland, Hillview/Billabong could provide approximately 37 ha of potential habitat for this species, which is estimated to be able to support approximately 1,900 individuals.

6.4.2 *Gulf Mountain Property*

i. *Purpose*

The primary objective for the inclusion of Gulf Mountain in the Biodiversity Offset is to:

- Conserve a significant area of similar vegetation types and suitable habitat for threatened flora and fauna impacted by the Modifications;
- Conserve a considerable area of foraging and habitat for bird and bats; and
- Conserve a significant area of potential habitat for *Eucalyptus cannonii*.

ii. Background

Gulf Mountain is a large property approximately 17 km to the north-west of the Modifications. The property contains extensive areas of like for like vegetation. The property adjoins private forested land. The property has 5.4 kilometres of Turon River frontage. The property contains a suite of conglomerate, sandstone, mudstone siltstone geological units, including similar geological formations to those that occur in parts of the Modification Boundaries.

iii. Vegetation

Three vegetation types that occur in the Modification Boundaries (impact area) predominate across Gulf Mountain, including Ribbon Gum Forest, Brittle Gum - Broad-leaved Peppermint Woodland and Scribbly Gum Woodland.

Aspect and topography dictate the distribution and occurrence of vegetation communities on Gulf Mountain. Very steep, rocky and west facing slopes generally supported Scribbly Gum Woodland where Scribbly Gum (*Eucalyptus rossii*) and Red Stringybark (*Eucalyptus macrorhyncha*) were most common. The understorey varied in structure and composition depending on aspect. Exposed slopes were sparsely vegetated and species poor; some steep south facing slopes had a rich grassy ground layer. On less steep slopes, mountain saddles and in sheltered dry gullies, Broad-leaved Peppermint (*Eucalyptus dives*) and Brittle Gum (*Eucalyptus mannifera*) Woodland occurred with a grassy and herbaceous ground layer. At some gully heads on gentle slopes, Mountain Gum (*E. dalrympleana*) and Ribbon Gum (*E. viminalis*) were common and sometimes dominated the canopy.

Riparian River Oak Forest dominated by River oak (*Casuarina cunninghamiana*) was confined to the Turon River (see **Photograph 6.3**) with creek flats and upland drainage lines supporting Sheltered Ribbon Gum (*Eucalyptus viminalis*) Open Forest with the understorey varying from shrubby to grassy (**Photograph 6.4**).

An estimate of the extent of each vegetation community recorded on the property during the site investigation is presented below in **Table 6.4**.

Table 6.3 Approximate Areas of Vegetation in the Gulf Mountain Offset Property

Vegetation Community	Gulf Mountain Offset Area (ha)
Tableland Gully Ribbon Gum Blackwood Applebox Forest	36
Tableland Scribbly Gum – Narrow-leaved Stringybark Shrubby Open Forest	405
Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	85
Riparian River Oak Forest	6
TOTAL	532



Photograph 6.3 Riparian River Oak Forest along Turon River



Photograph 6.4 Ribbon Gum Open Forest in drainage line

iv. *Connectivity*

The property is not connected directly to any nature reserve, but links indirectly through to Winburndale Nature Reserve via a strip of uncleared forest and woodland to the south of the property. Winburndale Nature Reserve connects to Turon National Park and Sunny Corner State Forest.

v. *Threatened Species Habitat*

a. Flora

No threatened flora species were recorded during the site investigation; though the property provides potential habitat in gullies and slopes for a number of threatened plants known in the area, including *Derwentia blakelyi* and *Eucalyptus cannonii*.

b. Fauna

Surveys of the property detected a suite of fauna species including some that are predicted to be impacted by the Modifications. These include the following threatened fauna species listed under the TSC Act and/or EPBC Act:

- Powerful Owl (*Ninox strenua*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Scarlet Robin (*Petroica boodang*);
- Varied Sittella (*Daphoenositta chrysoptera*); and
- Squirrel Glider (*Petaurus norfolcensis*).
- Booroolong Frog (*Litoria booroolongensis*) listed Endangered under the EPBC Act;
- Rainbow Bee-eater (*Merops ornatus*) listed Migratory under the EPBC Act; and
- Satin Flycatcher (*Myiagra cyanoleuca*) listed Migratory under the EPBC Act.

6.4.3 *Additional Offset Areas*

i. *Purpose*

The primary objective for inclusion of the Additional Offset Areas in the Biodiversity Offset is to:

- Conserve and rehabilitate similar vegetation to that located within the Modification Disturbance Boundaries; and
- Conserve and rehabilitate known and potential *Eucalyptus cannonii* habitat.

ii. Background

The Additional Offset Areas cover a combined area of approximately 29.7 ha and are situated adjacent to Cullen Valley Mine (see **Figure 6.3**). They comprise all or part of the following parcels of land:

- Lot 3 DP 1148418;
- Lot 1 DP 160808;
- Lot 36 DP 755769;
- Lot 331 DP 46518;
- Lot 332 DP 46518;
- Lot 3 DP 249955; and
- Lot 4 DP 249955;

Some of these land parcels are partly located within the approved Cullen Valley Mine disturbance areas or include land that has previously been secured as a Compensatory Habitat under DA 200-5-2003. These parts of the Additional Offsets Area parcels have been excised from the Biodiversity Offset Strategy and are not considered as compensatory habitat for the Modifications.

Lot 3 DP 249955, which covers an area of approximately 40.3 ha will be included in the Biodiversity Offset Strategy for the Modifications, however this parcel has been excluded from all offset calculations presented in this report. The biodiversity values provided by this lot will be included as part of the Additional Offset Areas following the completion of vegetation survey and mapping.

iii. Vegetation

The Additional Offset Areas contain the following vegetation communities:

- Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native Grassland;
- Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest;
- Tableland Gully Ribbon Gum Blackwood Applebox Forest Derived Native Grassland;
- Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest; and
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland

Of these communities, Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest is known to support *Eucalyptus cannonii* and provides potential habitat for this

species. The derived grassland areas have been cleared and grazed however they are likely to be able to be restored to their original vegetation community as much of the groundcover is still intact. **Table 6.4** provides an approximation of the area of each vegetation community on the Additional Offset Areas.

Table 6.4 Approximate Areas of Vegetation in the Additional Offset Areas

Vegetation community	Area (ha)*
Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest Derived Native Grassland	4.5
Tableland Slopes Brittle Gum – Broad-leaved Peppermint Grassy Forest	4.3
Tableland Gully Ribbon Gum Blackwood Applebox Forest Derived Native Grassland	2.0
Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest	17.8
Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland	1.2
TOTAL	29.7

* This area excludes lands within approved mining or rehabilitation areas at Cullen Valley Mine, or the vegetation provided by Lot 3, DP 249955.

iv. *Connectivity*

The Additional Offset Areas adjoin the Cullen Valley Mine and existing Compensatory Habitat areas. Once the properties are fully rehabilitated, they will increase the extent of woodland and forest habitat adjacent to the Ben Bullen State Forest.

v. *Threatened Species Habitat*

a. *Flora*

No threatened flora species were recorded during survey of the Additional Offset Areas, however potential habitat for *E. cannonii* has been identified.

b. *Fauna*

No threatened fauna species were recorded within the Additional Offset Areas during surveys, however, like the study area many species are considered to occur or have potential to occur. Considering the proximity of the property to the study area and the similarity of habitats between the two areas, the Additional Offset Areas provides habitat for the majority of the potentially impacted fauna, with the exception of the Brush-tailed Rock Wallaby and Broad-headed Snake, which utilise various habitats associated with rocky escarpments.

vi. *Rehabilitation*

The rehabilitation of grasslands also provides scope to re-introduce *Eucalyptus cannonii* in the Additional Offset Areas. The density of *E. cannonii* on the property is unknown; however using data obtained from surveys of *Eucalyptus cannonii* by Cumberland Ecology (2012a) in the study area within intact areas of Tableland Gully Mountain Gum - Broad-leaved Peppermint Grassy Forest, the Additional Offset Properties could provide approximately 18 ha of potential habitat for this species, which is estimated to be able to support approximately 800 individuals.

Conclusion

Coalpac seeks modifications under Section 75W of the EP&A Act to conduct mining operations in additional mine extension areas adjacent to the currently approved Invincible Colliery and Cullen Valley Mine.

The Modification Disturbance Boundaries are located within Ben Bullen State Forest, which comprises a very large remnant patch of vegetation connected to Gardens of Stone National Park to the north and Newnes State Forest and Wollemi National Park to the east and south. The area is regularly used for recreation activities including four-wheel driving, motorbike riding and conservation hunting. There is also evidence that logging once occurred, and continues to occur on a non-commercial basis in some areas. Overall, however, relatively high quality habitat for flora and fauna is present within the Modification Boundaries.

The Modifications would require removal of approximately 151 ha of native woodland and grassland which provides habitat for threatened species. No C/EEC occur within the Modification Disturbance Boundaries or will be impacted by the Modifications.

One threatened flora species, *Eucalyptus cannonii* listed as Vulnerable under the TSC Act was recorded within the study area and Modification Disturbance Boundaries. *Eucalyptus aggregata* and *Persoonia marginata*, both listed as Vulnerable under the TSC Act and EPBC Act were recorded outside the Modification Boundaries and no impact is expected to occur to these species. No threatened fauna species have been recorded within the Modification Boundaries; however several species are considered to occur or have potential to occur.

Where feasible, areas of habitat for native species will be avoided during the development of the Modifications. Woodland areas to be cleared by open cut mining will be rehabilitated to forest and woodland communities in the long term, using local native species, thereby redeveloping treed habitat in the locality.

Areas of compensatory habitat have been established already as part of the existing Cullen Valley Mine and Invincible Colliery, and the rehabilitation of disturbed land will build onto and complement these existing areas.

Rehabilitation plans for the Modifications have been designed to include the restoration of Ben Bullen State Forest to the existing (pre-project development) forest and woodland communities, where practical. Rehabilitation of 193 ha of previously disturbed areas has already been undertaken to good effect. The restoration of Ben Bullen State Forest within the Modification Disturbance Boundaries will be a progressive process and has been

designed with the intention of providing a self-sustaining native forestry operation as well as restoring pre-mine biodiversity values in the long term.

To ensure the effective coordination of rehabilitation efforts, revised ecological management plans will be developed for Invincible Colliery and Cullen Valley Mine that will prescribe the progressive rehabilitation of all Modification disturbance, including *Eucalyptus cannonii* and supplementary habitat features, including translocated hollow logs and other habitat features where practicable.

In order to compensate for the residual impacts of the Modifications and improve ecological outcomes, a carefully designed and robust offsets strategy is proposed. The offset strategy identifies areas of habitat that contain high quality habitat or potential to create high quality habitats for threatened species in the LGA. An overall offset ratio of 4.3:1 for native vegetation is proposed. Approximately 645 ha of forest, woodland and grassland habitat occur within the Hillview/Billabong and Gulf Mountain properties and the Additional Offset Areas that will be permanently conserved.

It is recognised that the Modifications will impact on known habitat for threatened flora and fauna species. However, the combined mitigation measures and biodiversity offset strategy to be implemented over the life of the Modifications' life are expected to ameliorate these impacts to the extent that no threatened species are likely to become extinct as a result of the Modifications.

Moreover, the long term outcome of the Biodiversity Offset will provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportion of native forest and woodland in conservation tenure. This will complement the existing large areas of nearby habitats for all of the affected threatened flora and fauna that are known to occur within the locality of the study area.

When the proposed mitigation measures and the Biodiversity Offset is considered, the Modifications will have a net ecological benefit in the medium to long term and will considerably increase the area of forest and woodland under conservation tenure in the region.

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Appendix A

Flora Species List

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Trees																									
	<i>Allocasuarina littoralis</i>				X																				
Casuarinaceae	<i>Allocasuarina torulosa</i>	Forest Oak	X		X																				
Cupressaceae	<i>Callitris rhomboidea</i>	Port Jackson Pine			X																				
Fabaceae	<i>Acacia dealbata</i>	Silver Wattle	X	X	X																		X		
	<i>Acacia falciformis</i>	Broad-leaved Hickory			X	X	X			X		X					X	X				X			
	<i>Acacia floribunda</i>				X																				
	<i>Acacia obtusifolia</i>				X		X	X																	
Myrtaceae	<i>Eucalyptus aggregata</i>	Black Gum			X																				
	<i>Eucalyptus blakelyi</i>	Blakely's Red Gum			X	X																			X
	<i>Eucalyptus blaxlandii</i>			X	X					X															
	<i>Eucalyptus bridgesiana</i> <i>ssp. Bridgesiana</i>		X	X	X																X				X
	<i>Eucalyptus cannonii</i>	Capertee Stringybark	X		X	X	X					X		X			X	X		X	X	X	X	X	
	<i>Eucalyptus dalrympleana</i>	Mountain Gum	X	X	X	X			X								X					X	X		
	<i>Eucalyptus dives</i>	Broad-leaved Peppermint	X	X	X										X										

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Eucalyptus goniocalyx</i>		X	X																					
	<i>Eucaltptus laophila</i> x <i>E. stricta</i>				X																				
	<i>Eucalyptus macrorhyncha</i>	Red Stringybark	X	X	X			X																	X
	<i>Eucalyptus mannifera</i>	Brittle Gum	X	X	X																			X	
	<i>Eucalyptus mannifera?</i>				X																				
	<i>Eucalyptus mannifera</i> ssp. <i>praecox</i>	Brittle Gum			X															X					
	<i>Eucalyptus melliodora</i>		X		X	X																			
	<i>*Eucalytpus nicholii</i>																								
	<i>Eucalyptus pauciflora</i>	Snow Gum	X		X																				
	<i>Eucalyptus piperita</i>		X	X	X	X	X		X																
	<i>Eucalyptus punctata</i>	Grey Gum	X	X																					
	<i>Eucalyptus radiata</i>		X		X																				
	<i>Eucalyptus rossii</i>	Inland Scribbly Gum	X	X	X			X				X		X	X			X	X	X				X	
	<i>Eucalyptus rubida</i>		X																						
	<i>Eucalyptus sieberi</i>		X	X	X							X						X	X						

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Eucalyptus sparsifolia</i>		X	X	X				X		X	X	X		X				X						
	<i>Eucalyptus stellulata</i>	Black Sally																							
	<i>Eucalyptus stricta</i>				X																				
	<i>Eucalyptus viminalis</i>	Ribbon Gum	X		X	X			X							X	X	X							
Shrubs																									
Apiaceae	<i>Platysace ericoides</i>		X	X																					
	<i>Platysace lanceolata</i>		X	X	X																				
Apocynaceae	<i>Hymenanthera dentata</i>				X																				
Asteraceae	<i>Cassinia arcuata</i>		X	X	X			X																	
	<i>Cassinia laevis</i>			X																					
	<i>Cassinia longifolia</i>																								X
	<i>Cassinia quinquefaria</i>				X																				
	<i>Cassinia sp.</i>				X																				
	<i>Olearia erubescens</i>				X																				
	<i>Ozothamnus diosmifolius</i>		X		X					X						X					X				
Dilleniaceae	<i>Hibbertia obtusifolia</i>		X	X	X	X		X	X								X	X	X	X		X			
	<i>Hibbertia riparia</i>																								

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ericaceae	<i>Hibbertia sericea</i>				X																				
	<i>Hibbertia stricta</i>				X																				
	<i>Hibbertia sp.</i>				X																				
	<i>Acrotriche divaricata</i>																								
	<i>Acrotriche serrulata</i>		X																						X
	<i>Brachyloma daphnoides</i>		X	X	X			X																	
	<i>Epacris reclinata</i>				X																				
	<i>Leucopogon appressus</i>			X																					
	<i>Leucopogon lanceolata</i>		X		X	X	X			X					X				X						
	<i>Leucopogon microphyllus</i>			X																					
	<i>Leucopogon muticus</i>		X	X	X			X		X		X	X		X				X	X	X			X	
	<i>Leucopogon neo-anglicus</i>				X																				
	<i>Leucopogon virgatus</i>		X		X			X	X				X	X		X	X				X			X	
	<i>Leucopogon virgatus?</i>																								X
	<i>Lissanthe strigosa</i>	Peach Heath	X		X	X																			
	<i>Lissanthe strigosa ssp.</i>				X																				

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fabaceae	<i>subulata</i>																			
	<i>Monotoca scoparia</i>		X	X	X			X												X
	<i>Melichrys erubescens</i>				X															
	<i>Sprengelia incarnata</i>				X															
	<i>Styphelia triflora</i>				X	X														
	<i>Styphelia tubiflora</i>		X		X					X	X						X		X	X
	<i>Acacia acinacea</i>				X															
	<i>Acacia brownii</i>				X															
	<i>Acacia buxifolia</i>	Sunshine Wattle	X	X	X				X		X		X	X	X			X	X	X
	<i>Acacia dealbata</i>				X	X											X		X	X
	<i>Acacia falciformis</i>		X	X	X				X	X						X				X
	<i>Acacia floribunda</i>				X															
	<i>Acacia gunnii</i>		X																	
	<i>Acacia mearnsii</i>		X																	
	<i>Acacia myrtifolia</i>				X			X												
	<i>Acacia obtusifolia</i>		X	X	X	X		X								X				X
	<i>Acacia paradoxa</i>				X			X												X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Acacia sp.</i>				X																				X
	<i>Acacia terminalis</i>		X	X	X						X				X										
	<i>Acacia ulicifolia</i>		X	X	X			X							X	X									
	<i>Bossiaea buxifolia</i>				X																				
	<i>Bossiaea prostrata</i>				X																			X	
	<i>Bossiaea neo-anglica</i>		X		X																				
	<i>Daviesia ulicifolia</i>				X																				
	<i>Daviesia virgata</i>			X	X																				
	<i>Dillwynia phyllicoides</i>		X	X																					
	<i>Dillwynia ?retorta</i>				X																				
	<i>Dillwynia retorta</i>				X																				
	<i>*Genista monspessulana</i>																								
	<i>Gompholobium huegelii</i>		X	X																					
	<i>Hovea linearis</i>		X		X			X											X	X					
	<i>Hovea longifolia</i>				X																				
	<i>Hovea sp.</i>				X																				
	<i>Indigofera australis</i>		X		X				X				X				X		X	X			X	X	

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Mirbelia platyloboides</i>		X																						
	<i>Oxylobium sp.</i>				X																				
	<i>Platylobium sp.</i>				X																				
	<i>Podolobium ilicifolium</i>		X	X	X				X	X					X		X		X	X		X			
	<i>Pultenaea elliptica</i>																								
	<i>Pultenaea microphylla</i>		X	X	X															X			X	X	
	<i>Pultenaea retusa</i>				X																				
	<i>Pultenaea sp.</i>				X																				X
	<i>Logania albiflora</i>				X																				
Malaceae	<i>*Malus sp.</i>																								
Myrtaceae	<i>Callistemon ?pinifolius</i>				X																				
	<i>Calytrix tetragona</i>		X		X																				
	<i>Eucalyptus blakelyi</i>				X																				
	<i>Eucalyptus bridgesiana</i>																								
	<i>ssp. bridgesiana</i>				X																				
	<i>Eucalyptus</i>																								
	<i>dalrympleana</i>				X																				
	<i>Eucalyptus dives</i>				X																				

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Eucalyptus pauciflora</i>																								
	<i>Eucalyptus rossii</i>																								
	<i>Harmogia densifolia</i>				X																				
	<i>Kunzea parvifolia</i>				X																				
	<i>Leptospermum continentale</i>		X		X			X																	
	<i>Leptospermum juniperinum</i>				X																				
	<i>Leptospermum myrtifolium</i>																								
	<i>Leptospermum obovatum</i>																								
	<i>Leptospermum parvifolium</i>		X	X	X																				
	<i>Leptospermum polygalifolium</i>			X	X			X	X																
	<i>Leptospermum sphaerocarpum</i>		X																						
	<i>Leptospermum sp.</i>																								X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Leptospermum trinervium</i>		X																						
	<i>Micromyrtus ciliata</i>			X																					
Oleaceae	<i>Notelaea longifloia</i>				X																				
	<i>Notelaea neglecta</i>				X																				
Pittosporaceae	<i>Bursaria longisepala</i>				X																				
	<i>Bursaria spinosa</i>				X																				
	<i>Rhytidosporum procumbens</i>		X		X																				
Proteaceae	<i>Banksia cunninghamii</i>		X		X																				
	<i>Hakea dactyloides</i>				X																				
	<i>Hakea laevipes</i>																								
	<i>Hakea teretifolia</i>				X																				
	<i>Isopogon anethifolius</i>				X																				
	<i>Isopogon dawsonii</i>		X																						
	<i>Lomatia myricoides</i>				X																				
		Narrow-leaved																							
	<i>Persoonia linearis</i>	Geebung	X	X	X			X	X	X	X		X				X		X		X	X			

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rhamnaceae	<i>Persoonia marginata</i>	Clandulla Geebung			X															
	<i>Persoonia mollis</i>																			
	<i>Persoonia myrtilloides</i>		X		X			X							X					
	<i>Persoonia oblongata</i>																			
	<i>Cryptandra amara</i>			X	X															
	<i>Cryptandra spinescens</i>				X															
	<i>Pomaderris andromedifolia</i>		X																	
	<i>Pomaderris andromedifolia ssp. andromedifolia</i>				X															
	<i>Pomaderris prunifolia</i>				X															
	<i>*Cottoneaster sp.</i>																			X
Rosaceae	<i>*Rubus fruticosus</i>	Blackberry			X															
	<i>*Rosa rubiginosa</i>	Briar Rose																		X
	<i>Rubus sp.</i>				X															
Rutaceae	<i>Boronia microphylla</i>		X		X															
	<i>Boronia rigens</i>		X																	

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Boronia sp.</i>				X															
	<i>Correa reflexa</i>		X																	
	<i>Phebalium lamprophyllum</i>		X																	
	<i>Philotheca myoporoides</i> ssp. <i>Myoporoides</i>				X															
	<i>Zieria aspalathoides</i>				X															
	<i>Zieria cytisoides</i>		X		X															
	<i>Zieria sp.</i>		X																	
Santalaceae	<i>Choretrum pauciflorum</i>	Dwarf Sour Bush																		
	<i>Exocarpos cupressiformis</i>		X	X	X												X			
	<i>Exocarpos strictus</i>		X	X																
	<i>Leptomeria acida</i>		X	X	X				X	X	X		X	X	X			X	X	
	<i>Omphacomeria acerba</i>		X																	
Sapindaceae	<i>Dodonaea multijuga</i>				X															
	<i>Dodonaea viscosa</i> ssp. <i>cuneata</i>		X		X															

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Dodonaea viscosa ssp spatulata</i>				X															
Scrophulariaceae	<i>Derwentia perfoliata</i>				X															
Simaroubaceae	* <i>Ailanthus altissima</i>	Tree of Heaven																		
Solanaceae	<i>Solanum laciniatum</i>	Kangaroo Apple			X															
	<i>Solanum linearifolium</i>	Mountain Kangaroo Apple																		
	<i>Solanum prinophyllum</i>				X															
Herbs - Fern																				
Adiantaceae	<i>Adiantum aethiopicum</i>				X															
Aspleniaceae	<i>Asplenium flabellifolium</i>		X		X															
Blechnaceae	<i>Blechnum cartilagineum</i>				X															
	<i>Blechnum nudum</i>		X																	
Cyatheaceae	<i>Cyathea australis</i>		X		X															
Dennstaedtiaceae	<i>Pteridium esculentum</i>		X	X	X	X				X								X		
Dicksoniaceae	<i>Calochlaena dubia</i>				X															
Lindsaeaceae	<i>Lindsaea linearis</i>			X	X															
Polypodiaceae	<i>Pyrrosia rupestris</i>		X																	

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sinopteridaceae	<i>Cheilanthes austrotenuifolia</i>		X																	
	<i>Cheilanthes sieberi</i>		X	X	X														X	
	Herbs - Dicots																			
Acanthaceae	<i>Brunoniella austalis</i>				X															X
	<i>Brunoniella pumilio</i>																			
Apiaceae	<i>Centella asiatica</i>																			
	<i>*Conium maculatum</i>																			
	<i>Daucus glochidiatus</i>				X	X														
	<i>Hydrocotyle laxiflora</i>		X		X	X				X	X	X		X		X	X	X		X
	<i>Hydrocotyle tripartita</i>				X															X
	<i>Hydrocotyle sp.</i>																			
	<i>Xanthosia pilosa</i>				X															
	Asteraceae																			
	<i>Brachycome angustifolia</i>																			
	<i>Brachycome spathulata</i>			X	X				X	X										
	<i>Calotis cuneifolia</i>		X		X															X
	<i>*Cathamus lanatus</i>																			
	<i>Centipeda minima</i>		X																	

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Chrysocephalum apiculatum</i>				X																				
	<i>Chrysocephalum semipaposum</i>				X																				
	<i>Chrysocephalum</i> sp																								
	* <i>Cirsium vulgare</i>	Scotch Thistle	X		X	X												X				X	X		
	* <i>Conyxa bonariensis</i>	Flaxleaf Fleabane																							
	* <i>Conyza</i> sp.				X																				
	<i>Cymbonotus lawsonianus</i>		X		X	X																			
	<i>Euchiton sphaericus</i>		X	X	X																			X	
	<i>Euchiton</i> sp.																								
	* <i>Facelis retusa</i>																								
	* <i>Gnaphalium americanum</i>				X			X																	
	* <i>Gnaphalium</i> sp.				X																				
	<i>Helichrysum scorpiodes</i>		X		X			X																X	
	* <i>Hypochaeris radicata</i>	Flatweed	X		X	X				X						X	X				X		X		X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>*Lactuca seriola</i>																			
	<i>?Lagenophora sp.</i>																			
	<i>Lagenophora stipitata</i>		X		X	X	X		X	X									X	X
	<i>Olearia erubescens</i>	Pink-tip Daisy-bush																	X	X
	<i>Senecio hispidulus</i>																			
	<i>Senecio lautus</i>				X															
	<i>Senecio linearifolius</i>		X		X															
	<i>Senecio quadridentatus</i>				X	X	X													
	<i>Senecio sp.</i>																			
	<i>Senecio tenuiflorus</i>				X															
	<i>Senecio ?vagus</i>				X															
	<i>*Silybum marianum</i>				X															
	<i>Solenogyne sp.</i>				X															
	<i>*Sonchus aspera</i>																			
	<i>*Sonchus oleraceus</i>	Sow Thistle																		
	<i>*Taraxacum officinale</i>	Dandelion																		
	<i>*Tragopogon porrifolius</i>																			

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Vittadinia cuneata</i>		X		X															
Brassicaceae	* <i>Brassica</i> sp.																			
	* <i>Lepidium africanum</i>																			
	* <i>Sisymbrium</i> sp.				X															
Boraginaceae	<i>Cynoglossum australe</i>		X		X	X	X		X						X	X	X			
	<i>Cynoglossum suaveolens</i>																			
	* <i>Echium vulgare</i>	Patterson's Curse																		
Campanulaceae	<i>Wahlenbergia communis</i>				X															
	<i>Wahlenbergia gracilis</i>		X		X														X	
	<i>Wahlenbergia stricta</i>		X	X	X															
	<i>Wahlenbergia</i> sp.				X															
Caryophyllaceae	* <i>Polycarpon tetraphyllum</i>	Four-leaf All-seed																		
	<i>Stellaria pungens</i>		X		X	X	X		X								X	X		
Chenopodiaceae	<i>Einadia hastata</i>		X		X															
Clusiaceae	<i>Hypericum gramineum</i>		X		X		X			X		X							X	X
	* <i>Hypericum perforatum</i>	St John's Wort			X	X														
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed	X		X	X			X						X	X	X			

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Crassulaceae	<i>Crassula decumbens</i>				X															
	<i>Crassula sieberana</i>		X																	
Dilleniaceae	<i>Hibbertia obtusifolia</i>				X															
	<i>Chamaesyce sp.</i>				X															
Droseraceae	<i>Drosera peltata</i>																			
Fabaceae	<i>Desmodium varians</i>	Tick Trefoil			X	X				X										
	<i>Bossiaea prostrata</i>																			
	* <i>Medicago sp.</i>																			
	* <i>Trifolium dubia</i>	Yellow Suckling Clover	X																	
	* <i>Trifolium repens</i>	White Clover																		
Gentianaceae	* <i>Centaurium erythraea</i>	Common Centaury																		
	* <i>Centaurium tenuiflorum</i>																			
	<i>Schenkia spicata</i>				X		X													
Geraniaceae	<i>Geranium solanderi</i>	Storksbill	X	X	X	X	X											X		
	<i>Geranium homeanum</i>				X															
	<i>Geranium sp. 1</i>																			
	<i>Geranium sp. 2</i>																			

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Goodeniaceae	<i>Cooperhooikia barbata</i>			X																					
	<i>Goodenia bellidifolia</i>				X																				
	<i>Goodenia hederacea</i>		X	X	X			X	X												X	X		X	
	<i>Goodenia sp.</i>				X																				
Haloragaceae	<i>Gonocarpus longifolius</i>				X																				
	<i>Gonocarpus sp.</i>				X																				X
	<i>Gonocarpus ?sp.</i>				X																				
	<i>Gonocarpus tetragyna</i>		X	X	X		X	X	X									X			X	X	X	X	
	<i>Gonocarpus teucrioides</i>																								
	<i>Haloragis heterophylla</i>		X																						
Hemerocallidaceae	<i>Caesia sp.</i>																								
Hypoxidaceae	<i>Hypoxis hygrometrica</i>				X																				
Labiaceae	<i>*Marrubium vulgare</i>																								
Lamiaceae	<i>Ajuga australis</i>	Australian Bugle	X																						
	<i>Ajuga sp.</i>				X																				
	<i>*Lamium amplexicaule</i>																								
	<i>Metha diemenica</i>		X																						

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>*Prunella vulgaris</i>	Self-heal																		
Linaceae	<i>Linum marginale</i>		X		X															X
	<i>Linum trigynum</i>	French Flax																		
Lobeliaceae	<i>Isotoma axillaris</i>		X		X															
	<i>Isotoma fluviatilis</i>		X																	
	<i>Pratia pedunculata</i>				X															
	<i>Pratia purpurascens</i>		X		X				X											
Loganiaceae	<i>Mitracacme polymorpha</i>		X																	
Malvaceae	<i>*Modiola caroliniana</i>																			
Onagraceae	<i>*Oenothera sp.</i>																			
Oxalidaceae	<i>Oxalis exilis</i>				X	X					X									
	<i>*Oxalis ?sp. A</i>		X																	
	<i>*Oxalis sp. B.</i>																			
	<i>*Oxalis sp.</i>				X															X
	<i>Oxalis sp.</i>				X															
	<i>Oxalis perennans</i>				X															
Phyllanthaceae	<i>Phyllanthus hirtellus</i>		X		X															

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Poranthera corymbosa</i>		X		X															
	<i>Poranthera microphylla</i>				X	X	X		X	X		X	X					X	X	X
Pittosporaceae	<i>Rhytidosporum procumbens</i>																			
Plantaginaceae	<i>Plantago debilis</i>		X		X	X				X								X	X	X
	<i>*Plantago lanceolata</i>				X															X
	<i>Plantago sp.</i>				X															X
	<i>Plantago varia</i>																			
Primulaceae	<i>*Anagallis arvensis</i>	Scarlet Pimpernel																		
Polygalaceae	<i>Comesperma ericinum</i>		X																	
	<i>*Acetosella vulgaris</i>																			
	<i>*Emex australis</i>				X															
	<i>Rumex brownii</i>				X															
	<i>*Rumex crispus</i>	Dock																		
Ranunculaceae	<i>Ranunculus lappaceus</i>																			
Rosaceae	<i>Acaena agnipila</i>				X															
	<i>Acaena novae-zealandiae</i>		X		X	X				X										X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Acaena ovina</i>		X																						
	<i>Acaena sp.</i>																								
Rubiaceae	<i>Asperula conferta</i>	Common Bedstraw			X																		X		
	<i>Asperula sp.X</i>				X																				
	<i>Asperula sp.X</i>				X																				X
	<i>Galium binifolium</i>				X																				X
	<i>Galium propinquum</i>		X	X	X	X	X		X	X	X	X					X	X		X		X	X	X	
	<i>Galium gaudichaudii</i>				X																				
	<i>Galium sp.</i>				X																				
	<i>Opercularia aspera</i>		X		X										X	X		X			X	X		X	
	<i>Opercularia hispida</i>				X																				
	<i>Opercularia sp.</i>				X																				X
	<i>Pomax umbellata</i>		X		X						X														
		<i>*Sherardia arvensis</i>				X																			
Scrophulariaceae	<i>*Verbascum thapsus</i>	Blanket Weed																							
	<i>*Verbascum virgatum</i>	Twiggy Mullein																							
	<i>Veronica calycina</i>		X		X	X	X									X	X	X			X				

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Veronica gracilis</i>																			
	<i>Veronica plebeia</i>		X	X	X															X
Solanaceae	<i>Solanum brownii</i>				X	X														
Stackhousiaceae	<i>Stackhousia monogyna</i>	Creamy Candles	X		X				X								X	X	X	X
Stylidiaceae	<i>Stylidium graminifolium</i>		X		X															
	<i>Stylidium lineare</i>				X															
Thymeliaceae	<i>Pimelea glauca</i>				X															
	<i>Pimelea linifolia</i>		X																	
Verbenaceae	* <i>Verbena bonariensis</i>				X															
Violaceae	<i>Viola betonicifolia</i>	Native Violet	X	X	X	X				X		X					X			X
	<i>Viola hederacea</i>	Ivy-leaved Violet	X		X		X													
Herbs - Monocots																				
*Agavaceae	* <i>Agave americana</i>	Yucca																		
Anthericaceae	<i>Anthericaceae</i> sp.																			
	<i>Laxmannia gracilis</i>		X																	
	<i>Thysanotus</i> sp.		X																	
	<i>Tricoryne elatior</i>				X															X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Tricoryne simplex</i>																			
Caryophyllaceae	<i>*Petrorhagia nanteulii</i>				X															
Colchicaceae	<i>Wurmbea dioica</i>	Early Nancy																		
Cyperaceae	<i>Carex appressa</i>																			
	<i>Carex inversa</i>				X															
	<i>Carex sp.</i>																			
	<i>Cyperus sp.</i>																			
	<i>Lepidosperma laterale</i>				X															
	<i>Lepidosperma urophorum</i>		X																	
	<i>Lepidosperma sp.</i>		X																	
	<i>Schoenus sp.</i>		X																	
Droseraceae	<i>Drosera sp.</i>				X															
Iridaceae	<i>*Iris sp.</i>																			
	<i>Patersonia glabrata</i>	Purple Flag																		
	<i>Patersonia longifolia</i>			X	X															
	<i>Patersonia sericea</i>		X																	
	<i>Patersonia sp.</i>				X															

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Juncaceae	<i>Juncus australis</i>																			
	* <i>Juncus cognatus</i>				X															
	<i>Juncus planifolius</i>		X																	
	<i>Juncus sp.</i>				X															
	<i>Juncus subsecundus</i>																			
	<i>Luzula flaccida</i>																			
	<i>Luzula sp.</i>		X		X															
Lomandraceae	<i>Lomandra confertifolia</i>		X	X																X
	<i>Lomandra confertifolius ssp. rubiginosa</i>				X															
	<i>Lomandra filiformis</i>				X															
	<i>Lomandra filiformis ssp. coriacea</i>		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	<i>Lomandra filiformis ssp. filiformis</i>																			
	<i>Lomandra glauca</i>		X		X	X				X										
	<i>Lomandra longifolia</i>		X	X	X		X								X					X
	<i>Lomandra multiflora</i>		X		X					X	X		X			X	X		X	X

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Orchidaceae	<i>Lomandra sp.</i>				X															
	<i>Acianthus exsertus</i>	Mosquito Orchid			X															
	<i>Acianthus sp.</i>				X															
	<i>Caladenia alba</i>				X															
	<i>Caladenia carnea</i>	Pink Fingers			X															
	<i>Caladenia sp.</i>				X															
	<i>Dipodium punctatum</i>		X																	
	<i>Diuris maculata</i>				X			X			X			X	X					
	<i>Diuris sulphurea</i>	Tiger Orchid																		
	<i>Glossodia major</i>	Waxlip Orchid																		
	<i>Microtis uniflora</i>		X																	
Phormiaceae	<i>Pterostylis sp.</i>			X	X		X	X	X											
	<i>Thelymitra sp.</i>	a Sun Orchid	X		X			X												
	<i>Dianella longifolia</i>																			
	<i>Dianella revoluta</i>	Paroo Lily	X	X	X			X	X		X		X		X	X	X		X	X
	<i>Stypandra galuca</i>				X															
	<i>Agrostis avenacea</i> var.																			
	<i>avenacea</i>		X																	
Poaceae																				

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Anisopogon avenaceus</i>		X																						
	<i>*Anthoxanthum odoratum</i>	Sweet Vernal Grass			X																				
	<i>Aristida calycina</i>																								
	<i>Aristida jerichoensis</i>																								
	<i>Aristida ramosa</i>			X	X						X														
	<i>Aristida sp.</i>																								
	<i>Austrodanthonia caespitosa</i>		X																						
	<i>Austrodanthonia fulva</i>				X																				
	<i>Austrodanthonia laevis</i>		X																						
	<i>Austrodanthonia penicillata</i>				X																				
	<i>Austrodanthonia racemosa</i>		X	X	X																				X
	<i>Austrodanthonia sp.X</i>				X																				
	<i>Austrodanthonia sp.X</i>				X																				
	<i>Austrodanthonia sp.</i>				X																				

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																						
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	<i>Austrostipa rudis</i>		X																						
	<i>Austrostipa scabra</i>				X	X			X	X	X														
	<i>Austrostipa sp.</i>		X		X																				X
	<i>Bothriochloa sp.</i>				X																				
	<i>*Briza minor</i>	Shivery Grass																							
	<i>*Bromus catharticus</i>	Prairie Grass																							
	<i>*Bromus molliformis</i>																								
	<i>Cymbopogon refractus</i>				X																				
	<i>*Cynodon dactylon</i>	Couch Grass			X	X	X			X	X			X			X							X	
	<i>Chionochloa pallida</i>		X																						
	<i>*Chloris gayana</i>	Rhodes Grass																							
	<i>Danthonia sp.</i>	a Wallaby Grass																							
		Short-haired Plume																							
	<i>Dichelachne micrantha</i>	Grass		X																					
	<i>Dichelachne rara</i>		X																						
	<i>Echinopogon caespitosus</i>		X		X						X				X	X	X	X		X	X	X			X
	<i>Echinopogon ovatus</i>		X	X	X	X																	X		

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>*Eleusine tristachya</i>				X															
	<i>Elymus scaber</i>				X															
	<i>Entolasia stricta</i>		X	X	X															X
	<i>*Eragrostis cilianensis</i>																			
	<i>*Eragrostis curvula</i>	African Love-grass																		
	<i>Eragrostis leptostachya</i>				X															
	<i>Eragrostis sp.</i>																			
	<i>*Festuca sp.</i>																			
	<i>Imperatia cylindrica</i>				X															
	<i>Joycea pallida</i>			X	X			X							X	X	X		X	X
	<i>*Lolium perenne</i>	Perennial Rye																		
	<i>Lolium sp.</i>				X															
	<i>Microlaena stipoides</i>	Weeping Meadow-grass		X	X	X	X			X		X			X	X	X		X	X
	<i>*Nassella neesiana</i>	Chilean Needle Grass																		
	<i>Panicum effusum</i>				X															
	<i>*Paspalum dilatatum</i>	Paspalum																		
	<i>*Paspalum urvillei</i>																			

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>*Paspalum sp.</i>																			
	<i>*Pennesitum clandestinum</i>	Kikuyu																		
	<i>Phalaris aquatica</i>																			
	<i>Phragmites australis</i>	Common Reed																		
	<i>Poa labillardieri</i>		X																	
	<i>Poa sieberiana ssp cyanophylla</i>		X																	
	<i>Poa sieberiana ssp sieberiana</i>		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	<i>Poa sp.</i>																			
	<i>Poaceae sp.</i>																			
	<i>Themeda australis</i>	Kangaroo Grass	X	X	X	X												X	X	X
	<i>Vulpia bromoides</i>		X																	
	<i>?*Vulpia sp.</i>																			
Restionaceae	<i>Lepyrodia scariosa</i>		X																	
Typhaceae	<i>Typha orientalis</i>	Cumbungi			X															
Xanthorrhoeaceae	<i>Xanthorrhoea arborea</i>				X															

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																	
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	<i>Xanthorrhoea sp.</i>		X		X															
Vines & Scramblers																				
Apocynaceae	<i>Parsonsia brownii</i>				X															
Araliaceae	<i>*Hedera helix</i>	English Ivy																		
Convolvulaceae	<i>Convolvulus erubescens</i>	Blushing Bindweed			X															
Fabaceae	<i>Glycine clandestina</i>		X		X	X														
	<i>Glycine microphylla</i>																			X
	<i>Glycine tabacina</i>		X		X														X	
	<i>Hardenbergia violacea</i>	Purple Coral Pea	X		X				X	X					X			X	X	
	<i>Vicia sativa subsp. nigra</i>	Narrow-leaved Vetch																		
Lauraceae	<i>Cassytha melantha</i>				X															
	<i>Cassytha pubescens</i>				X															
Pittosporaceae	<i>Billardia scandens</i>	Apple Berry	X		X				X						X				X	X
Ranunculaceae	<i>Clematis aristata</i>		X		X	X				X										
Rosaceae	<i>*Rubus parviflora</i>				X															
	<i>Rubus hillii</i>				X															
Santalaceae	<i>Amperea xiphoclada</i>				X															

Table A.1 Flora Species Recorded in the Study Area Quadrats 1-20

Family/Form	Scientific Name	Common Name	CE Quadrats																								
			Lembit 1997	Lembit 2003	CE 2009-2011	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Mistletoes																											
Loranthaceae	<i>Amyema pendulum ssp.</i>																										
	<i>pendulum</i>		X		X																						

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Trees																														
Casuarinaceae	<i>Allocasuarina littoralis</i>				X																									
	<i>Allocasuarina torulosa</i>	Forest Oak	X		X																									
		Port Jackson																												
Cupressaceae	<i>Callitris rhomboidea</i>	Pine			X																									
Fabaceae	<i>Acacia dealbata</i>	Silver Wattle	X	X	X																									
		Broad-leaved																												
	<i>Acacia falciformis</i>	Hickory			X						X	X																		

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Myrtaceae	<i>Acacia floribunda</i>				X		X																							
	<i>Acacia obtusifolia</i>				X																									
	<i>Eucalyptus aggregata</i>	Black Gum			X																									
		Blakely's Red																												
	<i>Eucalyptus blakelyi</i>	Gum			X		X																							
	<i>Eucalyptus blaxlandii</i>			X	X								X																	
	<i>Eucalyptus bridgesiana</i> ssp. <i>bridgesiana</i>		X	X	X		X								X									X						
		Capertee																												
	<i>Eucalyptus cannonii</i>	Stringybark	X		X				X	X		X		X																
	<i>Eucalyptus dalrympleana</i>	Mountain Gum	X	X	X		X							X	X		X	X	X					X						
		Broad-leaved																												
	<i>Eucalyptus dives</i>	Peppermint	X	X	X						X		X		X	X		X												
	<i>Eucalyptus goniocalyx</i>		X	X																										
	<i>Eucaltptus laophila</i> x <i>E. stricta</i>				X																									

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																										
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
	<i>Eucalyptus</i>																												
	<i>macrorhyncha</i>	Red Stringybark	X	X	X			X	X	X																			
	<i>Eucalyptus mannifera</i>	Brittle Gum	X	X	X					X	X	X			X	X		X											
	<i>Eucalyptus</i>																												
	<i>?mannifera</i>				X			X																					
	<i>Eucalyptus mannifera</i>																												
	<i>ssp. praecox</i>	Brittle Gum			X																								
	<i>Eucalyptus melliodora</i>		X		X																								
	<i>*Eucalytpus nicholii</i>																												
	<i>Eucalyptus pauciflora</i>	Snow Gum	X		X																								adj
	<i>Eucalyptus piperita</i>		X	X	X		X						X																
	<i>Eucalyptus punctata</i>	Grey Gum	X	X																									
	<i>Eucalyptus radiata</i>		X		X																								
		Inland Scribbly																											
	<i>Eucalyptus rossii</i>	Gum	X	X	X								X																
	<i>Eucalyptus rubida</i>		X																										
	<i>Eucalyptus sieberi</i>		X	X	X		X																						
	<i>Eucalyptus sparsifolia</i>		X	X	X								X				X	X	X									adj	

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Shrubs	<i>Eucalyptus stellulata</i>	Black Sally																																												
	<i>Eucalyptus stricta</i>				X																																									
	<i>Eucalyptus viminalis</i>	Ribbon Gum	X		X	X			X																																					
	<i>Platysace ericoides</i>		X	X																																										
	<i>Platysace lanceolata</i>		X	X	X																																									
	<i>Hymenanthera dentata</i>				X					X		X																																		
	<i>Cassinia arcuata</i>		X	X	X																																									
	<i>Cassinia laevis</i>			X																																										
	<i>Cassinia longifolia</i>																																													
	<i>Cassinia quinquefaria</i>				X					X																																				
<i>Cassinia sp.</i>				X		X			X		X									X	X	X																								
<i>Olearia erubescens</i>				X																																										
<i>Ozothamnus diosmifolius</i>			X		X																																									
Dilleniaceae	<i>Hibbertia obtusifolia</i>		X	X	X			X									X	X		X																										

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			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Ericaceae	<i>Hibbertia riparia</i>																																													
	<i>Hibbertia sericea</i>				X			X																																						
	<i>Hibbertia stricta</i>				X											X																														
	<i>Hibbertia sp.</i>				X					X																																				
	<i>Acrotriche divaricata</i>																																													
	<i>Acrotriche serrulata</i>		X																																											
	<i>Brachyloma daphnoides</i>		X	X	X													X			X																									
	<i>Epacris reclinata</i>				X																																									
	<i>Leucopogon appressus</i>			X																																										
	<i>Leucopogon lanceolata</i>		X		X			X																																						
	<i>Leucopogon microphyllus</i>			X																																										
	<i>Leucopogon muticus</i>		X	X	X		X									X		X																												
	<i>Leucopogon neo-anglicus</i>				X																																									

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Family/Form	Scientific Name	Common Name	CE Quadrats																																											
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Fabaceae	<i>Leucopogon virgatus</i>		X		X		X	X																																						
	<i>Leucopogon virgatus?</i>																																													
	<i>Lissanthe strigosa</i>	Peach Heath	X		X												X	X	X																											
	<i>Lissanthe strigosa</i> <i>ssp. subulata</i>				X															X	X	X																								
	<i>Monotoca scoparia</i>		X	X	X																X																									
	<i>Melichrys erubescens</i>				X																																									
	<i>Sprengelia incarnata</i>				X																																									
	<i>Styphelia triflora</i>				X																																									
	<i>Styphelia tubiflora</i>		X		X																																									
	<i>Acacia acinacea</i>				X		X																																							
	<i>Acacia brownii</i>				X										X		X																													
	<i>Acacia buxifolia</i>	Sunshine Wattle	X	X	X												X	X	X	X	X	X	X																							
	<i>Acacia dealbata</i>				X													X			X		X						X																	
	<i>Acacia falciformis</i>		X	X	X					X				X																																
	<i>Acacia floribunda</i>				X			X	X					X																																
	<i>Acacia gunnii</i>		X																																											

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	<i>Acacia mearnsii</i>		X																											
	<i>Acacia myrtifolia</i>				X																									
	<i>Acacia obtusifolia</i>		X	X	X																									
	<i>Acacia paradoxa</i>				X																									
	<i>Acacia rubida</i>																													
	<i>Acacia sp.</i>				X	X			X																					
	<i>Acacia terminalis</i>		X	X	X		X	X													X									
	<i>Acacia ulicifolia</i>		X	X	X																									
	<i>Bossiaea buxifolia</i>				X																					X				
	<i>Bossiaea prostrata</i>				X																									
	<i>Bossiaea neo-anglica</i>		X		X										X															
	<i>Daviesia ulicifolia</i>				X																									
	<i>Daviesia virgata</i>			X	X																									
	<i>Dillwynia phyllicoides</i>		X	X																										
	<i>Dillwynia ?retorta</i>				X	X																								
	<i>Dillwynia retorta</i>				X																									
	* <i>Genista</i>																													

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	<i>monspessulana</i>																																													
	<i>Gompholobium</i>																																													
	<i>huegelii</i>		X	X																																										
	<i>Hovea linearis</i>		X		X																																									
	<i>Hovea longifolia</i>				X											X																														
	<i>Hovea sp.</i>				X									X				X																												
	<i>Indigofera australis</i>		X		X									X																																
	<i>Mirbelia platyloboides</i>		X																																											
	<i>Oxylobium sp.</i>				X		X	X																																						
	<i>Platylobium sp.</i>				X											X																														
	<i>Podolobium ilicifolium</i>		X	X	X													X				X																								
	<i>Pultenaea elliptica</i>																																													
	<i>Pultenaea microphylla</i>		X	X	X																																									
	<i>Pultenaea retusa</i>				X																																									
	<i>Pultenaea sp.</i>				X											X																														
	<i>Logania albiflora</i>				X																																									
Malaceae	* <i>Malus sp.</i>																																													

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Myrtaceae	<i>Callistemon ?pinifolius</i>				X																																									
	<i>Calytrix tetragona</i>		X		X																																									
	<i>Eucalyptus blakelyi</i>				X																					X																				
	<i>Eucalyptus bridgesiana</i> ssp. <i>bridgesiana</i>				X																		X																							
	<i>Eucalyptus dalrympleana</i>				X																X	X																								
	<i>Eucalyptus dives</i>				X															X		X																								
	<i>Eucalyptus pauciflora</i>																																													
	<i>Eucalyptus rossii</i>																																													
	<i>Harmogia densifolia</i>				X																																									
	<i>Kunzea parvifolia</i>				X																																									
	<i>Leptospermum continentale</i>		X		X																																									
	<i>Leptospermum juniperinum</i>				X																																									
	<i>Leptospermum</i>																																													

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			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44															
	<i>myrtifolium</i>																																											
	<i>Leptospermum obovatum</i>																																											
	<i>Leptospermum parvifolium</i>		X	X	X																																							
	<i>Leptospermum polygalifolium</i>			X	X				X																																			
	<i>Leptospermum sphaerocarpum</i>		X																																									
	<i>Leptospermum sp.</i>																																											
	<i>Leptospermum trinervium</i>		X																																									
	<i>Micromyrtus ciliata</i>			X																																								
Oleaceae	<i>Notelaea longifloia</i>				X							X																																
	<i>Notelaea neglecta</i>				X																																							
Pittosporaceae	<i>Bursaria longisepala</i>				X									X																														
	<i>Bursaria spinosa</i>				X																																							
	<i>Rhytidosporum</i>		X		X																																							

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Proteaceae	<i>procumbens</i>																																													
	<i>Banksia cunninghamii</i>		X		X																																									
	<i>Hakea dactyloides</i>				X																																									
	<i>Hakea laevipes</i>																																													
	<i>Hakea teretifolia</i>				X											X																														
	<i>Isopogon anethifolius</i>				X																																									
	<i>Isopogon dawsonii</i>		X																																											
	<i>Lomatia myricoides</i>				X																																									
		Narrow-leaved																																												
	<i>Persoonia linearis</i>	Geebung	X	X	X		X	X								X		X		X																										
		Clandulla																																												
	<i>Persoonia marginata</i>	Geebung			X																																									
	<i>Persoonia mollis</i>																																													
	<i>Persoonia myrtilloides</i>		X		X																																									
	<i>Persoonia oblongata</i>																																													
Rhamnaceae	<i>Cryptandra amara</i>			X	X																																									
	<i>Cryptandra</i>																																													
	<i>spinescens</i>				X																																									

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Rosaceae	<i>Pomaderris andromedifolia</i>		X																																											
	<i>Pomaderris andromedifolia</i> ssp. <i>andromedifolia</i>				X																																									
	<i>Pomaderris prunifolia</i>				X																																									
	* <i>Cottoneaster</i> sp.																																													
	* <i>Rubus fruticosus</i>	Blackberry			X							X									X		X	X					X																	
	* <i>Rosa rubiginosa</i>	Briar Rose																					X																							
	<i>Rubus</i> sp.				X	X																																								
Rutaceae	<i>Boronia microphylla</i>		X		X																																									
	<i>Boronia rigens</i>		X																																											
	<i>Boronia</i> sp.				X											X																														
	<i>Correa reflexa</i>		X																																											
	<i>Phebalium lamprophyllum</i>		X																																											
	<i>Philotheca myoporoides</i> ssp.				X																																									

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Santalaceae	<i>Myoporoides</i>																																													
	<i>Zieria aspalathoides</i>				X																																									
	<i>Zieria cytisoides</i>		X		X																																									
	<i>Zieria sp.</i>		X																																											
	<i>Choretrum pauciflorum</i>	Dwarf Sour Bush																																												
	<i>Exocarpos cupressiformis</i>		X	X	X																																									
	<i>Exocarpos strictus</i>		X	X																																										
	<i>Leptomeria acida</i>		X	X	X	X																																								
	<i>Omphacomeria acerba</i>		X																																											
	Sapindaceae	<i>Dodonaea multijuga</i>				X																																								
<i>Dodonaea viscosa ssp cuneata</i>			X		X																																									
<i>Dodonaea viscosa ssp spatulata</i>					X																																									
<i>Derwentia perfoliata</i>					X																																									
Scrophulariaceae		<i>Derwentia perfoliata</i>			X																																									

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Simaroubaceae	<i>*Ailanthus altissima</i>	Tree of Heaven																																												
Solanaceae	<i>Solanum laciniatum</i>	Kangaroo Apple			X																																									
		Mountain																																												
	<i>Solanum linearifolium</i>	Kangaroo Apple																																												
	<i>Solanum prinophyllum</i>				X																																									
Sterculiaceae	<i>Rulingia dasyphylla</i>	Kerrawang			X																																									
Herbs - Fern																																														
Adiantaceae	<i>Adiantum aethiopicum</i>				X																																									
	<i>Asplenium</i>																																													
Aspleniaceae	<i>flabellifolium</i>		X		X																																									
	<i>Blechnum</i>																																													
Blechnaceae	<i>cartilagineum</i>				X																																									
	<i>Blechnum nudum</i>		X																																											
Cyatheaceae	<i>Cyathea australis</i>		X		X																																									
Dennstaedtiaceae	<i>Pteridium esculentum</i>		X	X	X				X											X																										
Dicksoniaceae	<i>Calochlaena dubia</i>				X																																									
Lindsaeaceae	<i>Lindsaea linearis</i>			X	X																																									
Osmundaceae	<i>Todea barbara</i>	King Fern			X																																									

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Polypodiaceae	<i>Pyrrosia rupestris</i>		X																																											
	<i>Cheilanthes</i>																																													
Sinopteridaceae	<i>austrotenuifolia</i>		X																																											
	<i>Cheilanthes sieberi</i>		X	X	X	X					X	X		X	X		X		X	X	X																									
Herbs - Dicots																																														
Acanthaceae	<i>Brunoniella australis</i>				X	X								X																																
	<i>Brunoniella pumilio</i>																																													
Apiaceae	<i>Centella asiatica</i>																																													
	* <i>Conium maculatum</i>																																													
	<i>Daucus glochidiatus</i>				X																																									
	<i>Hydrocotyle laxiflora</i>		X		X															X	X																									
	<i>Hydrocotyle tripartita</i>				X	X		X	X	X	X		X	X		X		X																												
	<i>Hydrocotyle</i> sp.																																													
	? <i>Oreromyrrhis</i>	Australian																																												
	<i>eriopoda</i>	Carraway																																												
	<i>Xanthosia pilosa</i>				X																																									
	<i>Brachycome</i>																																													
Asteraceae	<i>angustifolia</i>																																													

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	<i>Brachycome</i>																																													
	<i>spathulata</i>			X	X																																									
	<i>Calotis cuneifolia</i>		X		X																																									
	<i>*Cathamus lanatus</i>																								X																					
	<i>Centipeda minima</i>		X																																											
	<i>Chrysocephalum</i>																																													
	<i>apiculatum</i>				X																					X																				
	<i>Chrysocephalum</i>																																													
	<i>semipaposum</i>				X																X	X						X																		
	<i>Chrysocephalum sp</i>																																													
	<i>*Cirsium vulgare</i>	Scotch Thistle	X		X							X														X																				
		Flaxleaf																																												
	<i>*Conyza bonariensis</i>	Fleabane																																												
	<i>*Conyza sp.</i>				X	X																			X	X	X	X																		
	<i>Cymbonotus</i>																																													
	<i>lawsonianus</i>		X		X	X																																								
	<i>Euchiton sphaericus</i>		X	X	X																X			X		X		X	X																	
	<i>Euchiton sp.</i>																																													

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	<i>*Facelis retusa</i>																																													
	<i>*Gnaphalium americanum</i>				X																																									
	<i>*Gnaphalium sp.</i>				X	X																																								
	<i>Helichrysum scorpiodes</i>		X		X	X										X		X			X	X							X																	
	<i>*Hypochaeris radicata</i>	Flatweed	X		X	X						X								X	X		X	X				X	X																	
	<i>*Lactuca seriola</i>																																													
	<i>?Lagenophora sp.</i>																																													
	<i>Lagenophora stipitata</i>		X		X				X					X						X																										
	<i>Olearia erubescens</i>	Pink-tip Daisy-bush																																												
	<i>Senecio hispidulus</i>																																													
	<i>Senecio lautus</i>				X						X	X	X																																	
	<i>Senecio linearifolius</i>		X		X																																									
	<i>Senecio quadridentatus</i>				X																																									
	<i>Senecio sp.</i>																																													

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Brassicaceae	<i>Senecio tenuiflorus</i>				X	X																																								
	<i>Senecio ?vagus</i>				X																																									
	<i>*Silybum marianum</i>				X							X																																		
	<i>Solenogyne sp.</i>				X							X					X																													
	<i>*Sonchus aspera</i>																																													
	<i>*Sonchus oleraceus</i>	Sow Thistle																																												
	<i>*Taraxacum officinale</i>	Dandelion																																												
	<i>*Tragopogon porrifolius</i>																																													
	<i>Vittadinia cuneata</i>			X		X												X																												
	<i>*Brassica sp.</i>																																													
Boraginaceae	<i>*Lepidium africanum</i>																						X																							
	<i>*Sisymbrium sp.</i>				X																							X																		
	<i>Cynoglossum australe</i>		X		X							X		X					X																											
	<i>Cynoglossum suaveolens</i>																																													
	<i>*Echium vulgare</i>	Patterson's Curse																																												

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Campanulaceae	<i>Wahlenbergia communis</i>				X																																									
	<i>Wahlenbergia gracilis</i>		X		X	X																																								
	<i>Wahlenbergia stricta</i>		X	X	X	X																																								
	<i>Wahlenbergia sp.</i>				X							X		X	X		X	X			X																									
	<i>*Polycarpon tetraphyllum</i>	Four-leaf All-seed																																												
Caryophyllaceae	<i>Stellaria pungens</i>		X		X					X	X																																			
Chenopodiaceae	<i>Einadia hastata</i>		X		X																																									
Clusiaceae	<i>Hypericum gramineum</i>		X		X	X			X	X						X																														
	<i>*Hypericum perforatum</i>	St John's Wort			X															X	X		X	X		X	X	X	X																	
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed	X		X	X			X											X																										
Crassulaceae	<i>Crassula decumbens</i>				X																																									
	<i>Crassula sieberana</i>		X																																											
Dilleniaceae	<i>Hibbertia obtusifolia</i>				X		X							X																																
	<i>Chamaesyce sp.</i>				X									X																																
Droseraceae	<i>Drosera peltata</i>																																													

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Fabaceae	<i>Desmodium varians</i>	Tick Trefoil			X	X						X																																		
	<i>Bossiaea prostrata</i>																																													
	* <i>Medicago</i> sp.																						X				X																			
		Yellow Suckling																																												
	* <i>Trifolium dubia</i>	Clover	X																																											
Gentianaceae	* <i>Trifolium repens</i>	White Clover																					X																							
		Common																																												
	* <i>Centaurium erythrea</i>	Centaury																									X	X																		
	* <i>Centaurium tenuiflorum</i>																																													
	<i>Schenkia spicata</i>				X																																									
Geraniaceae	<i>Geranium solanderi</i>	Storksbill	X	X	X	X						X										X				X	X		X																	
	<i>Geranium homeanum</i>				X				X																																					
	<i>Geranium</i> sp. 1																																													
	<i>Geranium</i> sp. 2																																													
Goodeniaceae	<i>Cooperhooikia barbata</i>			X																																										
	<i>Goodenia bellidifolia</i>				X																																									
	<i>Goodenia hederacea</i>		X	X	X	X	X						X	X	X	X		X																												

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Family/Form	Scientific Name	Common Name	CE Quadrats																																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Haloragaceae	<i>Goodenia sp.</i>				X															X	X	X																								
	<i>Gonocarpus longifolius</i>				X																																									
	<i>Gonocarpus sp.</i>				X	X			X						X	X	X		X																											
	<i>Gonocarpus ?sp.</i>				X	X																																								
	<i>Gonocarpus tetragyna</i>		X	X	X															X	X	X																								
	<i>Gonocarpus teucrioides</i>																																													
	<i>Haloragis heterophylla</i>		X																																											
Hemerocallidaceae	<i>Caesia sp.</i>																																													
Hypoxidaceae	<i>Hypoxis hygrometrica</i>				X	X																																								
Labiaceae	<i>*Marrubium vulgare</i>																																													
Lamiaceae	<i>Ajuga australis</i>	Australian Bugle	X																																											
	<i>Ajuga sp.</i>				X	X																																								
	<i>*Lamium amplexicaule</i>																																													
	<i>Metha diemenica</i>		X																		X																									
	<i>*Prunella vulgaris</i>	Self-heal																																												

Table A.2 Flora Species Recorded in the Study Area Quadrats 21 - 44

Family/Form	Scientific Name	Common Name	CE Quadrats																																											
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Linaceae	<i>Linum marginale</i>		X		X																																									
	<i>Linum trigynum</i>	French Flax																																												
Lobeliaceae	<i>Isotoma axillaris</i>		X		X								X																																	
	<i>Isotoma fluviatilis</i>		X																																											
	<i>Pratia pedunculata</i>				X																																									
	<i>Pratia purpurascens</i>		X		X																																									
	<i>Mitracacme</i>																																													
Loganaceae	<i>polymorpha</i>		X																																											
Malvaceae	<i>*Modiola caroliniana</i>																																													
Onagraceae	<i>*Oenothera sp.</i>																																													
Oxalidaceae	<i>Oxalis exilis</i>				X																																									
	<i>*Oxalis ?sp. A</i>		X																																											
	<i>*Oxalis sp. B.</i>																																													
	<i>*Oxalis sp.</i>				X	X		X											X																											
	<i>Oxalis sp.</i>				X				X	X										X	X																									
	<i>Oxalis perennans</i>				X							X		X																																
Phyllanthaceae	<i>Phyllanthus hirtellus</i>		X		X										X																															

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			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Pittosporaceae	<i>Poranthera corymbosa</i>		X		X																																									
	<i>Poranthera microphylla</i>				X							X																																		
	<i>Rhytidosporum procumbens</i>																																													
	Plantaginaceae	<i>Plantago debilis</i>		X		X									X																															
<i>*Plantago lanceolata</i>					X	X						X							X	X		X				X	X	X	X																	
<i>Plantago sp.</i>					X				X	X		X																																		
<i>Plantago varia</i>																																														
Primulaceae	<i>*Anagallis arvensis</i>	Scarlet Pimpernel																		X																										
Polygalaceae	<i>Comesperma ericinum</i>		X																																											
	<i>Comesperma volubile</i>																																													
	<i>*Acetosella vulgaris</i>																							X			X		X																	
	<i>*Emex australis</i>				X																																									
	<i>Rumex brownii</i>				X																						X	X	X																	
	<i>*Rumex crispus</i>	Dock																																												

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			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44																	
Ranunculaceae	<i>Ranunculus</i>																																													
	<i>lappaceus</i>																																													
Rosaceae	<i>Acaena agnipila</i>				X					X																																				
	<i>Acaena novae-zealandiae</i>		X		X				X			X							X	X	X		X																							
	<i>Acaena ovina</i>		X																																											
	<i>Acaena sp.</i>																												X																	
Rubiaceae		Common																																												
	<i>Asperula conferta</i>	Bedstraw			X									X																																
	<i>Asperula sp.X</i>				X				X																																					
	<i>Asperula sp.X</i>				X																																									
	<i>Galium binifolium</i>				X	X																																								
	<i>Galium propinquum</i>		X	X	X					X																																				
	<i>Galium gaudichaudii</i>				X																																									
	<i>Galium sp.</i>				X			X	X					X	X																															
	<i>Opercularia aspera</i>		X		X																																									
	<i>Opercularia hispida</i>				X																																									
	<i>Opercularia sp.</i>				X	X																X																								

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Scrophulariaceae	<i>Pomax umbellata</i>		X		X			X										X																												
	<i>*Sherardia arvensis</i>				X																																									
	<i>*Verbascum thapsus</i>	Blanket Weed																																												
	<i>*Verbascum virgatum</i>	Twiggy Mullein																																												
	<i>Veronica calycina</i>		X		X																																									
	<i>Veronica gracilis</i>																					X																								
Solanaceae	<i>Veronica plebeia</i>		X	X	X	X		X	X	X	X	X								X																										
	<i>Solanum brownii</i>				X																																									
Stackhousiaceae	<i>Stackhousia</i>	Creamy																																												
	<i>monogyna</i>	Candles	X		X							X							X																											
Stylidiaceae	<i>Stylidium graminifolium</i>		X		X	X														X																										
	<i>Stylidium lineare</i>				X																																									
Thymeliaceae	<i>Pimelea glauca</i>				X																																									
	<i>Pimelea linifolia</i>		X																																											
Verbenaceae	<i>*Verbena bonariensis</i>				X																																									
Violaceae	<i>Viola betonicifolia</i>	Native Violet	X	X	X					X							X																													
	<i>Viola hederacea</i>	Ivy-leaved Violet	X		X				X																																					

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Herbs - Monocots																																														
*Agavaceae	* <i>Agave americana</i>	Yucca																																												
Anthericaceae	<i>Anthericaceae</i> sp.																																													
	<i>Laxmannia gracilis</i>		X																																											
	<i>Thysanotus</i> sp.		X																																											
	<i>Tricoryne elatior</i>				X	X																																								
	<i>Tricoryne simplex</i>																																													
Caryophyllaceae	* <i>Petrorhagia nanteulii</i>				X																								X																	
Colchicaceae	<i>Wurmbea dioica</i>	Early Nancy																																												
Cyperaceae	<i>Carex appressa</i>																																													
	<i>Carex inversa</i>				X															X									X																	
	<i>Carex</i> sp.																																													
	<i>Cyperus</i> sp.																																													
	<i>Lepidosperma laterale</i>				X																																									
	<i>Lepidosperma urophorum</i>		X																																											

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			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Droseraceae	<i>Lepidosperma sp.</i>		X																											
	<i>Schoenus sp.</i>		X																											
	<i>Drosera sp.</i>				X											X					X									
Iridaceae	<i>*Iris sp.</i>																													
	<i>Patersonia glabrata</i>	Purple Flag																												
	<i>Patersonia longifolia</i>			X	X																									
	<i>Patersonia sericea</i>		X																											
	<i>Patersonia sp.</i>				X		X									X														
Juncaceae	<i>Juncus australis</i>																							X					X	
	<i>*Juncus cognatus</i>				X																									
	<i>Juncus planifolius</i>		X																											
	<i>Juncus sp.</i>				X																		X	X	X	X		X	X	
	<i>Juncus subsecundus</i>																									X				
	<i>Luzula flaccida</i>																													
	<i>Luzula sp.</i>		X		X																									
Lomandraceae	<i>Lomandra confertifolia</i>		X	X				X																						
	<i>Lomandra</i>				X																									

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Orchidaceae	<i>confertifolius ssp. rubiginosa</i>																																													
	<i>Lomandra filiformis</i>				X															X	X	X				X			X																	
	<i>Lomandra filiformis ssp. coriacea</i>		X	X	X		X	X		X	X	X		X	X	X	X	X	X																											
	<i>Lomandra filiformis ssp. filiformis</i>																																													
	<i>Lomandra glauca</i>		X		X																																									
	<i>Lomandra longifolia</i>		X	X	X														X		X																									
	<i>Lomandra multiflora</i>		X		X				X												X					X																				
	<i>Lomandra sp.</i>				X		X																																							
	<i>Acianthus exsertus</i>	Mosquito Orchid			X																																									
	<i>Acianthus sp.</i>				X			X						X																																
	<i>Caladenia alba</i>				X												X																													
	<i>Caladenia carnea</i>	Pink Fingers			X																																									
	<i>Caladenia sp.</i>				X			X																																						
	<i>Dipodium punctatum</i>		X																																											
	<i>Diuris maculata</i>				X																																									

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Phormiaceae	<i>Diuris sulphurea</i>	Tiger Orchid																																												
	<i>Glossodia major</i>	Waxlip Orchid																																												
	<i>Microtis uniflora</i>		X																																											
	<i>Pterostylis sp.</i>			X	X																																									
	<i>Thelymitra sp.</i>	a Sun Orchid	X		X															X																										
	<i>Dianella longifolia</i>														X																															
	<i>Dianella revoluta</i>	Paroo Lily	X	X	X	X	X								X	X	X	X			X	X																								
	<i>Stypandra galuca</i>				X																																									
	Poaceae	<i>Agrostis avenacea</i>																																												
<i>var. avenacea</i>			X																																											
<i>Anisopogon</i>																																														
<i>avenaceus</i>			X																																											
<i>*Anthoxanthum</i>		Sweet Vernal																																												
<i>odoratum</i>		Grass			X																						X																			
<i>Aristida calycina</i>																																														
<i>Aristida jerichoensis</i>																				X																										
<i>Aristida ramosa</i>				X	X										X	X			X		X																									
<i>Aristida sp.</i>																					X		X																							

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	<i>Austrodanthonia caespitosa</i>		X																																											
	<i>Austrodanthonia fulva</i>				X																																									
	<i>Austrodanthonia laevis</i>		X																																											
	<i>Austrodanthonia penicillata</i>				X					X				X			X																													
	<i>Austrodanthonia racemosa</i>		X	X	X	X					X																																			
	<i>Austrodanthonia sp.X</i>				X							X																																		
	<i>Austrodanthonia sp.X</i>				X							X																																		
	<i>Austrodanthonia sp.</i>				X								X														X																			
	<i>Austrostipa rudis</i>		X																																											
	<i>Austrostipa scabra</i>				X																																									
	<i>Austrostipa sp.</i>		X		X	X				X	X									X	X	X		X																						
	<i>Bothriochloa sp.</i>				X																																									
	<i>*Briza minor</i>	Shivery Grass																																												
	<i>*Bromus catharticus</i>	Prairie Grass																																												

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	<i>*Bromus molliformis</i>																																													
	<i>Cymbopogon refractus</i>				X																																									
	<i>*Cynodon dactylon</i>	Couch Grass			X																	X				X	X	X	X																	
	<i>Chionochloa pallida</i>		X																																											
	<i>*Chloris gayana</i>	Rhodes Grass																																												
	<i>Danthonia sp.</i>	a Wallaby Grass																																												
	<i>Dichelachne micrantha</i>	Short-haired Plume Grass		X																																										
	<i>Dichelachne rara</i>		X																																											
	<i>Echinopogon caespitosus</i>		X		X	X						X		X	X					X	X	X				X																				
	<i>Echinopogon ovatus</i>		X	X	X																																									
	<i>*Eleusine tristachya</i>				X																	X		X																						
	<i>Elymus scaber</i>				X	X																																								
	<i>Entolasia stricta</i>		X	X	X																																									
	<i>*Eragrostis cilianensis</i>																																													
	<i>*Eragrostis curvula</i>	African Love-																																												

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		grass																																												
	<i>Eragrostis</i>																																													
	<i>leptostachya</i>				X															X						X	X	X																		
	<i>Eragrostis sp.</i>																												X																	
	<i>*Festuca sp.</i>																						X		X	X																				
	<i>Imperatia cylindrica</i>				X																																									
	<i>Joycea pallida</i>			X	X	X				X		X	X	X	X	X	X	X			X	X						X																		
	<i>*Lolium perenne</i>	Perennial Rye																																												
	<i>Lolium sp.</i>				X																		X			X			X																	
		Weeping																																												
	<i>Microlaena stipoides</i>	Meadow-grass	X	X	X		X	X	X				X							X	X			X	X			X	X																	
		Chillean Needle																																												
	<i>*Nassella neesiana</i>	Grass																																												
	<i>Panicum effusum</i>				X							X		X						X		X			X	X																				
	<i>*Paspalum dilatatum</i>	Paspalum																																												
	<i>*Paspalum urvillei</i>																									X																				
	<i>*Paspalum sp.</i>																						X																							
	<i>*Pennesitum</i>	Kikuyu																					X	X	X																					

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	<i>clandestinum</i>																																													
	<i>Phelaris aquatica</i>																								X	X																				
	<i>Phragmites australis</i>	Common Reed																																												
	<i>Poa labillardieri</i>		X																																											
	<i>Poa sieberiana</i> ssp <i>cyanophylla</i>		X															X	X																											
	<i>Poa sieberiana</i> ssp <i>sieberiana</i>		X	X	X	X	X	X	X					X	X		X			X	X		X	X	X	X	X	X	X																	
	<i>Poa</i> sp.																																													
	<i>Poaceae</i> sp.																							X	X	X	X		X																	
	<i>Themeda australis</i>	Kangaroo Grass	X	X	X	X									X					X						X		X	X																	
	<i>Vulpia bromoides</i>		X																																											
	?* <i>Vulpia</i> sp.																																													
Restionaceae	<i>Lepyrodia scariosa</i>		X																																											
Typhaceae	<i>Typha orientalis</i>	Cumbungi			X																																									
	<i>Xanthorrhoea glauca</i>																																													
Xanthorrhoeaceae	ssp. <i>angustifolia</i>				X																																									
	<i>Xanthorrhoea</i> sp.		X		X								X																																	

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Vines & Scramblers																																																	
Apocynaceae	<i>Parsonsia brownii</i>				X																																												
Araliaceae	<i>*Hedera helix</i>	English Ivy																																															
	<i>Convolvulus</i>	Blushing																																															
Convolvulaceae	<i>erubescens</i>	Bindweed			X																																												
Fabaceae	<i>Glycine clandestina</i>		X		X	X																																											
	<i>Glycine microphylla</i>																																																
	<i>Glycine tabacina</i>		X		X							X																																					
		Purple Coral																																															
	<i>Hardenbergia violacea</i>	Pea	X		X			X	X					X			X			X		X																											
	<i>Vicia sativa</i> subsp. <i>nigra</i>	Narrow-leaved Vetch																																															
Lauraceae	<i>Cassytha melantha</i>				X																																												
	<i>Cassytha pubescens</i>				X																																												
Pittosporaceae	<i>Billardia scandens</i>	Apple Berry	X		X				X																																								
Ranunculaceae	<i>Clematis aristata</i>		X		X				X			X																																					
Rosaceae	<i>*Rubus parviflora</i>				X																																												
	<i>Rubus hillii</i>				X				X			X																																					

Table A.2 **Flora Species Recorded in the Study Area Quadrats 21 - 44**

Family/Form	Scientific Name	Common Name	CE Quadrats																										
			Lembit 1997	Lembit 2003	CE 2009- 2011	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Santalaceae	Amperea xiphoclada				X																								
Mistletoes																													
Loranthaceae	Amyema pendulum ssp. pendulum		X		X																								

Appendix B

Fauna Species List

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Amphibia												
Myobatrachidae												
Common Eastern Froglet	<i>Crinia signifera</i>		x									x
Eastern Banjo Frog	<i>Limnodynastes dumerilii</i>											x
Brown-striped Frog	<i>Limnodynastes peronii</i>											x
Spotted Grass Frog	<i>Limnodynastes tasmaniensis</i>		x									x
Bibron's Toadlet	<i>Pseudophryne bibronii</i>		x									
Smooth Toadlet	<i>Uperoleia laevigata</i>		x									x
Hylidae												
Bleating Tree Frog	<i>Litoria dentata</i>		x									x
Peron's Tree Frog	<i>Litoria peronii</i>		x									x
Reptiles												
Gekkonidae												
Lesueur's Velvet Gecko	<i>Oedura lesueurii</i>											x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Varanidae												
Lace Monitor	<i>Varanus varius</i>							x				x
Agamidae												
Jacky Lizard	<i>Amphiloburus muricatus</i>						x					x
Eastern Bearded Dragon	<i>Pogona barbata</i>							x				
Mountain Dragon	<i>Rankinia diemensis</i>						x					x
Scincidae												
Red-throated Skink	<i>Acritoscincus platynotum</i>						x					
Cunningham's Skink	<i>Egernia cunninghami</i>											x
White's Skink	<i>Egernia whitii</i>											x
Garden Skink	<i>Lampropholus delicata</i>						x					x
Grass Skink	<i>Lampropholus guichenoti</i>											x
Woodland Tussock-skink	<i>Pseudomoia entrecasteauxii</i>		x				x					x
Blotched Blue-tongue	<i>Tiliqua nigrolutea</i>						x					x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Elapidae												
Mustard-bellied Snake	<i>Drysdalia rhodogaster</i>						x					
Birds												
GALLIFORMES												
Phasianidae												
Brown Quail	<i>Coturnix ypsilophora</i>	x						x				x
ANSERIFORMES												
Anatidae												
Australian Wood Duck	<i>Chenonetta jubata</i>											x
PODICIPEDIFORMES												
Podicipedidae												
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>											x
COLUMBIFORMES												
Columbidae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Common Bronzewing	<i>Phaps chalcoptera</i>	x						x		x		x
Wonga Pigeon	<i>Leucosarcia picata</i>							x				x
CAPRIMULGIFORMES												
Podargidae												
Tawny Frogmouth	<i>Podargus strigoides</i>		x							x		x
Eurostopodidae												
White-throated Nightjar	<i>Eurostopodus mystacalis</i>											x
APODIFORMES												
Aegothelidae												
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>		x					x				x
ACCIPITRIFORMES												
Accipitridae												
Brown Goshawk	<i>Accipiter fasciatus</i>	x						x		x		x
Square-tailed Kite	<i>Lophoictinia isura</i>							x				

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Wedge-tailed Eagle	<i>Aquila audax</i>	x						x		x		x
FALCONIFORMES												
Falconidae												
Nankeen Kestrel	<i>Falco cenchroides</i>							x				x
CHARADRIIFORMES												
Turnicidae												
Painted Button-quail	<i>Turnix varius</i>	x										
PSITTACIFORMES												
Cacatuidae												
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	x										
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	x						x				x
Galah	<i>Eolophus roseicapillus</i>	x										x
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	x						x				

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Psittacidae												
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>							x				
Musk Lorikeet	<i>Glossopsitta concinna</i>	x										
Australian King-Parrot	<i>Alisterus scapularis</i>							x		x		x
Crimson Rosella	<i>Platycercus elegans</i>	x						x		x		x
Eastern Rosella	<i>Platycercus eximius</i>	x						x		x		x
CUCULIFORMES												
Cuculidae												
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	x								x		x
Pallid Cuckoo	<i>Cacomantis pallidus</i>	x										
Brush Cuckoo	<i>Cacomantis variolosus</i>											x
Shining Bronze-cuckoo	<i>Chrysococcyx lucidus</i>	x										
STRIGIFORMES												
Strigidae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Powerful Owl	<i>Ninox strenua</i>											x
Southern Boobook	<i>Ninox novaeseelandiae</i>	x	x							x		x
CORACIIFORMES												
Halcyonidae												
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	x						x		x		
Sacred Kingfisher	<i>Todiramphus sanctus</i>	x								x		x
Meropidae												
Rainbow Bee-eater	<i>Merops ornatus</i>	x										
PASSERIFORMES												
Menuridae												
Superb Lyrebird	<i>Menura novaehollandiae</i>	x								x		x
Climacteridae												
Climacteris picumnus	<i>Brown Tree creeper</i>							x				
White-throated Treecreeper	<i>Cormobates leucophaea</i>	x								x		x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Red-browed Treecreeper	<i>Climacteris erythrops</i>	x										
Ptilonorhynchidae												
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	x										x
Maluridae												
Superb Fairy-wren	<i>Malurus cyaneus</i>	x								x		x
Acanthizidae												
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>							x				
Rockwarbler	<i>Origma solitaria</i>	x										x
White-browed Scrubwren	<i>Sericornis frontalis</i>	x								x		x
Large-billed Scrubwren	<i>Sericornis magnirostra</i>											x
White-throated Gerygone	<i>Gerygone albogularis</i>	x								x		
Striated Thornbill	<i>Acanthiza lineata</i>	x								x		x
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>											x
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>	x								x		x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Brown Thornbill	<i>Acanthiza pusilla</i>	x								x		x
Pardalotidae												
Spotted Pardalote	<i>Pardalotus punctatus</i>	x								x		x
Striated Pardalote	<i>Pardalotus striatus</i>	x								x		x
Meliphagidae												
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	x								x		x
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	x								x		x
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	x										
Noisy Miner	<i>Manorina melanocephala</i>	x						x				
Red Wattlebird	<i>Anthochaera carunculata</i>	x								x		x
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	x										
White-naped Honeyeater	<i>Melithreptus lunatus</i>	x										x
Noisy Friarbird	<i>Philemon corniculatus</i>	x								x		x
Eupetidae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Spotted Quail-thrush	<i>Cinclosoma punctatum</i>	x										x
Neosittidae												
Varied Sittella	<i>Daphoenositta chrysoptera</i>									x		
Campephagidae												
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	x						x		x		x
Cicadabird	<i>Coracina tenuirostris</i>	x										x
Pachycephalidae												
Crested Shrike-tit	<i>Falcunculus frontatus</i>	x								x		
Golden Whistler	<i>Pachycephala pectoralis</i>	x								x		
Rufous Whistler	<i>Pachycephala rufiventris</i>	x								x		x
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	x								x		x
Oriolidae												
Olive-backed Oriole	<i>Oriolus sagittatus</i>	x								x		
Artamidae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Grey Butcherbird	<i>Cracticus torquatus</i>	x						x		x		
Australian Magpie	<i>Cracticus tibicen</i>	x						x		x		x
Pied Currawong	<i>Strepera graculina</i>	x						x		x		x
Grey Currawong	<i>Strepera versicolor</i>	x						x				
Rhipiduridae												
Grey Fantail	<i>Rhipidura albiscapa</i>	x						x		x		x
Rufous Fantail	<i>Rhipidura rufifrons</i>							x				
Willie Wagtail	<i>Rhipidura leucophrys</i>	x						x				x
Corvidae												
Australian Raven	<i>Corvus coronoides</i>	x						x				x
Monarchidae												
Leaden Flycatcher	<i>Myiagra rubecula</i>	x								x		x
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	x						x		x		x
Restless Flycatcher	<i>Myiagra inquieta</i>											x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Magpie-lark	<i>Grallina cyanoleuca</i>							x				
Corcoracidae												
White-winged Chough	<i>Corcorax melanorhamphos</i>	x						x				x
Petroicidae												
Scarlet Robin	<i>Petroica boodang</i>	x						x		x		x
Rose Robin	<i>Petroica rosea</i>							x				
Eastern Yellow Robin	<i>Eopsaltria australis</i>	x						x		x		x
Acrocephalidae												
Australian Reed-Warbler	<i>Acrocephalus australis</i>											x
Timaliidae												
Silvereye	<i>Zosterops lateralis</i>							x		x		x
Hirundinidae												
Welcome Swallow	<i>Hirundo neoxena</i>							x				x
Sturnidae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Common Starling	<i>Sturnus vulgaris</i>											x
Nectariniidae												
Mistletoebird	<i>Dicaeum hirundinaceum</i>									x		x
Passeridae												
House Sparrow	<i>Passer domesticus</i>											x
Motacillidae												
Australasian Pipit	<i>Anthus novaeseelandiae</i>											x
Mammals												
Prototheria												
MONOTREMATA												
Tachyglossidae												
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>		x									x
Marsupialia												
DASYUROMORPHIA												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Dasyuridae												
Yellow-footed Antechinus	<i>Antechinus flavipes</i>					x						
Brown Antechinus	<i>Antechinus stuartii</i>											x
DIPROTODONTIA												
Vombatidae												
Common Wombat	<i>Vombatus ursinus</i>		x							x		x
Phalangeridae												
Common Brushtail Possum	<i>Trichosurus vulpecula</i>		x							x		x
Petauridae												
Sugar Glider	<i>Petaurus breviceps</i>		x							x		x
Squirrel Glider	<i>Petaurus norfolcensis</i>		x									
Pseudocheiridae												
Greater Glider	<i>Petauroides volans</i>		x									x
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>		x							x		x

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Macropodidae												
Eastern Grey Kangaroo	<i>Macropus giganteus</i>		x					x		x		x
Wallaroo	<i>Macropus robustus</i>							x		x		x
Red-necked Wallaby	<i>Macropus rufogriseus</i>		x					x		x		x
Swamp Wallaby	<i>Wallabia bicolor</i>							x		x		x
Eutheria												
CHIROPTERA												
Rhinolophidae												
Eastern Horseshoe Bat	<i>Rhinolophus megaphyllus</i>			x								
Mollossidae												
Little Freetail Bat	<i>Mormopterus sp. 2</i>									x		
White-striped Freetail Bat	<i>Tadarida australis</i>			x						x	x	
Vespertilionidae												
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>			?								

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>			x						x	x	
Chocolate Wattled Bat	<i>Chalinolobus morio</i>			x						x	x	
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>										?	
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>			x	x					x		
Large-footed Myotis	<i>Myotis adversus</i>									?		
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>				x						x	
Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>				x						x	
Long-eared Bat Sp.	<i>Nyctophilus sp.</i>			x								
Eastern Broad-nosed Bat	<i>Scotorepens orion</i>									x	x	
Large Forest Bat	<i>Vespadelus darlingtoni</i>			x	x					x	x	
Southern Forest Bat	<i>Vespadelus regulus</i>			x	x					x	x	
Little Forest Bat	<i>Vespadelus vulturnus</i>			x	x					x	x	
RODENTIA												
Muridae												

Table B.1 Fauna Species Recorded From the Study Area

Family/Common Name	Scientific Name	Bird census	Spotlighting quadrat	Anabat	Harp Trapping	Trapping	Active Searches	Incidental	AES 2005	AES 2003	Ecotone 1996	Wildsearch 1996
Bush Rat	<i>Rattus fuscipes</i>											x
CARNIVORA												
Canidae												
Dog	<i>Canis familiaris</i>							x				x
Red Fox	<i>Vulpes vulpes</i>		x					x		x		x
PERISSODACTYLA												
Equidae												
Horse	<i>Equus caballus</i>											x
ARTIODACTYLA												
Bovidae												
Cattle	<i>Bos taurus</i>							x				x
LAGOMORPHA												
Leporidae												
European Rabbit	<i>Oryctolagus cuniculus</i>		x					x		x		x

Appendix C

Threatened Flora Population Data

Table C.1 Eucalyptus cannonii
Quadrat data

Quadrat	Division of quadrat	No. of E. cannonii
1	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	4
	40-50m	2
	50-60m	2
	60-70m	0
	70-80m	0
	80-90m	0
	90-100m	6
	Total:	14
2	0-10m	4
	10-20m	6
	20-30m	0
	30-40m	1
	40-50m	6
	50-60m	4
	60-70m	5
	70-80m	2
	80-90m	3
	90-100m	0
	Total:	31
3	0-10m	0
	10-20m	3
	20-30m	1
	30-40m	5
	40-50m	0
	50-60m	0
	60-70m	1
	70-80m	4
	80-90m	4
	90-100m	0
	Total:	18
4	0-10m	0

Table C.1 Eucalyptus cannonii
Quadrat data

Quadrat	Division of quadrat	No. of E. cannonii
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	3
	60-70m	1
	70-80m	0
	80-90m	0
	90-100m	0
	Total:	4
5	0-10m	10
	10-20m	5
	20-30m	9
	30-40m	2
	40-50m	12
	50-60m	5
	60-70m	3
	70-80m	9
	80-90m	0
	90-100m	0
	Total:	55
10	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	0
	60-70m	0
	70-80m	0
	80-90m	0
	90-100m	0
	Total:	0
11	0-10m	7
	10-20m	5

Table C.1 Eucalyptus cannonii
Quadrat data

Quadrat	Division of quadrat	No. of E. cannonii
	20-30m	5
	30-40m	0
	40-50m	2
	50-60m	3
	60-70m	0
	70-80m	2
	80-90m	0
	90-100m	0
	Total:	24
12	0-10m	0
	10-20m	1
	20-30m	0
	30-40m	3
	40-50m	0
	50-60m	0
	60-70m	0
	70-80m	1
	80-90m	4
	90-100m	0
13	Total:	9
	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	0
	60-70m	0
	70-80m	0
	80-90m	0
14	90-100m	0
	Total:	0
	0-10m	0
	10-20m	0
	20-30m	1

Table C.1 Eucalyptus cannonii
Quadrat data

Quadrat	Division of quadrat	No. of E. cannonii
	30-40m	0
	40-50m	0
	50-60m	3
	60-70m	1
	70-80m	0
	80-90m	0
	90-100m	1
	Total:	6
15	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	1
	60-70m	1
	70-80m	0
	80-90m	0
	90-100m	0
16	Total:	2
	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	0
	60-70m	0
	70-80m	0
	80-90m	0
17	90-100m	0
	Total:	0
	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0

Table C.1 Eucalyptus cannonii
Quadrat data

Quadrat	Division of quadrat	No. of E. cannonii
18	40-50m	0
	50-60m	1
	60-70m	0
	70-80m	0
	80-90m	0
	90-100m	0
	Total:	1
	0-10m	0
	10-20m	0
	20-30m	0
	30-40m	0
	40-50m	0
	50-60m	0
	60-70m	0
	70-80m	0
	80-90m	0
	90-100m	0
	Total:	0
19	0-10m	0
	10-20m	1
	20-30m	0
	30-40m	3
	40-50m	2
	50-60m	0
	60-70m	1
	70-80m	0
	80-90m	3
	90-100m	1
	Total:	11

Table C.2 *Persoonia marginata* Quadrat Results at Cullen Valley Mine Subpopulation

Quadrats	count	size of quadrat (m2)	No m2	No per ha
Area 1	2	10	0.20	2000
	0	10	0.00	0
	0	10	0.00	0
	0	10	0.00	0
Area 2	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	2	20	0.10	1000
Area 3	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	6	20	0.30	3000
	0	20	0.00	0
	0	20	0.00	0
	9	20	0.45	4500
	6	20	0.30	3000
Area 4 rail siding (plants present)	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
Area 5	0	20	0.00	0
	3	20	0.15	1500

Table C.2 *Persoonia marginata* Quadrat Results at Cullen Valley Mine Subpopulation

Quadrats	count	size of quadrat (m2)	No m2	No per ha
Area 6	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	2	20	0.10	1000
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	3	20	0.15	1500
	1	20	0.05	500
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	6	20	0.30	3000

Table C.2 *Persoonia marginata* Quadrat Results at Cullen Valley Mine Subpopulation

Quadrats	count	size of quadrat (m2)	No m2	No per ha
Area 7 (north of railway line)	1	20	0.05	500
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	2	20	0.10	1000
	1	20	0.05	500
	2	20	0.10	1000
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
Area 8	2	20	0.10	1000
	3	20	0.15	1500
	6	20	0.30	3000
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	3	20	0.15	1500
	1	20	0.05	500
	2	20	0.10	1000
	0	20	0.00	0
	3	20	0.15	1500
	2	20	0.10	1000
	4	20	0.20	2000

Table C.2 *Persoonia marginata* Quadrat Results at Cullen Valley Mine Subpopulation

Quadrats	count	size of quadrat (m2)	No m2	No per ha
	1	20	0.05	500
	3	20	0.15	1500
	8	20	0.40	4000
	11	20	0.55	5500
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	1	20	0.05	500
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
	0	20	0.00	0
Mean				466
Standard Deviation				965

Appendix D

Threatened Flora Likelihood of Occurrence

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Anthericaceae	<i>Caesia parviflora</i> <i>var. minor</i>	Small Pale Grass-lily	E		1	This variety occurs uncommonly in Tasmania, southern Victoria and south-east South Australia with an outlying population in NSW, in Barcoongere State Forest, between Grafton and Coffs Harbour. Found in damp places in open forest on sandstone	Low. Ostensible suitable habitat occurs in gullies of study area. Only known record is located more than 10km east of the Modifications in Newnes State Forest. Not detected during past or current surveys.
Asclepiadaceae	<i>Cynanchum elegans</i>		E	E	0	Cumberland Plain, the Forster area, Manning Valley, Hunter Valley, Yabbara State Forest, Brunswick Heads, Gerroa, Merriwa and northeast of Lithgow LGA. Not detected during Tenterfield. Most common isn the Kempsey region. This species occurs from near sea level to about 600 m above sea level and experiences hot humid summers with high summer-autumn rainfall, and cool winters with low spring rainfall.	Low. Known distribution restricted to coastal areas. Not known in the past or current surveys.
Asteraceae	<i>Olearia cordata</i>		V	V	6	Generally restricted to the south-western Hunter Plateau, eastern Colo Plateau, and the far north-west of the Hornsby Plateau near Wisemans Ferry east of Maroota. The species prefers sheltered easterly aspects slopes in dry open sclerophyll forest and open shrubland on sandstone ridges on Hawkesbury soil landscapes.	Low. Suitable habitat occurs on ridges in the study area. Not recorded within 10km of the study area. Closest known records are more than 30 km north east within Wollemi National Park. Not detected during past or current surveys.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Fabaceae (Faboideae)	<i>Pultenaea sp.</i> <i>Genowlan Point</i>		CE	CE	7	Known from a single population at Genowlan Point in the Capertee Valley within the Rylstone Local Government Area. The population is restricted to a very small area of only 250 square metres on Crown Land. Occurs on well-drained soil near cliff edge.	Low. Only known from a single population in Capertee Valley that occurs at the tip of a north-facing projection of Genowlan Mountain, an isolated mesa. Has a very restricted geographic distribution, with its current extent of occurrence estimated to be 0.0025 km ² . Not detected during past or current surveys.
Fabaceae (Faboideae)	<i>Pultenaea glabra</i>	Swamp Bush-pea	V	V	0	In NSW, it is confined to the higher Blue Mountains (Katoomba-Hazelbrook and Mount Victoria). Occurs in swamp margins, hillslopes, gullies and creekbanks in dry sclerophyll forest and in tall damp death on sandstone	Low. Confined to the higher Blue Mountains (Katoomba-Hazelbrook and Mt Victoria). Not detected during past surveys or current surveys.
Fabaceae (Mimosoideae)	<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V	1	Hunter district on the Central Coast south to Berrima and Mittagong in the Southern Highlands. The stronghold of the species' distribution is in the Blue Mountains area. Occurs in dry sclerophyll forest on sandy soils and seems to prefer open, disturbed sites. The substrate is typically sand and sandy clay, often	Low. Known records in NSW occur largely east of the Great Dividing Range and within the Blue Mountains National Park. One records within the Lithgow LGA since 1980. Located near Bogee approximately 30km away (date 2007) of the study

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						with ironstone gravels and is usually very infertile and well-drained.	area. Suitable habitat occurs in the study area. Not detected during past or current surveys.
Fabaceae (Mimosoideae)	<i>Acacia flocktoniae</i>		V	V	0	Isolated occurrences from Mt Wilson and Little Hartley south to Yerranderie and Picton, in the Central Tablelands of NSW This species grows in dry sclerophyll forest on low nutrient soils derived from sandstone.	Low. Isolated distribution. Ostensible suitable habitat in relation to broad habitat description. Not known in the Lithgow LGA. Not detected during past or current surveys.
Fabaceae (Mimosoideae)	<i>Acacia gordonii</i>		E	E	0	The species is restricted to the Central Coast region of NSW. Chiefly found in the lower eastern slopes of the Blue Mountains This species grows in dry sclerophyll open forest, woodland and heath on sandy soil amongst sandstone outcrops. It occurs on rock platforms on ridgetops and spurs at 0-400 m asl. The substrate is Hawkesbury Sandstone with some residual clay and laterite influence, low in nutrients and well drained.	Low. From current information species is restricted to the Central Coast and lower slopes of eastern Blue Mountains. Ostensible suitable habitat in relation to broad habitat description. Not known in the Lithgow LGA. Not detected during past or current surveys.
Haloragaceae	<i>Haloragodendron</i>		E	E	12	Known locations within NSW occur on North Shore	Low. Known locations occur largely

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
	<i>lucasii</i>					Sydney and within Wollemi National Park. Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland	on Sydney's North Shore. Records from the LGA are confined to two positions within Wollemi National Park more than 20km east of the study area. Suitable habitat found within study area. Not detected during past or current surveys.
Lamiaceae	<i>Prostanthera cryptandroides subsp. cryptandroides</i>	Wollemi Mint-bush	V	V	22	Occurs in restricted areas but over a fairly broad range from the Lithgow and Sandy Hollow Districts into the Border Rivers/Gwydir Catchment and up into Queensland. Occurs in the Wollemi National Park and is likely to also occur within the Goulburn River National Park. Occurs in open forest, exposed woodland, heath and scrubland.	Moderate. Recorded from Ben Bullen State Forest to north of Baal Bone Colliery. Potential to occur in within pagoda shrublands and exposed ridgetops. Not detected during past surveys or current targeted searches.
Lamiaceae	<i>Prostanthera stricta</i>	Mount Vincent Mint-bush	V	V	13	<i>Prostanthera stricta</i> occurs in the Widden Valley district of New South Wales. The species is also known from Mt Vincent and Genowlan Mountain in the Central Tablelands. <i>Prostanthera aff. stricta</i> is found at Dingo Creek and the Widden and Baerami Valleys in the Central Western Slopes. Occurs on skeletal or well-drained soils in areas of	Low. Known records within Lithgow LGA occur around Capertee Valley and further north. Closest record is approximately 15km away. No suitable habitat in the form of riparian habitats recorded within the study area. Not detected during past or

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						steep rocky slopes, cliff lines, sandstone platforms or sandstone outcropping, usually within the riparian zone.	current surveys.
Myrtaceae	<i>Baeckea kandos</i>		E	E	0	This species is apparently confined to the Kandos Weir area in Wollemi National Park, NSW, where it is known from two small populations. This species grows in heathland or shrubland. Associated species include <i>Leptospermum parvifolium</i> , <i>Leptospermum arachnoides</i> and <i>Grevillea diffusa</i> . It occurs on skeletal sandy soil derived from sandstone.	Low. Confined to two small populations north at Kandos Weir in Wollemi National Park. Known ostensible habitat occurs in the study area. Not detected during past or current surveys.
Myrtaceae	<i>Callistemon linearifolius</i>	Nettled Bottlebrush	V		1	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park.	Low. Known distribution occurs predominantly east of the Great Dividing Range. One known records exists in Lithgow LGA approximately 25 km north of the study area. Suitable habitat exists within areas of dry sclerophyll forest, however not well known in the LGA. Not detected during past surveys or current surveys.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Myrtaceae	<i>Darwinia peduncularis</i>		V		9	Grows in dry sclerophyll forest on the coast and adjacent ranges. Occurs as local disjunct populations in coastal NSW with a couple of isolated populations in the Blue Mountains. Occurs on or near rocky outcrops on sandy, well-drained low nutrient soils.	Low. Within the Lithgow LGA known records occupy habitats within Wollemi National Park. The closest known record is approximately 20 km north east of study area. Not well known within the LGA. Ostensible suitable habitat exists according to broad habitat descriptions. Not detected during past or current surveys.
Myrtaceae	<i>Eucalyptus aggregata</i>	Black Gum		V	9	In NSW it occurs in the South Eastern Highlands Bioregion and on the western fringe of the Sydney Basin Bioregion. Black Gum has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands, for example in the Blayney, Crookwell, Goulburn, Braidwood and Bungendore districts. Grows in the lowest parts of the landscape. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers.	Present. Found within Lot 112 DP DP 877190, Invincible Coal Mine's 2008 offset.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						Often grows with other cold-adapted eucalypts, such as Snow Gum or White Sallee (<i>Eucalyptus pauciflora</i>), Manna or Ribbon Gum (<i>E. viminalis</i>), Candlebark (<i>E. rubida</i>), Black Sallee (<i>E. stellulata</i>) and Swamp Gum (<i>E. ovata</i>). Black Gum usually occurs in an open woodland formation with a grassy groundlayer dominated either by River Tussock (<i>Poa labillardierei</i>) or Kangaroo Grass (<i>Themeda australis</i>), but with few shrubs.	
Myrtaceae	<i>Eucalyptus cannonii</i>	Capertee Stringybark	V	V	129	<i>Eucalyptus cannonii</i> is restricted to an area of about 100 by 60 km in the central tablelands of NSW. The western border is approximately marked by a line between Bathurst and Mudgee, while the eastern locations occur approximately on a line between Lithgow and the town of Bylong. Within this area the species is often locally frequent. The altitude range of <i>Eucalyptus cannonii</i> is from about 460 m to 1040 m. Within the range, the species appears to tolerate most situations except the valley floors. Has been recorded on the midslopes to floors of steep-sided gullies and on some east-facing slopes.	Present. Found to be locally abundant with <i>Eucalyptus macrorhyncha</i> (Red Stringybark) in study area. Detected during past surveys and current targeted searches.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Myrtaceae	<i>Eucalyptus pulverulenta</i>	Silver-leafed Gum	V	V	12	The Silver-leafed Gum is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro. . Silver-leaved Mountain Gum occurs on the crests or upper slopes of moderately steep hillsides or mountain, at altitudes of 800–1000 m, usually on well-drained skeletal soils with frequent rock outcrops. Occurs in the understorey on shallow soils in communities with Brittle Gum (<i>Eucalyptus mannifera</i>), Red Stringybark (<i>E. macrorhyncha</i>), Broad-leaved Peppermint (<i>E. dives</i>), Silvertop Ash (<i>E. sieberi</i>) and Apple Box (<i>E. bridgesiana</i>)	Moderate. Known distribution within Lithgow LGA, occupies habitat further south and south-east of study area. Closest record is approximately 6 km away, though dated in 1958. Suitable habitat occurs within upper slopes where aforementioned species occur. Not detected during past or current surveys.
Myrtaceae	<i>Homoranthus darwinioides</i>		V	V	1	Rare in the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district. It is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo SF. The species has been collected from Lee's Pinch, but not relocated at its original locality north of Mt Coricudgy above the headwaters of Widden Brook. Goonoo SF is established as a definite locality. Grows in various woodland habitats with shrubby	Low. Ostensible suitable habitat occurs within flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes of study area. Only known record is located more than 40km north of the Modifications in Wollemi National Park. Not detected during past or current surveys

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand.	
Myrtaceae	<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V		1	Found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Occurs in damp places, near streams or low-lying areas on alluvial soils of low slopes of sheltered aspects.	Low. No suitable habitat in the form of damp stream habitats. Not detected during past or current surveys.
Myrtaceae	<i>Triplarina imbricata</i>	Creek Triplarina	E	E	1	Found only in a few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW. Along watercourses in low open forest with Water Gum (<i>Tristania laurina</i>).	Low. No suitable habitat of associated tree species found within study area. Not detected during past or current surveys.
Orchidaceae	<i>Caladenia tessellata</i>	Thick-lipped Spider Orchid	E	V	0	The Tessellated Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population	Low. study area is west of known distribution. Not recorded during current or previous surveys of the study area. Not known in the LGA.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Orchidaceae	<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	V	V	0	near Braidwood is in low woodland with stony soil. In NSW the species is found along the coast in the southern rivers, northern rivers, hawkesbury/nepean and hunter/central rivers. Found in heathlands, heathy woodlands, sedgeland, forests, and Spear Grass-tree plains.	Low. Species confined to coastal regions not west of dividing range. Not known in the Lithgow LGA. Not detected during past or current surveys.
Orchidaceae	<i>Genoplesium superbum</i>		E		2	The Superb Midge Orchid is restricted to the Southern Tablelands of NSW where it has been recorded from 2 locations near Nerriga, c. 20 km apart. Some plants occur in Morton National Park. Occurs in wet heathland on shallow soils above sandstone capping but also occurs in open woodland interspersed with heath.	Low. Only known record occurs within Newnes State Forest in the Lithgow LGA. No suitable habitat recorded within the study area. Not detected during past or current surveys.
Orchidaceae	<i>Microtis angusii</i>	Midge Orchid	E	E	0	Currently known from only one site at Ingleside, north of Sydney. Natural habitat is unknown as both confirmed locations are highly disturbed	Low. Only known from one population in the Warringah/Pittwater area in Sydney. A collection from Sunny Corner State Forest close to the study area has been confirmed to be genetically distinct. Not known within the Lithgow LGA. Not detected during past or current surveys.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Orchidaceae	<i>Prasophyllum sp. Wybong</i>	a leek Orchid		CE	0	The species' area of occupancy is estimated to be 1.5 km ² . It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. Occurs in open eucalypt woodland and grassland.	Low. Not known within the Lithgow LGA. Known distribution is very restricted. study area is beyond southern limit of known distribution. Suitable habitat occurs in the study area. Not detected during past or current surveys.
Poaceae	<i>Digitaria porrecta</i>	Finger Panic Grass	E	E	1	In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran. It largely occurs on private land. Native grassland, woodlands or open forest with a grassy understorey, on richer soils. In NSW, the most frequently recorded associated tree species are Eucalyptus albens and Acacia pendula. Common associated grasses and forbs in NSW sites include Austrostipa aristiglumis, Enteropogon acicularis, Cyperus bifax, Hibiscus trionum and Neptunia gracilis.	Low. One record found more than 30 km north of the Modifications. Suitable habitat occurs within areas of grassy woodlands and forests. Aforementioned species were not recorded in the study area. Not detected during past or current surveys.
Proteaceae	<i>Grevillea evansiana</i>	Evans Grevillea	V	V	17	Restricted to a small area east of Rylstone on the Central Tablelands. Known populations occur on the western side of Wollemi National Park and	Moderate. Distribution within NSW is largely within Wollemi National Park around Muswellbrook and Singleton.

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
Proteaceae	<i>Grevillea obtusiflora</i>		E	E	43	nearby private lands, within the Rylstone Local Government Area.	Known within Gardens of Stone National Park. Suitable habitat occurs as dry sclerophyll forest in study area. Not detected during past or current surveys.
						Occurs in dry sclerophyll forest and occasionally swampy heath in sandy soils over Hawkesbury Sandstone.	
						Subspecies obtusiflora occurs near Rylstone, while subspecies fecunda occurs in the Capertee Valley, north-west of Lithgow, and in the Gardens of Stone National Park.	Moderate. Numerous records found within Gardens of Stone National Park, north of the study area.
Proteaceae	<i>Isopogon fletcheri</i>		V	V	0	Subspecies obtusiflora occurs as scattered groups in the understorey of low open eucalypt forest at an altitude of 730 metres above sea level.	Majority of study area sits above 800 m above sea level. Suitable habitat occurs in eucalypt forest in the study area. Not detected during past or current surveys.
						Subspecies fecunda occurs in clusters within low, open scrub beneath open, dry sclerophyll forest, on orange, sandy loam soils with sandstone boulders, at an altitude of 570 metres.	
						Restricted to a very small area in the Blackheath district of the Blue Mountains on the Central Tablelands.	Low. Confined to Blackheath. No waterfall recorded in study area. Not known in the Lithgow LGA. Not detected during past or current surveys.
						Restricted to moist sheltered cliffs within the spray zone of a waterfall. Grows in dry	

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						sclerophyll forest and heath on sandstone and is confined to sheltered moist positions	
Proteaceae	<i>Persoonia acerosa</i>	Needle Geebung	V		2	The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area. Occurs in dry sclerophyll forest, scrubby low woodland and heath on low fertility soils.	Low. Not well distributed in the Lithgow LGA, more common south east of Lithgow LGA. Closet records occurs in Newnes State Forest approximately 25 km south-east of the study area. Suitable habitat occurs in the study area. Not detected during past or current surveys.
Proteaceae	<i>Persoonia hindii</i>		E		73	Restricted to the Newnes Plateau in the Blue Mountains, north of Lithgow. Was only discovered in 1989 and all known locations occur within Newnes State Forest. Occurs in dry sclerophyll forests and woodland on sandy soils.	Low. Only known from the Newnes Plateau. Suitable habitat occurs in the study area. Not detected during past or current surveys.
Proteaceae	<i>Persoonia marginata</i>	Clandulla Geebung	V	V	29	Known from only four disjunct locations on the Central Tablelands and Central Coast. Core of the species distribution is within Clandulla State Forest, to the east of pit 106 and within west of Kandons. Disjunct populations occur; to the	High. Recorded in three locations north of Cullen Valley Mine pit 106, to the east of pit 106 and within Cullen Valley Mine Habitat

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						north at Dingo Creek and Mount Dangar within the Wollemi and Goulburn River National Parks; to the south within Ben Bullen State Forest, south-east of Capertee; and to the south-east at Devils Hole, north of Colo Heights within Parr State Recreation Area.	Compensation Area 5. Could potentially occur in other areas of the study area; however has not been recorded elsewhere during past or current surveys.
						P. marginata is found in dry woodland communities associated with Shoalhaven Group sediments. Soils are shallow hardsetting sandy loams, generally with gravel or rocks, and the topography is flat.	
Proteaceae	<i>Persoonia nutans</i>	Nodding Geebung	E	E	1	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south, though this record contradicts this. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	Low. One record located in Jenolan State Forest, more than 30 km south. Within study area valleys contain alluvium sediments. No aeolian sediments were recorded in the study area. No detected during past or current surveys.
Rhamnaceae	<i>Pomaderris brunnea</i>	Brown Pomaderris	V	V	2	Brown Pomaderris is found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area.	Low. Not well distributed within Lithgow LGA. Closest record occurs within Wollemi National Park, more

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						Occurs in open forest in moist woodland or forest on clay or alluvial soils on floodplains or in creek lines.	than 35 kms away. No suitable habitat recorded within the study area. Not detected during past or current surveys.
Rubiaceae	<i>Galium asutrale</i>	Tangled Bedstraw	E		2	Once regarded as presumed extinct in NSW, this species is now known from the Towamba Valley near Bega, Lake Yarrunga near Kangaroo Valley, Cullendulla Creek Nature Reserve near Batemans Bay, Conjola National Park, Swan Lake near Swanhaven, and the Big Hole in Deua National Park. It was recorded historically from the Clyde River near Batemans Bay and the Mongarlowe area near Braidwood.	Low. Not well known in the LGA. Closest records are located approx. 10 km east in Newnes State Forest. Suitable habitat occurs in moist gullies of tall forest i.e. Tableland Gully Ribbon Gum – Blackwood – Apple Box Forest in study area. Not detected during past or current surveys.
						In NSW Tangled Bedstraw has been found in moist gullies of tall forest, Eucalyptus tereticornis forest, coastal Banksia shrubland, and Allocasuarina nana heathland	
Rutaceae	<i>Asterolasia buxifolia</i>		E		3	Occurs on a granitic outcrop near Lett River. Apparently restricted to dense riparian scrub along rocky watercourses with a granitic substrate. Known from a single site at a granite outcrop in the riparian zone of the Lett River	Low. Not well distributed within Lithgow LGA. Known records occur near Hartley, approximately 20km south east. No suitable habitat recorded within the study area. Not

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
							detected during past or current surveys.
Rutaceae	<i>Asterolasia elegans</i>		E	E	0	<i>Asterolasia elegans</i> is endemic to and has a disjunct distribution within the hills north of Central Coast botanical subdivision of NSW. The species' current known distribution equates to a linear range of less than 37km and an extent of occurrence of approximately 22 km². Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>), Smooth-barked Apple (<i>Angophora costata</i>), Sydney Peppermint (<i>Eucalyptus piperita</i>), Forest Oak (<i>Allocasuarina torulosa</i>) and Christmas Bush (<i>Ceratopetalum gummiferum</i>).	Low. Known distribution of species is beyond study area. Not known in the Lithgow LGA. Not detected during past or current surveys.
Rutaceae	<i>Boronia deanei</i>	Deane's Boronia	V	V	24	There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River	Low. Closest records scatter Newnes State Forest. No suitable habitat recorded within the study

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves.	area. Not detected during past or current surveys.
						Occurs in wet weather, often along forest margins adjoining swamps or along streams.	
Rutaceae	<i>Leionema sympetalum</i>	Rylstone Bell V			32	Restricted to a small area within Wollemi National Park, east of Rylstone on the Central Tablelands. Has only ever been recorded at four sites. All known sites are in the Rylstone Local Government Area.	Low. Only known at four sites approximately 30 km north-east within Wollemi National Park in the Rylstone LGA. Suitable habitat occurs within pagoda habitats in the study area. Not detected during past or current surveys. .
						Restricted to pagoda formations in dry sclerophyll forest or heath communities.	
Rutaceae	<i>Phebalium bifidum</i>	E			17	Phebalium bifidum is restricted to the Capertee Valley, south east of Kandos in the South Eastern Highlands bioregion in NSW. The species is extremely rare, in being known from only four disjunct sites from within the Valley.	Low. Species has a known restricted distribution. Known only from two populations in the Capertee Valley. Suitable habitat occurs in study area. Not detected during past or current surveys.
						Occurs in dry sclerophyll woodland or heath on structured loamy soils.	
Rutaceae	<i>Philothea ericifolia</i>		V		0	Known only from the upper Hunter Valley and Pilliga to Peak Hill districts of NSW. The records are scattered over a range of over 400 km between	Low. Not known within the Lithgow LGA. Not suitable habitat recorded within the study area. Not detected

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						West Wyalong and the Pilliga Scrub. Site localities include Pilliga East State Forest, Goonoo State Forest, Hervey Range, Wingen Maid Nature Reserve, Toongi, Denman, Rylestone district and Kandos Weir. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Specific microclimates include damp sandy flats, alluvial deposits of coarse gravel in dry creek beds and along a spur receiving soakage from high ground.	during past or current surveys.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax, Toadflax	V	V	0	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Occurs in grassy woodland or grassland in association with <i>Themeda australis</i>, on which it parasitises.	Low. Not known within the Lithgow LGA. Suitable habitat occurs in study area associated within grassy woodlands. study area occurs beyond known distribution. Not detected during past or current surveys.
Scrophulariaceae	<i>Derwentia blakelyi</i>		V		50	Restricted to the western Blue Mountains, near	Moderate-high. In the Lithgow LGA

Table D.1 Likelihood of Occurrence in the Study Area of Threatened Flora Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Count in LGA	Distribution and Habitat Requirements	Likelihood of Occurrence
						Clarence, near Mt Horrible, on Nullo Mountain and in the Coricudgy Range. Occurs in eucalypt forest, often in moist areas.	known distribution largely occupies Newnes State Forest, though outliers occur within areas of Ben Bullen State Forest, less than 5 km away. Suitable habitat occurs in the study area. Not detected during past or current surveys.
Scrophulariaceae	<i>Euphrasia arguta</i>			CE	0	Recorded from Bathurst to Walcha area Grows in grassy areas near rivers,	Low. Species listed as Critically Endangered under EPBC. No suitable habitat occurs in study area. Not known within the Lithgow LGA. Not detected during past or current surveys.

Appendix E

Threatened Fauna Likelihood of Occurrence

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Insecta							
Lycaenidae	<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	E1	V	88	Occurs above 850 m elevation, at sites with a south-west to north-west aspect, usually where direct sunlight reaches the habitat, and with extremes of cold such as regular winter snowfalls or heavy frosts. Geology, soils and dominant vegetation canopy species vary between habitat locations. However vegetation structure is consistent, commonly open woodland or open forest with a sparse understorey that is dominated by the shrub, Blackthorn <i>Bursaria spinosa subsp. lasiophylla</i> . Its lifecycle relies on a mutualistic relationship with the ant, <i>Anonychomyra itinerans</i> , and on the presence of <i>B. spinosa subsp. lasiophylla</i> which is used as the larval food plant. Adult males fly rapidly at about one metre from the ground and rest with wings parted in places exposed to full sun. Females fly less rapidly and tend to remain nearer to the host plant. The butterflies generally remain in the vicinity of <i>B. spinosa subsp. lasiophylla</i> , and are rarely observed more than 10 m distant from the plant.	Low-medium. Nearby OEH records at Blackmans Flat on what looks to be south-west and south-east facing slopes, Within the study area there are some areas of suitable habitat in the form of open woodland or open forest above 900m, though a shrub layer dominated by <i>Bursaria spinosa subsp. lasiophylla</i> was not recorded. Not detected during past or current surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Petaluridae	<i>Petalura gigantea</i>	Giant Dragonfly	E1		25	Live in permanent swamps and bogs with some free water and open vegetation. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. Females lay eggs into moss or other soft vegetation bordering swamps. Larvae dig long branching burrows under the swamp. Larvae leave their burrows at night and feed on insects and other invertebrates on the surface and also use underwater entrances to hunt for food in the aquatic vegetation.	Low. Not recorded within the study area during current or previous surveys. No nearby OEH records. No suitable habitat within the study area.
Amphibia							
Hylidae	<i>Litoria booroolongensis</i>	Booroolong Frog	E1	E	15	Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks near flowing water during summer. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.	Low. Not recorded within the study area during current or previous surveys. Nearest OEH records in Turon National Park, approximately 6km northwest of the study area. No suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Litoria littlejohni</i>	Littlejohn's Tree Frog		V	0	This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground.	Low. Not associated with any habitat type but is infrequently recorded in general and no records within the vicinity of the Modifications. .
Myobatrachidae	<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V	4	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.	Low. Not recorded within the Modifications study area during current or previous surveys. The study area is well to the west of the known distribution. No suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Mixophyes balbus</i>	Stuttering Frog	E1	V	2	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Breed in streams during summer after heavy rain. Eggs are laid on rock shelves or shallow riffles in small, flowing streams. As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose.	<u>Low</u> . Not recorded within the study area during current or previous surveys. The study area is to the west of the known distribution. No suitable habitat within the study area.
	<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E	0	Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer	Low. Not recorded within the study area during current or previous surveys. Not known in the LGA. No suitable habitat.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Pseudophryne australis</i>	Red-crowned Toadlet	V		14	Occurs in open forests, mostly on Hawkesbury or Narabeen 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 found under rocks and logs on sandstone ridges and forage amongst leaf-litter.	Low. Not recorded within the study area during current or previous surveys. The study area is well to the west of the known distribution. No suitable habitat within the study area.
Fish							
Ambassidae	<i>Ambassis agassizii</i>	Olive Perchlet / Agassiz's glassperch		E	0	Inhabits rivers, creeks, ponds and swamps in both eastern (coastal) and western (Murray-Darling) drainage lines. This species is usually found in slow flowing or still water, often in proximity to overhanging vegetation, snags and boulders during the day. At night they disperse to feed on microcrustaceans and insects (NSW Department of Primary Industries 2009).	Low. There is no preferred habitat available for this species in the study area. Not known in the LGA.
Eleotridae	<i>Mogurnda</i>	Purple Spotted		E	0	A Murray-Darling fish, now reduced to a patchy distribution	Low. There is no habitat

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>adpersa</i>	Gudgeon				in Northern New South Wales and Southern Queensland. Slow flowing waters among weed where suitable hard objects are available for spawning. Primarily a bottom dweller, rarely swims continuously. Longer distances accomplished by a series of jerky darts. Migrate from deeper water and spend winter in sheltered situations. An ambush predator, lying motionless on bottom until suitable prey approaches.	available for this species in the study area. Not known in the LGA.
Percichthyidae	<i>Maccullochella peelii peelii</i>	Murray Cod	-	V	0	The Murray Cod occurs in lower reaches of the Murray-Darling Basin, where the water temperature is warm. The diverse range of habitats frequented by the Murray Cod includes slow moving rivers, murky billabongs and clear, rocky rivers (Department of the Environment and Water Resources, 2007).	Low. There is no habitat available for this species in the study area. Not known in the LGA.
Reptillia							
Elapidae	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E1	V	8	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	Moderate-high. Not recorded during the current or previous surveys within the study area. Nearby recent record (2010) just south-east of study area. Suitable forage, shelter and habitat occur

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Scincidae	<i>Eulamprus leuraensis</i>	Blue Mountains Water Skink	E1	E	19	Occurs at high elevation: the lowest altitude recorded for this species is 560 m at Williams Ridge, south of Hazelbrook, NSW. Restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps that have boggy soils and appear to be permanently wet. The vegetation in these swamps typically takes the form of a sedgeland interspersed with shrubs, but may occur as a dense shrub thicket. The lizard is semi-aquatic and is active on warm, sunny days from September until late April. When disturbed, the lizards flee to shelter in dense grass tussocks or down holes.	within the sandstone escarpments of the study area. Low. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. No suitable habitat within the study area.
Varanidae	<i>Varanus rosenbergi</i>	Rosenberg's Goanna	V		5	Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Individuals require large areas of habitat. Shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens.	Low. Not recorded during the current or previous surveys within the study area. Few OEH records in wider locality (Turon and Wollemi National Parks). Suitable forage, shelter and breeding habitat occurs within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Aves							
Acanthizidae	<i>Chthonicola sagittata</i>	Speckled Warbler	V		56	Lives in a wide range of <i>Eucalyptus</i> 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.	High. Recorded nearby study area during current survey. Suitable habitat occurs within the grassy woodlands of the survey area.
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle			26	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used	Moderate. Not recorded during current or previous surveys. Suitable habitat occurs within the grassy woodlands of the survey area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Lophoictinia isura</i>	Square-tailed Kite	V		6	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. 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 ² .	High. Recorded foraging nearby the study area during the current surveys.
Anatidae	<i>Oxyura australis</i>	Blue-billed Duck	V		3	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.	Low. Not recorded within the study area during current or previous surveys. No suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift		M	0	The Fork-tailed Swift is almost exclusively aerial. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. They sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines	Low. May fly over in search of forage. Not known in the Lithgow LGA. Not detected during past or current surveys.
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail		M	18	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007).	Moderate-high. Suitable habitat within the study area. Known within Lithgow LGA. Records scatter the site. Not recorded within the study area during current or previous surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Ardeidae	<i>Ardea alba</i>	Great Egret		M	0	Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets. (Australian Museum 2003).	Low. Not recorded within the study area during current or previous surveys. No suitable habitat within the study area.
Ardeidae	<i>Ardea ibis</i>	Cattle Egret		M	0	Subspecies A. i. coromanda is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	Low. Not recorded within the study area during current or previous surveys. No suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Ardeidae	<i>Botaurus poiciloptilus</i>	Australian Bitten		E	0	In NSW, it occurs along the coast and is frequently recorded in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers The Australasian Bittern occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands	Low. The Modifications are located inland west of the dividing range. No suitable habitat recorded in the study area. no record in the LGA. Not detected during past or current surveys.
	<i>Ixobrychus flavicollis</i>	Black Bitten	V		1	In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. 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.	Low. The Modifications are located inland west of the dividing range. No suitable habitat recorded in the study area. One record in the LGA. Not detected during past or current surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Cacatuidae	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V		229	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.	High. Recorded nearby study area during current and previous surveys. Suitable forage and breeding habitat within the study area.
Cacatuidae	<i>Calyptorhynchus lathami</i>	Glossy Black Cockatoo	V		88	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (<i>Allocasuarina littoralis</i>), Forest She-oak (<i>A. torulosa</i>) or Drooping She-oak (<i>A. verticillata</i>) occur. Feeds almost exclusively on the seeds of several species of she-oak (<i>Casuarina</i> and <i>Allocasuarina</i> species). Dependent on large hollow-bearing eucalypts for nest sites.	Moderate. Suitable forage and breeding habitat within the study area. Though not feed trees where not recorded in abundance or frequently. Not recorded within the study area during current or previous surveys. Nearby OEH records.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Climacteridae	<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V		67	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.	High. Recorded nearby study area during current survey. Suitable habitat occurs within the grassy woodlands of the survey area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Dicruridae	<i>Monarcha melanopsis</i>	Black-faced Monarch		M	33	The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Moderate-low. Records within Lithgow LGA are confined to Wollemi National Park. Similar habitat available between Ben Bullen State Forest and Wollemi National Park. Not detected during past or current surveys.
Dicruridae	<i>Myiagra cyanoleuca</i>	Satin Flycatcher		M	7	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 2007).	High. Recorded nearby study area during current surveys and previous surveys (wildsearch 1996; AES 2003).
Dicruridae	<i>Rhipidura rufifrons</i>	Rufous Fantail		M	51	Is found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas. Strongly migratory in the south of its range, it moves northwards in winter, and	Low. Within Lithgow LGA, records are mainly located in Wollemi National Park and Newnes State Forest. One recent record (dated 2009)

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
						virtually disappears from Victoria and New South Wales at this time.	located in Ben Bullen State Forest less than 10km away. No suitable habitat in the form of wet forest or rainforest, though species may forage over site. Not detected during past or current surveys.
Estrildidae	<i>Stagonopleura guttata</i>	Diamond Firetail	V		99	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.	High. Not recorded during current or previous surveys. Nearby recent records (dated 2009) at Baal Bone Colliery. Suitable habitat occurs within the grassy woodlands of the survey area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Megapodiidae	<i>Leipoa ocellata</i>	Mallee Fowl		V	0	In New South Wales, it typically occurs west of the Great Dividing Range. Its distribution extends from Pilliga south-west to the districts of Griffith and Wentworth, although the species is absent from the southern parts of the Riverina region The Malleefowl occurs in semi-arid and arid zones of temperate Australia, where it occupies shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine <i>Callitris</i> woodlands, acacia shrublands, Broombush <i>Melaleuca uncinata</i> vegetation or coastal heathlands	Low. No suitable habitat in the form of mallee. Site supports eucalypt vegetation within some pine. Not record in the LGA. Not detected during past or current surveys.
Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater	E1	E	596	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. 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 Mugga Ironbark, Yellow Box,	High. Not recorded within the study area during current or previous surveys. Nearby OEH record (dated 2004) approx. 1 km north of the study area. Suitable habitat within Box Gum Woodland of the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
						Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises : Grey Box <i>Eucalyptus microcarpa</i> , Grey Gum (<i>Eucalyptus punctata</i>), Red Box (<i>Eucalyptus polyanthemos</i>), Grey Box (<i>Eucalyptus mollucana</i>), Swamp Messmate (<i>Corymbia robusta</i>), Narrow-leaved Stringybark (<i>Eucalyptus crebra</i>), Caley's Ironbark (<i>Eucalyptus caleyi</i>), Spotted Gum (<i>Corymbia maculate</i>), McKie's Stringybark (<i>Eucalyptus mckieana</i>), Red Stringybark (<i>Eucalyptus macrorhyncha</i>), Silvertop Stringybark (<i>Eucalyptus laevopinea</i>) and Rough-barked Apple (<i>Angophora floribunda</i>). Nectar and fruit from the mistletoes <i>Amyema miquelii</i> , <i>Amyema pendula</i> and <i>Amyema cambagei</i> are also eaten during the breeding season.	
Meliphagidae	<i>Epthianura albifrons</i>	White-fronted Chat	V		1	In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles	Low. No suitable habitat recorded in the study area. One record in the LGA. Not detected during past or current surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
						caught from or close to the ground.	
	<i>Grantiella picta</i>	Painted Honeyeater	V		3	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.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Meliphagidae	<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V		65	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	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records from within several kilometres of the study area. Suitable habitat within the study area, which may form a component of a much larger home-range.
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater		M	39	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings.	Moderate-low. Ostensible suitable habitat, although lack of water reducing suitability. Suitable foraging habitat. Majority of records are restricted to Valleys. Recent record approx. 12 km away at Wolgan Valley. Not recorded during current or previous surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V		69	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.	High. Not recorded within the study area during current survey. Recorded nearby during 2003 surveys (AES (2003). Nearby OEH records from within several kilometres of the study area. Suitable habitat within the study area, which may form a component of a much larger home-range.
Petroicidae	<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V		8	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 10 ha during the breeding season, to 30 ha in the non-breeding season.	Moderate. Not recorded during current or previous surveys. Suitable habitat occurs within the grassy woodlands of the survey area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Petroica boodang</i>	Scarlet Robin	V		175	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding	High. Recorded nearby study area during current surveys and during previous surveys by Wildsearch (1996) and AES (2003). Suitable habitat occurs within the grassy woodlands of the survey area.
	<i>Petroica phoenicea</i>	Flame Robin			57	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgeland at high altitudes.	High. Not recorded during current or previous surveys. Suitable habitat occurs within the grassy woodlands of the survey area..

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Pomatostomidae	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V		14	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.	Low. Not recorded during current or previous surveys. Suitable habitat occurs within the grassy woodlands of the survey area.
Psittacidae	<i>Glossopsitta pusilla</i>	Little Lorikeet	V		104	Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. 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 melaleucas and mistletoes. On the western slopes and tablelands White Box (<i>Eucalyptus albens</i>) and Yellow Box (<i>Eucalyptus melliodora</i>) are particularly important food sources for pollen and nectar. They are also reported as feeding on fruits, particularly those of mistletoes. Nest	High. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area in Gardens of Stone National Park. Suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
						hollows are located at heights of between 2m and 15m, mostly in living, smooth-barked eucalypts, especially Manna Gum (<i>Eucalyptus viminalis</i>), Blakely's Red Gum (<i>Eucalyptus blakelyi</i>) and Tumbledown Gum (<i>Eucalyptus dealbata</i>). Hollow openings are very small, approximately 3cm in diameter, and are kept open by the activities of the occupants, which use their beaks to bite away living bark from around the opening. Nest hollows are occasionally located in dead trees, but birds generally desert hollows within two years of tree death. 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.	

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Psittacidae	<i>Lathamus discolor</i>	Swift Parrot	E1	E	30	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.	High. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage habitat within the study area.
	<i>Neophema pulchella</i>	Turquoise Parrot	V		57	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.	Moderate. Not recorded during current or previous surveys. Suitable habitat occurs within the grassy woodlands of the survey area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Polytelis swainsonii</i>	Superb Parrot	V	V	0	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both forage and feed within box woodland, mostly nesting in dead trees (Garnett & Crowley 2000).	Low. Not recorded during current or previous surveys. Suitable habitats are available for this species. Not known in the LGA.
Rostratulidae	<i>Gallinago hardwickii</i>	Latham's Snipe		M	9	In NSW the Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation.	Low. There is no preferred habitat available for this species in the study area. Not recorded during current to previous surveys.
	<i>Rostratula australia</i>	Australian Painted Snipe	V		0	Scattered throughout NSW. The species inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains	Low. There is no preferred habitat available for this species in the study area. Not recorded during current to previous surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Rostratulidae	<i>Rostratula benghalensis</i>	Painted Snipe	E1	VM	0	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as <i>Eucalyptus camaldulensis</i> (River Red Gum), <i>E. populnea</i> (Poplar Box) or shrubs such as <i>Muehlenbeckia florulenta</i> (Lignum) or <i>Sarcocornia quinqueflora</i> (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, mollusks and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	Low. There is no preferred habitat available for this species in the study area. Not recorded during current to previous surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Strigidae	<i>Ninox connivens</i>	Barking Owl	V		31	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as <i>Acacia</i> and <i>Casuarina</i> species, or the dense clumps of canopy leaves in large <i>Eucalypts</i> . 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 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts including River Red Gum (<i>Eucalyptus camaldulensis</i>), White Box (<i>Eucalyptus albens</i>), Red Box (<i>Eucalyptus polyanthemos</i>) and Blakely's Red Gum (<i>Eucalyptus blakelyi</i>). Breeding occurs during late winter and early spring.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage, roosting and breeding habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Strigidae	<i>Ninox strenua</i>	Powerful Owl	V		67	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 comprising species such as Turpentine <i>Syncarpia glomulifera</i> , Black She-oak <i>Allocasuarina littoralis</i> , Blackwood <i>Acacia melanoxylon</i> , Rough-barked Apple <i>Angorophora floribunda</i> , Cherry Ballart <i>Exocarpus cupressiformis</i> and a number of eucalypt species. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. 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 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters.	High. Not recorded within the study area during current surveys. Recorded nearby the study area during previous surveys (Wildsearch 1996). Suitable forage, roosting and breeding habitat, particularly in the taller forest communities of the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Tytonidae	<i>Tyto novaehollandiae</i>	Masked Owl	V		6	Lives in dry eucalypt forests and woodlands from sea level to 1100 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 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage, roosting and breeding habitat within the study area.
Tytonidae	<i>Tyto tenebricosa</i>	Sooty Owl	V		10	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.	Low. Not recorded within the study area during current or previous surveys. No suitable habitat or nearby OEH records.

Mammalia

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Burramyidae	<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V		7	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, except in north-eastern NSW where they are most frequently encountered in rainforest. 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); nest-building appears to be restricted to breeding females; 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 0.68 hectares and females about 0.35 hectares. Frequently spends time in torpor especially in winter.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Dasyuridae	<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V	E (southeastern mainland population)	29	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 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creeklines.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage, den and breeding habitat within the study area.
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V		2	Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats, with and without trees.	Moderate. Not recorded within the study area during current or previous surveys. No nearby OEH records. Suitable forage, roosting and breeding habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1	V	15	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 15 ha.	Moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable habitat on the sandstone escarpment within the study area.
Molossidae	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V		10	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.	High. Not recorded within the study area during current or previous surveys. OEH record in study area. Suitable forage, roosting and breeding habitat within the study area.
Muridae	<i>Pseudomys novaehollandiae</i>	New Holland Mouse		V	2	The New Holland Mouse has been found from coastal areas and up to 100 km inland on sandstone country. Prefers deeper top soils and softer substrates for digging. In open heathland, open woodland with a heathland understorey and vegetated sand dunes.	Low. Known records are located east of study area within Wollemi National Park and Newnes State Forest. Ostensible suitable habitat. Not detected during past or

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
							current surveys. Not well known in the LGA.
Peramelidae	<i>Isoodon obesulus obesulus</i>	Southern Bandicoot		E	0	Within NSW, the Southern Brown Bandicoot (eastern) is apparently rare and almost exclusively restricted to the coastal fringe of the state, from the southern side of the Hawkesbury River in the north to the Victorian border in the south.	Low. study area is located west of the dividing range beyond known distribution of species. Not know in the Lithgow LGA. Not detected during past of current surveys.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Petauridae	<i>Petaurus australis</i>	Yellow-bellied Glider	V		64	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 between 20 to 85 ha to encompass dispersed and seasonally variable food resources.	High. Not recorded within the study area during current or previous surveys. Nearby OEH records from Newnes State Forest and Wollemi National Park. Suitable forage, roosting and breeding habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
Petauridae	<i>Petaurus norfolcensis</i>	Squirrel Glider	V		14	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.	High. Recorded within the East Tyldesley area outside the study area during current surveys. Not recorded during previous surveys. Nearby OEH records within several kilometres of the study area. Suitable habitat throughout the study area.
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V		25	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 two ha to several hundred hectares in size.	Low-moderate. Not recorded within the study area during current or previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage trees within the study area including <i>Eucalyptus punctata</i> and <i>Eucalyptus viminalis</i> .
Potoroidae	<i>Potorous tridactylus</i>	Long-nosed Potoroo		V	0	There is no consistent pattern to the habitat of the Long-nosed Potoroo (SE Mainland); it can be found in wet eucalypt forests to coastal heaths and scrubs. The main	Low. Not known in the Lithgow LGA. Not detected during past or current

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
						factors would appear to be access to some form of dense vegetation for shelter and the presence of an abundant supply of fungi for food.	surveys.
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	62	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.	High. Potential Anabat record nearby the study area during current surveys. Not recorded during previous surveys. Nearby recent OEH record (dated 2009) within several kilometres of the study area. Suitable forage, roosting and breeding habitat within the study area.
	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V		49	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.	High. Not recorded within the study area during current surveys. Probable record during previous surveys (Wildsearch 1996). OEH record within study area dated 2003. Suitable forage, roosting and breeding habitat

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
							within the study area.
	<i>Miniopterus australis</i>	Little Bent-wing Bat	V		1	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.	Low-moderate. Not recorded within the study area during current or previous surveys. Record is approximately 15km north within Gardens of Stone National Park. Suitable forage, roosting and breeding habitat within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V		34	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 centred 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 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia.	High. Recorded nearby the study area during current surveys. Not recorded during previous surveys. Nearby OEH records within several kilometres of the study area. Suitable forage, roosting and breeding habitat within the study area.
	<i>Myotis macropus</i>	Large-footed Myotis	V		6	Most habitats near water, including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland. 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.	Low. Potential anabat record within the study area during previous surveys (AES 2003). Despite this no nearby OEH records. All known records with LGA are located near water courses. No significant forage habitat near water for this species within the study area.

Table E.1 Likelihood Of Occurrence in the Study Area of Threatened Fauna Species Recorded in the Lithgow LGA

Family	Scientific Name	Common Name	TSC Status	EPBC Status	Lithgow LGA Count	Habitat requirements	Likelihood of occurrence
	<i>Nyctophilus timoriensis</i>	South-eastern Long-eared Bat		V	0	The South-eastern Long-eared Bat occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. The South-eastern Long-eared Bat is known to roost in deadwood or hollow trunks/branches	Low. Not recorded during current or previous surveys. Suitable habitat. Not known in the LGA.
	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		10	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 - 6 m. Although this species usually roosts in tree hollows, it has also been found in buildings. Females congregate at maternity sites located in suitable trees.	High. Potential anabat record nearby study area during current surveys. Not recorded during previous surveys. Recent OEH record (dated 2003) within study area. Suitable forage, roosting and breeding habitat within the study area.

Appendix F

Assessments of Significance

F.1 Assessment of Significance (TSC Act)

The following terms have been used within the Assessments:

Local population: the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.

The *local population* of a threatened *plant* species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.

The *local population* of *resident fauna* species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.

The *local population* of *migratory or nomadic fauna* species comprises those individuals that are likely to occur in the study area from time to time.

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F.1.1 Threatened Flora

i. *Eucalyptus cannonii* (Capertee Stringybark)

The Capertee Stringybark (*Eucalyptus cannonii*) is listed as Vulnerable under the TSC Act. There are 129 records of the species within Lithgow LGA (OEH, 2013). This species has been recorded during previous and current field surveys and occurs sporadically over much of the study area.

The Capertee Stringybark is a narrow range endemic tree species restricted to an area of approximately 100 km by 60 km in the central tablelands of NSW, where it is known from 55 locations. The western border aligns generally with between Bathurst and Mudgee, while the eastern locations occur approximately between Lithgow and the town of Bylong. Within this area the species is often locally frequent (DEC (NSW), 2005a). Seed viability appears to be high and seed is spread by wind or gravity, generally in close proximity to the parent plant (<30m). The altitude range of *Eucalyptus cannonii* is from approximately 460 m to 1040 m (DEC (NSW), 2005a). The species mostly occurs on rocky, usually poor, steep ridges in dry sclerophyll forest, although it can also be found in valleys and on gentle slopes (Threatened Species Scientific Committee, 2008a), but less commonly on valley floors (DEC (NSW), 2005a).

Associated tree species include Red Stringybark (*E. macrorhyncha*), Thin-leaved Stringybark (*E. eugenoides*), Red Box (*E. polyanthemos*) and Scribbly Gum (*E. rossii*). On the intermediate slopes there may also be Narrow-leaved Red Ironbark (*E. crebra*), *E. blakelyi*, *E. melliodora*, *E. bridgesiana*, *E. dalrympleana* and *E. viminalis*, whilst on the on lower slopes it may occur with *E. mannifera* subsp. *praecox*, *E. laevopinea*, *E. oblonga*, *E. sparsifolia*, *E. dives* and *E. goniocalyx*. On rocky areas *Angophora intermedia* has been recorded co-existing. *E. cannonii* is also known to hybridise with *E. macrorhyncha*. (Threatened Species Scientific Committee, 2008a).

E. cannonii was previously listed as Vulnerable under the EPBC Act; however it was de-listed in 2013. This is due to the assessment of new information which indicated that the species has not undergone substantial decline as it has a naturally restricted range. According to the EPBC Act listing advice for this species, it has no known threats and is well represented in conservation reserves (TSSC 2013).

(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 Modifications will remove a significant number of *E. cannonii* estimated to occur in the study area and suitable habitat for the species. However, the viability of the local population is not expected to be greatly reduced as a large number of individuals, ranging from seedlings to mature remnant trees, will remain within the study area and continue to reproduce. Seed viability and natural propagation of the species is high; seeds are spread by wind or gravity, generally in close proximity to the parent plant (<30m) (NPWS 2000).

Appropriately timed fire regime of suitable intensity is important to the maintenance of the life cycle of this species by encouraging natural regeneration. The Modifications are not expected to increase the likelihood of fire events; however it may decrease the likelihood of fire which may impact on regeneration capabilities such that in the short term, populations consist of mainly mature or senescent plants. However, natural regeneration at disturbed sites is still likely as it has been shown that the proportion of immature plants increases in disturbed areas. This corresponds to the species' seed viability and ability to re-establish from the soil or canopy seed bank.

The Modifications will reduce the current abundance and distribution of *E. cannonii* in the locality; however it will not place the local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of known and potential habitat occur within the study area.

No area of habitat will become isolated or fragmented because the Modification Disturbance Boundaries are located directly adjacent to existing mining, and will not separate currently contiguous areas of habitat. The habitat to be removed is not considered to be important to the long term survival of the species in the locality. It is estimated that over 14,500 individuals will remain in the study area based on the densities recorded during the field surveys, and large numbers (in excess of 20,000) individuals are known to be present within

conservation reserves, and will be protected for the long term. Large numbers are also likely to be present in the remaining parts of Ben Bullen State Forest.

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

No critical habitat for *E. cannonii* has been identified by the Director-General of OEH under the TSC Act.

(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. *E. cannonii* has been assigned to the Site-managed species management stream under the Saving our Species program, under the auspices of the NSW OEH.

(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 project will result in the operation of the key threatening process “clearing of native vegetation”. No other key threatening processes will be enacted or exacerbated by the proposed Modifications.

Conclusion

The Modifications are proposed to remove approximately 148 ha of known and potential habitat for *E. cannonii*. This includes areas known to contain individuals, and areas that provide suitable habitat in which the species has potential to occur.

This is a relatively small area of habitat compared to the far larger areas of potential habitat for this species that occur in the Modification Boundaries and the study area, and beyond in Ben Bullen State Forest. It is estimated that over 14,500 individuals will remain in the study area in areas of suitable habitat. This species is relatively well conserved and has been de-listed from the EPBC Act list of threatened species as a result of its relative abundance within its narrow distribution and the high degree of representation in conservation reserves.

A range of compensation and mitigation measures will be implemented for this species including targeted plantings of this species in offset properties. The proposed extensive plantings in offset sites will establish large additional numbers of this species in the locality. This species is known to propagate readily and has been shown to be successfully replanted in rehabilitation sites.

Considering the relatively small area of impact, the large numbers of individuals that will remain in the study area and the area of habitat that will remain in the study area and beyond, it is not considered that the Modifications will result in a significant impact to *E. cannonii*.

ii. *Persoonia marginata* (Clandulla Geebung)

Persoonia marginata (Clandulla Geebung) is listed as Vulnerable under both the TSC Act and EPBC Act. There are 29 records of the species within Lithgow LGA (OEH, 2011). This species was recorded adjacent to the study area.

Persoonia marginata is a decumbent shrub that grows to 20-60cm and has yellow flowers. It is known from disjunct populations on the central tablelands and central coast of NSW (DEWHA 2008 conservation advice, DECC, 2005). The species occurs within the Central West, Hawkesbury–Nepean and Hunter–Central Rivers (NSW) Natural Resource Management Regions (DECC, 2005). The core of its distribution is within Clandulla State Forest, with four disjunct populations occurring to the north at Dingo Creek and Mount Dangar within the Wollemi and Goulburn River National Parks; to the south within Ben Bullen State Forest, south-east of Capertee; and to the south-east at Devils Hole within the Parr State Recreation Area (DECC, 2005).

Persoonia marginata is known to inhabit dry sclerophyll forest and woodland on low ridges of sandstone and heavy clay or gravelly loams derived from Permian geologies at altitudes of approximately 700m. Commonly occurring co-dominant canopy species include *Eucalyptus punctata*, *E. sparsifolia*, *E. rossii*, *E. fibrosa* and *E. crebra*. The understorey is typically shrubby with a medium density, and the grassy understorey is of low to medium density (DEWHA, 2008).

The species appears to respond well to disturbance, with greater densities found along the edges of tracks and in areas disturbed by forestry activities (DECC, 2005).

(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

Prior to current surveys, *Persoonia marginata* was known from only four disjunct locations on the Central Tablelands and Central Coast (DEC (NSW), 2005). Two of these disjunct populations occur close to the study area, within the Wollemi National Park and within Ben Bullen State Forest (DEC (NSW), 2005c) and Gardens of Stone. Known populations have been recorded to date on flat ground within dry sclerophyll forest and woodland on sandy loam, clayey, and/or rocky soils derived from Permian rock (Threatened Species Scientific Committee, 2008b).

A new population was recorded at three locations adjacent to the study area and is estimated to comprise of approximately 21,088 individuals, as three subpopulations. The Modifications will not reduce the current abundance and distribution of *Persoonia marginata* and will not impact any habitat known to support this species. The Modifications will not place the local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

The Modifications will not impact any individuals, population or habitat of the species.

No area of habitat will be fragmented or isolated from other areas of habitat.

No known habitat for *Persoonia marginata* will be removed or impacted by the Modifications, and the vegetation to be removed is not considered to be important for this species.

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

No critical habitat for *Persoonia marginata* has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

DoE has identified a number of regional and local priority actions to promote the recovery of *Persoonia marginata* and the abatement of key threatening processes affecting its occurrence.

It has also identified existing plans and management prescriptions that are relevant to *Persoonia marginata*:

- Wollemi National Park Fire Management Strategy (DEC, 2005) and Management Plan (NSW NPWS, 2001a);
- Goulburn River National Park Fire Management Plan (DEC, 2004) and Management Plan (NSW NPWS, 2003a);

- Parr State Conservation Area Plan of Management (NSW NPWS, 2001b) and Fire Management Strategy (NSW NPWS, 2003b); and
- Threat Abatement Plan for Dieback Caused by the Root-Rot Fungus *Phytophthora cinnamomi* (EA, 2001).

(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 Key Threatened Process of “clearing native vegetation” will be brought into operation by the Modifications.

Conclusion

Approximately 21,088 individuals are predicted to occur within 47.8 ha of suitable habitat that occurs in Ben Bullen State Forest. The populations of the species, individuals and their habitat will not be impacted by the proposal, with the mine footprint designed specifically to avoid the species and its habitat.

The Modifications will not result in a significant impact to the local and overall occurrence, of *Persoonia marginata*.

F.1.2 Threatened Insects

i. Bathurst Copper Butterfly (*Paralucia spinifera*)

The Bathurst Copper Butterfly (*Paralucia spinifera*) is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. There are 88 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area. It is considered to have some potential to occur based on proximity of existing OEH records and due to the limited availability of suitable habitat in the form of *Bursaria spinosa* subsp. *lasiophylla*.

The Bathurst Copper Butterfly occurs on the Central Tablelands of NSW at elevations greater than 900m. The species is found at 35 locations within an area approximately bounded by Oberon, Hartley and Bathurst, although more locations are likely. Habitat requirements include vegetation structure of open eucalypt woodland or open forest with a sparse understorey dominated by the shrub Blackthorn (*Bursaria spinosa* subsp. *lasiophylla*) on which larvae depend for food and from which adults are rarely observed more than 10m away from the plant. Known habitat sites are south-west to north-west facing aspects where direct sunlight reaches the habitat, and with cold extremes, including regular snowfalls or heavy frosts. The species emerge between August and November with a two-week peak of activity in September. Eggs are laid on or in the immediate vicinity of Blackthorn and hatched larvae are attended by the ant *Anonychomyra itinerans* in a mutualistic relationship. Pupation occurs between December and August in the ants' underground nest at the base of the host plant.

According to NSW Atlas records, the closest records of the Bathurst Copper Butterfly to the study area are approximately 5km away at the Pinedale Mine. This record represents the northern limit of the species' known distribution within the Lithgow LGA.

(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 Modifications will not remove potential forage and breeding habitat suitable for the Bathurst Copper Butterfly as no suitable habitat was recorded in the study area. An individual of *Bursaria spinosa* subsp. *lasiophylla* was detected to the north of the Modification Boundaries. There is potential for additional specimens to be present, but as no others have been recorded they are not likely to be present in high numbers and are unlikely to provide extensive habitat for the Bathurst Copper Butterfly.

The Modifications are not considered likely to affect the life cycle of the 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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 suitable habitat was recorded in the study area. An individual of *Bursaria spinosa* subsp. *lasiophylla* was detected to the north of the Modification Boundaries. There is potential for additional specimens to be present, but as no others have been recorded they are not likely to be present in high numbers and are unlikely to provide extensive habitat for the Bathurst Copper Butterfly.

As the species is not considered likely to occur within the study area, the removal of patches of native vegetation that do not contain Blackthorn is not considered likely to fragment or isolate habitat for this species.

The habitat to be removed is not considered to be important habitat for this species as it lacks suitable habitat containing all of the elements required by the species and no records of individuals were made during field surveys.

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

No critical habitat for the Bathurst Copper Butterfly has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Recovery Plan for the Bathurst Copper Butterfly (*Paralucia spinifera*) 2001-2006 was prepared by the NSW National Parks and Wildlife Service and Environment Australia in June 2001.

OEH has identified 21 priority actions to promote the recovery of the Bathurst Copper Butterfly in New South Wales and the abatement of key threatening processes affecting its occurrence.

(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 Modifications will result in the operation of the Key Threatening Process; "clearing of native vegetation".

Conclusion

The Bathurst Copper Butterfly is not considered likely to occur within the study area due to a lack of sufficient habitat. Although an individual of *Bursaria spinosa* subsp. *lasiophylla* was detected to the north of the Modification Boundaries they are not likely to be present in high numbers and are unlikely to provide extensive habitat for the Bathurst Copper Butterfly. The removal of an individual plant of suitable habitat is not considered likely to constitute a significant impact to the Bathurst Copper Butterfly, when the species requires expansive areas of suitable habitat to form breeding colonies. As such, the Modifications are not considered likely to have a significant impact on the local occurrence of the Bathurst Copper Butterfly.

F.1.3 Threatened Woodland Birds

- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Diamond Firetail (*Stagonopleura guttata*);
- Flame Robin (*Petroica phoenicea*);

- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Glossy Black-Cockatoo (*Calyptorhynchus lathamii*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- Hooded Robin (*Melanodryas cucullata cucullata*);
- Scarlet Robin (*Petroica boodang*);
- Speckled Warbler (*Pyrrholaemus sagittatus*);
- Superb Parrot (*Polytelis swainsonii*);
- Turquoise Parrot (*Neophema pulchella*); and
- Varied Sittella (*Daphoenositta chrysoptera*).

i. *Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)*

The Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) is listed as Vulnerable under the TSC Act. There are 67 records of the species within Lithgow LGA (OEH, 2011). This species was recorded during current field surveys of the study area.

The Brown Treecreeper is an insectivorous woodland species endemic to eastern NSW. They are a sedentary species most commonly found in open woodlands and dry forest with an open grassy understorey for foraging, and in grasslands with scattered mature trees (Birds Australia, 2011; Garnett & Crowley, 2000). Suitable nesting and foraging habitat typically contains a high abundance of important habitat components such as fallen timber, hollows in stags and live trees (NSW Scientific Committee, 2004; Garnett & Crowley, 2000). The species is dependent on the availability of small tree hollows for nesting, and as such, prefers patches of remnant vegetation which contain trees of hollow-bearing age of at least 150 years old. Home ranges for this species typically range from 1.1 ha to 10.7 ha.

(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 Modifications will remove known and potential forage and breeding habitat for the Brown Treecreeper; however it is unlikely to place the local population at risk of extinction. Despite the area of woodland and open forest proposed to be removed, the species will be able to disperse to large extents of suitable habitat that will remain with the study area. These areas will continue to provide important forage, nesting and breeding habitat features for the species including structurally intact habitat and complexity.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes known and potential foraging, breeding and nesting habitat for local populations of the Brown Treecreeper.

No areas of habitat will become fragmented or isolated as the Modification Disturbance Boundaries are located directly adjacent existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important for this species. Large areas of habitat will remain in Ben Bullen State Forest that contain important habitat features for the Brown Treecreeper such as hollows and woody ground debris. Connectivity will remain within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Brown Treecreeper has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Brown Treecreeper. No threat abatement plans are relevant to this species. Seven recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Brown Treecreeper will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland habitat. This includes the removal of known and potential foraging, nesting and breeding habitat for locally occurring populations of the Brown Treecreeper. This is likely to result in the short-term displacement of some individuals; however it will not result in long-term, adverse impacts to the species. Extensive areas of good quality habitat will still be available elsewhere within the study area and in surrounding conservation areas. Accordingly, the Modifications are considered unlikely to have a significant impact on the the Brown Treecreeper.

ii. Diamond Firetail (Stagonopleura guttata)

The Diamond Firetail (*Stagonopleura guttata*) is listed as Vulnerable under the TSC Act. There are 99 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable grassy woodland habitat.

The Diamond Firetail is a woodland species endemic to south-eastern Australia with scattered distribution in NSW (NSW Scientific Committee, 2010f). This species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain of western Sydney and the Hunter, Clarence, Richmond and Snowy River valleys. They are a mainly sedentary, ground-foraging species most commonly found in or on the edge of lightly timbered open eucalypt forest and woodlands including box-ironbark and casuarina associations (NSW Scientific Committee, 2010f). They also occur in farmland and grassland with remnant trees and a sparse understorey, and along watercourses (Birds Australia, 2011). The species nests and roosts mainly in dense shrubs.

(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 Modifications will remove some potential foraging, nesting and breeding habitat for the Diamond Firetail. However, this species has not been recorded in the study area despite multiple field surveys and is considered unlikely to currently support a local population of

Diamond Firetails. Therefore, the Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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 will be removed, although approximately 148 ha of potential woodland and open forest habitat are proposed to be removed as part of the Modifications. This includes potential forage, breeding and nesting habitat for the Diamond Firetail. Due to a lack of observations despite multiple surveys, resident populations are not expected to occur within the study area.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The area of potential habitat to be removed is not considered to be important for the Diamond Firetail. Extensive areas of habitat suitable for this species will also remain available within both the study area and the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Diamond Firetail has been identified by the Director-General of OEHS under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Diamond Firetail. No threat abatement plans are relevant to this species. Eight recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Diamond Firetail will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Diamond Firetail.

This species has not been recorded during field surveys but has potential to occur within the study area and elsewhere in the locality based on the availability of suitable habitat. Despite the proposed removal of vegetation associated with the Modifications, extensive areas of good quality habitat will still be available elsewhere within the study area and surrounding conservation areas.

The Modifications are considered unlikely to have a significant impact on the local occurrence of the Diamond Firetail.

iii. Flame Robin (Petroica phoenicea)

The Flame Robin (*Petroica phoenicea*) is listed as Vulnerable under the TSC Act. There are 57 records of the species within Lithgow LGA (OEHS, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable grassy woodland habitat.

The Flame Robin is a small, insectivorous bird found in a broad coastal band across the south-east corner of the Australian mainland and in Tasmania (Birds Australia, 2011). In NSW it breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats such as

grassland with scattered trees and open woodland on the inland slopes and plains. The species forages on the ground for insects and arthropods and forages in scattered flocks in non-breeding seasons. They construct small cup nests in tree cavities or rock faces.

(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

This species has not been recorded during field surveys but has potential to occur as suitable habitat in the form of woodland and open forest with grassy understorey and ground debris is available in the study area. The Modifications will remove potential foraging, nesting and breeding habitat for the Flame Robin. Despite the area of woodland and open forest proposed to be removed, extensive areas of adjacent habitat will remain with the study area. Therefore the Modifications are considered unlikely to have an adverse effect on the life cycle of individuals potentially occurring in the study area or place a viable local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes potential forage, breeding and nesting habitat for the Flame Robin.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

Due to a lack of observations despite multiple surveys, local winter-populations are not expected to occur within the study area. As such, the Modifications are considered unlikely to lead to social consequences such as smaller group size; reduced breeding success and nesting success; or place the local population at risk of extinction. The Modifications are unlikely to result in a loss of connectivity due to the proximity of similar, extensive habitat elsewhere within the study area that will not be removed. Any local populations that do occur are considered to have a high capacity to disperse to this adjacent habitat and successfully relocate due to the presence of important features required by the Flame Robin such as woody ground debris and small tree hollows.

Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest. It is thus considered that the Modifications will not place the species at risk of extinction.

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

No critical habitat for the Flame Robin has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Flame Robin. No threat abatement plans are relevant to this species. Three recommended actions have been identified to promote the recovery of this population and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Flame Robin will be brought into action by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Flame Robin.

This species has not been recorded during field surveys but has potential to occur within the study area and elsewhere in the locality based on the availability of suitable habitat and the species' irregular migratory movements. Despite the proposed removal of vegetation associated with the Modifications, the species has a high capacity for dispersal and can relocate to extensive areas of good quality habitat that will still be available elsewhere within the study area and surrounding conservation areas.

The Modifications are considered unlikely to have a significant impact on the Flame Robin.

iv. *Gang-gang Cockatoo (Callocephalon fimbriatum)*

The Gang-gang Cockatoo (*Callocephalon fimbriatum*) is listed as Vulnerable under the TSC Act. There are 229 records of the species within Lithgow LGA (OEH, 2011). This species has been recorded during surveys of the study area on a number of occasions. Suitable forage, nesting and breeding habitat is available within the study area.

The Gang-gang Cockatoo is endemic to south-eastern Australia, with distribution along the coast and tablelands of NSW. The species breed in heavily timbered and mature wet sclerophyll mountain forests (DEC (NSW), 2005f)(DEC (NSW), 2005f), then migrate to open forest and woodland such as box-ironbark in the lower valleys and coastal regions for the winter (Schodde and Tidemann, 1986, NSW Scientific Committee, 2005). They form close monogamous pairs with high nest fidelity and often breed semi-colonially where densities are high. Breeding usually occurs in tall mature sclerophyll forests that have a dense understorey (DEC (NSW), 2005f)(DEC (NSW), 2005f) and nest territories range from 7-22km². The Gang-gang Cockatoo feeds primarily on the seeds of native shrubs and trees, including eucalypts, acacias and cypress pine (Schodde and Tidemann, 1986).

The Modifications lies within the known distributional range of the Gang-gang Cockatoo. The species has been recorded on multiple occasions from a number of field surveys within the study area. During current surveys, groups of up to 4 individuals were observed at any one time. This indicates that habitat within the study area forms part of the territorial range of a local, semi-colonially breeding population. The majority of field records within the study area were from during the October 2009 survey, where individuals were observed examining hollows in tall trees. This suggests that suitable breeding habitat is present in the study area and that the species may occupy the study area, primarily in Spring and Summer months when breeding occurs.

(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 Modifications will remove known and potential forage and breeding habitat for the Gang-gang Cockatoo. This is unlikely to place the local population at risk of extinction.

Large areas of suitable habitat will remain in the study area and continue to provide important forage, nesting and breeding habitat features for the species including structurally intact habitat and complexity.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes known and potential forage, breeding and nesting habitat for local populations of the Gang-gang Cockatoo.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Gang-gang Cockatoo has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Gang-gang Cockatoo. The Modifications are unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

(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 Key Threatening Processes relevant to the Gang-gang Cockatoo will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of known and potential forage, nesting and breeding habitat for local Gang-gang Cockatoo populations.

Extensive areas of good quality habitat will remain in the study area and surrounding conservation areas. This species is highly mobile and is considered likely to be able to relocate to these areas. Extensive areas of potential habitat for this species is being provided and rehabilitated as part of the offsets package. Accordingly, the Modifications are considered unlikely to have a significant impact on the the Gang-gang Cockatoo.

v. Glossy Black-Cockatoo (Calyptorhynchus lathami)

The Glossy Black-Cockatoo (*Calyptorhynchus lathami*) is listed as Vulnerable under the TSC Act. There are 88 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat and the proximity of existing OEH records.

The Glossy Black-Cockatoo was previously widely distributed across most of south-eastern Australia (Higgins, 1999). In NSW the species now has patchy distribution along the coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species. The species tends not to live in country where extensive clearing has taken place, and they prefer to fly over intact habitat rather than open country (NSW Scientific Committee, 2004c). The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species) (Garnett and Crowley, 2000). It generally nests in tree hollows of approximately 26 cm wide and up to 1.4 m deep in live

trees or stags. Pairs defend the immediate area surrounding the nest hollow and have extensive forage ranges (NSW NPWS, 1999a).

(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 Glossy Black Cockatoo has not been recorded despite numerous field surveys of the study area. The Modifications will remove potential nesting and breeding habitat for the Glossy Black Cockatoo. Although the species has potential to occur given the availability of suitable breeding and nesting habitat, the absence of records suggests that the study area does not constitute core habitat or form part of the territorial range of a local population, and the Modifications are thus considered unlikely to place a local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. Critical forage resources, in the form of *Allocasuarina* sp., are limited in the study area and considered unlikely to support resident populations.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important for this species. It is not known to occur in the Modification Boundary and extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, and some parts of Ben Bullen State Forest.

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

No critical habitat for the Glossy Black-Cockatoo has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Glossy Black-Cockatoo. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

Three recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Glossy Black-Cockatoo will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of potential nesting and breeding habitat for the Glossy Black Cockatoo.

The species has not been recorded in the study area and no local populations are known to occur. Based on habitat requirements, the study area is likely to offer some nesting habitat in the form of large hollow-bearing trees; however it does not support sufficient forage resources. The Modifications are considered unlikely to have a significant impact on the Glossy Black Cockatoo.

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

The Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) is listed as Vulnerable under the TSC Act. There are 14 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable grassy woodland habitat.

The Grey-crowned Babbler (eastern subspecies) is a woodland insectivorous species endemic to eastern Australia. The species is abundant and widespread in northern Queensland, but is in considerable decline in the southern part of its range in Victoria and NSW. It is a ground-dwelling, sedentary species most commonly found in open forest and woodland dominated by acacias or eucalypt box-ironbark associations where they live in extended family groups (NSW Scientific Committee, 2010g). Flight is laborious for the species and birds are generally unable to cross large open areas. The species forages for insects on trunks and branches of eucalypts and other woodland trees, and on the ground amongst litter and tussock grasses (Garnett & Crowley, 2000). Several dome-shaped stick nests are built and maintained for roosting each night and are usually located in shrubs or sapling eucalypts.

The species is only found in habitat containing all of the following elements: woodland or open forest on fertile or heavy soils; abundant trees, with a high proportion of large, mature eucalypts with a trunk measuring >90 cm DBH; an understorey of shrubs with DBH of 10–30 cm, for nesting and sheltering; and an open ground layer with much leaf litter and fallen timber debris, and sparse grass cover (Birds Australia, 2011). Once lost from a habitat fragment, natural re-colonisation is unlikely (Garnett & Crowley, 2000).

Despite multiple surveys, the species has not been recorded in the study area. This suggests that the study area does not constitute core habitat or form part of a territorial range of a local population.

(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 Modifications will remove potential forage, nesting and breeding habitat for the Grey-crowned Babbler. This species has not been recorded during field surveys but has potential to occur as suitable habitat in the form of woodland and open forest with grassy understorey and ground debris are available in the study area. Extensive areas of habitat will remain within the study area and surrounds and will continue to provide important habitat features for the Grey-crowned Babbler and allow the species to disperse within the locality.

The Modifications are considered unlikely to place a viable local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Grey-crowned Babbler.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Grey-crowned Babbler has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Grey-crowned Babbler. No threat abatement plans are relevant to this species. Nine recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Grey-crowned Babbler will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Grey-crowned Babbler. However, this species has not been recorded during field surveys of the study area and a low count in the Lithgow LGA suggests that the species does not frequent the locality. The Modifications are considered unlikely to have a significant impact on the local occurrence of the Grey-crowned Babbler.

vii. Hooded Robin (Melanodryas cucullata cucullata)

The Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) is listed as Vulnerable under the TSC Act. There are 8 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable grassy woodland habitat.

The Hooded Robin (south-eastern form) is a woodland species with a sparse distribution in south-eastern Australia. It is a mostly sedentary species that prefers open and lightly timbered acacia or eucalypt woodlands, particularly box-ironbark, that are structurally diverse, have moderately tall native grasses and are often at the edges of clearings and grassland (Birds Australia, 2011). The species forages on the ground, perching on fallen timber and low-lying branches to feed on insects. The species breeds between July and November, building nests in tree forks, hollows or crevices at heights between one – five metres (NSW Scientific Committee, 2010d). Territories range from approximately 10 ha during breeding season to 30 ha in the non-breeding season.

(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 Modifications area lies within the known distributional range of the Hooded Robin. The Modifications will remove potential forage, nesting and breeding habitat for the Hooded Robin. This species has not been recorded during field surveys but has potential to occur as suitable habitat in the form of woodland and open forest with grassy understorey and ground debris is available in the study area.

The Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction. Extensive areas of habitat that remain within the study area and surrounding conservation areas will continue to provide important habitat features for the Hooded Robin and allow the species to disperse within the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Hooded Robin.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Hooded Robin has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Hooded Robin. No threat abatement plans are relevant to this species. Seven recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Hooded Robin will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Hooded Robin.

This species has not been recorded during field surveys but has potential to occur within the study area and elsewhere in the locality based on the availability of suitable habitat. Despite the proposed removal of vegetation associated with the Modifications, the species has a high capacity for dispersal and can relocate to extensive areas of good quality habitat that will still be available elsewhere within the study area and surrounding conservation areas.

The Modifications are considered unlikely to have a significant impact on the local occurrence of the Hooded Robin.

viii. Scarlet Robin (Petroica boodang)

The Scarlet Robin (*Petroica boodang*) is listed as Vulnerable under the TSC Act. There are 175 records of the species within Lithgow LGA. This species has been recorded during multiple surveys of the study area on a number of occasions. Suitable forage, nesting and breeding habitat is available within the study area.

The Scarlet Robin is an insectivorous, woodland species endemic to south-eastern NSW and south-western WA. Core bioregions for the species are on the slopes and tablelands of NSW. It is a mainly sedentary species that does not undertake movements greater than 10km (Higgins and Peter, 2002). The species is most commonly found in drier open

woodland and forest of mature and regrowth eucalypts with an open understorey, although it may also use paddocks with scattered remnant trees (Birds Australia, 2011). Abundant logs and fallen timber are critical habitat features, allowing the species to forage for insects on the ground. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. In NSW, the species breeds between July – January and builds nests in tree forks (DECCW (NSW), 2010b).

(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 Modifications will remove known and potential breeding, nesting and forage habitat for the Scarlet Robin. This may impact on the capacity of some individuals to disperse and relocate to surrounding habitat within the locality. However, based on the species' high record count in the LGA and the availability of suitable habitat elsewhere in the locality, this is considered unlikely to result in long-term impacts to local population dynamics within the area such that it would place viable local population of the species 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

Not applicable to threatened species.

(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

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

The Modifications lie within the known distributional range of the Scarlet Robin. The species has been recorded on multiple occasions during various field surveys of the study area. This

suggests that suitable forage and breeding habitat is present in the study area and that the area forms part of the territorial range of a local population of the species.

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes known and potential forage, breeding and nesting habitat for the Scarlet Robin. However, this is not considered likely to result in long-term impacts that would place the local population at risk of extinction.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine. As the species can undertake movements of up to 10 km (Higgins and Peter, 2002), the species is unlikely to have difficulty relocating to adjacent areas of good quality habitat that will still remain within the study area, or to the extensive conservation areas in the vicinity of the Modifications.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Scarlet Robin has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Scarlet Robin. No threat abatement plans are relevant to this species. Seven recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Scarlet Robin will be brought into operation as a result of the Modifications:

Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and

- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of known and potential forage, nesting and breeding habitat for local Scarlet Robin populations.

As suggested by the high number of LGA records, the Scarlet Robin is a woodland bird likely to occur elsewhere in the locality. Extensive areas of good quality habitat will still be available to this species within the study area and surrounding conservation areas and will thus allow the continued viability of the species in the region. Accordingly, no significant impact is expected to occur to the Scarlet Robin as a result of the Modifications.

ix. *Speckled Warbler (Pyrrholaemus saggitatus)*

The Speckled Warbler (*Chthonicola saggitatus*) is listed as Vulnerable under the TSC Act. There are 56 records of the species within Lithgow LGA (OEH, 2011). This species was recorded during current field surveys of the study area.

The Speckled Warbler is a woodland species endemic to south-eastern Australia. The species is most commonly found in eucalypt-dominated dry sclerophyll forest and woodland with a grassy understorey (NSW Scientific Committee, 2010e) particularly on the western slopes and tablelands of the Great Dividing Range and along the drier sections of the coast (Garnett & Crowley, 2002). Large, relatively undisturbed remnants are required for the species to persist in an area. It is a territorial, sedentary species with a typical home range of approximately 10 ha (NSW Scientific Committee, 2010e). It forages on the ground for seeds and insects around tussocks and under shrubs and trees, and nests on the ground in undergrowth and thick litter.

The Modifications lies within the known distributional range of the Speckled Warbler. The species has been recorded once in the study area during current field surveys. As this is a territorial, sedentary species that tends not to undertake movements outside of its 10 ha home range (Higgins and Peter, 2002), it is likely that habitat within the study area supports suitable habitat and forms part of the home range of a local Speckled Warbler population.

(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 Modifications will remove known and potential breeding, nesting and forage habitat for the Speckled Warbler. Due to their sedentary nature, this may impact on the capacity of some individuals to disperse and relocate to surrounding habitat within the locality. However, this is considered unlikely to result in long-term impacts to local population dynamics within the area such that it would place the species at risk of extinction. The species will be able to disperse to large extents of suitable habitat that will remain both within the study area and extensive conservation areas. These areas will continue to provide important forage, nesting and breeding habitat features for the species including habitat complexity and features such as logs and woody ground debris.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes known and potential forage, breeding and nesting habitat for the Speckled Warbler.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Speckled Warbler has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Speckled Warbler. No threat abatement plans are relevant to this species. Seven recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Speckled Warbler will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of known and potential forage, nesting and breeding habitat for local Speckled Warbler populations. The Speckled Warbler is a woodland bird likely to occur elsewhere in the locality, particularly as extensive areas of good quality habitat are available in surrounding conservation areas which will allow the continued viability of the species in the region. Accordingly, the Modifications are considered unlikely to have a significant impact on the Speckled Warbler.

x. Superb Parrot (Polytelis swainsonii)

The Superb Parrot (*Polytelis swainsonii*) is listed as Vulnerable under both the TSC and EPBC Acts. No records exist for this species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area. Despite the lack of records, this species is considered to have low potential to occur due to the availability of suitable habitat.

The Superb Parrot is a partly migratory woodland species endemic to eastern inland Australia. Regular seasonal movements are undertaken, and are attributable to the availability of forage resources between breeding and non-breeding seasons. The species typically inhabits Box-Gum, Box-Cypress pine and River Red Gum forest and woodlands, and scattered paddock trees near water. The species' core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. (DEC (NSW) 2005). The species breeds between September and January and nests in small colonies sometimes in the same tree hollow. Superb Parrots feed on grass seeds, herbaceous plants, fruits, berries and flowers and may forage up to 10km from nesting sites, primarily in grassy box woodland. It is estimated that there are less than 5000 breeding pairs left in the wild.

(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 Superb Parrot has not been recorded within the study area during field surveys and is not known to occur within the LGA. The Modifications are not likely to have an adverse effect on the life cycle of the species such that a viable population of the species 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest of potential habitat for the Superb Parrot will be removed from the Modification Disturbance Boundaries.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. It has not been recorded from the study area or locality and extensive areas of woodland remain within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Superb Parrot has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications are consistent with the objectives and actions of the National Recovery Plan for the Superb Parrot (*Polytelis swainsonii*), published by the VIC Department of Sustainability and Environment, 2011. The draft NSW Recovery Plan for the Superb Parrot (Baker-Gabb D, 2011) accords with and complements this national Recovery Plan.

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Swift Parrot. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

(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 Key Threatening Processes relevant to the Superb Parrot will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of habitat suitable for the Superb Parrot.

The Superb Parrot has not been recorded within the LGA and is not considered likely to occur. Accordingly, the Modifications are unlikely to have a significant impact on the Superb Parrot.

xi. Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot (*Neophema pulchella*) is listed as Vulnerable under the TSC Act. There are 57 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have the potential to occur due to the availability of suitable grassy woodland habitat.

The Turquoise Parrot is a woodland species endemic to south-eastern Australia, with patchy distribution in NSW. It occurs on the western side of the tablelands and inland slopes, plains

and some dry coastal valleys in eastern NSW (Pizzey & Knight, 2003). The species is most commonly found in open, grassy woodland composed of mixed assemblages of eucalypt species, including box-ironbark, with abundant hollow-bearing trees and stags for nesting (NSW Scientific Committee, 2010h). The Turquoise Parrot occurs solitarily, in pairs, in family groups, or in small flocks. It breeds in solitary pairs, though pairs are possibly clumped in favoured nesting patches. Turquoise Parrots are generally resident in an area, but some local seasonal movement occurs. Foraging is typically ground-based among seeding grasses and weeds, and sometimes near cropland (Birds Australia, 2011).

The Modifications area lies within the known distributional range of the Turquoise Parrot. The Turquoise Parrot has not been observed within the study area but is considered to have the potential to occur as suitable habitat is available. However, the lack of records, despite multiple field surveys, suggests that habitat in the study area does not constitute core habitat or form part of the territorial range of a local population. Turquoise Parrots are generally a sedentary, territorial species with limited home territories ranging up to 1.4km.

(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 Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction. The species has not been recorded and extensive areas of habitat that remain within the study area and surrounding conservation areas will continue to provide important habitat features for the Turquoise Parrot.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Turquoise Parrot.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Turquoise Parrot has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The "Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species" is relevant to the Turquoise Parrot. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

(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 Key Threatening Processes are relevant to the Turquoise Parrot:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of potential forage, nesting and breeding habitat for the Turquoise Parrot. The Turquoise Parrot has not been recorded during field surveys but has the potential to occur within the study area based on the availability of good quality

habitat. However, as extensive areas of habitat will still be available to the species elsewhere in the study area and locality, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Turquoise Parrot.

xii. *Varied Sittella (Daphoenositta chrysoptera)*

The Varied Sittella (*Daphoenositta chrysoptera*) is listed as Vulnerable under the TSC Act. There are 69 records of the species within Lithgow LGA (OEH, 2011). The Varied Sittella is an insectivorous woodland species endemic and widespread in across mainland Australia. They are a sedentary species most commonly found in eucalypt woodlands and dry forest, and acacia woodland containing mature trees and dead branches (Birds Australia, 2011). The species feeds on arthropods and insects on stags, dead branches, in decorticating bark and in the canopy. The Varied Sittella often re-uses the same fork or living tree to build its nest in successive years (NSW Scientific Committee, 2010c).

The species was previously recorded during 2003 field surveys, but has not been recorded in the study area since. The species is considered likely to occur due to proximity of OEH records (within several kilometres) and the availability of suitable habitat which may form a component of a much larger home-range.

(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 Modifications will remove potential forage, nesting and breeding habitat for the Varied Sittella. However, the Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction as extensive areas of habitat that will remain within the study area and surrounding conservation areas will continue to provide important habitat features for the Varied Sittella and allow the species to disperse within the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Varied Sittella.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider area, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Varied Sittella has been identified by the Director-General of OEHS under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Varied Sittella. No threat abatement plans are relevant to this species. Six recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Varied Sittella will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to remove approximately 148 ha of known and potential woodland and forest forage, nesting and breeding habitat for the Varied Sittella. Extensive areas of habitat suitable for this species will remain in the wider locality, including within the protected Wollemi National Park and Gardens of Stone National Park. Accordingly, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Varied Sittella.

F.1.4 Threatened Nectarivorous Birds

- Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Painted Honeyeater (*Grantiella picta*);
- Honeyeater (*Anthochaera phrygia*); and
- Swift Parrot (*Lathamus discolor*).

i. Black-chinned Honeyeater (eastern subspecies) (Melithreptus gularis gularis)

The Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) is listed as Vulnerable under the TSC Act. There are 65 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat and proximity of OEH records (within several kilometres).

The eastern subspecies of the Black-chinned Honeyeater is endemic to eastern Australia from inland slopes of the Great Dividing Range to the coast (Pizzey & Knight, 2003). The species is declining in the wheat-belt region of western NSW where large areas would have once contained suitable habitat.

The species is most commonly found in the upper levels of dry open eucalypt woodlands and forest containing box-ironbark associations where they build suspended nests and feed on insects, nectar and lerps (NSW Scientific Committee, 2010k). Feeding territories are large, at least 5 ha, making the species locally nomadic in response to the availability of forage resources.

Despite multiple surveys, the species has not been recorded in the study area. The location of records within the locality suggests that the species may occasionally utilise habitat within the study area as part of a larger foraging range.

(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 Modifications will remove potential forage, nesting and breeding habitat for the Black-chinned Honeyeater. This species has not been recorded during field surveys; however records exist within close proximity to the study area. As such, the species has potential to occur and habitat in the study area may form part of a foraging territory for a local population as suitable habitat in the form of woodland and open forest containing eucalypt feed tree species is present.

As no individuals have been recorded despite multiple surveys, The Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction. Although some forage habitat may be removed, extensive areas of habitat will remain within the study area and surrounds and will continue to provide important habitat features for the Black-chinned Honeyeater and allow the species to disperse within the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Black-chinned Honeyeater.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Black-chinned Honeyeater has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Black-chinned Honeyeater. No threat abatement plans are relevant to this species. Six recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Black-chinned Honeyeater will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Black-chinned Honeyeater.

The Black-chinned Honeyeater is a nectarivorous bird known to occur elsewhere in the locality. It has potential to disperse through treed areas and forage within the study area as part of a larger home range. While suitable habitat and feed trees are available, a resident population of Black-chinned Honeyeaters is not known to occur within the study area. As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Black-chinned Honeyeater.

ii. *Little Lorikeet (Glossopsitta pusilla)*

The Little Lorikeet (*Glossopsitta pusilla*) is listed as Vulnerable under the TSC Act. There are 104 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat and proximity of OEH records (within several kilometres).

The Little Lorikeet is a nectarivorous species endemic to eastern mainland Australia. In NSW, the species is most commonly found in dry, open sclerophyll forests and woodlands dominated by eucalypts, from the coast to the western slopes of the Great Dividing Range and extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri (Pizzey & Knight, 2003). The species has been found in both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes, where it forages in the canopy. It is generally thought to be nomadic in response to food availability, though in some areas it is considered resident, particularly during breeding season from April to December (NSW Scientific Committee, 2010j). The species feeds on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts. It breeds in tree hollows with openings of approximately 3cm at heights of 2-15m in living trees, occupying the same hollow over many years.

(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 Modifications will remove potential forage, nesting and breeding habitat suitable for the Little Lorikeet. As no individuals have been recorded despite multiple surveys, the Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction. Although some forage habitat may be removed, extensive areas of habitat will remain within the study area and surrounds and will continue to provide important habitat features for the Little Lorikeet and allow the species to disperse within the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable forage, breeding and nesting habitat for the Little Lorikeet.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Little Lorikeet has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Little Lorikeet. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

No other recovery plans have been prepared for this species. Six recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Little Lorikeet will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of suitable forage, nesting and breeding habitat for the Little Lorikeet.

The Little Lorikeet is a nectarivorous bird that is partly nomadic in response to food availability. This species has the potential to occur within the study area and elsewhere in the locality based on the availability of extensive areas of suitable habitat including feed trees and hollows. While suitable habitat is available, a resident population of Little Lorikeets is not known to occur within the study area. As such, the Modifications are not considered likely to have a significant impact on the local occurrence of the Little Lorikeet.

iii. Painted Honeyeater (Grantiella picta)

The Painted Honeyeater (*Grantiella picta*) is listed as Vulnerable under the TSC Act. There are 3 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat and proximity of OEH records (within several kilometres).

The Painted Honeyeater is a nectarivorous bird endemic to eastern Australia. It is rare throughout its range and has sparse distribution in south-east NSW (NSW Scientific Committee, 2010i). The species often occurs singly or in pairs and is most commonly found in dry open woodland and forest, such as box-ironbark, which support parasitic *Amyema* mistletoe species. The Painted Honeyeater is closely associated with mistletoes and is a

specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias (Pizzey & Knight, 2003). The species has a general north-south seasonal movement linked to the fruiting of mistletoe. It also feeds on nectar and insects in tree canopies. Breeding occurs south of Queensland on inland slopes of the Great Dividing Range. The species nests from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.

(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 Modifications will remove some suitable forage, nesting and breeding habitat for the Painted Honeyeater. As no individuals have been recorded despite multiple surveys, the Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population 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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable breeding and nesting habitat and some limited forage habitat for the Painted Honeyeater.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Painted Honeyeater has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Painted Honeyeater. No threat abatement plans are relevant to this species. Recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Painted Honeyeater will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of some suitable habitat for the Painted Honeyeater. The Painted Honeyeater is a specialist nectarivorous bird that feeds primarily on the fruits of mistletoes. The species is considered to have low potential to occur in the study area as mistletoe are limited in abundance. Should the species visit the locality during migratory movements, remaining habitat within the study area and within local conservation areas will continue to provide habitat for the species. The Modifications are considered unlikely to have a significant impact on the local occurrence of the Painted Honeyeater.

iv. *Regent Honeyeater (Anthochaera phrygia)*

The Regent Honeyeater (*Anthochaera phrygia*) is listed as Endangered under both the TSC and EPBC Acts. It is also listed as Migratory under the EPBC Act. There are 596 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur during migratory movements due to the availability of suitable forage habitat and number and proximity of OEH records.

The Regent Honeyeater is a nectarivorous migratory species endemic to south-eastern Australia where it is widespread but sparsely scattered in temperate woodlands and open forests. In NSW the species mainly occurs around the Great Dividing Range, but has been recorded in the Hunter Valley and Pilliga regions (Pizzey & Knight, 2003; Birds Australia, 2011). They prefer box-ironbark associations in wet, fertile sites along creeklines and river valleys, or dry open forest and woodland which have large numbers of mature trees, high canopy cover and an abundance of mistletoes. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), in NSW at Capertee Valley and the Bundarra-Barraba region (DEC (NSW), 2005a1). Numbers fluctuate greatly between years and sites, and movement outside of breeding season is poorly understood. Only 1500 individuals are thought to make up the single Capertee Valley subpopulation of this species. Regent Honeyeaters are generalist foragers that mainly feed on nectar from a variety of eucalypts and mistletoes in the canopy tops of mature feed trees. The species roosts in saplings (Oliver, 1998), suggesting they require a more extensive area of habitat than other similar nectarivorous species.

(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 Modifications will remove potential forage habitat for the Regent Honeyeater. The species has not been recorded during field surveys but is considered to have potential to occur during migrations. However, Regent Honeyeaters are unlikely to make significant recurrent use of the study area and as the species is migratory, the Modifications are unlikely to place a viable local population of the species 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of forest and woodland are proposed to be removed as part of the Modifications which provides potential forage habitat for the Regent Honeyeater.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Regent Honeyeater has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Regent Honeyeater (*Xanthomyza phrygia*) Recovery Plan 1999-2003 was prepared by the Commonwealth government in 1999 (Department of Environment and Conservation NSW, 2004). The general aims of the plan included the protection and enhancement of key breeding and foraging habitats for this species. The Modifications area does not occur in any key breeding or foraging areas for the Regent Honeyeater and is therefore consistent with recovery plans.

Ten recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Regent Honeyeater will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest that provides potential habitat for the Regent Honeyeater.

Given that the Regent Honeyeater is a wide-ranging migratory species, it is possible that it may forage within the study area during intense blossom periods. However, also because it is migratory, the species will be able to utilise abundant flowering resources that will still be available in the study area, and in conservation reserves in the locality. As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Regent Honeyeater.

v. *Swift Parrot (Lathamus discolor)*

The Swift Parrot (*Lathamus discolor*) is listed as Endangered under both the TSC and EPBC Acts. There are 30 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage habitat and proximity of OEH records (within several kilometres).

The Swift Parrot only breeds in Tasmania and migrates to south-eastern Australia from March to October (Pizzey & Knight, 2003). In NSW they are found in dry sclerophyll eucalypt forests and woodlands such as box-gum woodlands (DSEWPC, 2011a). The species is semi nomadic in winter and generally found in Victoria and New South Wales with other populations found in south-eastern Queensland. The timing of their migration causes a heavy reliance on abundant lerp infestations and winter flowering eucalypts: *Eucalyptus robusta*, *Corymbia maculata*, *C. gummifera*, *E. sideroxylon*, and *E. albens* (Kennedy & Tzaros, 2005; Saunders & Heinsohn, 2008). The species has high site fidelity and returns to sites on a cyclic basis. However, this site fidelity depends on availability of foraging resources.

(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 Modifications will remove potential forage habitat for the Swift Parrot. This species has not been recorded during field surveys and targeted searches, however it has potential to occur based on the availability of some forage habitat.

Swift Parrots are unlikely to make significant recurrent use of the study area and as the species is migratory and does not breed on the mainland, the Modifications are unlikely to displace any populations or place the species at risk of extinction. The Modifications are also unlikely to reduce forage availability as extensive areas of similar habitat are present in close proximity to the study area and elsewhere in the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes some potential forage habitat for the Swift Parrot.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Swift Parrot has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications are consistent with the objectives of the Swift Parrot (*Lathamus discolor*) Recovery Plan 2001-2005 prepared by the Tasmanian Department of Primary Industries,

Water and Environment for the Commonwealth government in 2001. The general aims of this plan include the protection and enhancement of key breeding and foraging habitats for the 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 Key Threatening Processes relevant to the Swift Parrot will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest. This includes potential forage habitat for the Swift Parrot.

This species is a non-breeding migrant to the mainland where it occurs in areas with abundant forage resources. While the study area supports some flowering resources, they are unlikely to be locally significant for Swift Parrots as no favoured winter feed trees are present. The species is migratory in response to the availability of food, and is considered unlikely to be impacted by the removal of vegetation by the Modifications, particularly as extensive areas of similar habitat are available elsewhere in the locality.

As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Swift Parrot.

F.1.5 Threatened Diurnal Raptors and Large Owls

- Barking Owl (*Ninox connivens*);
- Little Eagle (*Hieraaetus morphnoides*);
- Masked Owl (*Tyto novaehollandiae*);
- Powerful Owl (*Ninox strenua*); and
- Square-tailed Kite (*Lophoictinia isura*).

All of these raptor species require relatively large home ranges (measured in square kilometres) to obtain adequate prey. For the purposes of the following Assessments of Significance, for such widely dispersed raptorial birds with relatively large territories, it is assumed that a viable local population may be as little as a single nesting pair of birds.

i. *Barking Owl (Ninox connivens)*

The Barking Owl (*Ninox connivens*) is listed as Vulnerable under the TSC Act. There are 31 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Barking Owl is a sedentary, medium-sized owl widespread on the mainland. The species is most commonly found in dry open sclerophyll woodland and open forest dominated by eucalypts such red gums (Birds Australia, 2011). It also inhabits fragmented remnant patches, partly cleared farmland and casuarinas along watercourses which contain large roost trees (NSW NPWS, 2003b). The species roosts in shaded portions of dense tree canopies, including tall mid-storey trees with dense foliage such as *Acacia* and *Casuarina* species. Habitat preference is strongly biased towards areas that provide a high density of large trees greater than 60cm diameter and a high density of hollow trees of a range of sizes, including large hollows greater than 15cm diameter which are suitable nesting places for Barking Owls. The species nests alone or in pairs, in hollows of large, old eucalypt trees and requires very large permanent territories in most habitats due to sparse prey densities. Monogamous breeding pairs hunt over as much as 6000 ha, with 2000 ha being more typical in NSW habitats (NSW Scientific Committee, 2004m). Barking Owls primarily feed on invertebrates, however during breeding season, birds and small mammals are also preyed upon.

Barking Owls are thought to be sedentary, probably remaining in the same territory all year around and from year to year. However, this species has not been recorded during field surveys of the study area. While the Barking Owl is considered to have potential to occur based on the availability of suitable habitat and availability of prey, the species has not been recorded during field surveys and is known from a low number of records in the LGA.

(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 Modifications lie within the known distributional range of the Barking Owl and will remove potential forage, nesting and breeding habitat for the species. The study area is not considered likely to currently support a local population of this species and therefore it is unlikely that the Modifications will have an adverse effect on the life cycle of the species or place a viable local population of the Barking Owl 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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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.

The Modifications lies within the distributional range of the Barking Owl. Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This is unlikely to affect connectivity or the species' movement and dispersal within the locality as they are highly mobile species with naturally sparse distribution and extensive home ranges.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Barking Owl has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications will remove remnant hollow-bearing trees and is therefore not consistent with the objectives and actions of the 2003 Draft "Recovery Plan for the Barking Owl". No Threat Abatement Plans apply to this species.

Ten recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Barking Owl will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat. This includes the removal of potential roosting, breeding and forage habitat for the Barking Owl, including the removal of suitable habitat for prey species. However, this species is an infrequent visitor to the locality, is highly mobile with a large home range and can readily migrate to extensive areas of woodland elsewhere in the locality in response to local conditions.

The Modifications are not considered likely to have a significant impact on the local occurrence of the Barking Owl.

ii. Little Eagle (Hieraetus morphnoides)

The Little Eagle (*Hieraetus morphnoides*) is listed as Vulnerable under the TSC Act. There are 26 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable grassy woodland habitat.

The Little Eagle is a small, territorial raptor, uncommon but with widespread distribution across mainland Australia (Pizzey & Knight, 2003). The species is considered partly migratory, with adults generally resident and sedentary, while the juvenile birds tend to disperse. The species is most commonly found in open eucalypt forest and woodland with abundant prey availability, she-oak or acacia woodlands and riparian woodlands (Debus, 1984). The species is tolerant of agricultural landscapes provided woodland habitat is available for nesting (Marchant & Higgins, 1993), where they require a tall living tree within a remnant patch.

(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 Modifications will remove potential forage, nesting and breeding habitat for the Little Eagle. This species has not been recorded during field surveys but has potential to occur as suitable habitat in the form of woodland and open forest with a grassy understorey, and

adjacent open agricultural land are available within and adjacent to the study area. The Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction as large areas of similar habitat will remain in the locality.

(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

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of 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

(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

The study area lies within the known range of the Little Eagle. Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes potential forage, breeding and nesting habitat for the Little Eagle.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Little Eagle has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans have not been prepared for the Little Eagle. No threat abatement plans are relevant to this species. Four recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Little Eagle will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Little Eagle. This includes the removal of potential roosting, breeding and forage habitat, including the removal of suitable habitat for prey species. The long-term viability of the species in the locality is unlikely to be impacted as the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to woodland margins and surrounding agricultural land elsewhere in the locality.

As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Little Eagle.

iii. Masked Owl (Tyto novaehollandiae)

The Masked Owl (*Tyto novaehollandiae*) is listed as Vulnerable under the TSC Act. There are 6 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have the potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Masked Owl is restricted to the coast of NSW and Victoria (Pizzey & Knight, 2003). The species is found within a diverse range of habitats that provide large hollow-bearing trees for roosting and nesting, typically in riparian vegetation, and adjacent open areas for foraging. The Masked Owl is also tolerant of disturbed areas and has a close association with drier, unlogged, or selectively logged forests (Kavanagh, 2002). It is most commonly found within dry eucalypt forests and woodland from sea level to 1100m. Pairs of Masked Owls have a

large home range of 500-1000 ha (NSW Scientific Committee, 2010). The species is threatened by clearing which reduces habitat availability, particularly by limiting nesting resources, and because regrowth after logging makes the habitat less suitable for foraging on key prey such as terrestrial mammals.

(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

This species has not been recorded during field surveys of the study area. The Masked Owl is considered to have potential to occur based on the availability of suitable habitat. However, as the species has not been recorded during field surveys and is known from only 4 records in the LGA, the study area is not considered likely to currently support a local population of this species. Given the species' large home range (pairs maintain and hunt throughout a home range that may be up to 500-1000 ha), it is unlikely that the Modifications will have an adverse effect on the life cycle of the species or place a viable local population of the Masked Owl 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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest which forms potential habitat for this species are proposed to be removed as part of the Modifications.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Masked Owl has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Approved Recovery Plan for the Large Forest Owls was prepared by DEC (NSW) in 2006, the objectives and actions of which cover the Masked Owl.

Three recommended actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Masked Owl will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Masked Owl. This includes the removal of potential forage habitat with the removal of suitable habitat for prey species. The long-term viability of the species in the locality is unlikely to be impacted as the species is an infrequent visitor to the locality; is highly mobile; has a large home range and naturally sparse distribution; and will be able to disperse to extensive areas of habitat elsewhere in the locality. As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Masked Owl.

iv. *Powerful Owl (Ninox strenua)*

The Powerful Owl (*Ninox strenua*) is listed as Vulnerable under the TSC Act. There are 67 records of the species within Lithgow LGA (OEH, 2011). This species was not recorded during current field surveys of the study area; however it was recorded during 1996 surveys. Suitable forage, roosting and breeding habitat is available for this species in the study area, particularly in taller forest communities.

The Powerful Owl occurs in the eastern quarter of NSW, from the coast to the inland slopes where it inhabits eucalypt forests and woodlands and inland riverine woodland (Barrett et al., 2003). It requires large tracts of native vegetation but can survive in fragmented landscapes. The species requires dense vegetation and large hollows up to 1 m wide and 2 m deep in large remnant trees for nesting (NSW Scientific Committee, 2004o). It feeds on arboreal mammals, particularly ringtail possums. Breeding pairs usually maintain a territory of between 300 and 1500 ha, although size is dependent on the availability of suitable prey densities and habitat quality.

(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

This species was not recorded during current field surveys, though it was recorded during previous surveys by Wildsearch (1996) of the study area. The Powerful Owl is considered to occur based on the availability of suitable habitat and a historical record within the study area. The species was not recorded during current surveys, despite being detected in 1996. Therefore it can be assumed that study area forms part of the species habitat. Given the large home range of the species (pairs maintain and hunt throughout a home range that may be up to 1000 ha), and the amount of remaining habitat in the area, it is unlikely that the viability of a local Powerful Owl population will be adversely affected by the Modifications or place the species 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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Powerful Owl has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Approved Recovery Plan for the Large Forest Owls was prepared by DEC (NSW) in 2006, the objectives and actions of which cover the Powerful Owl.

Twenty-one priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening processes relevant to the Powerful Owl will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this destroys populations of the species and their habitats;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and

- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Powerful Owl. This includes the removal of largely forage habitat, but also some nesting and breeding habitat. The long-term viability of the species in the locality is unlikely to be impacted as the species is highly mobile; has a large home range and naturally sparse distribution; and will be able to disperse to extensive areas of habitat elsewhere in the locality. As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Powerful Owl.

v. *Square-tailed Kite (Lophoictinia isura)*

The Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act. There are 6 records of the species within Lithgow LGA (OEH, 2011). This species has been recorded foraging during field surveys of the study area.

The Square-tailed Kite is a raptor endemic to Australia, with widespread but sparse distribution in coastal and sub-coastal areas (Birds Australia, 2011). The species is most commonly found in open forests and woodlands associated with ridge and gully forests, with particular preference for timbered watercourses; it is a regular resident along the major west-flowing river systems of NSW (NSW NPWS, 1999b; Marchant & Higgins, 1993). The Square-tailed Kite has a large home range of over 100 square kilometres. The species is specialist hunter of passerines (particularly honeyeaters) and foliage insects, with most prey taken from the outer foliage of the tree canopy (NSW NPWS, 1999b).

Except when breeding, this species tends to be a solitary bird, usually seen hunting alone high in, or just above the tree canopy in coastal or sub-coastal rainforest, forest or woodland. Breeding occurs from July to February. Nest sites are usually located near watercourses in a high fork or large horizontal branches of eucalypts (Birds Australia, 2011; Debus & Czechura, 1989) and made from a platform of sticks up to 90cm across.

(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

This species has been recorded during field surveys of the study area and the Modifications will remove potential forage and roosting habitat for the Square-tailed Kite. Given the species' large home range (pairs maintain and hunt throughout a home range that may be up to 10000 ha), it is unlikely that the Modifications will have an adverse effect on the life cycle of the species or place a viable local population of Square-tailed Kites at risk of extinction. Should the species frequent the locality, they will still be able to utilise large extents of suitable habitat that will remain both within the study area and extensive conservation areas. These areas will continue to provide important forage, nesting and breeding habitat features for the species.

(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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Square-tailed Kite has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening processes relevant to the Square-tailed Kite will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this destroys populations of the species and their habitats; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat for prey species.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Square-tailed Kite. This includes the removal of known forage habitat. The long-term viability of the species in the locality is unlikely to be impacted as the species is not a frequent visitor to the locality; is highly mobile; has a large home range and naturally sparse distribution; and will be able to disperse to extensive areas of habitat elsewhere in the locality. As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Square-tailed Kite.

F.1.6 Threatened Microchiropteran Bats

Composite Assessments of Significance have been prepared that consider impacts to the following species of microchiropteran bats (microbats) that are known to occur or have the potential to occur in the study area due to the availability of suitable forage, breeding or roosting habitat and proximity of existing OEH records. They are separated by habitat requirements into hollow-roosting species and cave-roosting species:

- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Little Bent-wing Bat (*Miniopterus australis*); and
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

i. *Hollow-roosting Microbats*

The following Assessment of Significance has been prepared as a composite test for a number of hollow-roosting microbat species considered to have potential to occur within the study area.

a. Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is listed as Vulnerable under the TSC Act. There are 49 records of the species within Lithgow LGA (OEH, 2011). This species was not recorded during recent field surveys of the study area. It was recorded during 1996 surveys, although calls could not be positively identified. The species is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Eastern False Pipistrelle is an insectivorous, hollow-roosting species endemic to south-eastern Australia. The species is most commonly found in open forest, wet sclerophyll and coastal forest and mallee, with trees greater than 20m in height and a dense understorey (Churchill, 2008). The species has a home range of up to 148 ha and generally roosts in colonies of three to 80 in the hollow trunks of old eucalypt trees; different roosts are used each night, typically 750m-3.5km apart (Van Dyck & Strahan, 2008). They are absent from small patches of remnant forest, preferring continuous forest where they can forage along tracks, creeks and river.

b. Eastern Freetail-bat (*Mormopterus norfolkensis*)

The Eastern Freetail-bat (*Mormopterus norfolkensis* syn. *Micronomus norfolkensis*) is listed as Vulnerable under the TSC Act. There are 10 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Eastern Freetail-bat is a solitary, insectivorous bat 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 (NSW NPWS, 2004). They tend to forage in gaps in upper-slope vegetation and over larger waterways.

c. Greater Broad-nosed Bat (*Scoteanax rueppellii*)

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as Vulnerable under the TSC Act. There are 10 records of the species within Lithgow LGA (OEH, 2011). This species was tentatively recorded during current field surveys of the study area, however anabat calls could not positively identify the species. This species is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Greater Broad-nosed Bat is a large insectivorous species with limited distribution along the east coast of Australia. They are found in a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest (NSW Scientific Committee, 2004d). This species mainly roosts in tree hollows and cracks or fissures in trunks and branches. The species flies slowly and directly along creek and river corridors in open woodland habitat and dry open forest at low altitudes of up to six metres, foraging for beetles and other large, slow-flying insects after sunset (DEC (NSW), 2005g). They are known to prey on other microbat species (Churchill, 2008).

d. Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) is listed as Vulnerable under the TSC Act. There are 2 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Yellow-bellied Sheath-tail Bat is a tree-hollow roosting species with wide-ranging distribution through tropical Australia, although is considered rare in south-eastern Australia. It is an insectivorous species that primarily forages above the tree canopy in almost all habitats (DEC (NSW), 2005f). Most records in NSW have been obtained between January and May, leading to speculation that the species may be migratory in the southern portion of its range, although very little is currently known about seasonal movements. This species roosts in large tree-hollows in groups of between two and thirty (Churchill, 2008).

(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 Modifications will remove 148 ha of potential forage and roosting habitat for the Eastern False Pipistrelle, Eastern Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat. The Eastern False Pipistrelle and Greater Broad-nosed Bat have been tentatively recorded during 1996 and current field surveys, respectively; however the calls were not positively identified. The Eastern Freetail-bat and Yellow-bellied Sheath-tail-bat have not been recorded during surveys of the study area.

These species are considered to have potential to occur based on the availability of suitable forage habitat and hollow-trees for roosting. However, as the species were not recorded during field surveys and as each has low records in the LGA, the study area is not considered likely to currently support local populations of these species. The Modifications are considered unlikely to have an adverse effect on the life cycle of the species or place a viable local population at risk of extinction. Should these species frequent the locality, they will still be able to utilise large extents of suitable habitat that will remain both within the study area and extensive conservation areas.

(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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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

Approximately 148 ha of woodland and forest are proposed to be removed as part of the Modifications. This includes potential forage and roosting habitat for the Eastern False Pipistrelle, Eastern Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat.

No area of habitat for these species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for these species. Extensive areas of habitat suitable will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Yellow-bellied Sheath-tail-bat, Greater Long-eared Bat, Eastern Freetail-bat and Greater Broad-nosed Bat has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Action Plan for Australian Bats recovery plan published in 1999 is applicable to these species and outlines actions to promote the recovery of these species and the abatement of key threatening processes affecting their occurrence.

(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 Key Threatening Processes relevant to hollow-dependent microbats will be brought into action by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and roosting habitat available for these species;
- Loss of hollow-bearing trees as this reduces the abundance of roosting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and roosting habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest habitat for the Yellow-bellied Sheath-tail-bat, Greater Long-eared Bat, Eastern False Pipistrelle, Eastern Freetail Bat and Greater Broad-nosed Bat. This includes the removal of potential forage, roosting and breeding habitat.

Despite the availability of suitable habitat, these microbat species have low record counts within the LGA and have not been positively recorded in the study area. As such, the study area is considered unlikely to support resident populations or have a significant impact on the foraging behaviour or roosting capabilities of these species. The long-term viability of the species in the locality is unlikely to be impacted and no significant impact is predicted to occur.

ii. Cave-roosting Microbats

The following Assessment of Significance has been prepared as a composite test for a number of cave-roosting microbat species known or considered to have potential to occur within the study area based on the availability of suitable habitat.

*a. Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)*

The Eastern Bent-wing Bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the TSC Act. There are 31 records of the species within Lithgow LGA (OEH, 2011). This species was recorded during current field surveys of the study area. Suitable forage, roosting and breeding habitat is available for this species within the study area.

The Eastern Bent-wing Bat is an insectivorous species that almost exclusively roost in caves and artificial constructions such as mines along the east coast of Australia (Churchill, 2008). The species occurs in large colonies of up to 150,000 individuals and forages above the

canopy over forested areas for insects. In south-eastern Australia it hibernates in underground sites in winter (usually large caves with a constant microclimate). It requires very specific conditions in terms of temperature and humidity for maternity sites (Van Dyck & Strahan, 2008). The species changes roosts in response to seasonal needs, and long-distance movements occur occasionally (DECC (NSW), 2005).

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

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under both the EPBC and TSC Acts. There are 54 records of the species within Lithgow LGA (OEH, 2011). This species was tentatively recorded during current field surveys of the study area; anabat calls could not positively identify the species. As such, this species is considered to have potential to occur due to the availability of suitable forage, roosting and breeding habitat and proximity of OEH records (within several kilometres).

The Large-eared Pied Bat is an insectivorous species with poorly known population densities and distribution. It is considered to be patchily distributed from mid-Queensland to southern NSW (DECC (NSW), 2005). Little is known about the habitat requirements of the species, but natural roosts are typically dependent on extensive sandstone outcrops, cliffs and caves, and old mine workings.

The species appears to prefer low to mid-elevation dry open forest and woodland close to these roost features, particularly areas containing gullies. They typically exist in small colonies consisting of less than 50 individuals and use the same cave over many years (SEWPaC, 2011a).

c. Little Bent-wing Bat (*Miniopterus australis*)

The Little Bent-wing Bat (*Miniopterus australis*) is listed as Vulnerable under the TSC Act. There is 1 record of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area. This species is being assessed as a precautionary measure; despite only 1 LGA record, suitable forage, roosting and breeding habitat for this species is available in the study area.

The Little Bent-wing Bat is an insectivorous species that roosts in caves, tunnels, tree hollows, abandoned mines, culverts and other man-made infrastructure. The species prefers well timbered moist eucalypt forest, rainforest, vine thicket and sclerophyll forest where it can forage beneath the dense canopy for small insects. Maternity colonies, of which only five are known in Australia, form in spring and are often associated with those of Common Bent-wing Bats, where larger colonies provide the high temperatures required to rear young. Males and juveniles generally disperse in summer.

(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 Modifications will remove forage habitat for the Eastern Bent-wing Bat and Large-eared Pied Bat, and potential forage habitat for the Little Bent-wing Bat habitat. The Little Bent-wing Bat has not been recorded during field surveys of the study area and is only known

from 1 record within the LGA. As such it is not considered likely to occur. Based on field survey records and LGA counts, it is likely that the study area supports local populations of the Eastern Bent-wing Bat and Large-eared Pied Bat. The Eastern Bent-wing was recorded during current field surveys; and the Large-eared Pied Bat was tentatively recorded but calls could not be positively identified.

No caves or sandstone 'pagodas' will be removed and therefore the Modifications are unlikely to place a viable local population of either species at risk of extinction. Sandstone caves and crevices are abundant in the area and any local populations that currently roost within the study area will be able to relocate to new sites elsewhere in the locality. No maternity sites are known to occur within the LGA.

The removal of vegetation is unlikely to reduce the availability of foraging resources within the locality; these species are unlikely to be adversely impacted as they frequently travel across large distances to find suitable forage habitat. Should the species frequent the locality, they will still be able to utilise large extents of suitable habitat that will remain both within the study area and extensive conservation areas.

(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

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of 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

(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

The Eastern Bent-wing Bat, Large-eared Pied Bat and Little Bent-wing Bat are predominantly cave-roosting species, although bent-wing bat species have also been known to roost in mine shafts, culverts, roof cavities and other artificial structures.

The Modifications will not remove cave habitat or directly displace local populations although, the Modifications will remove approximately 148 ha of forest and woodland which is likely to include potential forage habitat for these species.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Eastern Bent-wing Bat, Large-eared Pied Bat and Little Bent-wing Bat has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Action Plan for Australian Bats recovery plan published in 1999 is applicable to these species and outlines actions to promote the recovery of these species and the abatement of key threatening processes affecting their occurrence.

(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

- Clearing of native vegetation as this reduces the area of forage habitat available for these species; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Modifications are expected to impact on approximately 148 ha of woodland and open forest foraging habitat for the Eastern Bent-wing Bat, Large-eared Pied Bat and Little Bent-wing Bat. This includes the removal of forage habitat to species considered likely to occur (Eastern Bent-wing Bat, Large-eared Pied Bat).

These microbats are cave-roosting species that tend to have large forage ranges and can thus still forage in habitat that will remain available elsewhere in the study area and surrounding conservation areas. Accordingly, no significant impact is predicted to occur to these species as a result of the Modifications.

F.1.7 Threatened Mammals

- Brush-tailed Rock-wallaby (*Petrogale penicillata*);
- Eastern Pygmy-possum (*Cercartetus nanus*);
- Koala (*Phascolarctos cinereus*);
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*);
- Squirrel Glider (*Petaurus norfolcensis*); and
- Yellow-bellied Glider (*Petaurus australis*).

i. Brush-tailed Rock-wallaby (*Petrogale penicillata*)

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. There are 14 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat on the sandstone escarpments within the study area and proximity of OEH records.

The Brush-tailed Rock-wallaby was historically widespread and abundant in south-eastern Australia; however it is now restricted in its range and comprised of many isolated populations which are genetically different. It is estimated that the total population size is between 15 000 and 30 000 individuals. In NSW, the species has been recorded in central, southern and western regions and up to 80% of the total population occurs in northern NSW alone (DEC 2005). The species is in 'severe decline' in the Sydney Basin Bioregion (NSW NPWS, 2002).

The Brush-tailed Rock-wallaby prefers complex rocky habitats, generally with north-facing slopes and cliff lines, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray et al. 2008; (Short, 1982)). It also utilises tree limbs (Maxwell et al. 1996; Sharman & Maynes 1983). The species is closely associated with dense arboreal cover and occurs in dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest. Vegetation on and below cliffs provide important food resources and shelter. Brush-tailed Rock-wallabies typically shelter during the day in rock crevices, caves and overhangs, yet often bask in exposed sunny spots (Sharman & Maynes 1983). Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways (Joblin, 1983) and these are often defended vigorously (Bayne, 1994). The species typically forages at night on a diet primarily consisting of grasses, forbs and some shrubs and ferns (NSW NPWS, 2003). Home ranges are estimated to be 6 to 30 ha in size along the cliff line.

The Brush-tailed Rock-wallaby is considered to have potential to occur within the study area due to the presence of suitable habitat and known records in the LGA. Fifteen known colonies have been identified within one population in the Yengo National Park and Parr State Recreation Area (Rummary et al. 1995), which are approximately 50km to the east of the study area. Within a population, 'colony' describes an aggregation of individuals in a patch of suitable habitat, surrounded by unoccupied habitat. As the species is sedentary; has low migration rates between colonies; high site fidelity; and small home ranges of approximately 15ha (700m in length along cliff lines), these known colonies will not be impacted by the Modifications.

It is considered to have potential to occur in select areas of the study area based on the availability of rocky sandstone outcrops and caves on the escarpments and the presence of vegetated areas for foraging. However, the Modifications will not remove any sandstone cliffs or pagodas that are critical habitat for this species. The species is known to occur to the east and north of the study area within Gardens of Stone National Park and Wollemi National Park. It is possible that the species may utilise habitat within the study area on occasion, but as no sightings, den sites or other evidence of activity (e.g. scats) have been identified despite multiple surveys, the Modification Boundaries are not considered likely to support a local resident colony.

(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 Modifications will remove potential forage, den and breeding habitat for the Brush-tailed Rock-wallaby; however, the species has not been recorded and no resident colony is considered to occur. Accordingly, the Modifications will not place a local population 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. The Modifications will not directly impact the plateaus, ridges and upper slopes, which contain the sandstone outcropping and the pagoda landscapes suitable for the Brush-tailed Rock-wallaby. These habitat features will be retained and buffered with 20-50m setback from the extent of open cut mining proposed for the Modifications. Other areas of protected high quality remnants in Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest will remain in the area.

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

No critical habitat for the Brush-tailed Rock-wallaby has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications are consistent with the aims and objectives of the 'Recovery Plan for the Brush-tailed Rock-wallaby (*Petrogale penicillata*)', prepared by the then Department of Environment and Climate Change NSW (DECC) in 2008.

The Action Plan for Australian Marsupials and Monotremes, prepared by Wildlife Australia in 1996, is also applicable to the Brush-tailed Rock-wallaby.

Twenty-seven priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Brush-tailed Rock-wallaby will be put into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage habitat available for this species;
- Bushrock removal; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and den habitat;

Conclusion

The Modifications are expected to impact on approximately 148 ha of vegetation which includes some forage habitat for the Brush-tailed Rock-wallaby in areas below cliff lines. The Modifications will not remove important breeding and shelter habitat such as rocky outcrops and sandstone plateaus on which the species depends. Further, the Modification's open cut footprints will be set back from cliff lines by at least 20-50 metres. The long-term viability of the species in the locality is unlikely to be impacted as no Brush-tailed Rock-wallaby colonies are known to exist within the study area or near vicinity. A known population occurs within Yengo National Park; however this is approximately 50km away and will not be impacted by the Modifications. Locally occurring populations or colonies will still be able to utilise extensive areas of habitat elsewhere in the locality, including protected national parks.

As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Brush-tailed Rock-wallaby.

ii. *Eastern Pygmy-possum (Cercartetus nanus)*

The Eastern Pygmy-possum (*Cercartetus nanus*) is listed as Vulnerable under the TSC Act. There are 7 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat and proximity of OEH records.

The Eastern Pygmy-possum is a small (15 to 43 grams) possum distributed across south-eastern Australia. In NSW, the species extends from the coast to the western slopes and is most commonly found in rainforest, sclerophyll forest and woodland, and heath. The species shelters in tree hollows, rotten stumps, shredding bark, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females. The species is generally solitary and individuals maintain several nests. The species frequently spends time in torpor in winter. Males have non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares (DEC (NSW), 2005d). Forage resources are primarily nectar and pollen collected from banksias, eucalypts and bottlebrushes; soft fruits and insects are important where flowers are less abundant.

(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 records for the Eastern Pygmy-possum exist within the study area, despite multiple surveys and no resident population is considered to occur. The Modifications will remove potential nesting and forage habitat for the Eastern Pygmy-possum; however, the Modifications are unlikely to affect the life cycle or overall viability of the species such that it would place a local population 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes potential nesting and forage habitat for the Eastern Pygmy-possum.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Eastern Pygmy-possum has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Action Plan for Australian Marsupials and Monotremes, prepared by Wildlife Australia in 1996, is applicable to the Eastern Pygmy-possum.

Priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Eastern Pygmy-possum will be put into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Eastern Pygmy-possum. This includes the removal of potential forage and nesting habitat.

This species has not been recorded in the study area despite multiple surveys. The Modifications are considered unlikely to affect the long-term viability of the species in the locality or place the species at risk of extinction. The Modifications are considered unlikely to result in a significant impact on the Eastern Pygmy-possum.

iii. Koala (Phascolarctos cinereus)

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the TSC Act. There are 25 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable habitat, including important feed trees *Eucalyptus viminalis*, and proximity of OEH records.

Koalas are large arboreal mammals with wide but fragmented distribution in eastern Australia ranging from the temperate south to the tropical north. The species is most commonly found in eucalypt forests, on the foliage of which the species feeds almost exclusively (Strahan, 1995; Department of Planning, 1995). They are a solitary, sedentary and largely nocturnal species that spend most of the day sleeping in a low fork and climbing into the canopy to feed at dusk

(DECC (NSW), 2008b). They often change trees at night and, as favoured trees may be several hundred metres away, they spend a considerable amount of time on the ground. Koala home ranges can vary in size depending on the abundance of local feed trees; in quality habitat, individual home ranges may be as small as 1-2ha and overlap, while in semi-arid country they are generally discrete and around 100ha (Van Dyck & Strahan, 2008). The species is vulnerable to a lack of suitable food and fragmentation which can make them more susceptible to disease and predation (DECC (NSW), 2008b).

The Modifications lie within the known range of the Koala; however only 25 records exist for the species within the LGA. NSW Atlas records indicate that their distribution within the Lithgow LGA is scattered and restricted to Newnes State Forest and Wollemi National Park. The closest record occurs at Wolgan State Forest, around 8 km north-east of the study area. Although Koalas have the potential to occur within the study area, the absence of records during current and previous surveys indicates that abundances would be low. It is possible that the species may utilise habitat within the study area on occasion, but as no sightings or other evidence of activity (e.g. scats or markings) have been identified despite multiple surveys, the Modifications are not considered likely to support a local population.

(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 Koala has not been recorded within the study area despite multiple field surveys. Habitat assessments identified some portions of the study area that support primary and secondary food trees for the species, including Grey Gum and Ribbon Gum. However, the absence of records indicates that the study area is unlikely to support a resident population and, as indicated by relatively low LGA records, that Koala abundance in the locality is low. The Modifications will remove potential forage and breeding habitat for the Koala; however, this is unlikely to affect the life cycle or overall viability of the species such that it would place a local population 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes the removal of suitable habitat, comprising of some Koala primary and secondary feed trees species (Grey Gums and Ribbon Gums).

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Koala has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications are consistent with the aims and objectives of the 'Recovery Plan for the Koala (*Phascolarctos cinereus*)', prepared by the then Department of Environment and Climate Change NSW (DECC) in 2008.

The 'Action Plan for Australian Marsupial and Monotremes', prepared by Wildlife Australia in 1996, and the 'National Koala Conservation and Management Strategy 2009-2014', prepared by the Natural Resource Management Ministerial Council in 2009, are strategic conservation actions also applicable to the Koala.

Priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Process relevant to the Koala will be put into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage habitat available for this species.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat which includes some primary and secondary feed trees for the Koala.

The locality supports some known feed tree species; however, the low number of records within the LGA and the absence of records from field surveys of the study area indicate the low likelihood for resident populations. Transient individuals have the potential to travel through the study area infrequently. While the species may occur on occasion, the Modifications are not likely to impact on the long-term viability of the species in the locality.

As such, the Modification is considered unlikely to have a significant impact on the Koala.

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

The Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) is listed as Vulnerable under the TSC Act and Endangered under the EPBC Act. There are 26 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, den and breeding habitat and proximity of OEH records (within several kilometres).

The Spotted-tailed Quoll is rare across its range in south-eastern Australia. It has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest (Van Dyck and Strahan, 2008). They require forest with suitable den site features including rock crevices, caves, large hollow logs, burrows and tree hollows (NSW NPWS, 1999b). This is a nocturnal, solitary species with a large home range. Females occupy home ranges up to about 750 ha and males up to 3500 ha, and they have been known to travel more than 6km a night, usually traversing their ranges along densely vegetated creek lines (DEC (NSW), 2005m). The species hunts medium-sized reptiles and mammals including possums and rabbits, and carrion.

The Modifications lie within the known range of the Spotted-tailed Quoll; however the species has not been recorded in the study area despite multiple surveys and no den sites have been identified. As the Spotted-tailed Quoll has been recorded in the wider locality and the species occupy large home ranges (up to 3,500 ha), habitat within the study area is not considered critical to a local population; however it is considered likely that individuals would occasionally forage or den in the study area. The Spotted-tailed Quoll requires a large hunting range of forest/woodland habitat, particularly containing timbered watercourses along which it can traverse landscapes. This species creates dens in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields or rocky-cliff faces which are habitat features available within the study area, particularly around the sandstone pagoda outcrops.

(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 Modifications will remove potential forage, den and breeding habitat for the Spotted-tail Quoll. However, no den sites or evidence of activity (e.g. scats) have been identified during surveys, and the study area is not considered likely to currently support a local population of this species. Given the species' naturally widespread distribution and low numbers; relatively low LGA count; and large home range (females ranges are up to 750 ha and males maintain and hunt throughout a home range that may be up to 3500 ha), it is unlikely that the Modifications will have an adverse effect on the life cycle of the species or place a viable local population of the Spotted-tail Quoll 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest that is considered to be potential habitat for the Quoll are proposed to be removed as part of the Modifications.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider

locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Spotted-tailed Quoll has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A draft national recovery plan for the Spotted-tailed Quoll is currently being prepared. The Action Plan for Australian Marsupials and Monotremes, prepared by Wildlife Australia in 1996, is applicable to the Spotted-tailed Quoll.

Thirty-three priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Spotted-tailed Quoll will be put into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species and its prey; and
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and den habitat

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for this species through direct and indirect impacts. This includes the removal of potential forage, den and breeding habitat for the Spotted-tailed Quoll.

The long-term viability of the species in the locality is unlikely to be impacted as the Spotted-tailed Quoll is not a frequent visitor; is highly mobile; has a large home range and naturally sparse distribution; and will be able to disperse to extensive areas of habitat elsewhere in the locality. Important den habitat in rocky outcrops and caves will not be removed by the Modifications, and prey species will remain available elsewhere in the locality.

As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Spotted-tailed Quoll.

v. *Squirrel Glider (Petaurus norfolcensis)*

The Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act. There are 14 records of the species within Lithgow LGA (OEH, 2011). This species was recorded during field surveys within the study area. Suitable habitat is available throughout the study area.

The Squirrel Glider is widely, but sparsely distributed in eastern Australia from northern Queensland to western Victoria. It commonly inhabits mature or old growth Box-Gum, Box-Ironbark woodlands and River Red Gum forest as the species requires abundant tree hollows for refuge during the day, and nest sites (DEC (NSW), 2005n, NSW Scientific Committee, 2004f). They live in family groups and nest in tree hollows and prefer Eucalypt stands with a shrubby or an Acacia midstorey where they can forage at night. Diet varies seasonally but consists of Acacia gum, eucalypt sap, nectar, pollen and insect material. They prefer stands of mixed forests with at least one species of winter-flowering eucalypt or banksia to provide a reliable food source year round (DEC (NSW), 2005n, Van Dyck and Strahan, 2008)

(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 Modifications will remove known and potential nesting and forage habitat for the Squirrel Glider. Large areas of suitable habitat will remain outside the Modification Disturbance Boundary however, and a viable local population of the species is not likely to 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes known and potential nesting and forage habitat for the Squirrel Glider.

No areas of habitat will become fragmented or isolated as the Modification Disturbance Boundaries are located directly adjacent existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not important to the long term survival of the species in the locality. Large areas of suitable habitat will remain in the study area and the wider locality for the Squirrel Glider, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wollan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Squirrel Glider has been identified by the Director-General of OEH under the TSC Act.

(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.

The Action Plan for Australian Marsupial and Monotremes, prepared by Wildlife Australia in 1996, is applicable to the Squirrel Glider.

Six priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Squirrel Glider will be put into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and

- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Squirrel Glider. This includes the removal of known and potential forage and nesting habitat.

This is a relatively small area of habitat that occurs directly adjacent to existing mining development. Extensive areas of similar habitat are available within adjacent areas of vegetation in the study area as well as in nearby conservation areas that will not be affected. Accordingly, the Modifications are not considered likely to have a significant impact on the Squirrel Glider.

vi. *Yellow-bellied Glider (Petaurus australis)*

The Yellow-bellied Glider (*Petaurus australis*) is listed as Vulnerable under the TSC Act. There are 64 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, den and breeding habitat. OEH records exist within Newnes State Forest and Wollemi National Park.

The Yellow-bellied Glider is widely and sparsely distributed across south-eastern Australia. In NSW, its distribution is generally coastal, extending inland to adjacent ranges. The species is a nocturnal, arboreal mammal found in tall sclerophyll forests and woodlands (Van Dyck and Strahan, 2008). During the day the species dens in mature hollow-bearing trees. At night, it feeds on eucalypt nectar, sap, manna and invertebrates found under shedding bark (DECC, 2007). Sap is extracted from deep V-notched incisions made in the bark of eucalypts and individuals and families demonstrate preference for repeated use of individual trees for many seasons (Mackowski, 1988). Yellow-bellied Gliders are known to utilise a home range of between 30 and 65 ha (Goldingay, 1992, NSW Scientific Committee, 2004h), and being highly vocal, are more often heard than observed.

Although suitable habitat is available, the species has not been recorded within the study area. Despite multiple field surveys no den sites in tree hollows or evidence of activity (e.g. V-notched incisions on trees or calls) have been identified, suggesting the study area does not support a resident population of Yellow-bellied Gliders. The closest known records for the species are located approximately 25km to the north and to the east of the Modifications within Newnes State Forest and Wollemi National Park. As the species have home ranges of up to 65 ha, it is possible that individuals occasionally utilise habitat within the study area.

(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 Modifications will remove suitable nesting, den and forage habitat for the Yellow-bellied Glider. However, due to the large area of similar habitat that will be retained nearby, the removal of potential habitat for the Modifications are considered unlikely to affect the life

cycle or overall viability of the species such that it would place a local population 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes suitable nesting, den and forage habitat that may potentially be utilised by the Yellow-bellied Glider.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for this species. Extensive areas of habitat suitable for this species will also remain available in the wider locality, including within the protected Wollemi National Park, Gardens of Stone National Park, Winburndale Nature Reserve and other remnants including Newnes State Forest, Sunny Corner State Forest, Wolgan State Forest and some parts of Ben Bullen State Forest.

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

No critical habitat for the Yellow-bellied Glider has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Modifications are consistent with the aims and objectives of the 'Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*), prepared by the NSW National Parks and Wildlife Service in 2003.

The Action Plan for Australian Marsupial and Monotremes, prepared by Wildlife Australia in 1996, is also applicable to the Yellow-bellied Glider.

Priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(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 Key Threatening Processes relevant to the Yellow-bellied Glider will be put into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat; and
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat.

Conclusion

The Modifications are expected to impact on approximately 148 ha of habitat for the Yellow-bellied Glider. This includes the removal of potential forage and nesting habitat.

No evidence of Yellow-bellied Gliders has been identified in the study area, and no resident populations are expected to occur. The long-term viability of the species in the locality will not be reduced as known populations that exist within national parks approximately 25km from the Modifications will not be impacted. Surrounding conservation areas are extensive and contain important habitat features that can potentially support a large viable population. The species is also highly mobile with naturally sparse distribution and, should any individuals occur, they will be able to disperse to extensive areas of adjacent wooded habitat.

As such, the Modifications are considered unlikely to have a significant impact on the local occurrence of the Yellow-bellied Glider.

F.1.8 Threatened Reptiles

i. Broad-headed Snake (Hoplocephalus bungaroides)

The Broad-headed Snake (*Hoplocephalus bungaroides*) is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. There are 8 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area, though one recent record occurs in close proximity to the study area. Therefore the species is considered to have potential to occur due to the availability of suitable forage habitat and shelter within the sandstone escarpments and vegetation below the these cliffs of the study area.

It should be noted that although only limited records of this species exist within the LGA, more are considered likely to occur as the species is cryptic and can inhabit a wide range of rock and hollow shelters that are not easily accessible for survey.

The Broad-headed Snake occurs from the coast to ranges of south-eastern Australia, where it is largely confined within an area approximately 250 km of Sydney where Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, occur. The nocturnal species inhabits rock crevices and shelters under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. During summer the species typically migrates about 200m from the sandstone escarpments to hollows in large trees below. The species feeds primarily on geckos and small skinks but occasionally also eats frogs and small mammals. Broad-headed Snakes have low fecundity, producing four to 12 live young from January to March.

The Broad-headed Snake is considered to have potential to occur in select areas of the study area based on the availability of rocky outcrops, crevices and caves on the sandstone escarpments and the presence of vegetation and hollows for summer shelter.

(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 Modifications will remove approximately 148 ha of woodland and forest that provide summer habitat for this species. No winter habitats will be removed. Large areas of similar summer habitat will remain nearby and the Modifications are considered unlikely to place a viable local population 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

Not applicable to threatened species.

(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*

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*

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications that forms potential summer habitat for this species.

No area of habitat for this species will be fragmented or isolated as the Modification Boundaries are located directly adjacent to existing mining development in Invincible Colliery and Cullen Valley Mine.

The habitat to be removed is not considered to be important habitat for the Broad-headed Snake. There are vast areas of similar suitable habitat within the nearby Wollemi National Park and the Blue Mountains National Park that would adequately support the small population known to occur in the LGA. The Modifications will not directly impact the plateaus, ridges and upper slopes, which contain the sandstone outcropping and the pagoda landscapes suitable for the Broad-headed Snake.

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

No critical habitat for the Broad-headed Snake has been identified by the Director-General of OEH under the TSC Act.

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

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to 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 Key Threatening Processes relevant to the Broad-headed Snake will be brought into operation by the Modifications:

- Clearing of native vegetation as this reduces the area of summer foraging habitat available; and
- Bushrock removal as this removes important habitat for this species

Conclusion

The Broad-headed Snake was not recorded during the field surveys, though one nearby record occurs in close proximity to the study area. The Modifications will impact on approximately 148 ha of potential habitat for the Broad-headed Snake. This includes the removal of summer forage and shelter habitat and no sandstone winter habitats will be impacted.

Large areas of suitable habitat (summer and winter) for this species exist in adjacent conservation areas that will not be affected by the Modifications. Accordingly, the Modifications are not considered likely to have a significant impact on the Broad-headed Snake.

ii. Rosenberg's Goanna (*Varanus rosenbergi*)

The Rosenberg's Goanna (*Varanus rosenbergi*) is listed as Vulnerable under the TSC Act. There are 5 records of the species within Lithgow LGA (OEH, 2011). This species has not been recorded during field surveys of the study area but is considered to have potential to occur due to the availability of suitable forage, shelter and breeding habitat. The species is known from the wider locality including records in Turon and Wollemi National Parks.

Rosenberg's Goanna occurs in heath, open forest and woodland on Sydney Sandstone. It is known from Wollemi National Park, the Goulburn and ACT regions and near Cooma. It also occurs in South Australia and Western Australia (DEC (NSW), 2005). The species requires large areas of habitat, with home ranges estimated to range from 2-40 ha, and is strongly associated with termites and their nests. The species is not considered territorial as many of these home ranges overlap. Termite mounds are critical habitat for this species as it is where they nest, laying up to 14 eggs from which hatchlings emerge after approximately 4 months. Females typically lay batches of eggs in the same termite mound over consecutive years. Hollow logs, rock crevices and burrows, either self-made or dug by other animals (e.g. rabbit warrens) provide suitable shelter for this species. Young goannas are cryptic and are believed to spend the majority of time living in trees. The species feeds on carrion and actively preys on birds, eggs, reptiles and small mammals.

The study area is not considered likely to support a local resident population of Rosenberg's Goanna. It is possible that the species may occasionally utilise habitat within the study area as the species requires large tracts of habitat which contain termite mounds which are habitat features critical for the species' life cycle. Due to this reliance, it is possible that the four known records within the Lithgow LGA may occasionally utilise habitat within the study area as the Modifications falls within the large home range (on average 20 ha) of individuals. Preferred prey species (birds, reptiles and small mammals) were recorded during current

and previous surveys of the study area; however these species are abundant elsewhere in the locality and within the home range of known records.

(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 Modifications will remove potential forage, breeding and shelter habitat for Rosenberg's Goanna; however, this is unlikely to affect the life cycle or overall viability of the species such that it would place a local population 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

Not applicable to threatened species.

(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

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

Approximately 148 ha of woodland and open forest are proposed to be removed as part of the Modifications. This includes some suitable shelter, nesting and forage habitat that may potentially be utilised by Rosenberg's Goanna.

No area of habitat for this species will be isolated or fragmented as the Modification Boundary is located directly adjacent to existing mining development in Cullen Valley Mine and Invincible Colliery.

The habitat to be removed is not considered to be important to the long term survival of this species in the locality. The Modifications will not directly impact the plateaus, ridges and upper slopes, which contain the sandstone outcropping and the pagoda landscapes suitable for Rosenberg's Goanna. These habitat features, as well as woody debris and prey habitat, will be retained in the study area and also within protected conservation areas and will continue to support any local populations.

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

No critical habitat for Rosenberg's Goanna has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to 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 Key Threatening Processes are relevant to Rosenberg's Goanna and will be brought into operation as a result of the Modifications:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available;
- Bushrock removal as this removes important habitat for the species; and
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging habitat.

Conclusion

The Modifications will impact on approximately 148 ha of potential habitat for Rosenberg's Goanna. This includes the removal of some potential forage, shelter and nesting habitat.

Rosenberg's Goanna has not been recorded during the field surveys and is known from only 4 records within the LGA, mostly in Wollemi National Park. Suitable shelter habitat for this species occurs in some portions of the study area along the sandstone escarpments. However, termite mounds, which are critical nesting habitat for the species, are scattered and not abundant in the study area. As the Modifications will retain rocky outcrop habitat, and as suitable habitat exists in adjacent conservation areas where known records exist, the

Modifications are not considered likely to have a significant impact on the local occurrence of Rosenberg's Goanna.