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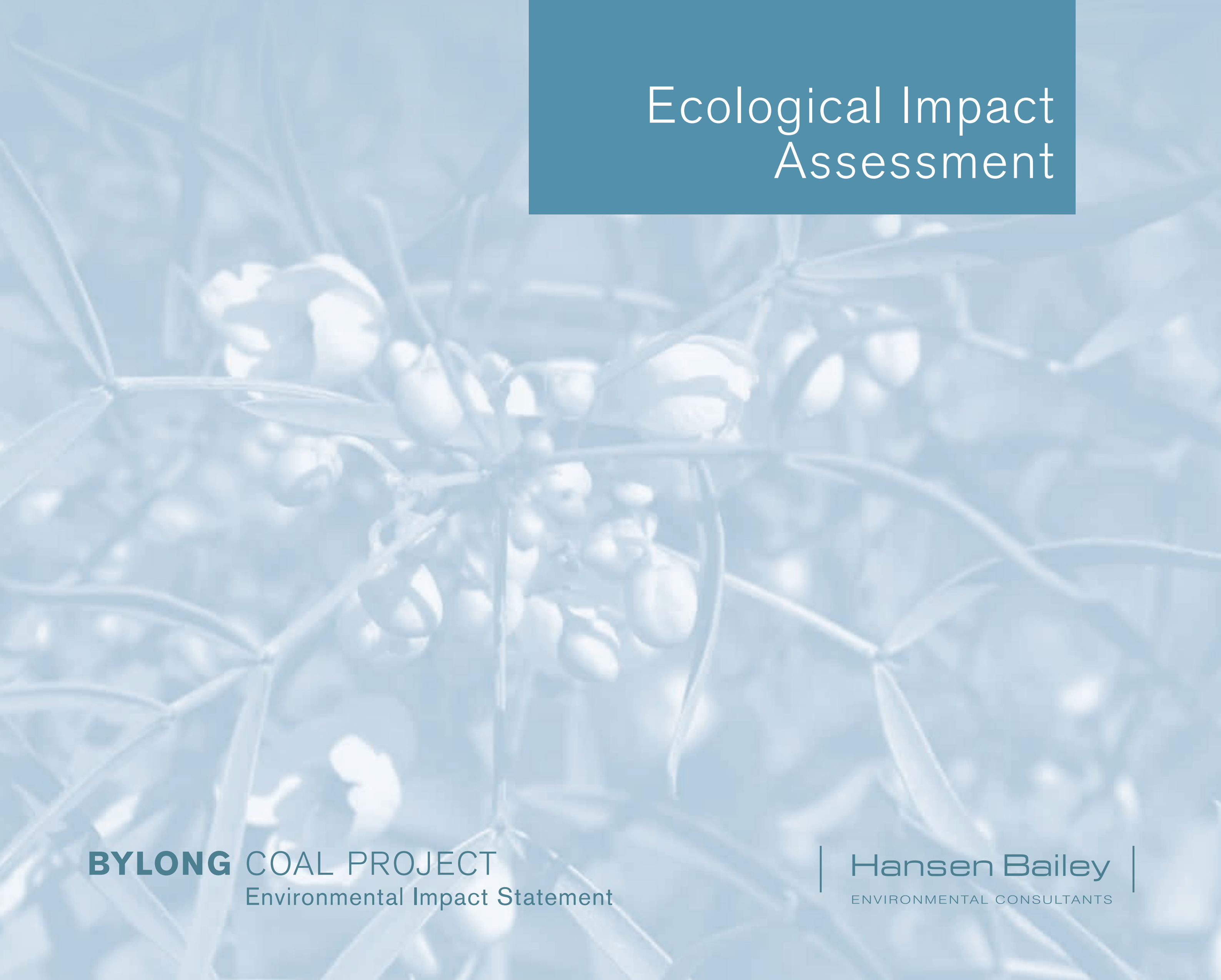
Ecological Impact Assessment



BYLONG COAL PROJECT
Environmental Impact Statement

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

BYLONG COAL PROJECT

Ecological Impact Assessment

For:

Hansen Bailey

August 2015

Final

CUMBERLAND ECOLOGY

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CUMBERLAND ECOLOGY

Report No. 12052RP1

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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Position: Director

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CUMBERLAND ECOLOGY

Table of Contents

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

CUMBERLAND ECOLOGY

Table of Contents *(Cont'd)*

List of Appendices

List of Tables

CUMBERLAND ECOLOGY

List of Tables

List of Figures

CUMBERLAND ECOLOGY

List of Figures

List of Graphs

List of Photographs

CUMBERLAND ECOLOGY

Glossary of Terms

AHD	Australian Height Datum
the Authorisations	Authorisations 287 and 342
BBAM	BioBanking Assessment Methodology
BMP	Biodiversity Management Plan
BOS	Biodiversity Offsets Strategy
BSAL	Biophysical Strategic Agricultural Land
CEEC	Critically Endangered Ecological Community
CHPP	Coal Handling and Preparation Plant
DoE	Commonwealth Department of the Environment
DP&E	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
EIA	Ecological Impact Assessment
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
FM Act	NSW *Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
GPS	Global Positioning System
IR camera	Infra-red camera
KEPCO	KEPCO Bylong Australia Pty Ltd
KTP	Key threatening process
LGA	Local Government Area
Locality	The area within a 10 km buffer from the northern, eastern, southern and western extents of the Study Area (see **Figure 1.1**)
MDS	Multi-Dimensional Scaling
MNES	'Matters of National Environmental Significance' that are listed by the EPBC Act
Mtpa	Million tonnes per annum
NSW	New South Wales
OEA	Overburden Emplacement Area

OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
the Project	The Bylong Coal Project
Project Disturbance Boundary	The area directly impacted by the Project and includes the Open Cut Mining Areas, internal access roads and the associated Mining Infrastructure Areas (see **Figure 1.2**)
RDP	Rapid Data Point
ROM	Run of Mine
SEARs	Secretary's Environmental Assessment Requirements
SEPP 44	NSW *State Environmental Planning Policy 44 – Koala Habitat Protection*
SSD	State Significant Development
Study Area	The area within Authorisations 287 and 342 (see **Figure 1.1**)
Subsidence Study Area	The area predicted and mapped as being indirectly impacted by subsidence (see **Figure 1.2**)
TEC	'Threatened Ecological Community' as listed under the TSC Act and/or EPBC Act
TSC Act	NSW *Threatened Species Conservation Act 1995*
VEC	Vulnerable Ecological Community
WorleyParsons	WorleyParsons Services Pty Ltd
WM Act	NSW *Water Management Act 2000*

CUMBERLAND ECOLOGY

Executive Summary

S1 Introduction

Cumberland Ecology was commissioned by Hansen Bailey on behalf of WorleyParsons Services Pty Ltd (WorleyParsons) to undertake an Ecological Impact Assessment (EIA) of the Bylong Coal Project (the 'Project'). The Project involves the construction and operation of an open cut and underground mining operation for a period of approximately 25 years. This EIA will form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of this report is to document the findings of ecological investigations completed across the Study Area and to assess the impacts of the Project on the biodiversity values present.

S2 Methodology

S2.1 Literature Review and Database Analysis

A review of ecological literature relevant to the Study Area was undertaken as part of this EIA to evaluate the flora and fauna values associated with the Study Area. Key documents reviewed for this EIA include mapping and fauna reports prepared by the NSW Office of Environment and Heritage (OEH) as well as ecological assessments undertaken for other mining projects within the wider region.

Database analysis was conducted for the locality of the Study Area using the OEH Atlas of NSW Wildlife Database (OEH, 2014b) and the Department of the Environment (DoE) Protected Matters Search Tool (DoE, 2014h). The locality is defined as the area within a 10 km buffer from the northern, eastern, southern and western extents of the Study Area.

S2.2 Flora Surveys

Eastcoast Flora Survey was commissioned to undertake flora surveys within the Study Area. Cumberland Ecology was also commissioned to complete some ancillary flora surveys. Flora surveys were undertaken by Eastcoast Flora Survey from October 2011 to November 2013; and by Cumberland Ecology from April 2014 to May 2014. Surveys included:

- Vegetation mapping through the collection of Rapid Data Points (RDPs);
- Grassland surveys to assist in assessing the grassland areas in relation to components of the Box Gum Woodland and Derived Native Grassland Threatened Ecological Community (TEC);

- Quadrat sampling to aid classification of vegetation communities;
- BioBanking surveys to provide a measure of the ecological impacts of the Project and to allow for an assessment of adequacy of proposed offsets; and
- Threatened flora surveys to target the detection of potentially occurring threatened species.

S2.3 Fauna Surveys

Cumberland Ecology conducted fauna surveys across the Study Area from November 2012 to May 2014. Surveys included:

- General habitat assessments noting the abundance of various habitat features as well as an assessment of the likelihood of occurrence of potentially occurring threatened fauna species;
- Hollow-bearing tree assessments to determine approximate densities of hollow-bearing trees per hectare within the Project Disturbance Boundary;
- Targeted cliff line assessments including the collection of data from direct assessments points and observation points, IR camera surveys and scat searches;
- Trapping for terrestrial and arboreal fauna using Elliot A, Elliot B and cage traps;
- Hair tube surveys for terrestrial and arboreal mammals using 'Faunatech' hair tubes;
- Diurnal bird surveys, including targeted surveys at census points;
- Amphibian and reptile surveys of suitable habitat involving lifting of bark, fallen logs, bush rock and scraping of topsoil, including targeted surveys at search points;
- Microchiropteran bat surveys including the use of 'Anabats' for ultrasonic call detection and harp traps;
- Spotlighting for amphibians, birds, mammals and reptiles;
- Call playback for threatened nocturnal birds and mammals; and
- Infra-red (IR) camera surveys for a variety of species for long, medium and short term durations.

S2.4 Aquatic Surveys

Surveys were conducted of aquatic environments within the Study Area between 18 and 19 March 2014 by Cumberland Ecology. These surveys provide baseline habitat data for development of future monitoring programs for the Project. A total of 11 sites were surveyed within the Study Area. Habitat assessments were undertaken at all surveyed sites, however water quality measurements and macro-invertebrate sampling was only undertaken at six of these sites, as these were the only sites within which surface water was present at the time of the survey.

Aquatic surveys were conducted in accordance with *The Australia Wide Assessment of River Health: NSW AusRivAS Sampling and Processing Manual* (Turak and Waddell, 2001b). This approach involved undertaking habitat assessments, in-situ water quality measurements and collecting aquatic macro-invertebrate samples to provide an indication of the current condition of the aquatic survey locations.

S3 Results

S3.1 Vegetation Communities

Vegetation within the Study Area includes intact patches of native woodland and forest, partially disturbed woodland and forest remnants, derived native grassland and cultivated lands. The Study Area has had a history of agricultural development which has resulted in the degradation and clearing of native vegetation on the valley floor and lower slopes. The woody vegetation within the Study Area is dominated by a variety of eucalypts forming both grassy and shrubby woodlands. In general, low-lying lands within the Study Area contain box-type eucalypts of various kinds and correspond to an overall topographical sequence. Some of these communities occur as highly restricted remnants of vegetation due to past land use. The sandstone hills are more complex, with differing aspects and soil depths dictating the distribution of vegetation communities. Ironbark-dominated forests are the most widespread in sandstone areas. Riparian vegetation has historically been cleared and now occurs as highly degraded woodland in scattered patches.

Twenty-four (24) locally-defined vegetation communities have been mapped by Eastcoast Flora Survey as occurring within the Study Area. Of these, three contain variants based on structure and land use history.

Three TECs have been identified as occurring within the Study Area, including:

- Hunter Valley Footslopes Slaty Gum Woodland (NSW *Threatened Species Conservation Act 1995* (TSC Act): Vulnerable Ecological Community (VEC); Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): Not listed);

- Hunter Floodplain Red Gum Woodland (TSC Act: Endangered Ecological Community (EEC); EPBC Act: Not listed); and

- Box Gum Woodland and Derived Native Grassland (TSC Act: EEC; EPBC Act: Critically Endangered Ecological Community (CEEC)).

Two vegetation communities occurring within the Study Area have been identified as regionally significant by Eastcoast Flora Survey: Coastal Grey Box Woodland and Fuzzy Box Woodland.

S3.2 Groundwater Dependent-Ecosystems

The alignment of Bylong River and Lee Creek is characterised by shallow water tables that could have the potential to support Groundwater Dependent Ecosystems (GDEs) (AGE, 2015). Communities assessed as GDEs within this report include River Oak / Redgum Riparian Woodland (Unit 3) and Blakely's Red Gum / Apple Riparian Forest (Unit 4). It is difficult to ascertain the degree of dependence of terrestrial ecosystems on groundwater. Given that the watercourses within the Study Area are typically ephemeral and historically have been degraded due to surrounding land use and water extraction, it is likely that communities characterised by *Eucalyptus camaldulensis* (River Red Gum) and *Casuarina cunninghamiana* (River Oak) trees have a moderate reliance on, but not a complete dependence, on groundwater.

S3.3 Flora

The land within the Study Area supports a high diversity of flora species. Over 550 flora species have been recorded within the Study Area, including more than 100 exotic species. The dominant plant families within the Study Area include the Poaceae, Asteraceae, Myrtaceae and Fabaceae (Faboideae) families. The most common genera encountered is *Eucalyptus* (canopy tree species), with 20 species recorded within the Study Area.

The matrix of habitats within the Study Area provides potential habitat for a suite of threatened flora species. The following threatened flora species have been recorded within the Study Area:

- *Tylophora linearis* (TSC Act: Vulnerable; EPBC Act: Endangered);
- *Ozothamnus tesselatus* (TSC Act: Vulnerable; EPBC Act: Vulnerable);
- *Acacia pendula* population in the Hunter catchment (TSC Act: Endangered Population; EPBC Act: Not listed);
- *Eucalyptus camaldulensis* population in the Hunter catchment (TSC Act: Endangered Population; EPBC Act: Not listed);
- *Cymbidium canaliculatum* population in the Hunter Catchment (TSC Act: Endangered Population; EPBC Act: Not listed);
- *Diuris tricolor* (Pine Donkey Orchid) (TSC Act: Vulnerable; EPBC Act: Not listed); and
- *Pomaderris queenslandica* (Scant Pomaderris) (TSC Act: Endangered; EPBC Act: Not listed).

A number of other threatened flora species listed under the TSC Act and/or EPBC Act are known to occur within the locality and eight species are considered to have some potential to occur within the Study Area due the presence of suitable habitat.

A total of 14 regionally significant flora species have been recorded within the Study Area. These species are considered as regionally significant as they are rare, extend known distributional ranges or support few recent records. Additionally, three species collected within the Study Area have been confirmed by taxonomic experts to likely represent new flora species.

S3.4 Fauna

S3.4.1 Fauna Habitat

The Study Area contains extensive areas of intact woodland and forest vegetation as well as modified grassland areas. The matrix of fauna habitats within the Study Area occur within the various vegetation formations, topographical formations and ephemeral water resources. The habitat features are numerous and provide potential foraging, shelter and breeding opportunities for a suite of fauna species. Key habitat features within the Study Area include: riparian environments; terrestrial habitat features; hollow-bearing trees and stags; blossom-producing trees and shrubs; Koala feed tree species; and cliff lines and associated features such as caves and rocky outcrops.

S3.4.2 Fauna Species

Over 180 vertebrate fauna species have been recorded within the Study Area during this ecological assessment. This includes six amphibian species, 130 bird species, 37 mammal species and nine reptilian species. A total of 13 exotic species were recorded during surveys, including foxes (*Vulpes vulpes*), dogs (*Canis lupus*), goats (*Capra hircus*) and pigs (*Sus scrofa*). **Table S.1** lists the threatened fauna species recorded within the Study Area.

A number of other threatened fauna species listed under the TSC Act and/or EPBC Act are known to occur within the locality and 23 species are considered to have some potential to occur within the Study Area due the presence of suitable habitat.

Table S.1 Threatened fauna species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Birds			
Anthochaera phrygia	Regent Honeyeater	CE	E
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	
Glossopsitta pusilla	Little Lorikeet	V	
Neophema pulchella	Turquoise Parrot	V	
Chthonicola sagittata	Speckled Warbler	V	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	

CUMBERLAND ECOLOGY

Table S.1 Threatened fauna species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	
Stagonopleura guttata	Diamond Firetail	V	
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	
Callocephalon fimbriatum	Gang-gang Cockatoo	V	
Circus assimilis	Spotted Harrier	V	
Hieraaetus morphnoides	Little Eagle	V	
Ninox connivens	Barking Owl*	V	
Ninox strenua	Powerful Owl*	V	
Merops ornatus	Rainbow Bee-eater		M
Hirundapus caudacutus	White-throated Needletail*		M
Mammals			
Dasyurus maculatus	Spotted-tailed Quoll*	V	E
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	
Nyctophilus corbeni	Corben's Long-eared Bat*	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	
Pseudomys novaehollandiae	New Holland Mouse		V
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory
**Data obtained from the Atlas of NSW Wildlife (OEH, 2014b)*

S3.5 Aquatic

Bylong River is the main waterway present within the Study Area, with the remaining waterways forming tributaries to it. Bylong River flows into Goulburn River approximately 7 km downstream of the Study Area. Goulburn River in turn flows into the Hunter River approximately 95 km downstream.

The waterways within the Study Area are ephemeral in nature, thus for the majority of the year the creek lines are mostly dry with some relatively permanent small or large pools of water at specific locations. Analysis of the water table against surface water occurrence indicates significant interaction between alluvial groundwater and surface water (AGE, 2013). Monitoring has confirmed that during times of low rainfall the water in these pools is replenished by groundwater.

CUMBERLAND ECOLOGY

S3.5.1 Habitat Assessment

Aquatic habitat along the waterways within the Study Area is considered to be highly degraded and unsuitable to support significant macro-invertebrate or fish populations. Nevertheless, some sites provide deep enough pools to support some exotic fish, and where relatively permanent water is present; it is likely to provide a drinking water source for birds and habitat for amphibians.

S3.5.2 Macro-invertebrates

The macro-invertebrate communities across all sites were dominated by True Flies (Diptera), which comprised 45% of all the organisms identified. Mayflies (Ephemoptera) and Beetles (Coleoptera) were also significant components of the communities, comprising 18% and 15% of all organisms identified respectively. The analysis shows that waterways within the Study Area have been significantly altered or affected by surrounding land practices and do not support a diverse assemblage of aquatic macro-invertebrate fauna.

S3.5.3 Vertebrate Species

Although no surveys were carried out within the Study Area due to the ephemeral nature of the waterways, Eastern Gambusia (*Gambusia holbrooki*) were observed at a number of locations and Carp (*Cyprinus carpio*) were observed in the Bylong River. The presence of these species indicates that if populations of native fish are present, they would currently be adversely affected by competition with Eastern Gambusia and Carp and likely to be under significant stress.

S3.5.4 Threatened Communities and Species

Neither the Bylong River, Goulburn River or Hunter River have aquatic ecological communities that are listed as critically endangered, endangered or vulnerable ecological communities under the *Fisheries Management Act 1994* (FM Act). One threatened species listed under the FM Act, the Darling River Hardyhead, has been identified as occurring within the Mid-Western Regional Local Government Area (LGA), in which the Bylong River occurs. Given that this species hasn't been recorded despite extensive sampling within the Hunter River Catchment, that the threats to the population includes many of the stressors that have been identified exist within the Study Area, and that the aquatic habitat within the Study Area is degraded – it is considered unlikely that this fish would be present within the Study Area.

S4 Impact Assessment

S4.1 Direct Impacts

S4.1.1 Vegetation Removal

The largest direct impact of the Project is the removal of native vegetation communities that also provide habitat for a wide range of flora and fauna species. The Project Disturbance Boundary (direct impact) is 1,160 ha in size and includes the Open Cut Mining Area the associated Mining Infrastructure Areas and other supporting infrastructure. An additional 1,714 ha of land occurs above the Subsidence Study Area (indirect impact).

S4.1.2 Habitat Removal

The Project will impact on a range of habitats including a suite of specific habitat features, which include riparian environments, terrestrial habitat features, hollow-bearing trees and stags, rocky outcrops, blossom-producing trees and shrubs and feed tree species for the Koala (*Phascolarctos cinereus*).

Despite the Project resulting in the removal of habitat and specific features, extensive areas of land containing similar habitat occurs within the Study Area. It is anticipated that the types of flora and fauna species utilising the habitat within the Project Disturbance Boundary will continue to persist within other areas of the Study Area where suitable habitat is present. The habitats within the Study Area are well connected within similar habitats within the locality.

S4.2 Indirect Impacts

The Project will have a range of indirect impacts on the ecological values of remaining vegetation and habitat within the Study Area, including subsidence, fragmentation, edge effects, alteration to wildlife corridors, alteration to hydrological regimes and changes to weed occurrence and feral animal abundance. Additionally, a number of construction and operational impacts, such as those relating to dust, noise, light and erosion, will also impact the remaining vegetation and habitat. Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of TECs and threatened species, such impacts cannot be mapped or accurately calculated in advance. However, subsidence impacts have been predicted and mapped as occurring within an area defined as the Subsidence Study Area which generally overlies the proposed longwall panels.

S4.3 Impacts to TECs

Three TECs have been identified to occur within the Study Area:

- Hunter Valley Footslopes Slaty Box Woodland;
- Hunter Floodplain Redgum Woodland; and
- Box Gum Woodland and Derived Native Grassland.

Only the Hunter Valley Footslopes Slaty Box Woodland and Box Gum Woodland and Derived Native Grassland occur within the Project Disturbance Boundary.

Additional areas of Hunter Valley Footslopes Slaty Box Woodland and Box Gum Woodland and Derived Native Grassland occur within the Subsidence Study Area. The extent of these TECs within the Project Disturbance Boundary and above the Subsidence Study Area is indicated in **Table S.2**.

The impacts to Hunter Valley Footslopes Slaty Gum Woodland and Hunter Floodplain Red Gum Woodland are not considered to be significant. In the absence of any mitigation or compensation measures, the Project is considered to result in a significant impact to Box Gum Woodland and Derived Native Grassland.

CUMBERLAND ECOLOGY

Table S.2 Extent of TECs known from the Study Area occurring within the Project Disturbance Boundary and Subsidence Study Area

Vegetation Community	TSC Act			EPBC Act		
	Status	Project Disturbance Boundary (ha)~	Subsidence Study Area (ha)~	Status	Project Disturbance Boundary (ha)~	Subsidence Study Area (ha)~
Hunter Valley Footslopes Slaty Gum Woodland						
9: Slaty Box Woodland	VEC	11	124	-	-	-
Box Gum Woodland and Derived Native Grassland						
6(1)A: Yellow Box Woodland	EEC	8	112	CEEC	8	112
7a(1)B: White Box Woodland (Grassy)	EEC	53	407	CEEC	53	407
DNG – 6(1)A: Yellow Box Woodland Derived Native Grassland	EEC	6	5	CEEC	6	5
DNG – 6(2)B: Yellow Box Woodland Derived Native Grassland	EEC	8	62	-	-	-
DNG – 7(1)A: White Box Woodland Derived Native Grassland	EEC	68	146	CEEC	68	146
DNG – 7(2)B: White Box Woodland Derived Native Grassland	EEC	63	105	-	-	-
DNG – 8(1)A: Blakely's Red Gum Woodland Derived Native Grassland	EEC	-	2	CEEC	-	2
Subtotal Box Gum Woodland and Derived Native Grassland		*206*	*839*		*135*	*672*
TOTAL+		**217**	**964**		**135**	**672**

TSC Act / EPBC Act Status: VEC = Vulnerable Ecological Community, EEC = Endangered Ecological Community, CEEC = Critically Endangered Ecological Community

A Sub-unit (1) represents Box Gum Woodland and Derived Native Grassland listed under both the TSC Act and EPBC Act

B Sub-unit (2) represents Box Gum Woodland and Derived Native Grassland listed only under the TSC Act

+ In some cases totals may not equal the appropriate total number due to rounding

~ Area calculations are approximate

S4.4 Impacts to GDEs

Given that the watercourses within the Study Area are typically ephemeral, it is likely that communities considered as GDEs have a moderate reliance, but not a complete dependence, on groundwater. The portions of communities occurring along drainage lines above the valley floor are considered to have a lower dependence than those occurring on the valley floor. The remaining water balance for these communities would be made up of rainfall, surface water and water stored in the soil. The rate of recharge within the Study Area is considered to mitigate the potential significant impacts from alteration of groundwater levels. However, monitoring of the communities considered as GDEs is proposed.

S4.5 Impacts to Threatened Flora Species

A number of threatened flora species listed under the TSC Act and/or EPBC Act have been recorded within the Study Area. Of the threatened flora species recorded within the Study Area, one has been recorded within the Project Disturbance Boundary ('*Acacia pendula* population in the Hunter catchment') and two additional species have been recorded within the Subsidence Study Area (*Ozothamnus tesselatus* and '*Cymbidium canaliculatum* population in the Hunter catchment').

The impacts to *Acacia pendula*, *Ozothamnus tesselatus* and *Cymbidium canaliculatum* population in the Hunter catchment are not considered to be significant. Many of the potentially occurring threatened flora species would occur outside of the Project Disturbance Boundary, with some habitat present within the Subsidence Study Area. The potential changes to these habitats resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat within these areas.

S4.6 Impacts to Threatened Fauna Species

A number of threatened fauna species listed under the TSC Act and/or EPBC Act have recorded within the Study Area. Several additional threatened species have the potential to occur within the Study Area, given the proximity of recent database records and the presence of suitable habitat for these species.

The Project will remove large areas of known and potential habitat for a suite of threatened fauna species. The majority of threatened fauna species known, or with the potential, to occur within the Study Area are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. However removal of habitat within the Project Disturbance Boundary is considered significant for the Regent Honeyeater.

S4.7 Impacts to Aquatic Habitat

The Project has a low potential to impact on aquatic biodiversity, as the ephemeral waterways present within the Study Area are significantly degraded due to past agricultural land uses. Pooled surface water was observed to be of low quality and contained significantly impaired macro-invertebrate communities and exotic fish species. Nevertheless, the Project has the potential to impact aquatic ecosystem health through ground movements, surface water runoff, water extraction and post-mining water quality.

S5 Avoidance and Mitigation Measures

S5.1 Avoidance

Mining projects cannot readily avoid impacts to biodiversity values where the resources are located beneath flora and fauna values. The alteration of a mine plan to completely avoid such impacts can lead to a project being unfeasible. However, avoidance can be achieved to varying degrees by the modification of the design and location of a project.

Key avoidance measures undertaken during development of the mine plan specific to biodiversity values within the Study Area include: reduction in the amount of clearing of woody vegetation, Box Gum Woodland and Derived Native Grassland, Hunter Valley Footslopes Slaty Gum Woodland and known habitat for *Tylophora linearis*. Adjustments to the underground mine plan design were instigated to avoid and reduce impacts to significant cliff lines.

KEPCO will endeavour to achieve further avoidance of sensitive biodiversity beyond that described during the detailed design and construction phases of the Project as the mine plan and associated infrastructure is refined.

S5.2 Mitigation

A range of mitigation measures are proposed to be implemented for the Project to minimise the impacts to biodiversity values relevant to the Study Area. These mitigation measures will be undertaken within the construction and operational phases of the Project with some measures extending beyond the life of mine (e.g. monitoring). The mitigation measures developed for the Project are primarily related to reducing impacts to vegetation and habitat within the Study Area. Specific details of a number of the mitigation measures will be contained within a Biodiversity Management Plan (BMP) for the Project, which will be approved prior to the commencement of the Project.

Mitigation measures for the Project will include:

- General construction and operational mitigation measures (e.g. dust minimisation, visual and lighting management);
- Minimising vegetation and habitat loss;
- Pre-clearance/clearing surveys;

- Aquatic mitigation measures relating to ground movements and surface water runoff;
- Mine rehabilitation;
- Monitoring; and
- Preparation and implementation of a detailed BMP.

S6 Offset Measures

A Biodiversity Offset Strategy (BOS) has been developed to compensate for the residual impacts of the Project once the appropriate avoidance and mitigation measures have been implemented. The BOS entails the acquisition of properties for permanent conservation of flora and fauna, including species predicted to be impacted by the Project. The BOS for the Project targets Box Gum Woodland and Derived Native Grassland and habitat for all threatened flora and fauna known to occur within the Study Area.

KEPCO has devised a BOS that includes "direct" biodiversity offsets. The current composition of the Biodiversity Offset Package of direct offsets includes:

1. **Onsite Offset Areas**, comprising:
    a. Conservation and ongoing management of existing vegetated land within Offset Area 1, Offset Area 2, Offset Area 3, Offset Area 4 and Offset Area 5;
    b. Restoration of vegetation communities and associated habitat within the aforementioned onsite offset areas;
2. **Offsite Offset Area**, comprising:
    a. Conservation and ongoing management of existing vegetated land within the Yarran View Offset Area; and
    b. Restoration of vegetation communities and associated habitat within the aforementioned offsite offset area.

A substantial BOS has been proposed to offset the predicted residual impacts of the Project. The BOS will protect approximately 3,684 ha of native vegetation. This includes a total of 1,509 ha of TSC Act listed Box Gum Woodland and Derived Native Grassland, 1,271 ha of EPBC Act listed Box Gum Woodland and Derived Native Grassland and 411 ha of TSC Act listed Hunter Valley Footslopes Slaty Gum Woodland. The BOS includes significant areas of known and potential habitat for the suite of species predicted to be impacted by the Project.

S7 Conclusion

The Project will remove up to 753 ha of native vegetation including three communities listed as TECs under the TSC Act and/or EPBC Act. Additional areas of vegetation have the potential to be impacted by subsidence related effects within the Subsidence Study Area. A suite of listed flora and fauna species are predicted to be impacted by the Project.

The proposed avoidance, mitigation and offset measures are likely to sufficiently ameliorate the impacts of the Project to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the BOS is to provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportions of native woodland and threatened species habitat under conservation tenure.

CUMBERLAND ECOLOGY

Chapter 1

Introduction

Cumberland Ecology was commissioned by Hansen Bailey on behalf of WorleyParsons Services Pty Ltd (WorleyParsons) to undertake an Ecological Impact Assessment (EIA) of the Bylong Coal Project (the 'Project'). The Project involves the construction and operation of an open cut and underground mining operation for a period of approximately 25 years. This EIA will form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.1 Purpose

The purpose of this report is to document the findings of ecological investigations completed across the Study Area, which comprises Authorisations 287 and 342 (the Authorisations) (see **Figure 1.1**) and to assess the impacts of the Project on the biodiversity values present. Biodiversity values include threatened species, populations and ecological communities protected under State and Commonwealth legislation. The main objective of this report is to determine whether the Project is likely to significantly affect threatened biodiversity values and how the Project plans to mitigate those impacts.

Specifically, the objectives of this EIA are to:

- Describe and map vegetation communities of the Study Area, identifying threatened ecological communities (TECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Identify and map the location of threatened flora and fauna species;
- Assess the likelihood as to whether threatened flora and fauna species could occur within the Study Area;
- Describe the types and extent of potential impacts arising from the Project; and
- Describe any avoidance, mitigation or offset measures proposed to manage impacts on threatened species and areas of high conservation value.

CUMBERLAND ECOLOGY

1.2 Project Description

In December 2010 KEPCO Bylong Australia Pty Ltd (KEPCO) acquired the Authorisations. Since this time, extensive exploration and mine planning work has been undertaken to determine the most socially responsible mine plan to recover the known coal resources within the Authorisations.

In August 2014, KEPCO commissioned WorleyParsons to manage the Project exploration activities, mine feasibility study planning, environmental approvals and ongoing environmental monitoring for the Project.

The Project life is anticipated to be approximately 25 years, comprising a two year construction period and a 23 year operational period, with underground mining operations commencing in Year 7. Various rehabilitation and decommissioning activities will be undertaken during both the course of, and following the 25 years of the Project. It is noted that further mineable coal resources exist within the Authorisations.

The Project generally comprises:

- The initial development of two open cut mining areas with associated haul roads and Overburden Emplacement Areas (OEAs), utilising a mining fleet of excavators and trucks and supporting ancillary equipment;
- The two open cut mining areas will be developed and operated 24 hours a day, 7 days a week over an approximate 10 year period and will ultimately provide for the storage of coal processing reject materials from the longer term underground mining activities;
- Construction and operation of administration, workshop, bathhouse, explosives magazine and other open cut mining related facilities;
- Construction and operation of an underground coal mine operating 24 hours a day, 7 days a week for a 20 year period, commencing mining in around year 7 of the Project;
- A combined maximum extraction rate of up to 6.5 Million tonnes per annum (Mtpa) Run of Mine (ROM) coal;
- A workforce of up to approximately 800 during the initial construction phase and a peak of 470 full-time equivalent operations employees at full production;
- Underground mining operations utilising longwall mining techniques with primary access provided via drifts constructed adjacent to the rail loop and Coal Handling and Preparation Plant (CHPP);
- The construction and operation of facilities to support underground mining operations including personnel and material access to the underground mining area, ventilation shafts, workshop, offices and employee amenities, fuel and gas management facilities;

- Construction and operation of a CHPP with a designed throughput of approximately 6 Mtpa of ROM coal, with capacity for peak fluctuations beyond this;
- The dewatering of fine reject materials through belt press filters within the CHPP and the co-disposal of dewatered fine and coarse reject materials within OEAs and final open cut voids (avoiding the need for a tailings dam);
- Construction and operation of a rail loop and associated rail load out facility and connection to the Sandy Hollow to Gulgong Railway Line to facilitate the transport of product coal;
- The construction and operation of surface and groundwater management and water reticulation infrastructure including diversion drains, dams (clean, dirty and raw water), pipelines and pumping stations;
- The installation of communications and electricity reticulation infrastructure;
- Construction and operation of a Workforce Accommodation Facility and associated access road from the Bylong Valley Way;
- The upgrade of Upper Bylong Road and the construction and operation of a Mine Access Road to provide access to the site facilities;
- Relocation of sections of some existing public roads to enable alternate access routes for private landholders surrounding the Project; and
- Infilling of mining voids, progressive rehabilitation of disturbed areas, decommissioning of Project infrastructure and rehabilitation of the land progressively following mining operations.

The conceptual layout of the Project is shown in **Figure 1.2**. The Study Area covers an area of 10,313 ha. Within the Study Area, the area directly impacted by the Project including the Open Cut Mining Areas, internal access roads and the associated Mining Infrastructure Areas is referred to as the Project Disturbance Area. The area predicted and mapped as being indirectly impacted by subsidence is referred to as the Subsidence Study Area.

1.3 Background

1.3.1 Location

The Project is wholly located within the Authorisations, which are located within the Mid-Western Regional Local Government Area (LGA). The closest regional centre is Mudgee, located approximately 55 km south-west from the Project. The small settlement of Bylong Village is located within the central portion of the Study Area. The Project is approximately 230 km by rail from the Port of Newcastle.

Figure 1.1 illustrates the regional locality of the Study Area in relation to the nearest town centres of Mudgee and Muswellbrook. Wollemi National Park is located immediately east and south of the Study Area and Goulburn River National Park is located immediately to the north. The Study Area occurs within the Hunter Local Land Services (formerly Hunter-Central Rivers Catchment Management Authority) area and the Sydney Basin Bioregion.

1.3.2 Landform, Geology and Soils

i. Landform

The Study Area is located within a landscape that is comprised of flat to undulating valley floors that are predominantly cleared, and steep slopes and cliff lines of the valley system that are less cleared. The Study Area includes a variety of terrains including the valley floor and lower hillsides of the Bylong Valley and the largely intact upper slopes and hill top areas.

The topography within the Study Area is shown in **Figure 1.3**. The valley floor occurs at approximately 250 m Australian Height Datum (AHD). Numerous topographic highs occur throughout the Study Area and are associated with Tal Tal Mountain (655 m AHD), Mt Penny (570 m AHD), Bylong Range, Cousins Range and Growee Range.

Extensive cliff lines are located throughout the Study Area in proximity to these topographic highs. A total of 730 cliff lines have been identified within the Study Area by MSEC, which have been defined as '*a continuous rockface having a maximum height greater than 10 m, a minimum length of 20 m and a minimum slope of 2 in 1*' (MSEC, 2015). The cliff lines vary in terms of their scale and physical complexity and the number of caves, overhangs and boulder beds also varies. The majority of cliff lines occur within the geological strata referred to as the Narrabeen Group (part of the Hawkesbury Sandstone landscape), with the parent rock comprising lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone.

ii. Geology

The geology of the Study Area generally includes (Hansen Bailey, 2014):

- Triassic Conglomeratic Sandstones;
- Permian Illawarra Coal Measures (including Farmers Creek, State Mine Creek, Goulburn, Glen Davis, Ulan and Coggan seams); and
- Late Permian Shoalhaven Group.

The basement geology in the northern end of the Study Area is comprised of shale conglomerate and sandstone of the Shoalhaven Group (Early Permian) and is exposed within Lee Creek and Dry Creek (SLR, 2014). Outcropping of the Illawarra Coal Measures occurs along the side of the valleys (SLR, 2014). These coal measures are overlain by the Triassic Narrabeen Group and are present in the east, west and north of the Study Area where they form conglomeritic sandstone escarpments (SLR, 2014).

Igneous intrusions and volcanic flows have been intersected within the Study Area, with the largest igneous intrusion in the Coggan Sill, which is located in the south-western portion of the Study Area (Hansen Bailey, 2014).

CUMBERLAND ECOLOGY

iii. Soils

A number of soil landscapes have been identified as occurring within the Study Area by SLR Consulting (2015b) and these are shown within **Figure 1.4**. **Table 1.1** summarises the extent of each soil landscape within the Study Area based on mapping by SLR Consulting (2015b) with soils landscape characteristics as described by Kovac and Lawrie (1991). The Study Area is dominated by the "Growee" and "Lees Pinch" Soil Landscapes, which are derived from the underlying geological units of Singleton Coal Measures and Narrabeen Group, respectively.

Table 1.1 Soil landscapes within the Study Area

Soil Landscape	% of Study Area	Landform	Geological Unit	Parent Rock	Soils
Bald Hill	17.3	Undulating low hillocks with rock cappings (basalt or dolerite sheets) on isolated hills or ridges and lava flows down some side slopes	Tertiary Basalt	Olivine basalt and dolerite	Red Dermosol, Red Chromosol.
Benjang	5.0	Rolling hills, ranging in elevation from 240-440 m which are generally rounded with frequent outcrops of sandstone or conglomerate on the summits	Illawarra Coal Measures	Shale, sandstone, conglomerate, mudstone, coal, tuff and some basalt	Brown Chromosol, Brown Vertosol and Yellow Sodosol.
Bylong	16.1	Alluvial flats and low terraces, with elevations ranging from 260-320 m	Quaternary Alluvium	-	Black Dermosol, Stratic Rudosol, Brown-Orthic Tenosol, Chernic-Leptic Tenosol, Leptic Tenosol, Grey Dermosol, and Brown Kandosol .
Growee	22.3	Undulating low hills with broad, widely spaced shallow valleys	Illawarra Coal Measures	Shale, sandstone, conglomerate, coal, tuff and clay	Red Chromosol, Brown Chromosol, Lithic Rudosols, Red Dermosols, Black Kandosols, Stratic Rudosols, Black Dermosols, Black-Orthic Tenosols and Yellow Sodosols.
Lees Pinch	24.6	Rolling hills to steep mountains with rounded summits, some edged by sandstone cliffs	Narrabeen Group	Lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone	Clastic Rudsol.
Olgilvie	13.4	Steep hills and escarpments with cliffs up to 20 m high	Narrabeen Group	Sandstone, shale and conglomerate	Brown Sodosol, Clastic Rudsol
Sandy Hollow	1.3	Undulating rises with slopes smooth and generally less than 10%	Quaternary colluviums from Narrabeen Group	Sandstone, shale and conglomerate	Red Sodsol.

1.3.3 Vegetation

Vegetation within the Study Area includes intact patches of native woodland and forest, partially disturbed woodland and forest remnants, derived native grassland and cultivated lands. The Study Area has had a history of agricultural development. Such land use has resulted in the degradation and clearing of native vegetation on the valley floor and lower slopes. Intact vegetation within the Study Area is typically associated with the slopes, escarpments, ridgelines and plateaus which have not been extensively used for agriculture or forestry. Areas within the Bylong State Forest are likely to have been selectively logged in the past for old growth timber.

Woody vegetation within the Study Area is dominated by a variety of eucalypts forming both grassy and shrubby woodlands. Lower lying alluvial slopes along Bylong Valley support remnant stands of *Eucalyptus conica* (Fuzzy Box), which then grade into *Eucalyptus moluccana* (Grey Box), then *Eucalyptus albens* (White Box) or *Eucalyptus dawsonii* (Slaty Gum) on slopes, with *Eucalyptus melliodora* (Yellow Box) on higher elevation soils derived from basalt. Ironbark-dominated forests are the most widespread in sandstone areas. Riparian vegetation has historically been cleared and now occurs as highly degraded woodland in scattered patches.

Good condition vegetation is typically associated with the slopes, escarpments, ridgelines and plateaus of intact vegetation which has not been used for agriculture or forestry. Due to the largely inaccessible nature of these areas, fewer disturbances to the flora and fauna values have occurred. Vegetation within these areas is structurally diverse and includes formations along gullies, slopes, ridgelines and plateaus.

Extensive areas of remnant native vegetation, including woodland and forest communities, occur within the wider locality of the Study Area. Notable vegetated areas occur within Wollemi National Park and Goulburn River National Park generally to the east and north of the Study Area. An extensive tract of remnant native vegetation also occurs to the west of the Study Area along the elevated areas of the Growee Ranges. The agricultural land uses also extend beyond the Study Area, generally along the valley floors.

1.3.4 Hydrology

The Study Area occurs within the Hunter River catchment. The catchment is bordered in the north-west by the Liverpool Ranges which separate it from the Namoi catchment, and on the west by the Great Dividing Range, which separates it from the Macquarie River catchment (DWE, 2009).

The Study Area intersects several surface drainage systems and contains numerous tributaries to these systems. The major surface drainage systems are shown on **Figure 1.3** and include:

- Bylong River;
- Growee River;

- Dry Creek;
- Lee Creek;
- Cousins Creek; and
- Crows Nest Creek.

Bylong River forms the main surface drainage system, with the remaining river and creeks forming tributaries to this system. Bylong River flows in a northerly direction into the Goulburn River which eventually flows into the Hunter River. Goulburn River and Bylong River have both been identified as having undergone major change and lack flow reliability (DWE, 2009). Despite the Goulburn River draining almost half of the Hunter River catchment, it only contributes 23% of the flow within the Hunter River (DWE, 2009).

Agricultural dams are also present within the Study Area. Many of the dams observed feature little aquatic and semi-aquatic vegetation and are surrounded by cleared land.

The groundwater regime at Bylong has been identified to consist of the following systems:

- Alluvium and colluviums;
- Tertiary basalt capping;
- Weathered Permian bedrock; and
- Coal seams.

Recharge to the groundwater system within the Study Area can be characterised from direct rainfall recharge through the soil zone to the water table and infiltration of surface water through the beds of rivers and creeks (AGE, 2015).

1.3.5 Land Uses

i. Land Uses within the Study Area

A high proportion of the valley floor landscape is used for a number of agricultural activities including cropping and cattle grazing. The agricultural land has been extensively cleared of vegetation which has resulted in a significant loss of flora and fauna habitats. Exotic flora species have been introduced within these areas, some of which have spread into adjacent remnant vegetation and along drainage lines. Removal of vegetation and grazing within these areas has led to the occurrence of erosion along drainage lines.

A portion of the Study Area would have historically been used for forestry (Bylong State Forest). The forestry land within Bylong State Forest would historically have been used for timber harvesting. Despite this history of clearing, Bylong State Forest is predominately comprised of native vegetation and still retains significant values for native flora and fauna.

The residual areas of land comprise largely intact forest and woodland. Much of this land has remained intact due to the inaccessibility resulting from steep terrain.

ii. Land Uses Adjacent to the Study Area

The agricultural land uses extend beyond the Study Area along the valley floors. Extensive areas of intact vegetation occur adjacent to these areas. Intact vegetation forming part of Wollemi National Park and Goulburn River National Park are currently managed for conservation. The conservation areas and forest reserves adjacent to the Study Area and in the wider locality are shown in **Figure 1.1**. These include:

- Wollemi National Park;
- Goulburn River National Park;
- Munghorn Gap Nature Reserve;
- Durridgere State Conservation Area;
- Manobalai Nature Reserve; and
- Avisford State Conservation Area.

1.4 Relevant Legislation

1.4.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

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

A Referral was submitted to the Commonwealth Department of the Environment (DoE) in February 2014 and the Project was deemed a Controlled Action for listed threatened species and communities (Section 18 and 18A) and a water resource, in relation to coal seam gas development and large coal mining development (Section 24D and 24E) under the EPBC Act on 12 March 2014. Commonwealth approval of the Project is being sought concurrently with the State approval through the utilisation of the Bilateral Agreement process (accredited assessment) under Chapter 3, Part 5 of the EPBC Act.

A number of listings for MNES have changed (either new listings or up-listings) since the Project was deemed a Controlled Action, some of which are relevant to the Project.

For the purposes of this report (which has been prepared over a period of more than two years), we have noted, assessed and discussed MNES in accordance the listings as they were at the time of the Project being deemed a Controlled Action on 12 March 2014.

1.4.2 NSW Environmental Planning and Assessment Act 1979 (EP&A Act)

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

The proponent is seeking State Significant Development (SSD) Consent under Division 4.1 of Part 4 of the EP&A Act. A SSD can be declared under the *State Environmental Planning Policy (State and Regional Development) 2011* or by the Minister for Planning.

Secretary's Environmental Assessment Requirements (SEARs) were issued by the NSW Department of Planning and Environment (DP&E) on 23 June 2014 for the Project and DP&E amended the SEARs on 11 November 2014 to reflect some minor amendments to the Project. The provisions that are relevant to this EIA are provided in ***Section 1.5***.

1.4.3 NSW Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs. The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. The potential impacts of any developments, land use changes or activities need to undergo an "Assessment of Significance" under Section 5A of the EP&A Act and in accordance with the *Threatened Species Assessment Guidelines* (DECC (NSW), 2007).

1.4.4 NSW Water Management Act 2000 (WM Act)

The objective of the NSW *Water Management Act 2000* (WM Act) is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources.

Water sharing plans establish rules for sharing water between the environmental needs of the river or aquifer and water users, and between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation. The Study Area is covered by the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.

Objectives within this plan relevant to the protection and enhancement of ecological assets include:

> *(a) protect, preserve, maintain or enhance the important river flow dependent and high priority groundwater dependent ecosystems of these water source;*
>
> *(d) manage these water sources to ensure equitable sharing between users;*
>
> *(f) provide recognition of the connectivity between surface water and groundwater; and*
>
> *(h) adaptively manage these water sources.*

Additionally, the environmental and other public benefit outcomes provided under this plan include:

> *1. the important river flow dependent environmental, Aboriginal, cultural and heritage values of these water sources are protected, preserved, maintained or enhanced;*
>
> *2. these water sources are managed to ensure equitable sharing between users; and*
>
> *3. basic landholder rights of owners, or occupiers, of land are protected.*

1.4.5 NSW Fisheries Management Act 1994 (FM Act)

The FM Act provides for the protection, conservation and recovery of fish stocks, key fish habitats, threatened species, populations and ecological communities of fish and marine vegetation as well as management of threats to threatened species, populations and ecological communities defined under the Act.

In particular, the FM Act has mechanisms for the protection of fish, fish habitats, mangroves, seagrasses and seaweeds on public water land and foreshores.

1.4.6 Other Relevant Legislation and Guidelines

Other NSW legislation and planning policies that are relevant to the protection of biodiversity are listed below:

- *National Parks and Wildlife Act 1974*; and
- *NSW State Groundwater Dependent Ecosystems Policy* (DLWC (NSW), 2002).

For the development of offsetting strategies for the Project, the following documents are relevant and were considered:

- NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014q); and

CUMBERLAND ECOLOGY

- *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (SEWPaC, 2012a).

1.5 NSW Secretary's Environmental Assessment Requirements for the Project

The SEARs for the Project were issued by DP&E on 23 June 2014 (with minor amendments on 11 November 2014) for the Project and the provisions that are relevant to this EIA are reproduced below.

The EIS must address the following specific issues:

- *Biodiversity – including:*
    - *an assessment of the likely biodiversity impacts of the development, having regard to OEH's, the Department of Primary Industries' and the (Commonwealth) Department of Environment's requirements (see Attachment 2);*
    - *a comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.*

Appendix A provides a copy of the DoE and NSW Office of Environment and Heritage (OEH) requirements, as well as requirements by other government agencies relating to biodiversity.

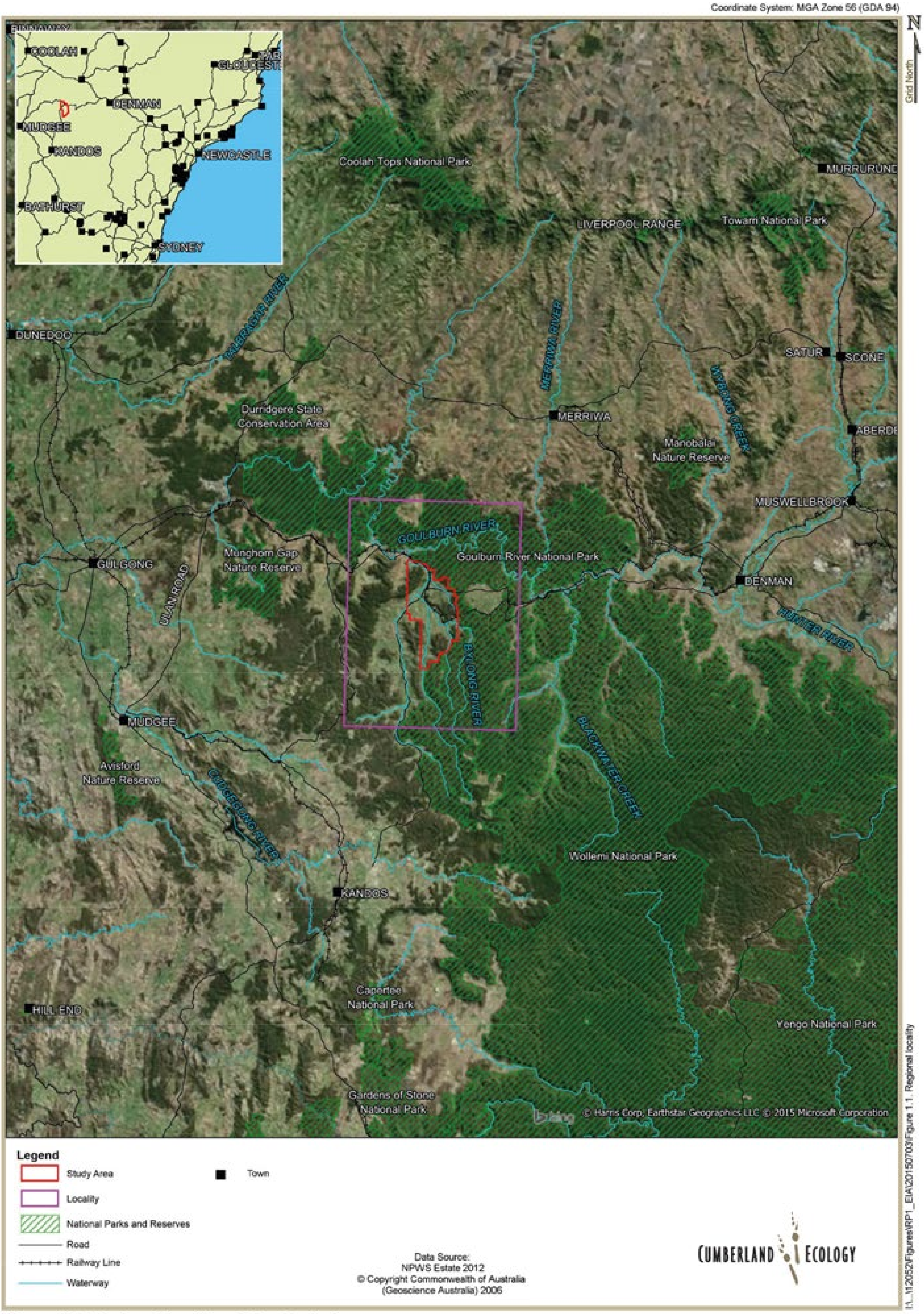


Figure 1.1. Regional locality of the Study Area

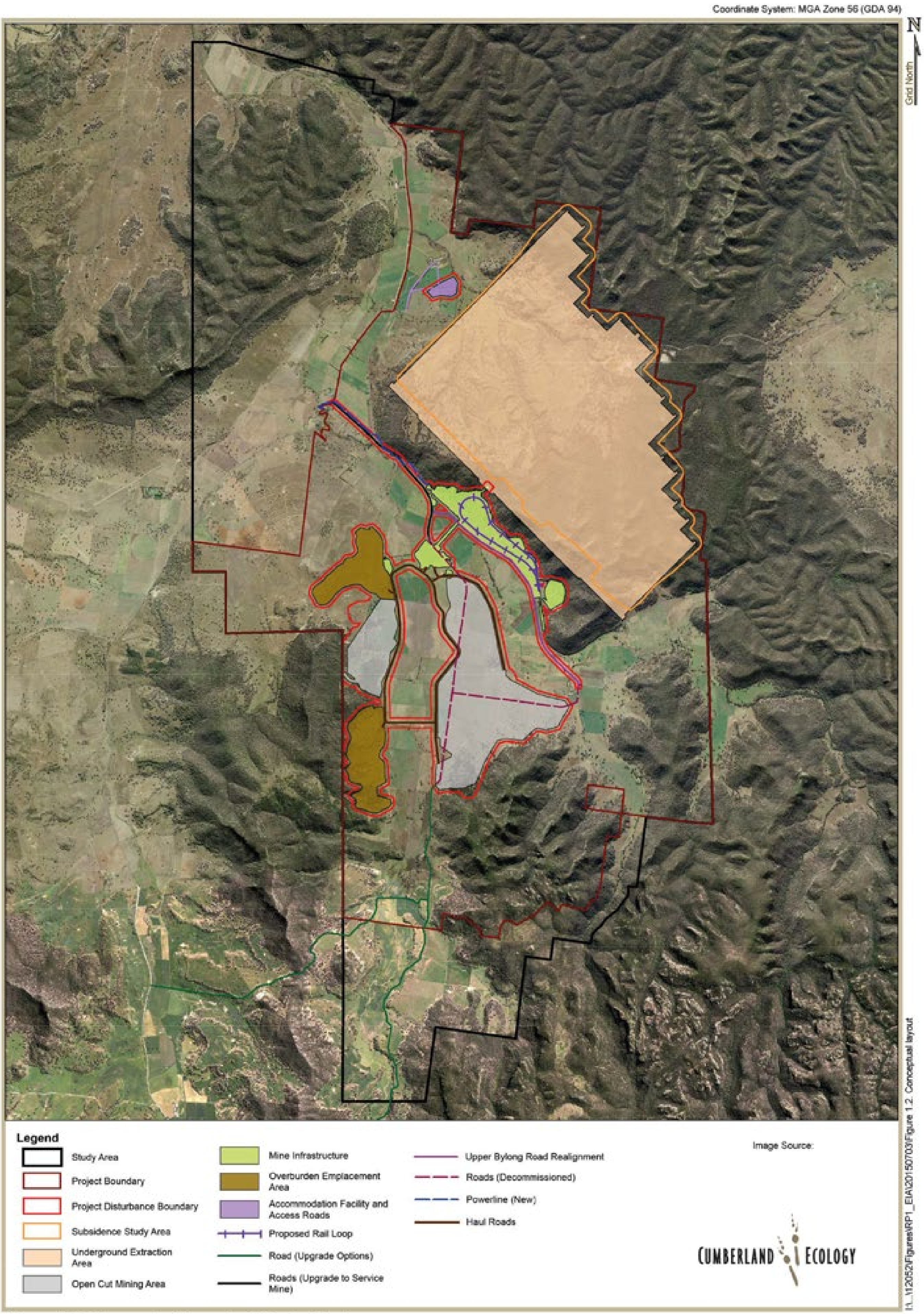


Figure 1.2. Conceptual layout of the Project

1000 0 1000 2000 3000 4000m

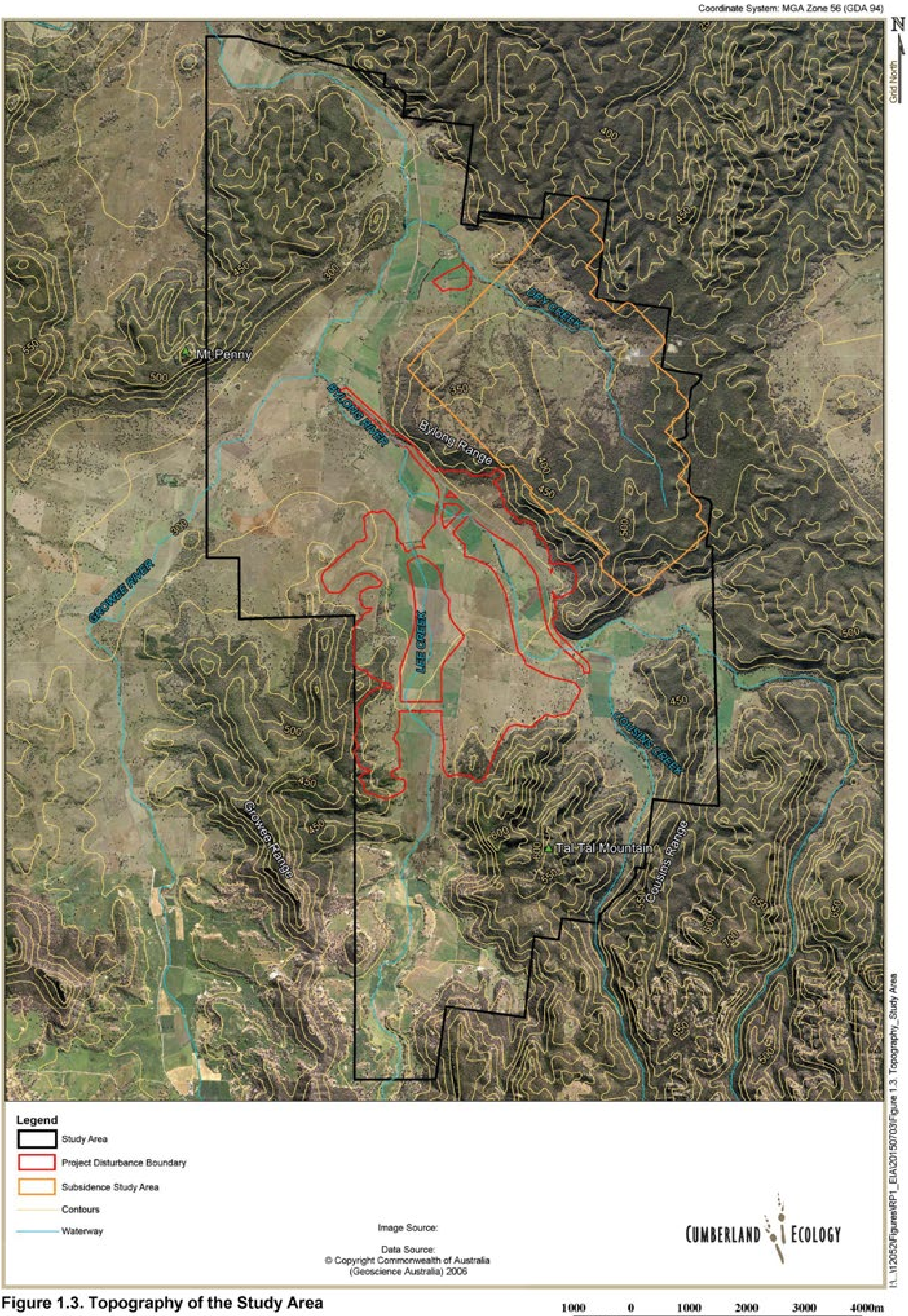


Figure 1.3. Topography of the Study Area

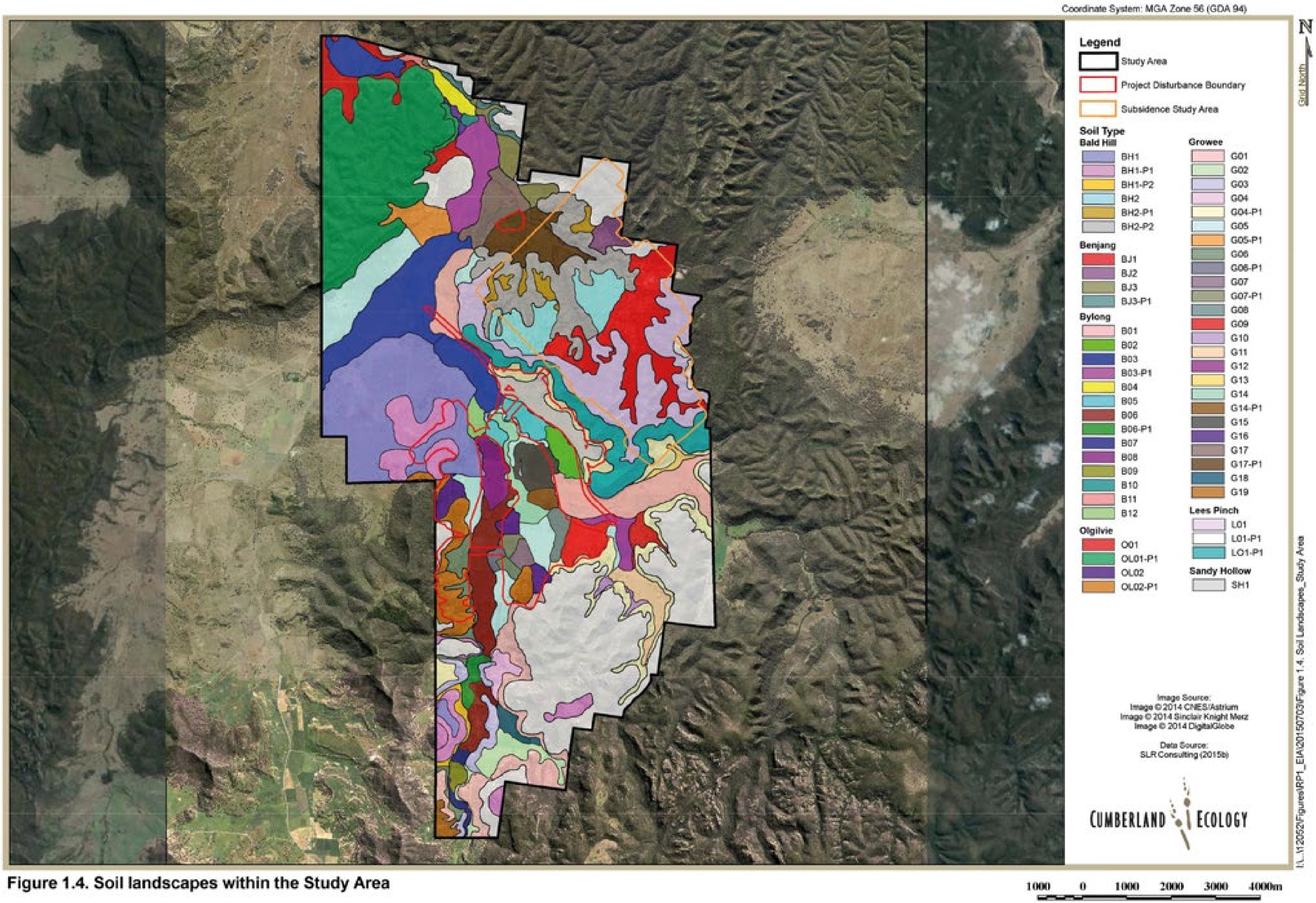


Figure 1.4. Soil landscapes within the Study Area

Chapter **2**

Methodology

2.1 Literature Review

A review of ecological literature relevant to the Study Area was undertaken as part of this ecological assessment to evaluate the flora and fauna values associated with the Study Area. Key documents reviewed for this EIA include:

- OEH (2012j): The Native Vegetation of North-west Wollemi National Park and Surrounds - Draft;
- OEH (2012g): The Greater Hunter Vegetation Mapping Project;
- Well Environmental Services (2011): Mt Penny Coal Project: Preliminary Environmental Assessment;
- DEC (2006):The Vertebrate Fauna of North-western Wollemi National Park;
- Umwelt (2009): Ulan Coal - Continued Operations Ecological Assessment;
- Ecovision Consulting (2008): Moolarben Coal Project Stage 2 Ecological Impact Assessment;
- Moolarben Biota (2006): Moolarben Coal Project Flora, Fauna and Aquatic Ecology Assessment;
- Mt King Ecological Surveys (2005): Wilpinjong Coal Project Terrestrial Fauna Assessment; and
- Greg Richards and Associates (2005): Wilpinjong Coal Project Bat Fauna Assessment.

The information collected during the literature review guided the field surveys undertaken for this ecological assessment. Information within the literature reviewed was also utilised in determining the likelihood of threatened species occurring within the Study Area and assessing the potential impacts of the Project.

This ecological assessment incorporates the methods and results of a detailed flora investigation undertaken by Eastcoast Flora Survey (2014). As such, a detailed review was also conducted of the report, which is provided in **Appendix B**.

2.2 Database Analysis

Database analysis was conducted for the locality of the Study Area using the OEH Atlas of NSW Wildlife Database (OEH, 2014b) and the DoE EPBC Protected Matters Search Tool (DoE, 2014h). The locality is defined as the area within a 10 km buffer from the northern, eastern, southern and western extents of the Study Area (see **Figure 1.1**). The Atlas of NSW Wildlife Database search facility was used to generate records of threatened flora and fauna species and populations listed under the TSC Act and/or EPBC Act within the locality of the Study Area. The abundance, distribution and age of records generated within the search areas provided supplementary information for the assessment of likelihood of occurrence of those threatened species within the Study Area. The Protected Matters Search Tool generated a list of potentially occurring MNES listed under the EPBC Act within the locality of the Study Area.

2.3 Flora Survey

2.3.1 Introduction

Eastcoast Flora Survey was commissioned to undertake the majority of flora surveys within the Study Area. Cumberland Ecology was commissioned to complete some ancillary surveys of the grasslands as well as BioBanking surveys of the Study Area. The report prepared by Eastcoast Flora Survey is provided in **Appendix B**.

This section summarises the methods used in the Eastcoast Flora Survey assessment and incorporates methods from the ancillary flora survey undertaken by Cumberland Ecology. Flora surveys were undertaken by Eastcoast Flora Survey from October 2011 to November 2013 and by Cumberland Ecology between April 2014 and May 2014.

Surveys included vegetation mapping, grassland investigations, forest and woodland investigations, BioBanking surveys and threatened flora surveys. The survey design was guided by the following:

- DEC (NSW) (2004): Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft);
- NSW Scientific Committee (2002b): White box yellow box Blakely's red gum woodland - endangered ecological community listing;
- NSW NPWS (2005): Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland;
- Threatened Species Scientific Committee (2006):Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland;
- DEH (2006): EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived grasslands;

- DEC (2009): BioBanking Assessment Methodology and Credit Calculator Operational Manual; and
- Sivertsen (2010) Native Vegetation Interim Type Standard.

The locations of all flora survey sites are shown in **Figure 2.1** to **Figure 2.4**.

2.3.2 Field Surveys

i. Vegetation Mapping

The vegetation within the Study Area was ground-truthed by Eastcoast Flora Survey to examine and determine the extent of the different vegetation communities present. Vegetation mapping was guided by the collection of Rapid Data Points (RDPs), which summarise floristic information recorded at explicit points in the field. A total of 2,471 RDPs were collected during surveys and their locations are shown in **Figure 2.1**.

The purpose of the RDPs is two-fold: in the first instance they direct where quadrat sampling is best undertaken to ensure observable variations are sampled; and secondly, once vegetation communities are classified, the RDPs contribute to the delineation of map polygons. RDPs were initially conducted during driving transects along existing tracks and were followed by foot traverses where tracks were absent.

The following information was recorded at each RDP:

- Canopy layer dominant species;
- Shrub layer dominant species;
- Ground layer dominant species;
- Draft or field recognised vegetation unit;
- Miscellaneous notes; and
- Recording of a waypoint using a handheld Global Positioning System (GPS) to mark the location of the RDP.

The data collected from the RDPs was analysed and the resultant information was synthesised using a Geographic Information System (GIS) to create a spatial database to produce a vegetation map of the Study Area.

Searches for potential Groundwater Dependent Ecosystems (GDEs) were also undertaken during the vegetation mapping surveys. Areas where ground seepage was evident were investigated, as well as patches of vegetation that supported moisture-loving flora species such as sedges, rushes or ferns.

CUMBERLAND ECOLOGY

ii. Grassland Investigations

Targeted grassland surveys were undertaken by Eastcoast Flora Survey and Cumberland Ecology to assist in assessing the grassland areas in relation to the derived native grassland components of Box Gum Woodland and Derived Native Grassland, a TEC listed under both the TSC Act and EPBC Act. The assessment of the grasslands within the Study Area was guided by the *EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived grasslands* (DEH, 2006) and the Final Determination for Box Gum Woodland and Derived Native Grassland under the TSC Act (NSW Scientific Committee, 2002b). The locations of all grassland surveys are shown in **Figure 2.2**.

Eastcoast Flora Survey collected data from 18 10 m x 10 m quadrats in May 2012. These surveys included collecting full floristic data from the quadrat, including applying a cover abundance score to all species recorded within the quadrat. Additional data was also collected in November 2013 within 10 20 m x 20 m quadrats in November 2013. During these surveys only detectable native, non-grass species were recorded.

Cumberland Ecology conducted additional surveys in April 2014, including the collection of data from 71 rapid grassland assessment points and 15 BioBanking plots. The purpose of collecting rapid grassland assessment points was to maximise the sampling coverage of large areas of grassland as much as possible in a limited survey timeframe and to determine if the grassland conformed to Box Gum Woodland and Derived Native Grassland. Surveys were timed to follow rainfall in February and March (62 mm and 149 mm, respectively), to maximise the detection of native non-grass species in the understorey.

Rapid grassland assessment points were sampled within a 20 m x 50 m area, which represents the minimum patch size (0.1 ha) for Box Gum Woodland and Derived Native Grassland as listed under the EPBC Act.

Data collected at the rapid grassland assessment points included:

- Native understorey species present (sampling ceased when 12 native understorey species were recorded);
- Dominant native grasses;
- Dominant exotic species;
- Percentage cover of natives in the ground stratum;
- Presence of regenerating eucalypts;
- Taking photographs of the rapid grassland assessment site; and
- Recording a waypoint using a handheld GPS to mark the location of the rapid grassland assessment.

Although the data collected from rapid plots cannot be analytically compared to the remaining dataset, they provide enough information to determine the condition and composition of grassland areas at their respective locations.

BioBanking surveys included the collection of full floristic data from 20 m x 20 m quadrats, including applying a cover abundance score to all species recorded within the quadrat. Although not required for BioBanking surveys, the presence of additional flora species occurring within the larger 20 m x 50 m BioBanking plot was also recorded.

iii. Woody Vegetation Investigations

A total of 62 quadrats have been sampled within woody vegetation of the Study Area by Eastcoast Flora Survey. An additional four quadrats undertaken as part of mapping of Wollemi National Park (OEH, 2012j) occur within the Study Area and have been taken into account within the Eastcoast Flora Survey assessment. The locations of all quadrats in woody vegetation utilised for this assessment are shown in **Figure 2.3**.

Quadrat sampling undertaken by Eastcoast Flora Survey was undertaken following a reconnaissance of the Study Area in various areas and vegetation types. Preferential sampling was undertaken to allow for sampling of observable differences in community diversity and to aid classification of communities. Quadrats sampling involved detailed survey within 0.04 ha areas (typically 20 m x 20 m, however in riparian zones this was modified to 40 m x 10 m). The process of quadrat sampling included the following:

- Identifying and recording all vascular flora species present;
- Assigning a cover-abundance value to each species recorded using a modified Braun-Blanquet scoring system (Braun-Blanquet, 1932);
- Physical attributes of the quadrat, including vegetation structure, soil type, elevation, slope, aspect and physiographical position;
- Taking photographs of the quadrat to provide a record of vegetation condition and appearance; and
- Recording a waypoint using a handheld GPS to mark the location of the quadrat.

The data collected from these quadrats was analysed to assist in determining the locally-defined vegetation communities and their descriptions.

iv. BioBanking Surveys

BioBanking surveys were undertaken within the Project Disturbance Boundary and immediate surrounds by Cumberland Ecology. The locations of all BioBanking plots are shown in **Figure 2.3**. Surveys followed the BioBanking Assessment Methodology (BBAM) (DECC, 2009) and included establishment of a 20 m x 50 m plot within which the following data was collected:

- Native species richness recorded within each stratum of a 20 m x 20 m plot;

- Native overstorey projected foliage cover recorded at 10 points along a 50 m transect;
- Native midstorey projected foliage cover recorded at 10 points along a 50 m transect;
- Native groundcover projected foliage cover recorded at 10 points along a 50 m transect for three life forms (shrubs, grasses and other);
- Weed species projective foliage cover expressed as a percentage of overstorey, midstorey and ground cover along a 50 m transect;
- Number of trees with hollows where entrance width is over 5 cm and hollow is at least 1 m above ground within the 20 m x 50 m plot;
- The percentage of regenerating canopy species within the vegetation zone; and
- The total length in metres of fallen logs over 10 cm in diameter within the 20 m x 50 m plot.

In addition to collection of native plant species richness within a 20 m x 20 m plot, full floristic data was also collected to enable classification of each vegetation zone to the best-fit Plant Community Type (PCT). BioBanking surveys were conducted within the Project Disturbance Boundary to provide a measure of the ecological impacts of the Project and to allow for an assessment of adequacy of the Biodiversity Offset Strategy (BOS).

v. Threatened Flora Surveys

Threatened flora surveys within the Study Area were undertaken by Eastcoast Flora Survey. Targeted surveys were conducted within potential habitat and additional threatened flora surveys were undertaken in conjunction with RDP collection. Surveys were targeted towards threatened species known to occur in the locality of the Study Area, however additional species were also considered.

Additional species considered during surveys include threatened or rare plant species known from Wollemi National Park and surround areas published in Bell (2001) and Bell (2008), as well as the recently described *Eucalyptus expressa* (Bell and Nicholle, 2012) and the undescribed new species *Eucalyptus* sp. aff. *fibrosa* (Klaphake, 2010). Whilst there is no legal requirement to take measures to protect them unless they are also listed under the TSC Act or EPBC Act, their significance in the region is noted in this ecological assessment.

Surveys involved foot traverses and driving transaction, and where threatened flora species were observed, the location was recorded with a handheld GPS and an estimate made on the population size. A summary of how each of the targeted threatened flora surveys was conducted is provided below.

The locations of threatened flora species incidentally observed during surveys were recorded with a handheld GPS. This includes species observed by Cumberland Ecology.

a. Terrestrial Orchids

Surveys for threatened terrestrial orchids including but not limited to *Diuris tricolor* (Painted Diuris) and *Prasophyllum* sp. *Wybong* were undertaken in early October 2012. As terrestrial orchids are more readily detectable during flowering periods, surveys were timed to coincide with the flowering periods of these species, taking into account known flowering periods in the wider region.

Previous information collected from the Study Area, as well as experience of the target species in the wider region, was utilised to determine suitable habitat for these species. Surveys were undertaken within grassland and grassy woodlands, with the most suitable habitat occurring in areas where there is a dominance of native grasses and herbs, relatively little weed abundance and an absence of cropping and heavy stock grazing.

In grassland areas showing good potential habitat for terrestrial orchids, slow driving transects were undertaken with two observers inspecting 15-20 m either side of the vehicle, with foot traverses undertaken when terrestrial orchids were observed. Additional foot traverses were undertaken within grassy woodland. A total of 52 km of search transect were examined during terrestrial orchid surveys within the Study Area. The locations of surveys for terrestrial orchids are shown in **Figure 2.4**.

b. Epiphytic Orchids

Surveys for the threatened epiphytic orchid population *Cymbidium canaliculatum* (Tiger Orchid) were undertaken throughout the survey period in areas supporting woody vegetation, particularly those containing *Eucalyptus albens* (White Box) or *Angophora floribunda* (Rough-barked Apple). The distinctive basal clump of this species is identifiable throughout the year and no other similar species occur within the wider region.

c. Trees

Surveys for threatened tree species or populations including but not limited to *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus cannonii* (Red Stringybark) were undertaken throughout the survey period within suitable habitat. Habitats targeted for *Eucalyptus camaldulensis* included alluvial flats and plains with inspections undertaken within stands of red gums. Habitats targeted for *Eucalyptus cannonii* included footslopes and low ridges within inspections undertaken within stands of stringybarks. The morphology of other eucalypts was carefully examined in key locations for new species including *Eucalyptus expressa* (Bell and Nicholle, 2012) and *Eucalyptus* sp. aff. *fibrosa* (Klaphake 2010).

Surveys were also undertaken for the threatened shrub *Acacia pendula* (Weeping Myall) within grassland habitats.

Although not listed as threatened flora species, *Eucalyptus albens* (White Box) and *Eucalyptus moluccana* (Grey Box) and their hybrids are known to occur within TECs. The potential for hybrids of these two species were examined in the field and additional advice was sought from the National Herbarium of NSW. This information was taken into account, along with field experience within the landscape and observations on morphology and flowering within the Bylong Valley.

d. Shrubs of Sandstone Benches

Surveys for threatened shrubs that typically occur on sandstone bench habitats, including but not limited to *Commersonia rosea*, *Homoranthus darwinioides* and *Philotheca ericifolia* were undertaken throughout the survey periods within suitable habitat. This includes any areas of heath or scrub on sandstone benches. Surveys for *Pomaderris sericea* (Bent Pomaderris) were also undertaken within woodland and forest on sandstone ridges.

e. Shrubs of Talus Slopes and Gullies

Surveys for threatened shrubs that typically occur on talus slopes and/or gullies, including but not limited to *Ozothamnus tesselatus*, *Pomaderris queenslandica* (Scant Pomaderris) and *Prostanthera discolor* were undertaken throughout the survey period within suitable habitat. Habitats searched for these species included footslopes and associated drainage lines.

vi. Plant Identification

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993), Harden (2002) and Harden and Murray (2000). Other references used to assist identification of plant taxa include Bishop (2000), Richardson et al. (2006) and Jacobs et al. (2008). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust, 2015) or published in recognised scientific journals.

Flora species of uncertain identity were collected for later examination and any specimens that were not readily identifiable, or of significant status, were lodged for identification with the National Herbarium of NSW.

2.3.3 Data Analysis

i. Vegetation Mapping

Classification and ordination were performed on woodland and forest quadrat data to explore patterns in floristic data and to validate woody vegetation map units. Data analysis was performed on the raw cover-abundance scores obtained from the quadrat surveys within native plant communities using the PRIMER V6 (Clarke and Gorley, 2006) statistical package to examine patterns in vegetation composition across the site. Agglomerative hierarchical cluster analysis and non-metric multidimensional scaling were performed on the dataset using the group averaging strategy, the Bray-Curtis similarity measure and a Beta value of – 0.1. Ordinations were performed in two and three dimensions with 25 random starts and a minimum stress of 0.01. The SIMPROF routine in PRIMER V6 was used to examine structure in the data and look for significant splits, while the SIMPER routine was used to generate diagnostic species lists for each defined floristic group.

The RDPs collected within the Study Area were classified into vegetation units reflecting the results of the numerical analysis outlined above. The RDPs were extrapolated to polygons through use of the Voronoi areas algorithm in Manifold GIS, which was then manually edited to reflect observable phototype patterns on digital orthorectified imagery. The Voronoi areas algorithm creates polygons where the boundary of each polygon lies midway between all neighbouring points of differing identity.

The canopy identities within each of the 2,471 RDPs were also utilised to assist in the delineation of derived native grasslands within the Study Area. The RDPs were used to prepare a pre-clearance (i.e. pre-1750) map of the vegetation. The RDPs in combination with topography and drainage data provided a guide to the likely former landscapes. Analysis of the data in this manner allowed for the derived native grasslands within the Study Area to be attributed to the various vegetation communities that previously occurred within cleared areas. This, in conjunction with analysis of additional data, assisted in determining which areas of derived native grasslands conform to TECs.

Note that area values presented within this report are approximate and are derived from a combination of aerial photo-interpretation, field based mapping and data extrapolation.

ii. Threatened Ecological Communities

Following review of potentially occurring TECs, the vegetation communities identified within the Study Area were examined against the listings of TECs under the TSC Act and EPBC Act.

For TECs listed under the TSC Act, vegetation communities were examined against the final determinations for potentially occurring TECs. A component of this analysis was to compare the species listed from the locally defined communities with the species lists provided in the final determinations. This was undertaken through the use of the purpose-written software *Match Species To Communities v2*. Additional information such as location and biophysical aspects of each final determination were also taken into account in the assessment.

For TECs listed under the EPBC Act, vegetation communities were examined against the DoE Species Profile and Threats Database and any associated documentation, such as listing advice and policy statements.

Further discussion is provided below for the identification of Box Gum Woodland and Derived Native Grassland within the Study Area as listed under the TSC Act and EPBC Act.

a. Identification of Box Gum Woodland and Derived Native Grassland under the TSC Act

A detailed description that defines the Box Gum Woodland and Derived Native Grassland is included in the final determination made by the NSW Scientific Committee (2002b) to list the community 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.

The TSC Act Final Determination of the Box Gum Woodland Endangered Ecological Community (EEC) provides the following description of the community:

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

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

Paragraph 2 was used to guide the identification of intact woodland patches and paragraph 11 was used to guide identification of modified patches, including grassland. The TSC Act final determination makes a comment about the viability of areas that are to be included in the TSC Act listing. Grassland forms of the TSC Act listed Box Gum Woodland are required to exhibit a natural regenerative ability (assisted or unassisted) that would indicate a mostly intact soil bed and associated seed bank. Therefore, to be considered to meet the TSC Act definition of Box Gum Woodland, the grassland should be capable of assisted natural regeneration and not require active planting of trees and understorey. Areas of low quality grassland were considered to conform to the TSC Act listing of the community where they occurred within an approximate 50 m buffer from woodland patches or scattered trees.

Assessment of the condition of Box Gum Woodland and Derived Native Grassland was guided by the *Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland* (NSW NPWS, 2005), which includes an initial identification assessment. The guidelines identify the following condition classes:

- '1' - Multi-aged overstorey with a grassy, herb-rich understorey;
- '2' - Partially cleared/thinned stands with a mixture of native and exotic understorey species;
- '3' - Stands where White Box, Yellow Box or Blakely's Red Gum have been killed and other species dominate the canopy;
- '4' - Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box Gum Woodland understorey is present; and
- '5' - Degraded remnants that have few, if any, native species in the understorey.

b. Identification of Box Gum Woodland and Derived Native Grassland under the EPBC Act

The *EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived grasslands* (DEH, 2006) provides a prescriptive, detailed methodology for determining the presence of the Box Gum Woodland and Derived Native Grassland Critically Endangered Ecological Community (CEEC).

The flow chart that summarises the method for identifying the community demonstrates that to confirm the occurrence of this community as listed under the EPBC Act, it is firstly necessary to confirm the presence or historical presence of *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) and/or *Eucalyptus blakelyi* (Blakely's Red Gum) within the area of interest. Then, the vegetation needs to have a predominantly native understorey and the patch has to be greater than 0.1 ha in size. A patch is then assessed to determine if there are 12 native understorey non-grass species and at least one is an "important" native plant as signified in the list of characteristic species appended to the policy. If the vegetation satisfies these criteria, then it is considered to conform to the listing of the community. If the required understorey species are absent, the vegetation may still conform to the listing of the community if the patch is >2 ha in size and has either an average of 20 or more mature trees per hectare or there is natural regeneration of the dominant overstorey eucalypts.

Field surveys were designed to allow for assessment against the flow chart for identifying the community as well as the consideration of the *Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Threatened Species Scientific Committee, 2006).

Assessment of the condition of Box Gum Woodland and Derived Native Grassland was guided by the condition classes provided within the DoE listing advice. The three condition classes are:

- 'A' - An overstorey of eucalypt trees exists, but there is no substantial native understorey;
- 'B' - A native understorey exists, but the trees have been cleared; and
- 'C' - Both a native understorey and an overstorey of eucalypts exist in conjunction.

All three conditions have been assessed within the Study Area. The listing advice notes that 'areas in which an overstorey exists without a substantially native understorey are degraded and are no longer a viable part of the ecological community' (Threatened Species Scientific Committee, 2006). As such, only conditions B and C within the Study Area were assessed as conforming to the EPBC Act listing of the community.

2.3.4 Plant Community Names

Currently within NSW, the naming of plant communities is inconsistent across mapping projects, policies and legislation owing to a series of potential names that can be used for any given vegetation type – sometimes three or more names can be used for the same community. If they are TECs listed under the TSC Act and EPBC Act they can be named using names that are applied for a specific TEC. However, such TEC names are often used for large and widespread vegetation communities that are found over broad areas and which often have local variations. As such other regional and local names can, and often do, also apply. This means that some plant communities can have a valid local or regional name and also a separate TEC name.

The primary nomenclature used within this report is locally defined map units that were determined following field investigations within the Study Area and supported by numerical analysis of systematic plot data. Where relevant, the locally defined map units were matched with the equivalent TECs under the TSC Act and EPBC Act.

As the adequacy of the BOS for the project was assessed using the Framework for Biodiversity Assessment (FBA) (OEH, 2014i), the locally defined map units were matched to PCTs held within OEH's VIS Classification 2.1 System database (OEH, 2015b). Where locally defined map units were not readily matched to PCTs, best-fit communities were selected.

2.3.5 Survey Effort

Flora survey methods and survey effort are summarised in **Table 2.1**. Surveys have been undertaken over a number of periods, including:

- 31 October - 2 November 2011;
- 15-17 February 2012;
- 2-4 May 2012;
- 26-29 June 2012;
- 4-6 September 2012;
- 9-11 October 2012;
- 21-24 May 2013;
- 2-5 July 2013;
- 20-23 August 2013;
- 5-8 November 2013;
- 2-3 April 2014; and
- 7-11 May 2014.

CUMBERLAND ECOLOGY

Table 2.1 Flora survey effort

Survey Task	Dates	Survey Effort
Vegetation Mapping	31/10/2011-2/11/2011, 15-17/02/2012, 2-4/05/2012, 26-29/06/2012, 4-6/09/2012, 21-24/05/2013, 2-5/07/2013, 20-23/08/2013, 5-8/11/2013	2,471 RDPs and throughout survey period
Characterisation of non-woody vegetation units (grassland surveys)	*Eastcoast Flora Survey* 2-4/05/2012, 5-8/11/2013 *Cumberland Ecology* 2-3/04/2014, 9-11/04/2014	28 grassland plots (18 10 m x 10 m quadrats and ten 20 m x 20 m quadrats), 71 rapid grassland assessments points, 15 BioBanking plots
Characterisation of woody vegetation units (quadrat sampling)	15-17/02/2012, 26-29/06/2012, 4-6/09/2012, 9-11/10/2012, 21-24/05/2013, 2-5/07/2013, 20-23/08/2013, 5-8/11/2013	62 quadrats (20m x 20 m or 40 m x 10 m) (woody vegetation)
Threatened Species Searches	31/10/2011-2/11/2011, 15-17/02/2012, 2-4/05/2012, 26-29/06/2012, 4-6/09/2012, 9-11/10/2012, 21-24/05/2013, 2-5/07/2013, 20-23/08/2013, 5-8/11/2013	Throughout survey period, 52 km of transect searches (driving and foot traverses) for terrestrial orchids
Collection of metric data for quantification of impacts (BioBanking surveys)	7-9/04/2014, 5-9/05/2014	49 BioBanking plots (15 grassland plots and 34 woodland plots)

2.3.6 Limitations of Flora Survey

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 vast areas requiring surveys. Despite this, it is considered that the survey represents an accurate baseline of floristic information for the Study Area.

The Study Area is large and the topography poses difficulties of access to many areas due to steep slopes and a lack of good tracks to some areas. Additionally, there were access restrictions on some private properties occurring within the Study Area. Vegetation occurring within inaccessible areas was mapped by extrapolation of mapping within adjoining areas, taking into account soils, topography and aspect. Additionally, some vegetation communities were not sampled, however incidental observations of these communities were made to provide a description. Vegetation communities occurring within the Project Disturbance Boundary were surveyed further as part of BioBanking surveys.

Note that area values presented within this report are approximate and are derived from a combination of aerial photo-interpretation, field based mapping and data extrapolation. Due the extensive area of land within the Study Area, this approach is considered to be appropriate and provides adequate and reliable information for this EIA.

It is considered that the flora species of conservation value have been adequately targeted to enable a comprehensive EIA to be prepared and are considered to be consistent with the OEH guidelines for threatened species surveys (DEC (NSW), 2004). A range of threatened flora is known to occur in the locality and there is suitable habitat present within the Study Area for a number of these species. It is possible that some threatened species were undetected even though surveys were conducted during suitable survey periods. For this reason a precautionary approach was used in the preparation of this report to assume the presence of species (particularly threatened species) where the presence of suitable habitat was recorded.

Surveys for the grassland component of Box Gum Woodland and Derived Native Grassland are ideally undertaken in late autumn when annual species have died back (DEH, 2006). The first round of grassland surveys were undertaken in May 2012 when it was noted that a high diversity of species were present due to good rains in the lead up to the survey. Subsequent surveys corresponded to prolonged low rainfall, including the November 2013 survey and as such, grassland could not be surveyed adequately. Additional surveys were undertaken in April 2014 following several months of good rainfall which allowed for adequate assessment of grasslands, particularly within the Project Disturbance Boundary.

2.4 Fauna Survey

2.4.1 Introduction

Cumberland Ecology conducted fauna surveys across the Study Area from November 2012 to May 2014. The fauna surveys included fauna habitat assessments, terrestrial and arboreal trapping, hair tube trapping, bird censuses, active searches, ultrasonic bat call detection, harp trapping, spotlighting, call playback and infra-red camera (IR camera) detection. The survey design was guided by the following:

- DEC (NSW) (2004):Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft);
- DEWHA (2010d): Survey guidelines for Australia's threatened frogs;
- DEWHA (2010b): Survey guidelines for Australia's threatened bats;
- DEWHA (2010c): Survey guidelines for Australia's threatened birds;
- SEWPaC (2011a): Survey guidelines for Australia's threatened mammals; and
- SEWPaC (2011b): Survey guidelines for Australia's threatened reptiles.

The locations of all fauna survey sites are shown in **Figure 2.5** and fauna survey effort and dates are listed in **Table 2.2**.

2.4.2 General Habitat Assessment

General habitat assessments were undertaken within the Study Area throughout the survey period. Targeted habitat assessments were undertaken at a number of locations within the Study Area and included an assessment on the abundance of various habitat features (such as hollow-bearing trees, ground cover, rocky outcropping, water and mistletoes) as well as an assessment of the likelihood of occurrence of potentially occurring threatened fauna species.

2.4.3 Hollow-bearing Tree Assessment

Within forest and woodland, hollow-bearing tree assessments were conducted in conjunction with BioBanking surveys. A total of 34 plots (20 m x 50 m) were surveyed within treed areas within the Project Disturbance Boundary and immediate surrounds. For each hollow-bearing tree identified within each plot, the following details were recorded:

- Tree species;
- Approximate height;
- Approximate diameter at breast height; and
- Number and size of hollows.

The data obtained was used to determine approximate densities of hollow-bearing trees per hectare within the Project Disturbance Boundary.

2.4.4 Targeted Cliff Line Assessment

Targeted surveys of cliff line habitat were undertaken between 11 - 15 November 2013 across the extent and in the immediate vicinity of two potential underground extraction areas investigated as an option during the development and planning of the Project. Surveys included habitat assessments, IR camera surveys and scat searches. Other surveys described above were also located in proximity to cliff line habitat and have been taken into account within this assessment.

i. Habitat Assessments

Habitat assessments of the cliff lines included direct assessments and observation points. Direct assessments were undertaken within the immediate proximity of cliff lines. Observation points were undertaken at a distance from cliff lines with observations made through the use of binoculars.

Habitat data collected during habitat assessments included:

- Cliff form (vertical, concave, convex);

- Key habitat features (caves, cracks);
- Assessment of habitat suitability for the Brush-tailed Rock-wallaby, Large-eared Pied Bat and Broad-headed Snake based upon published ecological requirements for each animal;
- Aspect;
- Slope downhill of cliff line; and
- Photographs.

General observations were also made about the habitat values of the cliff lines and surrounding vegetation.

ii. IR Camera Detection

In order to conduct a general census of fauna moving within select cliff line habitats, IR cameras were set up at four locations specifically for the cliff line assessment and left *in situ* for approximately three months. Methods for IR camera surveys followed those outlined within ***Section 2.4.12***.

iii. Scat Searches

Cave-dwelling animals typically leave deposits of scats (faecal deposits) and these are often distinctive enough to enable species identification. Scat searches were conducted during traverses of cliff line habitats as well as at the base of caves and cracks. The searches were focused towards the habitats of cave-dwelling insectivorous bats and the vulnerable Brush-tailed Rock-wallaby (*Petrogale penicillata*), the latter of which has been recorded within the southern portion of the Study Area.

2.4.5 Trapping Transects

Trapping was undertaken to detect arboreal and terrestrial fauna. A total of 12 trap lines were established across the Study Area with each trap line comprising the following:

- 25 Elliot A traps for small terrestrial and arboreal fauna;
- 10 Elliot B traps for small to medium sized terrestrial and arboreal fauna; and
- 2 wire cage traps for large terrestrial fauna.

Spacing between the terrestrial Elliot traps was approximately 10 - 20 m. Arboreal traps were positioned along the terrestrial line in suitable habitat trees at a height of approximately 2 m. Wire cage traps were positioned at the start and middle of the terrestrial line. Elliot A and Elliot B traps were baited with a mixture of peanut butter, honey, bacon and rolled oats. Wire cage traps were baited with chicken necks. Trapping lines were checked in the morning, and any fauna captured were identified and released.

2.4.6 Hair Tube Transects

Hair tube sampling was undertaken to detect arboreal and terrestrial mammals. A total of eight hair tube transects were established across the Study Area. ‘Faunatech’ hair tubes, which target both small and medium sized fauna, were utilised. Each hair tube transect comprised 20 hair tubes with half placed on the ground and half on trees. Hair tubes were baited with a mixture of peanut butter, honey and rolled oats. Hair samples collected from the hair tubes were sent to Georgeanna Story of ‘Scats About’ for identification.

2.4.7 Diurnal Bird Surveys

Visual observation and call identification of diurnal birds was carried out throughout the Study Area during the survey period. Targeted bird surveys were undertaken at census points which included recording all bird species observed and heard calling during a 30 minute period. Diurnal birds were also identified and recorded as they were encountered throughout the Study Area during all other surveys. In addition, call playback was used to elicit a response from threatened diurnal bird species. GPS coordinates were recorded near sightings of any threatened bird species.

2.4.8 Amphibian and Reptile Surveys

Visual observation and call identification of amphibians and reptiles was carried out throughout the Study Area during the survey period, particularly in the warmer months. Targeted searches were undertaken within active search areas which included recording of all reptiles and amphibians observed and heard calling during a 30 minute period. Searches of suitable habitat involved lifting of bark, fallen logs, bush rock and scraping of top soil. Captured animals were identified and then released. Nocturnal searches for amphibians and reptiles were undertaken as part of the spotlighting survey. Searches for reptiles were also undertaken during surveys of cliff line habitats.

2.4.9 Microchiropteran Bat Surveys

i. Ultrasonic Call Detection

Ultrasonic call detection surveys for microchiropteran bats were undertaken using “Anabat” units. Anabat units were positioned in suitable habitat, such as along tracks and near caves. Anabat units were set to activate before dusk each evening and switch off after dawn. Data was collected from each site over a period of two nights. Ultrasonic calls collected from the Anabat units were sent to Greg Ford of ‘Balance Environmental’ for identification.

ii. Harp Trapping

Harp traps were set up at suitable flyway locations adjacent to the trapping transects and utilised for 2-3 nights at each site. Microbats were collected from harp traps at dawn and the bat species subsequently identified. All microbats collected from harp traps were kept in a cool dark place during the day, and released at the point of capture the following evening to prevent unnecessary stress on collected individuals.

2.4.10 Spotlighting Transects

Spotlighting surveys for amphibians, birds, mammals and reptiles were undertaken throughout the survey period. Spotlighting surveys were conducted using a handheld spotlight while walking, or from a slow moving vehicle. Incidental spotlighting was also conducted while travelling between transects at night.

2.4.11 Call Playback

During spotlighting surveys, call playback of nocturnal calls were broadcast using a megaphone to illicit a response from targeted threatened nocturnal species. The Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Koala (*Phascolarctos cinereus*), Squirrel Glider (*Petaurus norfolcensis*) and Spotted-tailed Quoll (*Dasyurus maculatus*) were targeted during call playback surveys. Call playback was followed with listening and spotlighting in the immediate vicinity.

2.4.12 IR Camera Detection

IR cameras were set up at numerous locations within the Study Area and utilised throughout the survey period. Three long-term (approximately 3 months) IR cameras were utilised for the duration of the main survey period. Additional short/medium-term IR cameras (approximately 1-6 weeks) were utilised on some trapping transects and on all hair tube transects, long-term IR cameras were utilised during cliff line surveys and medium-term cameras were utilised at an aquatic survey site. The cameras were attached to trees or boulders and focused upon nearby buried bait (chicken necks), tracks or habitat features. The cameras are triggered when nearby fauna movement activates the motion sensor. Cameras were set to record a series of three still images during each trigger. Recorded footage was analysed to identify the detected fauna species. All IR cameras used during surveys were Reconyx HC500 HyperFire Lo-Glow Semi-Covert cameras or Reconyx HC600 Hyperfire H.D Covert IR cameras.

2.4.13 Incidental Observations

Any incidental vertebrate fauna species that was 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. This included collection of data from all survey periods undertaken within the Study Area.

The locations of threatened fauna species incidentally observed during surveys were recorded with a GPS. This includes species observed by Eastcoast Flora Survey during flora surveys.

2.4.14 Survey Effort

Fauna survey methods and survey effort are summarised in **Table 2.2**. Surveys were undertaken during the following main survey periods:

- 12-16 November 2012;

- 18-22 February 2013;
- 20-24 May 2013; and
- 19-23 August 2013.

In addition to these survey periods, additional fauna surveys were undertaken during cliff line surveys (November 2013), aquatic surveys (March 2014), grassland surveys (April 2014) and BioBanking surveys (April-May 2014).

Some survey techniques, such as hair tube trapping and IR cameras, involved the ongoing use of equipment for weeks/months beyond the main survey periods defined above. Additional incidental data was also obtained when this equipment was collected.

Table 2.2 Fauna survey effort

Survey Technique	Dates	Survey Effort
General Habitat Assessment	12-16/11/2012, 18-22/02/2013, 20-24/05/2013, 19-23/08/2013	Throughout survey period and 25 targeted sites
Hollow-bearing Tree Assessment	5-9/05/2014	34 20 m x 50m plots
Targeted Cliff Line Assessment	11-15/11/2014	17 direct assessments and 18 observation points
Trapping Transects – Elliot A (terrestrial)	12-16/11/2012, 18-22/02/2013, 20-24/05/2013, 19-23/08/2013	1,200 trap nights (12 sites)
Trapping Transects – Elliot B (arboreal)	12-16/11/2012, 18-22/02/2013, 20-24/05/2013, 19-23/08/2013	480 trap nights (12 sites)
Trapping Transects - Cage	12-16/11/2012, 18-22/02/2013, 20-24/05/2013, 19-23/08/2013	96 trap nights (12 sites)
Hair Tube Transect	12-16/11/2012, 18-22/02/2013, 20-24/05/2013, 19-23/08/2013	5,760 trap nights (8 sites)
Bird Census	13-15/11/2012, 21/02/2013, 22-23/05/2013, 20-22/08/2013, 18-19/03/2014, 2/04/2014, 7-9/04/2014, 5-9/05/2014	42 hours (84 sites)
Amphibian and Reptile Survey	12-14/11/2012, 20-22/02/2013, 21-22/08/2013	7.5 hours (15 sites)
Ultrasonic Call Detection	12-16/11/2012, 18-22/02/2013, 22-24/05/2013	32 trap nights (16 sites)
Harp Trapping	13-15/11/2012, 19-22/02/2013, 21-24/05/2013, 19-23/08/2013	30 trap nights (12 sites)
Spotlighting Transect	14-15/11/2012, 19/02/2013, 21/02/2013, 21/05/2013, 23/05/2013, 20-22/08/2013	Approx. 27 person hours

CUMBERLAND ECOLOGY

Table 2.2 Fauna survey effort

Survey Technique	Dates	Survey Effort
Call Playback	14-15/11/2012, 19/02/2013, 21/02/2013, 21/05/2013, 23/05/2013, 20-22/08/2013	16 sites
IR Camera Detection	14/11/2012 – 25/02/2014, 2/04/2014-12/05/2014	34 sites (1,699 nights)

2.4.15 Limitations of Fauna Survey

Data obtained from the fauna surveys are a "snapshot" in time and illustrate the fauna that were active during the time of the surveys. The data produced by the surveys is intended to be indicative of the types of species that could occur and not an absolute census of all vertebrate fauna species occurring within the Study Area. It is likely that if continued field sampling was undertaken within the Study Area, additional species could be identified.

As well as providing an overall census of the vertebrate fauna recorded within the Study Area, the survey also targeted threatened species predicted to occur. The targeted threatened species surveys generally utilised survey techniques outlined within the OEH guidelines and DoE, however in some instances the recommended effort for each technique was not utilised. Some additional survey techniques were used in conjunction, or as substitutes for, the techniques listed within the guidelines, particularly IR cameras. This approach is considered to be consistent with the guidelines which state that "*selection of the survey methods required will depend on the investigator's assessment of the types of animals (and habitats) potentially present on the site, based on the preliminary assessment and habitat assessment*" (DEC (NSW), 2004).

i. OEH Guidelines

Key variations to the minimum requirements for surveys are explained below:

- Wire cage traps: were deployed in lower numbers than guidelines suggest, as the number of cages utilised was considered appropriate for the one threatened species targeted, Spotted-tailed Quoll (*Dasyurus maculatus*). The lower numbers of wire cage traps were compensated for by analysis of database records for this species and by the use of IR cameras in woodland areas;

- Hair Tubes: As conical 'Faunatech; hair tubes, which can sample both small and large mammals, were utilised, it negated the need to use two different sizes of hair tubes;

- Arboreal hair tubes: were deployed in lower numbers than guidelines suggest, as the number of arboreal hair tubes utilised was considered appropriate for the species targeted. Other survey methods supplemented the survey effort for these species, such as arboreal Elliot B trapping and IR cameras;

- Call playback was not repeated at each fauna survey site as it was considered more appropriate to undertake surveys across the Study Area instead of at a few locations; and

- Bat Survey: A combination of harp trapping and ultrasonic call detection was used to target microbat species considered likely to occur in the locality.

The Commonwealth listed threatened Swift Parrot (*Lathamus discolor*) is relatively rare, migratory and only present on the Australian south-east mainland between March and October (OEH, 2012q). Targeted surveys for these species have been undertaken during winter within the Study Area. Available information suggests that the area surrounding the Study Area is not a major foraging area for this species and it is considered that the survey effort for this species is sufficient.

It is considered that the fauna species of conservation value have been adequately targeted to enable a comprehensive EIA to be prepared and are considered to be consistent with the OEH guidelines for threatened species surveys (DEC (NSW) 2004). The guidelines state that "*where limitations cannot be overcome, an assessment of the likelihood of threatened animals utilising the habitat must be made in order to comply with legislation… If it is not possible to sample for threatened species (eg. bats, frogs) previously recorded in the general area during appropriate seasons and weather conditions, it must be assumed that these species occur in the study site if suitable habitat exists*". A precautionary approach was used in the preparation of this report to assume the presence of species (particularly threatened species) where the presence of suitable habitat was recorded.

ii. DoE Guidelines

The DoE threatened species survey guidelines were consulted to inform survey effort and methodology. The guidelines state that: "*These guidelines are not mandatory. Proposals failing to meet these survey guidelines for reasons of efficiency, cost or validity will not necessarily default to a judgement that referral is required (that is, that a significant impact is likely), especially where the proponent issues an evidence-based rationale for an alternative survey approach.*"

Survey guidelines for threatened birds have been met, with targeted searches for the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*) occurring in areas of flowering eucalypts during winter. Additional surveys were undertaken throughout the survey period. As with other species with potential to utilise habitat within the Study Area, a precautionary approach has been taken and threatened and migratory species are assessed as though they are present.

DoE survey guidelines for threatened bats do not provide guidance for areas of habitat greater than 50 hectares. Based on the 50 hectare survey guidelines, survey guidelines have been exceeded for all bat species. However; greater than 50 ha of suitable habitat exists for each species within the Study Area. As such, conducting the level of survey effort required to fulfil the minimum guidelines per 50 ha (up to 20 trap nights per 50 ha for some species) was considered unfeasible. It is believed that the survey effort was appropriate, as one nationally threatened species, the Large-eared Pied Bat (*Chalinolobus dwyeri*), was detected on numerous occasions within the Study Area through both ultrasonic detection and harp trapping.

Survey guidelines for threatened mammals were met, with appropriate searches for individuals, scats and habitat searches undertaken. Additionally, trapping detected one threatened mammal, the New Holland Mouse (*Pseudomys novaehollandiae*), therefore trapping effort was considered appropriate for small mammals. Furthermore, baited infra-red cameras were deployed in areas of habitat suitable for the Brush-tailed Rock-wallaby (*Petrogale penicillata*) and Spotted-tailed Quoll (*Dasyurus maculatus*).

Surveys for threatened reptiles are considered broadly adequate, as nocturnal active and spotlighting searches were undertaken in suitable habitat for the Broad-headed Snake (*Hoplocephalus bungaroides*). Although no threatened reptiles were detected, a precautionary approach has been taken and impacts to the species are assessed based on the presence of suitable habitat.

Where surveys have not met minimum guidelines for species and a species has not been detected, alternate methodologies have been utilised to determine the likelihood of the species' occurrence on site, and the significance of impact to that species as a result of the Project. Alternate methodologies include analysis of fauna record databases to determine the presence of species within the locality and within the Study Area, an assessment of habitat suitability through vegetation survey and targeted habitat assessment, and a literature review of relevant research conducted on species to determine home ranges, habitat requirements and movement patterns. A precautionary approach has been taken; thus where suitable habitat occurs within the Study Area and records exist within the locality, the species is assumed to be present, and the significance of impact to the species is assessed as such.

2.5 Aquatic Survey

A broad assessment of the Hunter River catchment (within which the Study Area lies) was carried out by aerial photography to assess the likely general condition of the rivers within the catchment based on the land uses present.

Surveys were conducted of aquatic environments within the Study Area between 18 and 19 March 2014 by Cumberland Ecology. These surveys provide baseline habitat data for development of future monitoring programs for the Project. Surface water quality data collected by Douglas Partners, surface water flow data obtained from the NSW Office of Water and rainfall records from the Australian Bureau of Meteorology have been used to complement the aquatic survey results. These results have been incorporated into the current survey results to provide a comprehensive assessment of the aquatic biodiversity within the Study Area.

Aquatic surveys were conducted in accordance with The Australia Wide Assessment of River Health: NSW AusRivAS Sampling and Processing Manual (Turak and Waddell, 2001b). This approach involved undertaking habitat assessments, in-situ water quality measurements and collecting aquatic macro-invertebrate samples to provide an indication of the current condition of the aquatic survey locations. The aquatic survey did not include vertebrate sampling (e.g. fish), as no permanent watercourses were identified to occur within the Study Area.

The locations of aquatic survey sites focused on waterways potentially impacted by the Project and are shown on **Figure 2.6**. Sites also focused on locations where water was known to be relatively permanent within the Study Area. A total of 11 sites were surveyed within the Study Area, with the reach of each site being 100 m, in accordance with AusRivAS (because the modal width at each site was less than 10 m). Habitat assessments were undertaken at all surveyed sites, however water quality measurements and macro-invertebrate sampling was only undertaken at six of these sites, as these were the only sites within which surface water was present at the time of the survey.

2.5.1 Aquatic Habitat Assessments

The following observations were recorded to assess habitat potential at each aquatic survey location:

- Current land use and visual site assessment of disturbance related to human activities; and
- Site attributes including the following:
  - Topography;
  - Water level;
  - Riparian vegetation cover;
  - Water body width; and
  - Natural substrate description.

2.5.2 Macro-invertebrate Sampling

Macro-invertebrate sampling was conducted at six of the aquatic sites within the Study Area (i.e. where water was present). There were no riffle habitats within the Study Area, as a result only edge habitats were surveyed (i.e. areas along the creek bank with little or no flow). Within each site, all types of edge habitat were surveyed across a total length of 10 m of habitat. Surveys involved using a 250 micron mesh "kick net" to agitate the vegetation and substratum in the edge habitat, dislodging macro-invertebrates and allowing them to be collected by sweeping the net through the water.

Macro-invertebrate samples were live-sorted for a minimum of 40 minutes to maximise the diversity of macro-invertebrates collected. Active, common taxa were selected first, followed by searches for cryptic and/or smaller taxa. Specimens were preserved in 70% ethanol and labelled for further analysis. Macro-invertebrate analysis involved identification to family level. Some taxa were sorted to phylum, sub-family and class, as recommended by the AusRivAS guide. All macro-invertebrates were identified using taxonomic keys and aquatic invertebrate guides (Hawking and Smith, 1997; Turak and Waddell, 2001b; Chessman, 2003).

A PRIMER analysis was conducted to assess the similarity of the macro-invertebrate communities between sites within the Study Area. The macro-invertebrate data collected was also analysed using AusRivAS and Stream Invertebrate Grade Number – Average Level 2 (SIGNAL2) Analysis. These analyses are two separate macro-invertebrate scoring methods that can provide an indication of the status of the macro-invertebrate community and water quality, allowing an understanding of aquatic health.

i. PRIMER Analysis

To gain an appreciation of how similar the survey sites were in terms of macro-invertebrate assemblages, a Multi-Dimensional Scaling (MDS) plot was produced using PRIMER. The MDS plot shows graphically how similar macro-invertebrate communities at each site are to each other, whereby the closer the symbols, the more similar the assemblage.

ii. AusRivAS Analysis

AusRivAS is a set of computer models that compare the presence of macro-invertebrates collected from a sample site with a database from a large number of reference sites throughout Australia. The AusRivAS models compare the sample site to reference sites for similar types of streams in the same State or region; reference sites are those believed to be least altered by human activity. If the test site is lacking the macro-invertebrate families that are expected to occur, according to the reference site database, it is likely that the test site is more affected by human influences than the reference sites (Turak and Waddell, 2001a).

It should be noted that AusRivAS is designed to assess riffle and edge habitats within permanent streams and rivers. The technique uses rapid bio-assessment procedures to calculate river condition and only provides a preliminary indication of aquatic health and a broad indication of the habitat quality.

iii. SIGNAL2 Analysis

SIGNAL2 analysis was used to provide an indication of water quality in the sampling sites based on an analysis of the macro-invertebrates present at each site. SIGNAL2 assigns a value to each invertebrate family based on its sensitivity to pollution. A grade of 10 represents high sensitivity to pollution, while a grade of 1 represents high tolerance to pollution. Based on the invertebrates recorded from each site, SIGNAL2 assigns each site an overall 'score' between 1 and 10. SIGNAL2 scores are plotted against the taxonomic richness (total number of invertebrate families present) to assess aquatic health. High numbers of pollution sensitive taxa would result in a high SIGNAL2 score (close to 10), combined with a high taxonomic richness, this indicates that the aquatic site has relatively high water quality. Conversely, the presence of pollution tolerant taxa and a low taxonomic richness would indicate relatively poor water quality at a site, likely caused by pollution.

CUMBERLAND ECOLOGY

2.5.3 Assessment of Fish Species

The aquatic survey did not include vertebrate sampling (e.g. fish) as no permanent flowing waterways occur within the Study Area. Any fish species observed incidentally during aquatic surveys were recorded. An assessment of the potential occurrence of native fish species was guided by the results of database analysis. Database searches included interrogation of the OEH Atlas of NSW Wildlife (OEH, 2014b) and the NSW Department of Primary Industries Species Protection Database (DPI, 2014d).

2.6 Weather Conditions

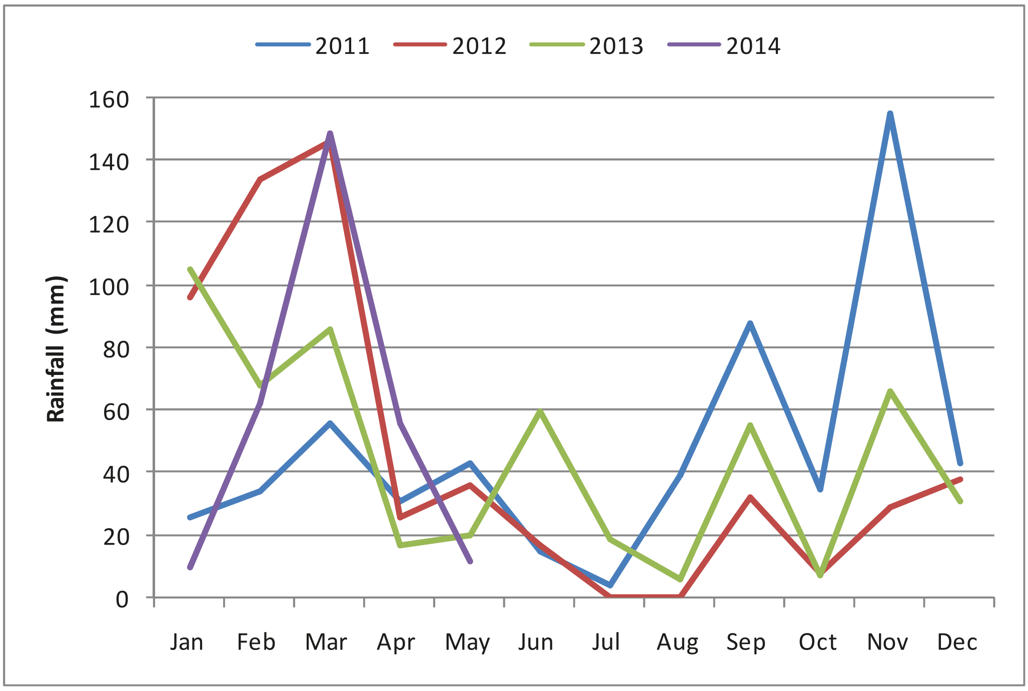
Weather conditions during flora and fauna surveys were generally appropriate for detection of a wide variety of flora and fauna. A summary of monthly rainfall data is shown in **Graph 2.1** and the weather conditions during the main fauna survey period are shown in **Table 2.3**.

The weather conditions at the time of the flora surveys were generally favourable for plant growth and production of features required for identification of most species. However, some survey periods were not considered suitable for grassland surveys, due to the preceding dry period (e.g. November 2012).

Conditions leading up to and during the first and second fauna survey periods were generally warm to hot with little rainfall. Conditions leading up to the third and fourth fauna survey periods were cool, with overnight temperatures during the fourth fauna survey period dropping to below 0ºC. One day of moderate rainfall occurred during the third fauna survey period.

The aquatic surveys were performed on clear sunny days, providing optimum conditions for live sorting of the macro-invertebrates. There was a total of 26 mm of rainfall recorded in the two weeks prior to sampling, providing some water to the catchment, but no recent flooding (which has the potential to affect the macro-invertebrate communities by washing them downstream).

CUMBERLAND ECOLOGY



Graph 2.1 Average rainfall data at Bylong (Glenview) station (Bureau of Meteorology, 2015)

Table 2.3 Weather conditions during the main fauna survey periods

Date	Minimum Temperature (ºC)*	Maximum Temperature(ºC)*	Rainfall (mm)^
12/11/2012	5.3	29.6	0.0
13/11/2012	8.8	33.9	0.0
14/11/2012	13.2	29.7	1.0
15/11/2012	14.7	32.5	0.0
16/11/2012	15.7	20.8	0.0
18/02/2013	13.8	27.7	0.0
19/02/2013	16.6	29.3	0.0
20/02/2013	16.0	28.6	0.0
21/02/2013	16.6	27.2	0.0
22/02/2013	16.6	24.8	1.0
20/05/2013	2.7	18.3	0.0
21/05/2013	3.5	21.4	0.0
22/05/2013	7.6	13.1	0.0
23/05/2013	8.7	15.6	12.0
24/05/2013	7.2	18.7	0.0
19/08/2013	5.2	19.5	0.0

CUMBERLAND ECOLOGY

Table 2.3 Weather conditions during the main fauna survey periods

Date	Minimum Temperature (ºC)*	Maximum Temperature(ºC)*	Rainfall (mm)^
20/08/2013	0.2	12.5	0.0
21/08/2013	0.9	15.3	0.0
22/08/2013	-0.8	17.1	0.0
23/08/2013	3.4	16.9	0.0

** Data obtained from the Merriwa (Roscommon) station (Bureau of Meteorology, 2015)*

^ Data obtained from the Bylong (Glenview) station (Bureau of Meteorology, 2015)

2.7 Offset Area Surveys

Detailed flora and fauna surveys have been undertaken within the offset areas for the Project. This included surveys undertaken as part of this EIA as well as additional targeted surveys. A description of the types of surveys, effort and limitations are provided in the EIS Biodiversity Offsets Report.

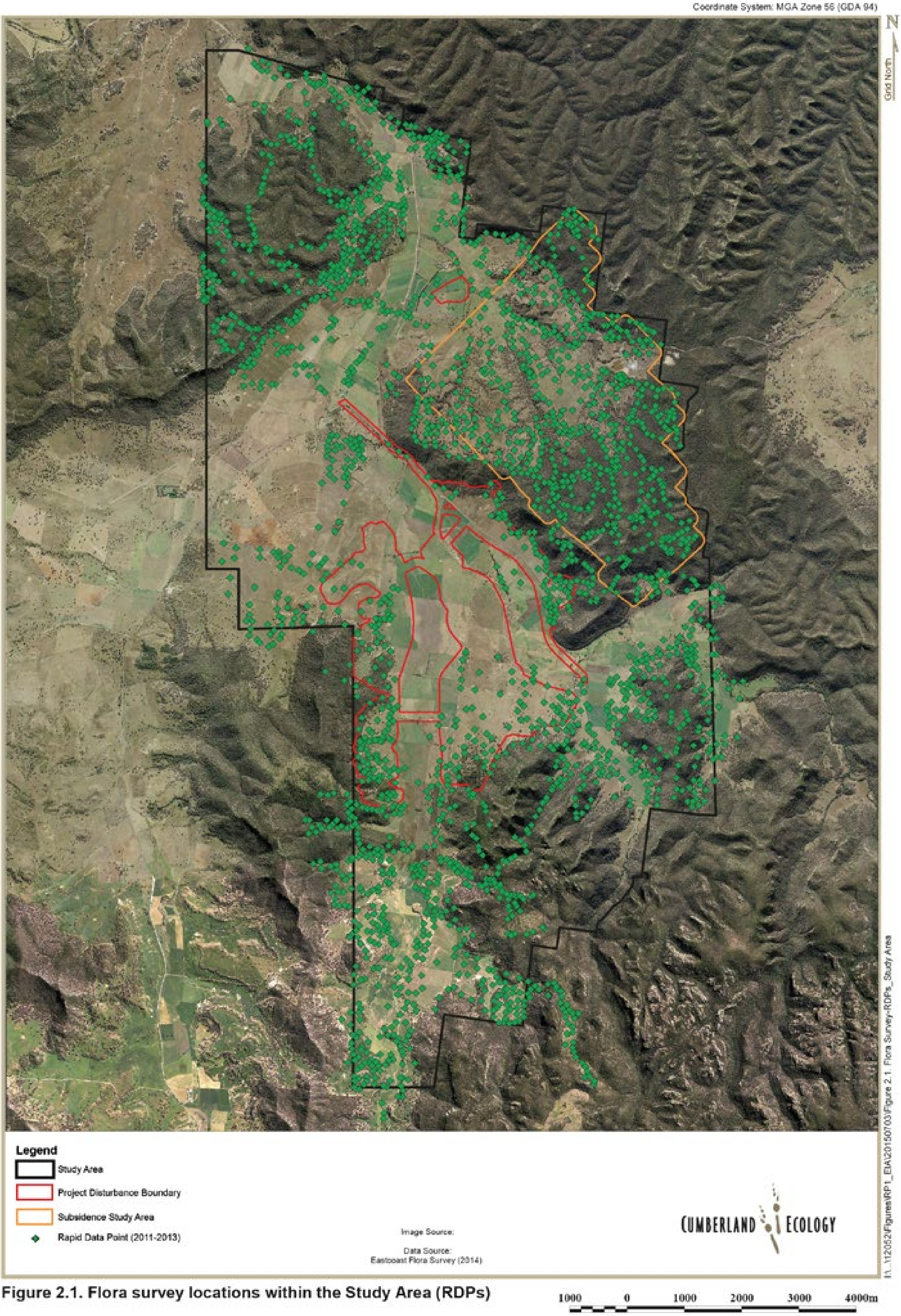


Figure 2.1. Flora survey locations within the Study Area (RDPs)

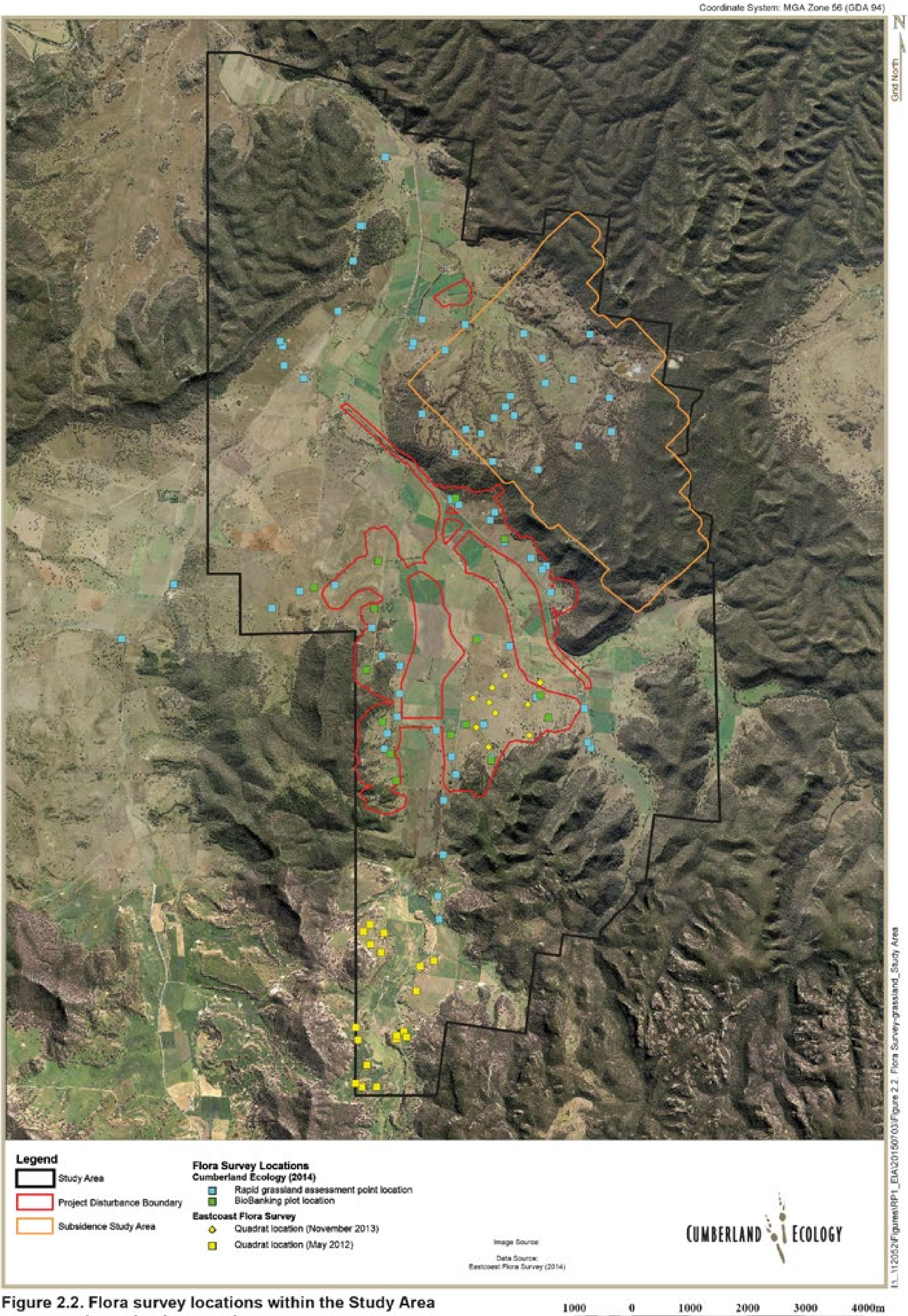


Figure 2.2. Flora survey locations within the Study Area (grassland surveys)

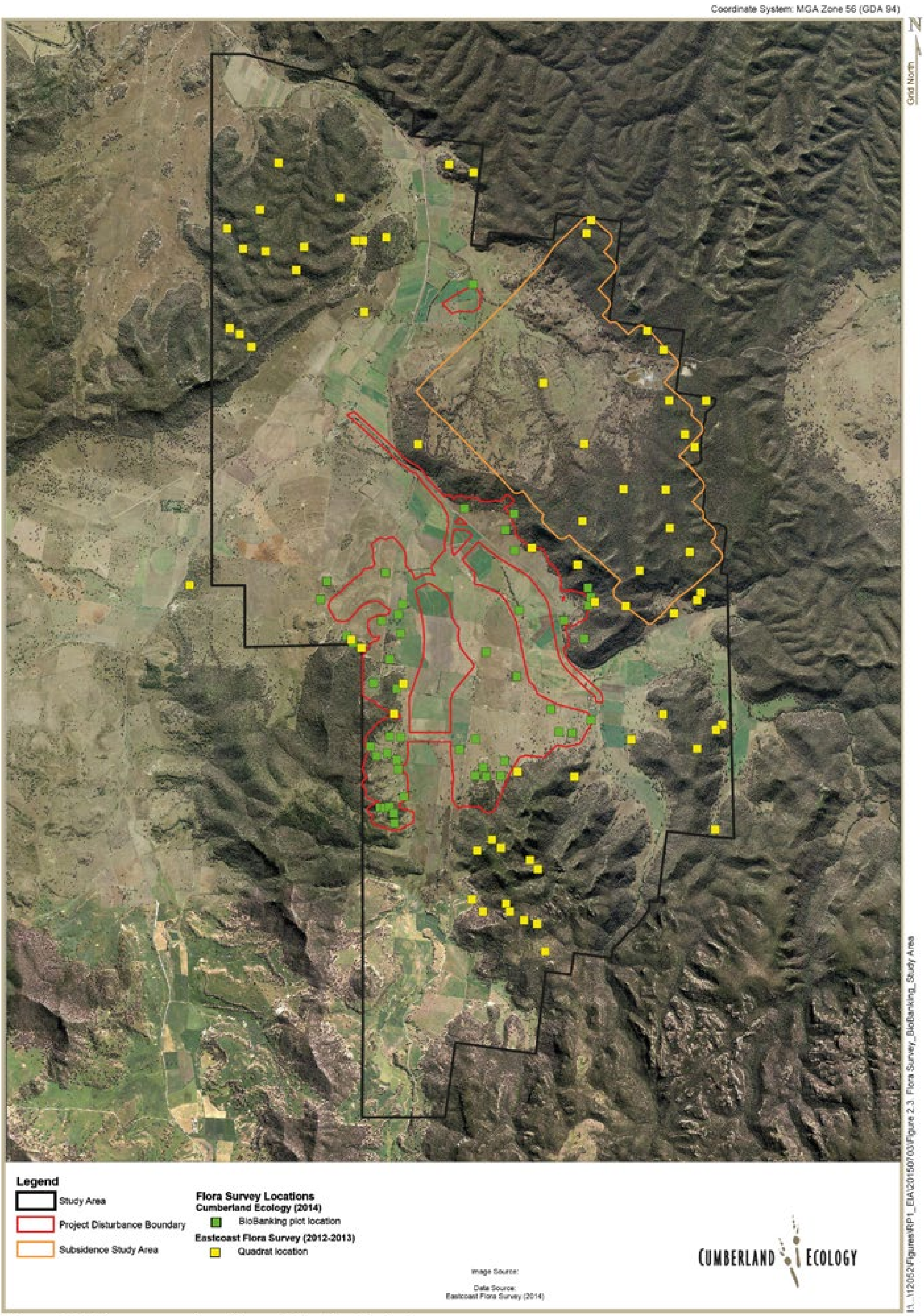


Figure 2.3. Flora survey locations within the Study Area (quadrat and BioBanking surveys)

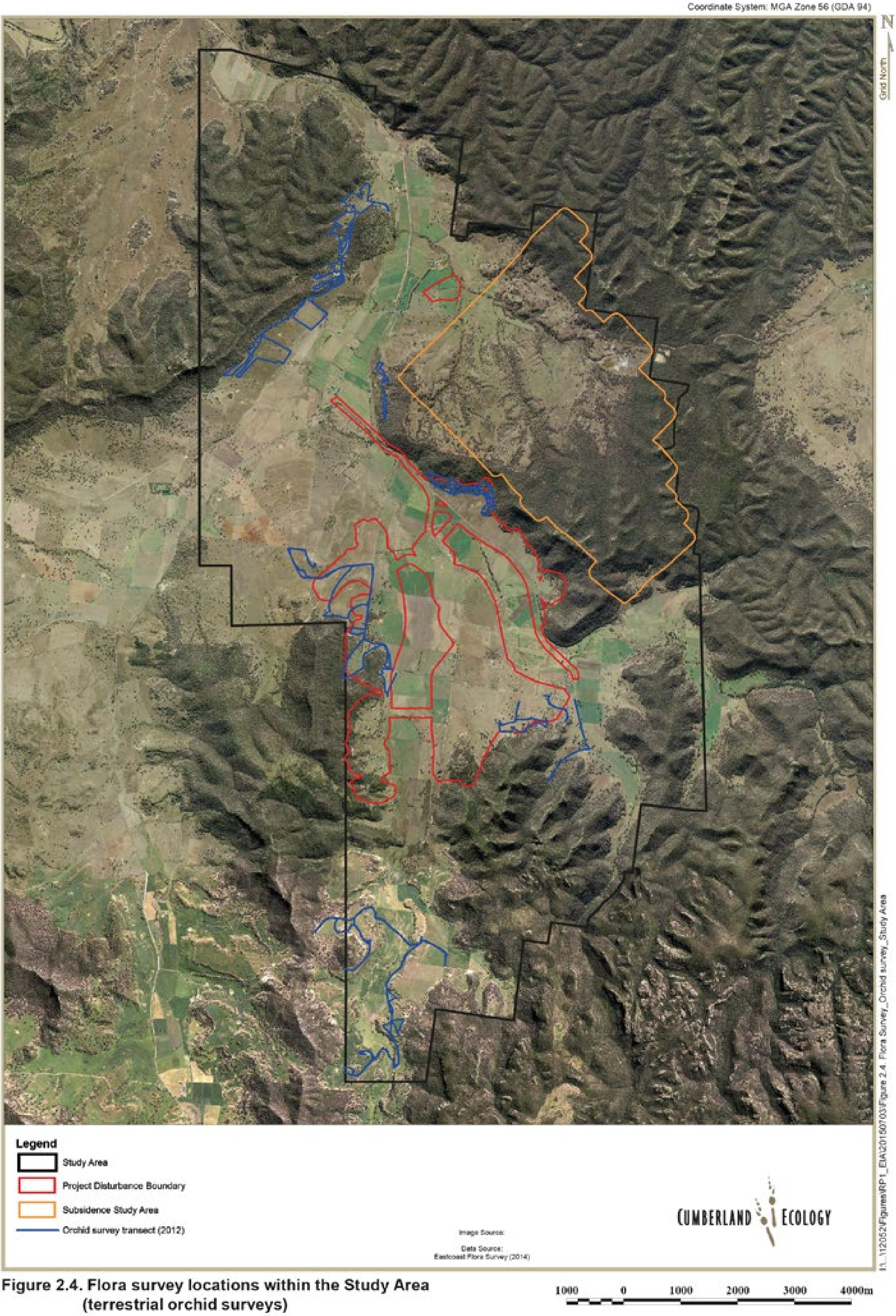


Figure 2.4. Flora survey locations within the Study Area (terrestrial orchid surveys)

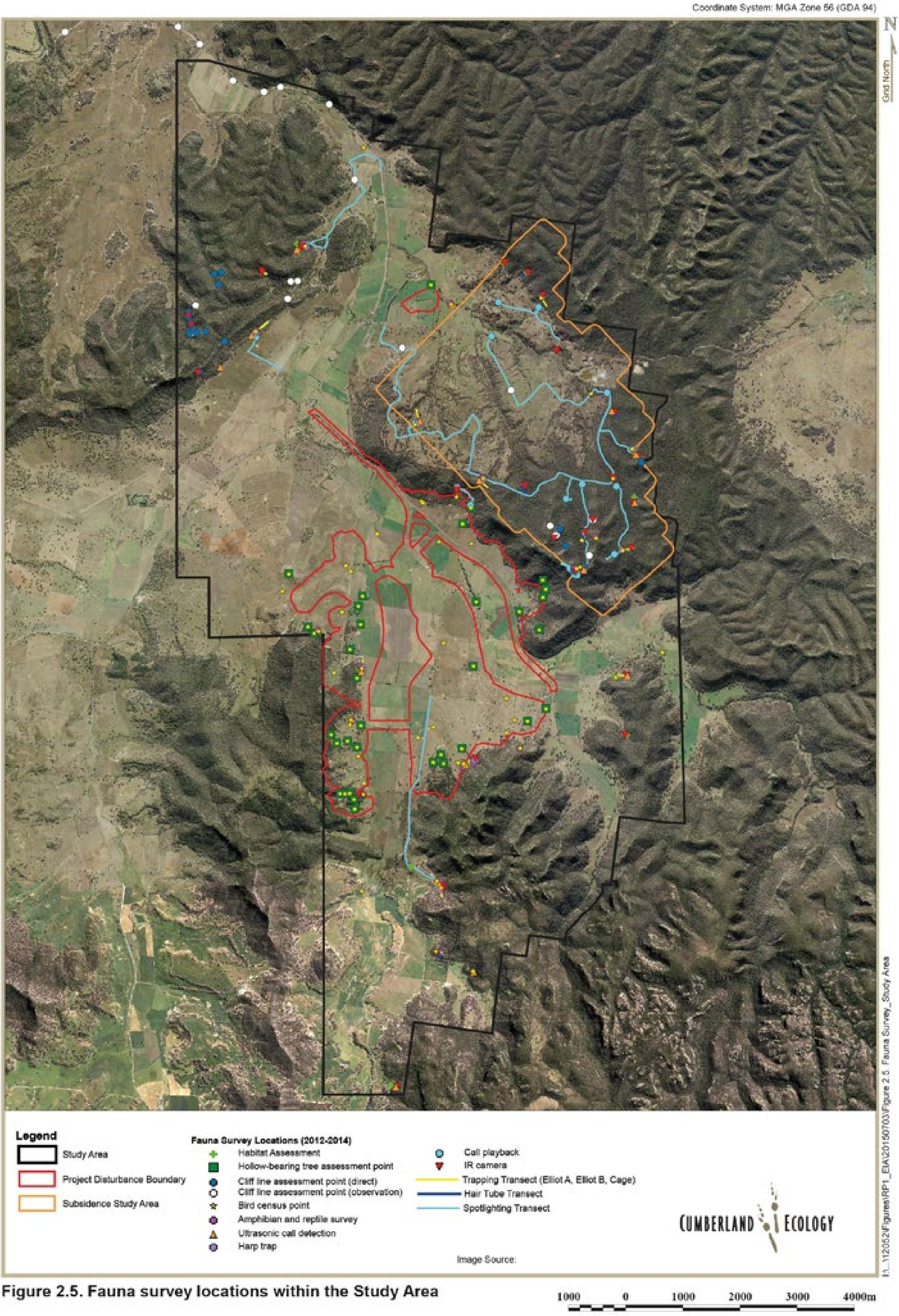


Figure 2.5. Fauna survey locations within the Study Area

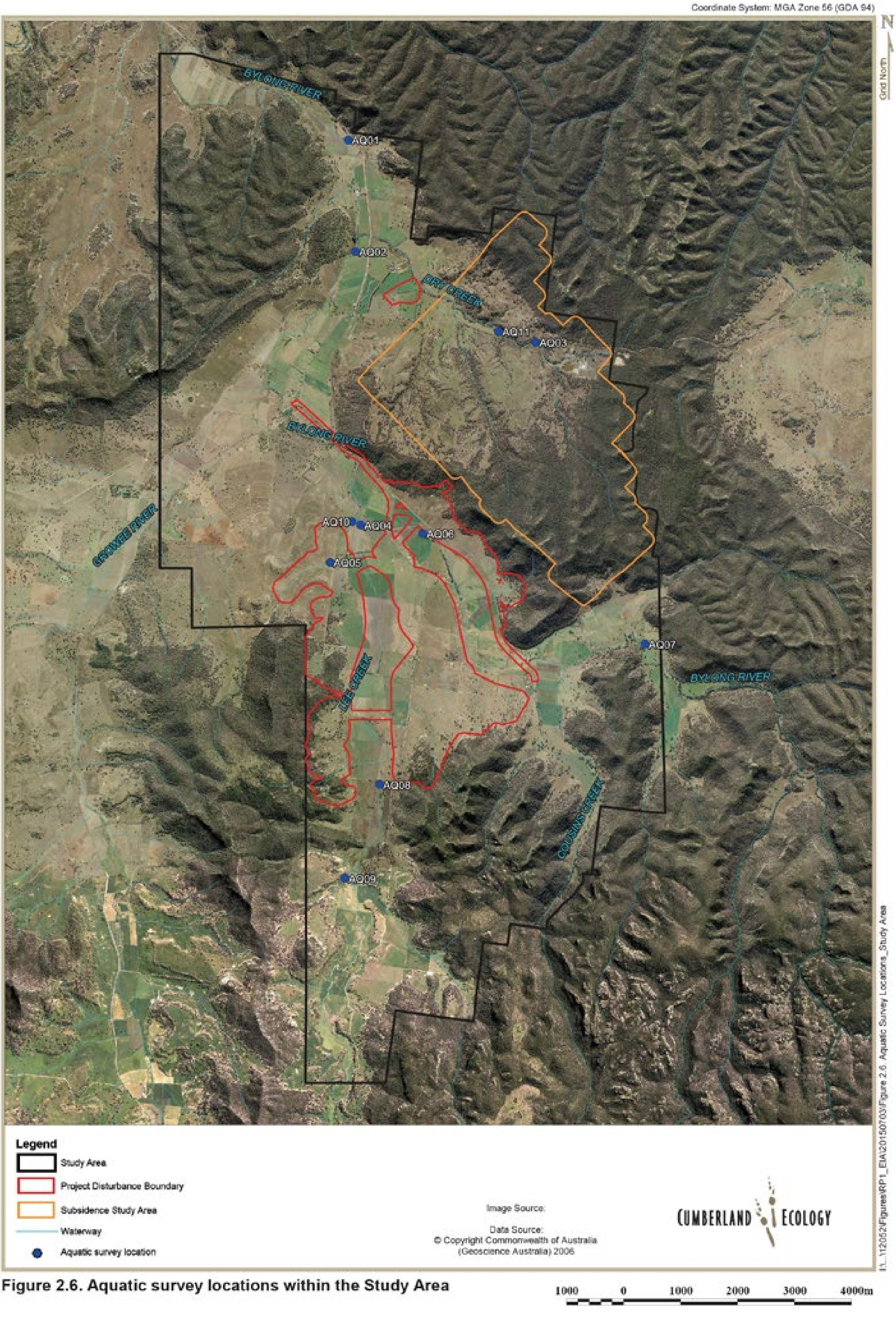


Figure 2.6. Aquatic survey locations within the Study Area

CUMBERLAND ECOLOGY

Chapter 3

Results: Flora

3.1 Overview

Vegetation within the Study Area includes intact patches of native woodland and forest, partially disturbed woodland and forest remnants, derived native grassland and cultivated lands. The Study Area has also had a history of agricultural development. Such land use has resulted in the degradation and clearing of native vegetation on the valley floor and lower slopes. Intact vegetation within the Study Area is typically associated with the slopes, escarpments, ridgelines and plateaus which have not been used for agriculture or forestry.

Woody vegetation within the Study Area is dominated by a variety of eucalypts forming both grassy and shrubby woodlands. In general, low-lying lands within the Study Area contain box-type eucalypts of various kinds and correspond to an overall topographical sequence. Some of these communities occur as highly restricted remnants of vegetation due to past land use.

Lower lying alluvial slopes along Bylong Valley support remnant stands of *Eucalyptus conica* (Fuzzy Box), which then grade into *Eucalyptus moluccana* (Grey Box), then *Eucalyptus albens* (White Box) or *Eucalyptus dawsonii* (Slaty Gum) on slopes, with *Eucalyptus melliodora* (Yellow Box) on higher basalt soils. The sandstone hills are more complex, with differing aspects and soil depths dictating the distribution of vegetation communities. Ironbark-dominated forests are the most widespread in sandstone areas. Riparian vegetation has historically been cleared and now occurs as highly degraded woodland in scattered patches.

Good condition vegetation is typically associated with the slopes, escarpments, ridgelines and plateaus of intact vegetation which has not been used for agriculture or forestry. Due to the largely inaccessible nature of these areas, fewer disturbances to the flora and fauna values have occurred. Vegetation within these areas is structurally diverse and includes formations along gullies, slopes, ridgelines and plateaus. Remnant patches of woodland surrounded by cleared and woodland immediately adjacent to cleared land have varying levels of invasion by exotic species.

Much of the cleared land within the Study Area is degraded to varying degrees by agricultural practices. A number of areas are heavily impacted by agriculture and exist as crops and/or pasture. Many areas of grassland adjacent to heavily impacted land comprise a mix of native grass and pasture cover, often with a low diversity of herbaceous native species. Years of agricultural use of these areas have resulted in a variety of ecological impacts including weed invasion, nutrient enrichment and soil erosion.

3.2 Vegetation Communities

Twenty-four (24) locally-defined vegetation communities have been mapped by Eastcoast Flora Survey as occurring within the Study Area. Of these, three contain variants based on structure and land use history. **Table 3.1** lists the vegetation communities occurring within the Study Area and their area of occupancy. A table aligning each of these communities with other relevant nomenclature is provided in **Appendix B**. Summary descriptions of the communities by Eastcoast Flora Survey are provided below and their distribution within the Study Area is shown in **Figure 3.1**. Further floristic information on each of these communities is provided in **Appendix B**.

Table 3.1 Vegetation communities occurring within the Study Area

Vegetation Community	Area (ha)~
1: Rusty Fig Dry Rainforest	1
2: Grey Myrtle Dry Rainforest	5
3: River Oak / Redgum Riparian Woodland	39
4: Blakely's Red Gum / Apple Riparian Forest	161
5: Blakely's Red Gum / Paperbark Forest	15
6: Yellow Box Woodland	161
7: White Box Woodland	
7a: White Box Woodland (Grassy)	714
7b: White Box Woodland (Shrubby)	502
8: Blakely’s Red Gum Woodland	
8a: Blakely’s Red Gum Woodland (Grassy)	16
8b: Blakely’s Red Gum Woodland (Shrubby)	22
9: Slaty Box Woodland	1,144
10: Coastal Grey Box Woodland	100
11: Fuzzy Box Woodland	60
12: Calytrix Rockplate Heath	8
13: Shrubby Regrowth	199
14: Dwyer's Red Gum Low Open Forest	70
15: Caley's Ironbark Forest	514
16: Blue-leaf Ironbark / Cypress Forest	911*
17: Red Ironbark / Cypress Forest	154
18: Cypress Pine Forest	82

CUMBERLAND ECOLOGY

Table 3.1 Vegetation communities occurring within the Study Area

Vegetation Community	Area (ha)~
19: Bloodwood / Ironbark Forest	29
20: Scribbly Gum / Grey Gum Forest	6
21: Exposed Grey Gum / Stringybark Forest	295^
22: Sheltered Grey Gum / Stringybark Forest	
DNG: Derived Native Grasslands	
DNG – 3: River Oak / Redgum Riparian Woodland Derived Native Grassland	453#
DNG – 4: Blakely's Redgum / Apple Riparian Forest Derived Native Grassland	
DNG – 6: Yellow Box Woodland Derived Native Grassland	137
DNG – 7: White Box Woodland Derived Native Grassland	1,114
DNG – 8: Blakely's Redgum Woodland Derived Native Grassland	10
DNG – 9: Slaty Box Woodland Derived Native Grassland	152
DNG – 10: Coastal Grey Box Woodland Derived Native Grassland	838
DNG – 11: Fuzzy Box Woodland Derived Native Grassland	284
CC: Cultivated Lands	2,025
Other (cleared, planted vegetation)	90
TOTAL+	**10,313**

Includes areas of Caley's Ironbark Forest (Unit 15) (see* ***Section 3.2.16**)*

^ Exposed Grey Gum / Stringybark Forest (Unit 21) and Sheltered Grey Gum / Stringybark Forest (Unit 22) are mapped concurrently

 # River Oak / Redgum Riparian Woodland Derived Native Grassland (Unit DNG – 3) and Blakely's Redgum / Apple Riparian Forest Derived Native Grassland (Unit DNG – 4) are mapped concurrently

+ In some cases totals may not equal the appropriate total number due to rounding

~ Area calculations are approximate

3.2.1 Rusty Fig Dry Rainforest (Unit 1)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

A single location within the Study Area supports a stand of *Ficus rubiginosa* (Rusty Fig) dry rainforest on a low rocky ridge. Associated with this vegetation is the emergent canopy species *Eucalyptus punctata* (Grey Gum) and high amounts of sandstone and conglomerate rock outcrop. The rocky, conglomerate nature of this site contributes to niche development favoured by figs through water retention capabilities. This community is shown in **Photograph 3.1**.

Photograph 3.1 Rusty Fig Dry Rainforest

3.2.2 Grey Myrtle Dry Rainforest (Unit 2)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

A few well protected gullies and lower slopes south of Bylong State Forest and in Crown land in the southern portion of the Study Area support narrow bands of Grey Myrtle Dry Rainforest. *Backhousia myrtifolia* (Grey Myrtle) typifies this community, but emergent *Eucalyptus punctata* (Grey Gum) and occasionally *Eucalyptus albens* (White Box) also occur. Few understorey species are present in this type due to dense shading from *Backhousia*, but *Notelaea longifolia* (Large Mock-olive) is normally present, with *Gahnia aspera* (Rough Saw-sedge) common on the ground. This community is shown in **Photograph 3.2**.

Photograph 3.2 Grey Myrtle Dry Rainforest

3.2.3 River Oak / Redgum Riparian Woodland (Unit 3)

Conservation Status:

TSC Act: Hunter Floodplain Red Gum Woodland (EEC)

EPBC Act: Not listed

General Description:

Areas where high energy flows of water can occur seasonally along the Bylong River and parts of Lee Creek support an intermittent gallery forest or woodland of *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) with occasional *Eucalyptus camaldulensis* (River Red Gum), *Eucalyptus blakelyi* (Blakely's Red Gum) or *Angophora floribunda* (Rough-barked Apple). Associated shrub and ground layer species typically comprise a high proportion of weeds, and a long history of grazing has degraded many kilometres of this vegetation type. This community is shown in **Photograph 3.3**.

Photograph 3.3 River Oak / Redgum Riparian Woodland

CUMBERLAND ECOLOGY

3.2.4 Blakely's Redgum / Apple Riparian Forest (Unit 4)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Areas where *Eucalyptus blakelyi* (Blakely's Red Gum) and/or *Angophora floribunda* (Rough-barked Apple) dominate the canopy occur principally in areas associated with drainage lines, and adjacent to channel-restricted River Oak / Redgum Riparian Woodland. Remnant trees along riparian areas and adjacent flats bear testament to a community now all but cleared. *Eucalyptus blakelyi* (Blakely's Red Gum) and *Angophora floribunda* (Rough-barked Apple) would once have dominated these areas, over a grassy understorey of various grasses, herbs and forbs. In places, *Eucalyptus camaldulensis* (River Red Gum) is also present. Many such areas now support improved pastures. A minor variant of this community also occurs on an elevated hill slope that appears to have suffered a geomorphological landscape slump long ago allowing the development of a moist forest with good representation of grasses and herbs, and establishment of *Angophora floribunda* (Rough-barked Apple) as the dominant canopy species. This community is shown in **Photograph 3.4**.

Photograph 3.4 Blakely's Redgum / Apple Riparian Forest

3.2.5 Blakely's Redgum / Paperbark Forest (Unit 5)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Minor drainage lines within and around the undulating topography of Bylong State Forest support narrow bands of *Eucalyptus blakelyi* (Blakely's Red Gum) over a distinct understorey of *Melaleuca thymifolia* (Thyme Honey-myrtle) and *Sannantha cunninghamii*, and the grasses *Aristida ramosa* (Purple Wiregrass), *Arundinella nepalensis* (Reedgrass) and *Aristida vagans* (Threeawn Speargrass). Such vegetation is unusual in the region, and typically occupies highly restricted riparian habitats. A potential new species (*Sannantha* sp. aff. *cunninghamii*) also occurs in this vegetation type, and requires further study with fertile material. This community is shown in **Photograph 3.5**.

Photograph 3.5 Blakely's Redgum / Paperbark Forest

3.2.6 Yellow Box Woodland (Unit 6)

Conservation Status:

TSC Act: White Box - Yellow Box - Blakely's Red Gum Woodland (EEC)

EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

Some small portions of this map unit do not conform to Box Gum Woodland under either the TSC Act or EPBC Act (remnant trees over cultivated land).

General Description:

Predominantly occurring on the basalt plateau and associated slopes in the northern portion of the Study Area. Dominated by *Eucalyptus melliodora* (Yellow Box) in the canopy, but understorey vegetation has been mostly cleared for grazing. A high diversity of grasses, herbs and forbs characterise this community. The bulk of the mapped area of Yellow Box Woodland is dominated by *Eucalyptus melliodora* (Yellow Box), over a grassy understorey of various native grasses, herbs and forbs. Shrubs are sparse or absent. This grassy form occupies the bulk of the basalt plateau, and forms a component of the Box Gum Woodland and Derived Native Grassland TEC. Some minor elements of Yellow Box Woodland along escarpment slopes support thickets of shrubs such as *Bursaria spinosa* (Blackthorn), and occasionally *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) or *Cassinia quinquefaria*. Ground layer vegetation is diverse, and supports numerous grasses, herbs and forbs. This community is shown in **Photograph 3.6**.

Photograph 3.6 Yellow Box Woodland

3.2.7 White Box Woodland (Unit 7)

Conservation Status (Grassy Form – Unit 7a):

TSC Act: White Box - Yellow Box - Blakely's Red Gum Woodland (EEC)

EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

Some small portions of this map unit do not conform to Box Gum Woodland under either the TSC Act or EPBC Act (remnant trees over cultivated land).

Conservation Status (Shrubby Form – Unit 7b):

TSC Act: Not listed

EPBC Act: Not listed

General Description:

White Box Woodland forms a mosaic pattern with the Slaty Box Woodland along all of the talus footslopes in the area, but also extending out onto some low rises on the plains. Two variants are present in the area, distinguished by the presence or absence of a shrub layer. Grassy areas are dominated by *Eucalyptus albens* (White Box), over an understorey of various native grasses, herbs and forbs. Shrubs are either widely scattered or absent. The grassy form typically occurs on the undulating lands of the valley floor, topographically above the Coastal Grey Box Woodland community, and conforms to Box Gum Woodland and Derived Native Grassland TEC as listed under the TSC Act and EPBC Act. Shrubby areas are also dominated by *Eucalyptus albens* (White Box) in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush), *Bursaria spinosa* (Blackthorn), *Olearia elliptica* (Sticky Daisy-bush) and *Cassinia quinquefaria*. Ground layer vegetation is diverse, and supports numerous grasses, herbs and forbs. The shrubby form predominates on the steeper sites along the escarpment footslopes, and does not conform to Box Gum Woodland and Derived Native Grassland TEC as listed under the TSC Act and EPBC Act. This community is shown in **Photograph 3.7**.

Photograph 3.7 **White Box Woodland**

3.2.8 Blakely's Redgum Woodland (Unit 8)

Conservation Status (Grassy Form – Unit 8a):

TSC Act: White Box - Yellow Box - Blakely's Red Gum Woodland (EEC)

EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

Some small portions of this map unit do not conform to Box Gum Woodland under either the TSC Act or EPBC Act (remnant trees over cultivated land).

Conservation Status (Shrubby Form – Unit 8b):

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Relatively minor areas of woodland dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) are present in the Study Area. Where they occur, past management practices has generally determined the grassy or shrubby nature of them. Both varieties are recognised in the mapping, although nether have been sampled in detail. Grassy areas are dominated by *Eucalyptus blakelyi* (Blakely's Red Gum), over a ground layer of native grasses, herbs and forbs. Shrubs are either widely scattered or absent. The grassy form occurs as small patches mainly on the western rim of the Bylong Valley, but also in the southern central portion of the Study Area. The grassy form unit conforms to Box Gum Woodland and Derived Native Grassland TEC as listed under the TSC Act and EPBC Act. Shrubby areas are dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush), *Bursaria spinosa* (Blackthorn), *Olearia elliptica* (Sticky Daisy-bush) and *Cassinia quinquefaria*. Ground layer vegetation supports several grasses, herbs and forbs. The shrubby form occurs mainly in the east of the Study Area in the vicinity of Bylong State Forest and does not conform to Box Gum Woodland and Derived Native Grassland TEC as listed under the TSC Act and EPBC Act. This community is shown in **Photograph 3.8**.

Photograph 3.8 Blakely's Redgum Woodland

3.2.9 Slaty Box Woodland (Unit 9)

Conservation Status:

TSC Act: Hunter Valley Footslopes Slaty Gum Woodland (Vulnerable Ecological Community (VEC))

EPBC Act: Not listed

General Description:

Common across most areas on talus footslopes on Permian sediments, and underlying the Triassic Narrabeen series. Dominated by *Eucalyptus dawsonii* (Slaty Gum) and *Callitris endlicheri* (Black Cypress Pine), with *Eucalyptus albens* (White Box) or *Eucalyptus moluccana* (Grey Box) occurring occasionally. The mid-layer is distinct, comprising *Acacia ixiophylla* (Sticky Leaved Wattle), *Olearia elliptica* subsp. *elliptica* (Sticky Daisy Bush), *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) and *Cassinia quinquefaria*, over a sparse, often bare, ground layer. One location within the Study Area supports dense stands of the regionally significant *Melaleuca lanceolata* (Moonah), occurring on a lower slope within Slaty Box Woodland. This community is shown in **Photograph 3.9**.

Photograph 3.9 Slaty Box Woodland

CUMBERLAND ECOLOGY

3.2.10 Coastal Grey Box Woodland (Unit 10)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Prior to clearing for agriculture, woodlands dominated by *Eucalyptus moluccana* (Grey Box) appear to have predominated across the lower plains, changing to *Eucalyptus albens* (White Box) woodlands on the adjacent steeper slopes. Data collected from a single site within the few remaining remnants of *Eucalyptus moluccana* (Grey Box) dominated vegetation was significantly different to all other grassy woodland communities. As for those communities, Coastal Grey Box Woodland supports a range of grasses, herbs and forbs, in addition to a scattered shrub layer of *Maireana microphylla* (Small-leaf Bluebush). This community is shown in **Photograph 3.10**.

Photograph 3.10 Coastal Grey Box Woodland

CUMBERLAND ECOLOGY

3.2.11 Fuzzy Box Woodland (Unit 11)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Present in a few locations on gentle rises and slopes, on alluvial or colluvial soils associated with drainage lines on the floor of the Bylong Valley, but formerly considerably more widespread. This community is dominated exclusively by *Eucalyptus conica* (Fuzzy Box), over a sparse or non-existent shrub layer, and a diverse ground layer of various grasses, herbs and forbs. One plot was sampled within an area with a long history of heavy grazing has ground layer vegetation supporting the unpalatable *Austrostipa verticillata* (Slender Bamboo Grass), which dominates these areas. Other stands of *Eucalyptus conica* (Fuzzy Box) woodland support a higher diversity of herbs, forbs and grasses. This community is shown in **Photograph 3.11**.

Photograph 3.11 Fuzzy Box Woodland

3.2.12 Calytrix Rockplate Heath (Unit 12)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Small, isolated patches of heath vegetation are present on the hard sandstone ridges of Crown land in the west and south-east of the Study Area. Species diversity is low here, with *Calytrix tetragona* (Common Fringe-myrtle), *Leptospermum parvifolium* and *Micromyrtus sessilis* the dominant species. In places, this community grades imperceptibly into the related Dwyer's Redgum Low Open Forest (Unit 14). This community is shown in **Photograph 3.12**.

Photograph 3.12 Calytrix Rockplate Heath

CUMBERLAND ECOLOGY

3.2.13 Shrubby Regrowth (Unit 13)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Some low hills and gentle undulations that have been previously cleared for grazing and then left to regenerate now support dense shrub stands of species such as *Acacia ixiophylla* (Sticky Leaved Wattle), *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) and *Bursaria spinosa* (Blackthorn). In most cases, these areas are likely to have formerly supported Slaty Box Woodland (Unit 9). This community is shown in **Photograph 3.13**.

Photograph 3.13 Shrubby Regrowth

3.2.14 Dwyer's Redgum Low Open Forest (Unit 14)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Typified by a low and widely spaced canopy of *Eucalyptus dwyeri* (Dwyer's Red Gum), *Callitris endlicheri* (Black Cypress Pine) and *Acacia doratoxylon* (Currawang), this community occurs along narrow rocky ridgelines in Crown land in the west and south-east of the Study Area, and also in and around Bylong State Forest. Typical shrub species present include *Leptospermum parvifolium, Philotheca salsolifolia, Leucopogon muticus* (Blunt Beard-heath) and *Calytrix tetragona* (Common Fringe-myrtle), with *Cleistochloa rigida* and *Lomandra confertifolia* (Mat-rush) dominating the ground layer. This community is shown in **Photograph 3.14**.

Photograph 3.14 Dwyer's Redgum Low Open Forest

3.2.15 Caley's Ironbark Forest (Unit 15)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Caley's Ironbark Forest dominates on the higher sandstone ridges, where it forms a mosaic with Blue-leaf Ironbark / Cypress Forest (Unit 16). This community is clearly dominated by *Eucalyptus caleyi* subsp. *caleyi*, with scattered occurrences of *Callitris endlicheri* (Black Cypress Pine) and *Acacia linearifolia* (Narrow-leaved Wattle). A shrubby mid-layer comprising *Cassinia quinquefaria, Persoonia linearis* (Narrow-leaved Geebung), *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) and *Leucopogon muticus* (Blunt Beard-heath) is present over a sparse ground layer. In the east, Caley's Ironbark Forest is the dominant ridgetop forest, but in the west this community forms a complex mosaic with Blue-leaf Ironbark / Cypress Forest (Unit 16). This community is shown in **Photograph 3.15**.

Photograph 3.15 Caley's Ironbark Forest

CUMBERLAND ECOLOGY

3.2.16 Blue-leaf Ironbark / Cypress Forest (Unit 16)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Blue-leaf Ironbark / Cypress Forest occurs on higher sandstone ridges, particularly in the west but also present in the south-east of the Study Area. This community forms a mosaic with Caley's Ironbark Forest (Unit 15) on ridges in the west. Blue-leaf Ironbark / Cypress Forest is dominated in the canopy by *Eucalyptus nubila* (Blue-leaved Ironbark) and *Callitris endlicheri* (Black Cypress Pine), with the shrubs *Persoonia linearis* (Narrow-leaved Geebung), *Acacia crassa* subsp. *crassa, Acrotriche rigida* and *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) commonly occurring. The sparse ground layer usually includes *Cleistochloa rigida*, *Lepidosperma gunnii* and *Phyllanthus hirtellus* (Thyme Spurge). This community is shown in **Photograph 3.16**.

Photograph 3.16 Blue-leaf Ironbark / Cypress Forest

3.2.17 Red Ironbark / Cypress Forest (Unit 17)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Small areas of forest dominated by *Eucalyptus fibrosa* (Red Ironbark) and *Callitris endlicheri* (Black Cypress Pine) are present on the higher grounds in the east of the Study Area, in and around Bylong State Forest. *Eucalyptus fibrosa* (Red Ironbark) and *Callitris endlicheri* (Black Cypress Pine) dominate the canopy here, with *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush), *Choretrum* sp. Coxs Gap, and *Acacia buxifolia* subsp. *buxifolia* (Box-leaf Wattle) typifying the shrub layer. Common ground species include *Aristida ramosa* (Purple Wiregrass), *Pomax umbellata* (Pomax) and *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern). This community is shown in **Photograph 3.17**.

Photograph 3.17 Red Ironbark / Cypress Forest

CUMBERLAND ECOLOGY

3.2.18 Cypress Pine Forest (Unit 18)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Stands of vegetation characterised by *Callitris gracilis* subsp. *gracilis* and *Callitris endlicheri* (Black Cypress Pine) occur within a surrounding matrix of Caley's Ironbark Forest (Unit 15) and other ridgeline vegetation. Understorey species typically present include *Prostanthera prunelloides, Leucopogon muticus* (Blunt Beard-heath)*, Persoonia linearis* (Narrow-leaved Geebung)*, Acrotriche divaricata, Astroloma humifusum* (Native Cranberry) and *Choretrum* sp. Coxs Gap, all at low abundances. Small stands of Cypress Pine Forest also occur in some locations on the valley floor, but these represent probable regrowth following past clearing, and have developed after long periods of fire suppression. This community is shown in **Photograph 3.18**.

Photograph 3.18 Cypress Pine Forest

3.2.19 Bloodwood / Ironbark Forest (Unit 19)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Present only in the north-east of the Study Area, this community is typified by *Corymbia trachyphloia* subsp. *amphistomatica* in the canopy, where it occurs with *Callitris endlicheri* (Black Cypress Pine) and *Eucalyptus nubila* (Blue-leaved Ironbark). Common understorey species include the shrubs *Gompholobium aspalathoides, Grevillea mucronulata, Hibbertia circumdans* and *Leucopogon muticus* (Blunt Beard-heath). *Lomandra glauca* (Pale Mat-rush)*, Platysace ericoides* and *Aristida ramosa* (Purple Wiregrass) are common ground layer species. This community is shown in **Photograph 3.19**.

Photograph 3.19 Bloodwood / Ironbark Forest

CUMBERLAND ECOLOGY

3.2.20 Scribbly Gum / Grey Gum Forest (Unit 20)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Two restricted locations of Scribbly Gum / Grey Gum Forest are present within the Study Area; one in the north-east and the other in the south-east. Both support the characteristic *Eucalyptus rossii* (Inland Scribbly Gum) in the canopy, along with *Eucalyptus punctata* (Grey Gum) and *Callitris endlicheri* (Black Cypress Pine). The shrub species *Leucopogon muticus* (Blunt Beard-heath), *Monotoca scoparia, Persoonia linearis* (Narrow-leaved Geebung) and *Boronia anethifolia* are common, while *Lomandra confertifolia* subsp. *rubiginosa*, *Goodenia hederacea* subsp. *hederacea* (Ivy Goodenia) and *Lomandra glauca* (Pale Mat-rush) typify the ground layer. This community is shown in **Photograph 3.20**.

Photograph 3.20 Scribbly Gum / Grey Gum Forest

3.2.21 Exposed Grey Gum / Stringybark Forest (Unit 21)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

The higher rocky landscapes in the south-east and west are typified by *Eucalyptus agglomerata* (Blue-leaved Stringybark) and *Eucalyptus punctata* (Grey Gum). Shrub species here include *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush), *Phebalium squamulosum* subsp. *gracile* (Scaly Phebalium), *Leucopogon muticus* (Blunt Beard-heath) and *Hovea lanceolata*, with *Cleistochloa rigida, Lomandra confertifolia* subsp. *rubiginosa* and *Lomandra glauca* (Pale Mat-rush) common ground species. This community is closely related to Sheltered Grey Gum / Stringybark Forest (Unit 22), and both share many species. Both are mapped collectively. This community is shown in **Photograph 3.21**.

Photograph 3.21 Exposed Grey Gum / Stringybark Forest

3.2.22 Sheltered Grey Gum / Stringybark Forest (Unit 22)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

Sheltered drainage lines and slopes within the higher rocky landscapes in the west and south-east support moist forest of *Eucalyptus punctata* (Grey Gum) and *Eucalyptus agglomerata* (Blue-leaved Stringybark). Understorey development tends to be better structured than the related Exposed Grey Gum / Stringybark Forest (Unit 21), with *Bursaria spinosa* (Blackthorn), *Acacia linearifolia* (Narrow-leaved Wattle), *Goodenia stephensonii, Macrozamia reducta* and *Dodonaea viscosa* var. *cuneata* (Wedge-leaf Hop-bush) dominating, and *Lomandra confertifolia* subsp. *rubiginosa, Microlaena stipoides* var. *stipoides* and *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern) in the ground layer. This community is shown in **Photograph 3.22**.

Photograph 3.22 Sheltered Grey Gum / Stringybark Forest

3.2.23 Derived Native Grasslands (Unit DNG)

Conservation Status:

TSC Act: White Box - Yellow Box - Blakely's Red Gum Woodland (EEC) (DNG – Unit 6 (1 and 2), DNG – Unit 7 (1 and 2), DNG – Unit 8 (1 and 2))

EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC) (DNG – Unit 6(1), DNG – Unit 7(1), DNG – Unit 8(1))

All remaining Derived Native Grassland units are not listed under either the TSC Act or EPBC Act.

General Description:

Derived Native Grasslands throughout the Bylong Valley formerly supported open grassy woodlands of various forms. Following clearing for agriculture, a suite of native grasses, herbs and forbs remain while canopy species may be sparse or very widely spaced. Under current legislation, some components of Derived Native Grasslands conform to some TECs, particularly Box Gum Woodland and Derived Native Grassland as listed under the TSC Act and EPBC Act. Reconstruction of the pre-settlement distribution of the Bylong Valley in map form allows these derived grasslands to be attributed to either Yellow Box Woodland (Unit 6), White Box Woodland (Unit 7), Blakely's Redgum Woodland (Unit 8), Slaty Box Woodland (Unit 9), Coastal Grey Box Woodland (Unit 10), Fuzzy Box Woodland (Unit 11), or a riparian complex comprising River Oak / Apple Riparian Forest (Unit 3) and Blakely's Redgum/ Apple Riparian Forest (Unit 4). Only derived grasslands attributable to Units 6, 7a, and 8a conform to listed TECs. An example of this community is shown in **Photograph 3.23**.

Derived Native Grasslands have been divided up into three classes:

- TSC Act and EPBC Act grasslands which support >12 native non-grass species, plus at least 1 'important' species (DNG – Unit 6(1), DNG – Unit 7(1), DNG – Unit 8(1));
- TSC Act only grassland which support <12 native non-grass species (low diversity native grasslands (Unit DNG – 6(2), Unit DNG – 7(2), Unit DNG – 8(2)); and
- Non-listed grassland (all remaining DNG units).

Where no detailed assessment of Derived Native Grasslands associated with Yellow Box Woodland, White Box Woodland and Blakely's Redgum Woodland has been undertaken, grasslands have been considered as both TSC Act and EPBC Act listed.

CUMBERLAND ECOLOGY

Photograph 3.23 Derived Native Grassland

CUMBERLAND ECOLOGY

3.2.24 Cultivated Lands (Unit CC)

Conservation Status:

TSC Act: Not listed

EPBC Act: Not listed

General Description:

The bulk of the alluvial flats along the Bylong River and Lee Creek have been heavily cleared and cropped over several decades. These areas currently support few native species, although in some areas scattered canopy trees remain (e.g. *Angophora floribunda* (Rough-barked Apple), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus camaldulensis* (River Red Gum). Depending on the season and the extent of grassland management, cultivated lands can support high densities of weed species. Other areas now support extensive paddocks of improved pastures, such as *Pennisetum clandestinum* (Kikuyu Grass). An example of this community is shown in **Photograph 3.24**.

Photograph 3.24 Cultivated Lands

3.3 Threatened Ecological Communities

Three TECs have been identified as occurring within the Study Area, including:

- Hunter Valley Footslopes Slaty Gum Woodland (TSC Act: VEC; EPBC Act: Not listed);
- Hunter Floodplain Red Gum Woodland (TSC Act: EEC; EPBC Act: Not listed); and
- Box Gum Woodland and Derived Native Grassland (TSC Act: EEC; EPBC Act: CEEC).

Table 3.2 summaries the extent of each TEC within the Study Area. A discussion of each TEC occurring within the Study Area is provided below. **Figure 3.2** shows the distribution and, where relevant, condition of TSC Act-listed TECs and **Figure 3.3** shows the distribution and condition of EPBC Act-listed TECs.

Table 3.2 TECs occurring within the Study Area

Vegetation Community	TSC Act		EPBC Act	
	Status	Area (ha)~	Status	Area (ha)~
Hunter Valley Footslopes Slaty Gum Woodland				
9: Slaty Box Woodland	VEC	1,144		
Hunter Floodplain Red Gum Woodland				
3: River Oak / Redgum Riparian Woodland	EEC	39		
Box Gum Woodland and Derived Native Grassland				
6(1)[A]: Yellow Box Woodland	EEC	160	CEEC	160
7a(1)[A]: White Box Woodland (Grassy)	EEC	708	CEEC	708
8a(1)[A]: Blakely's Red Gum Woodland (Grassy)	EEC	15	CEEC	15
DNG – 6(1)[A]: Yellow Box Woodland Derived Native Grassland	EEC	44	CEEC	44
DNG – 6(2)[B]: Yellow Box Woodland Derived Native Grassland	EEC	92		
DNG – 7(1)[A]: White Box Woodland Derived Native Grassland	EEC	657	CEEC	657
DNG – 7(2)[B]: White Box Woodland Derived Native Grassland	EEC	342		
DNG – 8(1)[A]: Blakely's Redgum Woodland Derived Native Grassland	EEC	3	CEEC	3
DNG – 8(2)[B]: Blakely's Redgum Woodland Derived Native Grassland	EEC	7		

Table 3.2 TECs occurring within the Study Area

Vegetation Community	TSC Act		EPBC Act	
	Status	Area (ha)~	Status	Area (ha)~
Subtotal Box Gum Woodland and Derived Native Grassland		*2,030*		*1,588*
TOTAL+		**3,212**		**1,588**

TSC Act / EPBC Act Status: VEC = Vulnerable Ecological Community, EEC = Endangered Ecological Community, CEEC = Critically Endangered Ecological Community

[A] Sub-unit (1) represents Box Gum Woodland and Derived Native Grassland listed under both the TSC Act and EPBC Act

[B] Sub-unit (2) represents Box Gum Woodland and Derived Native Grassland listed only under the TSC Act

+ In some cases totals may not equal the appropriate total number due to rounding

~ Area calculations are approximate

3.3.1 Hunter Valley Footslopes Slaty Gum Woodland

TSC Act Status: VEC

EPBC Act Status: Not listed

Hunter Valley Footslopes Slaty Gum Woodland is a VEC listed as *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* under the TSC Act. This community occurs at the interface of Narrabeen Sandstone and Permian sediments in the Hunter Valley (NSW Scientific Committee, 2010b). Hunter Valley Footslopes Slaty Gum Woodland is a woodland, or occasionally an open forest, with a sparse to moderately dense tree layer with occasional small trees and a moderately dense to dense shrub layer (NSW Scientific Committee, 2010b). The tree canopy is typically dominated by *Eucalyptus dawsonii* (Slaty Gum) and/or *Eucalyptus moluccana* (Grey Box) (NSW Scientific Committee, 2010b). The groundcover is typically sparse to very sparse and is relatively species poor (NSW Scientific Committee, 2010b). Hunter Valley Footslopes Slaty Gum Woodland has been recorded within Wollemi National Park (OEH, 2012j).

All of Slaty Box Woodland (Unit 9) occurring within the Study Area conforms to the listed community. A total of 1,144 ha of this community occurs within the Study Area and the distribution is shown in **Figure 3.2**. Condition mapping has not been undertaken for this community as there are currently no guidelines to assess condition classes.

Derived native grasslands associated with Hunter Valley Footslopes Slaty Gum Woodland are not included within the listing of the community. As such, grasslands associated with this community (Unit DNG – 9) within the Study Area have not been determined as conforming to the listed community.

3.3.2 Hunter Floodplain Red Gum Woodland

TSC Act Status: EEC

EPBC Act Status: Not listed

Hunter Floodplain Red Gum Woodland is an EEC listed as *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* under the TSC Act. This community occurs on floodplains and associated floodplain rises along the Hunter River and tributaries (NSW Scientific Committee, 2010a). Hunter Floodplain Red Gum Woodland typically forms a tall to very tall (18-35 m) woodland (NSW Scientific Committee, 2010a). Stands on major floodplains are generally dominated by *Eucalyptus camaldulensis* (River Red Gum) in combinations with *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus melliodora* (Yellow Box) and *Angophora floribunda* (Rough-barked Apple) (NSW Scientific Committee, 2010a). Within the community, stands of *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) and *Casuarina glauca* (Swamp Oak) can be present (NSW Scientific Committee, 2010a). The presence of weeds, grazing and fertilizer application is limiting the recruitment of understorey plants and tree species within this community (NSW Scientific Committee, 2010a).

All of River Oak / Redgum Riparian Woodland (Unit 3) occurring within the Study Area conforms to the listed community. A total of 39 ha of this community occurs within the Study Area and the distribution is shown in **Figure 3.2**. Condition mapping has not been undertaken for this community as there are currently no guidelines to assess condition classes.

Derived native grasslands with Hunter Floodplain Red Gum Woodland are not included within the listing of the community. As such, grasslands associated with this community (Unit DNG – 3) within the Study Area have not been determined as conforming to the listed community.

3.3.3 Box Gum Woodland and Derived Native Grassland

TSC Act Status: EEC

EPBC Act Status: CEEC

Box Gum Woodland and Derived Native Grassland is an EEC listed as *White Box Yellow Box Blakely's Red Gum Woodland* under the TSC Act and is a CEEC listed as *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* under the EPBC Act. This community occurs on relatively fertile soils in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria (NSW Scientific Committee, 2002b; Threatened Species Scientific Committee, 2006). Box Gum Woodland and Derived Native Grassland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations: *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) or *Eucalyptus blakelyi* (Blakely's Red Gum) (NSW Scientific Committee, 2002b). Grass and herbaceous species generally characterise the ground layer

(NSW Scientific Committee, 2002b). In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present (NSW Scientific Committee, 2002b). Grassland forms of this community are listed under both the TSC Act and EPBC Act.

i. Box Gum Woodland and Derived Native Grassland under the TSC Act

Portions of the following communities within the Study Area conform to the TSC Act listed Box Gum Woodland and Derived Native Grassland:

- Yellow Box Woodland (Unit 6);
- White Box Woodland (Grassy) (Unit 7a);
- Blakely's Redgum Woodland (Grassy) (Unit 8a);
- Yellow Box Woodland Derived Native Grassland (DNG – 6);
- White Box Woodland Derived Native Grassland (DNG – 7); and
- Blakely's Redgum Woodland Derived Native Grassland (DNG – 8).

Portions of the mapped areas of Yellow Box Woodland (Unit 6) and White Box Woodland (Grassy) (Unit 7a) are not considered to conform to the TSC Act listing of the community as they comprise remnant trees over non-native, cultivated land. Derived native grasslands not considered as having the potential for assisted natural regeneration and cultivated lands are also not considered to conform to the TSC Act listing of this community.

An approximate total of 2,030 ha of TSC Act listed Box Gum Woodland and Derived Native Grassland occurs within the Study Area, including 883 ha of the woodland form and 1,146 ha of the grassland form.

The TSC Act listed Box Gum Woodland and Derived Native Grassland within the Study Area was assessed against the condition classes provided within the *Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland* (NSW NPWS, 2005). The following condition classes were identified within the Study Area:

- 161 ha of Condition Class 1 (Multi-aged overstorey with a grassy, herb-rich understorey), which includes remnant patches with few historical disturbances;
- 722 ha of Condition Class 2 (Partially cleared/thinned stands with a mixture of native and exotic understorey species), which includes woodland remnants disturbed by past clearing, agricultural practices and other disturbances;
- 705 ha of Condition Class 4 (Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box Gum Woodland understorey is present), which include better quality derived native grasslands that also conform to the EPBC Act listing of the community; and

CUMBERLAND ECOLOGY

- 441 ha of Condition Class 5 (Degraded remnants that have few, if any, native species in the understorey), which includes lower quality grasslands that occur within an approximate 50 m buffer of remnant patches and paddock trees which are considered to have potential for assisted natural regeneration.

These four condition classes are shown on **Figure 3.2**. As ground-truthing to delineate each condition class was not specifically undertaken, division of these condition classes is based on review of survey data, site observations and aerial photograph interpretation. As such, there is likely some overlap between classes, particularly Condition Class 1 and Condition Class 2. Much of the Box Gum Woodland and Derived Native Grassland within the Study Area has been impacted by previous and current land uses.

ii. Box Gum Woodland and Derived Native Grassland under the EPBC Act

Portions of the following communities within the Study Area conform to the EPBC Act listed Box Gum Woodland:

- Yellow Box Woodland (Unit 6);
- White Box Woodland (Grassy) (Unit 7a);
- Blakely's Redgum Woodland (Grassy) (Unit 8a);
- Yellow Box Woodland Derived Native Grassland (DNG – 6);
- White Box Woodland Derived Native Grassland (DNG – 7); and
- Blakely's Redgum Woodland Derived Native Grassland (DNG – 8).

Portions of the mapped areas of Yellow Box Woodland (Unit 6) and White Box Woodland (Grassy) (Unit 7a) are not considered to conform to the EPBC Act listing of the community as they comprise remnant trees over cultivated land. Derived native grasslands not satisfying the criteria within the *EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived grasslands* (DEH, 2006) are also not considered to conform to the EPBC Act listing of this community.

An approximate total of 1,588 ha of EPBC Act listed Box Gum Woodland and Derived Native Grassland occurs within the Study Area, including 883 ha of woodland form and 705 ha of grassland form.

The EPBC Act listed Box Gum Woodland and Derived Native Grassland within the Study Area was assessed against the condition classes provided within the *Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Threatened Species Scientific Committee, 2006). The woodland forms of the EPBC Act listed Box Gum Woodland and Derived Native Grassland, totalling 883 ha, conform to Condition Class C (i.e. both a native understorey and an overstorey of eucalypts exist) and the grassland forms, totalling 705 ha, conforms to Condition Class B (i.e. a native understorey exists, but the trees have been cleared). These two condition classes are shown on **Figure 3.3**. Although occurring within the Study Area, Condition Class A (i.e.

overstorey present, however a substantial native understorey is absent), does not conform to the EPBC Act listing of the community.

3.4 Other Vegetation Communities of Conservation Significance

Two vegetation communities occurring within the Study Area have been identified as regionally significant by Eastcoast Flora Survey. Both Coastal Grey Box Woodland and Fuzzy Box Woodland have been assessed in detail and determined to not conform to any listed TECs under the TSC Act and/or EPBC Act (see **Appendix B**). Despite this, it has been recognised that these communities are of regional significance. A discussion of these communities is provided in **Appendix B** and outlined below. The occurrence of these communities within the Study Area is shown in **Figure 3.4**.

3.4.1 Coastal Grey Box Woodland

Woodlands and forests dominated or characterised by *Eucalyptus moluccana* (Grey Box) have been extensively described for the Hunter Valley (e.g. Peake (2006), DECC (2008f), OEH (2012j; 2012g)). However, few of these are defined by this species as the sole dominant in the canopy layer (exceptions are mainly those occurring on enriched basalt or shale soils within the Triassic Sandstone escarpments: DECC (2008f), OEH (2012j)).

The Permian Sediments of the Hunter Valley floor are overlain between Bylong and Sandy Hollow in the east by the Triassic Sandstone escarpments of northern Wollemi and Goulburn River National Parks. In effect, this massive sandstone deposit separates the valley floors of Bylong and the lower Goulburn River by a distance of ~50km, with an elevation change for valley flats from 180 m to 260 m above sea level east to west. Within the Permian Sediments, DMR (1999) delineates the Newcastle Coal Measures to the east, and the more elevated Illawarra Coal Measures to the west, separated by the Triassic Sandstone material. It is reasonable to assume that different vegetation communities may have once occurred on these differing geological types, and that communities characterised by *Eucalyptus moluccana* (Grey Box) also differ in their floristic compositions: the scarcity or absence of *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Corymbia maculata* (Spotted Gum) on the Illawarra Coal Measures is one example. To the north of Bylong, the Triassic Sandstones of Goulburn River National Park give way to the Tertiary Basalt of the Merriwa Plateau, each supporting floristically different habitat types.

To the west, between Bylong and Ulan, existing records of *Eucalyptus moluccana* (Grey Box) demarcate the Coastal Grey Box Woodlands as identified within the Study Area. This area incorporates the existing coal mines at Moolarben, Wilpinjong and Ulan, and casual observations made in these areas suggest that similar vegetation patterns occur. The Coastal Grey Box Woodlands between Bylong and Ulan are heavily depleted, with landscapes extensively used for agriculture.

A total of 100 ha of Coastal Grey Box Woodland has been identified to occur within the Study Area.

3.4.2 Fuzzy Box Woodland

There is considerable evidence that grassy woodlands dominated by *Eucalyptus conica* (Fuzzy Box) were once widespread on alluvial and colluvial plains in the upper Hunter Valley; however remaining remnants are small and highly degraded. Remnant trees within agricultural landscapes on the undulating alluvial plains from Martindale through to Ulan lend support to this observation (Dr. Stephen Bell pers. obs., OEH (2012j)). Benson (2008) defined *Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion* for locations outside of the Sydney Basin, and the TSC Act includes *Fuzzy Box Woodland on Alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregion* (Fuzzy Box Woodland), but omission of the adjoining Sydney Basin bioregion in this determination excludes its application to Bylong.

Most recently, OEH (2012j) described a Western Hunter Flats Fuzzy Box Woodland in their study which covered the north-western portion of Wollemi National Park and environs. They describe this vegetation as a rare community in the region, and one having affinities to both Fuzzy Box Woodland and Box Gum Woodland and Derived Native Grassland TECs, with greater affinities to the latter. Fuzzy Box Woodland within the Study Area has been determined not to conform to either TEC (see **Appendix B**). It is more feasible that the Western Hunter Flats Fuzzy Box Woodland identified by OEH (2012j), and Fuzzy Box Woodland within the Study Area, forms a highly endangered community in its own right, and should not be subsumed into a wide ranging TEC covering three States.

A total of 60 ha of Fuzzy Box Woodland has been identified to occur within the Study Area.

3.5 Groundwater Dependent Ecosystems

3.5.1 Definition

A number of definitions of GDEs are used within NSW and Australia. The NSW State Groundwater Dependent Ecosystem Policy (DLWC (NSW), 2002) defines GDEs and *'ecosystems which have their species composition and their natural ecological processes determined by groundwater'*.

GDEs can rely on groundwater for the maintenance of some or all of their species composition and ecological functions and this dependence can be variable, ranging from partial and infrequent dependence (i.e. seasonal or episodic) to total (entire / obligate, continual dependence) (Serov *et al.*, 2012). The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DoE, 2009). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans, 1998).

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

- Terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;

- Wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;

- River baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and

- Aquifer and cave ecosystems – the biology of karst or limestone caves, particularly micro-organisms and invertebrates, are heavily dependent on groundwater availability.

3.5.2 Mapping of GDEs within the Study Area

The potential presence of GDEs within the Study Area and locality has been mapped as part of the Commonwealth's Atlas of GDEs (Bureau of Meteorology, 2014) which '*incorporates multiple lines of scientific evidence including previous fieldwork, literature and mapping, and combines nation-wide layers of satellite remote sensing data*'. **Figure 3.5** shows the mapping by the Atlas of GDEs within the Study Area.

The Atlas of GDEs maps ecosystems that interact with the surface expression of groundwater and subsurface presence of groundwater. Within the Study Area the portions of Bylong River and Growee River has been identified as having potential for interaction with the surface expression of groundwater (see **Figure 3.5**). The Atlas of GDEs mapping shows the following levels of potential subsurface groundwater interaction within the Study Area:

- 1 ha of high potential for subsurface groundwater interaction;

- 3,686 ha of moderate potential for subsurface groundwater interaction;

- 26 ha of low potential for subsurface groundwater interaction; and

- 478 ha of un-analysed land.

It should be emphasised that these are all only estimates of potential interaction, and are not supported by quantitative measurements.

3.5.3 Assessment of the Occurrence of GDEs within the Study Area

As is indicated by rainfall data for the Study Area, the Bylong Valley is a very dry environment and the main river systems (Bylong River and Goulburn River) lack flow reliability (DWE, 2009). The vegetation present within the Study Area is typical of those in moisture-limited habitats, both on the Triassic Narrabeen sandstones and the underlying Permian sediments.

Despite the Atlas of GDEs mapping of potential groundwater interaction within the Study Area, Eastcoast Flora Survey observed no obvious evidence of GDEs. There have been no hanging swamps identified with perched water tables present on the sandstone hills, as are present in south-western Wollemi National Park and Blue Mountains National Park. Evidence of ground seepage was observed at one location within the Study Area, in the vicinity of Tal Tal Mountain, in a sandstone gully with a considerable amount of sandstone outcropping. The vegetation present in the gully does not support different vegetation than surrounding areas and the baseflow observed is consistent with ground seepage in areas with extensive sandstone outcropping.

The alignment of Bylong River and Lee Creek is characterised by shallow water tables that could have the potential to support GDEs (AGE, 2015). The identification of GDEs within the Study Area has been determined on the basis of the presence of species such as *Eucalyptus camaldulensis* (River Red Gum) and *Casuarina cunninghamiana* (River Oak), as well as other riparian vegetation communities. As these species and communities occur within floodplain and creek line areas, they are considered likely to have some root access to groundwater. Communities assessed as GDEs within this report include River Oak / Redgum Riparian Woodland (Unit 3) and Blakely's Red Gum / Apple Riparian Forest (Unit 4). These communities are shown in **Figure 3.6**.

It is difficult to ascertain the degree of dependence of terrestrial ecosystems on groundwater. Given that the watercourses within the Study Area are typically ephemeral and historically have been degraded due to surrounding land use and water extraction, it is likely that communities characterised by *Eucalyptus camaldulensis* (River Red Gum) and *Casuarina cunninghamiana* (River Oak) trees have a moderate reliance, but not a complete dependence, on groundwater. Such trees may have roots that penetrate to shallow groundwater of perched aquifers. Other plant species within these communities, particularly shrubs and grasses, which are shallower-rooted, are not likely to be dependent upon groundwater as their roots would not penetrate far enough into the soil. The portions of communities occurring along drainage lines above the valley floor are considered to have a lower dependence than those occurring on the valley floor.

3.6 General Flora Species

The area within the Study Area supports a high diversity of flora species. Over 550 flora species have been recorded within the Study Area, including over 100 exotic species. A total flora species list for the Study Area is provided in **Appendix C**.

The most commonly recorded species across low-lying areas of the Study Area are the herbs *Dichondra repens* (Kidney Weed), *Calotis lappulacea* (Yellow Burr-daisy), *Einadia hastata* (Berry Saltbush), the graminoids *Austrostipa scabra* (Speargrass), *Gahnia aspera* (Rough Saw-sedge) and *Aristida ramosa* (Purple Wiregrass), and the fern *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern). *Dodonaea viscosa* (Sticky Hop-bush), *Acacia ixiophylla* (Sticky Leaved Wattle) and *Cassinia quinquefaria* were the most frequent shrubs, while *Eucalyptus albens* (White Box) and *Eucalyptus dawsonii* (Slaty Gum) were the most frequent canopy species.

For the more rugged hills within the Study Area the most frequent species recorded were the graminoids *Cleistochloa rigida, Lomandra confertifolia* subsp. *rubiginosa, Lomandra glauca* (Pale Mat-rush), *Gahnia aspera* (Rough Saw-sedge) and *Lepidosperma laterale*, the fern *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern), the shrubs *Persoonia linearis* (Narrow-leaved Geebung), *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hop-bush), *Leucopogon muticus* (Blunt Beard-heath) and *Acacia linearifolia* (Narrow-leaved Wattle), and the trees *Eucalyptus punctata* (Grey Gum), *Callitris endlicheri* (Black Cypress Pine), *Eucalyptus nubila* (Blue-leaved Ironbark), *Eucalyptus dwyeri* (Dwyer's Red Gum) and *Eucalyptus agglomerata* (Blue-leaved Stringybark).

The dominant plant families within the Study Area include the Poaceae, Asteraceae, Myrtaceae and Fabaceae (Faboideae) families. The most common genera encountered is *Eucalyptus* (canopy tree species), with 20 species recorded within the Study Area. Six species of box-type eucalypts are present, including *Eucalyptus albens* (White Box), *Eucalyptus moluccana* (Grey Box), *Eucalyptus conica* (Fuzzy Box), *Eucalyptus macrocarpa* (Grey Box), *Eucalyptus dawsonii* (Slaty Gum) and *Eucalyptus melliodora* (Yellow Box). *Eucalyptus crebra* (Narrow-leaved Ironbark) is present only as small and scattered individuals in mid-slope or ridgeline habitats, while *Eucalyptus macrocarpa* (Grey Box), *Eucalyptus sideroxylon* (Mugga Ironbark) and *Eucalyptus rossii* (Inland Scribbly Gum) occur only in highly restricted localities. *Eucalyptus nubila* (Blue-leaved Ironbark), which is present across many parts of the higher sandstone areas.

3.7 Threatened Flora Species

The matrix of habitats within the Study Area provides potential habitat for a suite of threatened flora species. **Table 3.3** lists the threatened flora species recorded within the Study Area, including records from the Atlas of NSW Wildlife (OEH, 2014b). The locations of TSC Act listed and EPBC Act listed threatened flora species recorded during surveys are shown in **Figure 3.7** and **Figure 3.8**, respectively. A discussion of each of these species and their occurrence within the Study Area is provided below.

Table 3.3 Threatened flora species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Tylophora linearis		V	E
Ozothamnus tesselatus		V	V
Acacia pendula	*Acacia pendula* population in the Hunter catchment	EP	
Eucalyptus camaldulensis	*Eucalyptus camaldulensis* population in the Hunter catchment	EP	
Cymbidium canaliculatum	*Cymbidium canaliculatum* population in the	EP	

Table 3.3 Threatened flora species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
	Hunter Catchment		
Diuris tricolor	Pine Donkey Orchid	V	
Pomaderris queenslandica	Scant Pomaderris	E	

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, EP = Endangered Population

3.7.1 Tylophora linearis

TSC Act Status: Vulnerable

EPBC Act Status: Endangered

Tylophora linearis is a herbaceous climber that grows to about 2 m long (Threatened Species Scientific Committee, 2008f). This species occurs in dry scrub and open forest and has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa* (Red Ironbark), *Eucalyptus sideroxylon* (Mugga Ironbark), *Eucalyptus albens* (White Box), *Callitris endlicheri* (Black Cypress Pine), *Callitris glaucophylla* (White Cypress Pine) and *Allocasuarina luehmannii* (Bulloak) (OEH, 2014y). This species occurs most commonly in dense shrubland overtopped by eucalypts (Forster *et al.*, 2004). *Tylophora linearis* has rarely been collected and is known from the Dubbo and Barraba areas in NSW (Threatened Species Scientific Committee, 2008f). Although not commonly recorded, populations of this species are not thought to be under significant threat (Forster *et al.*, 2004; NSW Scientific Committee, 2008b).

This species was recorded at four locations within the Study Area within Slaty Box Woodland on talus slopes. *Tylophora linearis* has the potential to occur in other areas of the Study Area within Slaty Box Woodland and eucalypt woodland, particularly those with a dense shrub layer. In total, an estimate of 270 individuals of this species occurs within the Study Area.

The Atlas of NSW Wildlife holds no records of *Tylophora linearis* within the locality. *Tylophora linearis* has not been recorded within any conservation reserves within the locality or wider region. The presence of this species within the Study Area represents the first records for the Hunter Valley, however as this species is easily confused with *Marsdenia viridiflora* (Native Pear) and *Rhyncharrhena linearis* (Purple Pentatrope), it is potentially more common (Bell and Driscoll, 2013). The occurrence of this species represents a sizeable extension range to the east of the known distribution around Dubbo and Moree. Extensive areas of potential suitable habitat exist within the locality, including within Wollemi National Park and unreserved habitats.

3.7.2 Ozothamnus tesselatus

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Ozothamnus tesselatus is a dense shrub growing to 1 m high (Threatened Species Scientific Committee, 2008b). This species occurs in eucalypt woodland (Threatened Species Scientific Committee, 2008b; OEH, 2014r). This species is restricted to a few locations in an east-west zone south of Bunnan and between west of Bylong and east of Ravensworth (OEH, 2014r).

This species was recorded at a number of locations within the Study Area within Slaty Box Woodland and Blue-leaf Ironbark / Cypress Forest, typically on talus footslopes in habitat considered typical for this species. Habitat on these footslopes is typified by a canopy of *Eucalyptus dawsonii* (Slaty Gum), associated with *Eucalyptus punctata* (Grey Gum), *Eucalyptus albens* (White Box) or *Eucalyptus moluccana* (Grey Box). In total, an estimate of 300-500 individuals of this species occurs within the Study Area.

The Atlas of NSW Wildlife holds 43 records of *Ozothamnus tesselatus* within the locality with dates ranging from 1951 - 2012. *Ozothamnus tesselatus* is conserved in the locality and wider region within Goulburn River National Park and Munghorn Gap Nature Reserve. *Ozothamnus tesselatus* has also been recorded on the dry, northern footslopes of Wollemi National Park and surrounding lands (Bell, 2008). Additional potential suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

3.7.3 Acacia pendula

TSC Act Status: Endangered Population (in the Hunter catchment)

EPBC Act Status: Not listed

Acacia pendula (Weeping Myall) is an erect or spreading tree and grows 5 - 13 m in height (OEH, 2014a). Within the Hunter catchment this species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations (OEH, 2014a). The species occurs on the western slopes, western plains and far western plains of NSW, and south into Victoria and north into Queensland, however a disjunct population of fewer than 1,000 individuals that occurs in the Hunter Valley at the eastern distributional limit of the species' range (OEH, 2014a). Within the Hunter catchment, this species is listed as an endangered population, although there is some debate over the legitimacy of Hunter Valley plants (Bell and Driscoll, submitted).

This species has been recorded at two locations within the Study Area. A single, small planted garden specimen of *Acacia pendula* (Weeping Myall) is present adjacent to the Project field office, while the second location comprises three plants which occur on elevated land in grazing paddocks in the north east of the Study Area. It is likely that these latter plants have naturalised from past introductions, as this species occurs in alluvial soils near drainage depressions elsewhere in its range in NSW. Although under current legislation these four plants form part of the endangered '*Acacia pendula* population in the Hunter catchment', they are not considered to be natural components of the landscape within the Study Area.

The Atlas of NSW Wildlife holds no records of *Acacia pendula* (Weeping Myall) within the locality. *Acacia pendula* (Weeping Myall) has not been recorded within any conservation reserves within the locality or wider region. Additional potential suitable habitat occurs in the unreserved landscape at the margins of small floodplains.

3.7.4 *Eucalyptus camaldulensis*

TSC Act Status: Endangered Population (in the Hunter catchment)

EPBC Act Status: Not listed

Eucalyptus camaldulensis (River Red Gum) is a tree to 30 m high (Botanic Gardens Trust, 2015). In NSW, the species occurs along western flowering rivers within the Hunter catchment (NSW Scientific Committee, 2005b). It may occur with *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus melliodora* (Yellow Box), *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) and *Angophora floribunda* (Rough-barked Apple) (OEH, 2012f). The population of *Eucalyptus camaldulensis* (River Red Gum) in the Hunter occurs from the west of Bylong, south of Merriwa, to the east of Hinton, on the bank of the Hunter River and in the Port Stephens LGA (OEH, 2012f). The population of *Eucalyptus camaldulensis* (River Red Gum) in the Hunter is unique in NSW being the only one to occur in a coastal catchment (OEH, 2012f).

This species was recorded at three broad locations within the Study Area within River Oak / Redgum Riparian Woodland and Blakely's Red Gum Woodland (Grassy), as well as isolated trees in cleared areas. *Eucalyptus camaldulensis* (River Red Gum) has been recorded along Bylong River, Cousins Creek and Lee Creek. This species was previously known from the Study Area and additional individuals were recorded during surveys for this assessment. In total, an estimate of 80 individuals of this species occurs within the Study Area including old and new records.

The Atlas of NSW Wildlife holds 66 records of *Eucalyptus camaldulensis* (River Red Gum) within the locality with dates ranging from 2006 – 2010, all of which occur within the Study Area. *Eucalyptus camaldulensis* has not been recorded within any conservation reserves within the locality or wider region. Additional potential suitable habitat occurs along rivers within unreserved habitats.

3.7.5 *Cymbidium canaliculatum*

TSC Act Status: Endangered Population (in the Hunter catchment)

EPBC Act Status: Not listed

Cymbidium canaliculatum (Tiger Orchid) is an epiphytic orchid which grows in the hollows and forks of eucalypts and wattles, usually occurring singly or as a single clump, typically between two and six metres above the ground (OEH, 2013f). Within the Hunter catchment, *Cymbidium canaliculatum* (Tiger Orchid) is most commonly found in *Eucalyptus albens* (White Box) dominated woodlands and has also been found less commonly on *Eucalyptus dawsonii* (Slaty Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box), *Angophora floribunda* (Rough-barked Apple), *Acacia salicina* (Cooba) and on some other species, including dead stags (OEH, 2013f). This species has a scattered distribution across northern and eastern Australia and is restricted in NSW to the north-eastern quarter of the state (OEH, 2013f). A disjunct population of the species occurs in the Hunter Valley at the south-eastern distributional limit of the species' range (OEH, 2013f).

This species occurs at a number of locations within the Study Area within a number of communities including Yellow Box Woodland, Slaty Box Woodland and White Box Woodland (Grassy). Favoured hosts for the specimens recorded were *Angophora floribunda* (Rough-barked Apple), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus dawsonii* (Slaty Gum) and *Eucalyptus albens* (White Box). In total, an estimate of 36 individuals of this species occurs within the Study Area. Approximately half of the individuals recorded occur on the elevated basalt plateau in the northern portion of the Study Area. There is potential for this species to occur in other areas of the Study Area, particularly within communities dominated by favoured host tree species.

The Atlas of NSW Wildlife holds 38 records of *Cymbidium canaliculatum* (Tiger Orchid) within the locality with dates ranging from 2006 - 2012. *Cymbidium canaliculatum* (Tiger Orchid) is conserved in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional potential suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

3.7.6 Diuris tricolor

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

Diuris tricolor (Pine Donkey Orchid) is a terrestrial orchid growing to 20–40 cm high (Botanic Gardens Trust, 2015). This species grows in sclerophyll forest among grass, often with native Callitris species and is found in sandy soils, either on flats or small rises (OEH, 2014s). Associated species include *Callitris glaucophylla* (White Cypress Pine), *Eucalyptus populnea* (Poplar Box), *Eucalyptus intertexta* (Gum Coolibah), Ironbark and Acacia shrubland (OEH, 2014s). The understorey is often grassy with herbaceous plants such as Bulbine species (OEH, 2014s). *Diuris tricolor* (Pine Donkey Orchid) is sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the north of NSW.

This species was recorded at one location within the Study Area. A population of 37 individuals was recorded, which is considerably less than the large populations recorded in adjacent areas and with populations near Muswellbrook to the east (e.g. Bell (2012)). The occurrence of this species within the Study Area is within cleared lands adjacent to the wooded footslopes where native grasses predominate. There is potential for this species to occur in similar habitat within the Study Area.

The Atlas of NSW Wildlife holds 108 records of *Diuris tricolor* (Pine Donkey Orchid) within the locality with dates ranging from 2010 - 2012. *Diuris tricolor* (Pine Donkey Orchid) is conserved in the locality and wider region within Goulburn River National Park. Additional suitable habitat occurs throughout the locality and wider region in unreserved land.

3.7.7 *Pomaderris queenslandica*

TSC Act Status: Endangered

EPBC Act Status: Not listed

Pomaderris queenslandica (Scant Pomaderris) is a medium-sized shrub and grows 2 - 3 m in height (OEH, 2014u). This species is found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks (OEH, 2014u). It is widely scattered but not common in north-east NSW and in Queensland and is known from several locations on the NSW north coast and a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolata (OEH, 2014u).

This species was recorded at two locations within the Study Area in Blakely's Red Gum / Apple Riparian Forest and Exposed/Sheltered Grey Gum / Stringybark Forest. Approximately five plants were present at both locations. The occurrence of this species coincided with sheltered locations associated with creek lines, which is similar known habitat elsewhere in the region (Bell, 2001). Potential habitat for this species also present in other areas of the Study Area in similar habitat.

The Atlas of NSW Wildlife holds two records of *Pomaderris queenslandica* (Scant Pomaderris) within the locality with dates ranging from 1955 - 2010. *Pomaderris queenslandica* (Scant Pomaderris) is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Manobalai Nature Reserve. Additional potential suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

3.7.8 Potentially Occurring Threatened Species

A number of threatened flora species have been recorded from the locality, or have been predicted to occur, and have the potential to occur within the Study Area. **Appendix D** analyses the likelihood of occurrence within the Study Area for each threatened flora species recorded or predicted to occur within the locality. **Table 3.4** lists the threatened flora species considered to potentially occur within the Study Area. These species are discussed further below.

Table 3.4 Threatened flora species potentially occurring within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V
Prostanthera discolor		V	V
Commersonia rosea (syn. Androcalva rosea)		E	E
Eucalyptus cannonii	Capertee Stringybark	V	
Homoranthus darwinioides		V	V
Pomaderris sericea	Silky Pomaderris	E	V
Philotheca ericifolia			V
Thesium australe	Austral Toadflax	V	V

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered

i. Prostanthera cryptandroides subsp. cryptandroides

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Prostanthera cryptandroides subsp. *cryptandroides* (Wollemi Mint-bush) is a low-spreading shrub and grows 0.5 - 1 m in height (OEH, 2012s). This species occurs in dry sclerophyll forested slopes and gullies, in rocky areas, especially at the base of scree slopes and sandstone boulders, and in shallow sandy loam, as an understorey species to *Eucalyptus* sp. and *Acacia* sp (Threatened Species Scientific Committee, 2008d). In the Denman-Gungal and Widden-Baerami Valley areas, occurs on rocky ridgelines on Narrabeen Group Sandstones in association with a range of communities (OEH, 2012s). Associated communities include: Narrabeen Rocky Heath, Narrabeen Acacia Woodland, Narrabeen Exposed Woodland; Open Heath of *Calytrix tetragona* (Common Fringe-myrtle), *Leptospermum parvifolium* and *Isopogon dawsonii* (Nepean Conebush); and Open Scrubland of *Eucalyptus dwyeri* (Dwyer's Red Gum), *Harmogia densifolia, Dillwynia floribunda, Aotus ericoides* and *Hemigenia cuneifolia* (OEH, 2012s). *Prostanthera cryptandroides* subsp. *cryptandroides* (Wollemi Mint-bush) is distributed between Lithgow and Sandy Hollow on the NSW central west slopes, central tablelands and western parts of the central coast botanical regions with an additional record exists for the northern tablelands near Tenterfield (OEH, 2012s).

This species was not recorded during surveys of the Study Area; however there is the potential for this species to occur. Some of the higher elevation communities within the Study Area contain suitable habitat for this species.

The Atlas of NSW Wildlife holds no records of *Prostanthera cryptandroides* subsp. *cryptandroides* (Wollemi Mint-bush) within the locality. *Prostanthera cryptandroides* subsp. *cryptandroides* (Wollemi Mint-bush) is conserved in the locality and wider region within Wollemi National Park. Additional potential suitable habitat occurs within the locality and wider region.

ii. Prostanthera discolor

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Prostanthera discolor is an erect shrub and grows 0.6 – 3 m in height (OEH, 2013h). This species grows in dry sclerophyll forest in the side gullies of main creek lines, often on rocky or well-drained alluvial substrates (OEH, 2013h) and on escarpments in the midst of sandstone rocks fallen from cliffs above (Threatened Species Scientific Committee, 2008d). *Prostanthera discolor* is restricted in distribution to a few localities from Bylong to the Baerami Valley within the Mid-western Regional and Muswellbrook LGAs (OEH, 2013h).

This species was not recorded during surveys of the Study Area; however there is the potential for this species to occur. The woodland and forest communities within the Study Area contain suitable habitat for this species, particularly those in gullies and along creek lines.

The Atlas of NSW Wildlife holds 19 records of *Prostanthera discolor* within the locality with dates ranging from 1948 - 2009. *Prostanthera discolor* is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park (Threatened Species Scientific Committee, 2008d). Additional potential suitable habitat occurs within the locality and wider region.

iii. Commersonia rosea

TSC Act Status: Endangered

EPBC Act Status: Endangered

Commersonia rosea is a prostrate shrub and grows 0.1 - 0.3 m height (OEH, 2014g). This species occurs on skeletal sandy soils in scrub or heath vegetation with occasional emergents of *Eucalyptus crebra* (Narrow-leaved Ironbark), *Callitris endlicheri* (Black Cypress Pine) or *Eucalyptus caleyi* subsp. *caleyi* (OEH, 2014g). There is potential for this species to be fire ephemeral (Threatened Species Scientific Committee, 2008g; OEH, 2014g). *Commersonia rosea* is only known from four localities within an 8 km radius of Sandy Hollow (OEH, 2014g).

This species was not recorded during surveys of the Study Area; however there is the potential for this species to occur. Potential habitat for this species occurs within heath vegetation within the Study Area.

The Atlas of NSW Wildlife holds no records of *Commersonia rosea* within the locality. *Commersonia rosea* is conserved in the locality and wider region within Goulburn River National Park (Threatened Species Scientific Committee, 2014a). Additional potential suitable habitat occurs within the locality and wider region.

iv. Eucalyptus cannonii

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

Eucalyptus cannonii (Capertee Stringybark) is a tree and grows 10 - 15 m high (OEH, 2013e). Capertee Stringybark has a broad altitudinal range, from around 450 m to 1,050 m, tolerating most situations within this range, except the valley floors (OEH, 2013e). Associated eucalypt species are diverse: *Eucalyptus viminalis* (Ribbon Gum), *Eucalyptus mannifera* (Brittle Gum), *Eucalyptus polyanthemos* (Red Box), *Eucalyptus rossii* (Inland Scribbly Gum), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus oblonga* (Sandstone Stringybark), *Eucalyptus sparsifolia* (Narrow-leaved Stringybark), *Eucalyptus bridgesiana* (Apple Box), *Eucalyptus dalrympleana* (Mountain Gum), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus dives* (Broad-leaved Peppermint) and *Angophora floribunda* (Rough-barked Apple) (OEH, 2013e). *Eucalyptus cannonii* (Capertee Stringybark) is predominantly restricted to the central tablelands and slopes of NSW between the Golden Highway in the north, and the Mitchell Highway in the south (OEH, 2013e).

This species was not recorded during surveys of the Study Area; however it was recorded to the south. There is the potential for this species to occur at higher elevations with associated species.

The Atlas of NSW Wildlife holds 2 records of *Eucalyptus cannonii* (Capertee Stringybark) within the locality from 1983. *Eucalyptus cannonii* (Capertee Stringybark) is conserved in the locality and wider region within Wollemi National Park, Durridgere State Conservation Area and Avisford Nature Reserve. Additional potential suitable habitat occurs within the locality and wider region.

v. Homoranthus darwinioides

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Homoranthus darwinioides is a spreading shrub growing to 1.5 m high (Threatened Species Scientific Committee, 2008a). This species grows in various woodland habitats with shrubby understoreys, usually in gravely sandy soils (OEH, 2013e). Associated species include *Callitris endlicheri* (Black Cypress Pine), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus fibrosa* (Red Ironbark), *Corymbia trachyphloia* (White Bloodwood), *Eucalyptus beyeriana* (Beyer's Ironbark), *Eucalyptus dwyeri* (Dwyer's Red Gum), *Eucalyptus rossii* (Inland Scribbly Gum), *Leptospermum divaricatum, Melaleuca uncinata* (Broombush), *Calytrix tetragona* (Common Fringe-myrtle), *Allocasuarina* sp., *Micromyrtus* sp. and *Acacia* sp. (Threatened Species Scientific Committee, 2008a; OEH, 2013e). *Homoranthus darwinioides* is known from the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district and it is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo State Forest (OEH, 2013e).

This species was not recorded during surveys of the Study Area. There is the potential for this species to occur at higher elevations with associated species.

The Atlas of NSW Wildlife holds 27 records of *Homoranthus darwinioides* within the locality with dates ranging from 1951 - 2003. *Homoranthus darwinioides* is conserved in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional potential suitable habitat occurs within the locality and wider region.

vi. Pomaderris sericea

TSC Act Status: Endangered

EPBC Act Status: Vulnerable

Pomaderris sericea (Silky Pomaderris) is a deciduous shrub growing to about 2 m in height (Carter and Walsh, 2010). The population at Wollemi National Park occurs in dry sheltered forest with *Eucalyptus punctata* (Grey Gum), *Eucalyptus sparsifolia* (Narrow-leaved Stringybark), *Acacia buxifolia* (Box-leaf Wattle), *Acacia doratoxylon* (Currawang), *Dodonaea boroniifolia* (Fern-leaf Hop-bush), *Entolasia stricta* (Wiry Panic) and *Poa affinis* on soils derived from Narrabeen Sandstones (Carter and Walsh, 2010). *Pomaderris sericea* is widely but patchily distributed from the upper Genoa River in far-eastern Victoria to central eastern NSW (Carter and Walsh, 2010).

This species was not recorded during surveys of the Study Area. There is the potential for this species to occur at higher elevations with associated species.

The Atlas of NSW Wildlife holds one record of *Pomaderris sericea* (Silky Pomaderris) within the locality from 1997. *Pomaderris sericea* (Silky Pomaderris) is conserved in the locality and wider region within Wollemi National Park. Additional potential suitable habitat occurs within the locality and wider region.

vii. Philotheca ericifolia

TSC Act Status: Not listed

EPBC Act Status: Vulnerable

Philotheca ericifolia is a wide spreading shrub growing to 2 m high (Threatened Species Scientific Committee, 2008c). This species is known to occur chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies (Threatened Species Scientific Committee, 2008c). It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops and is known as a moisture-loving plant (Threatened Species Scientific Committee, 2008c). *Philotheca ericifolia* is known from the upper Hunter Valley and Pilliga to the Peak Hill districts of NSW, with records scattered over a range of more than 400 km between West Wyalong and the Pilliga Scrub (Threatened Species Scientific Committee, 2008c).

This species was not recorded during surveys of the Study Area. There is the potential for this species to occur at higher elevations in proximity to creek lines and seepages.

The Atlas of NSW Wildlife holds no records of *Philotheca ericifolia* within the locality. *Philotheca ericifolia* is conserved in the locality and wider region within Wollemi National Park. Additional potential suitable habitat occurs within the locality and wider region.

viii. Thesium australe

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Thesium australe (Austral Toadflax) is a small, straggling herb to 40 cm tall and is semi-parasitic on roots of a range of grass species (OEH, 2013a). This species occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast and is often found in association with *Themeda australis* (Kangaroo Grass) (OEH, 2013a). Within NSW, *Thesium australe* (Austral Toadflax) is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands (OEH, 2013a).

This species was not recorded during surveys of the Study Area. There is the potential for this species to occur within grassland and grassy woodlands.

The Atlas of NSW Wildlife holds no records of *Thesium australe* (Austral Toadflax) within the locality. *Thesium australe* (Austral Toadflax) has not been recorded within any conservation reserves within the locality or wider region. Additional potential suitable habitat occurs within the locality and wider region.

3.8 Other Flora Species of Conservation Significance

3.8.1 Regionally Significant Flora Species

A total of 14 regionally significant flora species have been recorded by Eastcoast Flora Surveys within the Study Area (see **Appendix B**). These species are considered as regionally significant as they are rare, extend known distributional ranges or support few recent records. A summary of each of these species is discussed below. Although not all locations of regionally significant flora species were recorded during surveys, the locations of those that were are shown on **Figure 3.9**.

i. Acacia harpophylla

Acacia harpophylla is considered a regionally significant flora species as it is an inland species, although it is considered to be planted. *Acacia harpophylla* is one of a number of inland arid *Acacia* species, some of which occur within the Hunter Valley at their distributional limits. A single stand of this species was recorded within the Study Area on former grazing land. It is postulated that these trees were planted to provide stock shelter, as habitat for this species recorded in the literature does not match well with that present in the Study Area.

ii. Acaena echinata var. subglabricalyx

Acaena echinata var. *subglabricalyx* is considered a regionally significant flora species as the occurrence within the Study Area represents a northerly range extension. *Acaena echinata* var. *subglabricalyx* was recorded at a single location within the Study Area within Coastal Grey Box Woodland. This prostrate forb is a southern species growing in herb and grass rich woodlands. The nearest known record to Bylong is ~100km to the south in western Sydney, and then >200km further to the south around Goulburn and Young (OEH, 2014b).

iii. Bertya linearifolia

Bertya linearifolia is considered a regionally significant flora species as is it very rare and a Hunter Valley endemic. *Bertya linearifolia* was recorded at a single location in the southern portion of the Study Area along a creek line within Exposed/Sheltered Grey Gum / Stringybark Forest. This species is endemic to the Hunter Valley (Halford and Henderson, 2002), and with only three other collections within Australian herbaria. Although not a listed threatened species, this taxon is exceedingly rare and evidently poorly collected.

iv. Boronia angustisepala

Boronia angustisepala is considered a regionally significant flora species as is it rare. *Boronia angustisepala* was recorded at a number of locations within the Study Area in the vicinity of Tal Tal Mountain in Cypress Pine Forest, Exposed/Sheltered Grey Gum / Stringybark Forest, Blue-leaf Ironbark / Cypress Forest and Scribbly Gum / Grey Gum Forest. This species occurs from the Gilbraltar and Nandewar Ranges south to Sandy Hollow and Bylong (Duretto, 1999). Numerous populations are present in the Sandy Hollow area, including many in National Park estate (OEH, 2014b). Duretto (1999) notes that plants in the Sandy Hollow-Bylong area are atypical (smaller flowers, more ovate sepals) and that research is required to determine if they form an intergrade within *Boronia rubiginosa*.

v. Epacris coriacea

Epacris coriacea is considered a regionally significant flora species as is it rare. *Epacris coriacea* was recorded at one location in the south east of the Study Area in Blue-leaf Ironbark / Cypress Forest. A single population of approximately 15 individuals was recorded. This species is a rare decumbent shrub that grows on sandstone rock faces and cliffs, in the Wollemi and Blue Mountains National Parks region.

vi. Chenopodium desertorum subsp. microphyllum

Chenopodium desertorum subsp. *microphyllum* is considered a regionally significant flora species as it is an inland species, with few local records. *Chenopodium desertorum* subsp.

microphyllum was recorded at one location within Slaty Box Woodland within the Study Area. The nearest known records occur ~150km to the west and southwest, in the Dubbo and Parkes regions (OEH, 2014b).

vii. Gonocarpus longifolius

Gonocarpus longifolius is considered a regionally significant flora species as is it rare. *Gonocarpus longifolius* was recorded at a number of locations within the Study Area in Exposed/Sheltered Grey Gum / Stringybark Forest, Blue-leaf Ironbark / Cypress Forest and Scribbly Gum / Grey Gum Forest. This species is a rare shrub, common across the Wollemi region where it occurs in a range of sandstone-based habitats (Bell, 2008). A total of ten populations were recorded within sandstone habitats and is likely to occur in other areas of the Study Area. Typically, this species occurs in sheltered gullies and on sheltered slopes in open forest.

viii. Hakea tephrosperma

Hakea tephrosperma is considered a regionally significant flora species as the occurrence within the Study Area represents an easterly range extension. *Hakea tephrosperma* was recorded at several locations within the Study Area, primarily in shrubby regrowth vegetation on stony knolls. This species is typical of the western slopes and plains, with the closest known records for this species occurring ~100km to the west around Dubbo (OEH, 2014b).

ix. Hibbertia pilifera

Hibbertia pilifera is considered a regionally significant flora species as it is a recently segregated species with an uncertain distribution. Toelken and Miller (2011) have recently revised the taxonomy of a number of Sydney Basin *Hibbertias*, and *Hibbertia pilifera* is one of these but with an uncertain distribution.

x. Homoranthus cernuus

Homoranthus cernuus is considered as a regionally significant flora species as is it rare. *Homoranthus cernuus* was recorded at one location in the south east of the Study Area. Approximately five plants were present at this location, which occurred at the head of a north-facing gully in open forest of Blue-leaf Ironbark / Cypress Forest. This species is endemic to north-western Wollemi National Park, where it is uncommon (Bell, 2008; Copeland *et al.*, 2011).

xi. Melaleuca lanceolata

Melaleuca lanceolata is considered a regionally significant flora species as there are few local records and the occurrence within the Study Area forms a disjunct population. *Melaleuca lanceolata* was recorded at one location within the Study Area, in Slaty Box Woodland which it forms dense thickets on the Permian footslope. Three previous records exist for *Melaleuca lanceolata* in the Bylong area, and one in the Capertee Valley, but otherwise this species is known only from Dubbo (150 km to the west) and around West Wyalong (~250 km to the southwest) and the South Western Slopes and Plains (OEH, 2014b). Stands of vegetation dominated by *Melaleuca lanceolata* have not previously been described for the Hunter Valley, primarily because this is a western species and occurs as a disjunct population within the Study Area.

xii. Myoporum platycarpum subsp. platycarpum

Myoporum platycarpum subsp. *platycarpum* is considered a regionally significant flora species as it is an inland species with few local records. *Myoporum platycarpum* subsp. *platycarpum* was recorded at a number of locations on the low hills and footslopes, often in shrubby regrowth areas. Few records exist in the Hunter Valley. There is a single record for the Muswellbrook area from 1912, and an earlier one from 1893 for 'Murrumbo' a grazing property immediately east of the Study Area (OEH, 2014b). The next nearest location is ~100km to the north on the Liverpool Plains, and 150km to the west around Dubbo (OEH, 2014b).

xiii. Scaevola albida var. pallida

Scaevola albida var. *pallida* is considered a regionally significant flora species as it is an inland species with few local records. *Scaevola albida* var. *pallida* was recorded within White Box Woodland (Shrubby) on footslopes. There are currently only five records of *Scaevola albida* var. *pallida*, with a single record from 1892 from Upper Bylong, within the Study Area, and other collections from the Bungonia and Abercrombie areas several hundred kilometres to the south (OEH, 2014b). The re-collection of this taxon within the Study Area after 120 years confirms that it persists in the area.

xiv. Rhynchosia minima

Rhynchosia minima is considered a regionally significant flora species as the occurrence within the Study Area is approaching the southern limit of this species. *Rhynchosia minima* was recorded at one location within Yellow Box Woodland within the Study Area. *Rhynchosia minima* occurs primarily to the north of the Hunter Valley, in the North Coast, Northern Tablelands, and North Western Slopes and Plains botanical subdivisions. Relatively few records exist for the Hunter, the nearest being in the Denman-Singleton-Muswellbrook area, with the most southern record ~50 km to the southwest near Mudgee (OEH, 2014b).

3.8.2 Potential New Species

During the course of field surveys within the Study Area, three collected species have been confirmed by taxonomic experts to likely represent new flora species. Each of these species is discussed below. The locations of potential new flora species are shown on **Figure 3.9**.

i. Hibbertia sp. aff. acicularis (Dilleniaceae)

Individuals of a *Hibbertia* species were collected from the north-western portion of the Study Area within Derived Native Grassland. These individuals were sent to Hellmut Toelken, a *Hibbertia* taxonomist at the South Australian State Herbarium. The specimens were confirmed as a probable new species within the *Hibbertia acicularis* group due to (among other features) its sub-sessile flowers.

ii. Sannantha sp. aff. cunninghamii (Myrtaceae)

Individuals of a *Sannantha* species were collected within Bylong State Forest in Blakely's Red Gum / Paperbark Forest. The individuals collected differ from *Sannantha cunninghamii* in the mostly entire, narrow linear leaves. Both taxa have fringe-like projections along young stems and appear to grow sympatrically in drainage depressions. Only one other collection of this likely new species exists and is from nearby Poggy Creek within Goulburn River National Park. Further study of this species is proposed to be undertaken by Dr. Peter Wilson from the National Herbarium of NSW.

iii. Grevillea sp. aff. patulifolia/sericea (Proteaceae)

Individuals of a *Grevillea* species were collected from a few locations within the northern portion of the Study Area in Slaty Box Woodland, Caley's Ironbark Forest, Red Ironbark / Cypress Forest, Blue-leaf Ironbark / Cypress Forest and Blakely's Red Gum Woodland (Shrubby). These individuals have affinities to *Grevillea patulifolia* and/or *Grevillea sericea*. These individuals were sent to Bob Makinson, a *Grevillea* expert at the National Herbarium of NSW. The specimens were determined to be a potential new species restricted to Goulburn River National Park.

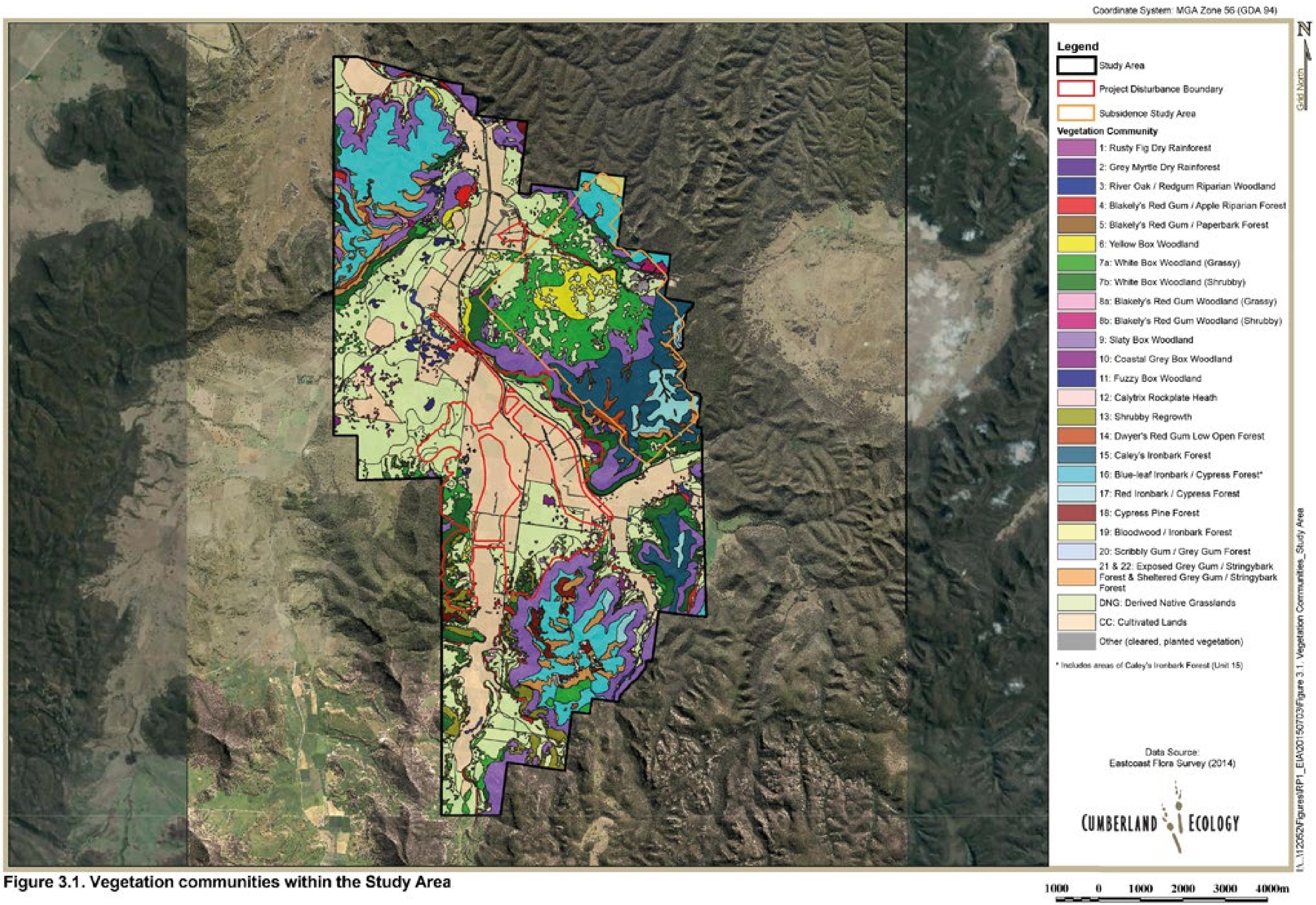


Figure 3.1. Vegetation communities within the Study Area

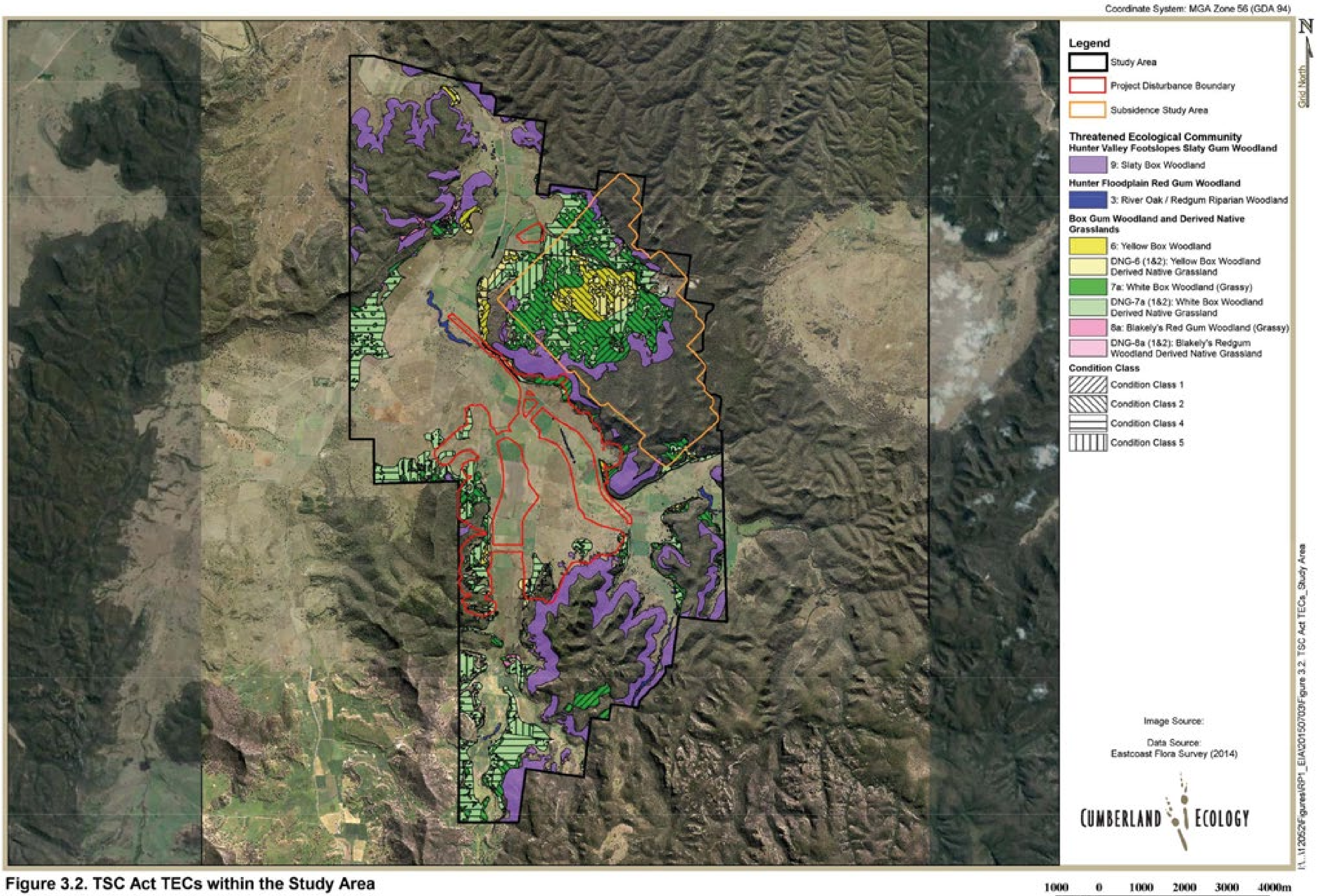


Figure 3.2. TSC Act TECs within the Study Area

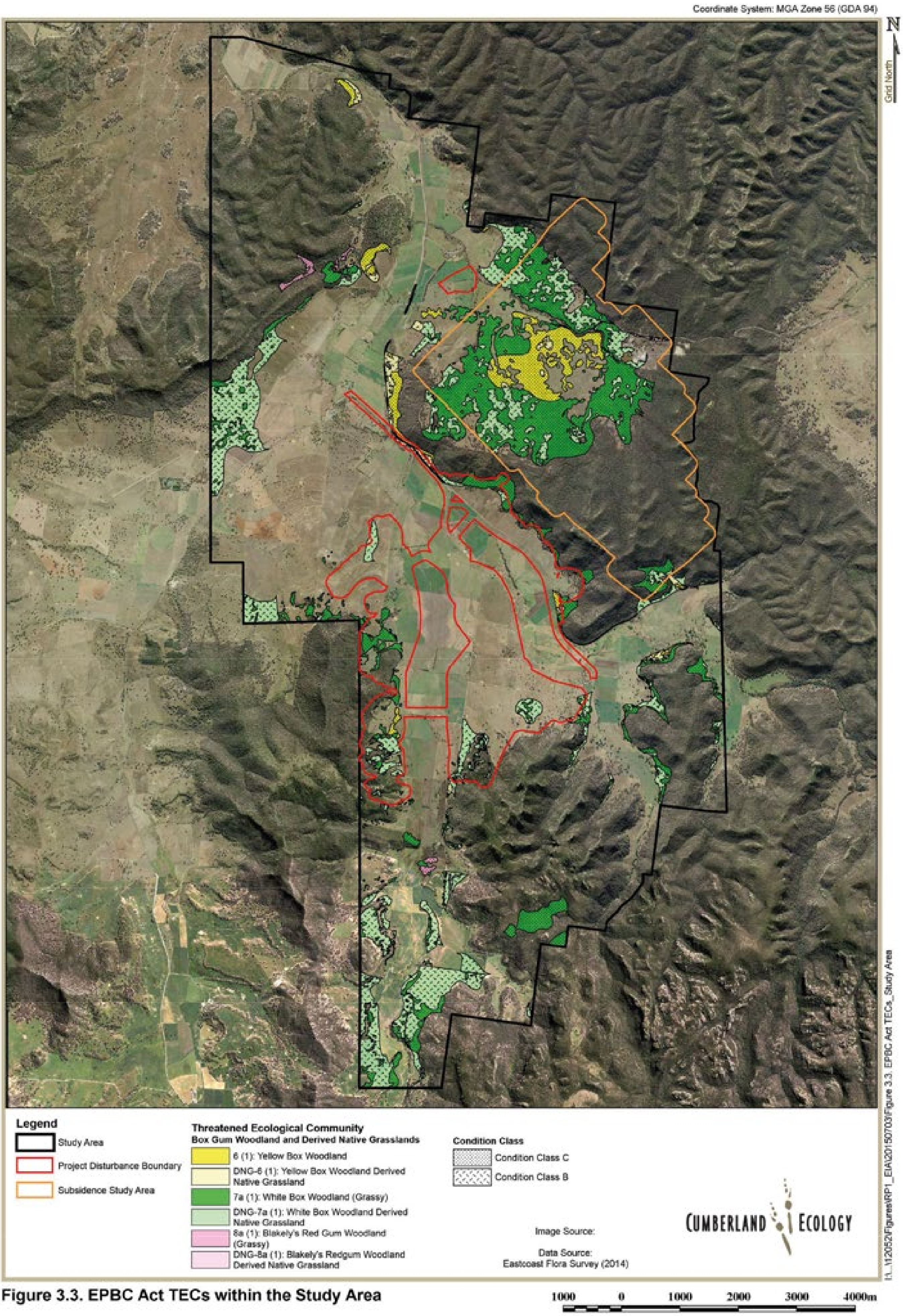


Figure 3.3. EPBC Act TECs within the Study Area

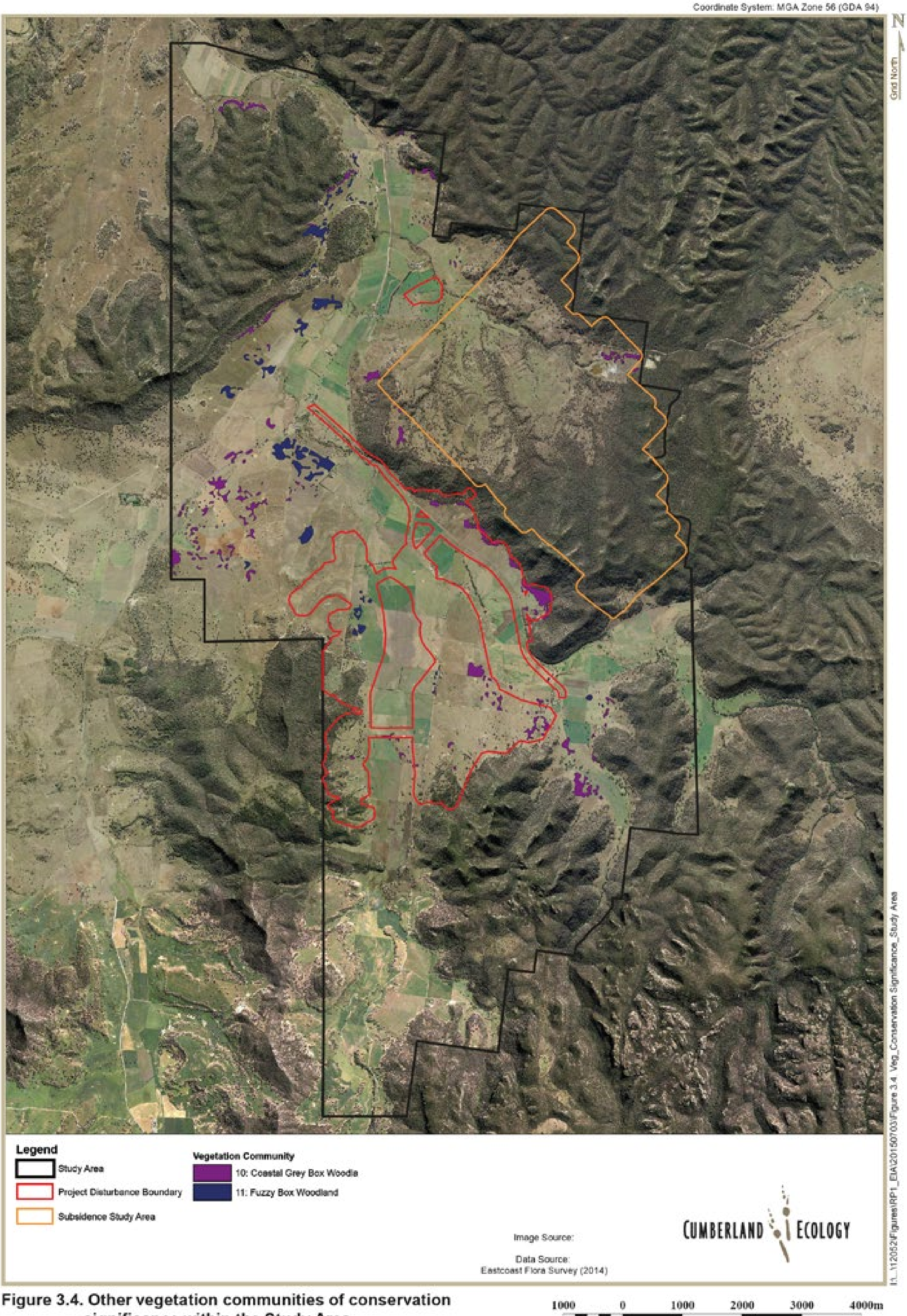


Figure 3.4. Other vegetation communities of conservation significance within the Study Area

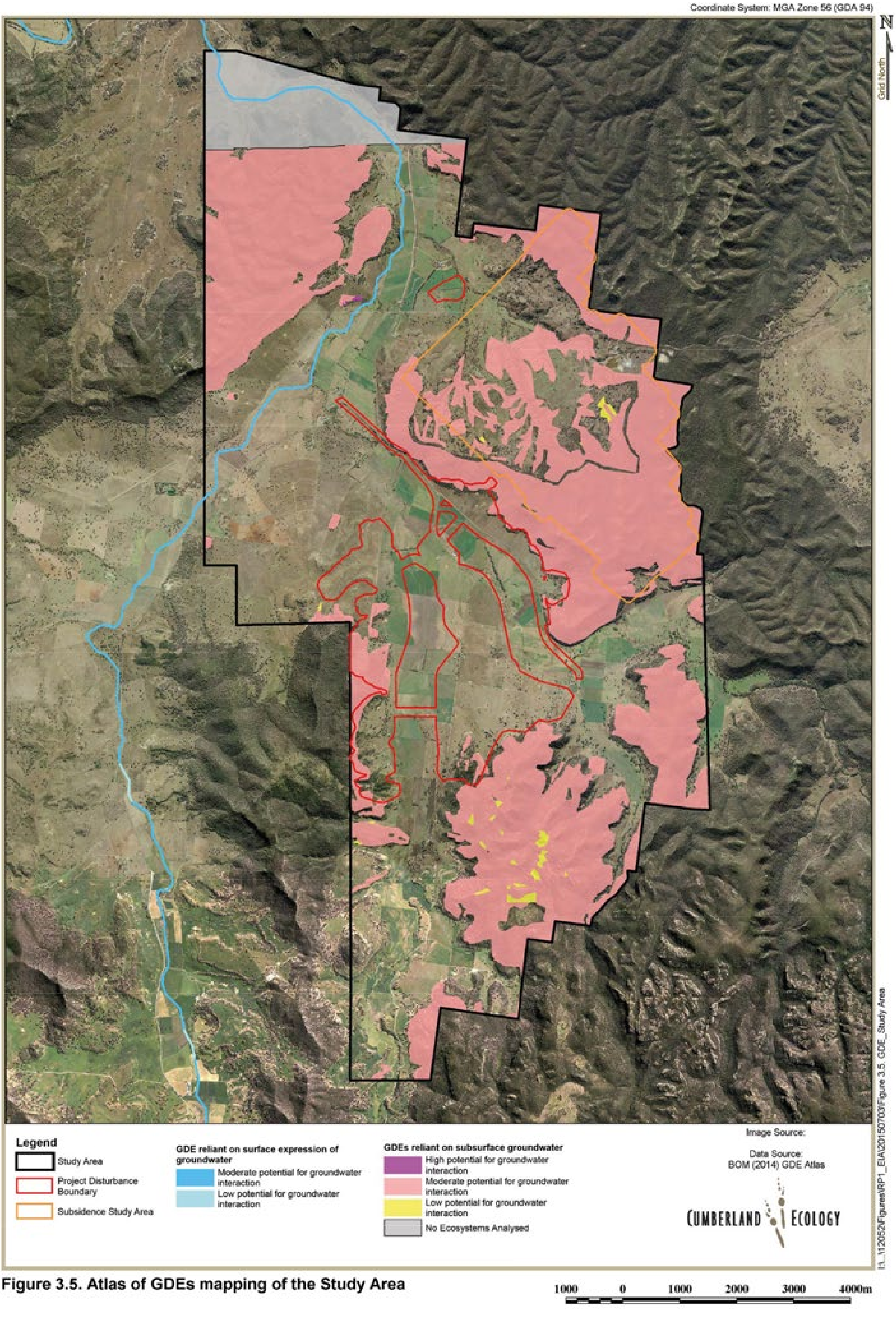


Figure 3.5. Atlas of GDEs mapping of the Study Area

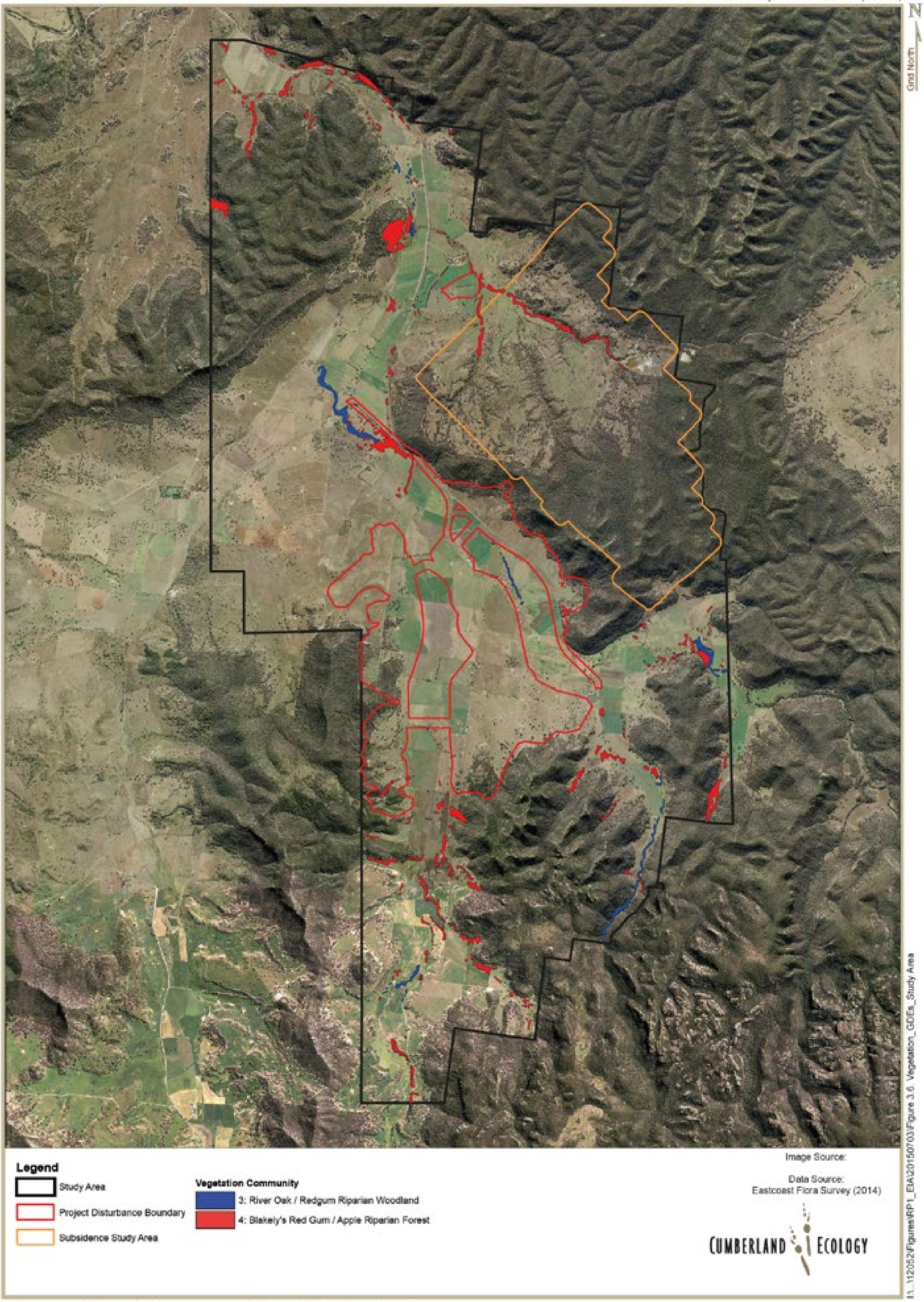


Figure 3.6. Vegetation communities within the Study Area identified as GDEs

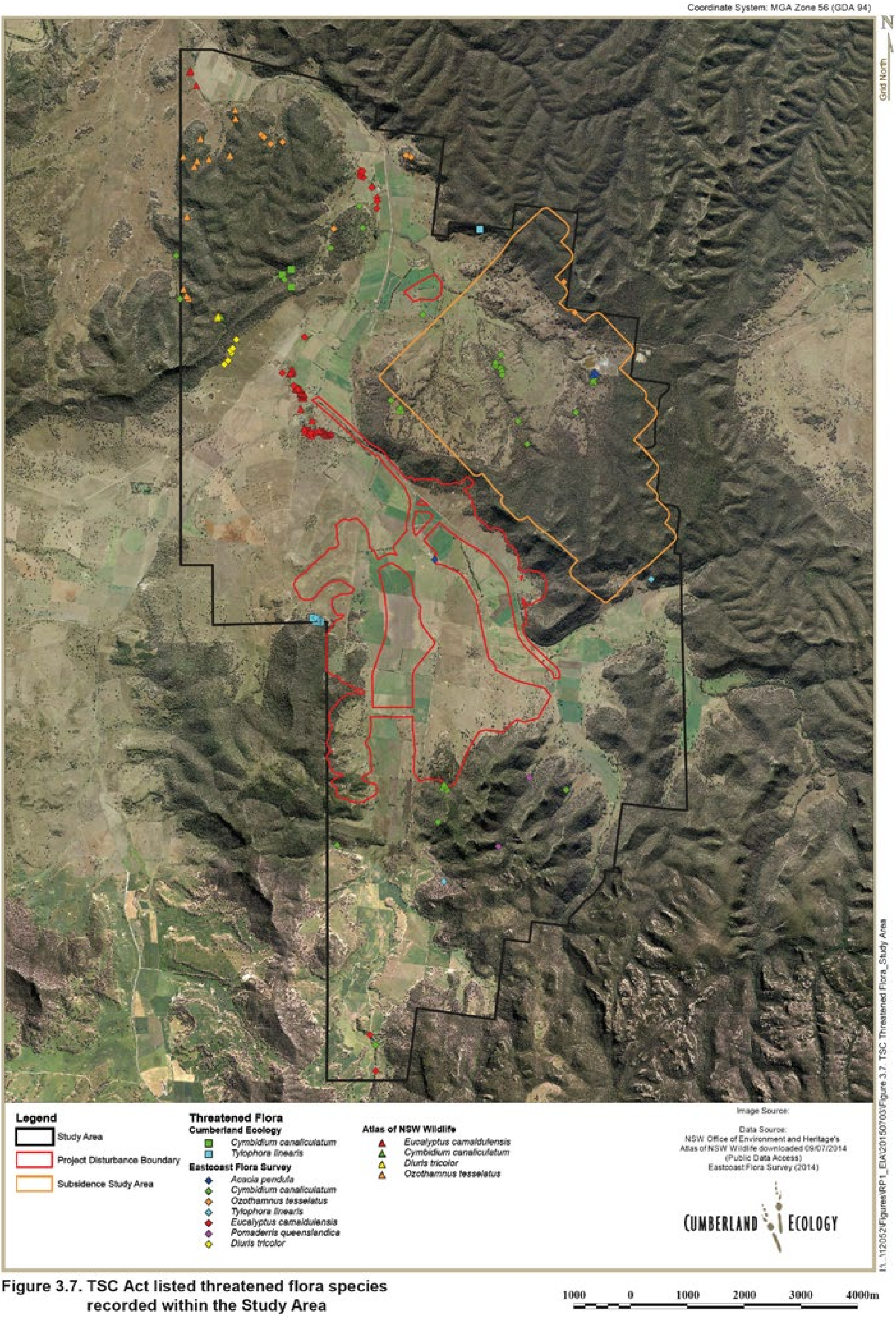


Figure 3.7. TSC Act listed threatened flora species recorded within the Study Area

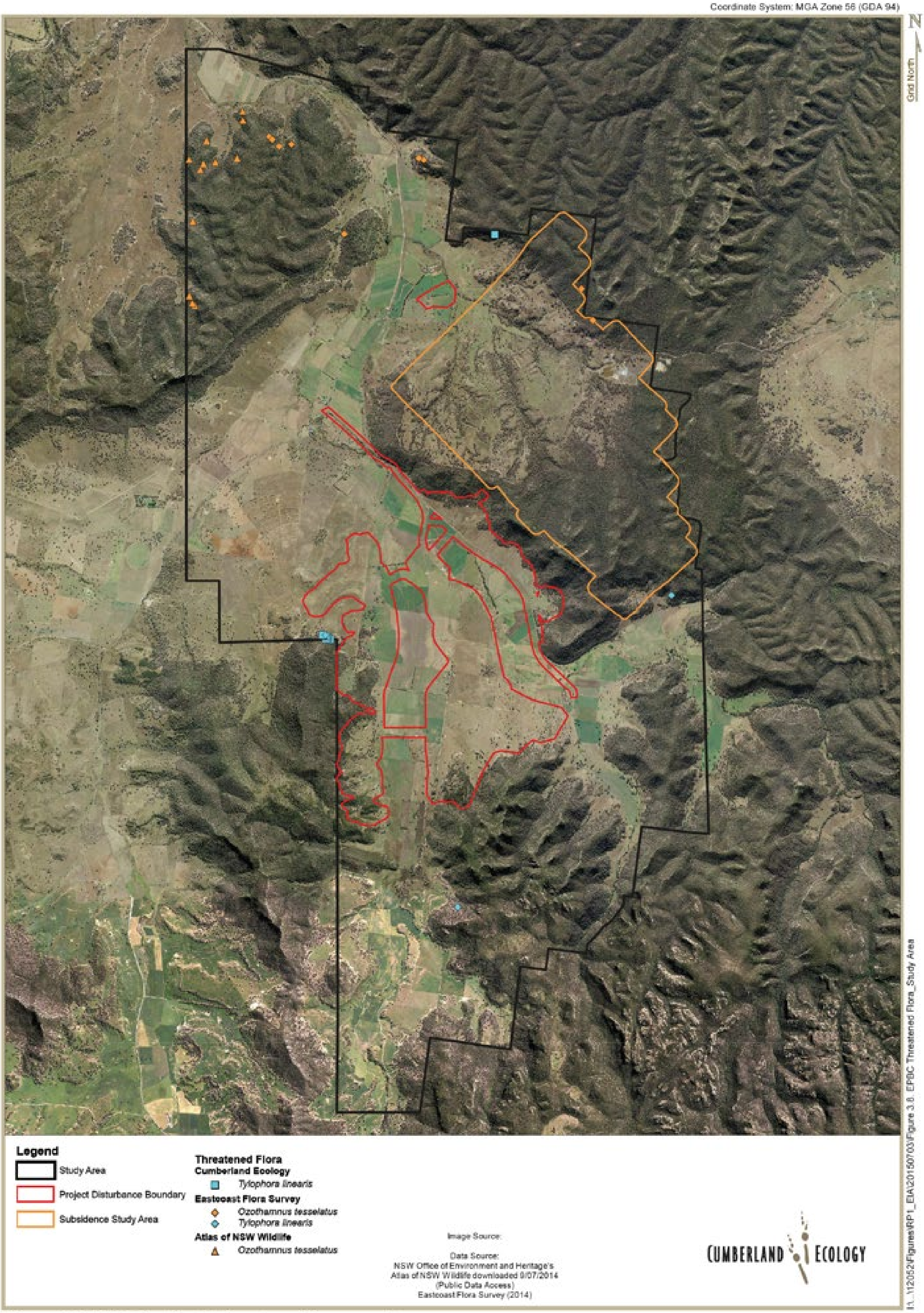


Figure 3.8. EPBC Act listed threatened flora species recorded within the Study Area

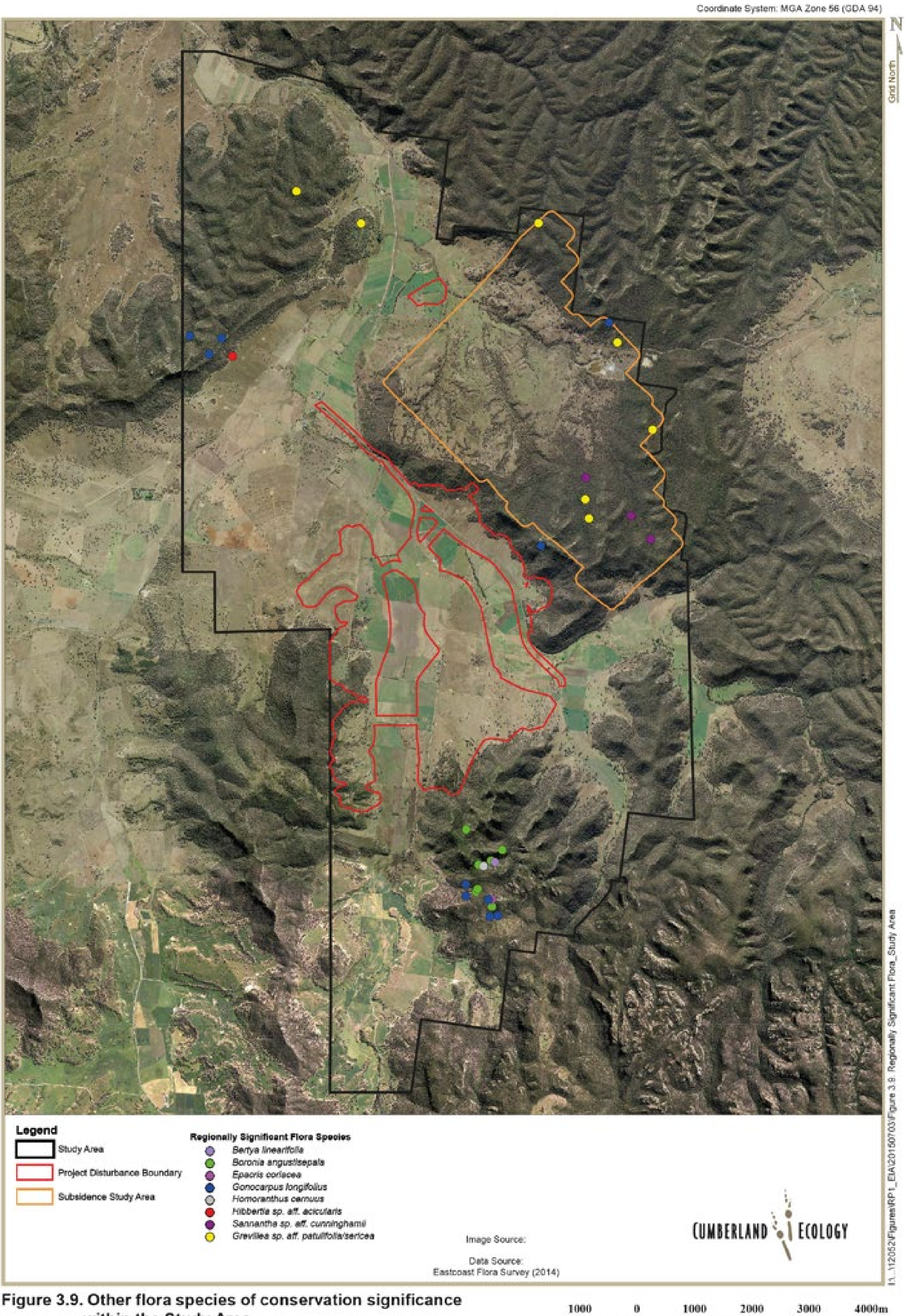


Figure 3.9. Other flora species of conservation significance within the Study Area

Chapter 4

Results: Fauna

4.1 Terrestrial Fauna Habitat

4.1.1 Habitat Features

The Study Area contains extensive areas of intact woodland and forest vegetation as well as modified grassland areas. The matrix of fauna habitats within the Study Area occur within the various vegetation formations, topographical formations and ephemeral water resources. The habitat features are numerous and provide potential foraging, shelter and breeding opportunities for a suite of fauna species. Key habitat features within the Study Area include:

- Riparian environments suitable for fauna species dependent on these habitats such as wetland birds, some amphibians and reptiles;
- Terrestrial habitat features such as ground and shrub layer vegetation, leaf litter, coarse woody debris and rocky outcrops suitable as shelter for small terrestrial fauna species;
- Hollow-bearing trees and stags suitable as shelter and breeding habitat for a range of hollow-dependent fauna;
- Blossom-producing trees and shrubs suitable as forage for a range of nectarivores;
- Koala feed tree species; and
- Cliff lines and associated features such as caves and rocky outcrops suitable for fauna species dependent on these habitats, such as microbats.

These features are discussed in more detail below.

i. Riparian Environments

Several surface drainage systems, including Bylong River, Growee River, Dry Creek, Lee Creek and Cousins Creek, and their tributaries occur within the Study Area. However none of these systems have permanent flowing water. Temporary pools within the network of drainage lines are present within the Study Area, with some aquatic vegetation present in pools where water persists for longer durations. The drainage lines within the Study Area provide suitable foraging and breeding habitat for a number of fauna species, including amphibians, birds, mammals and reptiles. Temporary pools of water would provide a valuable drinking source in hot and dry months.

Agricultural dams are also present within the Study Area on the valley floor. Many of the dams observed feature little aquatic and semi-aquatic vegetation and are surrounded by cleared land. The agricultural dams within the Study Area do not generally support aquatic vegetation. However, these dams do provide some limited habitat for wetland dependent species, including birds and amphibians. Additionally, the water contained within dams provides a drinking source for terrestrial mammals, microbats, birds and reptiles, including native and non-native species.

ii. Terrestrial Habitat Features

Features such as rocky outcrops, fallen logs, debris and leaf litter provide shelter for many of the small to medium sized terrestrial fauna species known from the Study Area. The structural integrity of woodland and forest habitats including the presence of rocky outcrops and coarse woody debris is a key factor in determining habitat suitability for a range of forest and woodland-dependent fauna.

Terrestrial habitat features are the most prevalent within the woodland and forest communities, where structural complexity is highest. However, the presence of some of these features, such as coarse woody debris, is also important within grassland areas for a number of species. In addition to providing habitat for terrestrial fauna, fallen logs and shrub vegetation provide foraging perches and calling locations for small woodland birds.

Extensive areas of rocky sandstone outcrops within the Study Area provide shelter and breeding habitat for many reptiles and ground-dwelling mammals. These features are often found in association with cliff line habitats.

iii. Hollow-bearing Trees and Stags

Tree hollows are an essential resource for a number of fauna species that rely on them for refuge and nesting (Newton, 1994; Gibbons and Lindenmayer, 2002; Heinsohn *et al.*, 2003; Cockle *et al.*, 2010) and they have been shown to be a key limiting resource for hollow-dependent fauna (Brawn and Balda, 1988; Lindenmayer *et al.*, 1990; Newton, 1994; Gibbons and Lindenmayer, 2002; Gibbons *et al.*, 2002; Heinsohn *et al.*, 2003; Cameron, 2006). Furthermore, many hollow-dependent species will only occupy hollows with specific hollow characteristics (Gibbons *et al.*, 2002), which means that many hollows are unlikely to be suitable, thereby increasing the demand on the remaining suitable hollows.

The mature living trees and stags within the Study Area provide a number of small to large-sized hollows for fauna species dependant on this resource. The woodland and forest communities provide the greatest abundances and diversity of hollows within the Study Area. However, large-sized hollows were observed within remnant paddock trees. Fewer large-sized hollows were observed within the Bylong State Forest, which is likely due to the history of logging within this area. The tree hollows and stags within the Study Area provide shelter, roosting and nesting habitat for a number of arboreal fauna species, including microchiropteran bats, gliders, diurnal birds, owls and some reptiles.

CUMBERLAND ECOLOGY

The count of tree hollows within the 34 sampled plots within the Project Disturbance Boundary is shown in **Table 4.1**. Within sampled plots, *Eucalyptus albens* (White Box) contains the highest number of hollows and most diverse range of hollow sizes. *Eucalyptus dawsonii* (Slaty Gum) also showed an abundance and range of hollows.

Table 4.1 Count of tree hollows within 34 sampled plots within the Project Disturbance Boundary

Scientific Name	Common Name	<5cm	5-10cm	11-15cm	16-20cm	21-25cm	25+cm
Angophora floribunda	Rough-barked Apple	0	0	2	0	0	0
Casuarina cunninghamiana	River Oak	0	2	0	1	0	0
Eucalyptus albens	White Box	24	24	11	17	8	2
Eucalyptus conica	Fuzzy Box	5	3	2	1	0	0
Eucalyptus dawsonii	Slaty Gum	6	1	7	4	6	5
Eucalyptus melliodora	Yellow Box	1	1	2	0	0	0
Eucalyptus moluccana	Grey Box	2	3	3	1	1	2
Stag	-	4	5	4	3	1	3

iv. Blossom-producing Trees and Shrubs

The vegetation across the Study Area would provide suitable foraging habitat for a range of nectivorous birds and arboreal mammals during blossom periods. It is expected that a number of nectar-dependent species would be attracted to the Study Area and wider locality during the blossoming period of dominant trees and shrubs.

The distribution, abundance, species composition, age and productivity of blossom-producing trees are significant factors affecting the distribution and abundance of blossom-dependent birds. A diversity of blossom-producing trees and shrubs occur throughout the Study Area. **Table 4.2** indicates that summer, autumn, winter and spring flowering trees can be found within the Study Area, therefore providing some sources of forage for blossom-dependent species throughout the year. Understorey species would also provide a foraging resource for some blossom-dependent species. Mistletoes, including *Amyema miquelii* and *Amyema quandang* var. *quandang*, occur consistently throughout the woodland and forest communities of the Study Area.

In addition to providing direct resources to birds and arboreal mammals, the blossom-producing trees and shrubs would also attract insects. Microbats known from the locality are insectivorous and would feed on moths, beetles and other insects.

Table 4.2 Flowering periods for dominant tree species

Scientific Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Angophora floribunda	Rough-barked Apple	✓	✓	✓								✓	✓
Eucalyptus albens	White Box			✓	✓	✓	✓						
Eucalyptus blakelyi	Blakely's Red Gum								✓	✓	✓	✓	✓
Eucalyptus caleyi subsp. caleyi		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
Eucalyptus camaldulensis	River Red Gum	✓	✓					✓	✓	✓	✓	✓	✓
Eucalyptus conica	Fuzzy Box						✓	✓	✓	✓			
Eucalyptus dawsonii	Slaty Gum										✓	✓	
Eucalyptus fibrosa	Red Ironbark			✓	✓	✓	✓	✓	✓				
Eucalyptus melliodora	Yellow Box	✓	✓							✓	✓	✓	✓
Eucalyptus moluccana	Grey Box	✓	✓	✓	✓								
Eucalyptus punctata	Grey Gum	✓	✓	✓	✓								✓

Source: (Benson and McDougall, 1998; Brooker and Kleinig, 2006)

v. Koala Feed Tree Species

The Study Area supports three species of feed trees for the Koala as listed under Schedule 2 of the *State Environmental Planning Policy 44 – Koala Habitat Protection* (SEPP 44). This includes *Eucalyptus albens* (White Box), *Eucalyptus punctata* (Grey Gum) and *Eucalyptus camaldulensis* (River Red Gum). These species primarily occur on the valley floor and footslopes within the Study Area.

The Study Area occurs within the Central and Southern Tablelands management zone for the Koala identified within the *Recovery plan for the koala (Phascolarctos cinereus)* (DECC (NSW), 2008b). One of the two primary food trees identified within this management zone, namely *Eucalyptus camaldulensis* (River Red Gum), occurs within the Study Area. Secondary feed trees within this management zone occurring within the Study Area include *Eucalyptus albens* (White Box), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus microcarpa* (Grey Box) and *Eucalyptus melliodora* (Yellow Box).

vi. Cliff Lines and Associated Features

The Study Area contains extensive areas of cliff lines which comprise various forms including vertical, concave areas and convex areas. A total of 730 cliff-lines have been identified within the Study Area by MSEC. Cliff lines within the Study Area are defined by MSEC (2015) as '*a continuous rockface having a maximum height greater than 10 m, a minimum length of 20 m and a minimum slope of 2 in 1*'. The cliff lines vary in terms of their scale and physical complexity and the number of caves, overhangs and boulder beds also varies. The locations of cliff lines identified within the Study Area are shown in **Figure 4.1**.

The majority of cliff-lines occur within the geological strata referred to as the Narrabeen Group (part of the Hawkesbury Sandstone landscape), with the parent rock comprising lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone. The landform of the two soil landscapes derived from the Narrabeen Group within the Study Area are described as follows (Kovac and Lawrie, 1991):

- Lees Pinch: Rolling hills to steep mountains with rounded summits, some edged by sandstone; and
- Olgilvie: Steep hills and escarpments with cliffs up to 20 m high.

Cliff lines of a similar size and complexity also occur within the locality of the Study Area, including extensive areas underlain by the Narrabeen Group geological unit (part of the Hawkesbury Sandstone landscape). Numerous areas within adjoining land, including Wollemi National Park and Goulburn River National Park occur on sandstone-dominated geologies that contain cliff lines. There is no indication that the cliff lines within the Study Area are particularly unique to the widespread cliffs in the locality or indeed elsewhere within the Sydney Basin Bioregion.

The results indicate that a variety of native fauna occur within the cliff line habitats of the Study Area and these areas are likely used as foraging, breeding, roosting and shelter habitat. The cliff lines provide a range of habitat features such as caves, cracks, overhangs, ledges, boulders of various sizes and laminating sandstone. Additionally, there are small areas with water seepage that occur in association with these features. These features would be used in conjunction with the surrounding vegetation by a suite of fauna species including microbats, mammals and reptiles.

There is confirmed habitat within the Study Area for the Brush-tailed Rock-wallaby (*Petrogale penicillata)* and threatened cave-roosting bats, and potential habitats for other threatened fauna including the Broad-headed Snake *(Hoplocephalus bungaroides).*

The camera results indicate that a number of feral animals are well established within the cliff line areas including goats and foxes. These are likely to reduce the quality and availability of habitat for a number of threatened species, particularly the Brush-tailed Rock-wallaby (*Petrogale penicillata*). Goats (*Capra hircus*) are known to compete for resources with the Brush-tailed Rock-wallaby displacing them from refuge habitats (Menkhorst and Hynes, 2010), and foxes (*Vulpes vulpes*) are known to prey upon wallabies.

4.1.2 Wildlife Corridors

Wildlife corridors are generally areas of habitat that connect reserves or blocks of disjunct habitat. Wildlife corridors allow wildlife to disperse and provide for gene flow between populations or subpopulations (Primack, 1993). Wildlife corridors are of varying relevance to fauna, and are of greatest relevance to ground dwelling species that cannot fly. Highly mobile birds and microbats can fly between patches of habitat, over human developments and clearings.

On a broad-scale, the woodland and forest vegetation within the Study Area is directly connected to Wollemi National Park and Goulburn River National Park, as well as extensive areas of unreserved vegetation to the west and south west (see **Figure 1.1**). The Study Area falls within the corridor delineated by the Great Eastern Ranges Initiative. Whilst it has no legal requirements, the initiative is a national effort which aims to maintain and improve connectivity of the mountainous ecosystems of eastern Australia (OEH, 2011). The corridor comprises a linked series of biodiversity hotspots interconnected by a wide diversity of native vegetation (OEH, 2011).

On a finer scale, detailed examination of the vegetation and landscape of the Study Area indicates numerous movement corridors for wildlife. There is good connectivity across the treed portions of the Study Area, with movement corridors relating to vegetation communities and their associated habitat types. The areas along creeks form corridors for many species. Movement of some species within the Study Area and to adjacent areas of habitat is impeded by cleared areas currently forming agricultural land. However the isolated remnant patches and scattered paddock trees within the agricultural landscape provides stepping stone habitat for a number of fauna species, particularly woodland birds.

4.1.3 Regional Distribution and Abundance of Fauna Habitat

A diverse range of vegetation, ranging from rainforests and wet sclerophyll forest, to dry sclerophyll forests, woodlands, shrublands and grasslands occurs within the local region of the Study Area. These various vegetation types provide extensive areas of varied habitat, an abundance of which is protected in formal conservation reserves, and is known to support a number of threatened flora and fauna species that have been recorded or have the potential to occur within the Study Area. Key habitat features discussed above are also found elsewhere in the region and provide habitat for threatened species.

Conservation areas adjacent to the Study Area and in the wider locality can influence the distribution and dispersal of flora and fauna into the wider locality, and as many are formally conserved, will continue to provide important areas of good quality habitat for locally occurring species. Such surrounding reserves include Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve.

4.2 General Fauna Species

Over 180 vertebrate fauna species have been recorded from the Study Area during this ecological assessment. This includes six amphibian species, 130 bird species, 37 mammal species and nine reptilian species. A total of 13 exotic species were recorded during surveys, including mammals and birds. A total fauna species list for the Study Area is provided in **Appendix E**. It is anticipated that a number of species known from the locality would also utilise the habitats within the Study Area. The occurrence of threatened fauna species within the Study Area, including those within the potential to occur, is outlined within ***Section 4.3***.

4.2.1 Amphibians

The water sources provided by the surface drainage systems and their tributaries, as well as dams, constitute habitat for a number of amphibian species. Six amphibians were recorded within the Study Area during surveys. The Common Eastern Froglet (*Crinia signifera*) was the most commonly encountered species within the Study Area. No threatened amphibians were recorded within the Study Area.

4.2.2 Birds

The Study Area supports a diversity of bird species, which is to be expected given the size of the Study Area, the habitat available and the mobility of this fauna group. During the surveys, 130 bird species were recorded within the Study Area. A variety of small to medium sized birds including finches, honeyeaters and lorikeets utilise the nesting and foraging habitat with the woodland and forest vegetation. The Noisy Friarbird (*Philemon corniculatus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*) were frequently recorded throughout the Study Area during surveys.

Raptors such as the Nankeen Kestrel (*Falco cenchroides*) and Black-shouldered Kite (*Elanus axillaris*) were commonly recorded within grassland areas and along the fringes of woodland and forest habitat. Suitable nesting habitat in the form of hollow-bearing trees occurs predominantly within the woodland and forest vegetation and provides habitat for owls and cockatoos. Numerous threatened bird species were recorded within the Study Area, as shown in **Table 4.3**.

4.2.3 Mammals

The Study Area supports a range of mammals for which habitat is primarily contained within the woodland and forest communities. A total of 37 mammal species, including 21 terrestrial mammals, three arboreal mammals and 13 microchiropteran bats, have been recorded within the Study Area. A total of 10 exotic mammals have been recorded during surveys. Common native species, such as the Common Wombat (*Vombatus ursinus*), macropods (including the Common Wallaroo (*Macropus robustus*) and Swamp Wallaby (*Wallabia bicolor*), and Common Brushtail Possum (*Trichosurus vulpecula*) were observed at numerous locations throughout the Study Area. Small terrestrial mammals were less common. Four threatened mammals have been recorded within the Study Area. A number of microbat calls were not reliably identified and include three threatened species. These species have been assessed as potentially occurring species.

4.2.4 Reptiles

A range of habitat features suitable for reptiles occurs throughout the Study Area. A total of nine reptile species were recorded within the Study Area, including skinks and geckos. The Lace Monitor (*Varanus varius*) was commonly recorded within the Study Area. No threatened reptiles were recorded within the Study Area.

4.2.5 Exotic Species

Thirteen exotic species were recorded during surveys of the Study Area. This includes three bird species and 10 mammal species. The distribution and abundance of exotic species within the Study Area is related to the historic and current land uses. House Sparrow (*Passer domesticus*) and Common Starling (*Sturnus vulgaris*) were recorded within agricultural areas. Rabbits (*Oryctolagus cuniculus*) and pigs (*Sus scrofa*) were also recorded within these areas, with foxes (*Vulpes vulpes*) occurring in both cleared and woodland/forest areas. Other exotic species recorded within woodland/forest areas include wild dogs (*Canis lupus*), goats (*Capra hircus*), deer (*Dama dama*) and cats (*Felis catus*).

4.3 Threatened Fauna Species

The matrix of fauna habitats within the Study Area provides potential foraging, shelter and breeding opportunities for a suite of threatened fauna species. **Table 4.3** lists the threatened fauna species recorded within the Study Area, including records from the Atlas of NSW Wildlife (OEH, 2014b).

The locations of TSC Act listed and EPBC Act listed threatened fauna species recorded during surveys are shown in **Figure 4.2** and **Figure 4.3**, respectively. A discussion of each of these species and their occurrence within the Study Area is provided below.

Table 4.3 Threatened fauna species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Birds			
Anthochaera phrygia	Regent Honeyeater	CE	E
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	
Glossopsitta pusilla	Little Lorikeet	V	
Neophema pulchella	Turquoise Parrot	V	
Chthonicola sagittata	Speckled Warbler	V	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	

Table 4.3 Threatened fauna species recorded within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	
Stagonopleura guttata	Diamond Firetail	V	
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	
Callocephalon fimbriatum	Gang-gang Cockatoo	V	
Circus assimilis	Spotted Harrier	V	
Hieraaetus morphnoides	Little Eagle	V	
Ninox connivens	Barking Owl*	V	
Ninox strenua	Powerful Owl*	V	
Merops ornatus	Rainbow Bee-eater		M
Hirundapus caudacutus	White-throated Needletail*		M
Mammals			
Dasyurus maculatus	Spotted-tailed Quoll*	V	E
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	
Nyctophilus corbeni	Corben's Long-eared Bat*	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	
Pseudomys novaehollandiae	New Holland Mouse		V
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory
**Data obtained from the Atlas of NSW Wildlife (OEH, 2014b)*

4.3.1 Birds

i. Regent Honeyeater

TSC Act Status: Critically Endangered

EPBC Act Status: Endangered

The Regent Honeyeater (*Anthochaera phrygia*) is a nomadic species that inhabits eucalypt open forests and woodlands, particularly box-ironbark vegetation as well as River Oak gallery forest (NSW Scientific Committee, 2011c). This species feeds on the nectar of eucalypts and key species include *Eucalyptus sideroxylon* (Mugga Ironbark), *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box) as well as the mistletoe *Amyema cambagei* which grows on *Casuarina cunninghamiana* (River Oak) (Menkhorst *et al.*, 1999). Additionally insects and other arthropods form a component of the diet of this species (Menkhorst *et al.*, 1999). There are only three known key breeding regions including the Chiltern-Albury area in Victoria and in the Capertee Valley and Bundarra-Barraba area in NSW (OEH, 2012l). In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (OEH, 2012l).

This species was recorded foraging at one location within the Study Area within Blakely's Red Gum / Apple Riparian Forest. It is expected that this species would forage across this vegetation community and other woodland and forest communities. A number of nectar producing trees identified within the OEH (2014t) and DoE (2014a) profiles for the species and the recovery plan (Menkhorst *et al.*, 1999), including *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box) occur within the Study Area. The nectar producing species identified as feed trees for this species occurring within the Study Area, as well as mistletoes, could be used on occasion by this species for foraging. The Study Area is not located within the known breeding areas within NSW, namely the Capertee Valley and Bundarra-Barraba regions. It is anticipated that the species would forage within the Study Area.

The Atlas of NSW Wildlife holds 15 records of the Regent Honeyeater within the locality with dates ranging from 1984 - 2010. The Regent Honeyeater is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

ii. Black-chinned Honeyeater (eastern subspecies)

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Black-chinned Honeyeater (*Melithreptus gularis gularis*) inhabits woodlands containing box-ironbark associations and *Eucalyptus camaldulensis* (River Red Gum) within NSW (NSW Scientific Committee, 2001a) and some open forests (OEH, 2014d). Commonly associated species include *Eucalyptus sideroxylon* (Mugga Ironbark), *Eucalyptus albens*

(White Box), *Eucalyptus microcarpa* (Grey Box), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus tereticornis* (Forest Red Gum) (OEH, 2014d). This species feeds on arthropods, nectar and lerp from eucalypt foliage and bark (OEH, 2014d). Nesting occurs in crowns of tall eucalyptus, often box or ironbark trees, usually in the uppermost lateral branches, concealed by foliage (OEH, 2014d). Within NSW, this species is widespread with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina (OEH, 2014d).

This species was recorded foraging at a few locations within the Study Area, including within White Box Woodland (Grassy) and Slaty Box Woodland. It is expected that this species would forage across these vegetation communities and other woody vegetation within the Study Area. A number of key tree species occur within the Study Area, including *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus camaldulensis* (River Red Gum). Numerous other nectar producing trees occur within the Study Area, as well as mistletoes, which could be used on occasion by this species for foraging. Nesting habitat is present within the Study Area in the form of box and ironbark eucalypts. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 28 records of the Black-chinned Honeyeater within the locality with dates ranging from 1998 - 2010. The Black-chinned Honeyeater is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

iii. Little Lorikeet

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Little Lorikeet (*Glossopsitta pusilla*) is considered to be a nomadic species mostly occurring in dry, open eucalypt forests and woodlands (NSW Scientific Committee, 2009a). Isolated flowering trees in open country are also utilised by this species (OEH, 2014o). The Little Lorikeet feeds 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 (OEH, 2014o). In some parts of its range, *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box) are particularly important food sources for pollen and nectar respectively (OEH, 2014o). This species nests in hollow-bearing trees, particularly those within smooth-barked eucalypts, including *Eucalyptus viminalis* (Manna Gum), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus dealbata* (Tumbledown Red Gum) (NSW Scientific Committee, 2009a). Hollows utilised by the Little Lorikeet are very small, with an approximate diameter of 3 cm (NSW Scientific Committee, 2009a). This species is widely distributed across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia, with NSW providing a large portion of the species' core habitat (OEH, 2014o). The nomadic movement of the species is influenced by season and food availability, although some areas retain residents for much of the year (OEH, 2014o).

This species was recorded foraging and flying over numerous locations within the Study Area within a suite of vegetation communities, including White Box Woodland (Grassy), Slaty Box Woodland and Caley's Ironbark Forest. It is expected that this species would forage across these vegetation communities and other woody vegetation within the Study Area. The occurrence of the species would be influenced by the presence of profusely flowering eucalypts. A number of key tree species occur within the Study Area, including *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box). Numerous other nectar producing trees occur within the Study Area, as well as mistletoes, which are known to be utilised by the species. Nesting habitat is present within the Study Area in the form of very small hollows within smooth-barked trees. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 48 records of the Little Lorikeet within the locality with dates ranging from 1963 - 2012. The Little Lorikeet is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area, Manobalai Nature Reserve and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

iv. Turquoise Parrot

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Turquoise Parrot (*Neophema pulchella*) inhabits eucalypt and cypress-pine open forests and woodlands, particularly box or box-ironbark woodlands, often in undulating or rugged country (NSW Scientific Committee, 2009c). It also occurs in open woodland or riparian gum woodland, and often near ecotones between woodland and grassland, or coastal forest and heath (NSW Scientific Committee, 2009c). Feeding occurs on the ground where the species feeds on seeds of grasses, forbs and native shrubs, as well as some flowers, nectar, fruits, leaves and scale-insects (NSW Scientific Committee, 2009c; OEH, 2014x). The Turquoise Parrot nests in tree hollows, logs or posts (OEH, 2014x). Hollows are often located within 1-2 m of the ground and, on average, have an entrance 10 x 7 m in size (NSW Scientific Committee, 2009c). The Turquoise Parrot occurs from southern Queensland through to northern Victoria (OEH, 2014x). Within NSW, the species occurs mainly on the western side of the tablelands, inland slopes and adjoining plains in the eastern half of NSW, and in some dry coastal valleys (NSW Scientific Committee, 2009c).

This species was recorded at a few locations within the Study Area, including within Blakely's Red Gum / Paperbark Forest, Caley's Ironbark Forest and Yellow Box Woodland. It is expected that this species would forage across these vegetation communities and other woody vegetation within the Study Area. However, the distribution may be impacted by the presence of abundant Noisy Miners (*Manorina melanocephala*). A number of habitat features suitable for nesting are present within the Study Area. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 29 records of the Turquoise Parrot within the locality with dates ranging from 1980 - 2013. The Turquoise Parrot is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve and Durridgere State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

v. Speckled Warbler

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Speckled Warbler (*Chthonicola sagittata*) inhabits a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies (OEH, 2012n). Typical habitat for this species would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (OEH, 2012n). This species forages on the ground and in the understorey for arthropods and seeds (NSW Scientific Committee, 2001c). Preferred areas of foraging habitat contain a combination of open grassy patches, leaf litter and shrub cover (NSW Scientific Committee, 2001c). Nests of this species are built using dry grass and strips of bark and are located in a slight hollow in the ground or at the base of a low dense plant, such as grass tussocks, often among fallen branches and other litter (OEH, 2012n) (NSW Scientific Committee, 2001c). The Speckled Warbler occurs from south-eastern Queensland, through central and eastern NSW to Victoria (NSW Scientific Committee, 2001c). In NSW, the Speckled Warbler occurs on the slopes west of the Great Dividing Range, with populations also occurring in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys (NSW Scientific Committee, 2001c).

This species was recorded foraging at numerous locations within the Study Area within a suite of vegetation communities, including Caley's Ironbark Forest, White Box Woodland (Shrubby) and White Box Woodland (Grassy). It is expected that this species would forage across these vegetation communities and other grassy woodland, shrubby woodland, shrubland and forest within the Study Area. Nesting habitat is present within the Study Area in the form of grass tussocks, leaf litter and coarse woody debris. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 51 records of the Speckled Warbler within the locality with dates ranging from 1963 - 2013. The Speckled Warbler is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

vi. Brown Treecreeper (eastern subspecies)

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Brown Treecreeper (*Climacteris picumnus victoriae*) inhabits eucalypt woodlands (including box-gum woodland) and dry open forest (OEH, 2014f). The woodlands and forests are usually dominated by stringybarks or other rough-barked eucalypts, typically with an open grassy understorey and sometimes with one or more shrub species (OEH, 2014f). This species forages on tree trunks and on the ground amongst leaf litter and on fallen logs for ants, beetles and larvae (NSW Scientific Committee, 2004a). Fallen timber is considered to be an important habitat component for foraging (OEH, 2014f). The Brown Treecreeper nests in hollows in standing dead or live trees and tree stumps are essential for nesting (OEH, 2014f). The Brown Treecreeper occurs through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys (NSW Scientific Committee, 2004a).

This species was recorded foraging at numerous locations within the Study Area within a suite of vegetation communities, including White Box Woodland (Grassy), Slaty Box Woodland, Yellow Box Woodland and Exposed/Sheltered Grey Gum / Stringybark Forest. It is expected that this species would forage across these vegetation communities and woody vegetation within the Study Area, favouring areas dominated by rough-barked species and where fallen logs are present. Nesting habitat is present within the Study Area in the form of hollow-bearing trees. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 79 records of the Brown Treecreeper within the locality with dates ranging from 1963 - 2013. The Brown Treecreeper is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area, Manobalai Nature Reserve and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

vii. Hooded Robin (south-eastern form)

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Hooded Robin (*Melanodryas cucullata cucullata*) inhabits lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas (OEH, 2014l). It requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses and dead timber (NSW Scientific Committee, 2004b; OEH, 2014l). The Hooded Robin perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey (OEH, 2014l). Foraging occurs in areas with a mix of bare ground,

ground cover and litter (NSW Scientific Committee, 2004b). Nests are built using bark, grasses and webs and are located in tree forks or crevices, approximately 1 - 5 m above the ground (OEH, 2014l). This species is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west (OEH, 2014l).

The species was recorded foraging at a few locations within the Study Area, including within White Box Woodland (Grassy), Coastal Grey Box Woodland and Yellow Box Woodland and adjoining Derived Native Grasslands. It is expected that this species would forage across riparian woodland/forest, grassy woodland and derived native grassland within the Study Area, favouring ecotonal habitat where fallen logs are present and in proximity to water resources. Nesting habitat is present within the Study Area in the form of woodland vegetation. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 15 records of the Hooded Robin within the locality with dates ranging from 1963 - 2010. The Hooded Robin is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

viii. Grey-crowned Babbler (eastern subspecies)

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) inhabits box-gum woodlands on the slopes and box-Cypress Pine and open box woodlands on alluvial plains (OEH, 2012h). Woodlands typically have regenerating trees, tall shrubs and an intact ground cover of grass and forbs (NSW Scientific Committee, 2011a). The Grey-crowned Babbler feeds on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst letter and tussock grasses (OEH, 2012h). Nests are built from sticks and are usually located in shrubs or sapling eucalypts, however they occasionally build nests in the outermost leaves of low branches of large eucalypts (OEH, 2012h). In NSW, this species occurs on the western slopes and plains and isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (NSW Scientific Committee, 2011a).

This species was recorded foraging at a number of locations within the Study Area within a suite of vegetation communities, including Caley's Ironbark Forest, Blakely's Red Gum / Paperbark Forest and Fuzzy Box Woodland. It is expected that this species would forage across these vegetation communities and other woody vegetation within the Study Area. Records of this species within the Study Area are located with more intact vegetation rather than the ecotonal areas. Nesting habitat is present within the Study Area in the form of woodland and forest vegetation. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds five records of the Grey-crowned Babbler within the locality with dates ranging from 1993 - 2012. The Grey-crowned Babbler is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

ix. Diamond Firetail

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Diamond Firetail (*Stagonopleura guttata*) inhabits eucalypt woodlands, forests and mallee where there is a grassy understorey (NSW Scientific Committee, 2001b). This species has been recorded within box-gum woodlands and *Eucalyptus pauciflora* (Snow Gum) woodlands, as well as open forest, mallee, riparian areas (rivers and creeks), lightly wooded farmland natural temperate grassland, and in secondary grassland derived from other communities (OEH, 2014h). This species feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in breeding season) (OEH, 2014h). Nests are built in the shrubby understorey, or higher up, particularly under nests of hawks or ravens (OEH, 2014h). The Diamond Firetail also roosts in dense shrubs or in smaller nests built especially for roosting (DEC (NSW), 2005a). In NSW, the 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 (NSW Scientific Committee, 2001b).

This species was recorded foraging at a number of locations within the Study Area, including within White Box Woodland (Grassy), Slaty Box Woodland and Yellow Box Woodland and adjoining Derived Native Grasslands. It is expected that this species would forage across these vegetation communities and riparian woodland/forest, grassy woodland, shrubby woodland, shrubland and derived native grassland within the Study Area, favouring ecotonal habitat. Nesting habitat is present within the Study Area in the form of woodland vegetation. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 38 records of the Diamond Firetail within the locality with dates ranging from 1963 - 2012. The Diamond Firetail is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve and Durridgere State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

x. Glossy Black-cockatoo

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Glossy Black-cockatoo (*Calyptorhynchus lathami*) inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of She-oak occur (OEH, 2014j).

This species feeds almost exclusively on the seeds of several species of She-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with their large bill (OEH, 2014j). Key food species on the coast and tablelands are *Allocasuarina torulosa* (Forest Oak) and *Allocasuarina littoralis* (Black She-oak), with some *Allocasuarina distyla* taken (Scrub She-oak) (NSW Scientific Commitee, 2008a). Inland, its key food species include *Allocasuarina verticillata* (Drooping Sheoak) and *Casuarina cristata* (Belah), as well as *Allocasuarina inophloia* (Stringybark She-oak), *Allocasuarina diminuta*, *Allocasuarina gymnanthera*, and sometimes *Allocasuarina luehmannii* (Buloke) (NSW Scientific Commitee, 2008a). Nesting occurs in large hollows (26 cm wide and up to 1.4 m deep) within live or dead eucalypts, commonly in a dead spout in a living tree (NSW Scientific Commitee, 2008a). The Glossy Black-cockatoo occurs from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina (OEH, 2014j).

Evidence of this species, including chewed cones and a feather was recorded in one general area within the Study Area. Chewed cones were observed within a stand of *Allocasuarina verticillata* (Drooping Sheoak) within Slaty Box Woodland and the feather was located within Shrubby Regrowth. It is expected that this species would forage across other stands of *Allocasuarinas* within riparian woodland/forest, shrubby woodland, shrubland and forest within the Study Area. Another known feed species, *Allocasuarina gymnanthera* also occurs within the Study Area. Nesting habitat is present within the Study Area in the form of large hollows. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 35 records of the Glossy Black-cockatoo within the locality with dates ranging from 1980 - 2010. The Glossy Black-cockatoo is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area, Manobalai Nature Reserve and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xi. Gang-gang Cockatoo

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Gang-gang Cockatoo (*Callocephalon fimbriatum*) inhabits eucalypt open forests and woodlands with an *Acacia* understorey (NSW Scientific Committee, 2008a). In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (OEH, 2015a). 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, and often found in urban areas (NSW Scientific Committee, 2005c; OEH, 2015a). It feeds on seeds obtained in trees and shrubs, particularly eucalypts and acacias, and is also known to feed on seeds of introduced trees and shrubs as well as insect larvae (NSW Scientific Committee, 2008a). This species nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water (NSW Scientific Committee, 2008a). The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern NSW (OEH, 2015a). In NSW the Gang-gang Cockatoo is restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the south-western slopes (NSW Scientific Committee, 2008a).

This species was recorded at two locations within the Study Area within Yellow Box Woodland and Cypress Pine Forest. It is expected that this species would forage within the woody vegetation of the Study Area, particularly during winter. Foraging could occur within communities with an understorey dominated by acacias.

The Atlas of NSW Wildlife holds 26 records of the Gang-gang Cockatoo within the locality with dates ranging from 1992 - 2010. The Gang-gang Cockatoo is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xii. Spotted Harrier

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Spotted Harrier (*Circus assimilis*) inhabits grassy open woodland including *Acacia* and mallee remnants, inland riparian woodland, grassland and shrub steppe (NSW Scientific Committee, 2010d). It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (NSW Scientific Committee, 2010d). The diet of the Spotted Harrier includes terrestrial mammals, such as bandicoots, bettongs and rodents, birds and reptiles, occasionally large insects and rarely carrion (NSW Scientific Committee, 2010d). Nests are located in trees and built from sticks (OEH, 2012p). The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and individuals disperse widely in NSW (NSW Scientific Committee, 2010d).

This species was recorded at a number of locations within the Study Area, typically within Derived Native Grasslands. It is expected that this species would forage across these vegetation communities and other woodland and grassland communities. Nesting habitat is present within the Study Area in the form of woodland vegetation. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds one record of the Spotted Harrier within the locality from 1982. The Spotted Harrier is not known from conservation reserves in the locality or wider region. This is likely due to the lack of extensive grassland areas within these reserves. Additional suitable habitat occurs throughout the locality and wider region in unreserved land.

xiii. Little Eagle

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Little Eagle (*Hieraaetus morphnoides*) inhabits open eucalypt forest, woodland or open woodland, she-oak woodlands, acacia woodlands, and riparian woodland within interior NSW, which have an abundance of prey (NSW Scientific Committee, 2011b). It feeds on birds, reptiles and mammals, occasionally consuming large insects and carrion. Nests are built using large sticks in tall living trees within remnant patches of vegetation (NSW Scientific Committee, 2011b). The Little Eagle is distributed throughout the mainland of Australia, except for the most densely forested parts of the Dividing Range escarpment (NSW Scientific Committee, 2011b).

This species was recorded at one location within the Study Area within Derived Native Grasslands. It is expected that this species would forage within riparian woodland/forest, grassy woodland, shrubby woodland, derived native grassland and cultivated land within the Study Area. Nesting habitat is present within the Study Area in the form of remnant woodland vegetation. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds two records of the Little Eagle within the locality with dates ranging from 2006 - 2010. The Little Eagle is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve and Durridgere State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xiv. Barking Owl

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Barking Owl (*Ninox connivens*) inhabits forests and woodlands of tropical, temperate and semi-arid zones that are typically dominated by eucalypts, often red gum species (NSW NPWS, 2003). It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas (OEH, 2014c). The diet of this species preferentially includes small arboreal mammals such as the Squirrel Glider and Common Ringtail Possum; however they are also known to feed on birds, invertebrates and terrestrial mammals such as rodents and rabbits (OEH, 2014c). This species roosts in or under dense foliage in large trees including rainforest species of streamside gallery forests, *Casuarina cunninghamiana* (River Oak), other *Casuarina* and *Allocasuarina* species, *Eucalypt*, *Angophora* or *Acacia* species (NSW NPWS, 2003). For breeding, this species required hollows in large eucalypts or paperbarks, usually near watercourses or wetlands (NSW NPWS, 2003). In NSW, the occurrence of the Barking Owl is widespread on the coastal plain and foothills and the inland slopes and plains (NSW NPWS, 2003).

This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area from 1983. This species is expected to both forage and breed within the woody vegetation of the Study Area. A number of potential prey items are present within the Study Area, including the common Ringtail Possum. Nesting habitat is present within the Study Area in the form of hollow-bearing trees within remnant woodland and forest vegetation in proximity to watercourses.

The Atlas of NSW Wildlife holds one record of the Barking Owl within the locality from 1983. The Barking Owl is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xv. Powerful Owl

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Powerful Owl (*Ninox strenua*) inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest (OEH, 2013g). Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials (DEC (NSW), 2006). The main prey items of this species are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider, with birds and flying foxes occasionally being consumed (OEH, 2013g). Roosting occurs in groves of dense mid-canopy trees or tall shrubs in sheltered gullies, typically on wide creek flats and at the heads of minor drainage lines, but also adjacent to cliff faces and below dry waterfalls (DEC (NSW), 2006). This species nests in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines, with hollows greater than 45 cm diameter and greater than 100 cm deep; surrounded by canopy trees and sub-canopy or understorey trees or tall shrubs (DEC (NSW), 2006). In NSW, the Powerful Owl is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains (OEH, 2013g).

This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area from 1983. This species is expected to both forage and breed within the woody vegetation of the Study Area. Prey items occurring within the Study Area include the Common Ringtail Possum and Sugar Glider. Nesting habitat is present within the Study Area in the form of large hollow-bearing trees within remnant woodland and forest vegetation in proximity to drainage lines.

The Atlas of NSW Wildlife holds nine records of the Powerful Owl within the locality with dates ranging from 1983 - 2010. The Powerful Owl is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area, Manobalai Nature Reserve and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xvi. Rainbow Bee-eater

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Rainbow Bee-eater (*Merops ornatus*) occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation, often in proximity to permanent water (DoE, 2014m). This species feeds mainly on insects, such as bees and wasps, and on occasion will take earthworms, spiders and tadpoles (DoE, 2014m). Nests of this species are located in long burrows or tunnels that are excavated in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces (DoE, 2014m). The Rainbow Bee-eater occurs across much of mainland Australia (DoE, 2014m).

This species was recorded at a few locations within the Study Area within Slaty Box Woodland and White Box Woodland (Grassy) and adjoining Derived Native Grasslands. It is expected that this species would forage across these vegetation communities and other rainforest, riparian woodland/forest, grassy woodland, shrubby woodland, shrubland, forest and derived native grassland. Nesting habitat is present within the Study Area in the form of incised drainage lines, dam banks and cliff faces. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 10 records of the Rainbow Bee-eater within the locality with dates ranging from 1963 - 2006. The Rainbow Bee-eater is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

xvii. White-throated Needletail

TSC Act Status: Not listed

EPBC Act Status: Migratory

The White-throated Needletail (*Hirundapus caudacutus*) is a migrant to Australia in the non-breeding season (DoE, 2014j). This species is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground, occurring above a wide range of habitats (DoE, 2014j). The diet of this species includes a wide variety of insects including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers (DoE, 2014j). This species breeds in Asia (DoE, 2014j). The White-throated Needletail is widespread in eastern and south-eastern Australia, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (DoE, 2014j).

This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area from 2006. This species is expected to forage aerially above the Study Area.

The Atlas of NSW Wildlife holds 11 records of the White-throated Needletail within the locality with dates ranging from 1997 - 2006. The White-throated Needletail has been recorded in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area and Avisford State Conservation Area. Additional suitable forage habitat occurs extensively in the locality and wider region.

4.3.2 Mammals

i. Spotted-tailed Quoll

TSC Act Status: Vulnerable

EPBC Act Status: Endangered

The Spotted-tailed Quoll (*Dasyurus maculatus*) inhabits a wide range of forest habitat types, although all appear to be characterised by relatively high (>600 mm/year) and predictable seasonal rainfall (Long and Nelson, 2010). The southern subspecies has been recorded from a wide range of habitat types including rainforest, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas (Long and Nelson, 2010). This species feeds mainly on medium-sized mammals (500 - 5000 g) with the main prey items including the Common Ringtail Possum (*Pseudocheirus peregrinus*), Common Brushtail Possum (*Trichosurus vulpecula*), Mountain Brushtail Possum (*Trichosurus cunninghami*) and Rabbit (*Oryctolagus cuniculus*) (DoE, 2014g). Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites (OEH, 2012o). The Spotted-tailed Quoll occurs on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland (OEH, 2012o). Within NSW, it is generally confined to within 200 km of the coast and range from the Queensland border to Kosciuszko National Park (DoE, 2014g).

This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area. Woody vegetation where there are few predators comprises suitable habitat for this species. Prey species present within the Study Area include the Common Ringtail Possum, Common Brushtail Possum and Rabbit. A number of features within the Study Area could be used for den sites including hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. This species is expected to forage and breed within the Study Area.

The Atlas of NSW Wildlife holds three records of the Spotted-tailed Quoll within the locality with dates ranging from 2004 - 2005. The Spotted-tailed Quoll is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

ii. Large-eared Pied Bat

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

The Large-eared Pied Bat (*Chalinolobus dwyeri*) inhabits a range of vegetation types including dry and wet sclerophyll forest, *Callitris glaucophylla* (White Cypress Pine) dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country (DoE, 2014f). The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging (DoE, 2014f). This species is expected to forage below the canopy, feeding on insects (DoE, 2014f). It roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*) (OEH, 2012i). The structure of maternity roosts appears to be very specific (arch caves with dome roofs) (DERM, 2011). The Large-eared Pied bat occurs from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands (OEH, 2012i). Much of the known distribution of the Large-eared Pied Bat occurs in NSW (DoE, 2014f).

This species was recorded at numerous locations within the Study Area within vegetation communities in proximity to cliff line habitat, including Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). One individual was caught in a harp trap, with the remaining records from ultrasonic call detection. It is expected that this species would roost within the cliff line habitat within the Study Area and forage within adjoining woody vegetation. It is unknown if any maternity roosts occur within the Study Area. Lactating females have been recorded in Ulan, to the west of the Study Area. It is expected that this species forages and roosts within the Study Area, however no breeding habitat has been recorded during surveys.

The Atlas of NSW Wildlife holds 29 records of the Large-eared Pied Bat within the locality with dates ranging from 1997 - 2010. The Large-eared Pied Bat is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

iii. Eastern Bentwing-bat

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) inhabits a variety of habitats including rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, melaleuca forests and open grasslands (Churchill, 2009). In treed areas, this species forages above the canopy and in more open areas it flies within a few metres of the ground

(Churchill, 2009). Their diet consists of moths, flies, cockroaches and beetles (Churchill, 2009). Foraging can occur long distances from the roost site (Churchill, 2009). Caves are the primary roosting habitat, but they also use derelict mines, storm-water tunnels, buildings and other man-made structures (OEH, 2012c). Maternity caves have very specific temperature and humidity regimes (OEH, 2012c). The Eastern Bentwing-bat occurs along the east and north-west coasts of Australia (OEH, 2012c).

This species was recorded at several locations within the Study Area within vegetation communities in proximity to cliff line habitat, including Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). All records of this species were from ultrasonic call detection. It is expected that this species would roost within the cliff line habitat within the Study Area and forage within adjoining woody vegetation. It is unknown if any maternity roosts occur within the Study Area. Surveys of the north western portion of Wollemi National Park indicated that breeding occurs in the region, however this is likely to occur in the Baerami Valley oil shale mines (DEC, 2006). It is expected that this species forages and roosts within the Study Area, however no breeding habitat has been recorded during surveys.

The Atlas of NSW Wildlife holds 20 records of the Eastern Bentwing-bat within the locality with dates ranging from 1997 - 2010. The Eastern Bentwing-bat is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

iv. Corben's Long-eared Bat

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

Corben's Long-eared Bat (*Nyctophilus corbeni*) inhabits a wide variety of vegetation types including *Eucalyptus camaldulensis* (River Red Gum), *Eucalyptus largiflorens* (Black Box), *Allocasuarina*, *Casuarina cristata* (Belah), mallee, open woodlands and savannahs (Churchill, 2009). It is commonly associated with vegetation with a distinct shrub layer and in proximity to watercourses (Churchill, 2009; DoE, 2014o). Foraging is undertaken close to vegetation both within the canopy and through gaps (Churchill, 2009). This species feeds on beetles, bugs and moths, however it is also known to feed on grasshoppers and crickets (DoE, 2014o). Roosting occurs in hollow-bearing trees where hollows are less than 3 m above the ground and with multiple small entrances of 5 – 10 cm diameter (Churchill, 2009). This species is also known to roost in tree crevices and under loose bark (OEH, 2012b). Corben's Long-eared Bat occurs primarily within the Murray Darling Basin and western slopes of the Great Dividing Range (Churchill, 2009).

This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area from 2010. This species was not positively identified as occurring within the Study Area as the calls of this species are difficult to differentiate from those of similar species. Available habitat includes woody vegetation for foraging and hollow-bearing trees for roosting. It is predicted that this species forages and roosts within the Study Area, however it is unknown if breeding occurs.

The Atlas of NSW Wildlife holds three records of Corben's Long-eared Bat within the locality with dates ranging from 2000 - 2010. The Corben's Long-eared Bat is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

v. Yellow-bellied Sheathtail-bat

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) inhabits a range of habitats including wet and dry sclerophyll forest, open woodland, *Acacia* shrubland, mallee, grasslands and deserts (Churchill, 2009). The species typically forages above the canopy and lower over open species and at the forest edge (Churchill, 2009). Their diet predominantly consists of beetles, but grasshoppers, crickets, leafhoppers, shield bugs, wasps and some flying ants are also consumed (Churchill, 2009). This species is known to roost in tree hollows and buildings, and in treeless areas they are known to utilise mammal burrows (OEH, 2014z). The Yellow-bellied Sheathtail-bat occurs across northern and eastern Australia (OEH, 2014z).

This species was recorded at a few locations within the Study Area within Red Ironbark / Cypress Forest, Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). All records of this species were from ultrasonic call detection. It is expected that this species would forage across these vegetation communities and other woodland and forest communities. Roosting habitat is present in the form of hollow-bearing trees. It is expected that this species forages and roosts within the Study Area, however it is unknown if breeding occurs.

The Atlas of NSW Wildlife holds four records of the Yellow-bellied Sheathtail-bat within the locality with dates ranging from 2006 - 2010. The Yellow-bellied Sheathtail-bat is conserved in the locality and wider region within Wollemi National Park, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

vi. New Holland Mouse

TSC Act Status: Not listed

EPBC Act Status: Vulnerable

The New Holland Mouse (*Pseudomys novaehollandiae*) inhabits open heathland, open woodland with a heathland understorey and vegetated sand dunes with peak abundances during the early to mid stages of vegetation succession three to five years after fire (DoE, 2014r). Due to diet requirements, sites where this species occurs are often high in floristic diversity, especially leguminous perennials (DoE, 2014r). This species is omnivorous with the main component of its diet comprising seeds, although leaves, fungi and invertebrates are consumed based on seasonal or floristic characteristics of individual sites (DoE, 2014r). This species is vulnerable to predation during foraging by native predators and introduced species, including the Fox (*Vulpes vulpes*), Cat (*Felis catus*) and Dog (*Canis lupus*) (DoE, 2014r). This species utilises burrows and soil type may be an important indicator of suitability of habitat (DoE, 2014r). The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, NSW and Queensland (DoE, 2014r).

This species was recorded at one location within the Study Area within White Box Woodland (Grassy), immediately adjacent to White Box Woodland (Shrubby). It is expected that this species would forage across small home ranges within vegetation with a shrubby understorey, including shrubby woodland, shrubland and forest. Burrows utilised for nesting would be established within these home ranges. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds no records of the New Holland Mouse within the locality. The New Holland Mouse is conserved in wider region within Wollemi National Park, Goulburn River National Park and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

vii. Brush-tailed Rock-wallaby

TSC Act Status: Endangered

EPBC Act Status: Vulnerable

The Brush-tailed Rock-wallaby (*Petrogale penicillata*) inhabits rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north (OEH, 2013b). A range of vegetation types are associated with the habitat of this species, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (DoE, 2014p). The diet of this species consists mainly of short grasses, with *Acacia* flowers, forbs, leaves, fruit, bark and fruiting bodies of hypogeal fungi also consumed (Menkhorst and Hynes, 2010). Most foraging occurs at night, in grassy habitats close to daytime refuges (Menkhorst and Hynes, 2010). A rocky habitat with an abundant supply of ledges, caves and potential pathways, plus a northerly aspect were found to be important for rock-wallabies to breed (DoE, 2014p). The Brush-tailed Rock-wallaby occurs in a patchy distribution along the Great Dividing Range from Yarraman, Queensland, to the upper Snowy River in eastern Victoria (Menkhorst and Hynes, 2010).

This species was recorded at one location by Eastcoast Flora Survey within the Study Area within Slaty Box Woodland and in close proximity to cliff line habitat. It is expected that this species would occur in similar habitat in other portions of the Study Area and in areas that have little disturbance and fewer predators. It is expected that this species both forages and breeds within the Study Area.

The Atlas of NSW Wildlife holds 34 records of the Brush-tailed Rock-wallaby within the locality with dates ranging from 1993 - 2010. The Brush-tailed Rock-wallaby is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

4.3.3 Potentially Occurring Threatened Species

A number of threatened fauna species have been recorded from the locality, or have been predicted to occur, and have the potential to occur within the Study Area. **Appendix F** analyses the likelihood of occurrence within the Study Area for each threatened fauna species recorded or predicted to occur within the locality. **Table 4.4** lists the threatened fauna species considered to potentially occur within the Study Area. These species are discussed further below.

Table 4.4 Threatened fauna species potentially occurring within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Birds			
Grantiella picta	Painted Honeyeater	V	
Lathamus discolor	Swift Parrot	E	E
Daphoenositta chrysoptera	Varied Sittella	V	
Petroica boodang	Scarlet Robin	V	
Petroica phoenicea	Flame Robin	V	
Lophoictinia isura	Square-tailed Kite	V	
Tyto novaehollandiae	Masked Owl	V	
Haliaeetus leucogaster	White-bellied Sea-eagle		M
Apus pacificus	Fork-tailed Swift		M
Ardea ibis	Cattle Egret		M
Ardea modesta	Eastern Great Egret		M
Myiagra cyanoleuca	Satin Flycatcher		M
Rhipidura rufifrons	Rufous Fantail		M
Mammals			
Phascolarctos cinereus	Koala	V	V
Petaurus norfolcensis	Squirrel Glider	V	
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	
Miniopterus australis	Little Bentwing-bat	V	
Scoteanax rueppellii	Greater Broad-nosed Bat	V	

CUMBERLAND ECOLOGY

Table 4.4 Threatened fauna species potentially occurring within the Study Area

Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Vespadelus troughtoni	Eastern Cave Bat	V	
Reptiles			
Hoplocephalus bungaroides	Broad-headed Snake	E	V
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V
Varanus rosenbergi	Rosenberg's Goanna	V	

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

i. Birds

a. Painted Honeyeater

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Painted Honeyeater (*Grantiella picta*) is a nomadic species that inhabits Boree, Brigalow and box-gum woodlands and box-ironbark forests (OEH, 2012k). The species feeds on the fruits of mistletoes, particularly those in the *Amyema* genus, growing on woodland eucalypts and acacias (OEH, 2012k). It also occasionally feeds on insects and nectar from mistletoe or eucalypts (OEH, 2012k). Nests are built in the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches (OEH, 2012k). The Painted Honeyeater occurs at low densities throughout its range, with the highest concentrations of this species occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland (OEH, 2012k).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing mistletoes from the *Amyema* genus. Numerous nectar producing trees occur within the Study Area which could be used on occasion by this species for foraging. Nesting habitat is present within the Study Area in the form of drooping eucalypts, she-oak and mistletoe branches.

The Atlas of NSW Wildlife holds three records of the Painted Honeyeater within the locality from 2006. The Painted Honeyeater is conserved in the locality and wider region within Wollemi National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

b. Swift Parrot

TSC Act Status: Endangered

EPBC Act Status: Endangered

The Swift Parrot (*Lathamus discolor*) is semi nomadic during winter, foraging in dry woodlands, primarily in Victoria and NSW (DoE, 2014l). The Swift Parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, NSW and southern Queensland (DoE, 2014l). The principal wintering grounds are the inland slopes of the Great Dividing Range and along the eastern coastal plains (DoE, 2014l). They occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations (OEH, 2012q). Favoured feed trees include *Eucalyptus robusta* (Swamp Mahogany), *Corymbia maculata* (Spotted Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus sideroxylon* (Mugga Ironbark) and *Eucalyptus albens* (White Box) (OEH, 2012q).

This species was not recorded during surveys; however there is the potential for this species to forage within the woody vegetation of the Study Area. The occurrence of the species would be influenced by the presence of winter-flowering eucalypts. One key tree species, *Eucalyptus albens* (White Box) is present within a number of locations within the Study Area. No breeding habitat is present within the Study Area as this species breeds within Tasmania.

The Atlas of NSW Wildlife holds one record of the Swift Parrot within the locality from 1995. The Swift Parrot is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

c. Varied Sittella

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Varied Sittella (*Daphoenositta chrysoptera*) inhabits eucalypt forests and woodlands, especially where rough-barked species and mature smooth-barked gums with dead branches are present, as well as mallee and *Acacia* woodland (NSW Scientific Committee, 2010e). This species 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 (OEH, 2012r). Nests are built from plant fibres and cobwebs in an upright tree fork high in the living tree canopy (OEH, 2012r). The Varied Sittella is distributed throughout NSW with a nearly continuous extent from the coast to the far west (NSW Scientific Committee, 2010e).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing rough-barked species. Nesting habitat is also present within these areas of the Study Area.

The Atlas of NSW Wildlife holds 24 records of the Varied Sittella within the locality with dates ranging from 1993 - 2010. The Varied Sittella is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Durridgere State Conservation Area, Manobalai Nature Reserve and Avisford State

Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

d. Scarlet Robin

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Scarlet Robin (*Petroica boodang*) inhabits dry eucalypt forests and woodlands, usually in areas where the understorey is open and grassy with few scattered shrubs (OEH, 2013i). It is known to occur in both mature and regrowth vegetation and occasionally in mallee and west forest communities, wetlands and tea-tree swamps (OEH, 2013i). Important structural components of its habitat include abundant logs and fallen timber (OEH, 2013i). It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris (NSW Scientific Committee, 2010c). Nests are built from plant fibres and cobwebs and are located in the fork of a tree, usually at least 2 m above the ground (NSW Scientific Committee, 2010c). The Scarlet Robin is found from south east Queensland to south east South Australia and also in Tasmania and south west Western Australia (OEH, 2013i). In NSW, it occurs from the coast to the inland slopes, and can disperse to the lower valleys and plains of the tablelands and slopes after breeding (OEH, 2013i).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly in areas containing abundant logs and fallen timber. This species is expected to occur within the Study Area as a vagrant.

The Atlas of NSW Wildlife holds six records of the Scarlet Robin within the locality with dates ranging from 1993 - 1997. The Scarlet Robin is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

e. Flame Robin

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Flame Robin (*Petroica phoenicea*) inhabits upland tall moist eucalypt forests and woodlands, often on ridges and slopes during breeding season and migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains) (OEH, 2013c). This species forages from low perches, from which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris (OEH, 2013c). Flying insects are often taken in the air and sometimes gleans for invertebrates from foliage and bark (OEH, 2013c). Nests are built from plant materials and spider webs, occurring in sheltered sites such as shallow cavities in trees, stumps or banks (OEH, 2013c). The Flame Robin is endemic to south eastern Australia, and ranges from near the Queensland border to south east South Australia and also in Tasmania (OEH, 2013c). In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains (OEH, 2013c).

This species was not recorded during surveys; however there is the potential for this species to forage within the woody vegetation of the Study Area, particularly areas containing perching material. This species is expected to occur within the Study Area as a vagrant.

The Atlas of NSW Wildlife holds two records of the Flame Robin within the locality with dates ranging from 1993 - 2010. The Flame Robin is conserved in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

f. Square-tailed Kite

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Square-tailed Kite (*Lophoictinia isura*) inhabits coastal and subcoastal eucalypt-dominated open forests and woodlands, and inland riparian woodland (NSW Scientific Committee, 2009b). Favoured habitat include productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes and Coolibah/River Red Gum on the inland plains (NSW Scientific Committee, 2009b). It is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage (OEH, 2014v). Nests are built using sticks in a live tree in open forest or woodland, or near edges or openings in forest vegetation (NSW Scientific Committee, 2009b). In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems (OEH, 2014v).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the riparian woodland/forest, grassy woodland, shrubby woodland, derived native grassland and cultivated land of the Study Area. Nesting habitat is present within the Study Area in the form of remnant woodland and forest vegetation.

The Atlas of NSW Wildlife holds two records of the Square-tailed Kite within the locality with dates ranging from 1985 - 2000. The Square-tailed Kite is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

g. Masked Owl

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Masked Owl (*Tyto novaehollandiae*) inhabits dry eucalypt forests of the tablelands, western slopes and the undulating wet-dry forests of the coast (DEC (NSW), 2006). Optimal habitat includes an open understorey and a mosaic of sparse (grassy) and dense (shrubby) ground cover on gentle terrain (DEC (NSW), 2006). This species hunts within forests and well as along their edges (OEH, 2014p), and is a specialist predator of terrestrial mammals, particularly native rodents (DEC (NSW), 2006). The diet is supplemented by bandicoots, arboreal mammals (Sugar Glider, Common Ringtail Possum), and some birds (DEC (NSW), 2006). Roosting occurs in hollows in live or occasionally dead eucalypts; dense foliage in gullies; and caves or recesses in cliffs (DEC (NSW), 2006). This species nests in old hollow eucalypts, live or dead but commonly live, in a variety of topographic positions from gully to upper slope, with hollows greater than 40 cm wide and greater than 100 cm deep; there is no relationship with distance to streams (DEC (NSW), 2006). The Masked Owl occurs from the coast to the western plains, with records of this species throughout much of NSW, excluding the most arid north-western corner (DEC (NSW), 2006).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area. Prey items occurring within the Study Area include terrestrial rodents and arboreal mammals, such as the Common Ringtail Possum and Sugar Glider. Nesting habitat is present within the Study Area in the form of large hollow-bearing trees within remnant woodland and forest vegetation.

The Atlas of NSW Wildlife holds two records of the Masked Owl within the locality from 2010. The Masked Owl is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

h. White-bellied Sea Eagle

TSC Act Status: Not listed

EPBC Act Status: Migratory

The White-bellied Sea-eagle (*Haliaeetus leucogaster*) inhabits coastal habitats, particularly those close to the sea-shore, and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands (DoE, 2014i). Habitat is characterised by the presence of large areas of open water including larger rivers, swamps, lakes and the sea, and have been recorded flying over a variety of terrestrial habitats (DoE, 2014i). This species feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans, and on carrion and offal (DoE, 2014i). A large nest is built from sticks and lined with leaves, grass or seaweed and may be built in a variety of sites including tall trees (especially *Eucalyptus* species), bushes, mangroves, cliffs, rocky outcrops, caves, crevices, on the ground or even on artificial structures (DoE, 2014i). The White-bellied Sea-eagle occurs along the coastline (including offshore islands) of mainland Australia and Tasmania (DoE, 2014i).

This species was not recorded during surveys, however there is the potential for this species to utilise the woody vegetation within the Study Area. This species is expected to utilise the Study Area as part of a much larger foraging range, surrounding Goulburn River. The Study Area also contains potential breeding habitat, however sites are typically located close to water and mainly in tall open forest or woodland (DoE, 2014i).

The Atlas of NSW Wildlife holds one record of the White-bellied Sea-eagle within the locality from 1997. The White-bellied Sea-eagle has been recorded in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional suitable habitat occurs extensively in the locality and wider region, particularly along major watercourses, such as the Goulburn River.

i. Fork-tailed Swift

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Fork-tailed Swift (*Apus pacificus*) is a migrant to Australia in the non-breeding season (DoE, 2014c). This species is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher, mostly over inland plains but sometimes above foothills or in coastal areas (DoE, 2014c). Foraging occurs anywhere from 1 m to 300 m above the ground, with the known diet comprising small bees, wasps, termites and moths (DoE, 2014c). This species breeds in Siberia (DoE, 2014c). In NSW, the Fork-tailed Swift is recorded in all regions, with many records occurring east of the Great Divide (DoE, 2014c).

This species was not recorded during surveys, however, there is potential for this species to fly over the Study Area. This species is expected to forage aerially above the Study Area.

The Atlas of NSW Wildlife holds two records of the Fork-tailed Swift within the locality from 2006. The Fork-tailed Swift has been recorded in the locality and wider region within Wollemi National Park and Avisford State Conservation Area. Additional suitable forage habitat occurs extensively in the locality and wider region.

j. Cattle Egret

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Cattle Egret (*Ardea ibis*) is a partial migrant, moving away from breeding colonies in winter (DoE, 2014d). This species inhabits tropical and temperate grasslands, wooded lands and terrestrial wetlands (DoE, 2014d). It often forages away from water on low lying grasslands, improved pastures and croplands. It feeds mostly on grasshoppers during the breeding season and is also known to consume other insects including cicadas, centipedes, spiders, cattle ticks, frogs, lizards and small mammals (DoE, 2014d). Roosting occurs in trees, or amongst ground vegetation in or near lakes and swamps (DoE, 2014d). Within Australia the principal breeding sites of the Cattle Egret are along the central east coast from Newcastle to Bundaberg (DoE, 2014d). The non-breeding distribution includes eastern and southern Australia from the far north-east of Queensland to Tasmania and the Eyre Peninsula, South Australia (DoE, 2014d).

This species was not recorded during surveys, however, there is potential for this species to forage within the Study Area. Foraging habitat occurs on the valley floor in agricultural areas comprising derived native grassland and cultivated land.

The Atlas of NSW Wildlife holds no records of the Cattle Egret within the locality. The Cattle Egret has been recorded in the locality and wider region within Wollemi National Park. Additional suitable forage habitat occurs extensively in the locality and wider region within agricultural areas.

k. Eastern Great Egret

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Eastern Great Egret (*Ardea modesta*) is a dispersive species and, in parts of its range, migratory. The species undertakes some regular seasonal movements, mostly to and from breeding colonies, and towards the coast in the dry season (DoE, 2014e). It has been reported in a wide range of wetland habitats, including swamps and marshes, margins of rivers and lakes, damp or flooded grasslands, pastures or agricultural lands, reservoirs, sewage treatment ponds, drainage channels, salt pans and salt lakes, salt marshes, estuarine mudflats, tidal streams, mangrove swamps, coastal lagoons, and offshore reefs (DoE, 2014e). This species mostly forages by wading through shallow to moderately deep water, by standing in water and capturing prey that wanders nearby, or by walking over shore or dry ground (DoE, 2014e). In Australia, breeding sites are located in wooded and shrubby swamps including mangrove forests, *Melaleuca* swamps and mixed eucalypt/acacia/lignum swamps (DoE, 2014e).

This species was not recorded during surveys, however, there is potential for this species to forage within the Study Area. Foraging habitat occurs on the valley floor in agricultural areas comprising derived native grassland and cultivated land.

The Atlas of NSW Wildlife holds one record of the Eastern Great Egret within the locality from 1993. The Eastern Great Egret has been recorded in the locality and wider region within Goulburn River National Park. Additional suitable forage habitat occurs extensively in the locality and wider region within agricultural areas.

l. Satin Flycatcher

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Satin Flycatcher (*Myiagra cyanoleuca*) is considered a migratory species, moving north in autumn to spend winter in northern Australia and New Guinea and returning south in spring to spend summer in south-eastern Australia (DoE, 2014n). This species inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DoE, 2014n). It prefer to nest in a fork of outer branches of trees, such as paperbarks, eucalypts, and banksias (DoE, 2014n). The Satin Flycatcher is widespread in eastern Australia and vagrant to New Zealand (DoE, 2014n).

This species was not recorded during surveys, however, there is potential for this species to forage within the Study Area. Potential foraging and breeding habitat for this species occur within the Study Area within intact woody vegetation in proximity to gullies.

The Atlas of NSW Wildlife holds one record of the Satin Flycatcher within the locality from 2005. The Satin Flycatcher has been recorded in the locality and wider region within Wollemi National Park and Munghorn Gap Nature Reserve. Additional suitable habitat occurs extensively in the locality and wider region.

m. Rufous Fantail

TSC Act Status: Not listed

EPBC Act Status: Migratory

The Rufous Fantail (*Rhipidura rufifrons*) has a movement pattern that is not well understood, however some populations in east Australia are considered migratory (DoE, 2014t). In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as *Eucalyptus microcorys* (Tallowwood), *Eucalyptus cypellocarpa* (Monkey Gum), *Eucalyptus radiata* (Narrow-leaved Peppermint), *Eucalyptus regnans* (Mountain Ash), *Eucalyptus delegatensis* (Alpine Ash), *Eucalyptus pilularis* (Blackbutt) or *Eucalyptus resinifera* (Red Mahogany), usually with a dense shrubby understorey often including ferns (DoE, 2014t). When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands, including *Corymbia maculata* (Spotted Gum), *Eucalyptus melliodora* (Yellow Box), ironbarks or stringybarks, often with a shrubby or heath understorey (DoE, 2014t). The Rufous Fantail occurs in coastal and near coastal districts of northern and eastern Australia (DoE, 2014t).

This species was not recorded during surveys, however, there is potential for this species to forage within the Study Area. Potential foraging habitat for this species occurs within the Study Area within woody vegetation.

The Atlas of NSW Wildlife holds one record of the Rufous Fantail within the locality from 2006. The Rufous Fantail has been recorded in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional suitable foraging habitat occurs extensively in the locality and wider region.

ii. Mammals

a. Koala

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

The Koala (*Phascolarctos cinereus*) inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalyptus species (DoE, 2014q). The Koala feeds almost entirely on the foliage of species of the *Eucalyptus* genus. A suite of feed tree species have been identified within SEPP 44 and the National Recovery Plan for the Koala. The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia (OEH, 2014m). In NSW it mainly occurs on the central coast and north coast with some populations in the west of the Great Dividing Range (OEH, 2014m).

This species was not recorded during surveys; however there is the potential for transient individuals to occur within the Study Area. Three feed trees identified within SEPP 44 occur within the Study Area, namely *Eucalyptus punctata* (Grey Gum), *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus albens* (White Box). These species primarily occur on the valley floor and footslopes within the Study Area. There are few recent records of the Koala within the locality of the Study Area and as such, this species is not expected to rely upon the available habitat within this area.

The Atlas of NSW Wildlife holds two records of the Koala within the locality with dates ranging from 1957 - 1980. The Koala is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Munghorn Gap Nature Reserve, Manobalai Nature Reserve and Avisford State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

b. Squirrel Glider

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Squirrel Glider (*Petaurus norfolcensis*) inhabits mature or old-growth box / box-ironbark woodland, *Eucalyptus camaldulensis* (River Red Gum) forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heathy understorey in coastal areas (OEH, 2014w). It prefers mixed species stands with a shrub or *Acacia* midstorey (OEH, 2014w). This species feeds on nectar, pollen, plant exudates (e.g. wattle and eucalypt sap), invertebrates, and honeydew (sugary exudate from insects), and rarely small vertebrates such as nestling birds (NSW Scientific Commitee, 2008b). The presence of large trees with abundant hollows are critical elements for nesting habitat (NSW Scientific Commitee, 2008b). Den and nest sites are in hollows, preferably with a large cavity that can house multiple gliders in a large nest, yet with a small entrance that protects the group from predators (NSW Scientific Commitee, 2008b). The Squirrel Glider is distributed from north Queensland to western Victoria, with a few records in extreme south-east South Australia where it may still persist (NSW Scientific Commitee, 2008b).

This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the Study Area. Suitable habitat includes mature woodland dominated by box species, including rainforest, riparian woodland/forest, grassy woodland, shrubby woodland and forest. Although present, the habitat containing *Eucalyptus camaldulensis* (River Red Gum) is considered to be too disturbed for this species. Nesting habitat is present in the form of hollow-bearing trees.

The Atlas of NSW Wildlife holds four records of the Squirrel Glider within the locality, from 2006. The Squirrel Glider is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park and Durridgere State Conservation Area. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

c. Eastern False Pipistrelle

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) inhabits wet sclerophyll and coastal mallee, preferring tall and wet forests where trees are more than 20m in height and the understorey is dense (Churchill, 2009). They also occur in open forests and lower altitudes (Churchill, 2009). Foraging occurs within gaps and spaces within the forest, avoiding areas with a dense understorey, and along tracks, creeks and rivers (Churchill, 2009). Their diet is mainly comprised of beetles and moths, with occasional bugs, ants and flies (Churchill, 2009). This species typically roosts in tree hollows, however there are a few records in caves and old buildings (Churchill, 2009). The Eastern False Pipistrelle occurs on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (OEH, 2012e).

This species was not recorded during surveys, however there is potential for this species to both forage and breed within the Study Area. There is potential for this species to occur within woody vegetation of the Study Area. Primary roosting habitat is present in the form of hollow-bearing trees, however this species may utilise caves.

The Atlas of NSW Wildlife holds one record of the Eastern False Pipistrelle from 2006. The Eastern False Pipistrelle is conserved in the locality and wider region within Wollemi National Park and Goulburn River National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

d. Little Bentwing-bat

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Little Bentwing-bat (*Miniopterus australis*) inhabits well timbered areas including rainforest, vine thicket, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill, 2009). Foraging occurs between shrub and canopy layers of densely wooded areas (Churchill, 2009). The diet of this species can include beetles, moths, flies, spiders, ants and wasps (Churchill, 2009). Few maternity sites are documented, with known sites typically occurring in limestone cave systems (Churchill, 2009). It is a cave-dwelling species with roosting occurring in caves, abandoned mines, tunnels, stormwater drains and occasionally buildings (Churchill, 2009). The Little Bentwing-bat occurs on east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (OEH, 2014n).

This species was not recorded during surveys of the Study Area, however there is the potential for this species to both forage and breed within the Study Area. There is the potential for this species to forage within the woody vegetation of the Study Area. Suitable roosting habitat is present in the form of caves.

The Atlas of NSW Wildlife holds two records of the Little Bentwing-bat within the locality from 2010. The Little Bentwing-bat is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

e. Eastern Cave Bat

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Eastern Cave Bat (*Vespadelus troughtoni*) inhabits tropical mixed woodland, wet and dry sclerophyll forest located in close proximity to sandstone or volcanic escarpments (Churchill, 2009). Little information is available on the foraging habitat of this species (OEH, 2012d), however it has been observed hawking mosquitoes (Churchill, 2009). Roosting can take place in sandstone overhang caves, boulder piles, mines and occasionally in buildings (Churchill, 2009). Maternity colonies have been observed in shallow sandstone caves (Churchill, 2009). The Eastern Cave Bat occurs in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW (OEH, 2012d).

This species was not positively identified as occurring within the Study Area as the calls of this species are difficult to differentiate from those of similar species. However, given the available habitat and the presence of records within the locality, this species is likely to occur within the Study Area. Available habitat in the Study Area includes woody vegetation for foraging and cave habitat for roosting. It is predicted that this species forages and roosts within the Study Area, however it is unknown if breeding occurs.

The Atlas of NSW Wildlife holds 11 records of the Eastern Cave Bat within the locality with dates ranging from 1997 - 2010. The Eastern Cave Bat is conserved in the locality and wider region within Wollemi National Park, Goulburn River National Park, Durridgere State Conservation Area and Manobalai Nature Reserve. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

f. Greater Broad-nosed Bat

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) inhabits a variety of habitats including moist gullies in mature coastal forest, rainforest, open woodland, Melaleuca swamp woodland, wet and dry sclerophyll forests, cleared paddocks with remnant trees and tree-lines creeks in open areas (Churchill, 2009). Foraging occurs at the edge of isolated trees and forest remnants (Churchill, 2009). Their diet consists mainly of beetles with moths, ants and large flies consumed occasionally (Churchill, 2009). This species roosts in tree hollows, cracks and fissures in trucks and dead branches, under exfoliating bark, as well as the roofs of old buildings (Churchill, 2009). The Greater Broad-nosed Bat occurs mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland, extending to the coast over much of its range (OEH, 2014k).

This species was not positively identified as occurring within the Study Area as the calls of this species are difficult to differentiate from those of similar species. However, given the available habitat and the presence of records within the locality, this species is likely to occur within the Study Area. Available habitat within the Study Area includes woody vegetation for foraging and hollow-bearing trees for roosting. It is predicted that this species forages and roosts within the Study Area, however it is unknown if breeding occurs.

The Atlas of NSW Wildlife holds 13 records of the Greater Broad-nosed Bat within the locality with dates ranging from 2006 - 2010. The Greater Broad-nosed Bat is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

g. Grey-headed Flying-fox

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

The Grey-headed Flying-fox (*Pteropus poliocephalus*) inhabits subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops (OEH, 2013d). The primary food source is blossom from eucalypts (genera *Eucalyptus*, *Corymbia* and *Angophora*), melaleucas and banksias, and in some areas it also utilises a wide range of rainforest fruits (DoE, 2014s). As none of the vegetation communities used by this species produces continuous foraging resources throughout the year, it has adopted complex migration traits in response to ephemeral and patchy food resources (DoE, 2014s). Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy (OEH, 2013d). The Grey-headed Flying-fox is generally found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (OEH, 2013d).

This species was not recorded during surveys of the Study Area; however there is the potential for this species to occasionally forage within the Study Area. The Study Area occurs to the west of the main distribution of this species. The woody vegetation within the Study Area contain a suite of eucalypts that may potentially be utilised as foraging habitat.

The Atlas of NSW Wildlife holds no records of the Grey-headed Flying-fox within the locality. The Grey-headed Flying-fox is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

iii. Reptiles

a. Broad-headed Snake

TSC Act Status: Endangered

EPBC Act Status: Vulnerable

The Broad-headed Snake (*Hoplocephalus bungaroides*) inhabits rocky outcrops and adjacent sclerophyll forest and woodland, with the most suitable sites occurring along sandstone ridgetops (DoE, 2014k). This species shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring (OEH, 2012a). In summer it moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments (OEH, 2012a). This species feeds on the Velvet Gecko (*Oedura lesueurii*), a variety of lizards, small-eyed snakes and mammals such as Brown Antechinus (*Antechinus stuartii*) (DoE, 2014k). The Broad-headed Snake is restricted to the sandstone ranges in the Sydney Basin and within a radius of approximately 200 km of Sydney (DoE, 2014k).

This species was not recorded during surveys of the Study Area, however there is the potential for this species to forage and breed within the Study Area. The Study Area occurs to the north of the current known distribution of this species. The cliff lines and associated habitats, including adjacent shrubby woodland, shrubland and forest containing hollow-bearing trees, provide suitable habitat for this species.

The Atlas of NSW Wildlife holds one record of the Broad-headed Snake within the locality from 2005. The Broad-headed Snake is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

b. Pink-tailed Legless Lizard

TSC Act Status: Vulnerable

EPBC Act Status: Vulnerable

The Pink-tailed Legless Lizard (*Aprasia parapulchella*) is a fossorial (lives underground) species and occurs in primary and secondary grassland, grassy woodland and woodland communities including mallee, and box-ironbark forest (DoE, 2014b). Most sites where Pink-tailed Worm-lizard occurs are characterised by the cover of predominantly native grasses, including *Themeda australis* (Kangaroo Grass), *Bothriochloa macra* and *Lomandra filiformis* (DoE, 2014b). The presence of other plant species, including grasses in the *Austrostipa* genus, weeds and *Poa labillardierei* (Tussock), decreases the likelihood of presence (DoE, 2014b). This species is most commonly found sheltering under small rocks (15–60 cm basal area) shallowly embedded in the soil (2–5 cm) (DoE, 2014b). The Pink-tailed Legless Lizard is known from a patchy distribution along the foothills of the western slopes of the Great Dividing Range, between Bendigo in Victoria and Gunnedah in NSW (DoE, 2014b).

This species was not recorded during surveys of the Study Area; however there is the potential for this species to occur within some portions of riparian woodland/forest, grassy woodland, shrubby woodland and derived native grassland.

The Atlas of NSW Wildlife holds one record of the Pink-tailed Legless Lizard within the locality from 2000. The Pink-tailed Legless Lizard is conserved in the locality and wider region within Goulburn River National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

c. Rosenberg's Goanna

TSC Act Status: Vulnerable

EPBC Act Status: Not listed

Rosenberg's Goanna (*Varanus rosenbergi*) inhabits heath, open forest and woodland (OEH, 2012m). It 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 (OEH, 2012m). This species feeds on carrion, birds, eggs, reptiles and small mammals (OEH, 2012m). Nesting occurs in termite mounds, which are a critical component of habitat (OEH, 2012m). Rosenberg's Goanna occurs on the Sydney sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south (OEH, 2012m).

This species was not recorded during surveys of the Study Area, however there is some potential for this species to forage and breed within the Study Area. Rainforest, shrubby woodland, shrubland and forest where hollow logs are abundant provides suitable shelter and foraging habitat for this species within the Study Area. However, few termite mounds were observed during surveys.

The Atlas of NSW Wildlife holds two records of Rosenberg's Goanna within the locality from 2006. The Rosenberg's Goanna is conserved in the locality and wider region within Wollemi National Park. Additional suitable habitat occurs to the west and south west of the Study Area within unreserved habitats.

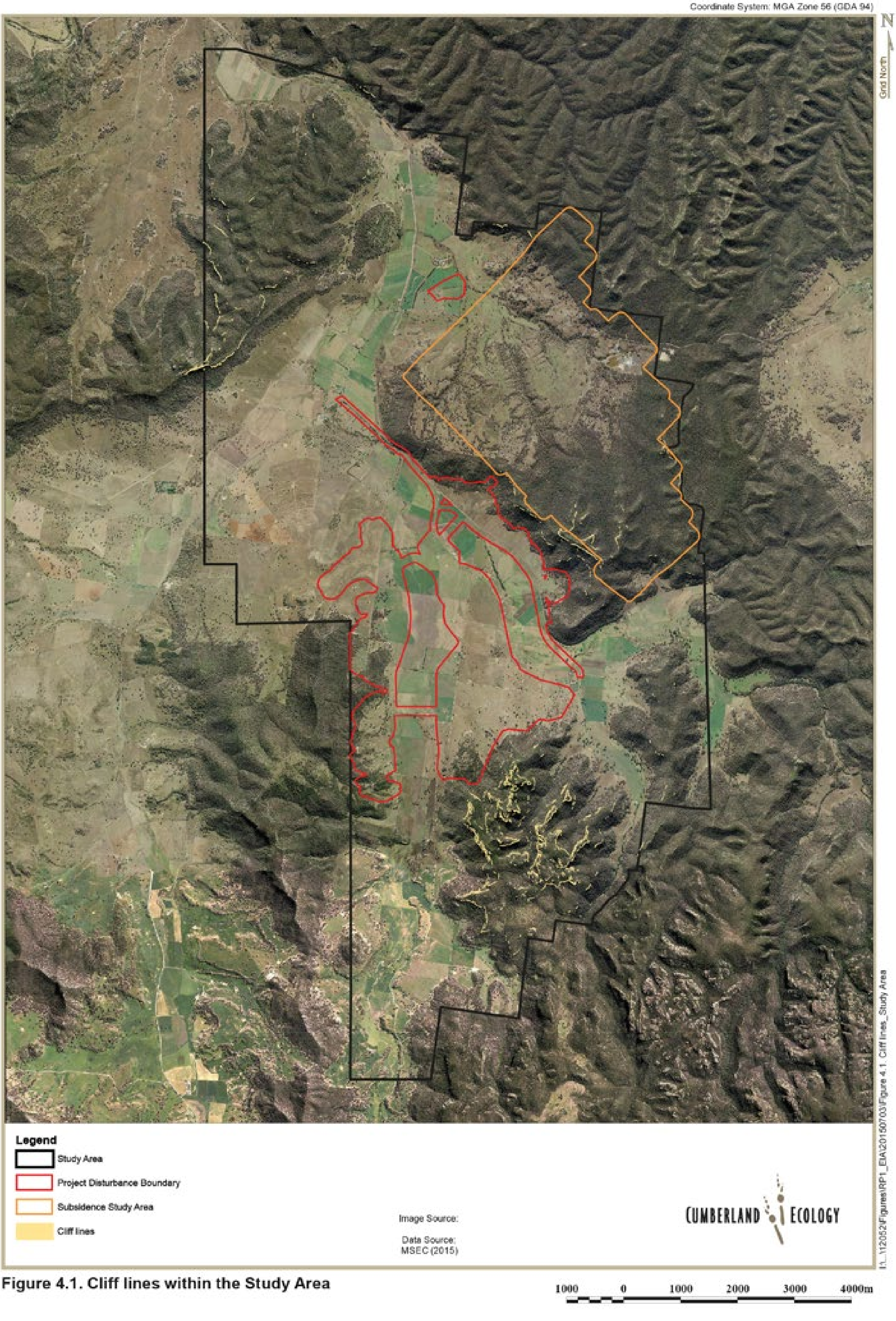


Figure 4.1. Cliff lines within the Study Area

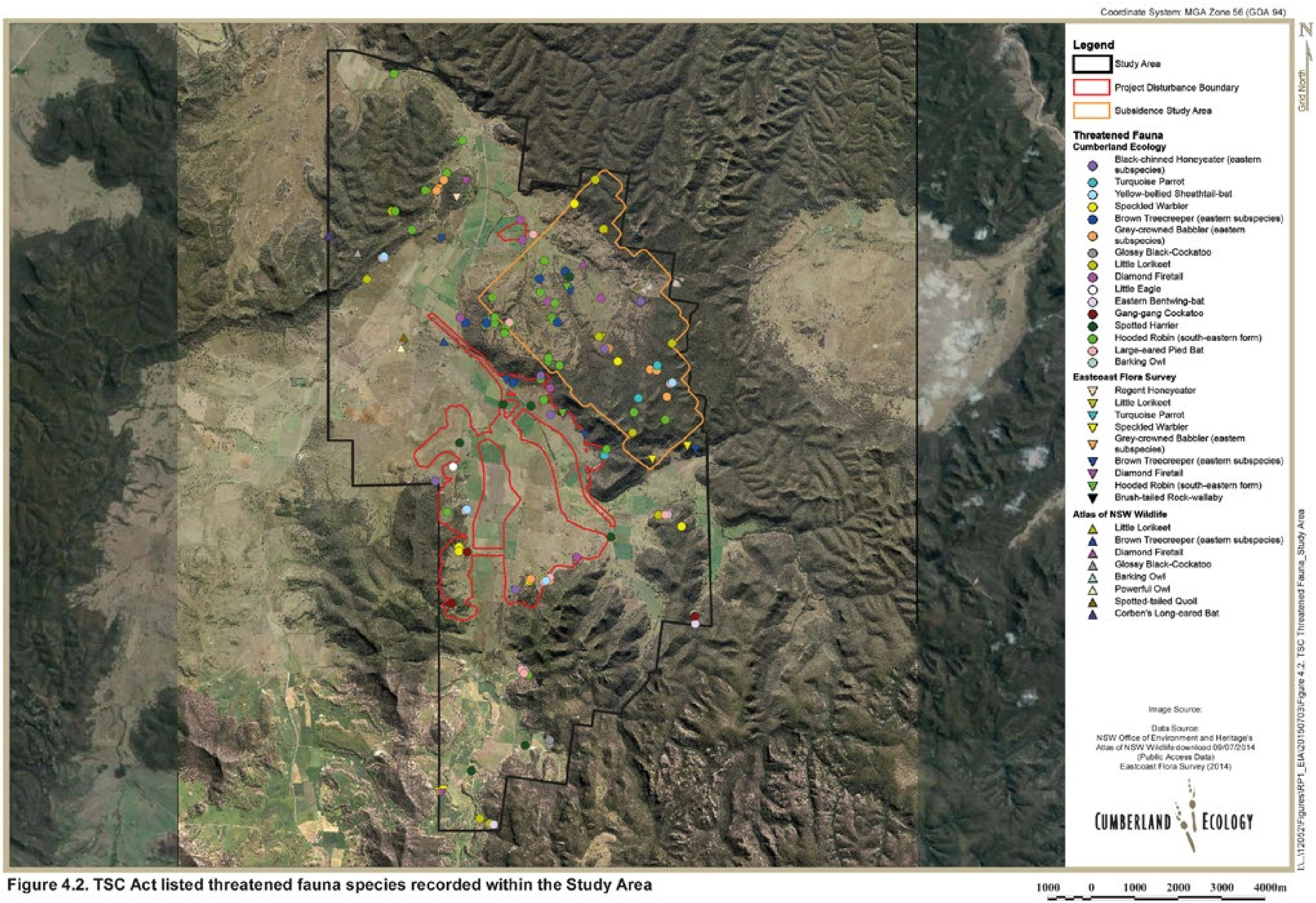


Figure 4.2. TSC Act listed threatened fauna species recorded within the Study Area

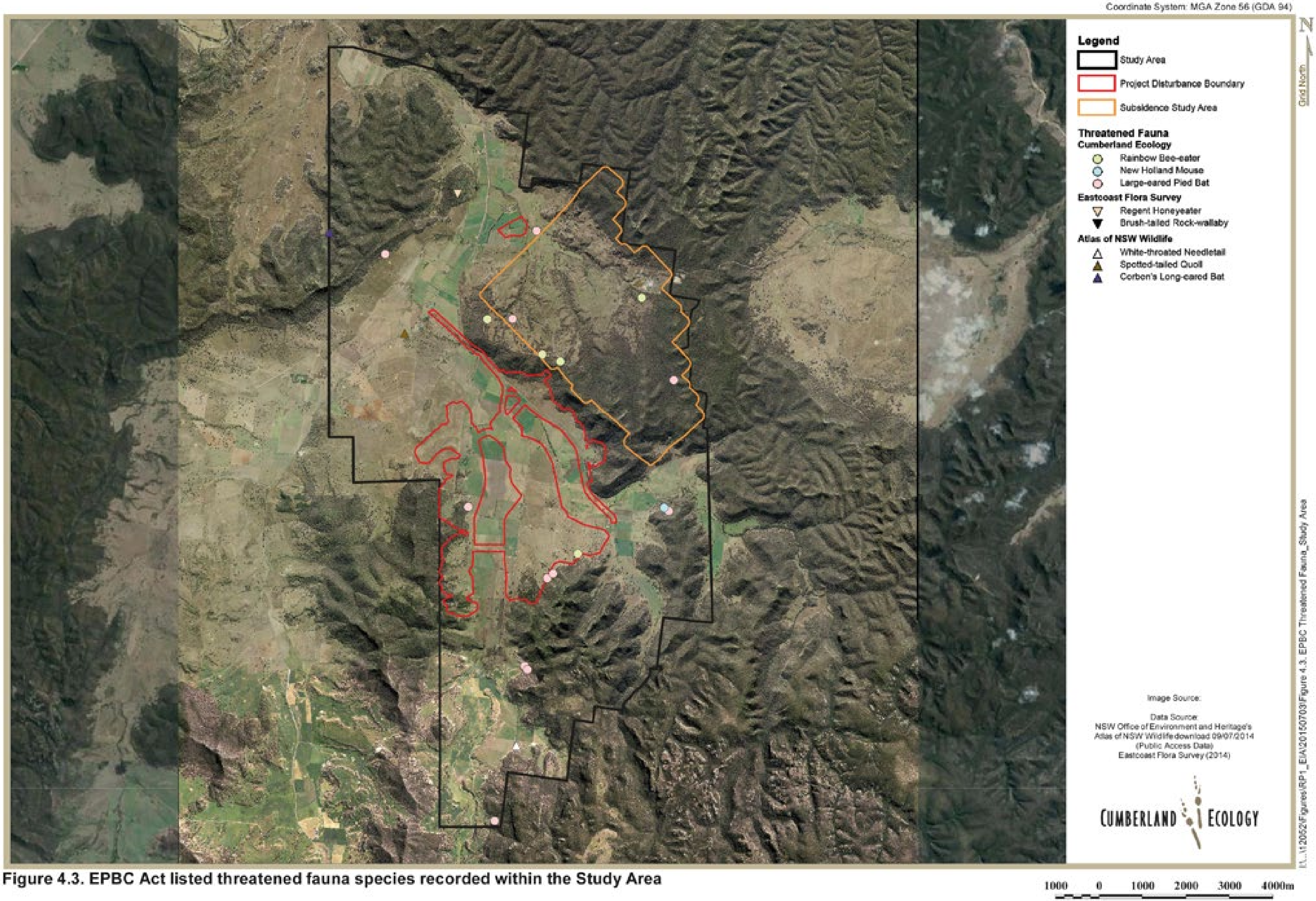


Figure 4.3. EPBC Act listed threatened fauna species recorded within the Study Area

Chapter **5**

Results: Aquatic Ecology

5.1 Overview

The Bylong River is the main waterway present within the Study Area, with the remaining waterways forming tributaries to it. Bylong River flows into Goulburn River approximately 7 km downstream of the Study Area. Goulburn River in turn flows into the Hunter River to the east of the Study Area near Denman. Both Goulburn River and the Hunter River have been heavily modified by agricultural activities, resulting in little native riparian and floodplain vegetation remaining. Although shortly after the confluence of Bylong River with Goulburn River, the latter appears to enter an area relatively undisturbed by humans, with little agriculture near the banks (due to the steep sides of the valley), further upstream along Goulburn River there are large areas of agriculture and human disturbance.

A total of eleven sites were surveyed along waterways within the Study Area, including five sites on Bylong River, two on Dry Creek, two on Lee Creek and one on an unnamed tributary to Lee Creek (**Figure 1.3**). Habitat assessments were undertaken at all surveyed sites, however the waterways within the Study Area are ephemeral (i.e. only flow when there is sufficient rainfall), thus water quality measurements and macro-invertebrate sampling was only undertaken at six sites, as the remainder were dry.

5.2 Aquatic Habitat Assessment

The majority of the Study Area lies within a broad valley. The waterways are ephemeral, thus for the majority of the year the creek lines are mostly dry with some relatively permanent small or large pools of water at specific locations. Analysis of the water table against surface water occurrence indicates significant interaction between alluvial groundwater and surface water (AGE, 2013). Therefore, it is likely that the water in these pools is predominantly replenished by groundwater.

The visual assessment of human disturbance of the waterways considered the water quality (where present), in-stream modifications and riparian zone to be (at least) highly disturbed (ranking of 3 or above) by human activities 67%, 64% and 82% of the time respectively (**Table 5.1**). Currently, agricultural land (generally improved grassland for grazing) extends to within metres of the waterways. The majority of native riparian and floodplain vegetation has been removed and there are few mature trees present. Gravels, sands, silts and clays dominate the substrates within the waterways, with small areas of bedrock observed on Dry Creek. This is in accordance with the geological data, where the sediments are described to consist of an upper layer of sand/silt and clay, overlying a basal layer of permeable sand and gravel (AGE, 2013). While the presence of silts and clays may natural in some areas, it is likely to have been exacerbated by sedimentation from agricultural practices. Where water is present, there is often evidence of its use as a drinking source for livestock.

Aquatic habitat along the waterways within the Study Area is considered to be highly degraded and unsuitable to support significant macro-invertebrate or fish populations because:

- The aquatic habitat is highly simplified due to the historical vegetation clearance and the uniform nature of the substrate; few macro-invertebrates can colonise and survive on bare substrates, even if water quality is suitable (Chessman, 2003) and the lack of vegetation and uniformity of the substrate provides poor conditions for fish spawning;

- There is a high potential for erosion due to the substrate type, which has likely been exacerbated by sedimentation and disturbance to banks by livestock; and

- There are significant barriers to fish movement due to the ephemeral nature of the waterways (i.e. any fish present are restricted to the relatively permanent pools of water for most of the year).

Nevertheless, some sites provide deep enough pools to support some fish, and where relatively permanent water is present; it is likely to provide a drinking water source for birds and potentially amphibians.

Table 5.1 Aquatic habitat assessment

Site	Surrounding Land Use	Topography	Water Level	Riparian Vegetation				Macrophyte Cover	Substrate Description	Visual Assessment of Human Disturbance*		
				Trees (>10m)	Trees (<10m) (% cover)	Shrubs / Vines / Rushes (% cover)	Grasses / Herbs / Ferns (% cover)			Water Quality	Instream	Riparian Zone
AS 1	Agricultural (improved grassland) / Road / Railway	Broad Valley	No Flow (water present)	Absent	0	60	80	50	Silt - Sand substrate with some clay	3	3	4
AS 2	Agricultural (improved grassland)	Broad Valley	No Flow (water present)	Present	2	80	50	50	Sand - Silt substrate with some gravel	2	3	3
AS 3	Agricultural (not improved)	Steep Valley	No Flow (water present)	Present	2	5	90	2	Bedrock substrate with some silt	1	1	2
AS 4	Agricultural (improved grassland)	Broad Valley	No Flow (water present)	Present	2	80	60	80	Gravel substrate with some Sand - Silt	3	3	4
AS 5	Agricultural (improved grassland)	Broad Valley	No Flow (water absent)	Absent	0	0	100	0	n/a	-	1	4
AS 6	Agricultural (improved grassland)	Broad Valley	No Flow (water present)	Absent	0	50	50	80	Mixture of gravel, sand, silt and clay	3	1	3
AS 7	Agricultural (improved grassland)	Broad Valley	No Flow (water absent)	Present	1	5	80	0	n/a	-	3	4
AS 8	Agricultural (improved grassland)	Broad Valley	No Flow (water absent)	Absent	0	5	100	0	n/a	-	3	4
AS 9	Agricultural (improved grassland)	Broad Valley	No Flow (water present)	Present	0	100	80	0	Silt substrate with some sand	4	4	4

Table 5.1 Aquatic habitat assessment

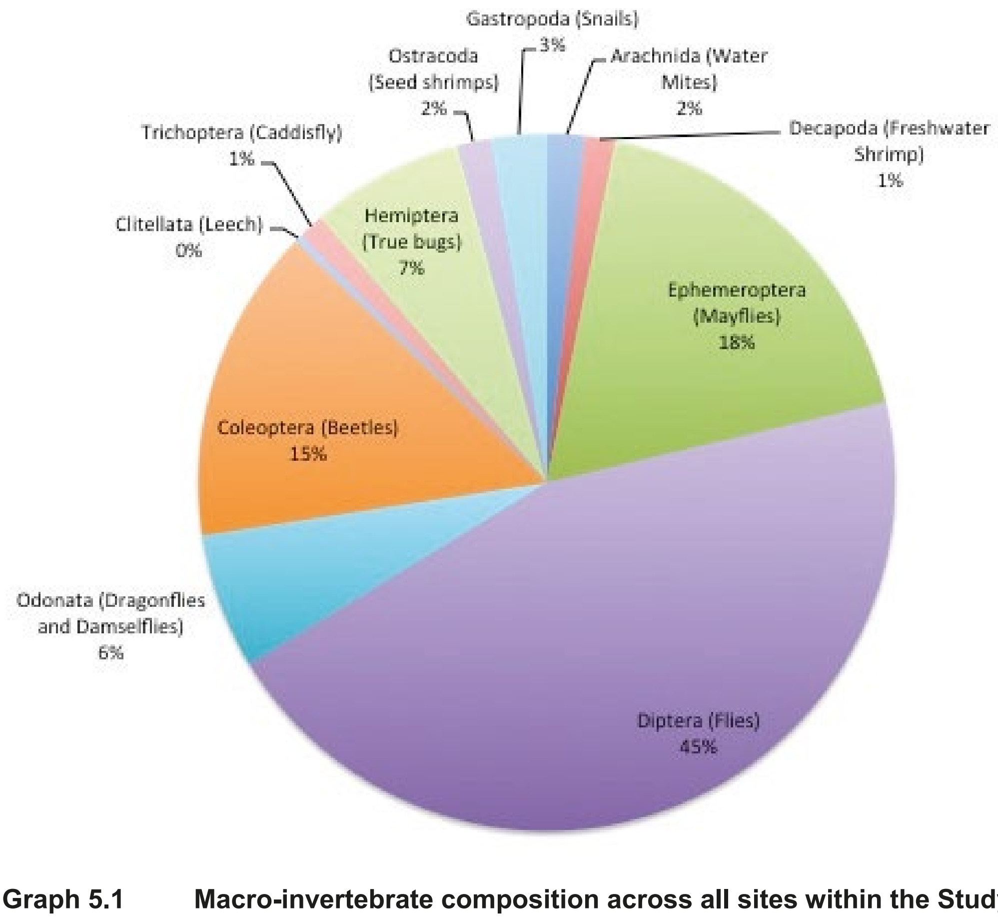
Site	Surrounding Land Use	Topography	Water Level	Riparian Vegetation				Macrophyte Cover	Substrate Description	Visual Assessment of Human Disturbance*		
				Trees (>10m)	Trees (<10m) (% cover)	Shrubs / Vines / Rushes (% cover)	Grasses / Herbs / Ferns (% cover)			Water Quality	Instream	Riparian Zone
AS 10	Agricultural (improved grassland)	Broad Valley	No Flow (water absent)	Absent	0	0	100	0	n/a	-	3	4
AS 11	Agricultural (improved grassland)	Steep Valley	No Flow (water absent)	Present	0	0	100	0	n/a	-	2	2

**Ranking: 0 = no evidence of disturbance, 1 = little disturbance, 2 = moderate disturbance, 3 = high disturbance, 4 = extreme disturbance (Turak and Waddell, 2001b).*

5.3 Macro-invertebrates

Aquatic macro-invertebrates are used as biological indicators of freshwater ecosystem health due to their sensitivity to changes in water quality, flow regime and general habitat condition (von der Ohe and Liess, 2004). The presence or absence of particular species, diversity, composition and abundance of communities provide general measures of health which can be used to assess impacts on aquatic systems (Maher and Norris, 1990). The condition and degree of ecological integrity of the aquatic survey sites was determined by inputting survey data into the AusRivAS macro-invertebrate predictive model (Turak and Waddell, 2001b) and the SIGNAL2 macro-invertebrate scoring system (Chessman, 2003).

The macro-invertebrate communities across all sites were dominated by True Flies (Diptera), which comprised 45% of all the organisms identified (**Graph 5.1**). Mayflies (Ephemoptera) and Beetles (Coleoptera) were also significant components of the communities, comprising 18% and 15% of all organisms identified respectively. A list of macro-invertebrates recorded within the Study Area, to the level identified (mostly family) is provided within **Appendix G**.



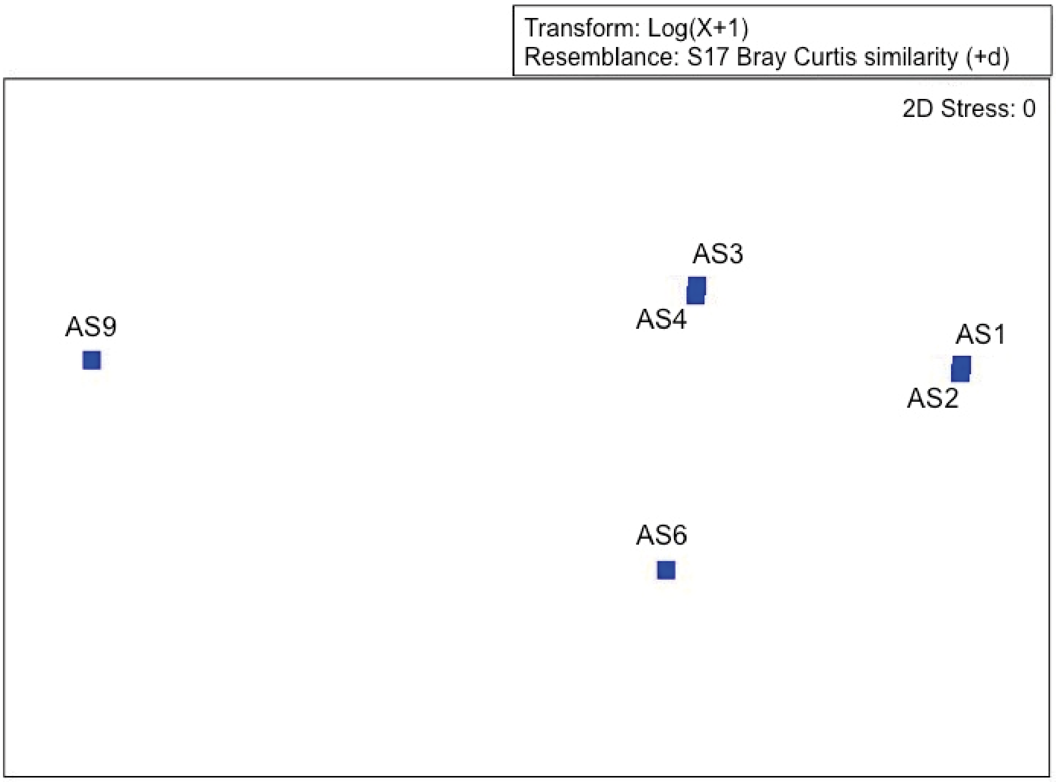
Graph 5.1 Macro-invertebrate composition across all sites within the Study Area

CUMBERLAND ECOLOGY

5.3.1 PRIMER Analysis

The MDS plot shown in **Graph 5.2** shows how similar macro-invertebrate communities at each site are in comparison to the other sites within the Study Area; the closer the symbols, the more similar the assemblage in terms of aquatic macro-invertebrate abundance and community composition. For example, sites which recorded low richness (numbers of species) and abundance of macro-invertebrates would be closer to each other on the plot than sites which recorded high richness and abundance. 'Stress' is an indication of confidence in the data and output patterns; stress of less than 0.2 is considered acceptable. In this analysis, a stress of 0 was recorded, which indicates that the output is considered to be robust.

The MDS plot shown in **Graph 5.2** shows similar macro-invertebrate communities were present in sites that were geographically closer to each other (AS1 and AS2); these sites were both quite similar in habitat characteristics and water quality. In comparison to the other sites, AS3 and AS4 also had similar communities. AS6 was more similar to AS1 – AS4 than AS9; this reflects the similar habitat types between these sites. However, the dissimilarity shown on the MDS plot between AS6 and AS 1 – 4 is likely to be due to the presence of fish, which were observed at AS6. The macro-invertebrate community at AS9 was clearly quite different from that at all the other sites. This is in accordance with the water quality and habitat at AS9, which was quite different from those other sites in that it was a very shallow pool, with a very silty substrate and visibly contaminated with livestock waste.



Graph 5.2 MDS plot of macro-invertebrate diversity and abundance

5.3.2 AusRivAS Analysis

To assess the aquatic health of the sampling sites using the AusRivAS models, the diversity of macro-invertebrates at each sampling location is compared with the diversity of published reference sites to allocate each sampling site into bands representing different levels of ecological condition. Reference sites are considered to be sites that have had little human disturbance, and the model assesses the relative health of the sampling site against the reference sites to calculate a value indicative of its ecological condition. When assessing the aquatic health of a stream, the model identifies reference sites that have similar physical characteristics (e.g. distance from source, alkalinity, and geographical location) and uses these reference sites to predict the macro-invertebrate community that should be present at a site. The model then compares the expected macro-invertebrate community with the observed macro-invertebrate community and calculates a score, which is called the observed to expected ratio or OE50.

An OE50 score of around 1 means that the observed macro-invertebrate community is similar to that expected, based on similar reference sites, and is therefore equivalent to that of a reference or undisturbed stream. A score lower than 1 means that fewer macro-invertebrates were observed than expected, and that the community is in poorer ecological condition in comparison to reference sites. To enable easier reading of OE50 scores, a banding system is used where Band A is given to sites with OE50 scores around 1, whilst Bands B, C and D are given to sites with respectively lower OE50 scores.

For NSW, the AusRivAS bands are as follows:

- X = sample site macro-invertebrate community is more diverse than reference site (OE50 score > 1.17);
- A = sample site macro-invertebrate community is similar to the reference site (OE50 score between 0.81 – 1.17);
- B = sample site macro-invertebrate community is significantly impaired in comparison to the reference site (OE50 score between 0.46 – 0.81);
- C = sample site macro-invertebrate community is severely impaired in comparison to the reference site (OE50 score between 0.11 – 0.46); and
- D = sample site macro-invertebrate community is extremely impaired in comparison to the reference site (OE50 score <0.11).

The results of the AusRivAS analysis performed on the macro-invertebrate communities present within the Study Area are provided in **Table 5.2**. These results should be treated with caution, because there were no reference sites in the AusRivAS model that had a similar alkalinity to the sites within the Study Area. Nevertheless, when the model was run with an adjustment of the alkalinity values to enable comparison to reference sites within the model, the macro-invertebrate communities present within the Study Area were classified as Band B (significantly impaired) or Band C (severely impaired). Sites that are classified as Band B contain *fewer*, and those classified as Band C contain *many fewer*, macro-invertebrate families than expected in healthy waterways, indicating that water quality and/or habitat condition is significantly and severely impaired respectively.

This analysis shows that waterways within the Study Area have been significantly altered or affected by surrounding land practices and do not support a diverse assemblage of aquatic macro-invertebrate fauna.

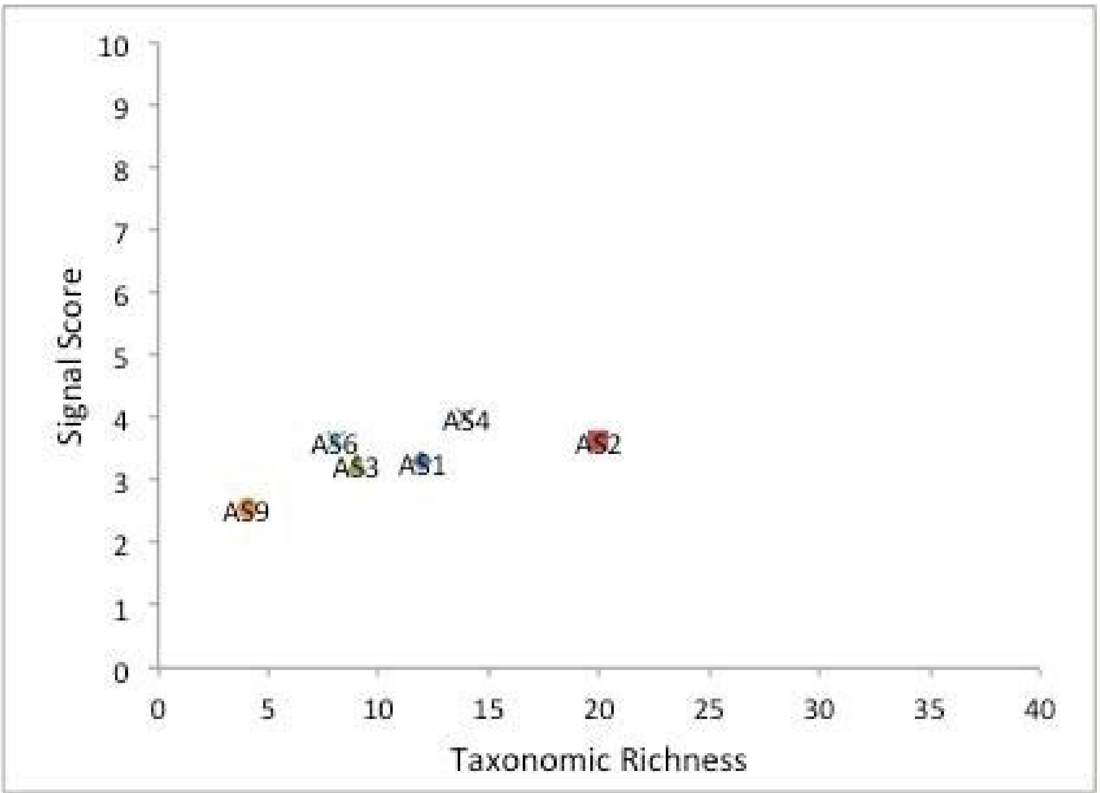
Table 5.2 AusRivAS analysis

Survey Location	OE50 Score	AusRivAS Band	Description	Interpretation Guide
AS1	0.43	C	Severely impaired	Many fewer families than expected. Loss of macro-invertebrate biodiversity due to substantial impacts on water and/or habitat quality.
AS2	0.61	B	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in the loss of taxa.
AS3	0.52	B	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in the loss of taxa.
AS4	0.17	C	Severely impaired	Many fewer families than expected. Loss of macro-invertebrate biodiversity due to substantial impacts on water and/or habitat quality.
AS6	0.43	C	Severely impaired	Many fewer families than expected. Loss of macro-invertebrate biodiversity due to substantial impacts on water and/or habitat quality.
AS9	0.78	B	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in the loss of taxa.

5.3.3 SIGNAL2 Analysis

SIGNAL2 analysis involves categorising the aquatic health of waterways based on the environmental tolerance of the macro-invertebrates recorded. Relatively pristine sites would be expected to have high macro-invertebrate diversity, including taxa that are sensitive to pollution. These sites would have a high SIGNAL2 score along with a high taxonomic richness (number of macro-invertebrate families). Sites that are highly degraded are expected to support a lower diversity of macro-invertebrate species, and these are expected to be pollution tolerant species. These sites would have a low SIGNAL2 score, with low taxonomic richness.

As shown in **Graph 5.3**, taxa with individual SIGNAL2 scores ≤3 (i.e. those which tolerate high levels of pollution) comprised 50% of all the taxa identified across all sites. These taxa included pollution tolerant fly and damselfly larvae, snails, leeches and true bugs. Site SIGNAL2 scores were all <5 and taxonomic richness was <20 (at healthy sites can as many as 40 different families can be recorded). These results indicate that the water quality in the waterways within the Study Area is poor and that this has affected the macro-invertebrate communities. These results are in accordance with the AusRivAS analyses and water quality analyses, described above.



Graph 5.3 SIGNAL2 scores versus taxonomic richness

5.4 Vertebrate Species

Although no surveys were carried out on site due to the ephemeral nature of the waterways, Eastern Gambusia (*Gambusia holbrooki*) were observed at a number of locations and Carp (*Cyprinus carpio*) were also observed at AS6 on Bylong River. The presence of these species indicates that if populations of native fish are present, they would currently be adversely affected by competition with Eastern Gambusia and Carp and likely to be under significant stress.

The Eastern Gambusia is a small fish native to south-eastern USA (DPI, 2014c). Eastern Gambusia have spread widely throughout NSW and thrive in shallow slow flowing water bodies, tolerating a wide range of temperatures and water quality (DPI, 2014c). Eastern Gambusia have been associated with the decline of abundance or range of at least 9

Australian native species through competition and predation, such as gudgeons, hardyheads and some rainbow fish (DPI, 2014c).

Carp are a large freshwater fish native to central Asia (DPI, 2014a). This species is very versatile, and can live in a great variety of habitats including highly degraded areas (DPI, 2014a). The distribution of carp in NSW now includes most of the Murray-Darling Basin as well as many coastal river systems, particularly in the central section of NSW from the Hunter in the north to the Shoalhaven (including the Southern Highlands and Tablelands) in the south (DPI, 2014a). Carp are widely believed to have detrimental effects on native aquatic plants, animals and general river health, particularly through their destructive feeding habits and because of their adaptability, carp have been very successful in their colonisation of new environments (DPI, 2014a).

5.5 Threatened Communities and Species

5.5.1 Endangered Ecological Communities

The Bylong River flows into the Goulburn River, which in turn flows into the Hunter River. None of these rivers have aquatic ecological communities that are listed as critically endangered, endangered or vulnerable ecological communities under the FM Act.

5.5.2 Threatened Species

There are no records of threatened species identified within the Hunter Local Land Services region. One threatened species listed under the FM Act, Murray Cod (*Maccullochella peelii*) has been identified as occurring within the Mid-Western Regional LGA, in which the Bylong River occurs. However this record is located within a separate river system: the site of the record is in the Cudgegong River, which is a westerly flowing river that flows into Lake Burrendong and eventually joins the Darling River, which joins the Murray River and flows to sea in South Australia.

It is believed that the Darling River Hardyhead, a small endemic Australian fish, is present within the Hunter River Catchment and it is listed as an endangered population. However, despite extensive sampling throughout its potential distribution, no individuals have been detected within the catchment since 2003 (DPI, 2014b). The fish are usually found in slow flowing, clear, shallow waters or in aquatic vegetation in edge habitats of these waters. Threats to the population include degradation of their habitat through soil erosion, land clearing and livestock damage to riverbanks, and the presence of competing species, including Carp. Given that this species hasn't been recorded despite extensive sampling within the Hunter River Catchment, that the threats to the population includes many of the stressors that have been identified exist within the Study Area, and that the aquatic habitat within the Study Area is degraded – it is considered unlikely that this fish would be present within the Study Area.

Chapter **6**

Impact Assessment

This chapter considers the ecological impacts of the Project on the biodiversity values within the Study Area. Impacts detailed within this chapter include those relating to both the open cut and underground mining areas, as well as the associated infrastructure. The ecological impacts of the Project are largely related to the direct disturbance of vegetation and associated habitat loss, represented by the removal of native and semi-cleared vegetation and future degradation of the remaining habitat. Secondary impacts due to indirect impacts, including those within the Subsidence Study Area, are also relevant to the Project and are discussed. This chapter also discusses the cumulative impacts of the Project on the flora and fauna within the locality, the duration and timing of anticipated impacts, and the permanence and reversibility of anticipated impacts.

6.1 Direct Impacts

6.1.1 Vegetation Removal

The largest direct impact of the Project is the removal of native vegetation communities that also provide habitat for a wide range of flora and fauna species. Although there are different types of flora and fauna habitat within the Study Area, such as natural and semi-cleared vegetation, cliff lines, gullies and ephemeral creeks, the most extensive habitat to be directly impacted is represented by native vegetation.

The total Project Disturbance Boundary (direct impact) is 1,160 ha and includes the Open Cut Mining Areas, internal access roads and the associated Mining Infrastructure Areas. **Table 6.1** provides a summary of the areas of each vegetation community within the Project Disturbance Boundary and **Figure 6.1** shows their distribution. The direct clearing of vegetation within the Project Disturbance Boundary will occur gradually over the proposed mining stages. An additional 1,714 ha of land occurs above the Subsidence Study Area (indirect impact).

The dominant vegetation communities impacted by the Project are Cultivated Lands (Unit CC) and various forms of Derived Native Grasslands (both listed and non-listed forms). The dominant communities comprising woody vegetation within the Project Disturbance Boundary are White Box Woodland (Shrubby) (Unit 7b) and White Box Woodland (Grassy) (Unit 7a). TECs occurring within the Project Disturbance Boundary include Hunter Valley Footslopes Slaty Gum Woodland and Box Gum Woodland and Derived Native Grassland. A third TEC, namely Hunter Floodplain Red Gum Woodland occurs in proximity to the Project Disturbance Boundary. Impacts to these TECs are discussed further within ***Section 6.3***.

Table 6.1 Vegetation clearance (direct disturbance) within the Study Area

Vegetation Community	Project Disturbance Boundary (ha)~	Study Area (ha)~	% Cleared within Study Area
1: Rusty Fig Dry Rainforest	0	1	0
2: Grey Myrtle Dry Rainforest	0	5	0
3: River Oak / Redgum Riparian Woodland	0	39	0
4: Blakely's Red Gum / Apple Riparian Forest	5	161	3
5: Blakely's Red Gum / Paperbark Forest	0	15	0
6: Yellow Box Woodland	8	161	5
7: White Box Woodland			
7a: White Box Woodland (Grassy)	54	714	8
7b: White Box Woodland (Shrubby)	71	502	14
8: Blakely's Red Gum Woodland			
8a: Blakely's Red Gum Woodland (Grassy)	0	16	0
8b: Blakely's Red Gum Woodland (Shrubby)	0	22	0
9: Slaty Box Woodland	11	1,144	1
10: Coastal Grey Box Woodland	31	100	31
11: Fuzzy Box Woodland	5	60	8
12: Calytrix Rockplate Heath	0	8	0
13: Shrubby Regrowth	40	199	20
14: Dwyer's Red Gum Low Open Forest	0	70	0
15: Caley's Ironbark Forest	0	514	0
16: Blue-leaf Ironbark / Cypress Forest	0	911*	0
17: Red Ironbark / Cypress Forest*	0	154	0
18: Cypress Pine Forest	4	82	5
19: Bloodwood / Ironbark Forest	0	29	0
20: Scribbly Gum / Grey Gum Forest	0	6	0
21: Exposed Grey Gum / Stringybark Forest^	0	295^	0
22: Sheltered Grey Gum / Stringybark Forest^			
DNG: Derived Native Grasslands			
DNG – 3: River Oak / Redgum Riparian Woodland Derived Native Grassland#	11	453#	2
DNG – 4: Blakely's Redgum / Apple Riparian Forest Derived Native Grassland#			

CUMBERLAND ECOLOGY

Table 6.1 Vegetation clearance (direct disturbance) within the Study Area

Vegetation Community	Project Disturbance Boundary (ha)~	Study Area (ha) ~	% Cleared within Study Area
DNG – 6: Yellow Box Woodland Derived Native Grassland	15	137	11
DNG – 7: White Box Woodland Derived Native Grassland	174	1,114	16
DNG – 8: Blakely's Redgum Woodland Derived Native Grassland	0	10	0
DNG – 9: Slaty Box Woodland Derived Native Grassland	31	152	20
DNG – 10: Coastal Grey Box Woodland Derived Native Grassland	241	838	29
DNG – 11: Fuzzy Box Woodland Derived Native Grassland	53	284	19
CC: Cultivated Lands	386	2,025	19
Other (cleared, planted vegetation)	21	90	23
GRAND TOTAL+	**1,160**	**10,313**	**11**

Includes areas of Caley's Ironbark Forest (Unit 15) (see* ***Section 3.2.16**)*

^ Exposed Grey Gum / Stringybark Forest (Unit 21) and Sheltered Grey Gum / Stringybark Forest (Unit 22) are mapped concurrently

 # River Oak / Redgum Riparian Woodland Derived Native Grassland (Unit DNG – 3) and Blakely's Redgum / Apple Riparian Forest Derived Native Grassland (Unit DNG – 4) are mapped concurrently

+ In some cases totals may not equal the appropriate total number due to rounding

~ Area calculations are approximate

The Project will remove 229 ha, or 4%, of the woody vegetation within the Study Area. **Table 6.2** shows the total woody vegetation cover within the Study Area and surrounds. The removal of woody vegetation within the Study Area represents a small percentage of woody vegetation in the vicinity of the Project.

Table 6.2 Estimated woody vegetation cover before and after the Project

Area	Woody Vegetation Cover Before the Project (%)	Woody Vegetation Cover After the Project (%)
Study Area	51	48
Study Area + 5 km buffer	69	69
Study Area + 10 km buffer	76	76
Study Area + 15 km buffer	81	81

6.1.2 Habitat Removal

The native and semi-cleared vegetation throughout the Study Area provides habitat for a range of flora and fauna; including some species that are listed as threatened or migratory under the TSC Act and/or EPBC Act. The vegetation communities within the Study Area support a range of habitat types for flora and fauna species, and specific habitat features provide foraging, shelter and breeding opportunities for fauna. The Project will remove a range of habitats including a suite of specific habitat features. The removal of habitat within the Project Disturbance Boundary is discussed in detail below.

Despite the Project resulting in the removal of habitat and specific features, extensive areas of land containing similar habitat occurs within the Study Area. It is anticipated that the types of flora and fauna species utilising the habitat within the Project Disturbance Boundary will continue to persist within other areas of the Study Area where suitable habitat is present. The habitats within the Study Area are well connected with similar habitats within the locality.

i. Vegetation Formations

Eight broad vegetation formations have been identified within the Project Disturbance Boundary including rainforest, riparian woodland/forest, grassy woodland, shrubby woodland, shrublands, forests, derived native grasslands and cultivated lands. The remaining land within the Project Disturbance Boundary is comprised of cleared land. A breakdown of the clearance of the eight vegetation formations within the Project Disturbance Boundary is provided in **Table 6.3**.

The most impacted vegetation formations are the various forms of Derived Native Grasslands (524 ha) and Cultivated Lands (386 ha). A range of habitat features are present within each of the vegetation formations and are discussed further below.

Table 6.3 Vegetation formations to be cleared within the Project Disturbance Boundary

Vegetation Formation	Project Disturbance Boundary (ha)~	Study Area (ha)~	% Cleared within Study Area
Rainforest (Units 1-2)	0	6	0
Riparian Woodland/Forest (Units 3-5)	5	214	2
Grassy Woodland (Units 6, 7a, 8a, 10-11)	98	1,050	9
Shrubby Woodland (Units 7b, 8b, 9)	82	1,668	5
Shrublands (Units 12-13)	40	207	19
Forests (Units 14-22)	4	2,061	0
Derived Native Grasslands (Unit DNG)	524	2,991	18
Cultivated Lands (Unit CC)	386	2,025	19

~ *Area calculations are approximate*

ii. Habitat Features

The Project will include the removal of habitat features within the Project Disturbance Boundary. Important fauna habitat features that will be removed by the Project include:

- Riparian environments suitable for fauna species dependent on these habitats such as wetland birds, some amphibians and reptiles;
- Terrestrial habitat features such as ground and shrub layer vegetation, leaf litter, coarse woody debris and rocky outcrops suitable as shelter for small terrestrial fauna species;
- Hollow-bearing trees and stags suitable as shelter and breeding habitat for a range of hollow-dependent fauna;
- Blossom-producing trees and shrubs suitable as forage for a range of nectarivores; and
- Koala feed tree species.

The loss of these habitat features within the Project Disturbance Boundary is detailed further below.

The removal of these habitat features also has the potential to directly impact the fauna species utilising the habitats during the clearing process. Although some species, including diurnal species and highly mobile species may relocate during this period, there is potential for fauna to remain within the habitat features, such as hollows, fallen logs and caves. Species with a higher potential to be impacted during the clearing process include nocturnal species, less mobile species and species that are hibernating or in torpor during the clearing period. Additionally species that have smaller home ranges may not be able to relocate into non-clearing areas. There is potential for injury and mortality during the clearing process to individuals that remain within the clearing areas.

a. Riparian Environments

Portions of the Bylong River and Lee Creek, including some associated drainage lines, occur within the Project Disturbance Boundary. Much of the habitat associated with Bylong River and Lee Creek has previously been impacted by agricultural land practices. Water flow is ephemeral and there are only limited occurrences of native aquatic vegetation that occur in areas where water persists for longer durations. Riparian environments within the Project Disturbance Boundary typically occur in association with the riparian woodland/forest vegetation formations. A number of agricultural dams located within the cultivation and derived native grassland vegetation formations will also be removed within the Project Disturbance Boundary.

The removal of these riparian environments and dams will remove foraging and breeding habitat for some fauna species, including amphibians, birds, mammals and reptiles. Threatened fauna species known to occur within the Study Area are not considered to solely rely on the riparian environments proposed to be removed. Numerous riparian environments also occur outside of the Project Disturbance Boundary. It is anticipated that these features will continue to provide habitat for the suite of species that may be utilising similar habitats within the Project Disturbance Boundary.

b. Terrestrial Habitat Features

The most extensive areas of terrestrial habitat features, including rocky outcrops, fallen logs, debris and leaf litter, occur within the treed vegetation formations within the Project Disturbance Boundary. These areas primarily occur at the north eastern, southern and central western extents of the Project Disturbance Boundary. Other important areas of terrestrial habitat features occur at the ecotone between grassland and treed areas, particularly where features such as fallen logs and boulders are present.

The removal of these features will remove foraging and breeding habitat for some fauna species, particularly terrestrial mammals and reptiles, and some woodland birds. Some of the threatened fauna species known to occur within the Study Area rely on terrestrial habitat features that are proposed to be removed.

Extensive areas of land containing these terrestrial habitat features occur outside of the Project Disturbance Boundary. It is anticipated that these features will continue to provide habitat for the suite of species utilising these habitats within the Project Disturbance Boundary.

c. Hollow-bearing Trees

The most extensive occurrence of hollow-bearing trees within the Project Disturbance Boundary is within the woody vegetation communities. However, remnant paddock trees also contain hollows. **Table 6.4** provides an estimate of the hollow-bearing trees to be cleared within woody vegetation communities within the Project Disturbance Boundary. White Box Woodland (Grassy) and Slaty Box Woodland contain the highest estimated number of hollow-bearing trees per hectare. In total, it is estimated that the Project will remove 3,318 hollow-bearing trees in woody vegetation within the Project Disturbance Boundary.

Of the hollow-bearing trees estimated to occur within the Project Disturbance Boundary, it is possible that only a small proportion of available hollows are likely to be functional habitats (Cockle *et al.*, 2008) and so the importance of this limited resource within the Study Area is likely to be quite high.

Much of the tree hollow resources will be lost in the short term and medium term from within the Project Disturbance Boundary. Furthermore, edge effects will have consequences for the integrity of the remaining hollow-bearing trees (e.g. susceptibility to wind). The loss of tree hollows will have important implications for threatened species such as microbats, owls, arboreal mammals and some diurnal birds.

Extensive areas of land containing terrestrial habitat features occur outside of the Project Disturbance Boundary. It is anticipated that these features will continue to provide habitat for the suite of species utilising these habitats within the Project Disturbance Boundary.

Table 6.4 Estimated loss of hollow-bearing trees in woody vegetation within the Project Disturbance Boundary

Vegetation Community	Hollow-bearing Trees / Hectare	Project Disturbance Boundary (ha)~	Estimate of Hollow-bearing Trees Cleared*
4: Blakely's Red Gum / Apple Riparian Forest	5.0	5	27
6: Yellow Box Woodland	15.0	8	124
7a: White Box Woodland (Grassy)	25.7	55	1,403
7b: White Box Woodland (Shrubby)	14.0	71	987
9: Slaty Box Woodland	22.5	11	251
10: Coastal Grey Box Woodland	15.0	31	458
11: Fuzzy Box Woodland	13.3	5	68
13: Shrubby Regrowth	0.0	40	0
18: Cypress Pine Forest	0.0	4	0
TOTAL+			**3,318**

~ *Area calculations are approximate*

* *Calculation uses non-rounded values*

+ *In some cases totals may not equal the appropriate total number due to rounding*

d. Blossom-producing Trees and Shrubs

A suite of blossom-producing trees and shrubs occur within the Project Disturbance Boundary that will be cleared by the Project. Blossom-producing eucalypts occurring within the Project Disturbance Boundary include *Angophora floribunda* (Rough-barked Apple), *Eucalyptus albens* (White Box), *Eucalyptus conica* (Fuzzy Box), *Eucalyptus dawsonii* (Slaty Gum), *Eucalyptus melliodora* (Yellow Box) and *Eucalyptus moluccana* (Grey Box). The flowering periods of each of these eucalypts, as indicated in **Table 4.2**, overlap and the combination of these species would provide a source of blossom throughout the year. *Eucalyptus albens* (White Box), a typically autumn and winter-flowering species, is the most commonly occurring canopy species within the Project Disturbance Boundary.

The highest diversity of blossom-producing shrub species occurs within the shrubby woodland vegetation formations; however other vegetation formations also provide these features. Approximately 82 ha of vegetation within the communities associated with the shrubby woodland vegetation formation will be cleared within the Project Disturbance Boundary. In conjunction with the removal of trees and shrubs, the Project will remove mistletoes associated with some canopy and shrub species.

The suite of blossom-producing trees and shrubs occurring within the Project Disturbance Boundary are also known to occur within other areas of the Study Area. It is anticipated that these features will continue to provide habitat for the suite of species utilising these habitats within the Project Disturbance Boundary.

e. Koala Feed Trees

Eucalyptus albens (White Box), a SEPP 44 feed tree for the Koala, occurs within the Project Disturbance Boundary. This species predominantly occurs within White Box Woodland vegetation community, with scattered occurrences in other woodland vegetation and as scattered paddock trees. The Project will remove potential feed trees for the Koala as identified under SEPP 44, predominantly in the form of *Eucalyptus albens* (White Box). Extensive areas of the Study Area contain this species, outside of the Project Disturbance Boundary. Two additional SEPP 44 feed trees, namely *Eucalyptus punctata* (Grey Gum) and *Eucalyptus camaldulensis* (River Red Gum) are also known to occur within the Study Area.

Eucalyptus camaldulensis (River Red Gum) is identified as a primary food tree for the Central and Southern Tablelands management zone which the Study Area falls within under the *Recovery plan for the koala (Phascolarctos cinereus)* (DECC (NSW), 2008b). The occurrence of this species within the Study Area is outside of the Project Disturbance Boundary. Secondary feed trees identified within this management zone occurring within the Project Disturbance Boundary include *Eucalyptus albens* (White Box), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus microcarpa* (Grey Box) and *Eucalyptus melliodora* (Yellow Box). Many of these species will remain within the Study Area.

The feed trees occurring within the Project Disturbance Boundary are not considered important for the long-term survival of the species within the locality. There are few recent records of the Koala within the locality of the Study Area and as such, this species is not expected to rely upon the available habitat within this area.

iii. Key Threatening Processes

The removal of the important habitat features identified above aligns with some of the Key Threatening Processes (KTPs) identified under the TSC Act and EPBC Act, including:

- Bushrock removal (TSC Act);
- Clearing of native vegetation (TSC Act);
- Land clearance (EPBC Act);
- Loss of hollow-bearing trees (TSC Act); and
- Removal of dead wood and dead trees (TSC Act).

Additional KTPs relevant to the indirect impacts of the Project include:

- Alteration of habitat following subsidence due to longwall mining (TSC Act); and
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (TSC Act).

As indicated within the determinations for these KTPs, a number of threatened fauna species occurring within the Study Area are recognised as relevant to the resulting impacts. A number of other threatened flora and fauna species may also be impacted by some of these KTPs. The impacts to threatened flora and fauna species are discussed within ***Section 6.5*** and ***Section 6.6***, respectively.

6.2 Indirect Impacts

The Project will have a range of indirect impacts on the ecological values of remaining vegetation and habitat within the Study Area, including subsidence, fragmentation, edge effects, alteration to wildlife corridors, alteration to hydrological regimes and changes to weed occurrence and feral animal abundance.

Additionally, a number of construction and operational impacts, such as those relating to dust, noise, light and erosion, will also impact the remaining vegetation and habitat. Indirect impacts relevant to the Project are considered in more detail below. Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of TECs and threatened species, such impacts cannot be mapped or accurately calculated in advance.

Indirect impacts may also be felt outside the Study Area. For mobile species with large territories, such as the Spotted Harrier and Little Eagle, the clearance of habitat within the Project Disturbance Boundary may potentially impact the territories further afield. Whilst not quantifiable, these impacts have been considered within the Assessments of Significance within **Appendix H** (TSC Act listed entities) and **Appendix I** (EPBC Act listed entities).

6.2.1 Subsidence

Subsidence impacts have been predicted to occur within an area defined as the Subsidence Study Area, which is approximately 1,714 ha in size. Subsidence movements include the vertical and horizontal displacement of ground, which may change the slope of the ground surface or cause fracturing and deformations in the bedrock or overlying strata. Although subsidence impacts can vary in terms of surface expression, typical subsidence effects can include surface cracking, rock fall and alterations to hydrological regimes.

i. Predicted Subsidence

The Subsidence Study Area has been defined, as a minimum, the surface area within the predicted limit of vertical subsidence, determined by the greater of the 26.5 degree angle of draw from the limit of the proposed secondary extraction, the maximum extent of the proposed first workings and the predicted 20 mm subsidence contour resulting from the extraction of the proposed longwalls (MSEC, 2015).

Within the Subsidence Study Area, subsidence movements as a result of longwall mining have been predicted by MSEC (2015). The maximum predicted vertical displacement as a result of longwall mining within the Subsidence Study Area is 3,300 mm. MSEC (2015) has also made an estimate of potential surface cracking over the Subsidence Study Area that may develop in tensile zones around the ends and sides of longwalls using a cut off for the development of tensile cracks of 0.5 mm/m predicted tensile strain and an allowance for surface cracks that may develop across the panel as the transient tensile/compressive zone travels along the length of the longwall. The estimated area of cracking was calculated as less than 1 % of the total subsidence area for the proposed longwalls. It is predicted that surface cracking in the flatter areas above the proposed longwalls will typically be between 25 mm and 50 mm, with some isolated cracking around 100 mm or more. On the steeper slopes, towards Bylong State Forest, surface cracks may be in the order of 50 mm to 100 mm, with isolated cracking of 200 mm or greater.

ii. Impacts to Vegetation and Associated Habitat

The extent of vegetation communities within the Subsidence Study Area is summarised in **Table 6.5** and their distribution shown in **Figure 6.1**. In terrestrial habitats, subsidence movements can lead to some tree fall or failure, a loss of habitat due to rock falls from cliff lines and modification of riparian vegetation.

The extent of predicted cracking within the Subsidence Study Area is outlined above. Tree fall or failure as a direct result of cracking is predicted to be quite localised and so is unlikely to significantly impact upon terrestrial habitat quality within the Subsidence Study Area. Large surface cracks have the potential to act as temporary pitfalls for small ground-dwelling fauna such as reptiles or small mammals (DoP, 2008). However, cracking can also have the potential benefits through the creation some niche habitat features for utilisation by flora and fauna species. Surface cracking also has the potential to increase erosion within the Subsidence Study Area.

Remediation works associated with surface cracking can also impact the ecological values within the Subsidence Study Area. The level of impacts associated with remediation works can vary depending on the number of cracks identified as well as the methods utilised during such works. MSEC (2015) has conservatively estimated the extent of disturbance for remediation works associated with surface cracking has been conservatively estimated at 10% of the Subsidence Study Area, largely comprising grassland. However appropriate management could reduce this impact to 5%.

Rock falls from cliff lines have the potential to be more significant where vegetation below the cliff line is damaged, habitat features are lost and individual species are lost, . However, it is recognised that the existence of the cliff with a rocky talus slope below is a demonstration that these are dynamic environments, where rock falls are not uncommon over significant periods of time (DoP, 2008). Species that occur in such landscapes are typically adapted to recolonise such disturbances. Where rock fall occurs, it could also create additional habitat features for some flora and fauna species.

A strategic review of the southern coalfields found that there is little to no evidence that vegetation or fauna habitats have been significantly altered as a result of cliff falls associated with subsidence (DoP, 2008). Similar conclusions have been made on underground mining projects in the wider locality of the Project (see Ecovision (2008), Umwelt (2009) and Umwelt (2011)).

Modifications to hydrological regimes as a result of subsidence (see ***Section 6.2.1iv***) can potentially impact riparian communities. Modifications are most likely to occur along Dry Creek as this is the primary watercourse within the Subsidence Study Area. Dry Creek has been classified as a "losing stream" which means that surface flows will continue to seep through the creek bed and into the underlying thin alluvial strata, thus continuing to provide and replenish water for use by riparian vegetation (AGE, 2015). As such, the impacts to riparian communities along this watercourse are considered minimal.

Table 6.5 Vegetation communities within the Subsidence Study Area

Vegetation Community	Subsidence Study Area (ha)~
2: Grey Myrtle Dry Rainforest	<1
4: Blakely's Red Gum / Apple Riparian Forest	15
5: Blakely's Red Gum / Paperbark Forest	15
6: Yellow Box Woodland	112
7: White Box Woodland	
7a: White Box Woodland (Grassy)	407
7b: White Box Woodland (Shrubby)	34

Table 6.5 Vegetation communities within the Subsidence Study Area

Vegetation Community	Subsidence Study Area (ha)~
8: Blakely's Red Gum Woodland	
8b: Blakely's Red Gum Woodland (Shrubby)	15
9: Slaty Box Woodland	124
10: Coastal Grey Box Woodland	4
13: Shrubby Regrowth	2
14: Dwyer's Red Gum Low Open Forest	31
15: Caley's Ironbark Forest	348
16: Blue-leaf Ironbark / Cypress Forest*	86
17: Red Ironbark / Cypress Forest	105
19: Bloodwood / Ironbark Forest	17
20: Scribbly Gum / Grey Gum Forest	1
21: Exposed Grey Gum / Stringybark Forest^	33
22: Sheltered Grey Gum / Stringybark Forest^	
DNG: Derived Native Grasslands	
DNG – 3: River Oak / Redgum Riparian Woodland Derived Native Grassland#	1
DNG – 4: Blakely's Redgum / Apple Riparian Forest Derived Native Grassland#	
DNG – 6: Yellow Box Woodland Derived Native Grassland	67
DNG – 7: White Box Woodland Derived Native Grassland	251
DNG – 8: Blakely's Redgum Woodland Derived Native Grassland	2
DNG – 9: Slaty Box Woodland Derived Native Grassland	16
DNG – 10: Coastal Grey Box Woodland Derived Native Grassland	12
Other (cleared, planted vegetation)	16
GRAND TOTAL+	**1,714**

Includes areas of Caley's Ironbark Forest (Unit 15) (see* ***Section 3.2.16**)*

^ Exposed Grey Gum / Stringybark Forest (Unit 21) and Sheltered Grey Gum / Stringybark Forest (Unit 22) are mapped concurrently

 # River Oak / Redgum Riparian Woodland Derived Native Grassland (Unit DNG – 3) and Blakely's Redgum / Apple Riparian Forest Derived Native Grassland (Unit DNG – 4) are mapped concurrently

+ In some cases totals may not equal the appropriate total number due to rounding

~ Area calculations are approximate

iii. Impacts to Cliff Line Habitat

MSEC (2015) identified 43 cliffs within the Subsidence Study Area of which 22 are located above the proposed longwall mining extent. Based on previous quantification of impacts at Ulan Colliery, it is expected that the percentage of cliffs above the longwalls that are likely to experience rock falls is of the order of 20% of the length of the cliffs, and visible mining subsidence movements is expected to occur in approximately 50% to 70% of the cliffs (MSEC, 2015). However, the potential for rock falls at locations beyond the longwall mining area is considered to be very low, though some cracking may be experienced to sites that are located within the Subsidence Study Area (MSEC, 2015).

As noted above, rock fall can result in impacts to vegetation below cliff lines. However; the loss of this vegetation is not considered to be significant, and may be temporary as vegetation is likely to regrow following such disturbance. Modification to cliff lines as a result of subsidence can result in the loss of existing roosting, sheltering and breeding habitat for a number of fauna species, particularly microbats.

iv. Impacts to Hydrological Regimes

Subsidence movements can result in the modification of hydrological regimes, such as through increased erosion or the removal of surface-waters by the diversion of water below ground. There is some potential for these impacts to occur as a result of the longwall mining within this Project and has been considered in further detail within the Subsidence Impact Assessment (MSEC, 2015), Surface Water Impact Assessment (WRM Water & Environment, 2015) and Groundwater Impact Assessment (AGE, 2015).

For the Project, the potential impacts to hydrological regimes resulting from subsidence include:

- Potential for increased levels of ponding, flooding and scouring within Dry Creek;
- Potential for changes in alignment of the drainage lines;
- Potential for cracking in the drainage line beds and fracturing of the bedrock; and
- Potential for drainage of any shallow perched groundwater occurring within the Dry Creek alluvium into the underlying fractured strata.

The Study Area is largely dry and the main vegetation within it is dry-land woodland and grassland, which are not dependent on streams or groundwater for their existence. For this reason, there is considered to be very limited potential for impacts from subsidence-triggered hydrological changes to impact most of the habitats of the Subsidence Study Area.

Aquatic habitats are limited to seasonal/ephemeral streams and drainage lines. A discussion of the potential hydrological impacts to such aquatic habitats is provided in ***Section 6.7***.

6.2.2 Alteration to Hydrological Regimes

'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' is identified as a KTP under the TSC Act. In addition to the impacts to hydrological regimes resulting from subsidence, the Project has the potential to result in other modifications to hydrological regimes.

Portions of the Bylong River and Lee Creek, including some associated drainage lines, occur between the Open Cut Mining Areas and Mining Infrastructure Area. However, the mine plan has been designed to remain outside of the 150 m boundary from the edge of the alluvium, and associated waterways, to ensure impacts are minimised as far as possible. Alteration of hydrological regimes has been considered in further detail within the Surface Water Impact Assessment (WRM Water & Environment, 2015) and Groundwater Impact Assessment (AGE, 2015).

The extraction of groundwater may also influence the baseflow within the waterways due to a significant interaction apparent between the surface water and groundwater in the alluvial system. Much of the habitat associated with these waterways has previously been impacted by agricultural land practices with severely or significantly impaired macro-invertebrate communities and exotic fish species present. Water flow is ephemeral and there are only limited occurrences of native aquatic vegetation that occur in areas where water persists for longer durations.

'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands' is recognised as a major factor contributing to the loss of biological diversity and ecological function in aquatic ecosystems, including floodplains (NSW Scientific Committee, 2002a). Potential impacts identified within the determination of this KTP that are relevant to the Project include:

- Riparian zone degradation through altered flow patterns;
- Increased habitat for invasive species; and
- Loss or disruption of ecological function.

The modification of hydrology necessary for habitat survival, such as surface water drainage patterns, can impact the retained habitats. Changes to the hydrological regime of waterways can affect the integrity, structure and composition of habitat and thus, have secondary impacts on the species that rely on them. Impacts to aquatic biodiversity are considered further within ***Section 6.7***.

6.2.3 Fragmentation

Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non-forest land (Primack, 1993; Fahrig, 2003; Lindenmayer and Fischer, 2006). Habitat fragmentation affects biodiversity by reducing the amount of available habitat for some species to occupy due to increased distances between habitat patches. Plants and other sessile organisms are usually directly removed, while mobile animals (especially birds and mammals) retreat into other remnant patches of habitat (Lindenmayer and Fischer, 2006). The displacement of mobile fauna can reduce the survivorship of species in the case where there are limited areas of sufficiently large habitat within dispersal distance to retreat to.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the area within the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. However, the Project predominantly requires clearing at the edge of treed habitat and will therefore encroach further into remaining core habitat rather than creating fragmented habitat patches. The encroaching into these areas will occur incrementally due to the staging of open cut mining.

6.2.4 Edge Effects

Edge effects are impacts that occur at the interface between natural habitats, especially forests and disturbed or developed land (Yahner, 1988). When an edge is created between woodland and a cleared area, changes to ecological processes within the vegetation can extend between 10 m and 100 m from the edge (Yahner, 1988). These include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species and therefore cause significant changes to the ecology of the patch (Lindenmayer and Fischer, 2006). These changes include; invasion by weeds, increase in feral animals, reduction in tree health, and barriers to dispersal or distribution (Yahner, 1988). Edge effects are typically more pronounced in small habitat fragments and they may extend throughout small patches, rendering them unsuitable for some species. In particular, small patches of woodland habitat may be unfavourable for species which require interior habitat.

The Project will result in edge effects where woodland is cleared within the Project Disturbance Boundary. Due to edge effects, the impacts of the Project will extend beyond the clearing limits into areas of adjacent woodland. It is primarily where edges are created between mining development and areas of existing woodland that impacts will occur to the ecological value of the woodland that remains. The edge created between agricultural land and mining development is not considered likely to significantly negatively affect the ecology within the Study Area, as this agricultural land does not provide significant habitat.

6.2.5 Wildlife Corridors

The Study Area falls within the corridor delineated by the Great Eastern Ranges Initiative. The corridor comprises a linked series of biodiversity hotspots interconnected by a wide diversity of native vegetation (OEH, 2011). However, the corridor is interspersed with cleared land. The removal of habitat within the Project Disturbance Boundary is not considered to have an impact on the function of this corridor in the locality of the Project. Additionally there are low numbers of records for threatened species that undertake regional movements.

The remaining habitat within the Study Area is connected to extensive areas of habitat within the locality, including Wollemi National Park and Goulburn River National Park. On a regional scale the Project will remove 229 ha of woody vegetated habitat within a larger tract of protected National Parks and State Forests covering more than 500,000 ha.

On a finer scale, the Project will reduce the extent of some local wildlife corridors within the Study Area. The reduction in the extent of these corridors will affect a range of fauna groups, particularly woodland birds and small mammals. The removal of fauna habitat within the Project Disturbance Boundary will impact these corridors in the short-medium term.

The existing cleared areas within the Study Area provide limited movement between remnant patches for some species. Isolated remnant patches of treed vegetation and scattered paddock trees provide stepping stone habitat across the valley floor. The Project will remove some of this stepping stone habitat and create larger gaps between remaining treed areas.

As the Project predominantly requires clearing at the edge of treed habitat, the potential of severing a wildlife corridor is reduced. The Project will result in the removal of some localised corridors within the treed areas, such as along drainage lines. However the removal of habitat within the Project Disturbance Boundary is not considered to significantly limit movement of species within the Study Area.

6.2.6 Construction and Operational Impacts

A number of indirect impacts relevant to the construction and operational phases of the Project have the potential to impact the ecological values of the Study Area, such as those relating to dust, noise, light and erosion. These impacts are most relevant to the construction and operation of the open cut component of the Project; however they are also relevant to the underground mining component. Open cut and surface facility construction is proposed to be undertaken over a two year period. The impacts from open cut mining are relevant in the medium term, as this component will be undertaken over an approximate eight year period. The impacts from the underground mining are relevant in the medium term, as this component will be undertaken over an approximate 19 year period.

A suite of mitigation measures are proposed to minimise the indirect impacts described below. These measures are discussed in **Chapter 7**.

i. Dust

Construction and mining activities have the ability to generate dust, which may impact on the ecology within the Study Area in a number of ways. Dust that settles can accumulate on leaf surfaces and reduce essential physiological processes including photosynthesis, respiration, and transpiration. It can also permit the penetration of phytotoxic gaseous pollutants into plants (Farmer, 1993).

Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. This can result in cumulative effects such as drought stress on already stressed species. This can result in decreased plant health, and even death in extreme circumstances. Decreased growth and vigour of plants may mean that they are more susceptible to pathogens and other disturbance, and these plants are more likely to be subject to increased mortality. Such impacts to individual plants generally result in decreased productivity and can result in changes in vegetation and community structure (Farmer, 1993).

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

Dust pollution can lead to a decrease in habitat quality which has the potential to extend the area of impact beyond the area directly disturbed by the Project. With regard to the remaining habitats within the Study Area, dust generated by the Project could impact vegetation within woodland communities, reducing health of some species along the edge of mined areas. It could also impact upon potential foraging resources for wildlife.

ii. Noise

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC, 2005).

Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise generated by the Project has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC, 2005).

The Project can generate significant noise during construction of infrastructure and through routine mining operations. Noise can be generated by large volumes of traffic, particularly large mining trucks, excavation machinery, explosions used during the mining phase, and generators and machinery used in the daily Project operation. Some fauna species are sensitive to elevated levels of noise in their environment and this has the potential to impact negatively on these species (AMEC, 2005)

The noise created by the construction and operation of the Project is likely to affect native species and affect the value of the habitats that remain. Some species are likely to move in response to noise, and therefore the habitat value of the woodlands remaining around the mining and infrastructure areas may decrease. This has the effect of increasing the amount of habitat for native species that will be removed as a result of the Project. However, it is likely that most animal species will habituate to the periodic noise disturbance (AMEC, 2005), and the construction and operational phases of the Project are likely to cause temporary disturbance only to fauna. Furthermore, the impacts from noise emissions are likely to be localised close to the active mining area and are not likely to have a significant, long-term, impact on wildlife populations.

iii. *Light*

The Project has the potential to increase the level of artificial light in the natural environment. 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).

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

- Changes in foraging behaviour;
- A disruption of seasonal day length cues which trigger critical behaviours (Longcore and Rich, 2004; Saleh, 2007; Longcore and Rich, 2010);
- Disorientation and/or temporary blindness; and
- Interference with predator-prey relationships.

While the construction and operational phases of the Project will have some effect on the surrounding woodland environment, the impacts from light pollution are likely to remain close to the disturbance associated with the infrastructure and open cut components, with only limited glare into the surrounding natural vegetation. Fauna species are known to occur in close proximity of open cut mines in the locality and wider region that have light pollution. It is likely that most fauna species would habituate to the periodic disturbance and light pollution from the Project is unlikely to have a significant or long-term impact on any fauna species.

iv. *Erosion*

The Project has the potential to increase the amount of erosion occurring within the Study Area through the construction of roads, tracks, and infrastructure. Water erosion of soil can be classified into four categories, being sheet, rill, gully, and tunnel erosion (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-surface layers that have a greater tendency to transport flowing water than does the surface layer.

The Project will result in the creation of roads and tracks throughout the Study Area, with an associated risk of increase in gully erosion. The effects of erosion can already be seen in places within the Study Area, particularly along drainage lines, mostly consisting of gully erosion. During wet periods large volumes of rain has the ability to wash away disturbed earth relatively easily, particularly if located on a slope. This may result in sedimentation and increased turbidity of streams and would therefore impact the aquatic environment.

There is an increased risk of sheet and rill erosion where large areas are cleared, particularly on the footslopes. Where there is no obvious existing channel for the water to follow, it will form rills or flow overland. A Water Management System has been designed for the Project to limit impacts resulting from erosion and sedimentation impacts. The surface water and flooding impact assessment prepared by WRM Water & Environment (2015) discusses the standard controls to be implemented for the Project.

6.2.7 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. Such species have potential to impact upon the original local native plant and animal species. Weeds such as thistles and other introduced plants have potential to out-compete regenerating native plant species. Feral animals such as foxes, rabbits and some species of birds can also breed in the more open areas following clearance of forest and woodland. They can cause problems for native fauna species by preying upon them or by competing with them for food and resources. These introduced predators have long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC, 2010). Feral pigs are also known to prey on frogs, reptiles, birds and small mammals (DEC (NSW), 2005b). The change to land use and tenure (i.e. from agriculture to mining) may lead to an increase in these feral species due to changes to land management practices, such as less regular suppression of exotic species. Feral animals within the Study Area are currently being managed in accordance with a Pest Management Program developed by KEPCO.

Some native fauna such as the Eastern Grey Kangaroo can become prolific on land utilised for mining developments as access by the public, including hunters, is denied. Overabundant native animals can cause overgrazing and other related problems. Aggressive birds such as the Noisy Miner would likely have a greater impact on smaller native birds as a result of increased edge effects and fragmentation of woodland habitat.

6.3 Impacts to Threatened Ecological Communities

Three TECs, namely Hunter Valley Footslopes Slaty Box Woodland, Hunter Floodplain Red Gum Woodland, and Box Gum Woodland and Derived Native Grassland, have been recorded within the Study Area. Only Hunter Valley Footslopes Slaty Box Woodland and Box Gum Woodland and Derived Native Grassland occur within the Project Disturbance Boundary.

Additional areas of Hunter Valley Footslopes Slaty Box Woodland and Box Gum Woodland and Derived Native Grassland occur above the Subsidence Study Area. The extent of these TECs within the Project Disturbance Boundary and above the Subsidence Study Area is indicated in **Table 6.6** and shown in **Figure 6.2** (TSC Act listed TECs) and **Figure 6.3** (EPBC Act listed TECs). A discussion of the potential impacts to these communities is provided below.

CUMBERLAND ECOLOGY

Table 6.6 Extent of TECs known from the Study Area occurring within the Project Disturbance Boundary and Subsidence Study Area

Vegetation Community	TSC Act			EPBC Act		
	Status	Project Disturbance Boundary (ha)~	Subsidence Study Area (ha)~	Status	Project Disturbance Boundary (ha)~	Subsidence Study Area (ha)~
Hunter Valley Footslopes Slaty Gum Woodland						
9: Slaty Box Woodland	VEC	11	124	-	-	-
Box Gum Woodland and Derived Native Grassland						
6(1)[A]: Yellow Box Woodland	EEC	8	112	CEEC	8	112
7a(1)[B]: White Box Woodland (Grassy)	EEC	53	407	CEEC	53	407
DNG – 6(1)[A]: Yellow Box Woodland Derived Native Grassland	EEC	6	5	CEEC	6	5
DNG – 6(2)[B]: Yellow Box Woodland Derived Native Grassland	EEC	8	62	-	-	-
DNG – 7(1)[A]: White Box Woodland Derived Native Grassland	EEC	68	146	CEEC	68	146
DNG – 7(2)[B]: White Box Woodland Derived Native Grassland	EEC	63	105	-	-	-
DNG – 8(1)[A]: Blakely's Red Gum Woodland Derived Native Grassland	EEC	-	2	CEEC	-	2
Subtotal Box Gum Woodland and Derived Native Grassland		*206*	*839*		*135*	*672*
TOTAL+		**217**	**964**		**135**	**672**

TSC Act / EPBC Act Status: VEC = Vulnerable Ecological Community, EEC = Endangered Ecological Community, CEEC = Critically Endangered Ecological Community

[A] *Sub-unit (1) represents Box Gum Woodland and Derived Native Grassland listed under both the TSC Act and EPBC Act*

[B] *Sub-unit (2) represents Box Gum Woodland and Derived Native Grassland listed only under the TSC Act*

[+] *In some cases totals may not equal the appropriate total number due to rounding*

[~] *Area calculations are approximate*

6.3.1 Hunter Valley Footslopes Slaty Gum Woodland

i. Significance

Hunter Valley Footslopes Slaty Gum Woodland is listed as a VEC as it is facing a high risk of extinction in NSW in the medium-term future (NSW Scientific Committee, 2010b). Slaty Gum Woodland is natural restricted in distribution, only occurring within the Sydney Basin Bioregion (OEH, 2012j). It mainly occurs on the southern side of the Hunter Valley from near Bulga to the Bylong and Goulburn River National Park area on colluvial soils on exposed footslopes associated with the interface between Triassic Narrabeen sandstones and Permian sediments (OEH, 2013f).

Within the Study Area it occupies approximately 1,144 ha. Studies within the wider region have indicated that this community occupies 11,857 ha within north-western Wollemi National Park and surrounds (OEH, 2012j) and a further 2,644 ha within the Central Hunter region (Peake, 2006). A significant proportion of the extant distribution of Hunter Valley Footslopes Slaty Gum Woodland occurs within conservation reserves (OEH, 2012j). It is known to be widespread across the northern perimeter of Wollemi National Park, immediately to the east of the Study Area (OEH, 2012j).

ii. Impacts

Of the communities recorded within the Study Area, Slaty Box Woodland (Unit 9) corresponds to this VEC and occupies approximately 1,144 ha. The Project will clear 11 ha of this community, representing a loss of 1 % within the Study Area. In addition to the direct removal of this community, 124 ha occurs above the Subsidence Study Area and has the potential to be impacted by subsidence effects. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this community.

As a result of the Project, there will be interfaces between the Project Disturbance Boundary and the remaining areas of Hunter Valley Footslopes Slaty Gum Woodland. The portions of this community occurring at this interface have the potential to be indirectly impact. Clearing of vegetation at this interface will increase edge effects on the retained portion of Hunter Valley Footslopes Slaty Gum Woodland and as a result, the community may be impacted by altered microclimates, weed invasion and soil erosion.

Avoidance and mitigation measures outlined within **Chapter 7** have sought to minimise impacts to Hunter Valley Footslopes Slaty Gum Woodland. However, the Project will still result in the clearance of 11 ha of this community within the Project Disturbance Boundary and potentially impact further areas as a result of subsidence effects. Given the extent of this community within the Study Area, locality and conservation reserves, the Project is not considered to result in a significant impact to the Hunter Valley Footslopes Slaty Gum Woodland community.

6.3.2 Hunter Floodplain Red Gum Woodland

i. Significance

Hunter Floodplain Red Gum Woodland is listed as a EEC as it is facing a high risk of extinction in NSW in the immediate future (NSW Scientific Committee, 2010a). This community generally occurs on floodplains and associated floodplain rises along the Hunter River and its tributaries (NSW Scientific Committee, 2010a). Within the Study Area it occupies approximately 39 ha. Studies within the wider region have indicated that this community occupies 436 ha within the Central Hunter region (Peake, 2006).

The position of this plant community within the landscape, the water requirement of the dominant trees within it, and the ephemeral nature of the streams it occurs along suggest that this community has some reliance upon shallow groundwater within alluvial aquifers.

ii. Impacts

Of the communities recorded within the Study Area, River Oak / Redgum Riparian Woodland (Unit 3) corresponds to this EEC and occupies 39 ha. No area of this community has been mapped as occurring within the Project Disturbance Boundary or above the Subsidence Study Area and so none will be directly impacted by the project.

Mapped areas of this community occur in proximity to the Project Disturbance Boundary and so there is some potential for indirect impacts to this community. The Project will reduce baseflow in Lee Creek and the Bylong River but does not have a measurable impact on flows in the Growee River, because it is more distant from the Project area (AGE, 2015). The Project may temporarily deplete shallow groundwater in some areas. However, on the valley floor where this community is located, groundwater levels respond rapidly to rainfall indicating recharge readily infiltrates the upper sequence of the aquifer, with the other primary recharge source being infiltration of surface water through the beds of rivers and creeks (AGE, 2015).

Avoidance and mitigation measures outlined within **Chapter 7** have sought to minimise impacts to Hunter Floodplain Red Gum Woodland. Given that no area of this community is proposed to be cleared and the expected recovery of the alluvial groundwater system following rainfall, the Project is not considered to result in a significant impact to Hunter Floodplain Red Gum Woodland.

6.3.3 Box Gum Woodland and Derived Native Grassland

i. Significance

Box Gum Woodland and Derived Native Grassland is listed as an EEC under the TSC Act as it is likely to become extinct in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee, 2002b). Box Gum Woodland and Derived Native Grassland is listed as a CEEC under the EPBC Act due to its very severe decline in geographic distribution and due to its integrity being very severely reduced across most of its geographic range (Threatened Species Scientific

Committee, 2006). It was once a geographically wide-spread community spanning three different states and covering an estimated pre-European area of several million hectares. Approximately 10% of its pre-European extent is estimated to remain today; the decline is primarily attributed to the community being situated largely on fertile, arable land in prime agricultural areas (DECCW (NSW), 2010). Although poorly represented in conservation reserves, Box Gum Woodland and Derived Native Grassland is known within the locality and wider region from Wollemi National Park, Goulburn River National Park and Manobalai Nature Reserve (NSW Scientific Committee, 2002b).

ii. Impacts

Portions of the following communities within the Project Disturbance Boundary and Subsidence Study Area conform to the TSC Act and/or EPBC Act listed Box Gum Woodland and Derived Native Grassland:

- Yellow Box Woodland (Unit 6);
- White Box Woodland (Grassy) (Unit 7a);
- Yellow Box Woodland Derived Native Grassland (DNG – 6);
- White Box Woodland Derived Native Grassland (DNG – 7); and
- Blakely's Redgum Woodland Derived Native Grassland (DNG – 8).

Table 6.6 shows the breakdown of each component of this community within the Project Disturbance Boundary and Subsidence Study Area. A total of 206 ha of this community will be removed within the Project Disturbance Boundary, all of which conforms to the TSC Act listing of the community (61 ha woodland form and 144 ha grassland form) and 135 ha of which conforms to the EPBC Act listing (61 ha woodland form and 74 ha grassland form).

As a result of the Project, there will be interfaces between the Project Disturbance Boundary and the remaining areas of Box Gum Woodland and Derived Native Grassland. The portions of this community occurring at this interface have the potential to be indirectly impacted. Clearing of vegetation at this interface will increase edge effects on the retained portion of Box Gum Woodland and Derived Native Grassland and as a result, the community may be impacted by altered microclimates, weed invasion and soil erosion.

In addition to the direct removal outlined above, 839 ha conforming to the TSC Act listing and 672 ha of the EPBC Act listing of this community occurs above the Subsidence Study Area and has the potential to be impacted by subsidence effects.

Avoidance and mitigation measures outlined within **Chapter 7** have sought to minimise impacts to Box Gum Woodland and Derived Native Grassland. However, the Project will still result in the clearance of 206 ha of the TSC Act listed form and 135 ha of the EPBC Act listed form of this community within the Project Disturbance Boundary and potentially impact further areas as a result of subsidence. In the absence of any mitigation or compensation measures, the Project is considered to result in a significant impact to Box Gum Woodland and Derived Native Grassland.

6.4 Impacts to Groundwater Dependent Ecosystems

No obvious GDEs were observed to occur within the Study Area (which included a consideration of hanging swamps with perched water tables). However, it is recognised that Bylong River and Lee Creek are characterised by shallow water tables that could have the potential to support GDEs (AGE, 2015). Such potential GDEs include vegetation communities containing *Eucalyptus camaldulensis* (River Red Gum) and *Casuarina cunninghamiana* (River Oak). As these species occur within floodplain areas they are therefore considered likely to have some root access to the alluvial groundwater.

Two communities within the Study Area fall into these categories, namely River Oak / Redgum Riparian Woodland (Unit 3) and Blakely's Redgum / Apple Riparian Forest (Unit 4).

No area of River Oak / Redgum Riparian Woodland occurs within the Project Disturbance Boundary. A total of approximately 5 ha Blakely's Redgum / Apple Riparian Forest will be removed within the Project Disturbance Boundary. Portions of this community within the Project Disturbance Boundary are of poor quality with high levels of weed infestation and degraded surrounding habitat. The clearing of portions of Blakely's Redgum / Apple Riparian Forest (Unit 4) within the Project Disturbance Boundary is not considered to result in a significant impact. Approximately 15 ha of Blakely's Redgum / Apple Riparian Forest occurs within the Subsidence Study Area.

The alteration to groundwater regime during the life of the Project has the potential to impact upon the remaining vegetation communities that have the potential to rely on groundwater. Alterations to the groundwater regime will result from groundwater extraction and depressurisation. It is proposed that groundwater, particularly from the alluvium, will be extracted during mining operations. Additionally, there is predicted to be a short period of time that the groundwater within the alluvium will not be available for use by vegetation due to the depressurisation resulting from mining. This has the potential to influence the baseflow within the waterways on and downstream of the Study Area, particularly due to the interaction between surface water and groundwater in the alluvial system. The Project will reduce baseflow in Lee Creek and the Bylong River but does not have a measurable impact on flows in the Growee River, because it is more distant from the Project area (AGE, 2015). Goulburn River is not predicted to be impacted within the current modelling (AGE, 2015).

Given that the watercourses within the Study Area are typically ephemeral, it is likely that communities considered as GDEs have a moderate but not a complete dependence, on groundwater. The portions of communities occurring along drainage lines above the valley floor are considered to have a lower dependence than those occurring on the valley floor. The remaining water balance for these communities would be made up of rainfall, surface water and water stored in the soil. On the valley floor, where these communities are located, groundwater levels respond rapidly to rainfall indicating recharge readily infiltrates the upper sequence of the aquifer, with the other primary recharge source being infiltration of surface water through the beds of rivers and creeks (AGE, 2015).

The rate of recharge within the Study Area is considered to mitigate the potential significant impacts from alteration of groundwater levels. However, monitoring of the GDE communities is proposed.

6.5 Impacts to Threatened Flora Species

A number of threatened flora species listed under the TSC Act and/or EPBC Act have been recorded within the Study Area. The potential impacts to the known species occurring within the Study Area and potentially occurring threatened flora species within potential habitat within the Project Disturbance Boundary is provided below. Impacts to each of these species have been considered within the Assessments of Significance for TSC Act species and EPBC Act species within **Appendix H** and **Appendix I**, respectively. In accordance with the *Threatened Species Assessment Guidelines* (DECC (NSW), 2007), no assessments of significance have been prepared where surveys or studies have been carried out and demonstrated that the species does not occur in the Study Area, will not use on-site habitats on occasion or will not be influenced by off-site impacts of the Project.

Several threatened species have the potential to occur within the Study Area, given the proximity of recent database records and the presence of suitable habitat for these species. However, many of the potentially occurring species would also occur outside of the Project Disturbance Boundary. As such, impacts to the following species have not been assessed in detail below: *Prostanthera cryptandroides* subsp. *cryptandroides* (Wollemi Mint-bush), *Commersonia rosea*, *Eucalyptus cannonii* (Capertee Stringybark), *Homoranthus darwinioides*, *Pomaderris sericea* (Silky Pomaderris) and *Philotheca ericifolia*. Areas of potential habitat for these species may occur at higher elevations within the Subsidence Study Area. These species are not considered to be influenced by the potential changes to habitat resulting from subsidence.

6.5.1 Tylophora linearis

Tylophora linearis is listed as Vulnerable under the TSC Act and Endangered under the EPBC Act. This species was recorded at four locations within the Study Area within Slaty Box Woodland on talus slopes. *Tylophora linearis* has the potential to occur in other areas of the Study Area within Slaty Box Woodland and eucalypt woodland, particularly those with a dense shrub layer.

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha of Slaty Box Woodland, within which this species has been recorded within the Study Area.

An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area, however the potential subsidence-related impacts within this area are not expected to significantly impact this species. Known habitat within similar vegetation occurs outside of the Study Area. Large areas of similar habitat occur in the locality outside of the Study Area that will not be affected by the Project.

No individuals of this species have been recorded within the Project Disturbance Boundary and the potential modification of habitat is not considered to result in a significant impact to this population. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Tylophora linearis,* and these are presented in **Chapter 7** and **Chapter 8**, respectively.

6.5.2 *Ozothamnus tesselatus*

Ozothamnus tesselatus is listed as Vulnerable under both the TSC Act. This species was recorded at multiple locations within the Study Area within Slaty Box Woodland and Blue-leaf Ironbark / Cypress Forest, typically on talus footslopes in habitat considered typical for this species.

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary; however approximately 15 individuals of the species have been recorded within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area.

Potential indirect impacts resulting from subsidence may also impact 124 ha of Slaty Box Woodland and 86 ha Blue-leaf Ironbark / Cypress Forest within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, locality and conservation reserves, the removal and possible modification of potential habitat is not considered to result in a significant impact to this species.

Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Ozothamnus tesselatus,* and these are presented in **Chapter 7** and **Chapter 8**, respectively.

6.5.3 *Acacia pendula*

The '*Acacia pendula* population in the Hunter catchment' is listed as an endangered population under the TSC Act. This species has been recorded at two locations within the Study Area. At one location it is planted and at the other location is considered likely that the plants have naturalised from past introductions.

The Project will remove one planted individual within the Project Disturbance Boundary.

Potential indirect impacts resulting from subsidence may also impact three naturalised individuals within the Subsidence Study Area. The potential changes to the habitat in which the individuals occur resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in the habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

Although under current legislation these four plants form part of the endangered '*Acacia pendula* population in the Hunter catchment', they are not considered to be natural components of the landscape within the Study Area. As such the removal of one of these individuals and the potential indirect impacts to the remaining individuals are not considered to result in a significant impact to the endangered population.

6.5.4 Eucalyptus camaldulensis

The *'Eucalyptus camaldulensis* population in the Hunter catchment' is listed as an endangered population under the TSC Act. This species was recorded at three broad locations within the Study Area within River Oak / Redgum Riparian Woodland and Blakely's Red Gum Woodland (Grassy), as well as isolated trees in cleared areas. *Eucalyptus camaldulensis* (River Red Gum) has been recorded along Bylong River, Cousins Creek and Lee Creek.

The position of this tree species within the landscape, the water requirement of the dominant trees within it, and the ephemeral nature of the streams it occurs along suggest that this community has some reliance upon shallow groundwater within perched alluvial aquifers.

No individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the Project Disturbance Boundary or Subsidence Study Area and it is unlikely that the species will be significantly directly impacted by clearing.

Groundwater exaction from the alluvium has the potential to influence the baseflow within the waterways on and downstream of the Study Area, particularly due to the interaction between surface water and groundwater in the alluvial system. Mapped areas of this species occur in proximity to the Project Disturbance Boundary and so there is some potential for indirect impacts to this species. The Project will reduce baseflow in Lee Creek and the Bylong River but does not have a measurable impact on flows in the Growee River because it is more distant from the Project area (AGE, 2015). The Project may temporarily deplete shallow groundwater in some areas. However, on the valley floor where this species is located, groundwater levels respond rapidly to rainfall indicating recharge readily infiltrates the upper sequence of the aquifer, with the other primary recharge source being infiltration of surface water through the beds of rivers and creeks (AGE, 2015).

Given that the watercourses within the Study Area are typically ephemeral and historically have been degraded due to surrounding land use and water extraction, it is likely that *Eucalyptus camaldulensis* (River Red Gum) trees have a moderate reliance, but not a complete dependence, on groundwater. As such, it is unlikely that the Project will have a significant impact on this endangered population as a result of alteration to groundwater levels.

No individuals of this species have been recorded within the Project Disturbance Boundary and the possible modification of potential habitat is not considered to result in a significant impact to this population. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the '*Eucalyptus camaldulensis* population in the Hunter catchment', and these are presented in **Chapter 7** and **Chapter 8**, respectively.

CUMBERLAND ECOLOGY

6.5.5 *Cymbidium canaliculatum*

The '*Cymbidium canaliculatum* population in the Hunter Catchment' is listed as an endangered population under the TSC Act. This species occurs at a number of locations within the Study Area within a number of communities including Yellow Box Woodland, Slaty Box Woodland and White Box Woodland (Grassy). Favoured hosts for the specimens recorded were *Angophora floribunda* (Rough-barked Apple), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus dawsonii* (Slaty Gum) and *Eucalyptus albens* (White Box).

No individuals of *Cymbidium canaliculatum* (Tiger Orchid) were recorded within the Project Disturbance Boundary and approximately 15 individuals were recorded within the Subsidence Study Area. Direct impacts to this species is the removal of potential habitat in the form of Yellow Box Woodland (8 ha), Slaty Box Woodland (11 ha) and White Box Woodland (Grassy) (55 ha), within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence effects may also impact these communities within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

No individuals of this species have been recorded within the Project Disturbance Boundary and the potential modification of habitat is not considered to result in a significant impact to this population. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the '*Cymbidium canaliculatum* population in the Hunter catchment', and these are presented in **Chapter 7** and **Chapter 8**, respectively.

6.5.6 *Diuris tricolor*

Diuris tricolor (Pine Donkey Orchid) is listed as Vulnerable under the TSC Act. This species was recorded at one location within the Study Area. A population of 37 individuals was recorded. The occurrence of this species within the Study Area is within cleared lands adjacent to the wooded footslopes where native grasses predominate.

No individuals of *Diuris tricolor* (Pine Donkey Orchid) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 525 ha of Derived Native Grasslands and 98 ha of grassy woodland. Potential indirect impacts resulting from subsidence may also impact these communities within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

No individuals of this species have been recorded within the Project Disturbance Boundary and the potential modification of habitat is not considered to result in a significant impact to this population. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Diuris tricolor* (Pine Donkey Orchid), and these are presented in **Chapter 7** and **Chapter 8**, respectively.

6.5.7 Pomaderris queenslandica

Pomaderris queenslandica (Scant Pomaderris) is listed as Endangered under the TSC Act. This species was recorded at two locations within the Study Area in Blakely's Red Gum / Apple Riparian Forest and Exposed/Sheltered Grey Gum / Stringybark Forest. The occurrence of this species coincided with sheltered locations associated with creek lines, which is similar known habitat elsewhere in the region (Bell, 2001). Potential habitat for this species also present in other areas of the Study Area in similar habitat.

No individuals of *Pomaderris queenslandica* (Scant Pomaderris) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The habitat available for this species occurs at higher elevations, with only a relatively small portion of habitat occurring within the Subsidence Study Area. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

No individuals of this species have been recorded within the Project Disturbance Boundary and the potential modification of habitat is not considered to result in a significant impact to this population. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Pomaderris queenslandica* (Scant Pomaderris), and these are presented in **Chapter 7** and **Chapter 8**, respectively.

6.5.8 Prostanthera discolor

Prostanthera discolor is listed as Vulnerable under the TSC Act and EPBC Act. This species was not recorded during surveys of the Study Area; however there is the potential for this species to occur. The woodland and forest communities within the Study Area contain suitable habitat for this species, particularly those in gullies and along creek lines.

No individuals of *Prostanthera discolor* were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest vegetation, particularly those occurring in gullies and along creek lines. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to *Prostanthera discolor*.

6.5.9 Thesium australe

Thesium australe (Austral Toadflax) is listed as Vulnerable under the TSC Act and EPBC Act. This species was not recorded during surveys of the Study Area. There is the potential for this species to occur within grassland and grassy woodlands.

The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat. The potential subsidence-related impacts within the Subsidence Study Area are not expected to significantly impact this species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to *Thesium australe* (Austral Toadflax).

6.6 Impacts to Threatened Fauna Species

A number of threatened fauna species listed under the TSC Act and/or EPBC Act have been recorded within the Study Area. Several additional threatened species have the potential to occur within the Study Area, given the proximity of recent database records and the presence of suitable habitat for these species. The potential impacts to the known and potentially occurring threatened fauna species is provided below. A summary of the area of habitat removed by the Project for each of these species is provided in ***Section 6.6.4***. Impacts to each of the known and potentially occurring fauna species have been considered within the Assessments of Significance for TSC Act species and EPBC Act species within **Appendix H** and **Appendix I**, respectively.

6.6.1 Birds

i. Blossom-dependent Birds

a. Regent Honeyeater (Anthochaera phrygia)

The Regent Honeyeater is listed as Critically Endangered under the TSC Act and Endangered under the EPBC Act. This species was recorded within Blakely's Red Gum / Apple Riparian Forest within the Study Area. However it is also expected that this species would forage across other woody vegetation, particularly those containing *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) and *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak).

The Regent Honeyeater will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging habitat will be removed, which is represented by woody vegetation. Of this area, approximately 169 ha comprises woody vegetation that is dominated or co-dominated by nectar producing trees identified within OEH (2014t) and DoE (2014a) profiles for the species and the recovery plan (Menkhorst *et al.*, 1999). Of this area, approximately 63 ha occurs within White Box Woodland (Grassy) and Yellow Box Woodland which are recognised as critical to the survival of the species (Menkhorst *et al.*, 1999). Removal of paddock trees would also pose a threat to this species. As the Study Area occurs outside of the known breeding areas of the Regent Honeyeater within NSW, the Project is not anticipated to impact breeding habitat for this species.

The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The flowering resources provided by White Box Woodland (Grassy) and Yellow Box Woodland within the Study Area are likely to be locally significant due to the past clearing of Box Gum Woodland on the valley floor in the locality. Drought periods and poor flowering seasons can increase the significance of remaining patches of intact woodland and forest..

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Regent Honeyeater. In the absence of appropriate mitigation measures and offset measures, the Regent Honeyeater is considered to be significantly impacted by the Project.

b. Black-chinned Honeyeater (eastern subspecies) (Melithreptus gularis gularis)

The Black-chinned Honeyeater is listed as Vulnerable under the TSC Act. This species was recorded within White Box Woodland (Grassy) and Slaty Box Woodland, however it is also expected that this species would forage and breed across other woody vegetation, particularly those containing *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus camaldulensis* (River Red Gum).

The Black-chinned Honeyeater will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging habitat will be removed, which is represented by woody vegetation. Of this area, approximately 139 ha occurs within communities dominated or co-dominated by *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) and *Eucalyptus blakelyi* (Blakely's Red Gum). No vegetation communities dominated by *Eucalyptus camaldulensis* (River Red Gum) occurs within the Project Disturbance Boundary. The Project will also remove breeding habitat which is present in the form of box and ironbark eucalypts.

Fragmentation of habitat is a recognised threat to the Black-chinned Honeyeater (NSW Scientific Committee, 2001a). The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Areas of known and potential habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Black-chinned Honeyeater.

c. Little Lorikeet (Glossopsitta pusilla)

The Little Lorikeet is listed as Vulnerable under the TSC Act. This species was recorded within numerous vegetation communities, including White Box Woodland (Grassy), Slaty Box Woodland and Caley's Ironbark Forest. It is expected to forage and breed across most woody vegetation, particularly those containing *Eucalyptus albens* (White Box) and *Eucalyptus melliodora* (Yellow Box).

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. Of this area, approximately 63 ha of occurs within White Box Woodland (Grassy) and Yellow Box Woodland which are recognised as important habitat for this species (NSW Scientific Committee, 2009a). The Project will also remove breeding habitat which is present in the form of very small hollows within smooth-barked trees. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of breeding sites and food resources from ongoing land clearing are recognised as major threats to the Little Lorikeet (NSW Scientific Committee, 2009a). The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Areas of known and potential habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Little Lorikeet.

d. Painted Honeyeater (Grantiella picta)

The Painted Honeyeater is listed as Vulnerable under the TSC Act. This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing mistletoes from the *Amyema* genus.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The removal of paddock trees with abundant mistletoe also has the potential to impact this species. The Project will also remove breeding habitat which is present in the form of drooping eucalypts, she-oak and mistletoe branches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The removal of large old trees and degradation of woodland and open forest remnants containing heavy mistletoe infestations is recognised as a threat to the Painted Honeyeater (OEH, 2012k). The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient known and potential habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Painted Honeyeater.

e. Swift Parrot (Lathamus discolor)

The Swift Parrot is listed as Endangered under both the TSC Act and EPBC Act. This species was not recorded during surveys; however there is the potential for this species to forage within the woody vegetation of the Study Area during autumn and winter, particularly those containing *Eucalyptus albens* (White Box).

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. Of this area, approximately 125 ha of occurs within communities dominated by *Eucalyptus albens* (White Box). As this species only breeds in Tasmania, no breeding habitat will be impacted by the Project. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Swift Parrot is particularly reliant on mass flowering events to fuel its migration to the next resource patch. Drought periods and poor flowering seasons can increase the significance of remaining patches of intact woodland and forest. The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. The available habitat within the Study Area is well connected to other habitat resources within the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Swift Parrot.

ii. Woodland Birds

a. Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot is listed as Vulnerable under the TSC Act. This species was recorded at a few locations within the Study Area, including within Blakely's Red Gum / Paperbark Forest, Caley's Ironbark Forest and Yellow Box Woodland. It is expected to forage and breed across most woody vegetation.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of tree hollows, logs and posts. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. Most movements of the Turquoise Parrot are local, with seasonal movements less than 10 km along treed corridors (NSW Scientific Committee, 2009c). The Project will not fragment treed corridors within the Study Area, with removal of potential habitat for this species predominantly occurring at the edge of treed land. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Turquoise Parrot.

b. Speckled Warbler (Chthonicola sagittata)

The Speckled Warbler is listed as Vulnerable under the TSC Act. This species was recorded at numerous locations within the Study Area within a suite of vegetation communities, including Caley's Ironbark Forest, White Box Woodland (Shrubby) and White Box Woodland (Grassy). It is expected to forage and breed across most woodland and forest communities.

Approximately 224 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by grassy woodland, shrubby woodland, shrubland and forest. The Project will also remove breeding habitat which is present in the form of grass tussocks, leaf litter and coarse woody debris.

Fragmentation is recognised as a threat to the Speckled Warbler with a reduction in woodland areas showing a decrease in abundance of the species (NSW Scientific

Committee, 2001c). 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). The fragmented patches of woodland proposed to be cleared occur on the valley floor and are <200 ha in size. The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Speckled Warbler.

c. Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)

The Brown Treecreeper is listed as Vulnerable under the TSC Act. This species was recorded within a suite of vegetation communities, including White Box Woodland (Grassy), Slaty Box Woodland, Yellow Box Woodland and Exposed/Sheltered Grey Gum / Stringybark Forest. It is expected to forage and breed across woody vegetation within the Study Area, favouring areas dominated by rough-barked species and where fallen logs are present.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of hollow-bearing trees.

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 100 m (Cooper *et al.*, 2002; Doerr *et al.*, 2011). The Project will result in some fragmentation between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Brown Treecreeper.

d. Hooded Robin (south-eastern form) (Melanodryas cucullata cucullata)

The Hooded Robin is listed as Vulnerable under the TSC Act. This species was recorded at a few locations within the Study Area including within White Box Woodland (Grassy), Coastal Grey Box Woodland and Yellow Box Woodland and adjoining Derived Native Grasslands. It is expected to forage and breed across other grassy woodland, derived native grassland and riparian woodland/forest vegetation, favouring ecotonal habitat where fallen logs are present and in proximity to water resources.

Approximately 628 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland and derived native grassland. The Project will also remove breeding habitat which is present in the form of woodland vegetation.

The Hooded Robin has a sedentary nature and limited capacity for dispersal, resulting in the species being susceptible to habitat fragmentation and genetic isolation; even in large remnant patches (Birds Australia, 2013). Once forced from a fragment they are unlikely to recolonise new habitat without assistance (Garnett and Crowley, 2011). The Project will result in some fragmentation between isolated patches of treed vegetation and derived native grassland. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Hooded Robin.

e. Grey-crowned Babbler (eastern subspecies) (Pomatostomus temporalis temporalis)

The Grey-crowned Babbler is listed as Vulnerable under the TSC Act. This species was recorded a number of locations within the Study Area within a suite of vegetation communities, including Caley’s Ironbark Forest, Blakely's Red Gum / Paperbark Forest and Fuzzy Box Woodland. It is expected to forage and breed across woody vegetation within the Study Area.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of woodland and forest vegetation.

Many woodland birds have limited capacity for dispersal and Grey-crowned Babblers were recorded in a recent study moving less than 900m (Blackmore *et al.*, 2011). The Project will result in some fragmentation between isolated patches of treed vegetation and scattered trees on the valley floor and the adjacent intact vegetation on the footslopes. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Grey-crowned Babbler.

f. Diamond Firetail (Stagonopleura guttata)

The Diamond Firetail is listed as Vulnerable under the TSC Act. This species was recorded at a number of locations within the Study Area, including within White Box Woodland (Grassy), Slaty Box Woodland and Yellow Box Woodland and adjoining Derived Native Grasslands. It is expected to forage and breed across other woodland, shrubland and derived native grassland vegetation, favouring ecotonal habitat.

Approximately 749 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland, shrubland and derived native grassland. The Project will also remove breeding habitat which is present in the form of woodland vegetation.

The Diamond Firetail is vulnerable to fragmentation and genetic isolation due to its sedentary nature and dispersal capacity is restricted to local movements. Populations appear unable to persist in areas which lack remnant native vegetation larger than 200 ha (NSW Scientific Committee, 2001b). The fragmented patches of woodland proposed to be cleared occur on the valley floor and are <200 ha in size. The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Diamond Firetail.

g. Varied Sittella (Daphoenositta chrysoptera)

The Varied Sittella is listed as Vulnerable under the TSC Act. This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing rough-barked species.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of woodland and forest. Removal of paddock trees is also an identified threat to this species (OEH, 2012r).

The sedentary nature of the Varied Sittella makes cleared land a potential barrier to movement (OEH, 2012r). The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Varied Sittella.

h. Scarlet Robin (Petroica boodang)

The Scarlet Robin is listed as Vulnerable under the TSC Act. This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing abundant logs and fallen timber. This species is expected to occur within the Study Area as a vagrant.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat within these areas.

Isolation of patches of habitat has been identified as a threat to this species, particularly where these patches are smaller than 30 ha, and in landscapes where clearing has been heavy or where remnants are surrounded by cropping or stock grazing (OEH, 2013i). Isolated patches of vegetation to be removed by the Project are <30 ha in size. The Project will result in some fragmentation between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Scarlet Robin.

i. Flame Robin (Petroica phoenicea)

The Flame Robin is listed as Vulnerable under the TSC Act. This species was not recorded during surveys, however there is the potential for this species to both forage and breed within the woody vegetation of the Study Area, particularly areas containing perching material. This species is expected to occur within the Study Area as a vagrant.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat within these areas. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. This species is expected to occur within the Study Area as a vagrant. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Flame Robin.

iii. Cockatoos

a. Glossy Black-cockatoo (Calyptorhynchus lathami)

The Glossy Black-cockatoo is listed as Vulnerable under the TSC Act. This species was recorded in one general area within the Study Area within Slaty Box Woodland and Shrubby Regrowth. It is expected that this species would forage across other stands of *Allocasuarinas* within forest, shrubby woodland and shrubland vegetation in the Study Area.

Approximately 130 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, shrubby woodland, shrubland and forest. The Project will also remove breeding habitat which is present in the form of large hollow-bearing trees.

The Glossy Black-cockatoo is highly mobile and able to disperse widely, even up to 60km (NSW Scientific Commitee, 2008a). Habitat fragmentation has the potential to lead to a reduction the range of individuals as it becomes energetically inefficient to travel long distances between feeding patches (NSW Scientific Commitee, 2008a). The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Glossy Black-cockatoo.

b. Gang-gang Cockatoo (Callocephalon fimbriatum)

The Gang-gang Cockatoo is listed as Vulnerable under the TSC Act. This species was recorded at two locations within the Study Area within Yellow Box Woodland and Cypress Pine Forest and is expected to forage across woody vegetation within the Study Area, particularly during winter.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Gang-gang Cockatoo is highly mobile (a partial or altitudinal migrant), but habitat fragmentation possibly inhibits dispersal and foraging efficiency (NSW Scientific Committee, 2008a). The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Gang-gang Cockatoo.

iv. Raptors

a. Spotted Harrier (Circus assimilis)

The Spotted Harrier is listed as Vulnerable under the TSC Act. The species was recorded at a number of locations within the Study Area, typically within Derived Native Grasslands. It is expected that this species would forage across a range of habitats within the Study Area.

Approximately 1,014 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland, derived native grassland and cultivated land. The Project will also remove breeding habitat which is present in the form of woodland vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light. The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Spotted Harrier.

b. Little Eagle (Hieraaetus morphnoides)

The Little Eagle is listed as Vulnerable under the TSC Act. The species was recorded at one location within the Study Area within Derived Native Grasslands. It is expected that this species would forage across a range of habitats within the Study Area.

Approximately 1,096 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland, derived native grassland and cultivated land. The Project will also remove breeding habitat which is present in the form of woodland and forest vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of habitat. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Little Eagle.

c. Square-tailed Kite (Lophoictinia isura)

The Square-tailed Kite is listed as Vulnerable under the TSC Act. This species was not recorded during surveys; however there is the potential for this species to both forage and breed within a range of habitats within the Study Area.

Approximately 1,096 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland, derived native grassland and cultivated land. The Project will also remove breeding habitat which is present in the form of remnant woodland and forest vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Square-tailed Kite is highly mobile and dispersive and it is inferred not to be susceptible to population fragmentation (NSW Scientific Committee, 2009b). The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Square-tailed Kite.

d. Barking Owl (Ninox connivens)

The Barking Owl is listed as Vulnerable under the TSC Act. This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area. The woody vegetation within the Study Area is expected to provide both foraging and breeding habitat for this species.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of hollow-bearing trees within remnant woodland and forest vegetation in proximity to watercourses. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. Some individuals may be tolerant to some disturbance in their habitat as shown by their occurrence in fragments of woodland or forest in agricultural landscapes (NSW NPWS, 2003). This species is highly mobile and are known to forage within 2000 ha ranges (OEH, 2014c). The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Barking Owl.

e. Powerful Owl (Ninox strenua)

The Powerful Owl is listed as Vulnerable under the TSC Act. This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area. The woody vegetation within the Study Area is expected to provide both foraging and breeding habitat for this species.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of large hollow-bearing trees within remnant woodland and forest vegetation in proximity to drainage lines. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The home range for the Powerful Owl has been estimated as 300-1,500 ha according to habitat productivity and the species is known to disperse through a mosaic of forest and cleared land (DEC (NSW), 2006). The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Powerful Owl.

f. Masked Owl (Tyto novaehollandiae)

The Masked Owl is listed as Vulnerable under the TSC Act. This species was not recorded during surveys, however there is the potential for this species to both forage and breed within woody vegetation of the Study Area.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. The Project will also remove breeding habitat which is present in the form of large hollow-bearing trees within remnant woodland and forest vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The home range for the Masked Owl has been estimated at between 400 ha and 1,000 ha according to habitat productivity and the species is known to disperse through a mosaic of forest and cleared land (DEC (NSW), 2006). The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Masked Owl.

v. Migratory Species

a. Rainbow Bee-eater (Merops ornatus)

The Rainbow Bee-eater is listed as a migratory species under the EPBC Act. This species was recorded at a few locations within the Study Area within Slaty Box Woodland and White Box Woodland (Grassy) and adjoining Derived Native Grasslands. It is expected that this species would forage across these vegetation communities and a range of habitats within the Study Area.

Approximately 753 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland, shrubland, forest and derived native grassland. Nesting habitat is present in the form of incised drainage lines, dam banks and cliff faces. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Rainbow Bee-eater.

b. White-throated Needletail (Hirundapus caudacutus)

The White-throated Needletail is listed as a migratory species under the EPBC Act. This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area. This species is expected to forage aerially above the Study Area.

Approximately 1,139 ha of habitat which this species would forage above will be removed within the Project Disturbance Boundary, which is represented by all vegetation communities. No breeding habitat will be impacted, as this species breeds in Asia (DoE, 2014j). Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of habitat will result in a net decrease in the amount of suitable habitat within the Study Area above which this species would forage. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the White-throated Needletail.

c. White-bellied Sea-eagle (Haliaeetus leucogaster)

The White-bellied Sea-eagle is listed as a migratory species under the EPBC Act. This species was not recorded during surveys, however there is the potential for this species to utilise the woodland vegetation within the Study Area.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation, particularly in proximity to water. Some potential breeding habitat is also present in tall woodland in proximity to water. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. This species is expected to utilise the Study Area as part of a much larger foraging range, surrounding Goulburn River. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the White-bellied Sea-eagle.

d. Fork-tailed Swift (Apus pacificus)

The Fork-tailed Swift is listed as a migratory species under the EPBC Act. This species was not recorded during surveys; however this species is expected to forage aerially above the Study Area.

Approximately 1,139 ha of habitat which this species would forage above will be removed within the Project Disturbance Boundary, which is represented by all vegetation communities. No breeding habitat will be impacted, as this species breeds in Asia (DoE, 2014c). Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of habitat will result in a net decrease in the amount of suitable habitat within the Study Area above which this species would forage. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Fork-tailed Swift.

e. Cattle Egret (Ardea ibis)

The Cattle Egret is listed as a migratory species under the EPBC Act. This species was not recorded during surveys; however this species has the potential to forage within the Study Area.

Approximately 910 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by derived native grassland and cultivated land on the valley floor. As the Study Area occurs outside of the known breeding areas of the Cattle Egret within NSW, the Project is not anticipated to impact breeding habitat for this species. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable forage habitat occurs extensively in the locality and wider region within agricultural areas.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Cattle Egret.

f. Eastern Great Egret (Ardea modesta)

The Eastern Great Egret is listed as a migratory species under the EPBC Act. This species was not recorded during surveys; however this species has the potential to forage within the Study Area.

Approximately 910 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by derived native grassland and cultivated land on the valley floor. No suitable breeding habitat occurs within the Study Area. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light. The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable forage habitat occurs extensively in the locality and wider region within agricultural areas.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Eastern Great Egret.

g. Satin Flycatcher

The Satin Flycatcher is listed as a migratory species under the EPBC Act. This species was not recorded during surveys, however this species has the potential to forage and breed within the Study Area within woody vegetation in proximity to gullies.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. Limited areas of breeding habitat occur within the Project Disturbance Boundary. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable foraging and breeding habitat occurs extensively in the locality and wider region.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Satin Flycatcher.

h. Rufous Fantail

The Rufous Fantail is listed as a migratory species under the EPBC Act. This species was not recorded during surveys; however this species has the potential to forage within the Study Area.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. This species is not expected to breed within the Project Disturbance Boundary. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable foraging and breeding habitat occurs extensively in the locality and wider region.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Rufous Fantail.

6.6.2 Mammals

i. Terrestrial Mammals

a. Spotted-tailed Quoll (Dasyurus maculatus)

The Spotted-tailed Quoll is listed as Vulnerable under the TSC Act and Endangered under the EPBC Act. This species was not recorded during surveys; however, the Atlas of NSW Wildlife holds one record of this species within the Study Area. This species is expected to utilise woody vegetation within the Study Area.

Approximately 229 ha of suitable foraging habitat will be removed within the Project Disturbance Boundary, which is represented by woody vegetation. Additional areas of habitat have the potential to be indirectly impacted through subsidence effects. Habitat features removed or indirectly impacted by the Project include hollow-bearing trees, fallen logs, small caves, rock crevices and cliff faces. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

Fragmentation of habitat is considered a threat to this species (OEH, 2012o). The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Spotted-tailed Quoll.

b. New Holland Mouse (Pseudomys novaehollandiae)

The New Holland Mouse is listed as Vulnerable under the EPBC Act. This species was recorded at one location within the Study Area within White Box Woodland (Grassy), immediately adjacent to White Box Woodland (Shrubby). It is expected that this species would forage across small home ranges within vegetation with a shrubby understorey.

The New Holland Mouse will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 125 ha of suitable habitat will be removed, which is represented by shrubby woodland, shrubland and forest. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The record of this species within the Study Area represents an extension to west of known records of this species in the vicinity of Wollemi National Park. Notwithstanding, the habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the New Holland Mouse.

c. Brush-tailed Rock-wallaby (Petrogale penicillata)

The Brush-tailed Rock-wallaby is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. This species was recorded at one location within Slaty Box Woodland and in close proximity to cliff line habitat in the southern portion of the Study Area and south of the Project Disturbance Boundary. It is expected that this species would occur in similar habitat in other portions of the Study Area in areas that have little disturbance and fewer predators.

Approximately 125 ha of suitable habitat will be removed within the Project Disturbance Boundary, which is represented by shrubby woodland, shrubland and forest. Less than 1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. Additional areas of habitat have the potential to be indirectly impacted through subsidence. Limited areas of the Project Disturbance Boundary have a north facing aspect, which is known to be important for breeding (DoE, 2014p). Subsidence has the potential to impact this species through modification of rocky habitat resulting from a reduction in the stability of features such as caves and overhangs. However, this species was not recorded during surveys within the Subsidence Study Area and the Atlas of NSW Wildlife holds no records of this species in the immediate vicinity. Construction and operational impacts, such as increased noise and light, also have the potential to impact this species.

The habitat occurring within the Project Disturbance Boundary represents poorer quality habitat available within the wider Study Area and locality. Much the area to be cleared or indirectly impacted contain a suite of feral fauna species. Notwithstanding, the loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Brush-tailed Rock-wallaby.

ii. Arboreal Mammals

a. Koala (Phascolarctos cinereus)

The Koala is listed as Vulnerable under both the TSC Act and EPBC Act. This species was not recorded during surveys; however there is the potential for transient individuals to occur within the Study Area, utilising woodland and forest communities.

The Koala will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable habitat will be removed, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland, shrubland and forest. Approximately 125 ha of vegetation is dominated by the SEPP 44 feed tree *Eucalyptus albens* (White Box). Extensive areas of the Study Area contain this species, outside of the Project Disturbance Boundary. Two additional SEPP 44 feed trees, namely *Eucalyptus punctata* (Grey Gum) and *Eucalyptus camaldulensis* (River Red Gum) are also known to occur within the Study Area. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. There are few recent records of the Koala within the locality of the Study Area and as such, this species is not expected to rely upon the available habitat within this area. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Koala.

b. Squirrel Glider (Petaurus norfolcensis)

The Squirrel Glider is listed as Vulnerable under the TSC Act. This species was not recorded during surveys; however there is the potential habitat for this species within woodland and forest communities.

The Squirrel Glider will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 189 ha of suitable habitat will be removed, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland and forest. The Project will also remove hollow-bearing trees. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. The available habitat within the Study Area is well connected to other habitat resources within the locality. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Squirrel Glider.

iii. Grey-headed Flying-fox (Pteropus poliocephalus)

The Grey-headed Flying-fox is listed as Vulnerable under the TSC Act and EPBC Act. This species was not recorded during surveys; however there is the potential for this species to occasionally forage within the Study Area within woody vegetation.

The Grey-headed Flying-fox will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable habitat will be removed, which is represented by woody vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light. The Grey-headed Flying-fox is recognised as a species affected by subsidence resulting from longwall mining (NSW Scientific Committee, 2005a).

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Grey-headed Flying-fox is a highly mobile species. However, this distribution of records of this species indicates that it is not reliant on the foraging resources present in the locality of the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable forage habitat occurs extensively in the locality and wider region.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Grey-headed Flying-fox.

iv. Cave-dependent Bats

a. Large-eared Pied Bat (Chalinolobus dwyeri)

The Large-eared Pied Bat is listed as Vulnerable under the TSC Act and EPBC Act. This species was recorded numerous times during surveys within the Study Area, through both ultrasonic detection and harp trapping. This species was recorded within the Study Area within vegetation communities in proximity to cliff line habitat, including Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). Additionally, habitat assessments identified suitable habitat for the species within woody vegetation in the Study Area, and suitable roosting habitat within cliff lines.

The Large-eared Pied Bat will be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of foraging habitat will be removed, which is represented by woody vegetation. No cliff lines have been identified to occur within the Project Disturbance Boundary. A total of 100 ha of woody vegetation occur within 500 m of identified cliff lines within the Project Disturbance Boundary. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats, modify cave structures and has the potential to impact on maternity roosting habitat, if present. Further temporary impacts will occur to roosting habitat through constructional and operational impacts, such as increased noise and light.

An important population of the species is considered to occur within the Study Area as a result of the high density of records in nearby Wollemi National Park, where extensive areas of habitat occurs. However, the loss and modification of woody vegetation will result in a reduction in a small amount of available foraging habitat for the species within the locality. Additionally, potential rock fall as a result of subsidence may create new habitat niches for the species. Extensive areas of suitable habitat for the species occur within the broader locality, including both foraging and roosting habitat.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Large-eared Pied Bat.

b. Eastern Bentwing-bat (Miniopterus schreibersii oceanensis)

The Eastern Bentwing-bat is listed as Vulnerable under the TSC Act, and is not listed under the EPBC Act. The Eastern Bentwing-bat was recorded seven times during the survey period through ultrasonic call detection. This species was recorded within the Study Area within vegetation communities in proximity to cliff line habitat, including Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). Additionally, habitat assessments identified suitable foraging habitat for the species within the woody vegetation of the Study Area, and suitable roosting habitat within cliff lines.

The Eastern Bentwing-bat will be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of foraging habitat will be removed within these areas, which are represented by woody vegetation. No cliff lines have been identified to occur within the Project Disturbance Boundary. A total of 100 ha of woody vegetation occur within 500 m of identified cliff lines within the Project Disturbance Boundary. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats, modify cave structures and has the potential to impact on maternity roosting habitat, if present. Additional impacts will occur to roosting habitat through constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Eastern Bentwing-bat is a highly mobile species (flying up to 65 km in one night), and utilises numerous roosts within its range. Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality. Additionally, potential rock fall as a result of subsidence may create new habitat niches for the species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Eastern Bentwing-bat.

c. Little Bentwing-bat (Miniopterus australis)

The Little Bentwing-bat is listed as Vulnerable under the TSC Act, and is not listed under the EPBC Act. The Little Bentwing-bat was not recorded during surveys but is known from two records in the locality, to the west of the Study Area. Habitat assessments identified suitable foraging habitat for the species within the woody vegetation of the Study Area, and suitable roosting habitat within cliff lines.

The Little Bentwing-bat will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of foraging habitat will be removed within these areas, which are represented by woody vegetation. No areas of identified cliff lines occur within the Project Disturbance Boundary. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats and will modify cave structures, potentially making them unsuitable for roosting. Additional impacts will occur to roosting habitat through constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality. Additionally, potential rock fall as a result of subsidence may create new habitat niches for the species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Little Bentwing-bat.

d. Eastern Cave Bat (Vespadelus troughtoni)

The Eastern Cave Bat is listed as Vulnerable under the TSC Act, and is not listed under the EPBC Act. The Eastern Cave Bat was not recorded during surveys but is known from eleven records in the locality, immediately to the west of the Study Area. Habitat assessments identified suitable foraging habitat for the species within the woody vegetation of the Study Area, and suitable roosting habitat within cliff lines.

The Eastern Cave Bat will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of foraging habitat will be removed within these areas, which are represented by woody vegetation. No areas of identified cliff lines occur within the Project Disturbance Boundary. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats and will modify cave structures, potentially making them unsuitable for roosting. Additional impacts will occur to roosting habitat through constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The species is highly mobile and utilises numerous roost sites within its range, typically within 1.5 km of each other (Van Dyck and Strahan, 2008). Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality. Additionally, potential rock fall as a result of subsidence may create new habitat niches for the species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Eastern Cave Bat.

v. Hollow-dependent Bats

a. Corben's Long-eared Bat (Nyctophilus corbeni)

The Corben's Long-eared Bat is listed as Vulnerable under both the TSC Act the EPBC Act. The Corben's Long-eared Bat was not recorded during surveys but is known from two records in the locality, immediately to the west and north of the Study Area. Habitat assessments identified suitable foraging and roosting habitat for the species within the woody vegetation of the Study Area.

The Corben's Long-eared Bat will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging and roosting habitat will be removed, which is represented by woody vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The species is localised and has a small home range, typically foraging within a few kilometres of roost sites (Turbill and Ellis, 2006). Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Corben's Long-eared Bat.

b. Yellow-bellied Sheathtail-bat (Saccolaimus flaviventris)

The Yellow-bellied Sheathtail-bat is listed as Vulnerable under the TSC Act. The Yellow-bellied Sheathtail-bat was recorded four times within the Study Area through ultrasonic detection, and has been recorded three times in the locality, outside of the Study Area. Within the Study Area this species was recorded within Red Ironbark / Cypress Forest, Slaty Box Woodland, White Box Woodland (Shrubby) and White Box Woodland (Grassy). Habitat assessments identified suitable foraging and roosting habitat for the species within the woody vegetation of the Study Area.

The Yellow-bellied Sheathtail-bat will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging and roosting habitat will be removed, which is represented by woody vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The species forages above canopies and in open grassland, and roosts in tree hollow (Van Dyck and Strahan, 2008).

Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Yellow-bellied Sheathtail-bat.

c. Eastern False Pipistrelle (Falsistrellus tasmaniensis)

The Eastern False Pipistrelle is listed as Vulnerable under the TSC Act. The Eastern False Pipistrelle has not been recorded within the Study Area, but has been recorded twice within the locality. Habitat assessments identified suitable foraging and roosting habitat for the species within the woody vegetation of the Study Area.

The Eastern False Pipistrelle will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging and roosting habitat will be removed, which is represented by woody vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The species forages immediately below canopies and along fire trails, and is rarely detected in lower fertility ridgetop vegetation. The species roosts in tree hollow and show significant gender biased segregation (Van Dyck and Strahan, 2008). Suitable habitat for the species occurs throughout the locality within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Eastern False Pipistrelle.

d. Greater Broad-nosed Bat (Scoteanax rueppellii)

The Greater Broad-nosed Bat is listed as Vulnerable under the TSC Act. The Greater Broad-nosed Bat has not been recorded within the Study Area, but has been recorded ten times within the locality, predominantly in lands to the west of the Study Area. Habitat assessments identified suitable foraging and roosting habitat for the species within the woody vegetation of the Study Area.

The Greater Broad-nosed Bat will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 229 ha of suitable foraging and roosting habitat will be removed within these areas, which are represented by woody vegetation. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging and roosting habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. Suitable habitat for the species occurs throughout the locality, and within connected conservation reserves, thus the species is considered likely to persist within the Study Area and the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Greater Broad-nosed Bat.

6.6.3 Reptiles

i. Broad-headed Snake (Hoplocephalus bungaroides)

The Broad-headed Snake is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. This species was not recorded during surveys of the Study Area, however there is the potential for this species to forage and breed within the Study Area in proximity to cliff lines and associated habitat features.

Approximately 125 ha of suitable habitat will be removed within the Project Disturbance Boundary, which is represented by shrubby woodland, shrubland and forest. This includes summer habitat comprising large hollow-bearing trees adjacent to sandstone escarpments. No cliff lines have been identified within the Project Disturbance Boundary. Additional areas of habitat have the potential to be indirectly impacted through subsidence. The Broad-headed Snake is recognised as a species affected by subsidence resulting from longwall mining (NSW Scientific Committee, 2005a). Subsidence has the potential to impact this species through modification of rocky habitat resulting from a reduction in the stability of features such as caves and overhangs. Construction and operational impacts, such as increased noise and light, also have the potential to impact this species.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Project is not considered to significantly fragment habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. The Study Area occurs to the north of the current known distribution of this species. Sufficient habitat will be retained within the Study Area and additional suitable habitat occurs extensively in the locality and wider region. Additionally, potential rock fall as a result of subsidence may create new habitat niches for the species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Broad-headed Snake.

ii. Pink-tailed Legless Lizard (Aprasia parapulchella)

The Pink-tailed Legless Lizard is listed as Vulnerable under the TSC Act and EPBC Act. This species was not recorded during surveys; however there is the potential habitat for this species within the Study Area.

The Pink-tailed Legless Lizard will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 710 ha of suitable habitat will be removed, which is represented by riparian woodland/forest, grassy woodland, shrubby woodland and derived native grassland. This species is not expected to be impacted indirectly through subsidence.

The loss of foraging and breeding habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and additional suitable forage habitat occurs extensively in the locality and wider region.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to the Pink-tailed Legless Lizard.

iii. Rosenberg's Goanna (Varanus rosenbergi)

Rosenberg's Goanna is listed as Vulnerable under the TSC Act. This species was not recorded during surveys; however there is the potential habitat for this species within the Study Area.

Rosenberg's Goanna will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. Approximately 125 ha of suitable foraging habitat will be removed, which is represented by, shrubby woodland, shrubland and forest. Additional areas of habitat have the potential to be indirectly impacted through subsidence. Rosenberg's Goanna is recognised as a species affected by subsidence resulting from longwall mining (NSW Scientific Committee, 2005a). The Project will also remove shelter habitat which is present in the form of hollow logs and rock crevices. Termite mounds, which are critical to the species, were not commonly observed within the Project Disturbance Boundary, therefore the Project is not considered to remove important breeding habitat for this species.

The Project is not considered to significantly fragment foraging habitat for this species as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches. Remaining habitat may potentially be impacted indirectly through modification of habitat from subsidence effects, as well as through impacts from constructional and operational impacts, such as increased noise and light.

The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The habitat to be removed within the Project

Disturbance Boundary is not considered important for the long-term survival of the species within the locality. The Study Area occurs to the north of the current known distribution of this species. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. A number of these measures are relevant to Rosenberg's Goanna.

6.6.4 Summary

A summary of the potential direct impacts to these species as a result of the Project is provided in **Table 6.7**. This table also show the extent of habitat within the Subsidence Study Area.

Table 6.7 Summary of impacts areas for threatened fauna species

Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Occurrence within Study Area	Preferred Habitat within Study Area^	Total Area in Study Area (ha)	Area Cleared within the Project Disturbance Boundary (ha)	Area within the Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Birds									
Regent Honeyeater	CE	E	15	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Black-chinned Honeyeater (eastern subspecies)	V		28	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Little Lorikeet	V		48	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Painted Honeyeater	V		3	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Swift Parrot	E	E	1	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Turquoise Parrot	V		29	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Speckled Warbler	V		51	Known	3,4,5,6	4,986	224	1,317	3,445
Brown Treecreeper (eastern subspecies)	V		79	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Hooded Robin (south-eastern form)	V		15	Known	2,3,7	4,255	628	902	2,725
Grey-crowned Babbler (eastern subspecies)	V		5	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Diamond Firetail	V		38	Known	2,3,4,5,7	6,131	749	1,078	4,304
Varied Sittella	V		24	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Scarlet Robin	V		6	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631

Table 6.7 Summary of impacts areas for threatened fauna species

Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Occurrence within Study Area	Preferred Habitat within Study Area^	Total Area in Study Area (ha)	Area Cleared within the Project Disturbance Boundary (ha)	Area within the Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Flame Robin	V		2	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Glossy Black-Cockatoo	V		35	Known	2,4,5,6	4,151	130	824	3,196
Gang-gang Cockatoo	V		26	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Spotted Harrier	V		1	Known	2,3,7,8	6,280	1,014	902	4,363
Little Eagle	V		2	Known	2,3,4,7,8	7,948	1,096	1,076	5,776
Square-tailed Kite	V		2	Potential	2,3,4,7,8	7,948	1,096	1,076	5,776
Barking Owl	V		1	Known*	1,2,3,4,5,6	5,207	229	1,347	3,631
Powerful Owl	V		1	Known*	1,2,3,4,5,6	5,207	229	1,347	3,631
Masked Owl	V		2	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Rainbow Bee-eater		M	10	Known	1,2,3,4,5,6,7	8,198	753	1,698	5,747
White-throated Needletail		M	11	Known*	1,2,3,4,5,6,7,8	10,222	1,139	1,698	7,385
White-bellied Sea-eagle		M	1	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Fork-tailed Swift		M	2	Potential	1,2,3,4,5,6,7,8	10,222	1,139	1,698	7,385
Cattle Egret		M	0	Potential	7,8	5,016	910	351	3,754
Eastern Great Egret		M	1	Potential	7,8	5,016	910	351	3,754
Satin Flycatcher		M	1	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Rufous Fantail		M	1	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631

Table 6.7 Summary of impacts areas for threatened fauna species

Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Occurrence within Study Area	Preferred Habitat within Study Area^	Total Area in Study Area (ha)	Area Cleared within the Project Disturbance Boundary (ha)	Area within the Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Mammals									
Spotted-tailed Quoll	V	E	3	Known*	1,2,3,4,5,6	5,207	229	1,347	3,631
New Holland Mouse		V	0	Known	4,5,6	3,936	125	795	3,016
Brush-tailed Rock-wallaby	E	V	34	Known	1,4,5,6	3,943	125	795	3,022
Koala	V	V	2	Potential	2,3,4,5,6	5,200	229	1,347	3,625
Squirrel Glider	V		4	Potential	1,2,3,4,6	4,999	189	1,345	3,465
Grey-headed Flying-fox	V	V	0	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Large-eared Pied Bat	V	V	29	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Eastern Bentwing-bat	V		20	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Little Bentwing-bat	V		2	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Eastern Cave Bat	V		11	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Corben's Long-eared Bat	V	V	3	Known*	1,2,3,4,5,6	5,207	229	1,347	3,631
Yellow-bellied Sheathtail-bat	V		4	Known	1,2,3,4,5,6	5,207	229	1,347	3,631
Eastern False Pipistrelle	V		1	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631
Greater Broad-nosed Bat	V		13	Potential	1,2,3,4,5,6	5,207	229	1,347	3,631

Table 6.7 Summary of impacts areas for threatened fauna species

Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Occurrence within Study Area	Preferred Habitat within Study Area^	Total Area in Study Area (ha)	Area Cleared within the Project Disturbance Boundary (ha)	Area within the Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Reptiles									
Broad-headed Snake	E	V	1	Potential	4,5,6	3,936	125	795	3,016
Pink-tailed Legless Lizard	V	V	1	Potential	2,3,4,7	5,923	710	1,076	4,138
Rosenberg's Goanna	V		2	Potential	1,4,5,6	3,943	125	795	3,022

**Data obtained from the Atlas of NSW Wildlife (OEH, 2014b)*

^Preferred Habitat: 1 = Rainforest (Units 1-2), 2 = Riparian Woodland/Forest (Units 3-5), 3 = Grassy Woodland (Units 6, 7a, 8a, 10-11) 4 = Shrubby Woodland (Units 7b, 8b, 9), 5 = Shrublands (Units 12-13), 6 = Forests (Units 14-22), 7 = Derived Native Grasslands (Unit DNG), 8 = Cultivated Lands (Unit CC)

CUMBERLAND ECOLOGY

6.7 Impacts to Aquatic Biodiversity

The Project has a low potential to impact on aquatic biodiversity as the ephemeral waterways present within the Study Area are significantly degraded due to past agricultural land uses. Pooled surface water was observed to be of low quality and contained significantly impaired macro-invertebrate communities and exotic fish species. Nevertheless, potential ways in which the proposed mining activities may impact aquatic ecosystem health are discussed below.

6.7.1 Ground Movements

Longwall mining activities are likely to cause subsidence and potentially affect the waterways that are located immediately above the longwall mining area. These include Dry Creek and the drainage lines that lead into Dry Creek. MSEC (2014) has estimated that the subsidence movements will lead to:

- An increase in ponding along the lower reaches of Dry Creek (estimated to be less than 1 metre deep and 50 – 100 metres long);
- Localised areas of ponding along other drainage lines that lead into Dry Creek;
- Minor localised changes in alignment in areas that currently have shallow gradients;
- Potential increases in localised flooding;
- Potential increases in scouring and erosion; and
- A diversion of surface waters below ground due to surface cracking in the beds of the drainage lines and fracturing of the uppermost bedrock.

An increase in scouring and erosion along the waterways may lead to a reduction in bank stability, more uniform aquatic habitats and in-stream sedimentation. The potential increase in ponding may lead to habitat creation along Dry Creek, while the diversion of surface waters below ground due to surface cracking may result in a reduction in aquatic habitats and loss in habitat connectivity. However, Dry Creek and the drainage lines that lead into it are ephemeral waterways, with low connectivity and few areas of permanent aquatic habitat and therefore the extent of potential impacts is reduced.

Where examined, the aquatic habitats on Dry Creek were found to have significantly impaired aquatic macro-invertebrate communities. Therefore, it is unlikely that the effects of subsidence described above will significantly impact upon aquatic communities. Any effects of subsidence that may occur will be localised, particularly because of the discontinuous nature of the stream flow, and therefore are unlikely to indirectly affect aquatic communities further downstream. In the longer term, monitoring will be undertaken to assess if subsidence has led to adverse impacts on aquatic biodiversity and a series of remediation measures are proposed as required. These measures will minimise any impacts that occur and are outlined within **Chapter 7**.

Open cut mining in close proximity to an alluvial system has the potential to fracture layers within the aquifer through blasting, with similar impacts to subsidence, as described above. Both the eastern and western open cut mining areas are located adjacent to Lee Creek.

The mine plan has been designed to remain outside of the 150 m boundary from the edge of the alluvium, and associated waterways, to ensure impacts are minimised as far as possible. Similar to Dry Creek, the aquatic habitats, where present, in Lee Creek and Bylong River were found to contain significantly impaired macro-invertebrate communities. Exotic fish species (Eastern Gambusia and Carp) were also observed in Bylong River. Therefore the effects of blasting within the open cut mines are unlikely to significantly impact the aquatic habitats within the Study Area, predominantly because they are already severely degraded.

6.7.2 Surface Water Runoff

Surface water runoff into waterways could occur during periods of rainfall and as a result of mining activities (e.g. dust suppression). The mine water management system will be designed to avoid release of mine water from the site. Sediment dams will be designed to capture sediment in accordance with the relevant guidelines which will likely overflow during periods of high rainfall. There is likely to be contaminated material on site and should surface water runoff from this material reach the waterways, it could impact on the water quality within them, in turn affecting aquatic biota.

However, as a result of a surface water management strategy, the only surface water that would reach a waterway having been in contact with mining operations will be treated prior to its release to ensure that it is within ANZECC Water Quality Guidelines (ANZECC and ARMCANZ, 2000). Water will only be released from sediment dams if it meets water quality criteria and the water is not required on site (WRM Water & Environment, 2015).

6.7.3 Water Extraction

It is proposed that in addition to the seepage into the mining areas groundwater from the alluvium will be extracted (under KEPCO's existing Water Access Licences) to supplement water demands throughout the mining operations. This has the potential to influence the water levels within and surrounding the Study Area, particularly due to the interaction between surface water and groundwater in the alluvial system.

Modelling has indicated that, for a short period of time, mining will reduce the baseflow in Lee Creek and the Bylong River but will not impact on baseflows in the Growee River or Goulburn River (AGE, 2015). A reduction in baseflow in Lee Creek and Bylong River may lead to a loss of aquatic habitat. However, because of the ephemeral nature of the waterways there are few permanent aquatic habitats along Lee Creek and Bylong River and, as discussed in **Chapter 5**, these aquatic habitats are of low quality, with severely or significantly impaired macro-invertebrate communities and exotic fish species. Therefore, there is unlikely to be a significant impact as a result of water extraction on aquatic habitats and the communities within them within the Study Area.

CUMBERLAND ECOLOGY

6.7.4 Post-mining Water Quality

i. Impacts

Potentially contaminated water stored on site, or that that comes into contact with areas disturbed by mining operations, has the potential to contain elevated levels of salt. Throughout the mining operations this water will be appropriately managed within the Mine Water Management System to ensure that the surrounding environment is not polluted.

As discussed within AGE (2015), groundwater levels at the completion of mining operations will gradually rise within the mining areas and eventually meet an equilibrium. AGE (2015) has modelled the water levels at 1,000 years post mining. These results indicate that the coarse and fine reject area acts as a groundwater sink during the underground mine life. Following the completion of the underground area, groundwater levels in the rejects area will gradually rise, causing groundwater to flow into the overburden material in the northern portions of the Eastern Open Cut Mining Area and then ultimately into the neighbouring alluvium and Bylong River.

The quality of water that may leach into the alluvial groundwater (and eventually reach surface waters) will depend on the geochemistry of the spoil and coarse and fine reject materials. The leaching tests completed by RGS Environmental (2014) indicate that the salinity generated by the potential coarse and fine reject materials will vary but could exceed the currently observed baseline water quality within the alluvial groundwater system, where this leachate is predicted to seep into.

If the leachate did reach the alluvial groundwater, it is likely to be heavily diluted with water within the alluvium. While flowing through the alluvial system, it is also likely that contaminants, if present, will be further 'removed' by natural filtration processes. In lieu of this, it is considered unlikely that contaminated water will significantly impact surface water quality in waterways as a result of leaching. Therefore, it is unlikely that aquatic communities will be significantly impacted by water that has leached from within the Study Area.

An assessment of the post-mining alluvial groundwater by AGE (2015) has indicated that salinity in the alluvium may rise by 12%. This assumes that the groundwater salinity increases on average from 699 mg/L to 783 mg/L and therefore potentially in the surface water baseflow when no rainfall runoff occurs.

WRM (2015) concluded the total salt load (surface runoff plus baseflow) could increase from 4,297 to 4,339 tonnes per year, which represents an increase of about 1%. A 1% change in salinity is considered to be well within the range for natural variation, based on the data that has been collected within the system to date. In addition, the estimated change does not change the beneficial use of the groundwater and connected surface water, as it remains fresh.

The potential for the salinity in the pools to increase by more than 1% is essentially impossible to quantify and measure with any confidence. For example assuming a pool has a salinity of 1,500 mg/L, a 1% increase represents a marginal change to 1,515 mg/L. The salinity within the pools depends on climatic conditions and salinity increases during periods of dry weather due to evaporation and decreases when rainfall runoff promotes flow within the river. Results from surface water gauges in the Project area show that water quality backs up this assumption, and fluctuates by up to 1,000 µS/cm (or ~100%) throughout the year.

ii. River Condition Index

The Aquifer Interference Policy (Office of Water, 2012) requires that the Project does not increase long-term average salinity in a highly connected surface water source nearest the activity by more than 1% unless studies can demonstrate that the River Condition Index category of the surface water source is not reduced at that point. The River Condition Index for the Bylong River catchment has been assessed as moderate and good condition (Hamstead, 2010) This condition assessment takes into account stream geomorphology, riparian vegetation, hydrology and biodiversity.

Riparian vegetation occurring within the Study Area and surrounds includes River Oak / Redgum Riparian Woodland and Blakely's Red Gum / Apple Riparian Forest. These communities and the associated flora and fauna habitat have previously been modified as a result of clearing and subsequently grazing for agricultural purposes. These vegetation types can tolerate a considerable natural degree of fluctuation in salinity as they occur along ephemeral streams where salinity varies from low during floods to high during summer and drought events. The predicted changes in salinity within these riparian habitats are expected to have minimal potential to result in a detectable change in floristic composition. If changes do occur, it is predicted that the dominant trees will persist and that to a limited extent salt-tolerant ground stratum species may increase as salinity increases.

The Project is considered to have a low potential to impact on aquatic (in-stream) biodiversity as the ephemeral waterways present within the Study Area are significantly degraded due to past agricultural land uses. Additionally, the Project has been designed to limit the direct disturbance to these systems (limited to the two haul road crossings and overland conveyor). The aquatic fauna is dominated by hardy, adaptable freshwater macroinvertebrates and to a lesser extent fish that are able to tolerate considerable variations in salinity.

As noted above the total salt load (surface runoff plus baseflow) could increase by about 1%, which has minimal ecological implications given the large natural variation within the system. As such, any potential changes to riparian vegetation, associated flora and fauna values and aquatic biodiversity are considered negligible.

The change in total salt load within the catchment is one component of how the catchment may be affected by the Project. An extensive offset package has been developed (see **Chapter 8**), which includes a number of properties within the Bylong River catchment and within the vicinity of the Project Disturbance Boundary. Biodiversity of the catchment is likely to improve as a result of management of these properties through the reduction of agricultural activities, impeding runoff through revegetation and improvement of vegetation condition along waterways.

Restoring vegetation cover with appropriate native species to control the surfacing of salt has previously been used as a measure to manage salinity in Australia (SEWPaC, 2012b). Native trees and shrubs have been identified as effective water-users with deep roots that can use water stored deep in the soil profile, retention of existing vegetation and revegetation of trees and deep-rooted plants can be used to (Johnson *et al.*, 2009):

- Reduce groundwater recharge by using water in the root zone and minimising recharge of (or 'leakage' to) deeper aquifers; and
- Reduce saline or potentially saline groundwater levels (make them deeper beneath the ground surface) through roots directly accessing the water table and increasing discharge.

In addition to assisting in the reduction of salinity levels, management of riparian vegetation, including protecting existing vegetation and revegetation works can provide benefits to aquatic environments. Vegetation can provide benefits to aquatic environments by (Woodfull *et al.* (1993) in Kimber *et al.* (1999):

- Acting as a filter for sediment and attached nutrients and contaminants (including bacteria);
- Providing shade and reducing fluctuations in water temperature and oxygen levels;
- Strengthening and stabilising banks, thereby helping to prevent erosion and subsequent silting of stream beds; and
- Providing terrestrial and stream habitat. Inputs of litter and other organic debris provide food for stream biota, and inputs of logs and other coarse debris provide habitat for invertebrates and fish.

The improvement in biodiversity values within the region will improve the quality of surface water runoff entering the Bylong River and associated tributaries and reduce the potential impacts to water quality post-mining. Therefore, the post-mining water quality changes resulting from the Project are not considered likely to result in a significant change to the biodiversity values within the catchment.

6.8 Impacts to OEH Estate

The Study Area is connected directly to Wollemi National Park to the east and south and to Goulburn River National Park to the north (see **Figure 1.1**). OEH has prepared guidelines for development occurring adjacent to OEH estate to assist in the assessment of impacts to this land. Issues of concern to OEH include (DECCW, 2010):

- Erosion and sediment control;
- Stormwater runoff;
- Wastewater;

- Management implications relating to pests, weeds, edge effects;
- Fire and the location of asset protection zones;
- Boundary encroachments and access to OEH estate;
- Visual, odour, noise, vibration, air quality and amenity impacts; and
- Threats to ecological connectivity and GDEs.

Each of these issues is discussed below.

6.8.1 Erosion and Sediment Control

Erosion and sedimentation can result in deposition of sediments on vegetation and in creeks, rivers, wetlands and other aquatic habitats, including changes to the hydrology of streams (DECCW, 2010).

Erosion and subsequent sedimentation resulting from land clearance is discussed within ***Section 6.2.6.iv***. Erosion impacts are most likely to occur in proximity to roads, tracks, infrastructure and adjacent to the Project Disturbance Boundary. These elements of the Project do not adjoin either Wollemi National Park or Goulburn River National Park, nor does the catchment flow towards these areas in the immediate vicinity of the Project.

The Project has the potential to alter hydrological flows within the Study Area. The waterways within the Study Area flow into Goulburn River, a portion of which is located within Goulburn River National Park. Potential surface water impacts are discussed within Surface Water Impact Assessment (WRM Water & Environment, 2015).

The aim of erosion and sediment control on OEH estate is to prevent erosion and the movement of sediment onto OEH land, and ensure no detrimental change to hydrological regimes (DECCW, 2010). The potential impacts will be minimised by erosion and sediment controls implemented as part of a surface water management plan for the Project. Management of vegetation clearance boundaries will also assist with these potential impacts. Any discharges into waterways within the Study Area will be undertaken in accordance with approved guidelines. OEH estate is not considered to be significantly impacted by erosion and sedimentation as a result of the Project.

6.8.2 Stormwater Runoff

The aim of stormwater runoff management on OEH estate is for nutrient levels to be minimised, and for stormwater flow regimes and patterns to mimic natural levels before it reaches the OEH estate (DECCW, 2010). The potential impacts will be minimised through the implementation of a surface water management plan for the Project. Any discharges into waterways within the Study Area will be undertaken in accordance with the relevant stormwater guidelines. The OEH estate will not be significantly impacted by stormwater runoff as a result of the Project.

CUMBERLAND ECOLOGY

6.8.3 Wastewater

The aim of wastewater management on OEH estate is to ensure there are no adverse impacts due to wastewater (DECCW, 2010). The potential impacts will be minimised through the implementation of a water management plan for the Project that will address discharges of water within the Study Area. Discharges into waterways within the Study Area will be undertaken in accordance with approved guidelines. OEH estate is not considered to be significantly impacted by wastewater as a result of the Project.

6.8.4 Management Implications Relating to Pests, Weeds and Edge Effects

The aims for management of pests, weeds and edge effects on OEH estate are to ensure an adjoining project does not (DECCW, 2010):

- Lead to increased impacts from invasive species (weeds and pests), domestic pets and stock;
- Facilitate unmanaged visitation, including informal tracks, resulting in negative impacts on cultural or natural heritage values;
- Lead to impacts associated with changes to the nature of the vegetation surrounding the reserve; and
- Impede OEH access for management purposes, including inappropriate fencing.

The Study Area and adjoining National Parks are currently impacted by a suite of feral species including foxes (*Vulpes vulpes*), dogs (*Canis lupus*), pigs (*Sus scrofa*) and goats (*Capra hircus*). The Project has the potential to result in the exacerbation of the impacts of weeds and feral animals (see ***Section 6.2.7***). Weed and feral animal management will also be incorporated into management of land within the Study Area during construction and operation of the Project (see ***Section 7.3***). The Project is not considered to result in increased impacts from invasive species to OEH estate.

A number of tracks have been established within the Study Area for the purposes of exploration activities. These tracks do not extend into the boundaries of the adjoining National Parks. The majority of these tracks are located within Bylong State Forest and as some of this area is located above the Subsidence Study Area, access to this land will be managed during the construction and operational phases of the Project.

The Project Disturbance Boundary is not located in close proximity to the boundaries of adjoining National Parks. The north-eastern extent of the Subsidence Study Area is in close proximity to Goulburn River National Park at some locations. Potential subsidence from the underground mining activities has been modelled by MSEC which indicates that the Subsidence Study Area is contained within the Study Area. The ecological impacts of subsidence are discussed within ***Section 6.2.1***.

Access to Wollemi National Park and Goulburn River National Park from the Study Area is currently limited. No formal access tracks enter these areas. As such, the Project is not expected to impede the existing limited access to the National Parks. Should any fencing be required at the boundary of the Subsidence Study Area and Goulburn River National Park, it will be undertaken in accordance with the OEH *Boundary Fencing Policy* (OEH, 2014e).

6.8.5 Fire and the Location of Asset Protection Zones

The aim of fire and asset protection zones management on OEH estate is to ensure all asset protection measures are undertaken within the development area and there is no expectation for OEH to alter its fire management regime (DECCW, 2010). The Project does not include the provision of asset protection zones. Bushfire hazards within the Study Area will be assessed and managed in accordance in accordance with the relevant legislative requirements. As such, it is not considered that the OEH fire management regime for the adjoining National Parks will be required to change.

6.8.6 Boundary Encroachments and Access through OEH Estate

The aim of boundary encroachment and access management on OEH estate is to ensure no pre-construction, construction or post-construction activity occurs on OEH estate and that access to the estate must be legally authorised and comply with park management objectives.

The proposed clearing for the Project Disturbance Boundary is not located in close proximity to the boundaries of adjoining National Parks. No access to Wollemi National Park and Goulburn River National Park is proposed.

6.8.7 Visual, Odour, Noise, Vibration Air Quality and Amenity Impacts

The aim of visual, odour, noise, vibration, air quality and amenity impact management on OEH estate is to ensure there is no reduction of amenity on OEH estate due to adjoining developments (DECCW, 2010). The visual disturbance associated with the Project will be located in the vicinity of the Project Disturbance Boundary and Subsidence Study Area. The Subsidence Study Area only adjoins the Goulburn River National Park at some locations. The Project Disturbance Boundary does not adjoin the Wollemi National Park or the Goulburn River National Park. The visual disturbance generated by the Project is not considered to reduce the amenity of either the Wollemi National Park or the Goulburn River National Park.

Indirect impacts such as increased dust, light and noise are discussed within ***Section 6.2.6***. A number of mitigation measures are proposed to minimise such indirect impacts. These impacts within the Project Disturbance Boundary are not considered to significantly impact adjoining National Parks.

6.8.8 Threats to Ecological Connectivity and Groundwater Dependent Ecosystems

The aims of ecological connectivity and GDE management on OEH estate are to ensure (DECCW, 2010):

- Native vegetation and other flora and fauna habitats that provide a linkage, buffer, home range or refuge role on land that is adjacent to reserves are maintained and enhanced, where possible; and
- GDEs in OEH estate are protected.

The Project will remove habitat for native flora and fauna adjacent to National Parks. A total of 1,160 ha of land will be cleared, including 229 ha of woody vegetation. The land to be cleared is located within the Project Disturbance Boundary. These elements of the Project do not adjoin either Wollemi National Park or Goulburn River National Park. However, the habitats to be cleared are connected via intact unreserved land.

The removal of habitat within the Project Disturbance Boundary is not considered to have an impact on the function of this corridor in the locality of the Project. On a regional scale the Project will remove 229 ha of woody vegetation within a larger tract of protected National Parks and State Forests covering more than 500,000 ha.

The groundwater modelling undertaken for the Project has predicted that groundwater (including from the alluvium) will be extracted throughout the life of mining operations. This has the potential to influence the baseflow within the waterways on and downstream of the Study Area during the short to medium term, particularly due to the interaction between surface water and groundwater in the alluvial system. The Project will reduce baseflow in Lee Creek and the Bylong River but does not have a measurable impact on flows in the Growee River, because it is more distant from the Project area (AGE, 2015). Goulburn River is not predicted to be impacted within the current modelling (AGE, 2015). As such, impacts to potential GDEs within Goulburn River National Park are not predicted to occur.

6.9 Cumulative Impacts

Cumulative impacts result when many small-scale alterations to the environment combine to cause an overall greater level of impact. In a mining environment, cumulative impacts can arise from the compounding activities of a single operation or multiple mining and processing operations in the same area, as well as the interaction of mining impacts with other past, current and future activities that may not be related to mining (Franks *et al.*, 2008).

Cumulative impacts can arise from either persistent losses of one resource, or the compounding effects of two or more impacts (Lindenmayer and Fischer, 2006). Direct and indirect impacts that may be considered insignificant on their own may be significant when considered together with other actions being undertaken as part of the Project, or with other similar projects in the locality.

The largest and most obvious impacts have come from clearing of the land for farming practices, with the greatest farming-induced changes evident on the fertile valley floors. The least impacts have been within the sandstone areas that are infertile and of little to no commercial use for farming. The valley in which the Project will take place has been highly cleared and modified. The mine will be superimposed upon such farming impacts and will entail some clearance of remaining semi-cleared forest and woodland, and some areas of semi-natural derived native grassland. Much of the surrounding locality is within National Parks within sandstone areas that are now well conserved and which will not be subject to further direct impacts from clearing.

Cumulative impacts on a local scale are likely as a result of the combination of open cut and underground mining operations, in addition to the operational impacts of the Project. A total of 753 ha of woody vegetation and native grassland will be directly impacted by the Project; however a further 1,714 ha of similar vegetation, as well as cliff line habitat, will undergo the impacts of subsidence at varying levels. Individually, these impacts may be considered insignificant if appropriate mitigation measures are put in place, with species likely to self-relocate to adjacent areas of suitable habitat. However; if these impacts are considered collectively, not only will “source” habitat be directly impacted, but areas of “sink” habitat have the potential to be modified through subsidence. Further to this, indirect impacts including lighting within the pit, dust generated by machinery and truck movements, and noise from the workings, blasting and infrastructure facilities may generate impacts on both the retained habitat within the Study Area, and on habitat within the adjacent Wollemi National Park.

Impacts to vegetation and fauna species in the locality have already occurred through vegetation clearing for agriculture and logging, and through ongoing agricultural practices. These practices include the degradation and loss of topsoil through ploughing and the introduction of additional nutrients and exotic species, thus impacting habitat for native flora species. The most fertile areas of soil have predominantly been cleared, being those soils which would have previously supported Box Gum Woodland. This clearing has led to the fragmentation of habitat for flora and fauna, with species reliant on vegetation derived from high-nutrient soils becoming threatened. The vegetation clearance that will occur as a result of the Project will exacerbate these existing ecological impacts if left unmitigated.

A number of operational and proposed mines occur within the wider region. These occur as both open cut and underground mines, and are predicted to generate similar impacts to the Project. The Project will add to the loss of vegetation from within the valleys of the location, adding to the historic farming impacts and also adding some further cumulative mining impacts to those of other projects such as have occurred at mines in the wider region. The long term impacts associated with the Project as well as other proximate mines will be offset by rehabilitation and appropriate conservation strategies.

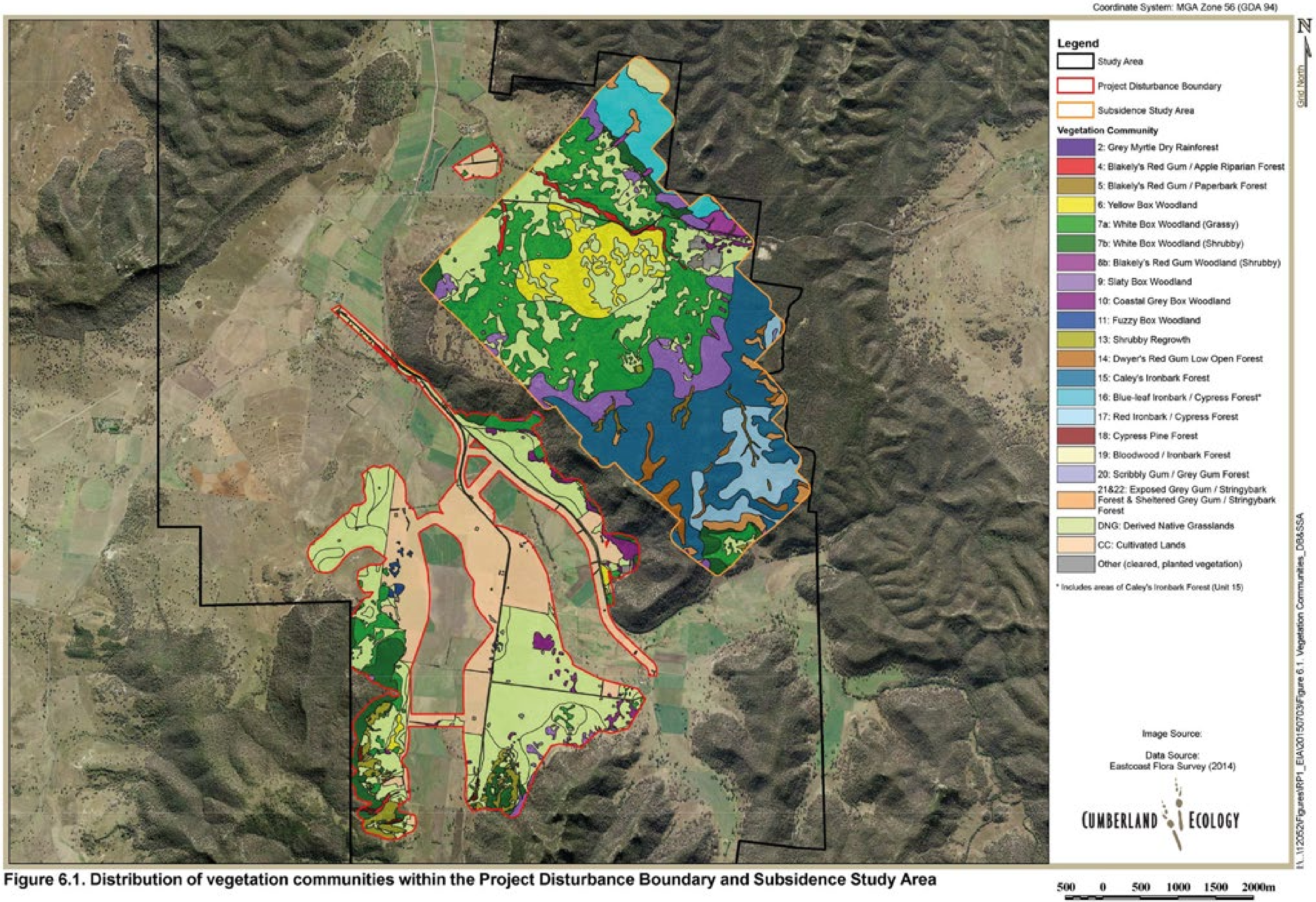


Figure 6.1. Distribution of vegetation communities within the Project Disturbance Boundary and Subsidence Study Area

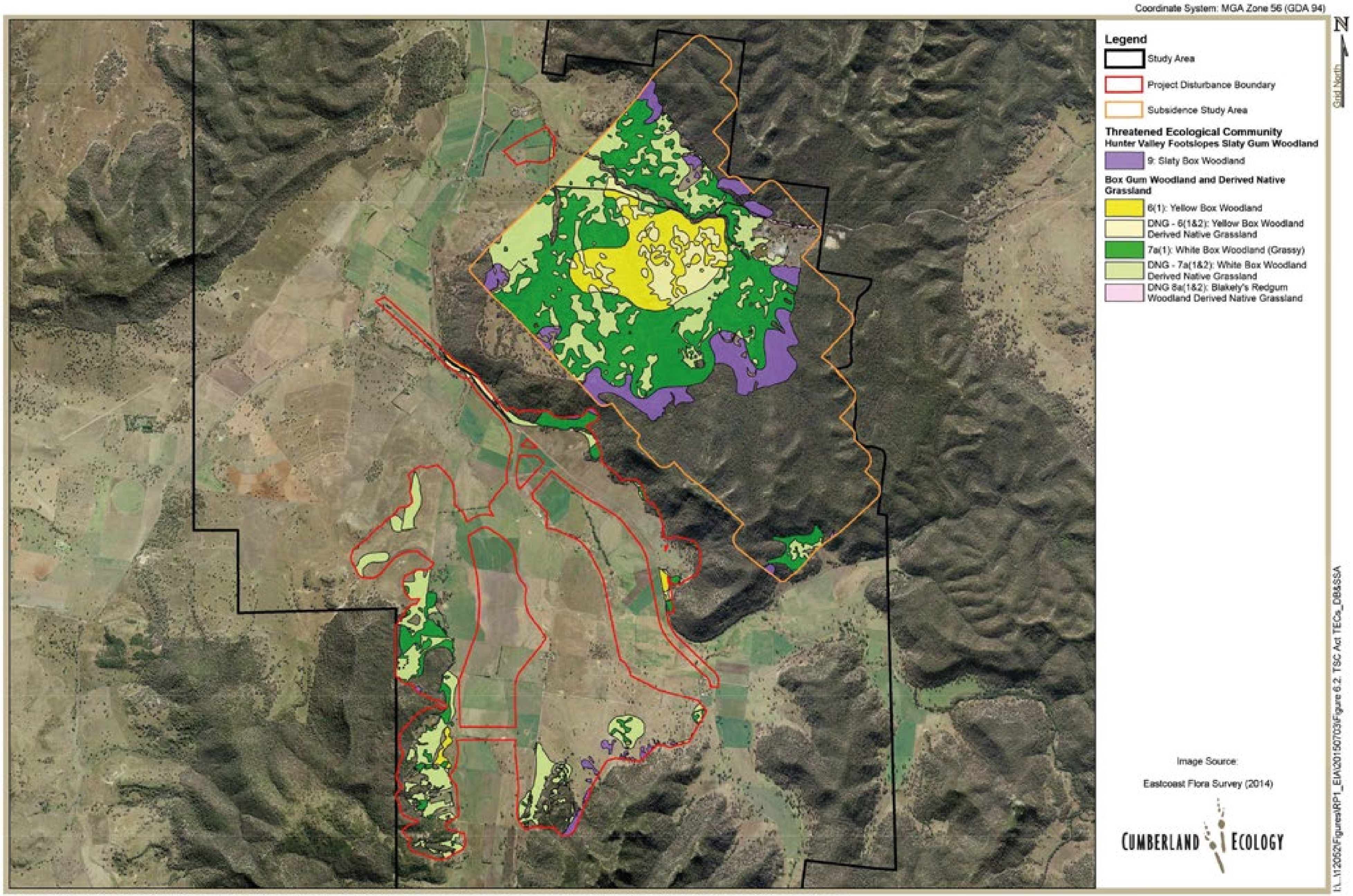


Figure 6.2. TSC Act TECs within the Project Disturbance Boundary and within the Subsidence Study Area

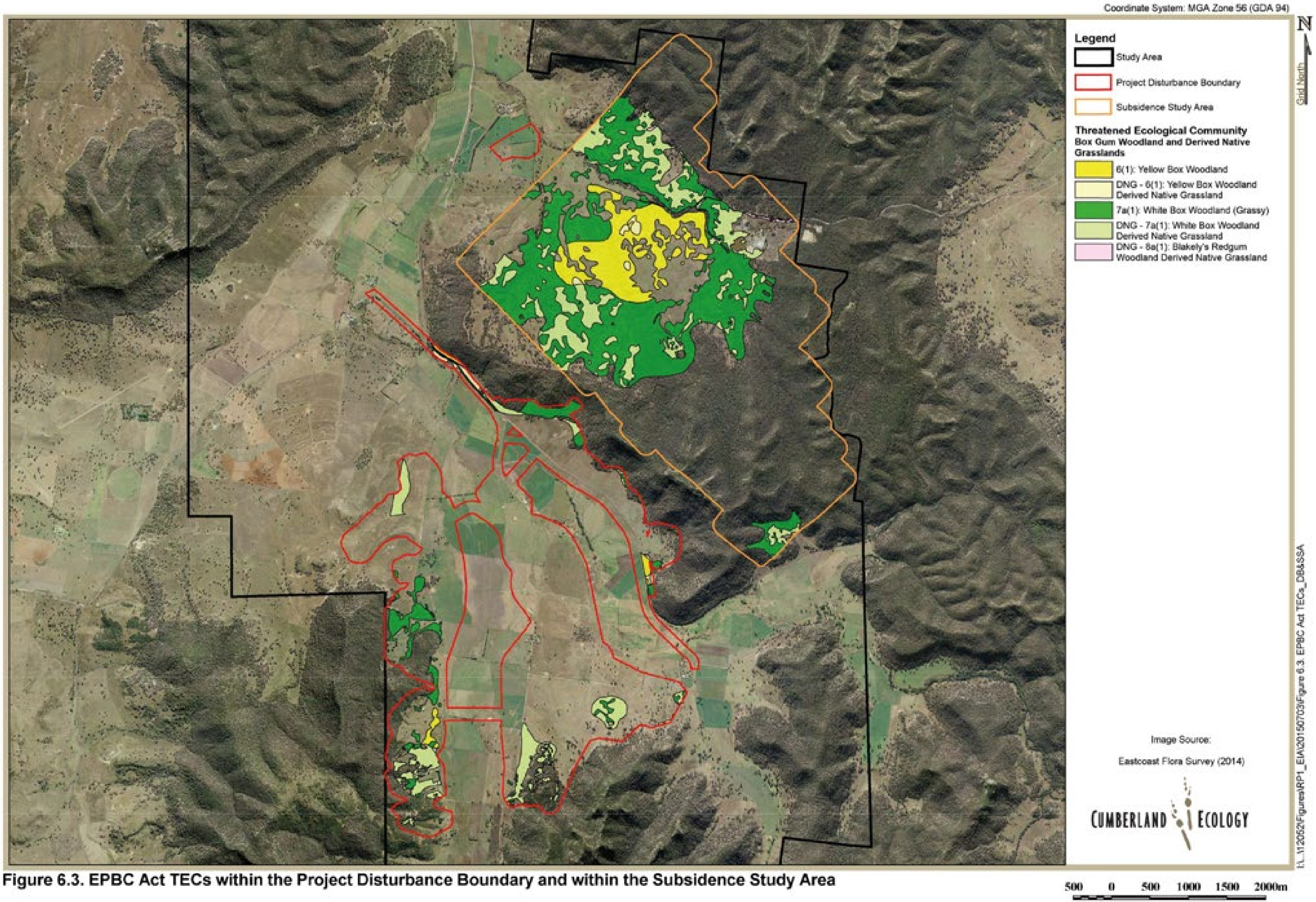


Figure 6.3. EPBC Act TECs within the Project Disturbance Boundary and within the Subsidence Study Area

Chapter **7**

Avoidance and Mitigation Measures

The purpose of this chapter is to outline the avoidance and mitigation measures proposed to ameliorate the impacts of the Project on biodiversity values. 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 the TSC Act and EPBC Act.

The impact reduction measures for the Project include the following hierarchy of principles:

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

The considerations for reducing the ecological impacts of the Project follow the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014q) and the DoE *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (SEWPaC, 2012a), which state that avoidance and mitigation measures should be considered prior to the use of offsets.

A comprehensive BOS has been provided in **Chapter 8** that outlines the measures taken to mitigate for the residual impacts of the Project once the appropriate avoidance and mitigation measures outlined in this chapter have been implemented.

7.1 Avoidance Measures

Mining projects cannot readily avoid impacts to biodiversity values where the resources are located beneath flora and fauna values. The alteration of a mine plan to completely avoid such impacts can lead to a project being unfeasible. However, avoidance can be achieved to varying degrees by the modification of the design and location of a project.

The Project has avoided impacts to biodiversity values through the selection of a combined open cut and underground mine, and through a process of refinement to the design, location of key mining activities and the associated infrastructure.

Avoidance measures that have been or are proposed to be implemented to the Project that are relevant to the assessed MNES are outlined within **Appendix I**.

7.1.1 Overall Mine Plan

To determine the most economic and environmentally responsible coal mining operation within the Authorisations, information collected through an extensive exploration program and detailed options and feasibility studies has been taken into account. The process of determining this mining operation included consideration of numerous mine plans, operational methods and infrastructure designs and alternatives.

Options considered for the Project included underground mining only and open cut mining only as well as a number of differing combinations of each mining methodologies. Initial mine plans included up to seven open cut mining areas and several underground areas which were progressively refined taking into to account social, environmental and economic factors to achieve the preferred project plan with two open cut mining areas and a single underground mining area.

The conceptual mine plan for the Project has been refined through the consideration of a number of alternatives which have reduced the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities and species.

7.1.2 Specific Outcomes

Key avoidance measures undertaken during development of the mine plan specific to biodiversity values within the Study Area include:

- Positioning of the Open Cut Mining Areas, Mining Infrastructure Areas, Overburden Emplacement Areas and Workforce Accommodation Facility predominantly within previously cleared land, thus reducing the impacts to woodland habitats;
- Positioning of the Mining Infrastructure Areas predominantly within previously cleared land and adjacent to existing infrastructure (e.g. Sandy Hollow-Gulgong Railway Line), thus minimising the amount of clearing of flora and fauna habitat required by the Project;
- Positioning the CHPP within the proposed Rail Loop area to reduce footprints required for mining related infrastructure;
- Modifications to the extent of the Open Cut Mining Areas, Mine Infrastructure Areas and Overburden Emplacement Areas to reduce the extent of impacts to Box Gum Woodland, which is also considered as critical habitat for the Regent Honeyeater;

- Refined mine planning to reduce the footprints of the Overburden Emplacement Areas to avoid a large population of *Tylophora linearis*;

- The underground mine plan has been refined to ensure the Main Headings will be positioned under most significant and visible cliff lines overlying the underground extraction area and longwall panels adjusted to ensure any significant subsidence related impacts are avoided at these locations; and

- Positioning of the longwall panel layouts to ensure that the Subsidence Study Area did not encompass subsidence impacts on the most significant and visible cliff lines which have been identified within the vicinity of the mining areas.

KEPCO will endeavour to achieve further avoidance of sensitive biodiversity beyond that described during the detailed design and construction phases of the Project as the mine plan and associated infrastructure is refined.

7.2 Mitigation Measures

A range of mitigation measures are proposed to be implemented for the Project to minimise the impacts to biodiversity values relevant to the Study Area. These mitigation measures will be undertaken within the construction and operational phases of the Project with some measures extending beyond the life of mine (e.g. monitoring). The mitigation measures developed for the Project are primarily related to reducing impacts to vegetation and habitat within the Study Area. Specific details of a number of the mitigation measures will be contained within a Biodiversity Management Plan (BMP) for the Project, which will be approved prior to the commencement of the Project.

Mitigation measures that have been or are proposed to be implemented to the Project that are relevant to the assessed MNES are outlined within **Appendix I**.

7.2.1 General Construction and Operational Mitigation Measures

A suite of general environmental control measures will be implemented for the Project which will help to protect the ecology of the Study Area and surrounds. These general measures are outlined within **Table 7.1**. Mitigation measures for mining and construction operations will be conducted in accordance with the relevant best practice guidelines.

Table 7.1 General mitigation measures relevant to biodiversity values

Mitigation Measures	General Ecological Benefits
Dust minimisation	Reduces the indirect impacts on vegetation condition and the habitat quality for all native species.
Noise minimisation	Benefits fauna by reducing the potential for disturbance of animals in habitat patches around the Project.
Management of surface water, erosion	Protects the integrity of the landscape.

CUMBERLAND ECOLOGY

Table 7.1 General mitigation measures relevant to biodiversity values

Mitigation Measures	General Ecological Benefits
and sedimentation	
Due diligence inspections for proposed disturbance areas	Provides data for ongoing adaptive management and protection of adjacent landscape areas if required.
Visual and lighting management	Benefits fauna by reducing the potential for disturbance of nocturnal animals via night light emissions around the Project.
Feral animal and overabundant native animal management	Benefits fauna by minimising competition for food and resources.

7.2.2 Minimising Vegetation and Habitat Loss

During the detailed design stage, opportunities to further minimise vegetation disturbance should be considered. In order to minimise clearing impacts and unnecessary disturbance to native vegetation, the following procedures should be implemented:

- Any clearing for the Project will be undertaken in accordance with an approved land disturbance protocol;
- The limits of clearing will be delineated during the construction and mining operation process and marked clearly on plans as well as on the ground using appropriate marking such as spinning reflective tape, wire fencing and/ or signage;
- Training of all clearing staff of impacts and mitigation requirements of native vegetation;
- Communication of clearing limits to all clearing staff during pre-start briefings;
- Native vegetation beyond the identified Project Disturbance Boundary should not be disturbed;
- Ancillary facilities such as stockpile sites, site compounds and construction zones should not be located beyond the limits of clearing; and
- Key habitat features within the clearing boundaries will be identified using the protocols described in ***Section 7.2.3***.

Clearing of vegetation and construction work is undertaken in accordance with best practice guidelines, and to ensure that protocols are in place should incidents relating to biodiversity occur. Where clearing of vegetation and fauna habitats will take place, clearing protocols should be followed (see ***Section 7.2.3***).

Monitoring of clearing areas will take place during and following the cessation of clearing works. Monitoring will ensure that designated clearing boundaries are clearly marked and not exceeded.

7.2.3 Pre-clearance/Clearing Surveys

i. Pre-clearing Surveys

In order to minimise impacts to both threatened and non-threatened flora and fauna species, pre-clearing surveys will be undertaken, and clearing of vegetation will be supervised by an appropriately qualified person. Prior to the commencement of clearing, a survey will be conducted to mark key habitat features within the clearing area. Key habitat features can include:

- Rock piles suitable for native mammals, amphibians and reptiles;
- Hollow-bearing trees, containing suitable habitat for hollow-dependent fauna;
- Trees with decorticating bark, providing habitat for microbats and reptiles;
- Drainage lines containing water suitable for amphibians;
- Hollow logs containing suitable habitat for terrestrial mammals and reptiles; and
- Dense shrubby vegetation, containing suitable nesting habitat for small birds.

In addition to marking habitat features, salvage items deemed suitable for use in rehabilitation areas (e.g. tree hollows, fallen logs) will also be marked.

Habitat features are to be marked using a standardised system, where each habitat feature is given a unique identifier to ensure that it is accounted for following clearing. Trees and rock piles are to be marked appropriately with spray paint and flagging tape. Where areas of habitat occur such as a log pile or area of water, the boundaries of the area will be clearly demarcated using flagging tape, and the location of the area clearly identified with machinery operators prior to the commencement of works. The location and type of feature will be recorded for each habitat feature recorded.

At this time, seed collection could occur where seeds from shrubs are being collected. Additionally, searches for threatened flora will occur. Impacts to threatened flora will be managed in accordance with the BMP. Further to this, incidences of noxious weeds will be identified so that they can be managed prior to clearing.

Following the completion of a pre-clearing survey, a report will be compiled detailing the location and type of each habitat feature, and records of any fauna detected during the survey. If appropriate, traps such as cage, pitfall and Elliot will be erected within the clearing area prior to the commencement of works so as to maximise the chance of detecting and relocating fauna prior to commencement of clearing.

ii. Clearing Supervision

Clearing is to occur within a two week period of the pre-clearing survey being undertaken, as fauna can create nests within a short timeframe. Clearing supervision will be conducted by appropriately qualified environmental or ecological personnel. Clearing will be undertaken in a controlled manner, with a minimum of one person working with each clearing machine. Personnel will be properly equipped, with adequate protective equipment, suitable storage devices for captured animals (such as calico bags and solid plastic boxes), and communications equipment to ensure positive communications with machinery operators.

Prior to the commencement of clearing, a release point will be identified. This should be an area of similar habitat, outside of the Project Disturbance Boundary, ideally within an offset or conservation area. This detail will be included in the BMP.

Clearing is to be undertaken in a two-stage process. The initial phase of clearing will involve clearing around identified habitat features and salvage items. Clearing around large habitat features will firstly make fauna feel less secure when returning to the feature due to its isolation, thus increasing the chance of self-relocation, and secondly will make the feature easier to survey following clearing. Habitat features will be left overnight once they have been cleared around, and cleared the following day. Once features are cleared, they are to be thoroughly inspected by an appropriately qualified person. Inspection techniques include the use of crow bars to crack hollows open, torches and inspection cameras to inspect inside hollows and the use of ultrasonic bat detectors to identify high frequency bat calls. Following clearing, features will then be left a second night to allow any fauna remaining within them to relocate. Habitat features can then be removed and salvage items stockpiled.

Clearing is ideally undertaken as late as possible in summer. Though numerous fauna reproduce throughout the year, a significant proportion of species reproduce in early spring. As a result, clearing in late summer will generate the highest likelihood that juveniles are independent. Clearing are not to be conducted past mid-autumn, as microchiropteran bats enter a period of lower activity and hibernation and large forest owls breed in winter. Clearing outside these times will minimise impacts to these fauna groups.

7.2.4 Aquatic Measures

i. Ground Movements

Although no significant impact on aquatic habitats as a result of ground movements is predicted to occur, mitigation measures will ensure that any impacts are minimised. These measures will include:

- Visual monitoring of the land within the Subsidence Study Area and the overlying the mined longwall panels will be undertaken in conjunction with survey monitoring points to identify areas of surface cracking and changes in gradient, and whether adverse effects are occurring as a result of these changes;

- During (and/or following) mining, establishment of erosion protection measures where necessary, which may include planting of riparian vegetation or installation of rip-rap;

- Following completion of mining activities, surface remediation measures will be employed if adverse impacts are found to re-establish natural gradients along waterways and drainage lines; and

- Following completion of mining activities, surface cracks that have appeared and are causing adverse impacts will be filled where safe and practical with surface soils or other suitable materials, or by regrading and compacting the surface.

ii. Surface Water Runoff

Surface water runoff is not expected to significantly impact upon aquatic communities, primarily as a result of the implementation of a surface water management plan, in which the three types of surface water runoff will be managed as follows:

- 'Clean water' will be diverted wherever possible around mining disturbed areas and released from site;
- 'Dirty water' will be stored on site within 'sediment dams'. The water may be released if necessary into neighbouring waterways; this will only occur after analysis and treatment of the water if it does not comply with the ANZECC Water Quality Guidelines. This will also be managed through a sediment and erosion control plan; and
- 'Mine water' will be collected in onsite storage and used to satisfy mine site water demands.

The surface water management plan will ensure that any water that may be released from within the Study Area complies with the ANZECC Water Quality Guidelines. This will assist in minimising the impacts to aquatic ecology within the Study Area.

7.2.5 Mine Rehabilitation

The land disturbed within the Project Disturbance Boundary will be progressively rehabilitated over the life of the Project, particularly within the Open Cut Mining Areas and Overburden Emplacement Areas. Approximately 758 ha of land is proposed to be rehabilitated within the Project Disturbance Boundary. The overarching objectives of rehabilitation and post-mining land use are to:

- Where practical, return the land to its pre-mining land capability and land use;
- Limit impacts on Biophysical Strategic Agricultural Land (BSAL) and minimise the total quantity of BSAL foregone within the Project Disturbance Boundary;
- Return land subject to temporary disturbance to pre-mining condition; and
- Return a similar quantity of good quality land, (including BSAL) for land directly and permanently impacted by mining related activities.

A site-specific Rehabilitation Management Plan will be prepared to guide the rehabilitation of land within the Project Disturbance Boundary. The Rehabilitation Management Plan will contain further information on the staged rehabilitation of the Project Disturbance Boundary and will specify how areas will be rehabilitated for specific post mining land uses. The location of rehabilitation areas within the Project Disturbance Boundary are shown in **Figure 7.1**.

Approximately 34 ha of land will be rehabilitated to woodland. Species selected for inclusion within woodland rehabilitation will incorporate species representative of analogue sites of the targeted woodland communities which may include Hunter Valley Footslopes Slaty Gum Woodland and Box Gum Woodland and Derived Native Grassland (SLR Consulting, 2015a). Species composition of plantings should generally reflect the original community in the location, and be sympathetic to environmental variables such as landscape position, aspect, slope and proximity to water. The rehabilitated native vegetation will also aim to provide habitat for a diverse range of viable flora and fauna populations and provide additional habitat connectivity.

Local native plant species will be utilised where possible which and supplemented by additional native species represented in the area to ensure the rehabilitation objectives are achieved. Where practical, topsoil will be translocated from proposed mining areas to conserve the native seed bank of local ecological communities.

The rehabilitation will also incorporate the use of salvage items from the clearing process. Hollow-bearing trees could be replaced in the ground to form arboreal fauna habitat, and logs and rocks can form ground refugia for terrestrial fauna. To this end, rehabilitation will to provide additional areas of habitat adjacent to existing remnants. This is particularly important in areas adjacent to known populations of threatened fauna, as the addition of habitat would allow for greater movement of species within the Study Area.

7.2.6 Monitoring

It is essential to monitor the ongoing status and health of flora and fauna assemblages that will be retained within the Study Area in order to assess the success of the mitigation measures. This will be achieved through the establishment of an ecological monitoring program for the Project, including monitoring of vegetation, flora and fauna species and aquatic habitat. Details of the monitoring program will be contained within the BMP and will include monitoring of vegetation, threatened species and aquatic habitat. The proposed monitoring program includes the use of appropriate reference sites that are located away from mining activities to use as a baseline against which to compare the status of habitats in close proximity to mining.

This section discusses the proposed monitoring programs that will be developed for the Project. More detailed prescriptions for monitoring strategies and the development of reference sites will be incorporated into the BMP, including a framework for reporting on the results of the monitoring.

i. Vegetation Monitoring

Vegetation monitoring will occur through the annual repetition of vegetation plots, which will record the cover abundance of species within the plot, as well as the presence of habitat features such as logs and hollow bearing trees. These monitoring locations will be used throughout the life of the Project so as to detect changes in the quality of vegetation within the Study Area, should any changes occur. Key monitoring locations will include reference sites in non-impacted vegetation, areas above the Subsidence Study Area and areas of GDE vegetation. Additional monitoring sites will be created in rehabilitated areas once rehabilitation works have commenced.

Information will be used in adaptive management, in order to continually improve the outcomes of the rehabilitation and land management strategy. Appropriate data management procedures will be implemented to ensure that all data is collected using appropriate techniques and suitably analysed to allow meaningful spatial and temporal comparisons to be made.

ii. Species Monitoring

Regular species monitoring will be undertaken within the Study Area. General monitoring of flora species can be undertaken with vegetation monitoring outlined above. Fauna species monitoring will also be undertaken to determine if there are any changes to the faunal assemblage of the Study Area as a result of the Project as described in the BMP. Fauna surveys can include bird surveys, ultrasonic call detection and IR camera surveys. Results from these surveys will be analysed over time to assess changes in the diversity and abundance of fauna species.

Monitoring will also be undertaken on selected threatened species of flora and fauna, in order to determine whether populations are being adversely affected by the Project. Threatened species monitoring will:

- Enable the identification of the impacts of the Project on threatened species;
- Identify changes in population numbers over time;
- Determine the success of impact mitigation and conservation measures; and
- Highlight areas for improvement if these measures are found to be inadequate.

Threatened species monitoring will involve conducting regular targeted threatened species surveys in areas of known habitat in order to record the abundance of selected species. This will include both flora and fauna species. The level of monitoring effort will be determined according to risk level and biology of the particular species in question (e.g. coordinating with breeding or movement times).

iii. Aquatic Habitat Monitoring

Regular monitoring will occur within local waterways through the collection of water quality samples and through macroinvertebrate sampling. Regular monitoring points will be established, and the results of surveys compared using the AusRIVAS system, to detect any changes to water quality over time.

iv. Reporting

Monitoring reports will be prepared to document the findings of the monitoring program in accordance with the approved BMP. Monitoring reports will compare the existing environmental conditions to those from previous years, and will analyse any changes between years.

7.3 Biodiversity Management Plan

In order to provide a comprehensive framework for the implementation of the proposed biodiversity impact mitigation and offset measures, a BMP will be developed for the Project and resourced by KEPCO. The BMP will ensure that the Project's conservation objectives are met and that impacts to biodiversity are adequately managed for the life of the Project. The BMP will incorporate all of the impact mitigation measures as described in this chapter that are proposed to be undertaken for the Project, and provide detailed specifications for their implementation.

The BMP will be prepared in accordance with any conditions of consent but may include the following:

- A description and plan of onsite conservation measures (long and short term);
- Measures to protect local biodiversity values (including weed and feral animal management);
- Provisions to address specific issues such as the occurrence of threatened species;
- Details of appropriate areas for rehabilitation and conservation;
- Details of revegetation priorities and techniques;
- Details of reference sites, monitoring methodology, and other contributions to conservation;
- Description of key performance indicators against which to measure progress; and
- Specification of appropriate review periods where progress is reviewed and the document updated as required.

The BMP is intended to be a working document that guides all facets of biodiversity management and biodiversity mitigation for the Project, and will include clear objectives and actions. The BMP will specify what measures will be undertaken, how they will be undertaken, and will provide a timeline to ensure that all activities are conducted according to the plan. The BMP will enable site environmental managers to enact the 'avoid and mitigate' principles during the operation of the Project.

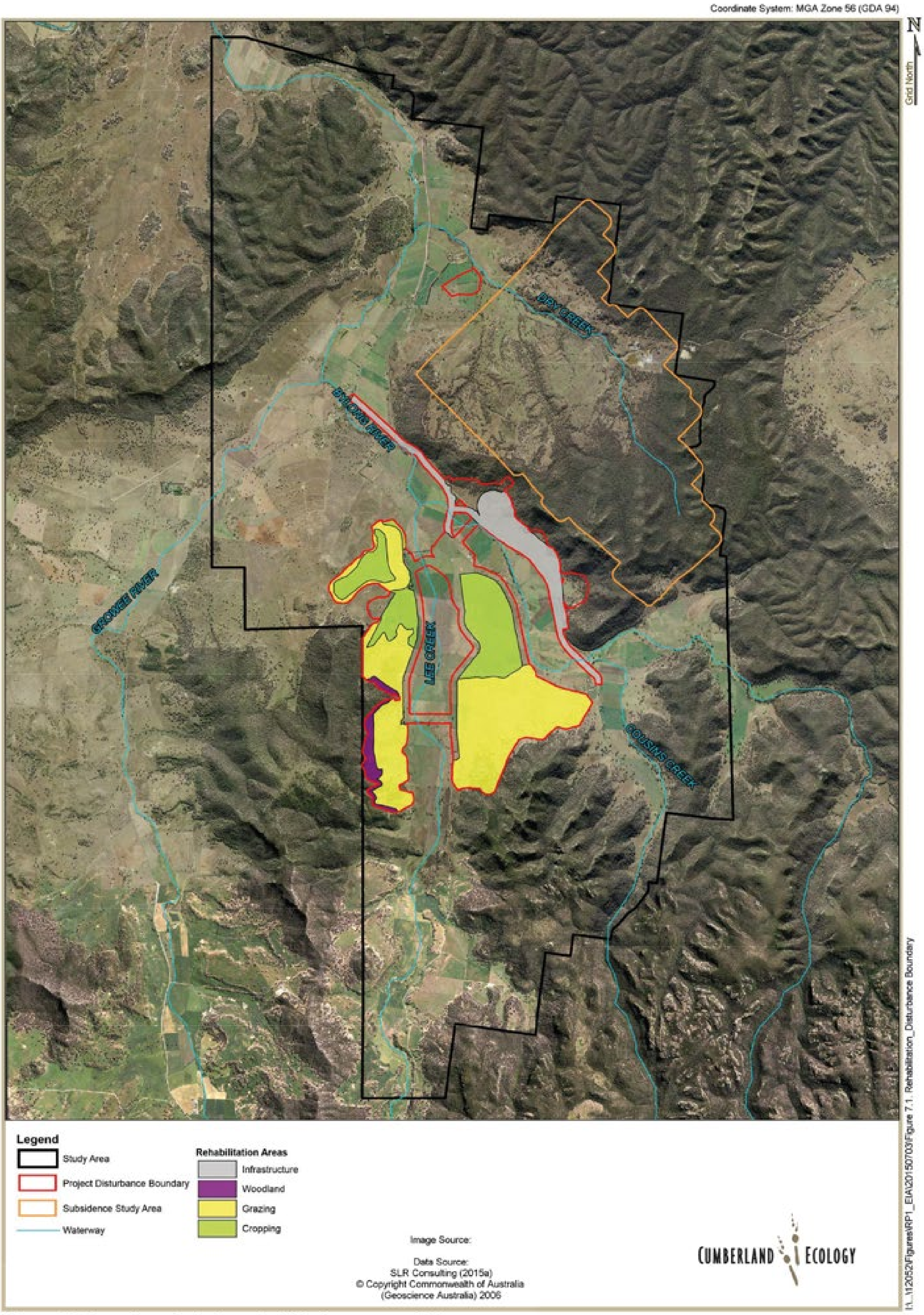


Figure 7.1. Location of mining rehabilitation areas within the Project Disturbance Boundary

CUMBERLAND ECOLOGY

Chapter 8

Offset Measures

A detailed Biodiversity Offsets Report has been prepared for the Project and is provided as part of the EIS documentation. The purpose of this section is to provide an overview of the Biodiversity Offsets Report. It explains the overall rationale for the offsetting of the residual biodiversity impacts through the BOS. The adequacy of the BOS is then assessed using, including its compliance with government offset principles and policies.

8.1 Introduction

In NSW and for Commonwealth-assessed projects, the requirement for offsetting is considered within the following hierarchy for managing impacts: avoid, mitigation and compensate. A suite of avoidance and mitigation measures have been proposed for the Project and are outlined within **Chapter 7**. The BOS for this Project has been developed to compensate for the residual impacts of the Project once the appropriate avoidance and mitigation measures have been implemented.

The considerations for offsetting the residual ecological impacts of the Project have been guided by the following policies:

- NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014q); and
- *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (SEWPaC, 2012a).

For biodiversity offsets to be considered ‘appropriate’, the principles outlined within these policies must be adhered to where possible.

8.2 Biodiversity Offset Strategy and Package

The BOS entails acquisition of offset properties for permanent conservation of flora and fauna, including species predicted to be impacted by the Project, and by provision of indirect offsets. The BOS targets Box Gum Woodland and Derived Native Grassland and other habitats for all threatened flora and fauna known to occur within the Study Area.

The offset areas include various forms of forest, woodland and grassland, which constitute habitat for threatened flora and fauna. The inclusion of these lands as biodiversity offsets will provide additional conservation areas within the locality of the Project.

KEPCO has devised a BOS that includes "direct" biodiversity offsets. The current composition of the Biodiversity Offset Package of direct offsets includes:

1. **Onsite Offset Areas**, comprising:

    a. Conservation and ongoing management of existing vegetated land within Offset Area 1, Offset Area 2, Offset Area 3, Offset Area 4 and Offset Area 5;

    b. Restoration of vegetation communities and associated habitat within the aforementioned onsite offset areas;

2. **Offsite Offset Area**, comprising:

    a. Conservation and ongoing management of existing vegetated land within the Yarran View Offset Area; and

    b. Restoration of vegetation communities and associated habitat within the aforementioned offsite offset area.

A detailed description of each of the offset areas is provided in the Biodiversity Offsets Report. The locations of the offset areas in relation to the Project Disturbance Boundary are shown on **Figure 8.1**.

A summary of the strategic values of the offset areas is provided in **Table 8.1**.

Table 8.1 Summary of strategic values of the offset areas

Strategic Values	Offset Area 1	Offset Area 2	Offset Area 3	Offset Area 4	Offset Area 5	Yarran View Offset Area
Are proximate to the location of the Project	✓	✓	✓	✓	✓	✓
Contain comparable, or "like for like" vegetation community types to the vegetation within the Project Disturbance Boundary	✓	✓	✓	✓	✓	✓
Contain areas of TECs, including Box Gum Woodland	✓	✓	✓	✓	✓	✓
Contain known habitat for threatened species predicted to be impacted by the Project	✓	✓	✓	✓	✓	✓
Contain potential habitat for threatened species predicted to be impacted by the Project	✓	✓	✓	✓	✓	✓
Portions of the properties have the potential to be improved to provide additional areas of TECs	✓	✓	✓	✓	✓	✓
Portions of the properties have the potential to be improved to provide additional areas of threatened species habitat	✓	✓	✓	✓	✓	✓
Portions of the properties have the potential to be improved to provide additional connectivity across previously cleared land	✓	✓	✓	✓	✓	✓
Are connected directly to existing conservation reserves	✓				✓	✓

8.3 Adequacy of BOS

In recent years, there have been a number of approaches to evaluate the type and quantum of offsets required for major projects. This assessment has utilised the following methods:

- Ratios: Calculation of the ratios of areas of vegetation within proposed offsets and expressing such areas as a ratio for the areas of vegetation proposed to be cleared. The intention is to demonstrate that offsets are several times the size of the proposed impact area so as to provide for a net gain in biodiversity;

- NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014q): The NSW Government has developed a set of principles for assessing impacts to biodiversity values and determining acceptable offsets. Within these principles, the losses and gains of a Project and its offsets can be assessed using established assessment tools, including FBA and BBAM; and

- DoE Offset Principles (SEWPaC, 2012a): DoE has developed eight principles for determining the suitability of offsets for a Project. The *Offsets Assessment Guide*, which accompanies this policy, has been developed in order to give effect to the requirements of this policy, utilising a balance sheet approach to measure impacts and offsets.

As the SEARs did not specify the use of the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014q), the Project it not required to formally undertake an assessment in accordance with the policy. As the EIA for the Project was largely prepared prior to the introduction of the policy, surveys and reporting outlined within the policy could not be completely followed. As such, this assessment has used it as a tool for assessing the adequacy of the offsets for the Project.

8.3.1 Vegetation Removal and Offset Ratios

For the purpose of establishing minimum size thresholds for the BOS, a ratio of 5:1 for components of TECs listed under both State and Commonwealth legislation, 4:1 for components of TECs listed under State legislation and 3:1 for non-listed native vegetation has been adopted. Ideally, offsets were on a ‘like for like’ basis in that they offset identical vegetation communities, however where this was not possible, other communities have been proposed as surrogates. The required amount of offsets using the ratio method is 2,611 ha, including 959 ha of TSC Act listed Box Gum Woodland and Derived Native Grassland and 676 ha of EPBC Act listed Box Gum Woodland and Derived Native Grassland.

The BOS meets the targets established for vegetation and TECs directly impacted by the Project. The BOS provides 3,684 ha of native vegetation and provides the following offset ratios for TECs:

- 7:1 for TSC Act listed Box Gum Woodland and Derived Native Grassland;

- 9:1 for EPBC Act listed Box Gum Woodland and Derived Native Grassland; and

- 37:1 for TSC Act listed Hunter Valley Footslopes Box Gum Woodland.

The total area of native vegetation that will be supplied by the BOS in the long term will offset the predicted direct impacts of the Project. The proposed management of the offset areas will further complement the retention of remnant woodland and will also ensure that there is no net loss of habitat for the suite of species predicted to be impacted by the Project.

8.3.2 NSW Biodiversity Offsets Policy for Major Projects

The Framework for Biodiversity Assessment (FBA) is the tool used to quantify the impacts and offset requirements under the *NSW Biodiversity Offsets Policy for Major Projects*. "Credits" are the currency used within FBA and they are not specifically area measurements. Rather, they are a measure of the current quality of habitat for threatened flora and fauna.

The required amount of offsets using the FBA method is 21,741 ecosystems credits, including 6,275 ecosystem credits for TSC Act listed Box Gum Woodland and Derived Native Grassland and 5,022 ecosystem credits for EPBC Act listed Box Gum Woodland and Derived Native Grassland. The Project also requires 13,031 species credits for the Regent Honeyeater, 12 species credits for the Brush-tailed Rock-wallaby and 1,300 species credits each for the Eastern Bentwing-bat (breeding habitat) and Large-eared Pied Bat (breeding habitat).

The BOS meets the targets established for ecosystem credits directly impacted by the Project, including the targets for TECs. The BOS provides a total of 43,006 ecosystem credits. The results of the assessment indicate that the BOS provides:

- 8,690 more ecosystem credits for TSC Act listed Box Gum Woodland and Derived Native Grassland than is required;
- 7,654 more ecosystem credits for EPBC Act listed Box Gum Woodland and Derived Native Grassland than is required; and
- 5,468 more ecosystem credits for Hunter Valley Footslopes Slaty Gum Woodland than is required; and

It is estimated that the Project provides an excess of 150 species credits for the Regent Honeyeater, 2,025 species credits for the Brush-tailed Rock-wallaby, 6,264 species credits for the Eastern Bentwing-bat (breeding habitat) and 6,264 species credits for the Large-eared Pied Bat (breeding habitat).

The BOS for the Project aims to meet the principles for the provision of offsets under the *NSW Biodiversity Offsets Policy for Major Projects*. **Table 8.2** shows how each of these principles has been addressed by the BOS. The results of the assessment of the Project against the *NSW Biodiversity Offsets Policy for Major Projects* indicate that the BOS provides adequate offsets for the biodiversity predicted to be impacted by the Project.

Table 8.2 Assessment of the Project against the NSW Biodiversity Offsets Policy for Major Projects

Principle	Assessment
1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.	Changes have been made to the design of the Project to minimise disturbance to established woodland areas, in particular reduction in areas of Box Gum Woodland and Derived Native Grassland and avoidance of a large population of *Tylophora linearis*. Details of the avoidance and mitigation measures for the Project are outlined within the EIA.
2. Offset requirements should be based on a reliable and transparent assessment of losses and gains.	Extensive surveys have been conducted within the Study Area and offset areas to provide a basis for determining the losses and gains from the Project. The FBA and BBAM calculators have been used as one method to assess these losses and gains. Based on the results of this assessment, the Project will provide 43,006 ecosystem credits to offset the loss of 21,741 ecosystem credits (including provision of 14,965 ecosystems credits for TSC Act listed Box Gum Woodland and Derived Native Grassland). The Project also provides sufficient species credits for the Regent Honeyeater, Brush-tailed Rock-wallaby, Eastern Bentwing-bat and Large Eared Pied Bat.
3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.	The BOS has been developed to target the communities and species impacted by the Project. The BOS provides extensive areas of TEC vegetation. Where there is a shortfall of offsets for vegetation communities, additional areas of communities of higher conservation value have been included (e.g. additional Box Gum Woodland provided to compensate for loss of Coastal Grey Box Woodland and Fuzzy Box Woodland as there is limited availability of these communities). The offset areas also provide extensive areas of known and potential habitat for the suite of threatened species known to be impacted.
4. Offsets must be additional to other legal requirements.	The proposed offsets are supplementary in that they are proposed exclusively for the Project and are not already funded or being managed for biodiversity value for another development proposal.

CUMBERLAND ECOLOGY

Table 8.2 Assessment of the Project against the NSW Biodiversity Offsets Policy for Major Projects

Principle	Assessment
5. Offsets must be enduring, enforceable and auditable.	The proposed offset areas will be secured by an appropriate land zoning or other alternative means. A BMP will be prepared to manage the offset areas and will include provisions for ongoing monitoring and maintenance. When the offsets are formalised and a BMP is in place, it is anticipated that the Farm Manager appointed to manage KEPCO-owned land within the Study Area will oversee and coordinate activities for the purposes of biodiversity management.
6. Supplementary measures can be used in lieu of offsets.	The BOS is underpinned by the provision of substantial direct offsets.

8.3.3 DoE Environmental Offsets Policy

Under the DoE *Environmental Offsets Policy*, an offset is required if residual impacts to MNES (i.e. impacts remaining after avoidance and mitigation measures) from a project are assessed to be significant by the *Significant Impact Guidelines*.

The following MNES have been assessed using the DoE *Offsets Assessment Guide* as the residual impacts of the Project are considered significant:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (woodland and grassland components assessed separately); and
- Regent Honeyeater (*Anthochaera phrygia*).

For Box Gum Woodland and Derived Native Grassland, when woodland and components are combined, the BOS provides greater than 100% of the offset requirement through retention and management of existing habitat. The BOS also provides greater than 100% of the offset requirement for Regent Honeyeater.

The BOS for the Project aims to meet the principles for the provision of offsets under the *DoE Environmental Offsets Policy*. **Table 8.3** shows how each of these principles has been addressed by the BOS. The results of the assessment of the Project against the *DoE Environmental Offsets Policy* indicate that the BOS provides adequate offset for the MNES predicted to be significantly impacted by the Project.

CUMBERLAND ECOLOGY

Table 8.3 Assessment of the Project against the EPBC Act Environmental Offsets Policy

Principle	Assessment
1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.	The BOS has been assessed via a number of methods including the Offsets Assessment Guide. Results of these assessments indicate that the BOS will improve the viability of the relevant MNES.
2. Suitable offsets must be built around direct offsets but may include other compensatory measures.	The BOS primarily consists of direct offsets, however some supplementary measures are also proposed. All indirect offsets will be targeted towards the biodiversity values relevant to the Project. The results of the Offsets Assessment Guide indicate that the direct offsets fulfil the offsetting requirements for the species considered to be significantly impacted by the Project.
3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	The Offsets Assessment Guide, as well as the proposed ratios for the Project have taken into account the level of protection afforded to each MNES.
4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.	The Offsets Assessment Guide has taken into account the size and quality of the impact and offsets. The results of the assessment indicate that the BOS provides above the requirement for the relevant MNES through direct offsets.
5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.	The Offsets Assessment Guide takes into account the risks associated with the offsets not succeeding. The risks of the offset not succeeding have also been minimised by the provision of additional areas of direct offsets (above the 100% requirement) and the advance provision of offsets. Additionally, the risks associated with inclusion of the portion of Offset Area 5 occurring above the Subsidence Study Area have been taken into account during calculations.
6. Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.	The proposed offsets are supplementary in that they are proposed exclusively for the Project and are not already funded or being managed for biodiversity value for another development proposal.

CUMBERLAND ECOLOGY

Table 8.3 Assessment of the Project against the EPBC Act Environmental Offsets Policy

Principle	Assessment
7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.	The proposed offsets are considered to be efficient and effective, as measurable conservation gains will be achieved with reasonable investment of time and money. They are timely as they are being provided in advance of the disturbance (with the exception of any restoration works which will occur progressively) and are proposed to be long lasting. They are transparent, in that measurable conservation gains will be achieved and monitoring of results will be conducted. They are scientifically robust, and are known to produce conservation outcomes. They are reasonable, and utilise well known approaches for biodiversity conservation.
8. Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	A comprehensive BMP will be prepared for monitoring and auditing the performance of the offset lands. When the offsets are formalised and a BMP is in place, it is anticipated that the Farm Manager appointed to manage the KEPCO-owned land within the Study Area will oversee and coordinate activities for the purposes of biodiversity management.
9. In assessing the suitability of an offset, government decision-making will be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.	Not relevant to this assessment. The Offsets Assessment Guide takes into account the risks and uncertainties associated with the establishment and management of offsets. The risks of the offset not succeeding have also been minimised by the provision of additional areas of direct offsets (above the 100% requirement) and the advance provision of offsets. Additionally, the risks associated with inclusion of the portion of Offset Area 5 occurring above the Subsidence Study Area have been taken into account during calculations.
10. In assessing the suitability of an offset, government decision-making will be conducted in a consistent and transparent manner.	Not relevant to this assessment.

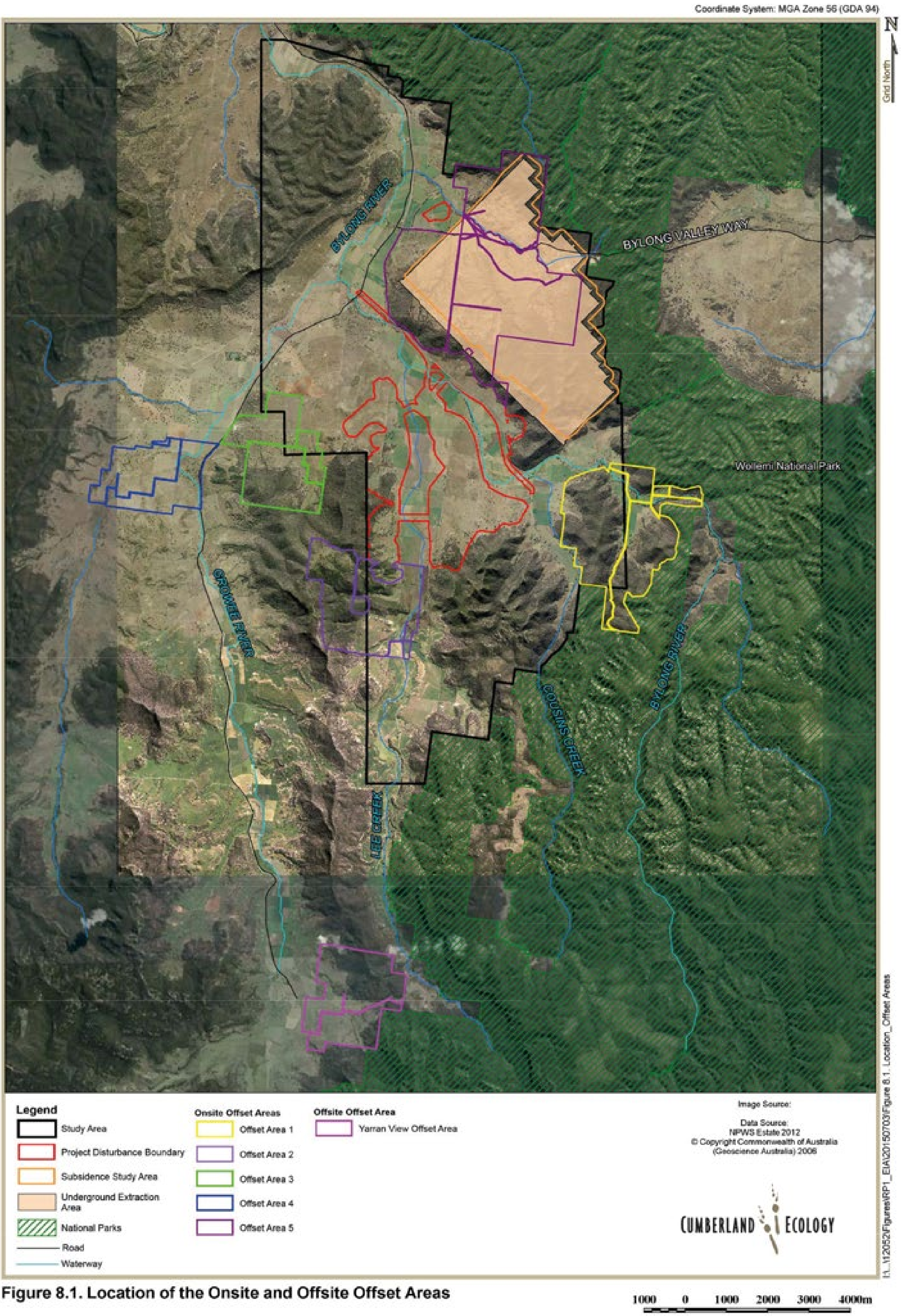


Figure 8.1. Location of the Onsite and Offsite Offset Areas

CUMBERLAND ECOLOGY

Chapter 9

Conclusion

The Project will remove up to 753 ha of native vegetation including several communities listed as TECs under the TSC Act and/or EPBC Act. This includes approximately 206 ha of TSC Act listed Box Gum Woodland and Derived Native Grassland, 135 ha of EPBC Act listed Box Gum Woodland and 11 ha of TSC Act listed Hunter Valley Footslopes Slaty Gum Woodland. Additional areas of land have the potential to be impacted by subsidence effects, however these are not expected to be significant.

The woodland vegetation within the Project Boundary provides habitat for a range of threatened species, including numerous threatened flora and fauna species as listed under the TSC Act and/or EPBC Act. A total of seven threatened flora species have known habitat within the Study Area and a further eight have potential habitat. A total of 19 listed fauna species have known habitat within the Study Area and a further 26 have potential habitat.

In recognition of the potential ecological impacts of the Project, substantial avoidance, mitigation and compensatory measures have been proposed. The considerations for reducing the ecological impacts follow a hierarchy of principles:

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

The Project will remove broad areas of vegetation and associated habitat from the Study Area in the short term. Potential impacts through subsidence effects have the potential to occur over the medium term.

A substantial BOS has been proposed to offset the predicted residual impacts of the Project. The BOS will protect approximately 3,684 ha of native vegetation. This includes a total of 1,509 ha of TSC Act listed Box Gum Woodland and Derived Native Grassland, 1,271 ha of EPBC Act listed Box Gum Woodland and 411 ha of TSC Act listed Hunter Valley Footslopes Slaty Gum Woodland. The BOS includes significant areas of known and potential habitat for the suite of species predicted to be impacted by the Project.

The proposed avoidance, mitigation and offset measures are likely to sufficiently ameliorate the impacts of the Project to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the BOS is to provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportions of native woodland in conservation tenure.

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CUMBERLAND ECOLOGY

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CUMBERLAND ECOLOGY

Appendix A

Secretary's Environmental Assessment Requirements (Ecology)

CUMBERLAND ECOLOGY

Commonwealth Department of the Environment

1 THE ACTION

The Environmental Impact Statement (EIS) must describe in detail all construction, operational and (if relevant) decommissioning components of the action. This must include the precise location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that make have impacts on matters of national environmental significance (MNES).

The description of the action must also include details on how the works are to be undertaken (including states of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.

The EIS must also include how the action related to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action.

2 THE ENVIRONMENT INCLUDING MNES

a) The EIS must include a description of the environment and management practices of the proposal site and the surrounding areas and other areas that may be affected by the action. Include the relevant MNES protected by controlling provisions of Part 3 of the EPBC Act:
   i. Listed threatened species and communities (including suitable habitat) that are or are likely to be present in the vicinity of the site, including the following details:
      o Detailed of the scope, timing/effort (survey season/s and methodology for studies or surveys used to provide information on the listed species/community/habitat at the site (and in areas that may be impacted by the project). Include details of:
      o Best practice survey guidelines are applied; and
      o How they are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements
b) a description of the important water resources within the site and in surrounding areas, which is consistent with the most recent version of the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development's *Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water* Resources, and
c) a description of water related assets that are dependent on any important water resources, including an estimation of the water requirements of those assets (i.e. regional water use)

3 IMPACTS

a) The EIS must include a description of all the relevant impacts of the action on MNES (identified in Section 2). Impacts during the construction, operational and (if relevant) the decommissioning phases of the project must be addressed, and the following information provided:
   i. a description of the relevant impacts of the action
   ii. a detailed analysis of the nature and extent of the likely direct, indirect and consequential

impacts relevant to MNES, including likely short-term and long-term impacts;

iii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;

iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts;

b) The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)

c) The EIS should also provide a detailed assessment of any likely impact that this proposed action may facilitate on the relevant MNES at the local, regional, state, national and international scale.

d) The documentation provided must also include information addressing all relevant impacts on water resources and water related values. This must include, but not be limited to, potential impacts to Matters of National Environmental Significance. The information must be consistent with the most recent version of the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development's *Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water* Resources, which is available at http://www.environment.gov.au/coal-seam-gas-mining/.

4 AVOIDANCE AND MITIGATION MEASURES / ALTERNATIVES

Avoidance and Mitigation Measures

The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action on MNES.

The EIS also must take into account relevant agreements and plan that cover impacts on MNES including, but not limited to:

- any recovery plan, conservation advice for the species or community;
- any threat abatement plan for a process that threatens the species;
- any wildlife conservation plan for the species; and
- any Strategic Assessment

The EIS must include, and substantiate, specific and detailed descriptions of the proposed avoidance and mitigation measures, based on best available practices and must include the following elements:

a) A consolidated list of avoidance and mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action on MNES, including:

i. a description of the proposed avoidance and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State/Territory governments, local governments or the proponent;

ii. assessment of the expected or predicted effectiveness of the mitigation measures, including the scale and intensity of impacts of the proposed action and the on-ground benefits to be gained through each of these measures;

iii. a description of the outcomes that the avoidance and mitigation measures will achieve;

iv. any statutory of policy basis for the mitigation measures; and

v. the cost of the mitigation measures

b) A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant

CUMBERLAND ECOLOGY

MNES impacts of the action, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing.

c) Where appropriate, each project phase (construction, operation, decommission) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue.

d) The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.

<u>Alternatives</u>

The EIS must include any feasible alternatives to the action to the extent reasonably practicable, including:

a) if relevant, the alternative of taking no action;

b) a comparative description of the impacts of each alternative on the NES matters protected by controlling provisions of Part 3 of the EPBC Act for the action; and

c) sufficient detail to make clear why any alternative is preferred to another.

Short, medium and long-term advantages and disadvantages of the options must be discussed.

5 RESIDUAL IMPACTS / OFFSETS

The EIS must provide details of:

a) the likely residual impacts on MNES that are likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account.

   i. Include the reasons why avoidance or mitigation of impacts is not reasonably achieved; and

   ii. Identify the significant residual impacts on MNES.

<u>Offset Package (if relevant)</u>

The EIS must include details of an offset package to be implemented to compensate for the residual significant impact of the project, as well as an analysis about how the offset meets the requirements in the Department's *Environment Protect and Biodiversity Conservation Act 1999* Environmental Offsets Policy October 2012 (EPBC Act Offset Policy).

The offset package can comprise a combination of direct offsets and other compensatory measures, so long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected mater that is impacted in order to deliver a conservation gain.

Offsets should compensate for an impact for the full duration of the impact.

Offsets must directly contribute to the ongoing viability of the MNES impacted by the project and deliver an overall conservation outcome that improves or maintains the viability of the MNES as compared to what is likely to have occurred under the status quo, that is if neither the action not the offset had taken place.

Note offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.

Offsets required by the State/Territory can be applied if the offsets meet the Department's EPBC Act Offset Policy.

The EIS must provide:

a) Details of the offset package to compensate for significant residual impacts on MNES; and
b) An analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.

Further details of information requirements for EPBC Act offset proposals are provided at Appendix B.

6 ENVIRONMENTAL RECORD OF PERSON(S) PROPOSED TO TAKE THE ACTION

The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

a) the person proposing to take the action; and
b) for an action for which a person has applied for a permit, the person making the application.

If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.

7 ECONOMIC AND SOCIAL MATTERS

The economic and social impacts of the action, both positive and negative, must be analysed. Matters of interest may include:

a) details of any public consultation activities undertaken, and their outcomes;
b) details of any consultation with Indigenous stakeholders.
c) projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis of similar studies;
d) employment opportunities expected to be generated by the project (including construction and operational phases).

Economic and social impacts should be considered at the local, regional and national levels. Details of the relevant cost and benefits of alternative options to the proposed action, as identified in Section 4 above, should also be included.

8 INFORMATION SOURCES PROVIDED IN THE EIS

For information given in the EIS, state:

a) the source of the information;
b) how recent the information is;
c) how the reliability of the information was tested;
d) what uncertainties (if any) are in the information; and

CUMBERLAND ECOLOGY

e) what guidelines, plans and/or policies did you consider

9 CONCLUSION

An overall conclusion as to the environmental acceptability of the proposal on MNES, including:

a) a discussion on the consideration with the requirements of the EPBC Act, including the objects of the EPBC Act, the principles of ESE and the precautionary principle (Appendix C);

b) reasons justifying undertaking the proposal on the manner proposed, including the acceptability of the avoidance and mitigation measures; and

c) if relevant, a discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on MNES< and the relative degree of compensation and acceptability.

NSW Office of Environment and Heritage

1. Environmental impacts of the project

Impacts related to the following environmental issues need to be assessed, quantified and reported on:

a) Cumulative impact

b) Aboriginal cultural heritage

c) Biodiversity

d) OEH Estate (Land reserved or acquired under the NPW Act)

e) Subsidence

f) Greenhouse gas

Environmental assessments (EAs) should address the specific requirements outlined under each heading below and assess impacts in accordance with the relevant guidelines mentioned. A full list of guidelines is at Attachment 2.

2. Cumulative impact

The cumulative impacts from all clearing activities and operations, associated edge effects and other indirect impacts on cultural heritage, biodiversity and OEH Estate need to be comprehensively assessed in accordance with the *Environmental Planning and Assessment Act 1979*.

This should include the cumulative impact of the proponent's existing and proposed development and associated infrastructure (such as access tracks etc) as well as the cumulative impact of other developments located in the vicinity. This assessment should include consideration of both construction and operational impacts.

3. Aboriginal cultural heritage

The EA report should contain:

1. A description of the Aboriginal objects and declared Aboriginal places located within the area of the proposed development.
2. A description of the sensitivity (in relation to cultural heritage) of different landforms present in the landscape affected by the project.

CUMBERLAND ECOLOGY

3. A description of the cultural heritage values, including the significance of the Aboriginal objects and declared Aboriginal places, that exist across the whole area that will be affected by the proposed development, and the significance of these values for the Aboriginal people who have a cultural association with the land.
4. A description of how the requirements for consultation with Aboriginal people as specified in clause 80C of the *National Parks and Wildlife Regulation 2009* have been met.
5. The views of those Aboriginal people regarding the likely impact of the proposed development on their cultural heritage. If any submissions have been received as a part of the consultation requirements, then the report must include a copy of each submission and your response.
6. A description of the actual or likely harm posed to the Aboriginal objects or declared Aboriginal places from the proposed activity, with reference to the cultural heritage values identified.
7. A description of any practical measures that may be taken to protect and conserve those Aboriginal objects or declared Aboriginal places.
8. A description of any practical measures that may be taken to avoid or mitigate any actual or likely harm, alternatives to harm or, if this is not possible, to manage (minimise) harm.
9. Documentation of discussions with the Aboriginal stakeholders regarding commitments from the proponent related to social, economic and/or conservation gains to offset any loss of cultural heritage.
10. A specific Statement of Commitment that the proponent will complete an Aboriginal Site Impact Recording Form and submit it to the Aboriginal Heritage Information Management System (AHIMS) Registrar, for each AHIMS site that is harmed through the proposed development.

In addressing these requirements, the proponent must refer to the following documents:

a. *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (Department of Planning, 2005). These guidelines identify the factors to be considered in Aboriginal cultural heritage assessments for development proposals under Part 3A of the EP&A Act.
b. *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010) - This document further explains the consultation requirements that are set out in clause 80C of the National Parks and Wildlife Regulation 2009. The process set out in this document must be followed and documented in the Environmental Assessment Report. This document can be found at: http://www.environment.nsw.gov.au/licences/consultation.htm.
c. *Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010) - The process described in this Code should be followed and documented where the assessment of Aboriginal cultural heritage requires an archaeological investigation to be undertaken. This document can be found at: http://www.environment.nsw.gov.au/licences/archinvestigations.htm.

4. Biodiversity

Biodiversity impacts can be assessed using either the BioBanking Assessment Methodology (scenario 1) or a detailed biodiversity assessment (scenario 2). The requirements for each of these approaches are detailed below.

CUMBERLAND ECOLOGY

The BioBanking Assessment Methodology can be used either to obtain a BioBanking statement, or to assess impacts of a proposal and to determine required offsets without obtaining a statement. In the latter instances, if the required credits are not available for offsetting, appropriate alternative options may be developed in consultation with OEH officers and in accordance with the *'NSW OEH interim policy on assessing and offsetting biodiversity impacts of Part 3A, State significant development (SSD) and State significant infrastructure (SSI) projects.'*

Scenario 1 - Where a proposal is assessed using the BioBanking Assessment Methodology (BBAM)

1. Where a BioBanking Statement is being sought under Part 7A of the *Threatened Species Conservation* Act 1995 (TSC Act), the assessment must be undertaken by an accredited BioBanking assessor (as specified under Section 142B (1)(c) of the TSC Act 1995) and done in accordance with the *BioBanking Assessment Methodology and Credit Calculator Operational Manual* (DECCW, 2009). To qualify for a BioBanking Statement a proposal must meet the 'improve or maintain' standard.

1a. The Environmental Impact Statement (EIS) should include a specific Statement of Commitments that reflects all requirements of the BioBanking Statement including the number of credits required and any DG approved variations to impact on Red Flags.

2. Where the BioBanking Assessment Methodology is being used to assess impacts of a proposal and to determine required offsets, and a BioBanking Statement is not being obtained, the EIS should contain a detailed biodiversity assessment and all components of the assessment must be undertaken in accordance with the *BioBanking Assessment Methodology and Credit Calculator Operational Manual* (DECCW, 2009).

2a. The EIS should include a specific Statement of Commitments which:

   a. is informed by the outcomes of the proposed BioBanking assessment offset package;
   b. sets out the ecosystem and species credits required by the BioBanking Assessment Methodology and how these ecosystem and/or species credits will be secured and obtained;
   c. if the ecosystem or species credits cannot be obtained, provides appropriate alternative options to offset expected impacts, noting that an appropriate alternative option may be developed in consultation with OEH officers and in accordance with OEH policy;
   d. demonstrates how all options have been explored to avoid red flag areas; and
   e. includes all relevant BioBanking files (e.g. *.xml output files), data sheets, underlying assumptions (particularly in the selection of vegetation types from the vegetation types database), and documentation (including maps, aerial photographs, GIS shape files, other remote sensing imagery etc.) to ensure that the OEH can conduct an appropriate review of the assessment.

3. Where the *'NSW OEH interim policy on assessing and offsetting biodiversity impacts of Part 3A, State significant development (SSD) and State significant infrastructure (SSI) projects'* is being used then the proponent must stipulate which level(s) of offset is being offered in relation to each of the vegetation communities and threatened species that require species credits. In accordance with the interim policy, justification must be provided as to why it is appropriate to apply the Tier 2 ('no net loss') or Tier 3 ('mitigated net loss') outcomes. In considering whether the mitigated net loss standard is appropriate, justification must be provided on: (i) whether the credits required by the calculator are available on the market; (ii) whether alternative offset sites (other than credits)

are available on the market; and (iii) the overall cost of the offsets and whether these costs are reasonable given the circumstances'. This must be to satisfaction of, and in consultation with, OEH.

4. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby OEH estate reserved under the *National Parks and Wildlife Act 1974* or any marine and estuarine protected areas under the *Fisheries Management Act 1994* or the *Marine Parks Act 1997* should be considered. Please refer to the *Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water* (DECCW, 2010).
5. With regard to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the assessment should identify and assess any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.

Scenario 2 - Where a proposal is assessed outside the BioBanking Assessment Methodology:

1. The EIS should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. This assessment should address the matters included in the following sections.
2. A field survey of the site should be conducted and documented in accordance with relevant guidelines, including:
   a. the *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna -Amphibians* (DECCW, 2009);
   b. *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004); and
   c. Threatened species survey and assessment guideline information on www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm.
   d. Commonwealth assessment requirements (birds, bats, reptiles, frogs, fish and mammals):http://www.environment.gov.au/topics/environment-protection/environmentassessments. These are relevant when species or communities listed under the *Environment Protection and Biodiversity Conservation Act* are present.

   It is preferable for proponents to use the Interim Vegetation Mapping Standard data form to collect the vegetation plot data for the project site, and any offset site associated with the project. This will provide data that is useful for vegetation mapping as well as in the BioBanking Assessment Methodology. This is available at http://www.environment.nsw.gov.au/research/VISplot.htm.

   If a proposed survey methodology is likely to vary significantly from the above methods, the proponent should discuss the proposed methodology with the OEH prior to undertaking the EIS, to determine whether the OEH considers that it is appropriate.

   Recent (less than five years old) surveys and assessments may be used. However, previous surveys should not be used if they have:
   a. been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are unlikely to be detected or present, or

CUMBERLAND ECOLOGY

b. utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species,

unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the surveys. If a previous survey is used, any additional species listed under the TSC Act since the previous survey took place, must be surveyed for.

Determining the list of potential threatened species for the site must be done in accordance with the T*hreatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004) and the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005).

The OEH website (http://www.environment.nsw.gov.au/threatenedspecies/) and the *Atlas of NSW Wildlife* database must be the primary information sources for the list of threatened species present.

The BioBanking Threatened Species Database (http://www.environment.nsw.gov.au/threatenedSpeciesApp/), the Vegetation Types databases http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm) and other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http://ozcam.org.au/), previous or nearby surveys etc.) may also be used to compile the list.

3. The EIS should contain the following information as a minimum:
   a. The requirements set out in the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005);
   b. Description and geo-referenced mapping of study area (and associated spatial data files), e.g. overlays on topographic maps, satellite images and /or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (using the plant community types from OEH's vegetation type database – see above), key habitat features and reported locations of threatened species, populations and ecological communities present in the subject site and study area. Separate spatial files (.shp format) to be provided to the OEH should include, at a minimum, shapefiles of the project site, impact footprint, vegetation mapping and classification for both the impact and any offset site(s);
   c. Description of survey methodologies used, including timing, location and weather conditions;
   d. Detailed description of vegetation communities (including classification and methodology used to classify) and including all plot data. The vegetation classification used needs to be matched with Biometric and Endangered Ecological Community classifications. The condition of vegetation needs to be documented including areas of derived grassland. Plot data should be supplied to the OEH in electronic format (eg MS-Excel) and organised by vegetation community;
   e. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EIS;
   f. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status;

g. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor;

h. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed;

i. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below); and

j. Provision of specific Statement of Commitments relating to biodiversity.

4. An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the study area based on the presence of suitable habitat. This assessment must take into account:

   a. the factors identified in s.5A of the EP&A Act; and

   b. the guidance provided by *The Threatened Species Assessment Guideline – The Assessment of Significance (DECCW, 2007)* which is available at: http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf

5. Where an offsets package is proposed by a proponent for impacts to biodiversity (and a BioBanking Statement has not been sought) this package should:

   a. Meet either the OEH's *Principles for the use of biodiversity offsets in NSW*[1], (www.environment.nsw.gov.au/biocertification/offsets.htm) or the *'NSW OEH interim policy on assessing and offsetting biodiversity impacts of Part 3A, State significant development (SSD) and State significant infrastructure (SSI) projects'*;

   b. Take account of landscape design principles such patch size and building onto and connecting existing remnants;

   c. Identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites; and

   d. Include an appropriate Management Plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat enhancement features within the development footprint and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.

6. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby OEH estate reserved under the *National Parks and Wildlife Act 1974* or any marine and estuarine protected areas under the *Fisheries Management Act 1994* or the *Marine Parks Act 1997* should be considered. Refer to the *Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water* (DECC, 2010).

7. With regard to the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the assessment should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.

CUMBERLAND ECOLOGY

5. OEH estate

Land reserved or acquired under the National Parks and Wildlife Act 1974 (NPW Act).

The EA should include:

8. Consideration of the matters identified in the *Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECCW 2010)*.
9. A description of the mitigation and management options that will be used to prevent, control, abate or minimise identified impacts associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

6. Subsidence

The EA should include a comprehensive assessment of, and report on, the project's predicted subsidence and its impacts. Factors which should be investigated include:

- identification of all natural features and how impacts to these will be avoided, mitigated and offset. Natural features of particular concern that will need to be specifically addressed include (but are not restricted to); swamps such as shrub swamps and hanging swamps, pagodas, overhangs, art sites and talus slopes,
- potential risks to swamps by longwall mining as a consequence of tensile or compressive strains cracking bedrock and water draining into the fracture zone,
- whether the water loss impact will be temporary until the storage is filled or, if the fracture zone is connected to a source of escape (e.g. a deeper aquifer or bedding shear pathway to an open hillside), then whether it is possible for sufficient water to drain to alter the hydrologic balance of the swamp.
- potential effects on stream flow of alterations,
- the potential for geological structures such as faults, lineaments and joint sets to interact with longwall mining to increase subsidence and lead to unexpected outcomes.

Monitoring of flow:

Water lost from a swamp or stream as a result of subsidence induced fracturing will clearly impact on the downstream hydrology of the creeks/streams of the area. There is no certainty that all this water comes back into the creek, unless this can be backed up by an appropriate monitoring design that clearly demonstrates the return of any lost water to the stream system.

The EIS should outline a flow monitoring program in sufficient detail to provide unambiguous assessment of either impact or lack of impact on stream flows.

Monitoring of vegetation:

If water is lost from a swamp as a result of subsidence induced fracturing, vegetation impacts are highly likely to occur but unlikely to become evident for a significant time period after fracturing and draining. The EIS should outline a swamp vegetation monitoring program in sufficient detail to provide unambiguous assessment of either impact or lack of impact.

CUMBERLAND ECOLOGY

7. Greenhouse gas

1. The EA should include a comprehensive assessment of, and report on, the project's predicted greenhouse gas emissions (tCO2e). Emissions should be reported broken down by:
    a. direct emissions (scope 1 as defined by the Greenhouse Gas Protocol – see reference below),
    b. indirect emissions from electricity (scope 2), and
    c. upstream and downstream emissions (scope 3),
    d. before and after implementation of the project, including annual emissions for each year of the project (construction, operation and decommissioning).
2. The EA should include an estimate of the greenhouse emissions intensity (per unit of production). Emissions intensity should be compared with best practice if possible.
3. The emissions should be estimated using an appropriate methodology, in accordance with NSW, Australian and international guidelines (see below).
4. The proponent should also evaluate and report on the feasibility of measures to reduce greenhouse gas emissions associated with the project. This could include a consideration of energy efficiency opportunities or undertaking an energy use audit for the site.

8. GIS layers

The proponent must include with their Environmental Assessment to OEH spatial layer(s) that detail the:

- Mining Lease (ML) / Application boundary;
- Proposed Extraction Approval Area;
- All ancillary Infrastructure;
- Boundary of any offset sites;
- Vegetation mapping for both the impact and any offset site(s); and
- Vegetation sample plot location for both the impact and offset site(s).

This information must be provided in an Esri geodatabase (9.3) or shapefile format, or any esri compatible dataset in GDA or MGA 94.

Distribution records for plants and animal species in a format suitable to upload to the NSW Wildlife Atlas. See http://www.environment.nsw.gov.au/wildlifeatlas/about.htm#contribute

Department of Primary Industries (Fisheries NSW)

The proposed assessment of the aquatic habitats should also include:

- an assessment of those areas upstream that my contain permanent refuge areas and,
- if found, a sampling component to determine potential impacts on migratory species.

Department of Primary Industries (NSW Office of Water)

Groundwater Depended Ecosystems

It is suggested the EIS considered the potential impacts on any Groundwater Dependent Ecosystems

CUMBERLAND ECOLOGY

(GDEs) at the site and in the vicinity of the site and:

- Identify any potential impacts on GDEs as a result of the proposal including:
    - the effect of the proposal on the recharge to groundwater systems;
    - the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections; and
    - the effect on the function of GDEs (habitat, groundwater levels, connectivity)
- Provide safeguard measures for any GDEs

NSW Department of Resources and Energy

- An assessment of the biological resources associated with the proposed disturbance area and how they can be practically salvaged for utilisation in rehabilitation (i.e. topsoil, seed banks, tree hollows and logs, native seed etc.). This should include an evaluation of how topsoil/subsoil of suitable quality can be direct-returned for use in rehabilitation.
- The flora, fauna and ecological attributed of the disturbed area should be recorded and placed in a regional context.

NSW EPA

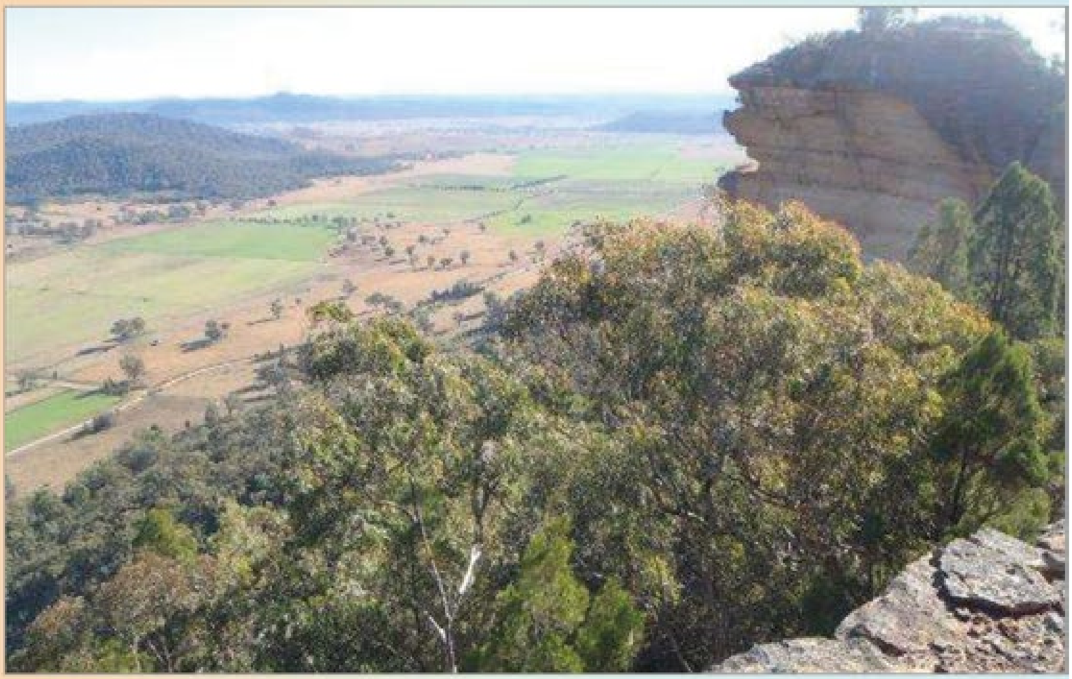
13. Assess impacts on groundwater and groundwater dependent ecosystems

Appendix B

Eastcoast Flora Survey Report

2014

Assessment and mapping of vegetation in the Bylong Valley: Authorisations 287 & 342



December 2014

Final Report to

Hansen Bailey Pty Ltd
PO Box 473
Singleton NSW 2330

Stephen Bell & Colin Driscoll

Eastcoast Flora Survey
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Cover image: View looking north-west across the Bylong Valley.

Report produced for:

Hansen Bailey Pty Ltd
PO Box 473
Singleton NSW 2330

Project Manager: Nathan Cooper (Environmental Scientist)

EXECUTIVE SUMMARY

Vegetation survey and mapping of two Authorisations (287 & 342: collectively covering 10,312 ha) in the Bylong Valley of New South Wales has revealed the presence of twenty-four (24) vegetation communities and over 450 plant species. Numerical classification of sixty-six (66) full floristic sample plots has been undertaken to delineate vegetation communities, and maps prepared showing their current-day distribution. In addition, a pre-1750 vegetation map has been constructed using topographical features and over 2700 rapid floristic data points, to assist in the determination of derived native grasslands that may meet the requirements of specific threatened ecological communities.

In summary, vegetation of significance within the Project Boundary includes:

- The Nationally-listed threatened ecological community *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland & Derived Grasslands*.
- The State-listed threatened ecological communities *Hunter Floodplain Redgum Woodland; Hunter Valley Footslopes Slaty Gum Woodland;* and *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland*.
- The Nationally-listed threatened plant species *Ozothamnus tesselatus* and *Tylophora linearis*.
- The State-listed threatened plant species *Acacia pendula* (Hunter Valley population); *Cymbidium canaliculatum* (Hunter Valley population); *Eucalyptus camaldulensis* (Hunter Valley population); *Diuris tricolor; Ozothamnus tesselatus; Pomaderris queenslandica;* and *Tylophora linearis*.
- Two (2) regionally significant vegetation communities both of which have been very heavily depleted through agricultural activities in the region. Coastal Grey Box Woodland and Fuzzy Box Woodland occur on gently undulating slopes of colluvial and alluvial soils, and are now represented by scattered paddock trees or small remnant patches.
- Fourteen (14) regionally significant plant taxa, representative of extensions to or at limits of geographical ranges, or few records in the region.
- Three (3) potential new plant species: *Grevillea* sp. aff. *patulifolia*/*sericea*; *Hibbertia* sp. aff. *acicularis*; *and Sannantha* sp. aff. *cunninghamii*, the taxonomy of which will be progressed with relevant expert taxonomists.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Background

In December 2010 KEPCO Bylong Australia Pty Ltd (KEPCO) acquired Authorisations (A) 287 and 342. Since this time, extensive exploration and mine planning work has been undertaken to determine the most socially responsible and economically viable mine plan to recover the known coal resources within the two Authorisations.

In August 2014 KEPCO commissioned WorleyParsons Services Pty Ltd (WorleyParsons) to manage the Project exploration activities, mine feasibility study planning, environmental approvals and ongoing environmental monitoring for the Bylong Coal Project (the Project).

The Project is located wholly within A287 and A342 which are located within the Mid-Western Regional Council (MWRC) Local Government Area (LGA). The closest regional centre is Mudgee, located approximately 55 km south-west of the Project Boundary. The Project is approximately 230 km by rail from the Port of Newcastle Figure 1 illustrates the locality of the Project within New South Wales (NSW). Figure 2 shows the regional locality of the Project in relation to the neighbouring town centres, mining authorities, major transport routes and reserves.

KEPCO is seeking State Significant Development Consent under Division 4.1 of Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the development and operation of the Project. The State Significant Development Application will be supported by an Environmental Impact Statement (EIS) which is being prepared by Hansen Bailey.

Eastcoast Flora Survey has been commissioned to undertake an assessment of vegetation within the Project Boundary (Authorisations A287 and A342: see Section 1.3). This assessment includes the preparation of a vegetation community map, and the identification of threatened plants and ecological communities. Initially, only the low-lying lands within the Project Boundary were assessed, awaiting access to individual properties to be arranged (the Stage 1 area). From mid-2013 the more rugged parts of the Project Boundary, including the Bylong State Forest, were examined (Stage 2). On completion of Stage 1, a report summarising the findings on the low-lying areas of the Project Boundary was prepared (Bell & Driscoll 2013). The current report details the results of investigations into the Stage 2 area, and presents a combined assessment of the vegetation within the entire Project Boundary.

1.2 Project Description

The Project life is anticipated to be approximately 25 years, comprising a two year construction period and a 23 year operational period, with underground mining operations commencing in Year 7. Various rehabilitation and decommissioning activities will be undertaken during both the course of, and following the 25 years of the Project. It is noted that further mineable coal resources exist within both A287 and A342.

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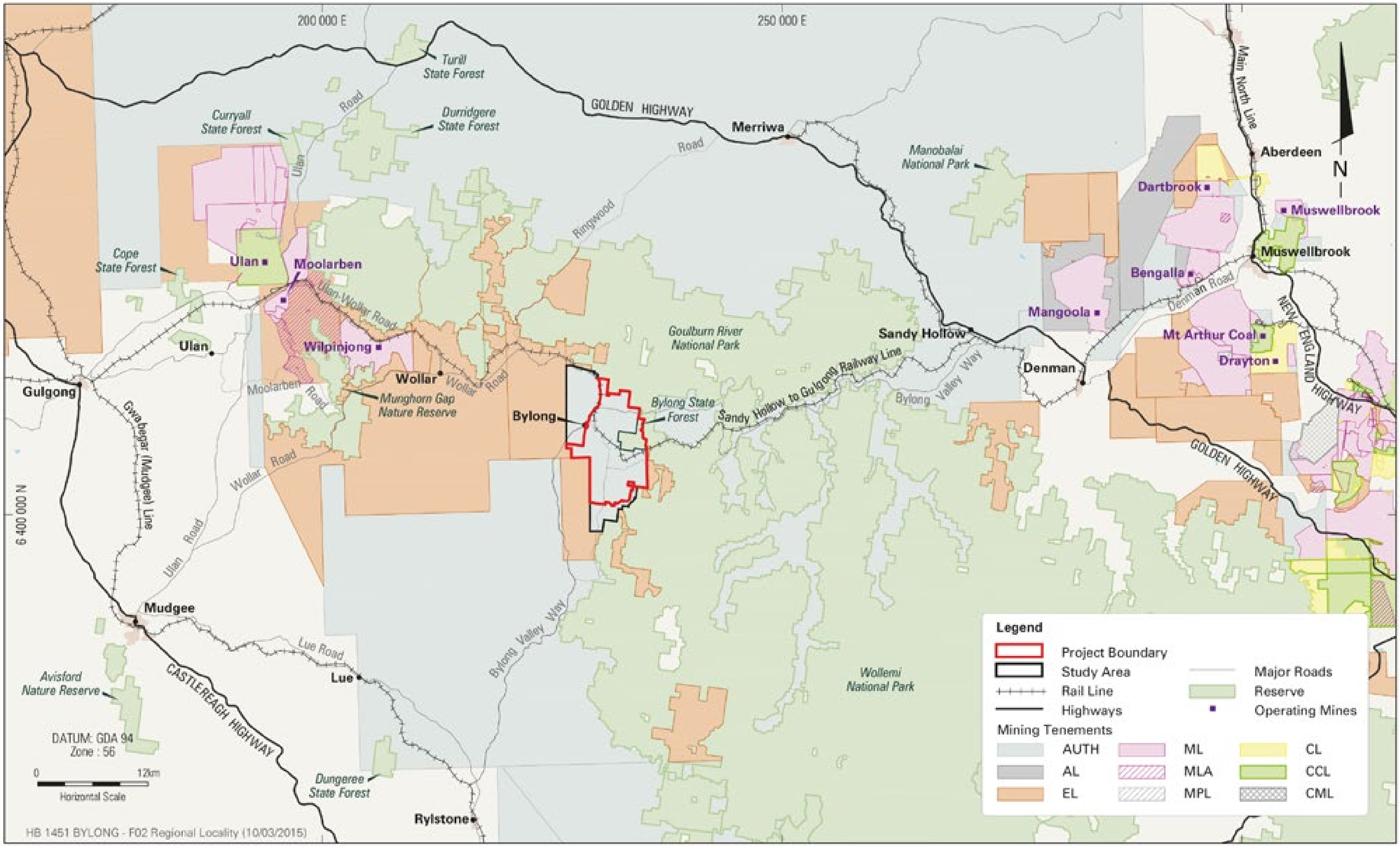
Locality Plan

FIGURE 1



BYLONG COAL PROJECT

Regional Locality

FIGURE 2

The Project is to be developed on land within the Project Boundary as illustrated on Figure 3. Key features of the Project are conceptually shown on Figure 3 and include:

- The initial development of two open cut mining areas with associated haul roads and Overburden Emplacement Areas (OEAs), utilising a mining fleet of excavators and trucks and supporting ancillary equipment;
- The two open cut mining areas will be developed and operated 24 hours a day, 7 days a week over an approximate 10 year period and will ultimately provide for the storage of coal processing reject materials from the longer term underground mining activities;
- Construction and operation of administration, workshop, bathhouse, explosives magazine and other open cut mining related facilities;
- Construction and operation of an underground coal mine operating 24 hours a day, 7 days a week for a 20 year period, commencing mining in around year 7 of the Project;
- A combined maximum extraction rate of up to 6.5 Million tonnes per annum (Mtpa) Run of Mine (ROM) coal;
- A workforce of up to approximately 800 during the initial construction phase and a peak of 470 full-time equivalent operations employees at full production;
- Underground mining operations utilising longwall mining techniques with primary access provided via drifts constructed adjacent to the rail loop and Coal Handling and Preparation Plant (CHPP);
- The construction and operation of facilities to support underground mining operations including personnel and materials access to the underground mining area, ventilation shafts, workshop, offices and employee amenities, fuel and gas management facilities;
- Construction and operation of a CHPP with a designed throughput of approximately 6 Mtpa of ROM coal, with capacity for peak fluctuations beyond this;
- The dewatering of fine reject materials through belt press filters within the CHPP and the co-disposal of dewatered fine and coarse reject materials within OEAs and final open cut voids (avoiding the need for a tailings dam);
- Construction and operation of a rail loop and associated rail load out facility and connection to the Sandy Hollow to Gulgong Railway Line to facilitate the transport of product coal;
- The construction and operation of surface and groundwater management and water reticulation infrastructure including diversion drains, dams (clean, dirty and raw water), pipelines and pumping stations;
- The installation of communications and electricity reticulation infrastructure;
- Construction and operation of a Workforce Accommodation Facility (WAF) and associated access road from the Bylong Valley Way;

- The upgrade of Upper Bylong Road and the construction and operation of a Mine Access Road to provide access to the site facilities;
- Relocation of sections of some existing public roads to enable alternate access routes for private landholders surrounding the Project; and
- Infilling of mining voids, progressive rehabilitation of disturbed areas, decommissioning of Project infrastructure and rehabilitation of the land progressively following mining operations.

1.3 Assessment Brief

This report addresses the following assessment aims, inferred from the original brief:

1. Survey and classify the vegetation within the Project Boundary into floristic groups using numerical analysis techniques;
2. Map the distribution of the various floristic groups apparent within the two Authorisations;
3. Survey for threatened plant species, at appropriate seasons;
4. Report on the findings of the study, including assessments of significance and the provision of Geographical Information System (GIS) map layers depicting the distribution of vegetation types, threatened ecological communities and threatened species.

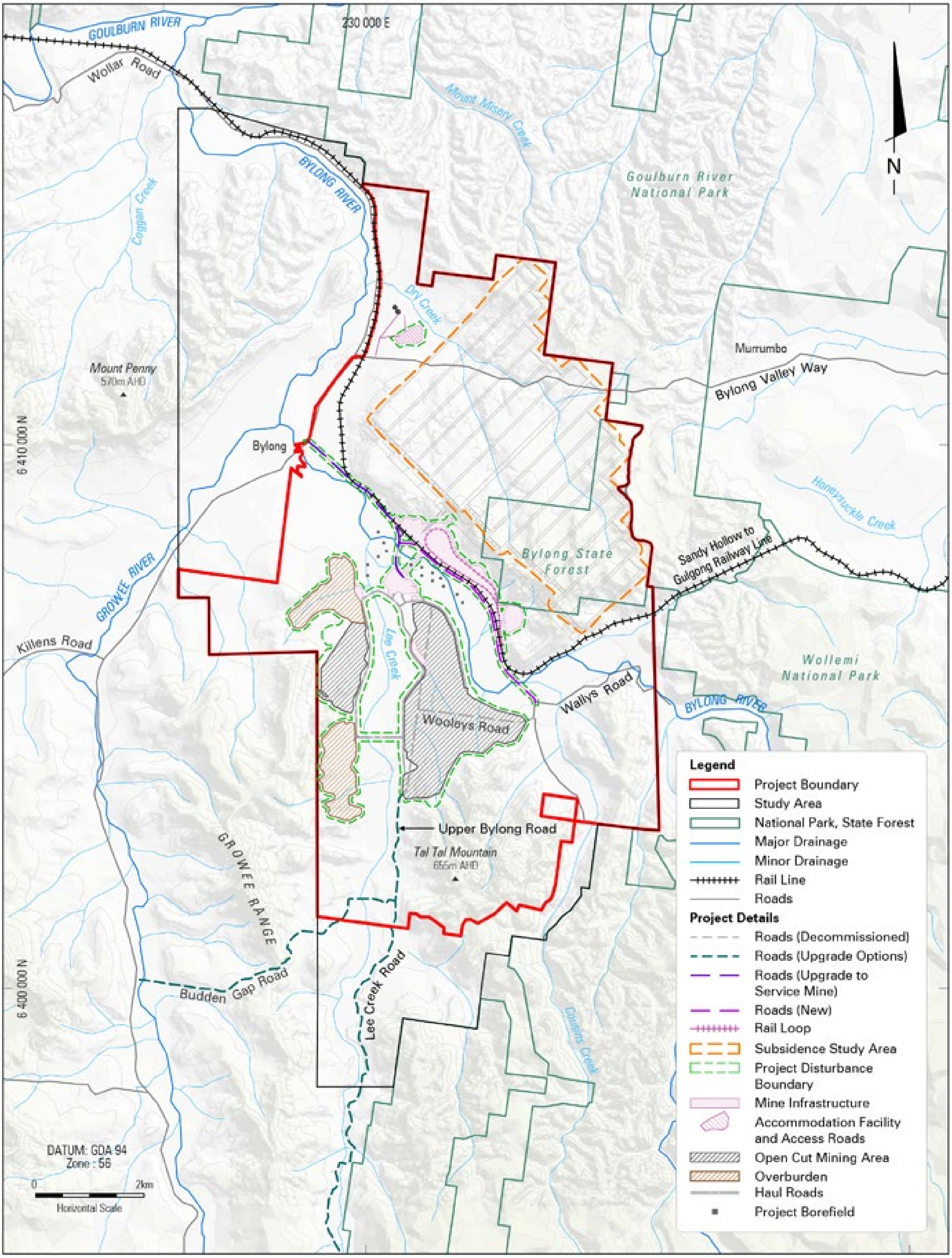
Previous reporting (Bell & Driscoll 2013) has presented data and mapping for Stage 1; this data has now been incorporated with Stage 2 to provide a full assessment of the Project Boundary area. Additional floristic and BioBanking data collected by Cumberland Ecology in some parts of the Project Boundary have also been utilised in this report.

1.4 Project Boundary

The total area of the Bylong Valley Authorisations is 10,312ha (A287 and A342). This land adjoins Goulburn River National Park in the north and east, and Wollemi National Park in the east and south. To the immediate west lie largely private and Crown lands, including the now disbanded Mt Penny Project, while Bylong State Forest falls within Authorisation 287 (see Figure 3). Stage 1 incorporated low-lying properties where agricultural practices have been operating for 100 years or more, while the majority of the Stage 2 lands remain relatively unimpacted by European occupation.

1.5 Previous Studies

A number of vegetation studies relevant to the Bylong Valley have been completed over the years. These provide important contextual information on the diversity of vegetation communities and the occurrence of significant plant species. Principal among these are:



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Conceptual Project Layout

FIGURE 3

Wollemi National Park - survey, classification and mapping of Wollemi National Park, adjoining the current Project Boundary along the eastern boundary, was completed by Bell (1998). This work provided the first comprehensive assessment of that 500,000 ha Park, identifying 72 communities and 70 rare or threatened plant species. Classification and mapping for this park is current being revised using improved techniques, parts of which are available for review (NSW DEC 2006; NSW DECC 2008a; NSW OEH 2012a). The North-west portion of the park, directly relevant to the current study, has been released and covers a portion of the current Project Boundary (NSW OEH 2012a).

Goulburn River National Park - Hill (1999) provided the first comprehensive classification and mapping project for Goulburn River National Park, which adjoins the current Project Boundary on the northern side. In that study, 27 communities were defined and several significant plant species recorded.

Bylong State Forest - no vegetation survey or mapping specific to Bylong State Forest has been completed, however it has been included in the revision of Wollemi NP currently underway by NSW OEH (see NSW OEH 2012a). Limited ground survey was undertaken in Bylong State Forest as part of that project.

Mt Penny Coal Mine - initial assessments of the now disbanded Mt Penny Project, immediately adjacent to the western boundary of the current Project Boundary, were undertaken by Eco Biological Pty Ltd (2010), with a summary provided in Wells Environmental Services (2011). This study revealed the presence of 13 vegetation communities, including vegetation equivalent to the State-listed *Hunter Valley Footslopes Slaty Gum Woodland EEC* and *White Box-Yellow Box-Blakely's Red Gum Woodland EEC*, and the Commonwealth-listed *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.* Also recorded were three threatened species (*Diuris tricolor, Ozothamnus tesselatus, Pomaderris queenslandica*), two Endangered Populations (*Cymbidium canaliculatum, Eucalyptus camaldulensis*), and two rare species (*Gonocarpus longifolius, Pomaderris precaria*). For the Vulnerable *Diuris tricolor*, populations in excess of 30,000 individuals have been recorded in recent years in and around the Mt Penny locality (NSW OEH Atlas).

Wilpinjong Coal Mine - located to the west of the current Project Boundary, the Wilpinjong Coal mine occupies similar landscapes and supports similar threatened species and vegetation. FloraSearch (2005) undertook a detailed assessment of the flora of this area, and described eight vegetation communities, including the *White Box - Yellow Box - Blakely's Redgum Grassy Woodland* Threatened Ecological Community (TEC). One threatened plant species (*Eucalyptus cannonii*) was recorded, along with the rare *Boronia angustisepala* and *Gonocarpus longifolius*, and a potential new species of *Chrysocephalum*. Further survey work is ongoing on lands associated with this mine.

Greater Hunter Vegetation Mapping - NSW OEH (2012b) have released a regional classification and mapping product for the Hunter Central Rivers Catchment Management Area, largely based on the earlier work of Somerville (2010). The distribution of 253 vegetation communities have been modelled and brief descriptions provided. Being regional in application, its use locally is limited. No information on threatened plant species is included in this work, apart from occasional inclusion of such species in community profiles.

1.6 Significant Species & Communities: Existing Records

Significant Plant Species - annotated notes of the ~100 threatened or rare plant species known from Wollemi National Park and surrounding areas were published in Bell (2001) and Bell (2008). These include the recently described *Eucalyptus expressa* (Bell & Nicole 2012) and the undescribed new species *Eucalyptus* sp. aff. *fibrosa* (Klaphake 2010), both of which potentially occur within the Project Boundary.

Table 1 summarises the threatened plant species and endangered populations considered to potentially occur within the Project Boundary, based on the Office of Environment & Heritage Wildlife Atlas (10km radius), and gleaned from other studies.

Table 1 Summary of threatened plant species previously recorded for the Project Boundary and surrounds [E = Endangered; V = Vulnerable; EP = Endangered Population].

Species	EPBC Act	TSC Act	Comment
Cymbidium canaliculatum	-	EP	likely; habitat present and nearby records
Diuris tricolor	-	V	likely; habitat present and nearby records.
Eucalyptus camaldulensis	-	EP	likely; habitat present and existing records
Acacia pendula	-	EP	possible; habitat present.
Bothriochloa biloba	V	-	possible; habitat present
Commersonia rosea	E	E	possible; habitat present on higher ground.
Eucalyptus cannonii	V	V	possible; habitat present.
Homoranthus darwinioides	V	V	possible; habitat present on higher ground.
Ozothamnus tesselatus	V	V	possible; habitat present and nearby records.
Philotheca ericifolia	V	-	possible; habitat present on higher ground.
Pomaderris queenslandica	E	-	possible; habitat present.
Pomaderris sericea	V	E	possible; habitat present on higher ground.
Prostanthera discolor	V	V	possible; habitat possibly present.

Significant Communities - of the 55 currently determined *TSC Act*-listed Threatened Ecological Communities within the Sydney Basin bioregion, thirteen potentially occur within the upper Hunter Valley and associated areas (Table 2). For the Commonwealth, two EPBC-listed communities potentially occur (Table 3).

1.7 Flora Survey Guidelines

The recent survey guidelines produced by Sivertsen (2010) present the preferred methods of vegetation survey, analysis and mapping for New South Wales. In effect, these guidelines supersede the flora and fauna survey guidelines previously produced by several government departments (eg: York et al. 1991; Wilson et al. 1997; NSW DLWC 2000; Murray et al. 2002; NSW DECC & DPI 2005). All sets of guidelines follow essentially the same methodology, and emphasise the need to be comprehensive, diligent and scientific in approach.

Table 2 Summary of NSW threatened ecological communities potentially present within the Project Boundary.

TSC Act - Threatened Ecological Community	Potential Occurrence
Hunter Floodplain Red Gum Woodland	possible
Hunter Valley Footslopes Slaty Gum Woodland	possible
River-flat Eucalypt Forest on Coastal Floodplains	possible
White Box Yellow Box Blakely's Red Gum Woodland	possible
Hunter Valley Weeping Myall Woodland	possible
Central Hunter Grey Box - Ironbark Woodland	unlikely
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	unlikely
Freshwater Wetlands on Coastal Floodplains	unlikely
Hunter Lowland Redgum Forest	unlikely
Hunter Valley Vine Thicket	unlikely
Lower Hunter Spotted Gum - Ironbark Forest	unlikely
Lower Hunter Valley Dry Rainforest	unlikely
Swamp Oak Floodplain Forest	unlikely

Table 3 Summary of Commonwealth threatened ecological communities potentially present within the Project Boundary.

EPBC Act - Threatened Ecological Community	Potential Occurrence
Weeping Myall - Coobah - Scrub Wilga Shrubland of the Hunter Valley	possible
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland & Derived Native Grassland	possible

Sivertsen (2010) advocates the use of environmentally stratified random sampling for the development of a classification; however this method assumes that environmental variables consistently operate as acceptable surrogates for community diversity, when this is not always the case. As an alternative, *preferential* sampling allows for sampling of observable differences in community diversity, and is therefore more likely to result in a locally-accurate classification and map (Bell 2013). A preferential sampling strategy has been adopted in the current work to ensure that all community diversity has been assessed and mapped. In effect, this strategy is stratifying on observable floristic variation, and is consistent with the Threatened Biodiversity Survey and Assessment Guidelines (NSWDEC 2004), and is a variation on Sivertsen (2010).

A twenty-four point cover abundance scale has also been recommended by Sivertsen (2010) as the standard measure in New South Wales for plot sampling. This is in spite of the vast amount of data that exists using the alternative Braun-Blanquet method (1-6 scale). The twenty-four point scale is open to considerable observer error (difficulties in applying 4% cover classes consistently), and hence has not been adopted in the current study. Instead, the 1-6 Braun-Blanquet method has been chosen in keeping with all other existing data in the upper Hunter region.

In relation to TECs, both State (NSW) and Commonwealth governments have issued survey guidelines for threatened ecological entities. For the Box-Gum TEC, the Commonwealth guidelines state that to qualify as part of this TEC an area ('patch') must "*be assessed at a scale of 0.1ha (1000m^2) or greater*". There is some confusion among practitioners that this assessment scale refers to the sample plot size required to assess an area: we interpret this guideline to be that the 0.1ha size reference is the minimum size of land that is covered by the TEC (a determiner common to most EPBC-listed TECs), not the size of the sample plot to be used. Clarification has been sought from the Commonwealth on this issue, but to date a conclusive answer has not been forthcoming.

2. Methods

Five separate but related tasks were undertaken in order to meet the objectives of this assessment:

- Collection of Rapid Data Points to assist classification and mapping
- Systematic flora survey to sample observable variations
- Numerical analysis of floristic data to classify the vegetation
- Mapping the distribution of defined vegetation communities or their variants
- Targeted survey for threatened plant species potentially present in the area

2.1 Mapping data

The collection of Rapid Data Points (RDP) forms a central component to a new method of mapping, which recognises that variability in vegetation distribution cannot yet be predicted blindly using computer GIS programs. Documenting what actually occurs on the ground is an essential component of producing a reliable final map. Many recent regional mapping programs have relied heavily on GIS capabilities to predict where certain vegetation communities occur, with often unreliable results (eg: the LHCCREMS vegetation modelling, NSW NPWS 2000; McCauley et al. 2005).

RDP are essentially summaries of floristic information recorded at explicit points in the field. At specific and regular locations, summaries of the vegetation are noted and recorded in a Garmin GPS unit (as a 'waypoint'), and later transferred to the GIS. Alternatively, these data can be recorded directly to a GIS with live connection to the GPS. Information recorded includes:

- Canopy layer dominant species
- Shrub layer dominant species
- Ground layer dominant species
- Draft or field-recognised vegetation unit
- Miscellaneous notes

Initially, all trafficable paths across the Project Boundary were driven by 4WD vehicle recording RDP. Where practical, those areas lacking extensive trail networks were then walked on foot with hand-held GPS units, recording the same information. In this way, a large dataset of summary information can be rapidly collected to use in vegetation mapping and classification procedures. RDP, once collected, are two-fold in their application: in the first instance, they direct where full floristic sampling is best undertaken for a classification, to ensure that observable variation is adequately sampled; secondly, when linked to the classification, RDP contribute directly to the attribution of map polygons.

This mapping method has been used in a number of studies in recent years, most notably for the Singleton Army Training Area (Bell & Carty 2012), the Tomago and Tomaree Sandbeds north of Newcastle (Bell & Driscoll 2006a), Watagans National Park and Jilliby State Conservation Area (Bell & Driscoll 2006b), the Cessnock-Kurri region (NSW DECC 2008b) and several smaller projects in the lower Hunter Valley. By comparison to traditional modelling methods, it offers a time-efficient and accurate alternative, producing a map of vegetation biodiversity based on real ground data.

2.2 Systematic Flora Survey

Systematic flora survey conducted across the Project Boundary consisted of the following steps:

Plot selection – Full floristic plot sampling was undertaken after a thorough reconnaissance of the Authorisations (via RDP collection), in areas and vegetation types considered typical of the observed variation present. This process recognises the fact that environmental stratification of an area (such as through the use of habitat surrogates like soil landscapes) does not adequately highlight certain floristic variations which may be evident in the field. Other workers have also recognised the problems of stratification in some environments (eg: Griffith et al. 2000), and this process of expert intuition is one of the central themes in the Braun-Blanquet system of plant classification (Braun-Blanquet 1932). Stratification based on observable floristic variation in the vegetation broadly equates to the 'environmental stratification' of Sivertsen (2010), but places less reliance on environmental attributes to guide sampling.

Plot sampling - Within areas considered to be representative of the major floristic variations present, detailed survey within 0.04ha sample plots was completed. On the whole, methods used were those adopted as standard by the Office of Environment and Heritage (Sivertsen 2010), and other land management agencies. This entailed the application of a 1-6 scale of cover abundance for all vascular plant species, differing from that suggested by Sivertsen (2010) (see below). These methods are consistent with the large body of existing data in the region (Bell 2000; NSW NPWS 2000). Benson (1999) provides an overview of how important consistent survey methods are for vegetation management across the State.

Within each 0.04ha site (nominally 20 X 20m, but can be 40 X 10m in riparian zones, etc), all vascular plant species present are recorded and applied with a cover abundance rating, based on a modified Braun-Blanquet scale (1 to 6). The six categories within this scale are: 1 (<5% cover and rare); 2 (<5% cover and common); 3 (5-25% cover); 4 (26-50% cover); 5 (51-75% cover); and 6 (76-100% cover). Sivertsen (2010) recommends the use of a 24-point cover abundance scale; however this has not been adopted in the current study due to the large amount of existing regional data using the 1-6 scale (see Bell 2000), which can be used for contextual analysis. Physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position, etc) are also recorded, and photographs taken of the site for later reference.

Plant identification - Plant specimens of unknown or significant status were collected for later identification or lodgement with the National Herbarium of New South Wales. Orchid specimens were identified in the field with the aid of Bishop (2000), or digital photographs taken to assist later identification.

2.3 Data Analysis

Numerical data analysis was undertaken on full floristic plot data to elucidate patterns in the dataset. The following steps were used in this process:

Taxonomic Review - Prior to data analysis, a review of plant taxonomy was conducted for all taxa included in the final analysis dataset to ensure consistency of nomenclature. Nomenclature according to Harden (1990a-1993; 2002) and Harden and Murray (2000) was used as the standard, except where more recent revisions have been published in recognised scientific journals and accepted by the National Herbarium of New South Wales (http://plantnet.rbgsyd.nsw.gov.au/ floraonline.htm).

Floristic Data Exploration - Floristic data were analysed with *Primer* V6 (Clarke & Gorley 2006), using multivariate techniques to assist in classifying the vegetation present. Agglomerative hierarchical cluster analysis and non-metric multidimensional scaling (nMDS) were performed on the dataset using the group averaging strategy, the Bray-Curtis similarity measure and a Beta value of – 0.1. Ordinations were performed in two and three dimensions with 25 random starts and a minimum stress of 0.01. The SIMPROF routine in *Primer* was used to examine structure in the data and look for significant splits, while the SIMPER routine was used to generate diagnostic species lists for each defined floristic group.

Threatened Ecological Community Analysis - Vegetation communities defined for the Project Boundary were examined against the Final Determinations for those threatened ecological communities potentially present in the area (see above in Table 2 & 3). One component of this analysis was to compare species lists from the defined communities with those included in final determinations. This was accomplished through use of the purpose-written software *Match Species To Communities* v2 (MS2C) (www.wildterrain.com.au). Other locational and biophysical aspects of each determination were also examined to determine the presence of TECs.

2.4 Vegetation Mapping

RDP collected across the Project Boundary were classified into vegetation units reflecting the numerical analysis (Section 2.3). Extrapolation of these point data to polygons was accomplished initially through use of the Voronoi areas algorithm in Manifold GIS, which was then manually edited to reflect observable phototype patterns on digital orthorectified imagery. The Voronoi areas algorithm creates polygons where the boundary of each polygon lies midway between all neighbouring points of differing identity, and has been used in a range of applications (Okabe et al. 2000; Alani et al. 2001).

Initially, all remnant stands of vegetation were mapped across the Project Boundary. This included isolated paddock trees and groups of paddock trees over grassland areas, knowledge of which could be later used for wildlife corridor planning in those areas excluded from ground disturbance. For impact assessment purposes, only scattered canopy trees at ≤ 75m separation distances and in groups of > 5 individuals were retained within the mapping units, as some of these areas may form part of listed threatened communities. Cultivated lands were mapped as a separate unit irrespective of remnant canopy trees, as it was assumed that native species diversity would be minimal in these areas, and that potential for derived native grasslands was negligible. Likewise, vegetation communities supporting both a grassy and shrubby understorey component were separated principally on contour and slope (steep = shrubby; flat = grassy) in keeping with knowledge of these landscapes elsewhere in the Hunter Valley.

2.5 Targeted Surveys

Threatened species searches were conducted in concert with RDP collection, as well as through targeted searches in habitats known to support specific species elsewhere in the region. Foot and vehicle traverses in selected areas were made with a hand-held GPS unit (Garmin GPSmap 60CSx) and significant plant species recorded where encountered with estimates of population size. GPS data were downloaded and imported into mapping layers on completion of each field search. Searches focused on the thirteen threatened entities shown in Table 1 (Section 1.5), although other potential species were also considered.

Each group of species was targeted in the following way:

Terrestrial orchids - Terrestrial orchids flower only during limited times of the year, and it is during flowering that they are most detectable. The principle threatened species targeted during surveys at Bylong were *Diuris tricolor* (Vulnerable, TSC Act 1995) and *Prasophyllum* sp Wybong C.Phelps ORG5269 (Critically Endangered, EPBC Act 1999). The nearby Mt Penny area supports large populations of *Diuris tricolor*, but no *Prasophyllum* (NSW OEH Wildlife Atlas).

Targeted surveys for both orchid species were carried out over two days in early October 2012 (9-10 October). Flowering was confirmed for both *Diuris* and *Prasophyllum* at another location near Denman (~50 km east) in the week prior to Bylong surveys, to ensure appropriate timing. Prior knowledge of the sixteen accessible properties within the two Authorisations enabled surveys to be focused on grasslands and grassy woodlands supporting the best potential habitat for orchids, based on experience of the two target species elsewhere in the Hunter Valley. This included a dominance of native grasses and herbs, relatively little weed abundance, and an absence of cropping and heavy stock grazing. There is some evidence to suggest that competition for inter-tussock space with exotic grasses may influence the suitability of habitat, as has been suggested for the threatened *Diuris fragrantissima* in Victoria (Cropper 1993). Large areas of grassland within the two leases did not meet these conditions, and hence were not surveyed. Best areas were immediately adjacent to retained bushland on the footslopes of the rugged hills.

In areas showing good potential orchid habitat, slow traverses in 4WD were made across the grassland, with two observers scanning either side of the vehicle for 15-20m. When orchids were detected, foot searches were conducted and a count made of all plants seen, and GPS co-ordinates recorded. In some cases, particularly promising areas of habitat (such as good quality grassy woodland) were walked on foot. All search tracks were recorded in the GPS.

Epiphytic orchids - stands of vegetation supporting canopy tree species, particularly rough-barked species such as *Eucalyptus albens* or *Angophora floribunda*, were examined for the presence of *Cymbidium canaliculatum* (Endangered Population, TSC Act 1995). The distinctive clump of basal leaves can be identifiable at any time of the year, as there are no other similar species in the region.

Eucalypts - all stands of redgums or stringybarks were examined for the presence of *Eucalyptus camaldulensis* (Endangered Population, TSC Act 1995) or *Eucalyptus cannonii* (Vulnerable, TSC Act 1995 & EPBC Act 1999). Habitats targeted for the former were alluvial flats and plains, while for the latter footslopes and low ridges. Morphology of eucalypts in the 'Red Ironbark' group were carefully examined in key locations for *Eucalyptus* sp. aff. *fibrosa* (Klaphake 2010). The identity of *Eucalyptus albens* and *Eucalyptus moluccana*, and the potential for hybrids between these two species to be present, were examined extensively in the field (given the inclusion of such hybrids in some threatened community determinations). Advice was also sought from the National Herbarium of New South Wales as to the formal characteristics of these hybrids, but few consistent traits were evident. We therefore relied on our own field experience in these landscapes, together with observations on morphology and flowering within the Bylong Valley.

Shrubs of sandstone benches - any areas of heath or scrub on sandstone benches were searched for *Commersonia rosea* (Endangered TSC Act 1995 & EPBC Act 1999), *Homoranthus darwinioides* (Vulnerable TSC Act 1995 & EPBC Act 1999) or *Philotheca ericifolia* (Vulnerable EPBC Act 1999). In woodland or forest on sandstone ridges, *Pomaderris sericea* (Vulnerable EPBC Act 1999; Endangered, TSC Act 1995) was also targeted.

Shrubs of talus slopes and gullies - footslopes and associated drainage lines were searched for *Ozothamnus tesselatus* (Vulnerable, TSC Act 1995 & EPBC Act 1999), *Pomaderris queenslandica* (Endangered, EPBC Act 1999) and *Prostanthera discolor* (Vulnerable, TSC Act 1995).

Grasslands - areas supporting good quality native grasslands and with little stock grazing pressure were examined for the presence of *Bothriochloa biloba* (threatened at the commencement of surveys, but recently delisted). This species has been prolific over recent seasons in the Hunter Valley (pers. obs.), and if present within the Project Boundary would be easily detectible. Stands or individual trees of *Acacia pendula* (Endangered Population, TSC Act 1995) were also targeted in grassland areas.

At all times during targeted survey, plant species of uncertain identity were collected for later examination, recognising the possibility that additional threatened species may also be present within the Project Boundary. Specimens that could not be clearly identified were sent to the NSW Herbarium for confirmation by other experts.

2.6 Grassland Surveys

Surveys specifically targeting native and derived grasslands were planned for the Project Boundary, principally to assist in determining the presence or otherwise of Derived Grasslands as defined under the EPBC Act 1999. Such surveys aim to record all native and exotic grass, herbs, forbs and ferns present in an area, to allow analysis against the lists of characteristic species contained in the Listing Advice and associated guidelines for *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland & Derived Native Grassland* TEC. During the survey period (2011-2013), drought conditions meant that only a limited amount of grassland survey could be completed by the authors.

Between 2011 and 2013, full floristic data were collected for grassland classification within 10 x 10m plots during the limited period of favourable climatic conditions for grassland growth (May 2012). Additional data collection targeting key species within 20 x 20m plots was also undertaken under drought conditions (November 2013), to determine the usefulness of survey at such times for assessing TEC equivalency. Cumberland Ecology collected further data within 20 x 50m and rapid assessment plots during April 2014, after several months of good rainfall. For the May 2012 surveys, all taxa present were applied a cover abundance code in the same way that full floristic plots of woody vegetation were undertaken (see Section 2.2 above). Only detectable native, non-grass species were recorded during November 2013 and April 2014 surveys, including those 'important' species outlined in the EPBC Guidelines. Surveying of rapid assessment plots generally ceased after 12 'important species' were detected.

Plots of 10 x 10m were selected for full floristic surveys in May 2012 as several recent studies have incorporated these dimensions to classify native grasslands in the Hunter Valley to good effect (eg: Bell 2011; Bell & Carty 2012), and sampling plots of this size have been shown to be appropriate for temperate grassland environments (e.g. Benson 1994). Chytrý & Otýpková (2013) suggest plots of even smaller size ($16m^2$) for such habitats in Europe.

The timing of vegetation surveys within grassland environments can have a marked impact on the diversity of species and communities identified. Many species of grass, forbs and herbs flower only during warmer times of the year and after sufficient rains have fallen, and identification at times other than this can be extremely difficult. Burrows (2004) examined this issue by establishing semi-permanent monitoring plots at nine sites mostly in the South Western Slopes region (Wagga Wagga) of New South Wales. For his study, Burrows (2004) found that surveys undertaken in mid to late spring recorded the highest percentage of plant species present. In addition, a single, optimally-timed survey conducted after near- or above-average rainfall in the two or three months preceding the survey, will record 65-75% of species diversity. A single or multiple survey over much of Summer, Autumn and early Winter will record fewer than 50% of the total species present.

2.7 Groundwater Dependent Ecosystems

In certain regions, vegetation types and habitats which rely on groundwater flows for their moisture requirements occur (Eamus & Froend 2006). Groundwater Dependent Ecosystems (GDEs) such as these are sensitive to alteration in the hydrological conditions within bedrock and soil material. Searches for potential GDEs were made while in the field collecting floristic and mapping data. Areas where ground seepage was evident were investigated, as were any patches of vegetation that supported moisture-loving plant species such as sedges, rushes or ferns (phreatophytic species).

3. Results

3.1 Mapping Data

Two thousand, four hundred and seventy-one (2,471) Rapid Data Points were collected during field reconnaissance within the Project Boundary. At each of these points, information on dominant plant species in each stratum was recorded and incorporated directly into the vegetation mapping process. All points were attributed a draft vegetation community code, which was reviewed after classification analysis of full floristic data (Section 3.3).

Figure 4 shows the distribution of RDP across within the Project Boundary, used to inform the mapping and plot selection processes.

3.2 Floristic Survey

3.2.1 Survey Periods and Sampling Intensity

Table 4 summarises when vegetation survey was undertaken within the Project Boundary between 2011 and 2013. Initially, survey periods were governed by access agreements to private properties organised by CCL. Grassland surveys were undertaken specifically during the May 2012 field trip, when it was noted that high diversity was present due to good rains in late Summer and Autumn 2011-12 (Figure 5). Subsequent field trips corresponded with prolonged low rainfall, and grasslands could not be surveyed adequately. Additional limited rapid assessment plots were undertaken in November 2013, and then again in April 2014 by Cumberland Ecology following better climatic conditions.

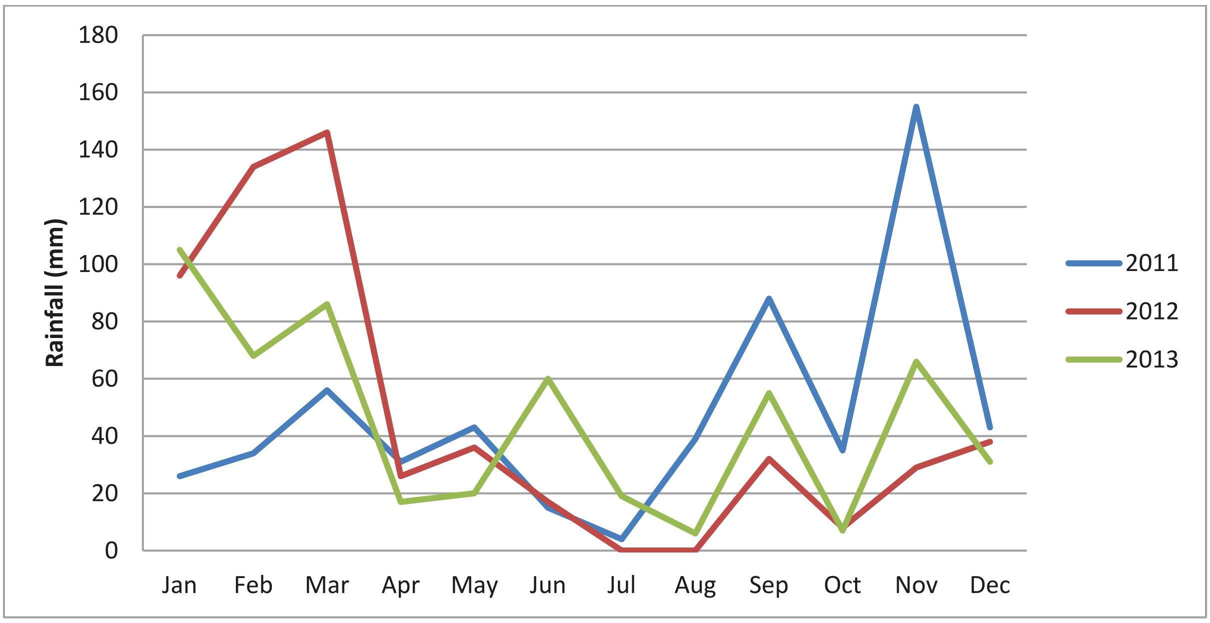

Figure 5 Rainfall received at Bylong (Glenview), 2011 to 2013 (from Bureau of Meteorology 2014).

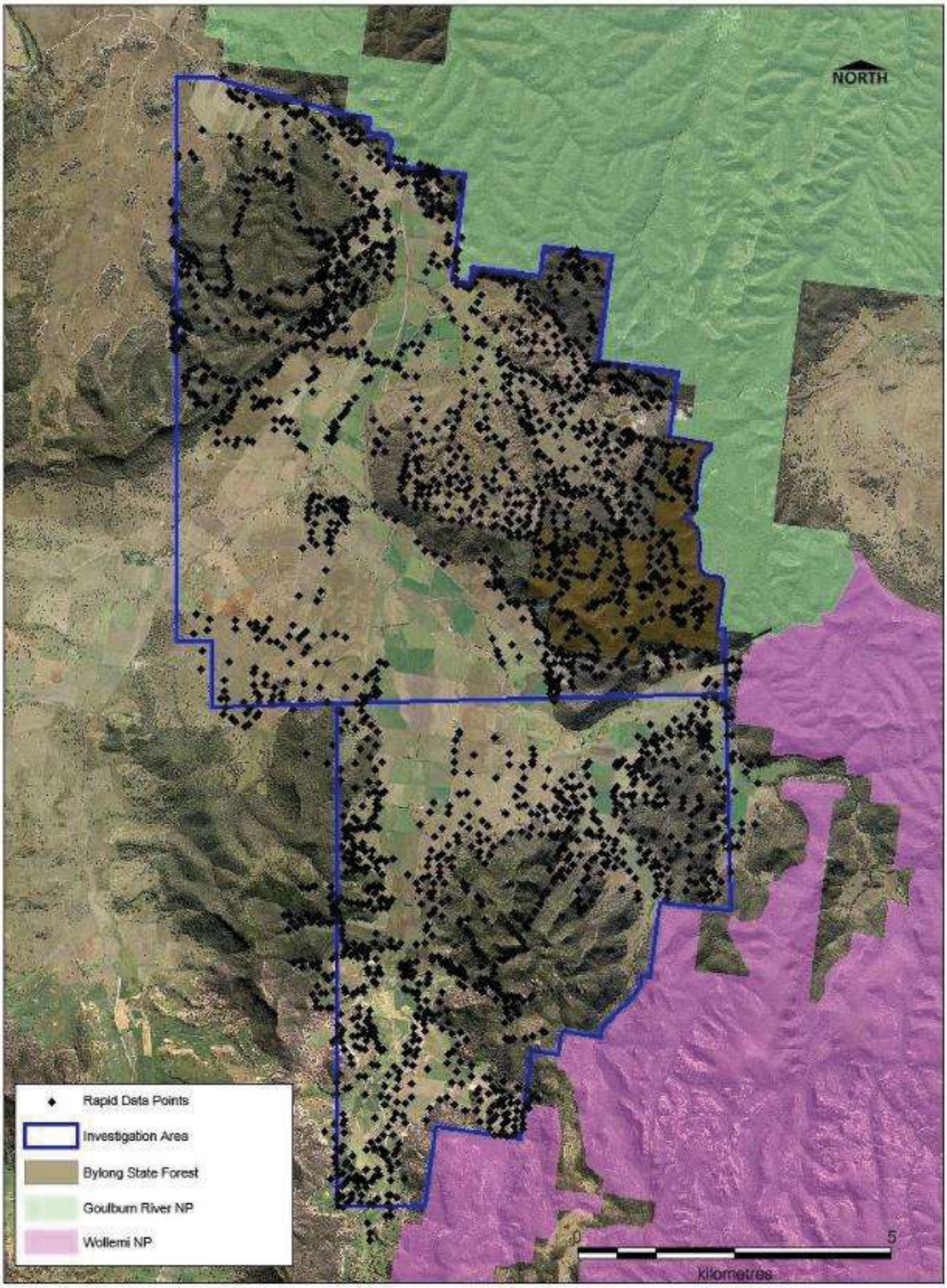

Figure 4 Distribution of Rapid Data Points (RDP) across the Project Boundary.

For the targeted terrestrial orchid survey undertaken in October 2012, 52 km of search transect (~162 ha) were examined over two days (Figure 6). Much of this area supported good orchid habitat, but few orchids were recorded. Additional survey for threatened terrestrial orchids subsequent to this period was not undertaken as plans for direct impact areas of the proposed mine were not finalized until late 2013. Given the extent of cattle grazing over the majority of the proposed direct impact areas, it is unlikely that sizeable populations of threatened orchids occur there.

Table 4 Survey dates and tasks.

Survey Date	Tasks (*& properties accessed*)
31 Oct - 2 Nov 2011	mapping data & threatened species searches (*Bylong Station, Harley Hill, Glen View*)
15 - 17 February 2012	mapping data, threatened species searches & floristic plot data (*Desreaux, Bylong Trail, Tarwyn Park, Rosemont Farm*)
2 - 4 May 2012	mapping, threatened species searches & grassland data (*Arabanoo, Carawatha*)
26 - 29 June 2012	mapping, threatened species searches & floristic plot data (*Wallings* properties)
4 - 6 September 2012	mapping, threatened species searches & floristic plot data (*Bylong Park*)
9 - 11 October 2012	targeted orchid survey & floristic plot data (*Bylong Park, Bylong Station, Wallings properties, Arabanoo, Carawatha*)
21 - 24 May 2013	mapping, threatened species searches & floristic plot data (*Crown land west of Bylong Park)*
2 - 5 July 2013	mapping, threatened species searches & floristic plot data (*Crown land south of Helvetia*)
20 - 23 August 2013	mapping, threatened species searches & floristic plot data (*Bylong State Forest*)
5 - 8 November 2013	mapping, threatened species searches & floristic plot data (*Bylong Station, Helvetia*); grassland plots (*Wallings property*)
2 - 11 April 2014	Cumberland Ecology grassland sampling (*direct impact area)*

3.2.2 Floristic Diversity and Plot Sampling

Sixty-two (62) full floristic survey plots within woody (non-grassland) vegetation were completed across the Project Boundary (Figure 7). The positions of these plots were selected preferentially within representative areas of vegetation, to aid numerical classification rather than to be used simply for the compilation of and overall list of plant species. An additional four (4) existing sample plots within the Project Boundary were completed as part of revisions to vegetation mapping in Wollemi National Park (NSW OEH 2012a), and were added to the analysis dataset for this assessment (66 plots in total).

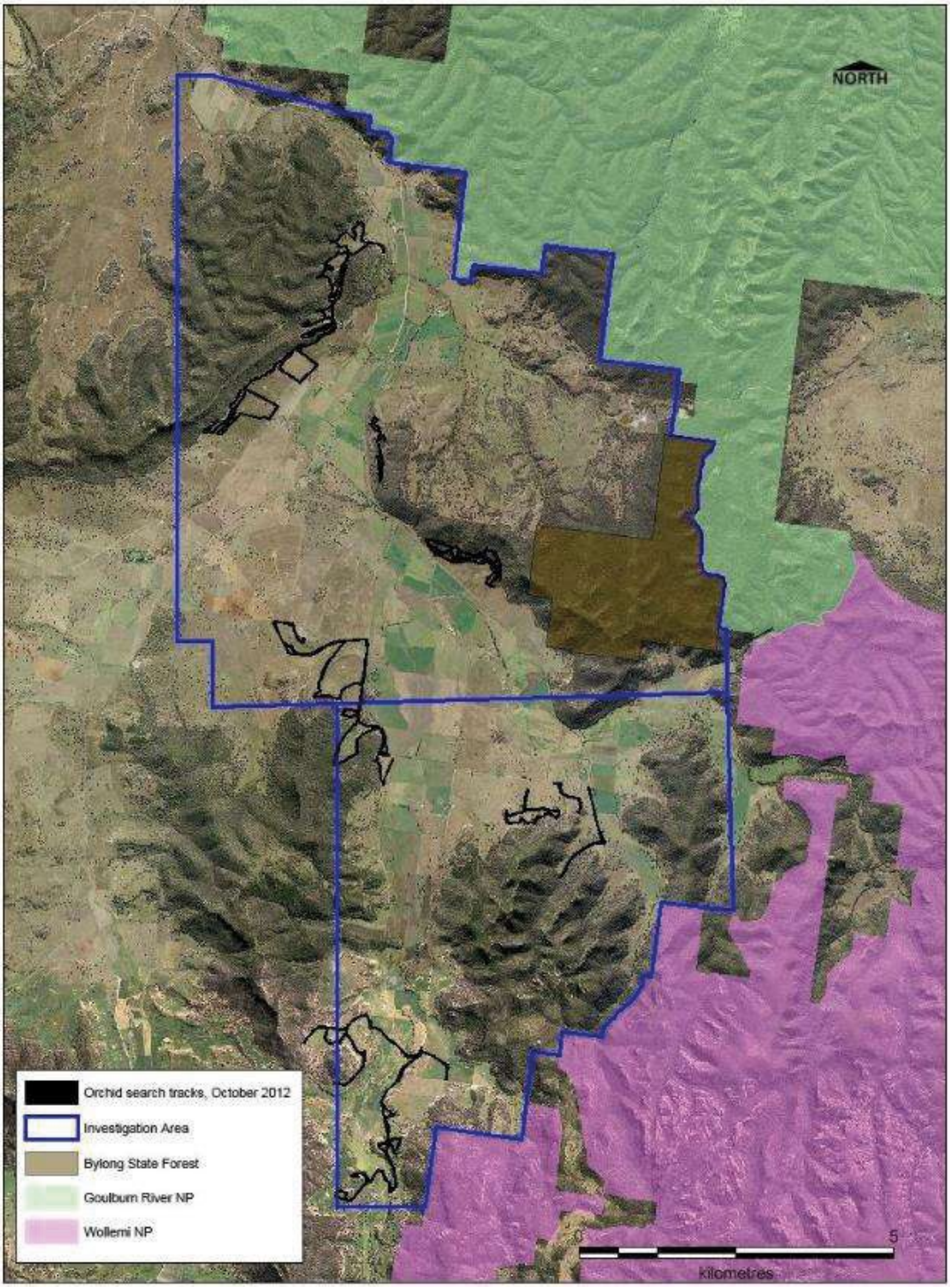

Figure 6 Orchid survey transects, October 2012.

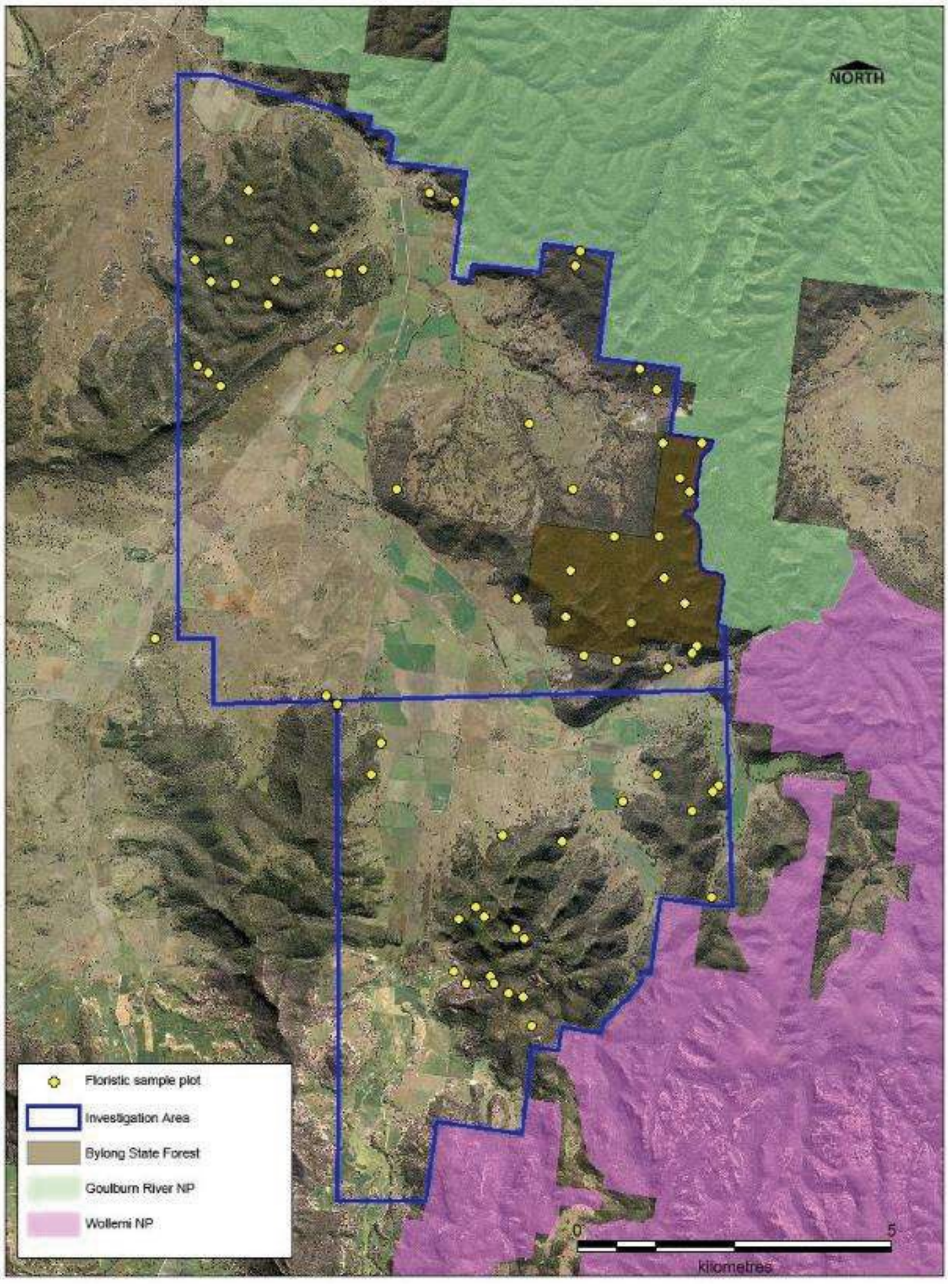

Figure 7 Distribution of non-grassland full floristic survey plots.

A total of 457 plant taxa (including 67 weed species) were recorded through systematic plot and general traverses across the Project Boundary. The most commonly recorded species across low-lying areas (Stage 1) were the herbs *Dichondra repens, Calotis lappulacea, Einadia hastata*, the graminoids *Austrostipa scabra, Gahnia aspera* and *Aristida ramosa*, and the fern *Cheilanthes sieberi* subsp. *sieberi*. *Dodonaea viscosa* subsp. *cuneata, Acacia ixiophylla* and *Cassinia quinquefaria* were the most frequent shrubs, while *Eucalyptus albens* and *Eucalyptus dawsonii* were the most frequent canopy species. For the more rugged hills examined in Stage 2, the most frequent species recorded were the graminoids *Cleistochloa rigida, Lomandra confertifolia* subsp. *rubiginosa, Lomandra glauca, Gahnia aspera* and *Lepidosperma laterale*, the fern *Cheilanthes sieberi* subsp. *sieberi*, the shrubs *Persoonia linearis, Dodonaea viscosa* subsp. *cuneata, Leucopogon muticus* and *Acacia linearifolia*, and the trees *Eucalyptus punctata, Callitris endlicheri, Eucalyptus nubila, Eucalyptus dwyeri* and *Eucalyptus agglomerata*.

Twenty-one (21) eucalypts (*Angophora, Corymbia, Eucalyptus*) have been recorded within the Project Boundary, including the endangered population of *Eucalyptus camaldulensis*. Six species of Box are present, including *Eucalyptus albens*, *Eucalyptus moluccana, Eucalyptus conica, Eucalyptus microcarpa, Eucalyptus dawsonii*, and *Eucalyptus melliodora*. *Eucalyptus crebra* is present only as small and scattered individuals in mid-slope or ridgeline habitats, while *Eucalyptus microcarpa*, *Eucalyptus sideroxylon* and *Eucalyptus rossii* occur only in highly restricted localities. *Eucalyptus nubila*, which is present across many parts of the higher sandstone areas, particularly in the west, potentially includes stands of the undescribed *Eucalyptus* sp. aff. *fibrosa* (Klaphake 2010), but resolution of taxonomic issues is beyond the scope of this assessment. The vulnerable *Eucalyptus cannonii* was also recorded along Bylong Trail outside of the southern Authorisation. A full species list for the entire Project Boundary is included in Appendix 7.1.

No evidence of hybridisation between *Eucalyptus albens* and *Eucalyptus moluccana* was found during field investigations. The two species were observed to flower at different times in 2012, so that the chances of hybrids occurring were considerably lessened. The extent of glaucousness and non-glaucousness of leaves and buds on *E. albens* and *E. moluccana* respectively was also consistent, and there was no difficulty in placing individuals in either species.

3.2.3 Grassland Sampling

Eighteen (18) grassland plots were completed during May 2012, following reasonable rains in late Summer and Autumn which induced good emergence and flowering of grasses, herbs and forbs (see Appendix 7.2). However, subsequent field trips during dryer conditions showed little emergence, and the collection of plot-based data was postponed. Attempts were made again in November 2013 to collect grassland data (native, non-grass species only), where ten (10) additional plots were surveyed, but again the prolonged dry conditions meant that few species could be detected. Consequently, no attempt has been made to classify grassland areas using systematic data. Cumberland Ecology sampled fifteen (15) full floristic plots within the direct disturbance area in April 2014, together with rapid assessments at an additional seventy-one (71) locations. All collected data has been used to assess whether or not sampled areas equate to Box-Gum woodland and derived grassland TEC (see Section 3.3.5 and Appendix 7.2).

Figure 8 shows the distribution of all one hundred and fourteen (114) grassland sample plots and rapid assessment points.

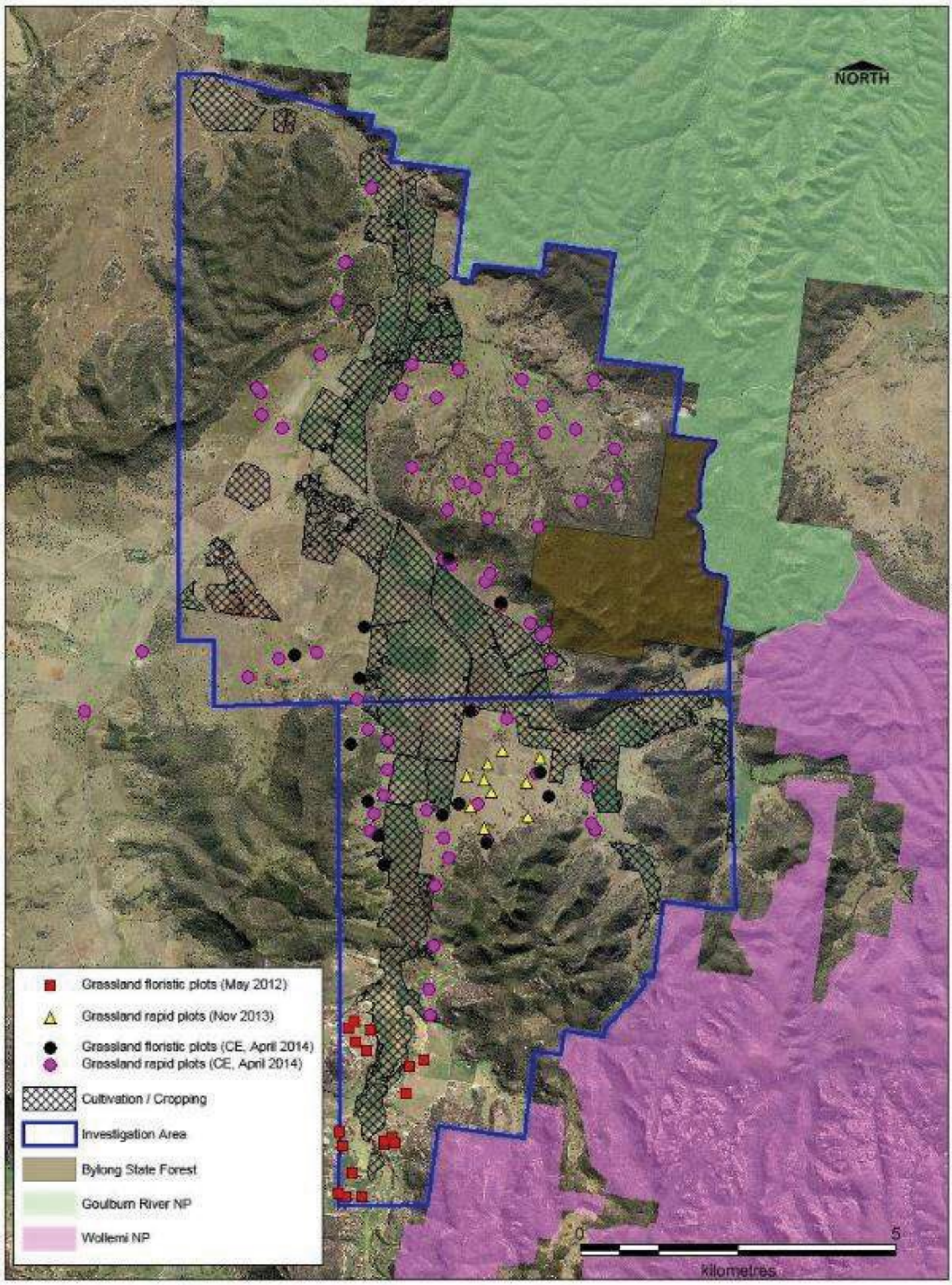

Figure 8 Distribution of grassland full floristic and rapid assessment survey plots. CE = additional data collected by Cumberland Ecology.

3.3 Data Analysis & Community Definition

3.3.1 Numerical Analysis (Woody Vegetation)

Multivariate cluster analysis of 66 non-grassland sample plots and 321 native plant taxa (using the Bray-Curtis association measure, flexible UPGMA fusion strategy, Beta –0.1) showed there to be two logically definable groups at 8% similarity (soil based), suggesting that the dataset structure is not random and that true divisions occur (Figure 9). These two groups comprise vegetation occurring on Permian, Tertiary Basalt and alluvial geologies (enriched soils), and those on Narrabeen Sandstone geology (poor soils). Further division within each of these groups showed additional evidence of data structure, with seven groups at 20% similarity. The SIMPROF test indicated there to be twenty-three statistically significant groups ($p<0.01$) within the dataset, distinguishing several sub-groups within the broader units. Table 5 details how these groups have been referable to locally-defined vegetation communities. Note that the single sample plot within Moonah (*Melaleuca lanceolata*) in Group 1 has been included as a variant of Slaty Box Woodland, although it is likely that if additional stands were present and sampled, a significantly distinct Moonah community would emerge from the dataset.

Ordination using non-metric multidimensional scaling (nMDS) supported the groupings evident in the cluster analysis, with a stress level of 0.16 and strong congruence with the broad cluster analysis groups (Figure 10). Broad groups are well separated in 2-dimensional space, although the floristic similarities of several communities are evident in the relatively close proximity in 2-dimensional space. It is likely that the long history of grazing, particularly in those low-lying habitats supporting grassy woodlands, has affected the distribution of native plant species such that clear distinctions through ordination analysis are difficult to obtain. Never-the-less, this analysis has supported field-recognised communities with the significant differences evident in cluster analysis.

Table 5 Groups defined from cluster analysis (at 20% similarity) and communities (with significance from SIMPROF analysis) from cluster analysis of 66 sample plots.

Group (20%)	Community	Significance	Comments
1a & 1b	Slaty Box Woodland	$p<0.01$	single sample in 1a probably a reflection of low species diversity. Otherwise, 9 of 10 samples grouped together within 1b, which also included 3 samples of White Box Woodland (Shrubby), indicative of the shrubby nature of both communities.
1c	Blakely's Redgum/ Apple Riparian Forest	$p<0.01$	all 2 samples in this cluster.
1d	White Box Woodland (Shrubby)	$p<0.01$	single sample of shrubby White Box Woodland. Other samples included within Group 1b or 1g, indicating the similarity in these three communities.

Group (20%)	Community	Significance	Comments
1e	Coastal Grey Box Woodland	p<0.01	only sample in this cluster; nearly all remaining remnants cleared or heavily disturbed.
1f	Fuzzy Box Woodland	p<0.01	2 of 3 samples in this cluster.
1g	White Box Woodland (Grassy)	p<0.01	3 of 4 samples within this cluster. Includes a single sample of shrubby White Box Woodland, but with a well developed herb/grass layer.
1h	Yellow Box Woodland	p<0.01	all 2 samples in this cluster, with 1 of 4 samples of grassy White Box Woodland.
2	Rusty Fig Dry Rainforest	p<0.01	single sample in this cluster, with a heavily grazed sample of Fuzzy Box Woodland (considered with Group 1f). Low species diversity in both may explain the two aligning together.
3	Calytrix Rockplate Heath	p<0.01	single sample in this cluster.
4	Grey Myrtle Dry Rainforest	p<0.01	all 3 samples in this cluster; includes gully and lower slope positions.
5	Cypress Pine Forest	p<0.01	all 2 samples in this cluster.
6a	Dwyer's Redgum Low Open Forest	p<0.01	all 5 samples in this cluster.
6b	Scribbly Gum/ Grey Gum Forest	p<0.01	all 2 samples in this cluster.
6c - 6e	Exposed Grey Gum/ Stringybark Forest	not significant	4 of 5 samples within these 3 clusters. Non-significance of group likely a reflection of variable nature of understorey dependent on aspect & soil depth. One additional sample also aligned with Group 6f, possibly due to close proximity of that community.
6f	Blue-leaf Ironbark/ Cypress Forest	p<0.01	all 2 samples in this cluster, with a single sample Exposed Grey Gum/ Stringybark Forest.
6g	Bloodwood/ Ironbark Forest	p<0.01	all 2 samples in this cluster.
7a	Sheltered Grey Gum/ Stringybark Forest	p<0.01	all 3 samples in this cluster.
7b	Caley's Ironbark Forest	p<0.01	all 6 samples in this cluster.
7c	Blakely's Redgum/ Paperbark Forest	p<0.01	all 4 samples in this cluster.
7d	Red Ironbark/ Cypress Forest	p<0.01	all 3 samples in this cluster.

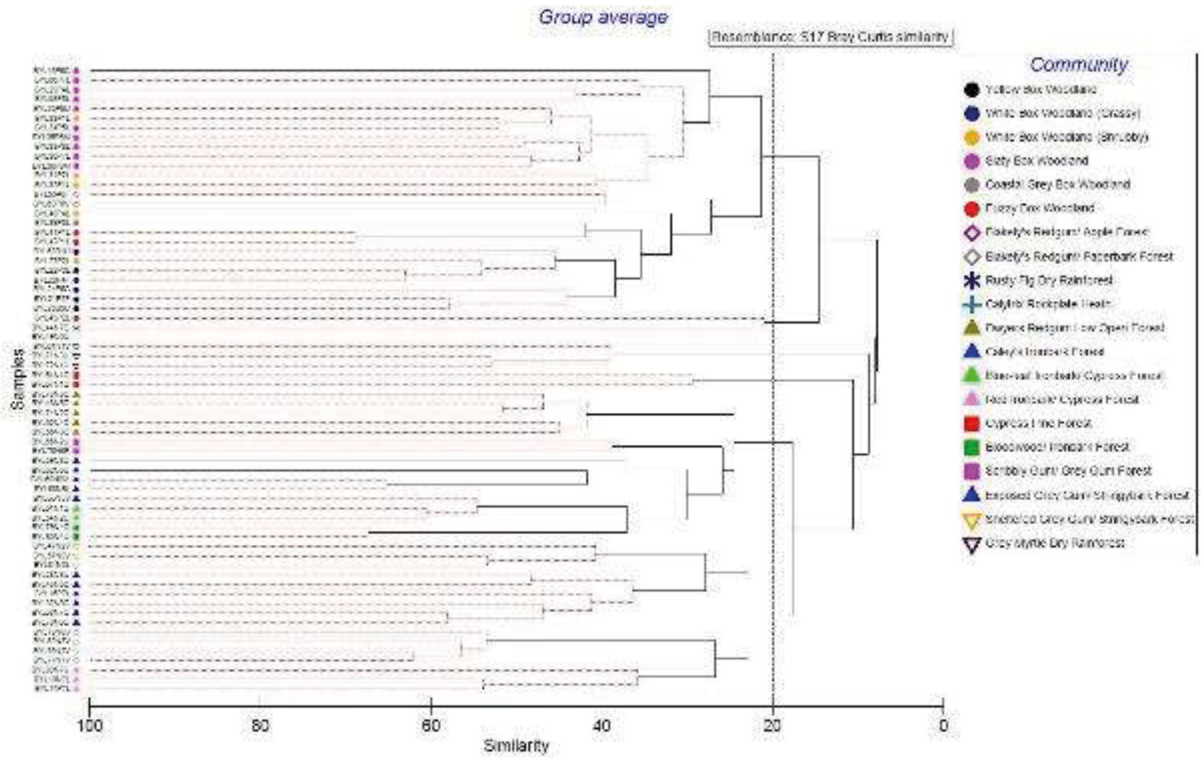

Figure 9 Site dendrogram produced from the cluster analysis. Seven groups at 20% similarity (dashed vertical line) and 23 significant splits (solid horizontal lines). Bray-Curtis association measure, flexible UPGMA, Beta = -0.1.

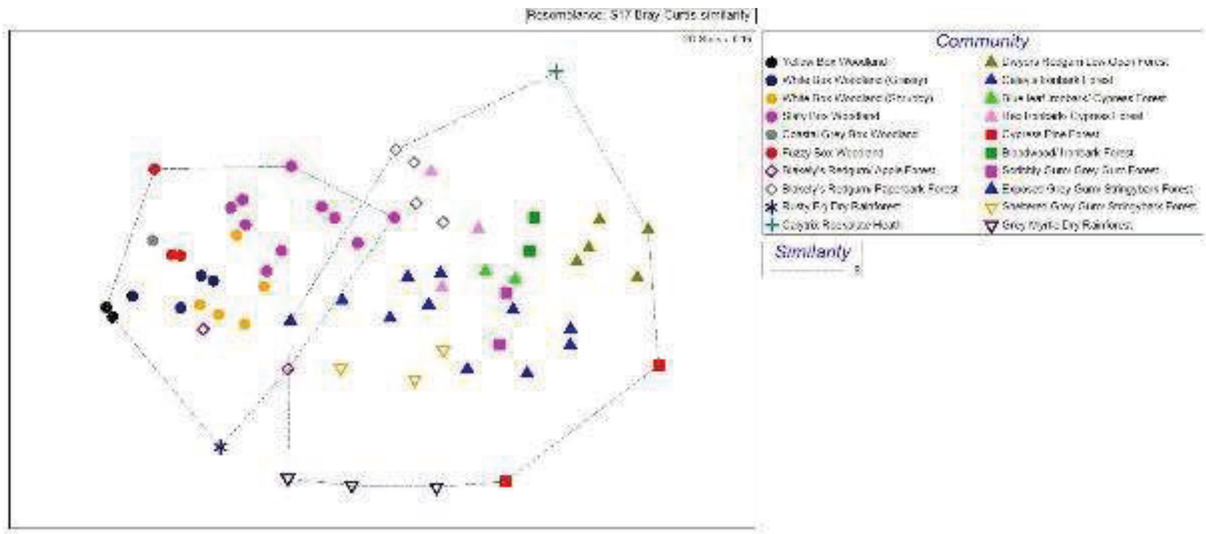

Figure 10 Ordination diagram of 2-dimensional non-metric multidimensional scaling. Cut-lines shown (at 8% similarity, from dendrogram in Figure 9), indicative of major geology types.

3.3.2 Vegetation Community Nomenclature

Vegetation community nomenclature has been structured in a hierarchical fashion, extending from local-scale to regional, State and Commonwealth. This enables application to a range of regulatory classification products where specific nomenclature is necessary. Communities have been described within the following scales of resolution:

- **Local** - units defined locally following field investigations within the Project Boundary, supported by numerical analysis of systematic plot data;
- **Regional** - locally-defined units cased within recognised regional classifications for the upper Hunter Valley (Section 3.3.4). In particular, the revised classification of Wollemi National Park and environs of NSW OEH (2012a), and the broader Greater Hunter Vegetation Types of NSW OEH (2012b). Note that Biometric Types are currently under review, and are to be replaced by the newer NSW Plant Community Type database of NSW OEH (2012b).
- **State** - where equivalency exists, regional-scale units are matched to the NSW Vegetation Community Assessment database of Benson (2006), and the broader NSW classes of Keith (2004), and shown in Section 3.3.4. Equivalency to NSW Threatened Ecological Communities (TEC) has also been completed, using the Final Determinations for each TEC as a guide (see Section 3.3.5).
- **Commonwealth** - allocation to Commonwealth Threatened Ecological Communities has been undertaken using the relevant Listing Advice for each (Section 3.3.5). At present, there is no nationally accepted nomenclature of native vegetation for the entire country.

3.3.3 Locally Defined Vegetation Communities

Twenty-four (24) locally-defined vegetation units have been delineated for the Project Boundary. Some of these communities occur as highly restricted remnants of vegetation due to past land use, and are difficult to adequately sample (3 communities). Brief descriptions of all communities follow, and Appendix 7.3 outlines further details on the floristic composition of each unit. In general, low-lying lands within the Project Boundary are dominated by Box eucalypts of various kinds, and the overall topographical sequence observed in their distribution are of interest. Lower lying alluvial slopes along Bylong Valley support remnant stands of Fuzzy Box (*Eucalyptus conica*), which then grade into Coastal Grey Box (*Eucalyptus moluccana*) or Yellow Box (*Eucalyptus melliodora*) in some areas, then White Box (*Eucalyptus albens*) or Slaty Box (*Eucalyptus dawsonii*) on slopes, with Yellow Box (*Eucalyptus melliodora*) on higher basalt soils. In recognition of structural descriptors included in both the State and Commonwealth listings of grassy Box TECs, some of these Box communities are here designated as Grassy or Shrubby. The sandstone hills are more complex, with differing aspects and soil depths dictating the distribution of vegetation communities. Ironbark-dominated forests are the most widespread in sandstone areas.

Rainforest

<u>**1: Rusty Fig Dry Rainforest**</u> - a single location within 'Bylong Park' supports a stand of *Ficus rubiginosa* dry rainforest on a low rocky ridge. Associated with this vegetation is the emergent canopy species *Eucalyptus punctata*, and high amounts of sandstone rock outcrop.

<u>2: Grey Myrtle Dry Rainforest</u> - a few well protected gullies and lower slopes south of Bylong State Forest and in Crown land in the east support narrow bands of Grey Myrtle Dry Rainforest. *Backhousia myrtifolia* typifies this community, but emergent *Eucalyptus punctata* and occasionally *Eucalyptus albens* also occur. Few understorey species are present in this type due to dense shading from *Backhousia*, but *Notelaea longifolia* is normally present, with *Gahnia aspera* common on the ground.

Riparian Woodland/ Forest

<u>3: River Oak/ Redgum Riparian Woodland</u> - high energy banks and riparian areas along the Bylong River and parts of Lee Creek support an intermittent gallery forest or woodland of *Casuarina cunninghamiana* with occasional *Eucalyptus camaldulensis, E. blakelyi* or *Angophora floribunda*. Associated shrub and ground layer species typically comprise a high proportion of weeds, and a long history of grazing has degraded many kilometres of this vegetation type. As a consequence, sampling opportunities are few and no detailed data has been collected.

<u>4: Blakely's Redgum/ Apple Riparian Forest</u> - areas where *Eucalyptus blakelyi* and/ or *Angophora floribunda* dominate the canopy occur principally in areas associated with drainage lines, and adjacent to channel-restricted River Oak/ Redgum Riparian Woodland. Remnant trees along riparian areas and adjacent flats bear testament to a community now all but cleared. *Eucalyptus blakelyi* and *Angophora floribunda* would once have dominated these areas, over a grassy understorey of various grasses, herbs and forbs. In places, *Eucalyptus camaldulensis* is also present. Many such areas now support improved pastures. A minor variant of this community also occurs on an elevated hillslope that appears to have suffered a geomorpholocial landscape slump long ago allowing the development of a moist forest with good representation of grasses and herbs, and establishment of *Angophora floribunda* as the dominant canopy species.

<u>5: Blakely's Red Gum/ Paperbark Forest</u> - minor drainage lines within and around the undulating topography of Bylong State Forest support narrow bands of *Eucalyptus blakelyi* over a distinct understorey of *Melaleuca thymifolia* and *Sannantha cunninghamii*, and the grasses *Aristida ramosa, Arundinella nepalensis* and *Aristida vagans*. Such vegetation is unusual in the region, and typically occupies highly restricted riparian habitats. A potential new species (*Sannantha* sp. aff. *cunninghamii*) also occurs in this vegetation type, and requires further study with fertile material (see Section 4.3).

Woodland

<u>6: Yellow Box Woodland</u> - predominantly occurring on the basalt plateau and associated slopes within 'Bylong Station' and 'Bylong Park'. Dominated by *Eucalyptus melliodora* in the canopy, but understorey vegetation has been mostly cleared for grazing. As for White Box Woodland, a high diversity of grasses, herbs and forbs characterise this community. The bulk of the mapped area of Yellow Box Woodland is dominated by *Eucalyptus melliodora*, over a grassy understorey of various native grasses, herbs and forbs. Shrubs are sparse or absent. This form occupies the bulk of the basalt plateau, and forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC (see later). Some minor elements of this community along escarpment slopes support thickets of shrubs such as *Bursaria spinosa*, and occasionally *Dodonaea viscosa* var.

cuneata or *Cassinia quinquefaria*. Ground layer vegetation is diverse, and supports numerous grasses, herbs and forbs.

7: White Box Woodland (Grassy or Shrubby) - forming a mosaic pattern with the Slaty Box Woodland along all of the talus footslopes in the area, but also extending out onto some low rises on the plains. Two variants are present in the area, distinguished by the presence or absence of a shrub layer.

- **7a: White Box Woodland (Grassy)** - dominated by *Eucalyptus albens*, over a grassy understorey of various native grasses, herbs and forbs. Shrubs are either widely scattered or absent. This form typically occurs on the undulating lands of the valley floor, where it changes into Coastal Grey Box Woodland, and forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC (see later).
- **7b: White Box Woodland (Shrubby)** - dominated by *Eucalyptus albens* in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata, Bursaria spinosa*, *Olearia elliptica* and *Cassinia quinquefaria*. Ground layer vegetation is diverse, and supports numerous grasses, herbs and forbs. The shrubby form predominates on the steeper sites along the escarpment footslopes, and can be excluded from the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC (see later).

8: Blakely's Redgum Woodland (Grassy or Shrubby) - relatively minor areas of woodland dominated by *Eucalyptus blakelyi* are present in the Project Boundary. Where they occur, past management practices has generally determined the grassy or shrubby nature of them. Both varieties are recognised in the mapping:

- **8a: Blakely's Redgum Woodland (Grassy)** - dominated by *Eucalyptus blakelyi*, over a ground layer of native grasses, herbs and forbs. Shrubs are either widely scattered or absent. This form occurs as small patches mainly on the western rim of the Bylong Valley, but also in the southern central section at 'Harley Hill'. This unit forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC (see later).
- **8b: Blakely's Redgum Woodland (Shrubby)** - dominated by *Eucalyptus blakelyi* in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata, Bursaria spinosa*, *Olearia elliptica* and *Cassinia quinquefaria*. Ground layer vegetation supports several grasses, herbs and forbs. The shrubby form occurs mainly in the east in the vicinity of Bylong State Forest, and can be excluded from the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC (see later).

9: Slaty Box Woodland - common across most areas on talus footslopes on Permian sediments, and underlying the Triassic Narrabeen series. Dominated by *Eucalyptus dawsonii* and *Callitris endlicheri*, with *Eucalyptus albens* or *Eucalyptus moluccana* occurring occasionally. The mid-layer is distinct, comprising *Acacia ixiophylla, Olearia elliptica, Dodonaea viscosa* var. *cuneata* and *Cassinia quinquefaria*, over a sparse, often bare, ground layer. One location within the 'Helvetia' property supports dense stands of the regionally significant *Melaleuca lanceolata,* occurring on a lower slope within Slaty Box Woodland. In the data analysis, the single sample plot completed in this vegetation type did not differ significantly from all other vegetation, and grouped within the surrounding Slaty Box Woodland.

10: Coastal Grey Box Woodland - prior to clearing for agriculture, woodlands dominated by *Eucalyptus moluccana* appear to have predominated across the lower plains, changing to *Eucalyptus albens* woodlands on the adjacent steeper slopes. Data collected from a single site within the few remaining remnants of *E. moluccana* dominated vegetation was significantly different to all other grassy woodland communities. As for those communities, Coastal Grey Box Woodland supports a range of grasses, herbs and forbs, in addition to a scattered shrub layer of *Maireana microphylla*.

11: Fuzzy Box Woodland - present in a few locations on gentle rises and slopes, on alluvial or colluvial soils associated with drainage lines on the floor of the main Bylong Valley, but formerly considerably more widespread. Dominated exclusively by *Eucalyptus conica,* over a sparse or non-existent shrub layer, and a diverse ground layer of various grasses, herbs and forbs. One plot sampled within 'Bylong Park' where a long history of heavy grazing has ground layer vegetation supporting the unpalatable *Austrostipa verticillata*, which dominates these areas. Other stands of Fuzzy Box woodland support a higher diversity of herbs, forbs and grasses.

Heath & Scrub

12: Calytrix Rockplate Heath - small, isolated patches of heath vegetation are present on the hard sandstone ridges of Crown land in the west and south-east. Species diversity is low here, with *Calytix tetragona, Leptospermum parvifolium,* and *Micromyrtus sessilis* the dominant species. In places, this community grades imperceptibilly into the related Dwyer's Redgum Low Open Forest.

13: Shrubby Regrowth - some low hills and gentle undulations that have been previously cleared for grazing and then left to regenerate now support dense shrub stands of species such as *Acacia ixiophylla, Dodonaea viscosa* var. *cuneata* and *Bursaria spinosa*. In most cases, these areas are likely to have formerly supported Slaty Box Woodland. Shrubby Regrowth has not been sampled in any detail during this study. At a local scale, some areas of Shrubby Regrowth may be considered to form part of Slaty Box Woodland (a State-listed TEC): any such areas requiring clearance should be assessed on a site-by-site basis.

Forest

14: Dwyer's Redgum Low Open Forest - typified by a low and widely spaced canopy of *Eucalyptus dwyeri, Callitris endlicheri* and *Acacia doratoxylon*, this community occurs along narrow rocky ridgelines in Crown land to the west and south-east, and also in and around Bylong State Forest. Typical shrub species present include *Leptospermum parvifolium, Philotheca salsolifolia, Leucopogon muticus* and *Calytris tetragona*, with *Cleistochloa rigida* and *Lomandra confertifolia* dominating the ground layer.

15: Caley's Ironbark Forest - dominates on the higher sandstone ridges, where it forms a mosaic with Blue-leaf Ironbark/ Cypress Forest. This community is clearly dominated by *Eucalyptus caleyi* subsp. *caleyi*, with scattered occurrences of *Callitris endlicheri* and *Acacia linearifolia*. A shrubby mid-layer comprising *Cassinia quinquefaria, Persoonia linearis, Dodonaea viscosa* var. *cuneata* and *Leucopogon muticus* is present over a sparse ground layer. In the east, Caley's Ironbark Forest is the dominant ridgetop forest, but in the west this community forms a complex mosaic with Blue-leaf Ironbark/ Cypress Forest.

16: Blue-leaf Ironbark/ Cypress Forest - occurs on higher sandstone ridges, particularly in the west but also present in the south-east. This community forms a mosaic with Caley's Ironbark Forest on ridges in the west. Blue-leaf Ironbark/ Cypress Forest is dominated in the canopy by *Eucalyptus nubila* and *Callitris endlicheri*, with the shrubs *Persoonia linearis, Acacia crassa, Acrotricha rigida* and *Dodonaea viscosa* var. *cuneata* commonly occurring. The sparse ground layer usually includes *Cleistochloa rigida*, *Lepidosperma gunnii* and *Phyllanthus hirtellus.*

17: Red Ironbark/ Cypress Forest - small areas of forest dominated by *Eucalyptus fibrosa* and *Callitris endlicheri* are present on the higher grounds in the east of the Project Boundary, in and around Bylong State Forest. *Eucalyptus fibrosa* and *Callitris endlicheri* dominate the canopy here, with *Dodonaea viscosa* var. *cuneata, Choretrum* sp Coxs Gap, and *Acacia buxifolia* typifying the shrub layer. Common ground species include *Aristida ramosa, Pomax umbellata* and *Cheilanthes sieberi* subsp. *sieberi*.

18: Cypress Pine Forest - stands of vegetation characterised by *Callitris gracilis* subsp. *gracilis* and *Callitris endlicheri* occur within a surrounding matrix of Caley's Ironbark Forest and other ridgeline vegetation. Understorey species typically present include *Prostanthera prunellioides, Leucopogon muticus, Persoonia linearis, Acrotriche divaricata, Astroloma humifusum* and *Choretrum* sp Cox Gap, all at low abundances. Small stands of Cypress Pine Forest also occur in some locations on the valley floor, but these represent probable regrowth following past clearing, and have developed after long periods of fire suppression.

19: Bloodwood/ Ironbark Forest - present only in the north-east of the Project Boundary, this community is typified by *Corymbia trachyphloia* subsp. *amphistomatica* in the canopy, where it occurs with *Callitris endlicheri* and *Eucalyptus nubila*. Common understorey species include the shrubs *Gompholobium aspalathoides, Grevillea mucronulata, Hibbertia circumdans* and *Leucopogon muticus*. *Lomandra glauca, Platysace ericoides* and *Aristida ramosa* are common ground layer species.

20: Scribbly Gum/ Grey Gum Forest - two restricted locations of Scribbly Gum/ Grey Gum Forest are present within the Project Boundary; one in the north-east and the other in the south-east. Both support the characteristic *Eucalyptus rossii* in the canopy, along with *Eucalyptus punctata* and *Callitris endlicheri*. The shrub species *Leucopogon muticus, Monotoca scoparia, Persoonia linearis* and *Boronia anethifolia* are common, while *Lomandra confertifolia, Goodenia hederacea* and *Lomandra glauca* typify the ground layer.

21: Exposed Grey Gum/ Stringybark Forest - the higher rocky landscapes in the south-east and west are typified by *Eucalyptus agglomerata* and *Eucalyptus punctata*. Shrub species here include *Dodonaea viscosa* var. *cuneata, Phebalium squamulosum, Leucopogon muticus* and *Hovea lanceolata*, with *Cleistochloa rigida, Lomandra confertifolia* and *Lomandra glauca* common ground species. This community is closely related to Sheltered Grey Gum/ Stringybark Forest, and both share many species. Both are mapped collectively.

22: Sheltered Grey Gum/ Stringybark Forest - sheltered drainage lines and slopes within the higher rocky landscapes in the west and south-east support moist forest of *Eucalyptus punctata* and *Eucalyptus agglomerata*. Understorey development tends to be better structured than the related

Exposed Grey Gum/ Stringybark Forest, with *Bursaria spinosa, Acacia linearifolia, Goodenia stephensonii, Macrozamia reducta* and *Dodonaea viscosa* var. *cuneata* dominating, and *Lomandra confertifolia, Microlaena stipoides* var. *stipoides* and *Cheilanthes sieberi* subsp. *sieberi* in the ground layer.

Grasslands

DNG: Derived Native Grasslands - Derived Native Grasslands throughout the Bylong Valley formerly supported open grassy woodlands of various forms. Following clearing for agriculture, a suite of native grasses, herbs and forbs remain while canopy species may be sparse or very widely spaced. Under current legislation, some components of Derived Native Grasslands conform to some Threatened Ecological Communities, particularly the National *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* and the NSW *White Box - Yellow Box - Blakely's Red Gum Woodland*. Reconstruction of the pre-settlement distribution of the Bylong Valley in map form allows these derived grasslands to be attributed to either Yellow Box Woodland (Unit 6), White Box Woodland (Unit 7), Blakely's Redgum Woodland (Unit 8), Slaty Box Woodland (Unit 9), Coastal Grey Box Woodland (Unit 10), Fuzzy Box Woodland (Unit 11), or a riparian complex comprising River Oak/ Apple Riparian Forest (Unit 3) and Blakely's Redgum/ Apple Riparian Forest (Unit 4). Only derived grasslands attributable to Units 6, 7, and 8 conform to listed TECs.

CC: Cultivated Lands - The bulk of the alluvial flats along the Bylong River and Lee Creek have been heavily cleared and cropped over several decades. These areas currently support few native species, although in some areas scattered canopy trees remain (eg: *Angophora floribunda, Eucalyptus blakelyi, Eucalyptus camaldulensis*). Depending on the season and the extent of grassland management, cultivated lands can support high densities of weed species. Other areas now support extensive paddocks of improved pastures, such as Kikuyu Grass (*Pennisetum clandestinum*).

3.3.4 Region and State Equivalency

Table 6 presents the equivalent vegetation communities for the current regional and State classifications of native vegetation. A number of these matches have been applied broadly, as it is difficult to reconcile local-scale diversity with regional nomenclatures that are not built within a hierarchical structure (local → regional → State).

3.3.5 Threatened Ecological Communities Equivalency

Floristic Comparisons - Floristic lists derived from twenty-nine 0.04ha sample plots collected from low-lying landscapes within the Project Boundary were compared against all NSW Threatened Ecological Communities from the Sydney Basin bioregion using the software *Match Species To Communities* v2 (Wild Terrain). After standardisation of plant taxonomy, these comparisons revealed that plant communities sampled within the Bylong Valley support species more similar to *Central Hunter Grey Box - Ironbark Woodland EEC* and *Hunter Valley Footslopes Slaty Gum Woodland EEC* than any other listed community in the Sydney Basin bioregion. Figure 11 shows the comparisons for all 29 sample plots across the ten TECs considered most likely to be present in the Project Boundary. No plots supported greater than 45% of the listed plant species within the respective TECs; however, it should be noted that all determinations state that supplied species lists are indicative only, and they should not be used as conclusive evidence of a TEC without reference to other biophysical determiners.

Table 6 Regional and State equivalents of vegetation units delineated for this study (DNG & CC grassland units excluded, as no equivalents).

Local (this study)	Regional Equivalency		State Equivalency	
	Wollemi NP & environs (NSW OEH 2012a)	**Greater Hunter Vegetation Type (NSW OEH 2012b)**	**NSW VCA (Benson 2006)**	**Keith Class (Keith 2004)**
1: Rusty Fig Dry Rainforest	Dry Ranges Rusty Fig Rainforest Scrub (S_RF15)	Rusty Fig/ Native Quince/ Native Olive/ dry rainforest of the Central Hunter Valley (MU025)	no equivalent	Dry Rainforests
2: Grey Myrtle Dry Rainforest	Sydney Hinterland Grey Myrtle Dry Rainforest (S_RF11)	Grey Myrtle/ Grey Gum gully dry rainforest on sandstone ranges of the Sydney Basin (MU022)	no equivalent	Dry Rainforests
3: River Oak / Redgum Riparian Woodland	River Oak Forest (S_FoW13)	River Red Gum/ River Oak grassy riparian woodland of the Hunter Valley (MU215)	River Oak Riparian Woodland of the North Coast and Northern Sydney Basin	Eastern Riverine Forests
4: Blakely's Redgum/ Apple Riparian Forest	Western Hunter Flats Rough-barked Apple Forest (S_FoW19)	Blakely's Red Gum/ Narrow-leaved Ironbark/ Rough-barked Apple shrubby woodland of the upper Hunter (MU089)	no equivalent	Eastern Riverine Forests
5: Blakely's Redgum/ Paperbark Forest	no equivalent	no equivalent	no equivalent	Western Slopes Dry Sclerophyll Forests
6: Yellow Box Woodland	(?) Central Tableland Clay White Box Woodland (S_GW11)	Yellow Box grassy woodland on basalt soils of the upper Hunter (MU171)	Blakely's Red Gum - White Box - Yellow Box - Black Cypress Pine box grass/shrub woodland on clay loam soils on undulating hills of central NSW South-western Slopes Bioregion	Western Slopes Grassy Woodland
7: White Box Woodland	Western Hunter Footslopes Box Woodland (S_GW05)	White Box/ Black Cypress Pine shrubby woodland of the Western Slopes (MU092)	Blakely's Red Gum - White Box - Yellow Box - Black Cypress Pine box grass/shrub woodland on clay loam soils on undulating hills of central NSW South-western Slopes Bioregion	Western Slopes Grassy Woodland

Local (this study)	Regional Equivalency		State Equivalency	
	Wollemi NP & environs (NSW OEH 2012a)	**Greater Hunter Vegetation Type (NSW OEH 2012b)**	**NSW VCA (Benson 2006)**	**Keith Class (Keith 2004)**
8: Blakely's Redgum Woodland	(?) Western Hunter Footslopes Box Woodland (S_GW05)	no equivalent	(?) Blakely's Red Gum - White Box - Black Cypress Pine box grass/shrub woodland on clay loam soils in undulating hills of central NSW Couth-western Slopes Bioregion	Western Slopes Grassy Woodland
9: Slaty Box Woodland	Hunter Escarpment Slaty Gum-Box Forest (S_DSF41)	Grey Box/ Slaty Box shrub/ grass woodland on sandstone slopes of the upper Hunter and Sydney Basin (MU137)	Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin	North-west Slopes Dry Sclerophyll Woodlands
10: Coastal Grey Box Woodland	(?) Western Hunter Footslopes Box Woodland (S_GW05)	(?) Grey Box/ Slaty Box shrub/ grass woodland on sandstone slopes of the upper Hunter and Sydney Basin (MU137)	(?) Grey Box - cypress pine - red gum woodland on deep sandy loam soil in northern NSW BBS Bioregion	Western Slopes Grassy Woodland
11: Fuzzy Box Woodland	Western Hunter Flats Fuzzy Box Woodland (S_GW06)	no equivalent	Fuzzy Box - Inland Grey Box on Alluvial Brown Loam Soils of the NSW South Western Slopes Bioregion and Southern Brigalow Belt South Bioregion	Western Slopes Grassy Woodlands
12: Calytrix Rockplate Heath	Western Hunter Rockplate Heath-Mallee (S_DSF62)	(?) Dywer's Red Gum/ Fringe Myrtle heathy open woodland on sandstone plateau of the upper Hunter and Sydney Basin (MU161)	no equivalent	Western Slopes Dry Sclerophyll Forests
13: Shrubby Regrowth	Regenerating Vegetation (S_RGS)	no equivalent	no equivalent	no equivalent
14: Dwyer's Red Gum Low Open Forest	Western Hunter Dwyer's Red Gum-Cypress Woodland (S_DSF61)	Dywer's Red Gum/ Fringe Myrtle heathy open woodland on sandstone plateau of the upper Hunter and Sydney Basin (MU161)	no equivalent	Western Slopes Dry Sclerophyll Forests

Local (this study)	Regional Equivalency		State Equivalency	
	Wollemi NP & environs (NSW OEH 2012a)	Greater Hunter Vegetation Type (NSW OEH 2012b)	NSW VCA (Benson 2006)	Keith Class (Keith 2004)
15: Caley’s Ironbark Forest	Western Hunter Caley’s Ironbark Low Forest (S_DSF57)	Caley's Ironbark/ Red Ironbark/ Currawang shrubby woodland on sandstone ranges of the Sydney Basin (MU159)	no equivalent	Western Slopes Dry Sclerophyll Forests
16: Blue-leaf Ironbark/ Cypress Forest	no equivalent	Blue-leaved Ironbark/ Black Pine shrubby tall woodlands on sandstone substrates of the Pilliga area	no equivalent	Western Slopes Dry Sclerophyll Forests
17: Red Ironbark / Cypress Forest	Goulburn River Ranges Cypress-Ironbark Forest (S_DSF48)	Caley's Ironbark/ Red Ironbark/ Currawang shrubby woodland on sandstone ranges of the Sydney Basin (MU159)	(?) Grey Gum - Narrow-leaved Stringybark - Ironbark Woodland on Ridges of the Upper Hunter Valley, Sydney Basin	Western Slopes Dry Sclerophyll Forests
18: Cypress Pine Forest	Goulburn River Ranges Cypress-Ironbark Forest (S_DSF48)	Black Pine/ Red Ironbark/ Brown Bloodwood shrubby woodland on sandstone ranges of the Sydney Basin (MU155)	(?) Ironbark - Grey Gum shrubby woodland of sandy gullies in the upper Hunter Valley, Sydney Basin	Western Slopes Grassy Woodland
19: Bloodwood/ Ironbark Forest	Western Hunter Caley's Ironbark Low Forest (S_DSF57)	(?) Red Ironbark/ Brown Bloodwood/ Black Pine heathy open forest on sandstone ranges of the Sydney Basin	no equivalent	Western Slopes Dry Sclerophyll Forests
20: Scribbly Gum/ Grey Gum Forest	(?) Growee Ranges Grey Gum-Scribbly Gum Forest (S_DSF49)	no equivalent	no equivalent	Southern Tablelands Dry Sclerophyll Forests
21: Exposed Grey Gum/ Stringybark Forest	(?) Growee Ranges Grey Gum Sheltered Forest (S_DSF50)	no equivalent	no equivalent	Southern Tablelands Dry Sclerophyll Forests
22: Sheltered Grey Gum/ Stringybark Forest	Growee Ranges Grey Gum Sheltered Forest (S_DSF50)	no equivalent	no equivalent	Southern Tablelands Dry Sclerophyll Forests

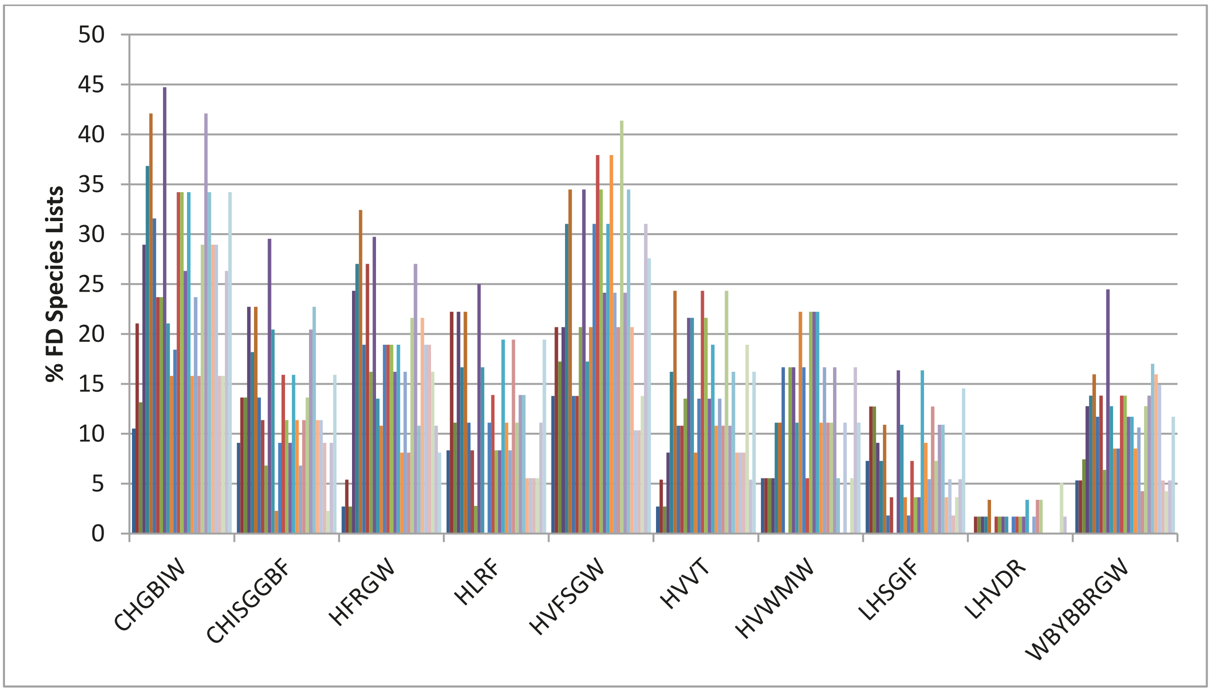

Figure 11 Percentage match of twenty-nine floristic sample plots to the ten most likely listed NSW Threatened Ecological Communities.

CHGBIW = Central Hunter Grey Box - Ironbark Woodland
CHISGGBF = Central Hunter Ironbark - Spotted Gum - Grey Box Forest
HFRGW = Hunter Floodplain Red Gum Woodland
HLRF = Hunter Lowlands Redgum Forest
HVFSGW = Hunter Valley Foot Slopes Grassy Woodland
HVVT = Hunter Valley Vine Thicket
HVWMW = Hunter Valley Weeping Myall Woodland
LHSGIF = Lower Hunter Spotted Gum - Ironbark Forest
LHVDR = Lower Hunter Valley Dry Rainforest
WBYBBRGW = White Box - Yellow Box - Blakely's Redgum Grassy Woodland

As suggested by the above analysis, the indicative presence of *Central Hunter Grey Box - Ironbark Woodland EEC* within the Project Boundary has been examined against the Final Determination for that TEC, and been dismissed. This is because Paragraph 4 of that determination states that "Central Hunter Grey Box – Ironbark Woodland typically forms a woodland dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark), *Brachychiton populneus* subsp. *populneus* (Kurrajong) and *Eucalyptus moluccana* (Grey Box). Other tree species may be present and occasionally dominate or co-dominate, and include *Angophora floribunda* (Rough-barked Apple) and *Callitris endlicheri* (Black Cypress Pine)". Apart from two small stands of low stunted trees on the sandstone hills, *Eucalyptus crebra* is absent from the Project Boundary, and nowhere does this species, *Brachychiton populneus* and *Eucalyptus moluccana* co-dominate the landscape (see discussion later). This combination of dominant species, and hence this TEC, applies to the Hunter Valley floor proper to the east, where the Newcastle Coal Measures outcrop at lower elevations than the Illawarra Coal Measures that are present in the Bylong Valley.

Canopy Comparisons - based on canopy characteristics alone, three NSW TECs potentially occur within the Project Boundary ('candidate-TECs'). One of these has not been sampled due to the lack of intact and sizeable remnants:

- White Box - Yellow Box - Blakely's Redgum Grassy Woodland
- Hunter Valley Foot Slopes Grassy Woodland
- Hunter Floodplain Red Gum Woodland (no plot data)

It then becomes important to consider factors other than floristic composition to determine the presence of TECs. All three of these candidate-TECs occur within the Sydney Basin bioregion. In addition to uncertainties highlighted by examining floristic composition, there are other problematic issues related to the identification of TECs, noted in the following text.

1. **White Box - Yellow Box - Blakely's Red Gum Grassy Woodland** - remnant vegetation characteristic of this TEC is widespread across the Project Boundary. As noted by FloraSearch (2005) for Wilpinjong Coal Mine, areas dominated by *Eucalyptus albens* are geographically separated from areas of *Eucalyptus melliodora* and those of *Eucalyptus blakelyi*. This is unlike areas on the western slopes of New South Wales, where it is not uncommon for all three species to co-dominate an area. The poor performance of the *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland EEC* (nearly all plots < 15% match) in the floristic comparisons (Figure 11 above) can be attributed to the broad nature of the Final Determination for that TEC, covering at least three States, compared to the regional context in which all others originated (NSW NPWS 2000; Peake 2006). Sample plots comprising the Grassy Box Woodlands (Groups 1 & 4 in the cluster analysis in Section 3.3.1) show correlations of between 5 and 24% with species listed in the Final Determination (Figure 12), averaging at 14%.

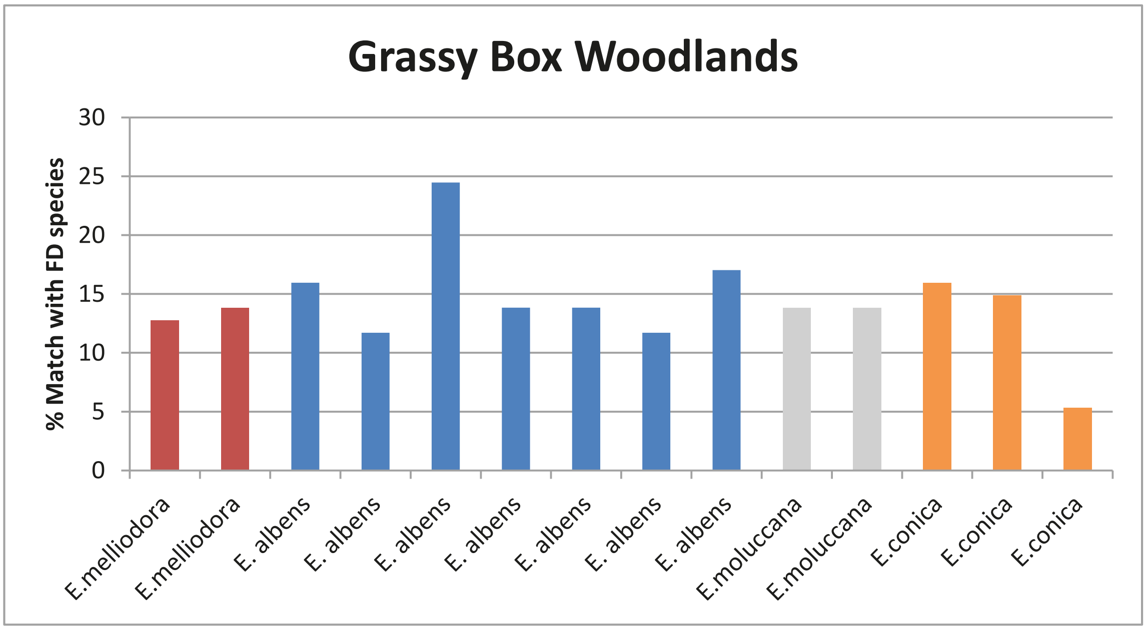

Figure 12 Percentage match of fourteen sample plots (with dominant canopy species indicated) within Grassy Box Woodlands to the species list in the Final Determination (FD) for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland.

While areas dominated by White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) and Blakely' Red Gum (*Eucalyptus blakelyi*) are present within the Project Boundary, there are other locations where Coastal Grey Box (*Eucalyptus moluccana*) and Fuzzy Box (*Eucalyptus conica*) dominate, and indeed appear to have formerly comprised distinct communities in their own right. Both of these species are included within the Final Determination for this TEC, but both are also important in the definition of other regional communities. In Paragraph 4 of the Final Determination, it is stated that "Woodlands including *Eucalyptus crebra, Eucalyptus dawsonii* and *Eucalyptus moluccana* (and intergrades with *Eucalyptus albens*), for example in the Merriwa plateau, Goulburn River National Park and western Wollemi National Park, are also included" in this TEC. In this regard, Paragraph 7 distinguishes and excludes stands of Coastal Grey Box from the lower Hunter Valley: "Related communities are the ...... and the *Eucalyptus moluccana*, Grey Box, communities of the Clarence, lower Hunter Valley and Western Sydney. These are not covered by this Determination". While these two statements may suggest that the Coastal Grey Box Woodland at Bylong is included within this TEC, this cannot be the case because nowhere within the Project Boundary is woodland dominated by "*Eucalyptus crebra, Eucalyptus dawsonii* and *Eucalyptus moluccana*".

Paragraph 6 of the Final Determination specifies that areas considered to comprise the Commonwealth *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Grassland TEC* are also included in the NSW Determination. The Commonwealth Listing Advice states "Associated, and occasionally co-dominant, trees include, but are not restricted to: Grey Box (*Eucalyptus microcarpa*), Fuzzy Box (*E. conica*), Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Red Stringybark (*E. macrorhyncha*), White Cypress Pine (*Callitris glaucophylla*), Black Cypress Pine (*C. endlicheri*), Long-leaved Box (*E. goniocalyx*), New England Stringybark (*E. calignosa*), Brittle Gum (*E. mannifera*), Candlebark (*E. rubida*), Argyle Apple (*E. cinerea*), Kurrajong (*Brachychiton populneus*) and Drooping She-oak (*Allocasuarina verticillata*)". However, confounding the issue still further, the Commonwealth Listing Advice states that "Sites dominated by Western Grey Box (*E. microcarpa*) or Coastal Grey Box (*E. moluccana*) without Yellow Box, White Box or Blakely's Red Gum as co-dominants are not considered to be part of the ecological community, except in the Nandewar Bioregion". By extension, it may be surmised that areas dominated by *Eucalyptus conica* without Yellow Box, White Box or Blakely's Red Gum should also be excluded from the Commonwealth TEC.

Following this rationale, it is concluded that;

- areas dominated by *Eucalyptus moluccana* are **excluded** from both the NSW *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland TEC* and the Commonwealth *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Grassland TEC*;

- areas dominated by *Eucalyptus conica* are **excluded** from both the NSW *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland TEC* and the Commonwealth *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Grassland TEC*.

Despite their exclusions from existing TECs, woodlands dominated by both *Eucalyptus conica* (Fuzzy Box Woodlands) and *Eucalyptus moluccana* (Coastal Grey Box Woodlands) within the Bylong Valley are considered of high conservation significance, principally in view of the fact that they represent vegetation communities' characteristic of a highly cleared landscape, and they support canopy species disjunct from their currently accepted ranges. Section 4.1.3 more fully discusses these two communities and their significance.

2. **Hunter Valley Footslopes Slaty Gum Woodland** - escarpment footslopes support open forest and woodland dominated by *Eucalyptus dawsonii*, and can be included within the Hunter Valley Footslopes Slaty Gum Woodland TEC. Overall, plot data analysed and depicted in Figure 11 above showed this TEC to be the second most likely TEC based on floristic composition (20-41% of listed species for plots dominated by *Eucalyptus dawsonii*: Figure 13). Hunter Valley Footslopes Slaty Gum Woodland occurs at the interface of Triassic Narrabeen and Permian sediments of the Hunter Valley (Paragraph 1), and is characterized by a canopy of *Eucalyptus dawsonii*. Interestingly, in the floristic comparison the sample plot placed within Moonah Thicket (*Melaleuca lanceolata*) supported the highest proportion of species for this TEC.

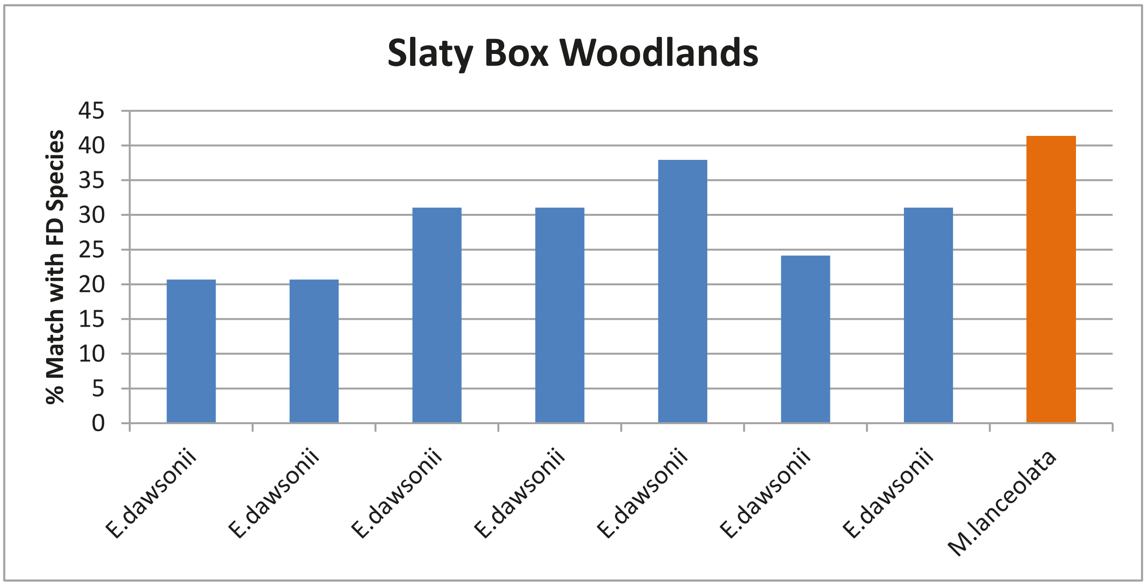

Figure 13 Percentage match of eight sample plots within Slaty Box Woodlands to the species list in Final Determination (FD) for Hunter Valley Footslopes Slaty Gum Woodland.

3. **Hunter Floodplain Red Gum Woodland** - floodplains within the Project Boundary, and indeed much of the Bylong Valley, support vegetation equating to the Hunter Floodplain Red Gum Woodland TEC. The bulk of these lands have been previously cleared for agriculture, and remain only as remnant paddock trees within exotic grasslands (and hence were not sampled for numerical classification), including *Eucalyptus camaldulensis*, *Eucalyptus blakelyi* and *Angophora floribunda*. Paragraph 4 of the Final Determination for this TEC also includes the narrow bands of River Oak which line the major streams: "Within the community stands of *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) and *Casuarina glauca* (Swamp Oak) can form a part of this community". Consequently, all remnant trees and vegetation within this floodplain, including the endangered population of *Eucalyptus camaldulensis* and the ribbons of River Oak, can be included within the Hunter Floodplain Red Gum Woodland TEC.

4. **Derived Grasslands** - Derived Native Grasslands (DNG) are rarely discussed in detail within TEC determinations or listing advices, but they are a particular issue for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland. Under the Commonwealth listing, areas of potential DNG must occur within lands formerly dominated by any of the three characteristic canopy species, must contain at least 12 native non-grass species, and must support one or more of the listed 'important' species (see further discussion in Section 4.1.1).

   Appendix 7.2 summarise those native non-grass species that were recorded during the three grassland survey periods in May 2012 (18 plots of 10 x 10m), November 2013 (10 plots of 20 x 20m), and April 2014 (15 plots of 20 x 50m, conducted by Cumberland Ecology). From data collected within individual sample plots, it is evident that 6 of the 18 plots sampled during May 2012 support vegetation that meets the requirements of Box-Gum derived grassland, but none of the 10 plots sampled in November 2013 qualify. This is despite the November 2013 plots sampling areas 4x the size of the May 2012 plots, and suggests that the recommended sampling time for grassy woodlands (late Spring) should not be adopted without due consideration of rainfall received in the preceding 3-6 months. Data collected in April 2014 by Cumberland Ecology showed 8 of 15 plots supporting Box-Gum derived grassland.

   For the May 2012 pooled data (all sample plots combined), a total of 42 native non-grass species (including 9 'important' species) were recorded across 0.18 ha of sample area, suggesting that all of the area investigated at that time (the former Garling & Loneragan, and Grieve properties) qualifies as Box-Gum TEC. Similarly, the pooled data for November 2013 shows a total of 16 native non-grass species (including 4 'important' species) across 0.4ha of sample area, also qualifying that area (part of the former Wallings property) as Box-Gum TEC.

3.4 Vegetation Community Map

A vegetation community map of the Project Boundary is presented as Figure 14, and incorporates information obtained from 2,471 RDP's and the results of the numerical classification analysis. The GIS layers associated with the mapping (supplied to the client) include fields for locally, regionally and State-defined communities, as well as Commonwealth and State Threatened Ecological Communities.

Table 7 shows the number of hectares occupied by each defined vegetation unit within the Project Boundary.

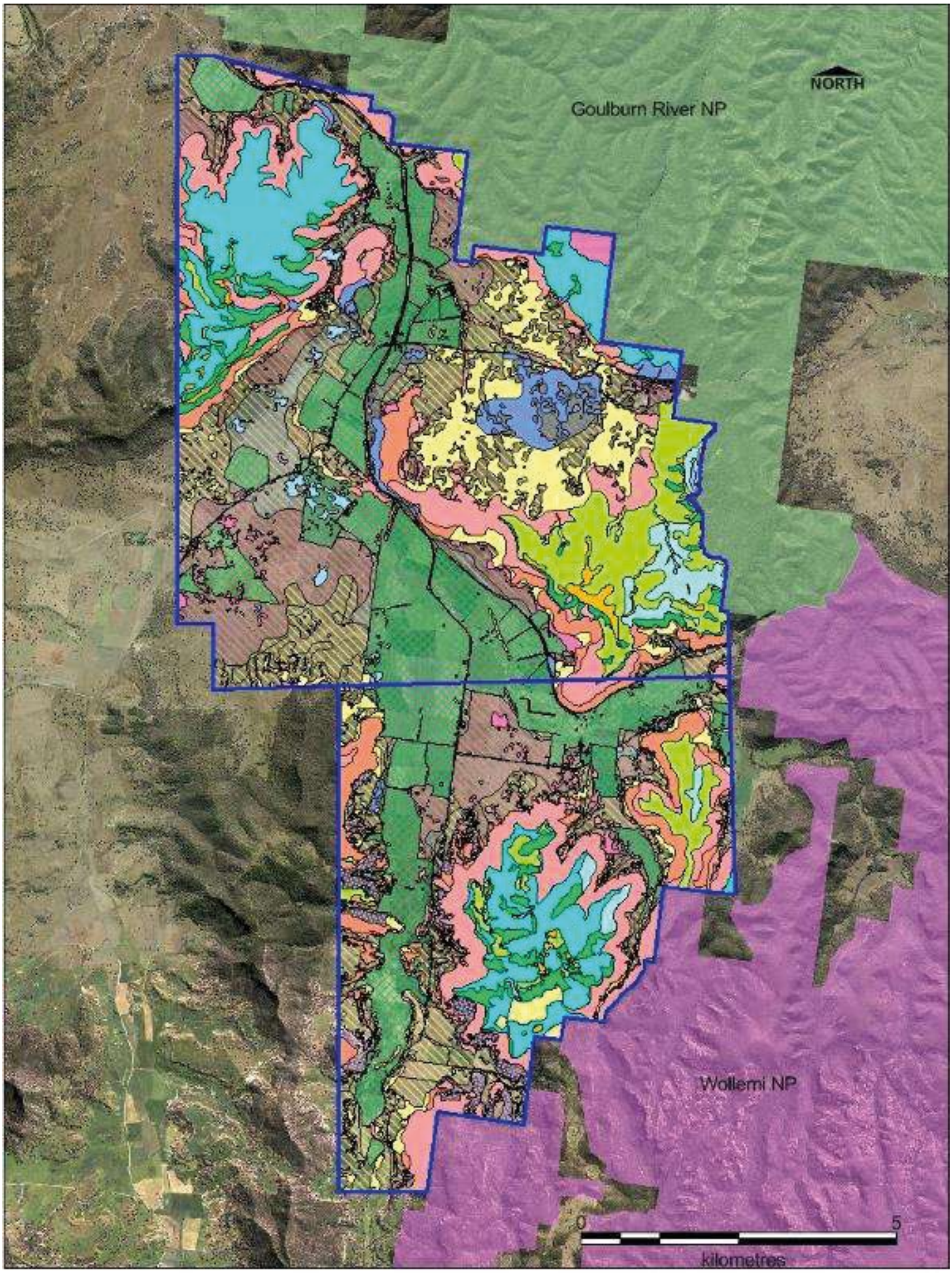

Figure 14 Vegetation map of the Project Boundary (see legend overleaf).

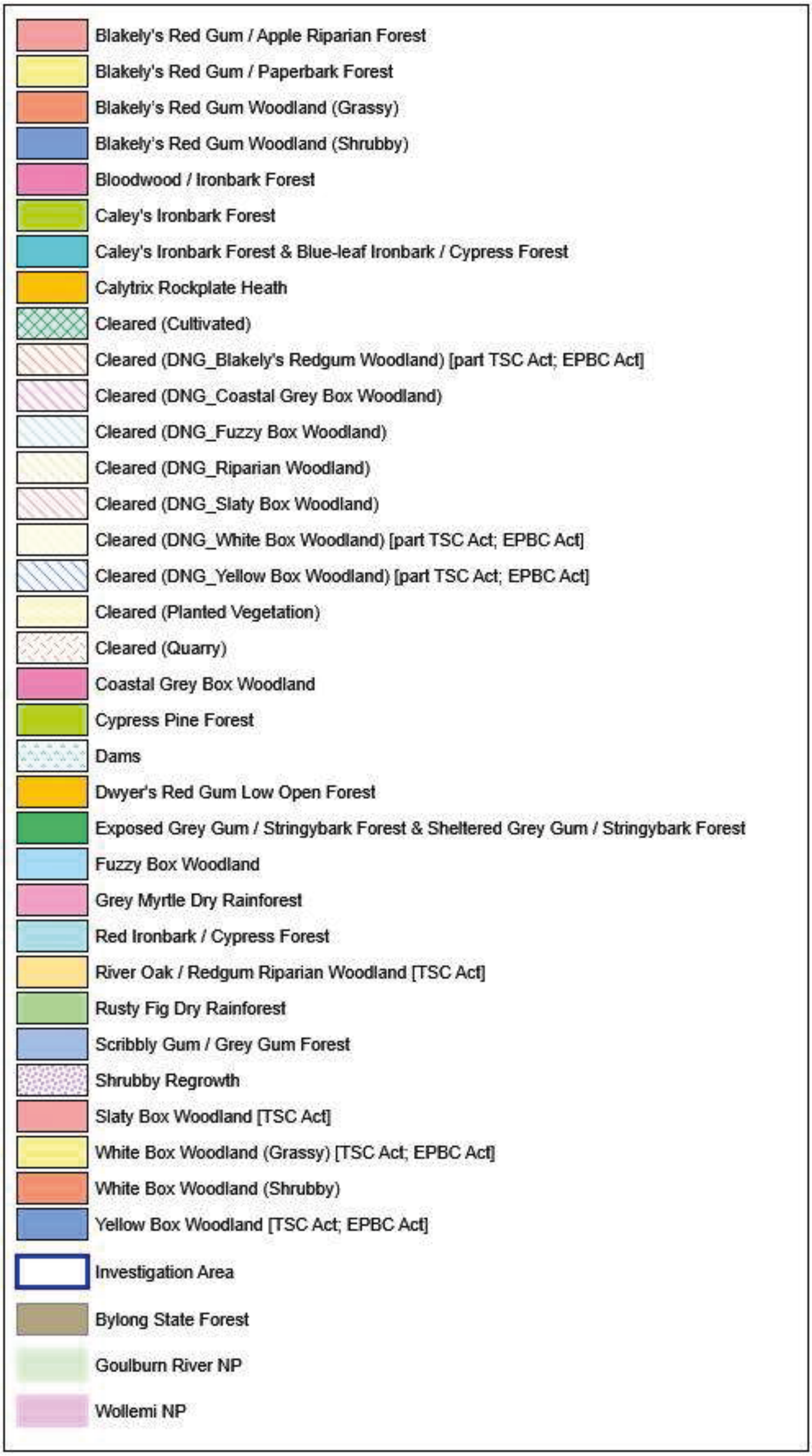
Blakely's Red Gum / Apple Riparian Forest
Blakely's Red Gum / Paperbark Forest
Blakely's Red Gum Woodland (Grassy)
Blakely's Red Gum Woodland (Shrubby)
Bloodwood / Ironbark Forest
Caley's Ironbark Forest
Caley's Ironbark Forest & Blue-leaf Ironbark / Cypress Forest
Calytrix Rockplate Heath
Cleared (Cultivated)
Cleared (DNG_Blakely's Redgum Woodland) [part TSC Act; EPBC Act]
Cleared (DNG_Coastal Grey Box Woodland)
Cleared (DNG_Fuzzy Box Woodland)
Cleared (DNG_Riparian Woodland)
Cleared (DNG_Slaty Box Woodland)
Cleared (DNG_White Box Woodland) [part TSC Act; EPBC Act]
Cleared (DNG_Yellow Box Woodland) [part TSC Act; EPBC Act]
Cleared (Planted Vegetation)
Cleared (Quarry)
Coastal Grey Box Woodland
Cypress Pine Forest
Dams
Dwyer's Red Gum Low Open Forest
Exposed Grey Gum / Stringybark Forest & Sheltered Grey Gum / Stringybark Forest
Fuzzy Box Woodland
Grey Myrtle Dry Rainforest
Red Ironbark / Cypress Forest
River Oak / Redgum Riparian Woodland [TSC Act]
Rusty Fig Dry Rainforest
Scribbly Gum / Grey Gum Forest
Shrubby Regrowth
Slaty Box Woodland [TSC Act]
White Box Woodland (Grassy) [TSC Act; EPBC Act]
White Box Woodland (Shrubby)
Yellow Box Woodland [TSC Act; EPBC Act]
Investigation Area
Bylong State Forest
Goulburn River NP
Wollemi NP

Table 7 Number of hectares of all vegetation communities within the Project Boundary.

Local (this study)	Area (ha)	Comments
1: Rusty Fig Dry Rainforest	0.9	single location only
2: Grey Myrtle Dry Rainforest	5.4	
3: River Oak / Redgum Riparian Woodland (TSC Act)	39.5	comprised of many small remnants
4: Blakely's Redgum/ Apple Riparian Forest	166.0	
5: Blakely's Redgum/ Paperbark Forest	14.6	
6: Yellow Box Woodland (TSC Act, EPBC Act)	161.0	
7: White Box Woodland (7a: TSC Act, EPBC Act)	1225.0	722 ha grassy (Unit 7a); 503 ha shrubby (Unit 7b)
8: Blakely's Redgum Woodland (8a: TSC Act, EPBC Act)	38.0	15.6 ha grassy (Unit 8a); 22.2 ha shrubby (Unit 8b)
9: Slaty Box Woodland (TSC Act)	1144.0	
10: Coastal Grey Box Woodland	108.0	
11: Fuzzy Box Woodland	60.7	
12: Calytrix Rockplate Heath	8.3	
13: Shrubby Regrowth	200.0	
14: Dwyer's Red Gum Low Open Forest	69.5	
15: Caley's Ironbark Forest	514.0	some areas mapped collectively with Blue-leaf/ Cypress Forest
16: Blue-leaf Ironbark/ Cypress Forest	911.0	includes some Caley's Ironbark Forest
17: Red Ironbark / Cypress Forest	154.0	
18: Cypress Pine Forest	82.0	
19: Bloodwood/ Ironbark Forest	28.7	
20: Scribbly Gum/ Grey Gum Forest	5.8	two small locations only
21: Exposed Grey Gum/ Stringybark Forest	296.0	mapped with Sheltered Grey Gum/ Stringybark Forest
22: Sheltered Grey Gum/ Stringybark Forest	296.0	mapped with Exposed Grey Gum/ Stringybark Forest
DNG: Derived Native Grassland (part TSCA Act, EPBC Act)	2972.0	all DNG types combined
CC: Cultivated Lands	2019.0	

3.5 Significant Plant Species

Table 8 summarises the significant plant species recorded across the Project Boundary. This includes legally threatened (7 taxa), rare (5 taxa), and several more widespread species which are at or extend known geographical distributions. Further discussion on threatened species, including their distribution within the Project Boundary, is presented in Section 4.2. Potential new plant species are discussed in Section 4.3. Note that *Bothriochloa biloba*, formerly listed on both EPBC and TSC Acts, has recently been removed from both legislative listings.

Table 8 Significant plant species recorded within the Project Boundary.

Species	Pop. Size	Status & Notes
Acacia pendula *	4 plants	Endangered Population (NSW)
Cymbidium canaliculatum	36 plants	Endangered Population (NSW)
Diuris tricolor	37 plants	Vulnerable (NSW)
Eucalyptus camaldulensis	80 plants	Endangered Population (NSW)
Ozothamnus tesselatus	300-500 plants	Vulnerable (NSW & C'th)
Pomaderris queenslandica	~10 plants	Endangered (NSW)
Tylophora linearis	270 plants**	Endangered (C'th) & Vulnerable (NSW)
Bertya linearifolia		rare species with few collections
Boronia angustisepala		rare species
Epacris coriacea		rare species
Gonocarpus longifolius		rare species
Homoranthus cernuus		rare species
Grevillea sp. aff. patulifolia/ sericea		potential new species, affinities to *G.patulifolia*
Hibbertia sp. aff. *acicularis*		potential new species with affinities to *H. acicularis*
Sannantha sp. aff. *cunninghamii*		likely new species restricted to Goulburn Valley NP area
Acacia harpophylla		western species, probably planted
Acaena echinata var. *subglabricalyx*		northerly range extension
Chenopodium desertorum subsp. *microphyllum*		western species, few local records
Hakea tephrosperma		easterly range extension
Hibbertia pilifera		recently segregated species with uncertain distribution
Melaleuca lanceolata		western species, few local records
Myoporum platycarpum subsp. *platycarpum*		western species, few local records
Scaevola albida var. *pallida*		western species, few local records
Rhynchosia minima		near southern limit

* Most likely planted or naturalised within the Project Boundary (Bell & Driscoll in press), but currently considered a threatened population in the Hunter.

** Population count by Cumberland Ecology

3.6 Groundwater Dependent Ecosystems

Field investigations within the Project Boundary revealed no evidence of Groundwater Dependent Ecosystems. The Bylong Valley is a very dry environment (~627mm/ year: Bureau of Meteorology 2014), and the vegetation types present are typical of those in moisture-limited habitats, both on the Triassic Narrabeen sandstones and the underlying Permian sediments. There are no hanging swamps with perched water tables present on the sandstone hills, as are present in south-western Wollemi and Blue Mountains National Parks (NSW DEC 2006).

At only one location was evidence of baseflow observed, in a sandstone gully with a considerable amount of outcropping (Figure 15). This gully, however, did not support vegetation different from the surrounding areas, even lacking the narrow strip of Grey Myrtle Dry Rainforest that occurs in a few other locations. The baseflow observed is consistent with ground seepage in areas with extensive sandstone outcropping.

Figure 15 Baseflow from sandstone outcropping in a small creekline, south-east portion of Authorisation on Crown land.

4. Conservation Significance

Assessment of the conservation significance of the vegetation within the Bylong Project Boundary has been undertaken separately for vegetation communities and individual species. Vegetation communities and significant species are discussed in relation to both Commonwealth (*EPBC Act 1999*) and State (*TSC Act 1995*) threatened species legislation, as well as within a regional context.

4.1 Threatened Communities

Portions of the remnant vegetation present within the Project Boundary (but representing a minority of communities present) aligns with the Commonwealth-listed *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland,* and the State-listed *White Box - Yellow Box - Blakely's Red Gum Woodland*. Other recognised State-listed TECs present include *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* and *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* (Table 9).

4.1.1 Commonwealth

White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Floristic, geographical and landscape features of this TEC are present in the vegetation within the Project Boundary, including grassy forms of the locally-defined White Box Woodland (Unit 7a), Yellow Box Woodland (Unit 6) and Blakely's Red Gum Woodland (Unit 8a) (see Section 3.3.5 and Figure 14). As observed in other areas of the upper Hunter Valley (eg: the Wilpinjong area: FloraSearch 2005), rarely do the three key canopy species within this TEC occur together. Management history is influential in determining which areas are included within this TEC: those lands subjected to past clearing and grazing by stock will readily meet the TEC criteria, while those left to regenerate a dense shrub layer will not. In general terms, this delineation is observed in the field to correlate with landscape position and slope.

The Derived Native Grassland (DNG) component of this TEC is also difficult to reconcile in some areas without detailed and comprehensive assessment of grassland composition. Dry conditions over the course of the study period meant that such detailed survey was limited to periods in May 2012 and April 2014 (see Section 3.2.3). Under the legislation, DNG can only occur in areas that formerly supported a woodland where *Eucalyptus albens, Eucalyptus melliodora* or *Eucalyptus blakelyi* were dominant. This would therefore exclude grassland areas where *Eucalyptus moluccana, Eucalyptus conica* or *Eucalyptus dawsonii* were once the dominant canopy species.

To further assist in the delineation of DNG within the Project Boundary, a pre-clearance ('pre-1750') map of the vegetation has been prepared (Figure 16). This used canopy identities from the 2,471 Rapid Data Points as a guide to the likely former landscapes, and when used in combination with topography and drainage data layers in the GIS, a picture of the landscape patterns prior to clearing emerges. This technique has been used elsewhere to create pre-clearance maps of native vegetation (eg: Bickford & Mackey 2004; NSWDECC 2008b; de Lacey et al. 2011; Bell 2013).

Table 9 Vegetation communities and their equivalent Threatened Ecological Communities.

	Box-Gum Woodland TEC	Hunter Floodplain TEC	Slaty Box TEC
3. River Oak/ Redgum Riparian Woodland		✓	
6. Yellow Box Woodland	✓		
7a. White Box Woodland (Grassy)	✓		
8a. Blakely's Redgum Woodland (Grassy)	✓		
9. Slaty Box Woodland			✓
DNG. Derived Native Grassland (Box-Gum only)	✓		
1. Rusty Fig Dry Rainforest			
2. Grey Myrtle Dry Rainforest			
4. Blakely's Redgum/ Apple Riparian Forest			
5. Blakely's Redgum/ Paperbark Forest			
7b. White Box Woodland (Shrubby)			
8b. Blakley's Redgum Woodland (Shrubby)			
10. Coastal Grey Box Woodland			
11. Fuzzy Box Woodland			
12. Calytrix Rockplate Heath			
13. Shrubby Regrowth *			all excluded
14. Dwyer's Redgum Low Open Forest			
15. Caley's Ironbark Forest			
16. Blue-leaf Ironbark/ Cypress Forest			
17. Red Ironbark / Cypress Forest			
18. Cypress Open Forest			
19. Bloodwood/ Ironbark Forest			
20. Scribbly Gum/ Grey Gum Forest			
21. Exposed Grey Gum/ Stringybark Forest			
22. Sheltered Grey Gum/ Stringybark Forest			
DNG. Derived Native Grasslands (non-Box-Gum)			
CC. Cultivated Lands			

* site-by-site assessment at a local scale may be required to discount Slaty Box TEC prior to any vegetation clearing work.

For the Bylong Valley, this pattern shows a toposequence of vegetation types, extending from a complex of vegetation types on higher Triassic sandstone environments, to White Box Woodland (Shrubby) or Slaty Box Woodland on the Permian escarpment slopes, Yellow Box Woodland or White Box Woodland (Grassy) on the edge of the valley floor, Coastal Grey Box Woodland on the lower gently undulating slopes, Fuzzy Box Woodland on older alluvial terraces associated with major creek lines, and Blakely's Redgum/ Apple Riparian Forest and River Oak/ Redgum Riparian Woodland on alluvial flats. When these patterns are intersected with current-day grassland areas, it is possible to determine which of these grasslands once supported Box-Gum woodlands (Figure 17).

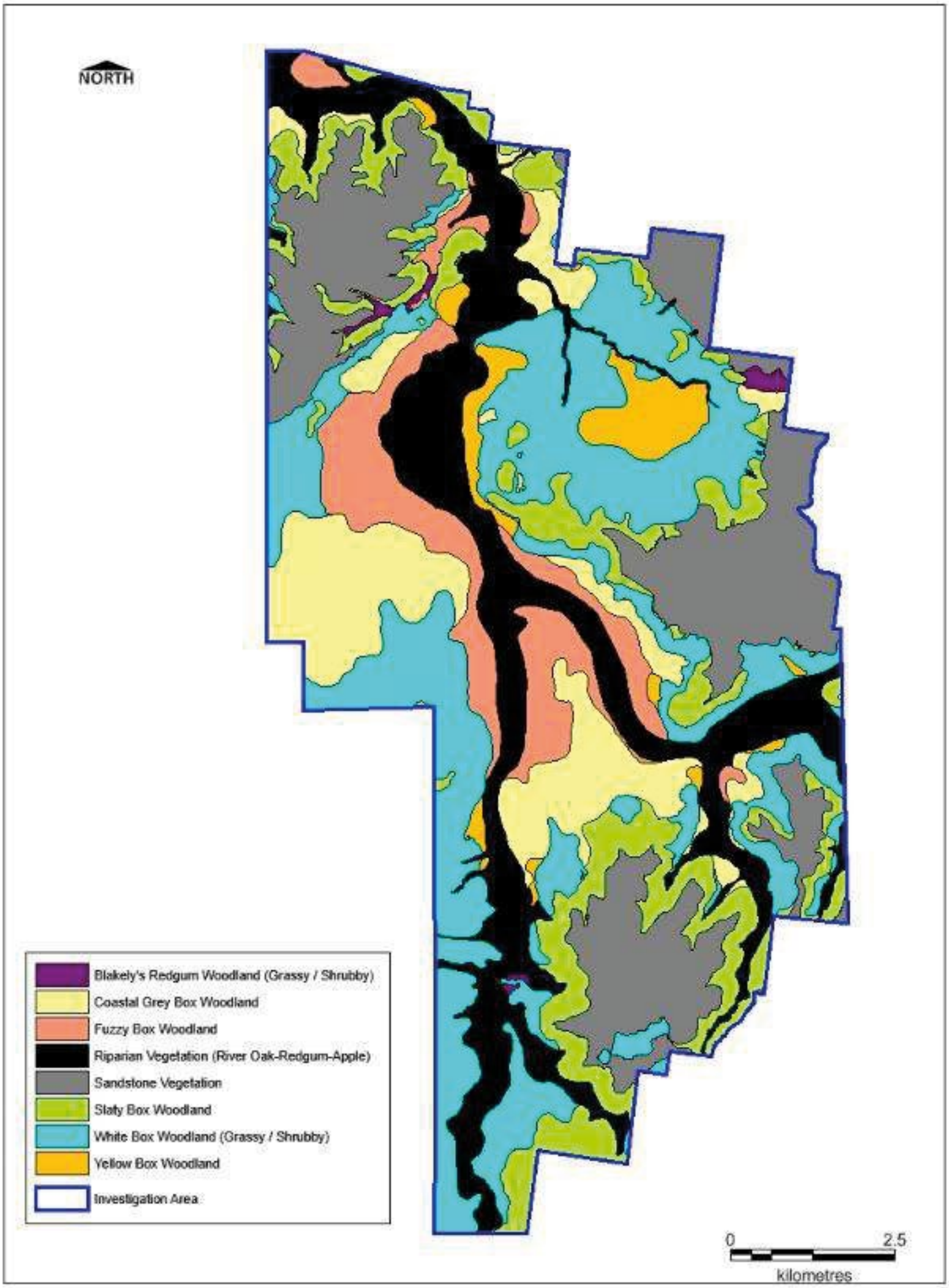

Figure 16 Reconstructed vegetation map of the Project Boundary.

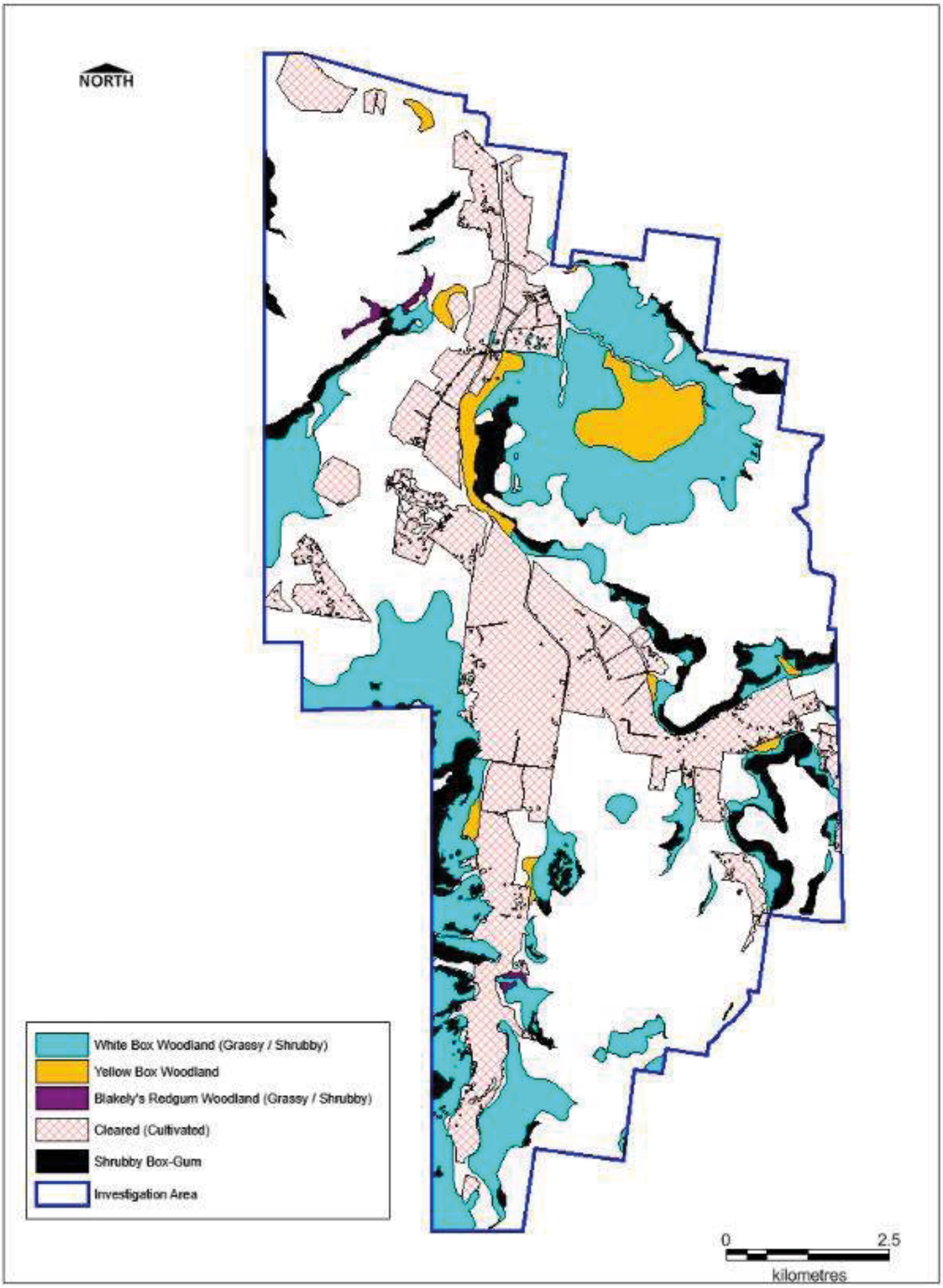

Figure 17 Reconstructed vegetation map of Box-Gum Woodlands, shown with current-day cultivated lands.

Some portions of lands mapped as Derived Native Grasslands within former Box-Gum woodlands lack detailed plot data or rapid assessment data, and it is difficult to determine the nature of these areas (ie: true derived grasslands vs directly seeded, improved native grasslands) from aerial imagery. On advice from Cumberland Ecology, certain areas have been re-annotated as Cultivated Lands (Unit CC) following field assessments undertaken by them in early 2014. Other areas of grassland with little or no remnant paddock trees have been determined as low condition Derived Native Grasslands, based on previous experiences of Cumberland Ecology for projects in similar landscapes elsewhere. They consider that areas within ~50m of remnant trees would most likely show reasonable recovery if allowed, while outside of 50m recovery would be difficult. Grasslands outside of this 50m buffer within the proposed direct impact area have therefore been annotated as low condition Derived Native Grasslands. Unless ground data on species composition shows otherwise (>12 native non-grass species, >1 important species), these areas do not form part of the Commonwealth TEC.

In addition, advice received from Scott Barnett & Associates (agricultural consultants: see Appendix 7.4) shows that certain portions of the former Wallings properties (within the proposed direct impact area) have been subjected to pasture improvement and fertilisation regimes over some decades. In particular, the north-western parts of these lands underwent pasture improvement during the 1990s, which involved over-sowing of clover (*Trifolium* spp), Phalaris (*Phalaris* spp) and Lucerne (*Medicago sativa*), and some temperate grass species. Over the last 20 years, fertiliser has also been applied to these lands every 2-3 years, with a high analysis fertiliser last applied in 2012. The south-eastern parts of the former Wallings properties had perennial winter pasture species (*Trifolium* spp, *Phalaris* spp and *Medicago sativa*) rough-sown into native and naturalised pasture in 2007, and has undergone a similar fertiliser application regime.

In combination, the larger expanses of tree-less grassland and the history of over-sowing of pasture species and fertiliser application suggest that these Derived Native Grasslands are of low condition, and do not form part of the Commonwealth TEC.

4.1.2 State

Hunter Floodplain Red Gum Woodland

Floodplain areas where *Eucalyptus camaldulensis, Eucalyptus blakelyi, Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda* occur as remnant canopy trees have been included within the Hunter Floodplain Red Gum Woodland TEC. This includes those areas mapped as River Oak/ Redgum Riparian Woodland (Unit 3), as shown in Figure 14.

Hunter Valley Footslopes Slaty Gum Woodland

All areas supporting vegetation dominated by *Eucalyptus dawsonii* in the canopy have been included in *Hunter Valley Footslopes Slaty Gum Woodland*. This incorporates areas mapped as Slaty Box Woodland (Unit 9) in Figure 14.

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

As for discussion in Section 4.1.1 above, areas dominated by either *Eucalyptus albens, Eucalyptus melliodora* and/or *Eucalyptus blakelyi* form part of the State TEC. All areas included in the

Commonwealth listing of Box-Gum Woodlands are also included in the State listing (Paragraph 6 in the final determination). Based on previous experience by Cumberland Ecology in similar landscapes elsewhere, Derived Native Grasslands do not form part of the State listing for Box-Gum Woodland if they occur outside of a 50m buffer around remnant paddock trees, and in a landscape that has undergone pasture improvement and fertiliser application (see Appendix 7.4). This is based on the assumption that recovery of Box-Gum Woodland would likely be more difficult for such areas, as understorey and canopy propagules would be limited in soil seed banks. On the advice of Cumberland Ecology, these areas have been mapped as low condition Derived Native Grassland, and do not form part of the State TEC.

4.1.3 Regional

Coastal Grey Box Woodland

Woodlands and forests dominated or characterised by *Eucalyptus moluccana* have been extensively described for the Hunter Valley (eg: Peake 2006; NSW DECC 2008b; NSW OEH 2012a, b). However, few of these are defined by this species as the sole dominant in the canopy layer (exceptions are mainly those occurring on enriched basalt or shale soils within the Triassic Sandstone escarpments: NSW DECC 2008b; NSW OEH 2012a). The Permian Sediments of the Hunter Valley floor are overlain between Bylong and Sandy Hollow in the east by the Triassic Sandstone escarpments of northern Wollemi and Goulburn River National Parks. In effect, this massive sandstone deposit separates the valley floors of Bylong and the lower Goulburn River by a distance of ~50km, with an elevation change for valley flats from 180m to 260m ASL east to west. Within the Permian Sediments, NSW DMR (1999) delineates the Newcastle Coal Measures to the east, and the more elevated Illawarra Coal Measures to the west, separated by the Triassic Sandstone material (Figure 18). It is reasonable to assume that different vegetation communities may have once occurred on these differing geological types, and that communities characterised by *Eucalyptus moluccana* also differ in their floristic compositions: the scarcity or complete absence of *Eucalyptus crebra* and *Corymbia maculata* on the Illawarra Coal Measures is one example, a trend likely to be repeated if an analysis of all floristic composition is examined. As has been shown in the current study, the Bylong Valley supports a number of species reaching their eastern distributional limits that have not yet been recorded on the Newcastle Coal Measures (eg: *Tylophora linearis, Melaleuca lanceolata*).

To the north of Bylong, the Triassic Sandstones of Goulburn River National Park give way to the Tertiary Basalt of the Merriwa Plateau, each supporting floristically different habitat types. To the west, between Bylong and Ulan, existing records of *Eucalyptus moluccana* demarcate the Coastal Grey Box Woodlands as defined in this study. As with the Fuzzy Box Woodlands, the Coastal Grey Box Woodlands between Bylong and Ulan are heavily depleted, with landscapes extensively used for agriculture. As a consequence, sampling opportunities to enact numerical classification are limited. This area incorporates the existing coal mines at Moolarben, Wilpinjong and Ulan, and casual observations made in these areas suggest that similar vegetation patterns occur. Indeed, FloraSearch (2005) did note similar patterns in the distribution of Box vegetation at Wilpinjong.

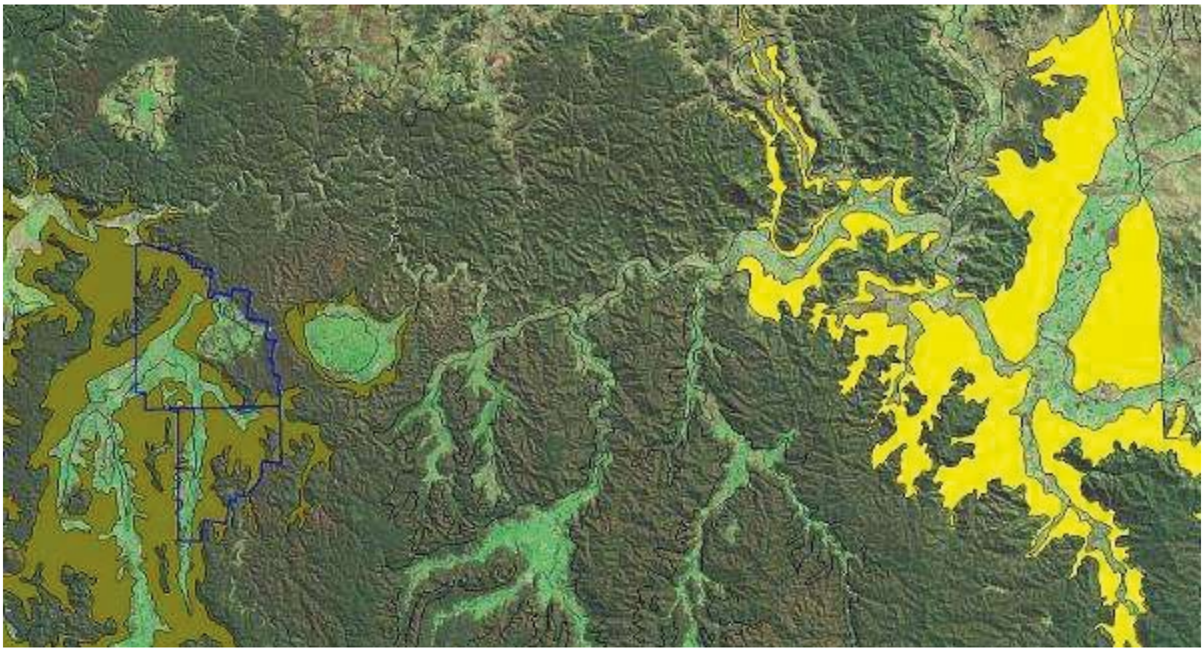

Figure 18 Newcastle Coal Measures (right) and Illawarra Coal Measures (left), in relation to the Bylong Authorisations.

Fuzzy Box Woodland

There is considerable evidence that grassy woodlands dominated by *Eucalyptus conica* were once widespread on alluvial and colluvial plains in the upper Hunter Valley; however remaining remnants are small and highly degraded. Remnant trees within agricultural landscapes on the undulating alluvial plains from Martindale through to Ulan lend support to this observation (pers. obs.; NSW OEH 2012a). Benson (2008) defined *Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion* for locations outside of the Sydney Basin, and the NSW TSC Act 1995 includes *Fuzzy Box Woodland on Alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregion*, but omission of the adjoining Sydney Basin bioregion in this determination excludes its application to Bylong.

Most recently, NSW OEH (2012a) described a Western Hunter Flats Fuzzy Box Woodland in their study which covered the north-western portion of Wollemi National Park and environs. They describe this vegetation as a rare community in the region, and one having affinities to the *Fuzzy Box Woodland on Alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregion* EEC. However, they considered that this community more definitively forms part of the *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Grassland TEC.* Given the statements earlier (Section 3.3.5) concerning dominance of canopy species within existing TECs, it is more feasible that the Western Hunter Flats Fuzzy Box Woodland forms a highly endangered community in its own right, and should not be subsumed into a wide ranging TEC covering three States. The importance of defining, recognising and managing rare vegetation communities has been outlined in Bell (2013), and is critical in the maintenance of community biodiversity.

4.2 Threatened Species

Figure 19 shows the distribution of threatened plant species (EPBC & TSC Acts) and endangered populations (TSC Act) across the Project Boundary. In total, two Commonwealth-listed and seven State-listed species were recorded. *Bothriochloa biloba*, formerly listed on both EPBC and TSC Acts, has recently been removed from both legislative listings.

4.2.1 Commonwealth

Ozothamnus tesselatus (Vulnerable: *EPBC Act 1999* and Vulnerable: *TSC Act 1995*)

New locations of the Hunter Valley endemic *Ozothamnus tesselatus* were recorded within 'Bylong Park' and environs, on talus footslopes and in habitat considered typical for this species. Bell (2008) noted that *Ozothamnus tesselatus* was present on the dry, northern footslopes of Wollemi National Park and surrounding lands, including Goulburn River National Park. Habitat on these footslopes is typified by a canopy of *Eucalyptus dawsonii*, associated with *E. punctata, E. albens* or *E. moluccana*. In total, an estimate of 300-500 individuals of this species was made for populations encountered within the Project Boundary.

Tylophora linearis (Endangered: *EBPC Act 1999* and Vulnerable: *TSC Act 1995*)

The twining vine *Tylophora linearis* was recorded from two locations in the Project Boundary (~270 individuals), both within Slaty Box Woodland on talus slopes. Few NSW records of *Tylophora linearis* exist, although populations are not thought to be under significant threat (Forster et al. 2004; NSW Scientific Committee 2008). Collections from the Project Boundary represent the first for the Hunter Valley, but as this species is easily confused with *Marsdenia viridiflora* and *Rhyncharrhena linearis*, it is potentially more common. The Bylong records also represent a sizeable extension of range to the east of the currently known distribution around Dubbo and Moree.

As expected, the documented habitat for *Tylophora linearis* has not yet included woodlands dominated by *Eucalyptus dawsonii*. Forster et al. (2004) stated that this species occurs most commonly in dense shrubland overtopped by eucalypts. In particular, an understorey of *Melaleuca uncinata* is singled out as being apparently preferential, although they make it clear that this is not a requirement for the presence of this species.

4.2.2 State

Acacia pendula (Endangered Population: *TSC Act 1995*)

Two locations within the Project Boundary support specimens currently ascribed to *Acacia pendula*. Within the Hunter catchment, this species is listed as an Endangered Population, although there is some debate over the legitimacy of Hunter Valley plants (Bell & Driscoll in press). A single, small planted garden specimen of *Acacia pendula* is present adjacent to the former Cockatoo Coal field office, while three plants occur on elevated land in grazing paddocks on 'Bylong Station'. It is likely that these latter plants have naturalized from past introductions, as this species normally occurs in alluvial soils near drainage depressions elsewhere in its range in New South Wales. Although under current legislation these four plants form part of the endangered Hunter Valley population of *Acacia pendula*, we do not consider them to be natural components of the landscape at Bylong.

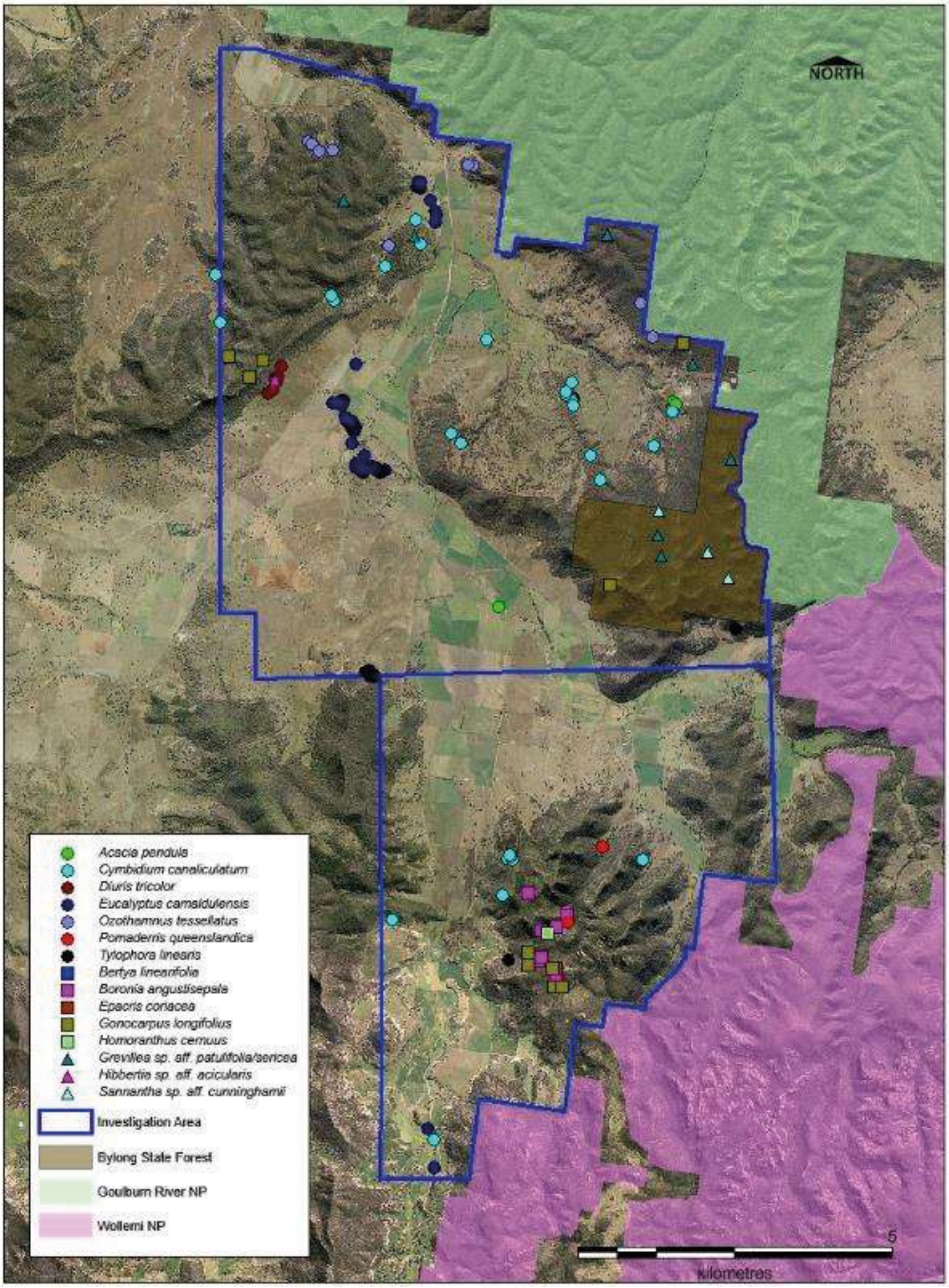

Figure 19 Significant plant species (threatened, rare, new taxa) located within the Project Boundary.

Cymbidium canaliculatum (Endangered Population: *TSC Act 1995*)

Thirty-six (36) new occurrences of the epiphytic orchid *Cymbidium canaliculatum* were located throughout the Project Boundary, although the bulk of specimens occur within the 'Bylong Station' property on the elevated basalt plateau. This species is widespread throughout New South Wales, but has been listed as an Endangered Population within the Hunter Valley, threatened by habitat loss and illegal collecting. Favoured hosts for the specimens recorded were *Angophora floribunda, Eucalyptus melliodora, Eucalyptus dawsonii* and *Eucalyptus albens.*

Diuris tricolor (Vulnerable: *TSC Act 1995*)

A targeted search for the terrestrial orchid *Diuris tricolor* was undertaken during Spring 2012. A population of 37 specimens of this species was located, considerably less than the large populations (~30,000) recorded in the adjacent proposed Mt Penny Project (NSW OEH Wildlife atlas) in recent years, and with populations near Muswellbrook to the east (eg: Bell 2012). All plants within the Project Boundary observed during 2012 were within the 'Bylong Park' property, generally in the cleared lands adjacent to the wooded footslopes where native grasses predominate.

Eucalyptus camaldulensis (Endangered Population: *TSC Act 1995*)

Point location data for the River Red Gum (*Eucalyptus camaldulensis*) were known for the Bylong Valley prior to the commencement of the current study, which comprise part of the Hunter Valley population of this species. Further individuals of this population were recorded within 'Bylong Park', extending the previous records north along the Bylong River floodplain. A population of 80 trees is estimated for the existing and new records of this species.

The Hunter catchment population of *Eucalyptus camaldulensis* is considered endangered due to land clearing and tree death associated with flood mitigation works, but also in recognition of the disjunct nature of these plants (in an easterly-flowing catchment) relative to the remainder of the Australia-wide population. McDonald et al. (2009) noted that specimens comprising the Hunter population are included in subsp. *camaldulensis*, which is otherwise present across much of New South Wales, Victoria and parts of South Australia and Queensland.

Ozothamnus tesselatus (Vulnerable: *TSC Act 1995* and Vulnerable: *EPBC Act 1999*)

See discussion above in Section 4.2.1 under Commonwealth species.

Pomaderris queenslandica (Endangered: *TSC Act 1995*)

Two locations of *Pomaderris queenslandica* were recorded in the Crown land to the south-east, both occurring in sheltered locations associated with creeklines, similar to elsewhere in the region (Bell 2001). Approximately five (5) plants were present at both locations.

Tylophora linearis (Endangered: *TSC Act 1995* and Vulnerable: *EBPC Act 1999*)

See discussion above in Section 4.2.1 under Commonwealth species.

4.2.3 Regional

Fourteen (14) regionally significant plant species were recorded in the Project Boundary, considered as such because they are rare, extend known distributional ranges or support few recent records. One of these, *Hibbertia pilifera*, is a recently defined species allied to the more widespread *Hibbertia rufa* and, along with many other taxa in the *Hibbertia* genus, requires further study (Toelken & Miller 2012).

Acacia harpophylla (inland species, probably planted)

Brigalow (*Acacia harpophylla*) is one of a number of inland arid *Acacia* species, some of which occur within the Hunter Valley at their distributional limits. A single stand of this species was recorded within 'Bylong Park' on former grazing land. It is postulated that these trees were planted to provide stock shelter, as habitat for this species recorded in the literature does not match well with that present in the Project Boundary (eg: Boland et al. 2006; Benson et al. 2010). It is uncertain if early records of Brigalow at Scone in the Hunter Valley (1897, 1899: NSW OEH Atlas) are natural or planted, as this part of the Hunter was one of the first settled by Europeans, acting as a staging post for stock movements onto the Liverpool Plains (McMinn 1970a, b).

Acaena echinata* var. *subglabricalyx (northerly range extension)

This prostrate forb is a southern species growing in herb and grass rich woodlands. The nearest known record to Bylong is ~100km to the south in western Sydney, and then >200km further to the south around Goulburn and Young (NSW OEH Atlas). Within the Project Boundary, *Acaena echinata* var. *subglabricalyx* was recorded at a single location in 'Tarwyn Park', within Coastal Grey Box Woodland.

Bertya linearifolia (very rare, Hunter Valley endemic)

A shrub species that is endemic to the Hunter Valley (Halford & Henderson 2002), and with only three other collections within Australian herbaria. Although not a listed threatened species, this taxon is exceedingly rare and evidently poorly collected. A single shrub was recorded along a creek line in Crown land in the south-east of the Project Boundary.

Boronia angustisepala (rare species)

A rare shrub species formerly included in Boronia rubiginosa, occurring from the Gilbraltar and Nandewar Ranges south to Sandy Hollow and Bylong (Duretto 1999). Numerous populations are present in the Sandy Hollow area, including many in national park estate (NSW OEH Atlas). Duretto (1999) notes that plants in the Sandy Hollow-Bylong area are atypical (smaller flowers, more ovate sepals) and that research is required to determine if *Boronia angustisepala* and *Boronia rubiginosa* intergrade there.

Epacris coriacea (rare species)

A rare, decumbent shrub growing on sandstone rock faces and cliffs, in the Wollemi and Blue Mountains National Parks region. A single population of approximately fifteen (15) plants was located on Crown land in the south-east of the Project Boundary. It is probable that additional populations are present in this rugged section of Authorisation 342.

Chenopodium desertorum **subsp. *microphyllum*** (inland species, few local records)

The prostrate shrub *Chenopodium desertorum* subsp*. microphyllum* was recorded from a single location within Slaty Box Woodland on the former Wallings property. The nearest known records occur ~150km to the west and southwest, in the Dubbo and Parkes regions (NSW OEH Atlas).

Gonocarpus longifolius (rare species)

A rare shrub, common across the Wollemi region where it occurs in a range of sandstone-based habitats (Bell 2008). Ten (10) populations of this species were recorded across the sandstone habitats within the Project Boundary, and it is likely that additional populations are present. Typically, this species occurs in sheltered gullies and on sheltered slopes in open forest.

Hakea tephrosperma (easterly range extension)

Several locations of *Hakea tephrosperma* were recorded within the Project Boundary, primarily in shrubby regrowth vegetation on stony knolls. This species is typical of the western slopes and plains, with the closest known records for this species occurring ~100km to the west around Dubbo (NSW OEH Atlas).

Hibbertia pilifera (recently segregated species, uncertain distribution)

Toelken and Miller (2011) have recently revised the taxonomy of a number of Sydney Basin *Hibbertias*, and *H. pilifera* is one of these but with an uncertain distribution. Specimens collected from the Authorisation area have been lodged with the State Herbarium of South Australia to further the research in this group.

Homoranthus cernuus (rare species)

A rare shrub recorded at a single location from Crown land in the south-east of the Project Boundary. Approximately five (5) plants were present at this location, at the head of a northerly-facing gully in open forest of Ironbark and Cypress Pine. This species is endemic to north-western Wollemi National Park, where it is uncommon (Bell 2008; Copeland et al. 2011).

Melaleuca lanceolata (few records, disjunct population)

Three previous records exist for *Melaleuca lanceolata* in the Bylong area, and one in the Capertee Valley, but otherwise this species is known only from Dubbo (150km to the west) and around West Wyalong (~250km to the southwest) and the South Western Slopes and Plains (NSW OEH Atlas). A single population of this species was recorded within the 'Helvetia' property, where it formed dense thickets on the Permian footslope. In Victoria this species forms a characteristic component of an endangered vegetation community (Moxham et al. 2009; Moxham & Turner 2011), but to date there are no threatened New South Wales communities supporting this species. Stands of vegetation dominated by *Melaleuca lanceolata* have not previously been described for the Hunter Valley, primarily because this is a western species and occurs as a disjunct population within the Project Boundary. Outside of the Hunter Valley, the nearest known locality for *Melaleuca lanceolata* is 150 km to the west around Dubbo.

Myoporum platycarpum **subsp*. platycarpum*** (inland species, few local records)

Few records exist in the Hunter Valley for this small tree species. Within the NSW OEH Atlas, there is a single record for the Muswellbrook area from 1912, and an earlier one from 1893 for 'Murrumbo' a grazing property immediately east of the current Project Boundary. The next nearest location is ~100km to the north on the Liverpool Plains, and 150km to the west around Dubbo. *Myoporum platycarpum* subsp*. platycarpum* was recorded in a number of locations on the low hills and footslopes of the Project Boundary, often in shrubby regrowth areas.

Scaevola albida **var*. pallida*** (inland species, few local records)

There are currently only five records of *Scaevola albida* var*. pallida* within the NSW OEH Atlas database, with a single record from 1892 from Upper Bylong, within the current Project Boundary, and other collections from the Bungonia and Abercrombie areas several hundred kilometres to the south. The re-collection of this taxon within shrubby White Box Woodland on footslopes during the current study after 120 years confirms that it persists in the area.

Rhynchosia minima (approaching southern limit)

Rhynchosia minima occurs primarily to the north of the Hunter Valley, in the North Coast, Northern Tablelands, and North Western Slopes and Plains botanical subdivisions. Relatively few records exist for the Hunter, the nearest being in the Denman-Singleton-Muswellbrook area, with the most southern record ~50km to the southwest near Mudgee (NSW OEH Atlas). The single record within the current Project Boundary was from Yellow Box Woodland on basalt soils within 'Bylong Station'.

4.3 New Plant Species

Over the course of plant survey work, some collected material has been confirmed by taxonomic experts to likely represent new plant species, and will require further work by them. These include:

Grevillea **sp. aff. *patulifolia/ sericea*** **(Proteaceae)**

Taxonomically, *Grevillea patulifolia* currently forms part of a complex of species which were formerly included in a broad circumscription of *Grevillea linearifolia*. Makinson (2000) revised this difficult group as part of the Flora of Australia project; however there are still some anomalies that require resolution (B. Makinson, pers .comm.). Current understanding shows that *Grevillea patulifolia* occurs from southern Sydney to Ulladulla, and inland onto the Southern Tablelands. Several collections of a taxon with affinities to *Grevillea patulifolia* and/or *Grevillea sericea* were made from Bylong State Forest and Crown land to the west. On examination by Bob Makinson (*Grevillea* expert, National Herbarium of NSW), it is possible that these specimens represent a new species restricted to the Goulburn River National Park area, and further research is required (B. Makinson, pers comm.).

Hibbertia **sp. aff. *acicularis*** **(Dilleniaceae)**

Specimens of *Hibbertia* collected from Bylong Park have been confirmed by Hellmut Toelken (*Hibbertia* taxonomist at the South Australian State Herbarium) as a probable new species within the

H. acicularis group, due to (among other features) its sub-sessile flowers. Further collections are required during flowering to continue the taxonomic resolution of this group.

***Sannantha* sp. aff. *cunninghamii* (Myrtaceae)**

A shrub occurring in shallow drainage lines of *Eucalyptus blakelyi* in and around Bylong State Forest, *Sannantha* sp. aff. *cunninghamii* differs from the related *S. cunninghamii* primarily in the mostly entire, narrow linear leaves (crenate or irregularly toothed margins, obovate to broad-elliptic leaves in *S. cunninghamii*), with both taxa having fringe-like projections along young stems. The two taxa appear to grow sympatrically in these drainage depressions. Only one other collection of the new entity has been made, by S. Bell from the nearby Poggy Creek (Goulburn River National Park) in January 1997 (National Herbarium of NSW, pers. comm.). Further study will be undertaken with Dr Peter Wilson of the National Herbarium of NSW on this taxon.

5. Discussion

Vegetation survey and mapping within two Authorisations (A287 & A342) in the Bylong Valley have revealed the presence of twenty-four (24) vegetation communities and over 450 plant species. Vegetation equivalent to one Nationally-listed threatened ecological community is present (*White Box - Yellow Box - Blakely's Red Gum Grassy Woodland & Derived Grasslands*), and three State-listed threatened ecological communities (*Hunter Valley Footslopes Slaty Gum Woodland; White Box - Yellow Box - Blakely's Red Gum Grassy Woodland; Hunter Floodplain Redgum Woodland*). All vegetation communities present have been delineated through numerical analysis of sixty-six (66) full floristic sample plots, and mapped across the Project Boundary. To assist in the demarcation of Derived Native Grasslands that are included within the *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland & Derived Grasslands* TEC, a pre-1750 vegetation map has also been prepared.

Two (2) Nationally-listed threatened plant species (*Ozothamnus tesselatus; Tylophora linearis*) and seven (7) State-listed threatened plants (*Acacia pendula* - Hunter Valley population; *Cymbidium canaliculatum* - Hunter Valley population; *Eucalyptus camaldulensis* - Hunter Valley population; *Diuris tricolor; Ozothamnus tesselatus; Pomaderris queenslandica; Tylophora linearis*) are also present. Three (3) potential new plant species are present within the Project Boundary (*Grevillea* sp. aff. *patulifolia/ sericea*; *Hibbertia* sp. aff. *acicularis*; *Sannantha* sp. aff. *cunninghamii*), the taxonomy of which will be progressed with relevant expert taxonomists.

In addition, two (2) vegetation communities considered of regional significance have been detailed, both of which have been very heavily depleted through agricultural activities in the region. Coastal Grey Box Woodland and Fuzzy Box Woodland occur on gently undulating slopes of colluvial and alluvial soils, and are now represented by scattered paddock trees or small remnant patches. Fourteen (14) plant taxa are considered of regional significance, primarily due to extensions to or limits of geographical ranges, or few records in the region.

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7.1 Appendix - Species List: All Data

Plant species recorded within all sample plots and miscellaneous recordings, 2011 to 2013.

Family	Species	Common Name
Acanthaceae	*Brunoniella australis*	Blue Trumpet
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair
	Adiantum hispidulum	Rough Maidenhair
	Cheilanthes distans	Bristly Cloak Fern
	Cheilanthes sieberi subsp. sieberi	Rock Fern
Amaranthaceae	*Alternanthera pungens* *	Khaki Weed *
	Alternanthera sp. A	
Anacardiaceae	*Schinus areira* *	Pepper Tree *
Anthericaceae	*Arthropodium minus*	Small Vanilla Lily
	Arthropodium sp. B	
	Laxmannia gracilis	Slender Wire Lily
Apiaceae	*Cyclospermum leptophyllum* *	Slender Celery *
	Daucus glochidiatus	Native Carrot
	Hydrocotyle laxiflora	Stinking Pennywort
	Hydrocotyle tripartita	Pennywort
	Platysace ericoides	
	Platysace lanceolata	Shrubby Platysace
Apocynaceae	*Gomphocarpus fruticosus* *	Narrow-leaf Cotton Bush *
	Marsdenia rostrata	Milk Vine
	Marsdenia viridiflora subsp. viridiflora	Native Pear
	Parsonsia eucalyptophylla	Gargaloo
	Parsonsia straminea	Common Silkpod
	Parsonsia velutina (?)	
	Tylophora linearis	
Araliaceae	*Astrotricha longifolia f. 'Inland'*	
Asphodelaceae	*Bulbine bulbosa*	Bulbine Lily
Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern
Asteraceae	*Aster subulatus* *	Wild Aster *
	Bidens pilosa *	Cobbler's Pegs *
	Bidens subalternans *	Greater Beggar's Ticks *
	Brachyscome dentata	
	Calocephalus citreus	Lemon Beauty-heads
	Calotis lappulacea	Yellow Burr-daisy
	Carthamus lanatus *	Saffron Thistle *
	Cassinia arcuata	Sifton Bush
	Cassinia cunninghamii	
	Cassinia decipiens	

Family	Species	Common Name
	Cassinia quinquefaria	
	Cassinia uncata	Sticky Cassinia
	Chrysocephalum apiculatum	Common Everlasting
	Chrysocephalum semipapposum	Clustered Everlasting
	Cineraria lyratiformis *	African Marigold *
	Cirsium vulgare *	Spear Thistle *
	Conyza bonariensis *	Flaxleaf Fleabane *
	Conyza spp. *	A Fleabane *
	Conyza sumatrensis *	Tall Fleabane *
	Cotula australis	Common Cotula
	Cymbonotus lawsonianus	Bear's Ear
	Euchiton involucratus	Star Cudweed
	Euchiton sphaericus	Star Cudweed
	Hypochaeris radicata *	Catsear *
	Lagenophora stipitata	Common Lagenophora
	Leiocarpa panaetioides	Wooly Buttons
	Leptorhynchos squamatus subsp. squamatus	
	Minuria leptophylla	
	Olearia elliptica subsp. elliptica	
	Ozothamnus diosmifolius	White Dogwood
	Ozothamnus tesselatus	
	Podolepis jaceoides	Showy Copper-wire Daisy
	Schkuhria pinnata var. abrotanoides *	Dwarf Marigold *
	Senecio madagascariensis *	Fireweed *
	Senecio pinnatifolius var. pinnatifolius	
	Senecio prenanthoides	
	Senecio quadridentatus	Cotton Fireweed
	Sigesbeckia australiensis	
	Silybum marianum *	Variegated Thistle *
	Soliva sessilis *	Bindyi *
	Sonchus oleraceus *	Common Sowthistle *
	Tagetes minuta *	Stinking Roger *
	Taraxacum officinale *	Dandelion *
	Triptilodiscus pygmaeus	Common Sunray
	Vernonia cinerea var. cinerea	
	Vittadinia cuneata var. cuneata	A Fuzzweed
	Vittadinia muelleri	A Fuzzweed
	Vittadinia sulcata	
	Xanthium spp. *	*
	Xerochrysum bracteatum	Golden Everlasting
	Xerochrysum viscosum	Sticky Everlasting
Boraginaceae	*Halgania brachyrhyncha*	
	Cynoglossum australe	
Brassicaceae	*Hirschfeldia incana* *	Buchan Weed *
	Lepidium africanum *	Common Peppercress *
	Raphanus raphanistrum *	Wild Radish *
Cactaceae	*Opuntia aurantiaca* *	Tiger Pear *
	Opuntia stricta var. stricta *	Common Prickly Pear *
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell

Family	Species	Common Name
	Wahlenbergia gracilis	Sprawling Bluebell
	Wahlenbergia luteola	Bluebell
Caryophyllaceae	*Arenaria serpyllifolia* *	Thyme-leaved Sandwort *
	Paronychia brasiliana *	Brazilian Whitlow *
	Petrorhagia nanteuilii *	Proliferous Pink *
	Spergularia rubra *	Sandspurry *
	Stellaria flaccida	
	Stellaria pungens	Prickly Starwort
Casuarinaceae	*Allocasuarina gymnanthera*	
	Allocasuarina luehmannii	Bulloak
	Allocasuarina rigida subsp. rigida	
	Casuarina cunninghamiana subsp. cunninghamiana	River Oak
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush
	Chenopodium desertorum subsp. microphyllum	
	Chenopodium pumilio	Small Crumbweed
	Einadia hastata	Berry Saltbush
	Einadia nutans subsp. linifolia	Climbing Saltbush
	Einadia nutans subsp. nutans	Climbing Saltbush
	Enchylaena tomentosa	Ruby Saltbush
	Maireana enchylaenoides	Wingless Fissure-weed
	Maireana microphylla	Small-leaf Bluebush
Clusiaceae	*Hypericum gramineum*	Small St John's Wort
	Hypericum perforatum *	St. John's Wort *
Commelinaceae	*Commelina cyanea*	Native Wandering Jew
Convolvulaceae	*Convolvulus arvensis* *	Field Bindweed *
	Convolvulus erubescens	Pink Bindweed
	Cuscuta australis	Australian Dodder
	Dichondra repens	Kidney Weed
	Dichondra sp. A	Kidney Weed
Crassulaceae	*Crassula sieberiana*	Australian Stonecrop
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine
	Callitris gracilis subsp. gracilis	
Cyperaceae	*Carex inversa*	Knob Sedge
	Cyperus gracilis	Slender Flat-sedge
	Gahnia aspera	Rough Saw-sedge
	Lepidosperma concavum	
	Lepidosperma gunnii	
	Lepidosperma laterale	Variable Sword-sedge
	Lepidosperma urophorum	
	Schoenus ericetorum	
	Scleria mackaviensis	
Dilleniaceae	*Hibbertia circumdans*	
	Hibbertia pedunculata	

Family	Species	Common Name
	Hibbertia pilifera	
	Hibbertia riparia	
	Hibbertia sp. aff. acicularis	
Ericaceae	*Acrotriche rigida*	
	Astroloma humifusum	Native Cranberry
	Brachyloma daphnoides	Daphne Heath
	Epacris coriacea	
	Leucopogon muticus	Blunt Beard-heath
	Melichrus erubescens	Ruby Urn Heath
	Melichrus urceolatus	Urn Heath
	Monotoca scoparia	
	Styphelia triflora	Pink Five-Corners
Euphorbiaceae	*Amperea xiphoclada var. xiphoclada*	
	Bertya linearifolia	
	Chamaesyce drummondii	Caustic Weed
Eupomatiaceae	*Eupomatia laurina*	Bolwarra
Fabaceae (Caesalpinioideae)	*Senna coronilloides*	
	Senna artemisioides subsp. zygophylla	
Fabaceae (Faboideae)	*Bossiaea prostrata*	
	Chorizema parviflorum	Eastern Flame Pea
	Daviesia genistifolia	Broom Bitter Pea
	Daviesia ulicifolia subsp. ulicifolia	
	Desmodium brachypodum	Large Tick-trefoil
	Desmodium gunnii	Slender Tick-trefoil
	Desmodium varians	Slender Tick-trefoil
	Dillwynia acicularis	
	Dillwynia rudis	
	Glycine canescens	Silky Glycine
	Glycine clandestina	Twining glycine
	Glycine microphylla	Small-leaf Glycine
	Glycine tabacina	Variable Glycine
	Gompholobium aspalathoides	
	Hovea apiculata	
	Hovea lanceolata	
	Indigofera adesmiifolia	Tick Indigo
	Indigofera australis	Australian Indigo
	Lotus australis	Australian Trefoil
	Medicago lupulina *	Black Medic *
	Medicago minima *	Woolly Burr Medic *
	Medicago polymorpha *	Burr Medic *
	Medicago sativa *	Lucerne *
	Medicago truncatula *	Barrel Medic *
	Oxylobium pulteneae	Wiry Shaggy Pea
	Podolobium ilicifolium	Prickly Shaggy Pea
	Pultenaea ferruginea	
	Rhynchosia minima	
	Swainsona galegifolia	Smooth Darling Pea
	Templetonia stenophylla	Leafy Templetonia

Family	Species	Common Name
	Trifolium arvense *	Haresfoot Clover *
	Trifolium repens *	White Clover *
	Zornia dyctiocarpa var. dyctiocarpa	Zornia
Fabaceae (Mimosoideae)	*Acacia amblygona*	Fan Wattle
	Acacia brownii	Heath Wattle
	Acacia buxifolia subsp. buxifolia	Box-leaved Wattle
	Acacia crassa subsp. crassa	
	Acacia deanei subsp. deanei	Deane's Wattle
	Acacia decora	Western Silver Wattle
	Acacia doratoxylon	Currawang
	Acacia hakeoides	Hakea Wattle
	Acacia harpophylla *	Brigalow *
	Acacia implexa	Hickory Wattle
	Acacia ixiophylla	
	Acacia lunata	Lunate-leaved Acacia
	Acacia linearifolia	Narrow-leaved Wattle
	Acacia obtusata	Blunt-leaf Wattle
	***Acacia pendula* ***	**Weeping Myall ***
	Acacia penninervis var. penninervis	Mountain Hickory
	Acacia piligera	
	Acacia salicina	Cooba
	Acacia sertiformis	
	Acacia subulata	Awl-leaved Wattle
	Acacia ulicifolia	Prickly Moses
Gentianaceae	*Centaurium erythraea* *	Common Centaury *
Geraniaceae	*Geranium solanderi var. solanderi*	
Goodeniaceae	*Dampiera adpressa*	Purple Beauty Bush
	Dampiera purpurea	
	Goodenia hederacea subsp. hederacea	
	Goodenia ovata	Hop Goodenia
	Goodenia pinnatifida	Scrambles Eggs
	Goodenia stephensonii	
	Scaevola albida var. pallida	
	Scaevola humilis	
Haloragaceae	*Gonocarpus elatus*	A Raspwort
	Gonocarpus longifolius	
	Haloragis heterophylla	Variable Raspwort
Juncaceae	*Juncus spp.*	A Rush
Lauraceae	*Cassytha glabella f. glabella*	
Lamiaceae	*Ajuga australis*	Austral Bugle
	Marrubium vulgare *	White Horehound *
	Mentha satureioides	Native Pennyroyal
	Prostanthera howelliae	Prostanthera
	Prostanthera ovalifolia	
	Prostanthera prunelloides	

Family	Species	Common Name
	Salvia verbenaca *	Vervain *
	Scutellaria humilis	Dwarf Skullcap
	Spartothamnella juncea	Bead Bush
	Stachys arvensis *	Stagger Weed *
	Teucrium corymbosum	Forest Germander
Linaceae	*Linum marginale*	Native Flax
Lobeliaceae	*Pratia purpurascens*	Whiteroot
Loganiaceae	*Logania albiflora*	
Lomandraceae	*Lomandra confertifolia subsp. pallida*	Matrush
	Lomandra confertifolia subsp. rubiginosa	
	Lomandra filiformis subsp. coriacea	Wattle Matt-rush
	Lomandra glauca	Pale Mat-rush
	Lomandra longifolia	Spiny-headed Mat-rush
	Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush
Loranthaceae	*Amyema miquelii*	Box Mistletoe
	Amyema quandang var. quandang	Grey Mistletoe
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry
Malvaceae	*Abutilon oxycarpum*	Straggly Lantern-bush
	Hibiscus sturtii var. sturtii	Hill Hibiscus
	Modiola caroliniana *	Red-flowered Mallow *
	Sida corrugata	Corrugated Sida
	Sida cunninghamii	Ridge Sida
	Sida rhombifolia *	Paddy's Lucerne *
	Sida spinosa	
	Sida trichopoda	High Sida
Meliaceae	*Melia azedarach*	White Cedar
Moraceae	*Ficus rubiginosa*	Port Jackson Fig
Myoporaceae	*Eremophila debilis*	Amulla
	Myoporum montanum	Western Boobialla
	Myoporum platycarpum subsp. platycarpum	
Myrsinaceae	*Anagallis arvensis* *	Scarlet Pimpernel *
Myrtaceae	*Angophora floribunda*	Rough-barked Apple
	Backhousia myrtifolia	Grey Myrtle
	Calytrix tetragona	Common Fringe-myrtle
	Corymbia trachyphloia subsp. amphistomatica	White Bloodwood
	Eucalyptus agglomerata	Blue-leaved Stringybark
	Eucalyptus albens	White Box
	Eucalyptus blakelyi	Blakely's Red Gum
	Eucalyptus caleyi subsp. caleyi	Caley's Ironbark
	Eucalyptus camaldulensis	**River Red Gum**
	***Eucalyptus cannonii* (outside of Authorisation)**	**Capertee Stringybark**

Family	Species	Common Name
	Eucalyptus conica	Fuzzy Box
	Eucalyptus crebra	Narrow-leaved Ironbark
	Eucalyptus dawsonii	Slaty Gum
	Eucalyptus dwyeri	Dwyer's Red Gum
	Eucalyptus eugenioides	Thin-leaf Stringybark
	Eucalyptus fibrosa	Red Ironbark
	Eucalyptus melliodora	Yellow Box
	Eucalyptus microcarpa	Western Grey Box
	Eucalyptus moluccana	Grey Box
	Eucalyptus nubila	Blue-leaved Ironbark
	Eucalyptus punctata	Grey Gum
	Eucalyptus rossii	Inland Scribbly Gum
	Eucalyptus sideroxylon	Mugga Ironbark
	Eucalyptus sparsifolia	Narrow-leaf Stringybark
	Harmogia densifolia	
	Homoranthus cernuus	
	Leptospermum arachnoides	
	Leptospermum parvifolium	
	Leptospermum sphaerocarpum	
	Leptospermum trinervium	Slender Tea-tree
	Melaleuca lanceolata	Moonah
	Melaleuca thymifolia	Thyme Honey-myrtle
	Melaleuca uncinata	Broombush
	Micromyrtus sessilis	
	Sannantha cunninghamii	
	Sannantha sp. aff. cunninghamii	
Nyctaginaceae	*Boerhavia dominii*	Tarvine
Oleaceae	*Notelaea microcarpa var. microcarpa*	
Orchidaceae	*Acianthus spp.*	Mosquito Orchid
	Caladenia catenata	White Caladenia
	Caladenia curtisepala	
	Cyanicula caerulea	Blue Caladenia
	Cymbidium canaliculatum	**Tiger Orchid**
	Dendrobium speciosum	Rock Lily
	Diuris aurea	
	Diuris sulphurea	Tiger Orchid
	Diuris tricolor	**Pine Donkey Orchid**
	Microtis unifolia	Common Onion Orchid
	Pterostylis bicolor	Black-tip Greenhood
	Pterostylis concinna	Trim Greenhood
	Pterostylis mutica	Midget Greenhood
	Thelymitra spp.	
Oxalidaceae	*Oxalis chnoodes*	
	Oxalis perennans	
Phormiaceae	*Dianella longifolia var. longifolia*	A Blue Flax Lily
	Dianella prunina	
	Dianella revoluta var. revoluta	A Blue Flax Lily
	Dianella tasmanica	

Family	Species	Common Name
	Stypandra glauca	Nodding Blue Lily
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush
	Phyllanthus hirtellus	Thyme Spurge
	Phyllanthus occidentalis	
	Phyllanthus virgatus	Wiry Spurge
	Poranthera corymbosa	
Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry
	Bursaria longisepala	
	Bursaria spinosa	Native Blackthorn
	Rhytidosporum procumbens	
Plantaginaceae	*Plantago debilis*	Shade Plantain
	Plantago gaudichaudii	Narrow Plantain
	Plantago lanceolata *	Lamb's Tongues *
	Veronica plebeia	Trailing Speedwell
Poaceae	*Agrostis spp.*	
	Aristida calycina var. calycina	
	Aristida personata	
	Aristida ramosa	Purple Wiregrass
	Aristida vagans	Threeawn Speargrass
	Arundinella nepalensis	Reedgrass
	Austrostipa pubescens	
	Austrostipa scabra subsp. falcata	Rough Speargrass
	Austrostipa scabra subsp. scabra	Rough Speargrass
	Austrostipa verticillata	Slender Bamboo Grass
	Axonopus fissifolius *	Narrow-leaf Carpet Grass*
	Bothriochloa biloba	
	Bothriochloa decipiens var. decipiens	Pitted Bluegrass
	Bromus catharticus *	Praire Grass *
	Cenchrus caliculatus	Hillside Burrgrass
	Chloris truncata	Windmill Grass
	Chloris ventricosa	Tall Chloris
	Cleistochloa rigida	
	Cymbopogon refractus	Barbed Wire Grass
	Cynodon dactylon	Common Couch
	Cynodon incompletus *	
	Dichanthium sericeum subsp. sericeum	Queensland Bluegrass
	Dichelachne micrantha	Shorthair Plumegrass
	Digitaria brownii	Cotton Panic Grass
	Digitaria coenicola	Finger Panic Grass
	Digitaria diffusa	Open Summer-grass
	Digitaria parviflora	Small-flower Finger Grass
	Digitaria ramularis	Finger Panic Grass
	Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass
	Eleusine tristachya *	Goose Grass *
	Elymus scaber var. scaber	Common Wheatgrass
	Enneapogon gracilis	Slender Nineawn
	Enneapogon truncatus	Bottlewashers
	Enteropogon acicularis	Curly Windmill Grass
	Entolasia stricta	Wiry Panic

Family	Species	Common Name
	Eragrostis alveiformis	
	Eragrostis elongata	Clustered Lovegrass
	Eragrostis leptostachya	Paddock Lovegrass
	Eragrostis sororia	
	Eriochloa pseudoacrotricha	Early Spring Grass
	Lolium perenne *	Perennial Ryegrass *
	Microlaena stipoides var. stipoides	Weeping Grass
	Notodanthonia longifolia	Long-leaf Wallaby Grass
	Panicum effusum	Hairy Panic
	Panicum queenslandicum var. queenslandicum	Yabila Grass
	Panicum simile	Two-colour Panic
	Paspalidium aversum	Bent Summer Grass
	Paspalidium criniforme	
	Paspalidium distans	
	Paspalidium gracile	Slender Panic
	Paspalum dilatatum *	Paspalum *
	Pennisetum clandestinum *	Kikuyu Grass *
	Phalaris minor *	Lesser Canary Grass *
	Poa affinis	
	Poa labillardierei var. labillardierei	Tussock
	Rytidosperma caespitosa	Ringed Wallaby Grass
	Rytidosperma fulva	Wallaby Grass
	Rytidosperma pallidum	Silvertop Wallaby Grass
	Rytidosperma racemosa var. racemosa	A Wallaby Grass
	Rytidosperma setacea	Small-flower Wallaby Grass
	Rytidosperma spp.	A Wallaby Grass
	Rytidosperma tenuior	A Wallaby Grass
	Setaria parviflora *	
	Sporobolus creber	Slender Rat's Tail Grass
	Themeda australis	Kangaroo Grass
	Urochloa panicoides *	Urochloa Grass *
Polygonaceae	*Polygonum aviculare* *	Wireweed *
	Rumex brownii	Swamp Dock
Portulacaceae	*Portulaca oleracea* *	Pigweed *
Proteaceae	*Grevillea mucronulata*	
	Grevillea sp. aff. patulifolia/ sericea	
	Grevillea robusta *	Silky Oak *
	Grevillea triternata	
	Hakea dactyloides	Finger Hakea
	Hakea tephrosperma	Hooked Needlewood
	Isopogon dawsonii	Nepean Conebush
	Persoonia linearis	Narrow-leaved Geebung
Ranunculaceae	*Clematis glycinoides var. glycinoides*	
Rhamnaceae	*Pomaderris intermedia*	
	Pomaderris prunifolia	Plum-leaf Pomaderris
	Pomaderris queenslandica	**Scant Pomaderris**
Rosaceae	*Acaena echinata var. subglabricalyx*	

Family	Species	Common Name
	Acaena ovina	Acaena
	*Rubus fruticosus sp. agg. **	Blackberry complex *
Rubiaceae	*Asperula conferta*	Common Woodruff
	Galium propinquum	Maori Bedstraw
	Opercularia diphylla	Stinkweed
	Opercularia hispida	Hairy Stinkweed
	Pomax umbellata	Pomax
	Psydrax odorata	Shiny-leaved Canthium
Rutaceae	*Boronia anethifolia*	
	Boronia angustisepala	
	Correa reflexa var. reflexa	Native Fuschia
	Eriostemon australasius	
	Phebalium glandulosum subsp. angustifolium	
	Phebalium squamulosum subsp. gracile	
	Philotheca myoporoides subsp. myoporoides	
	Philotheca salsolifolia subsp. salsolifolia	
	Zieria cytisoides	Downy Zieria
	Zieria pilosa	Pilose-leafed Zieria
Salicaceae	*Salix babylonica **	Weeping Willow *
Santalaceae	*Choretrum sp. Coxs Gap*	
	Exocarpos strictus	Dwarf Cherry
	Santalum lanceolatum	Northern Sandalwood
Sapindaceae	*Alectryon subcinereus*	Wild Quince
	Dodonaea multijuga	
	Dodonaea sinuolata subsp. sinuolata	
	Dodonaea triangularis	Hopbush
	Dodonaea truncatiales	Angular Hop-bush
	Dodonaea viscosa subsp. cuneata	Wedge-leaf Hop-bush
Solanaceae	*Lycium ferocissimum **	African Boxthorn *
	Solanum brownii	Violet Nightshade
	Solanum campanulatum	
	Solanum cinereum	Narrawa Burr
	*Solanum nigrum **	Black-berry Nightshade *
	Solanum parvifolium subsp. parvifolium	Nightshade
	Solanum prinophyllum	Forest Nightshade
Stackhousiaceae	*Stackhousia monogyna*	Creamy Candles
	Stackhousia muricata	Stackhousia
Sterculiaceae	*Brachychiton populneus subsp. populneus*	
	Rulingia dasyphylla	Kerrawang
Thymelaeaceae	*Pimelea curviflora var. sericea*	
	Pimelea latifolia subsp. elliptifolia	
	Pimelea linifolia subsp. linifolia	
Typhaceae	*Typha orientalis*	Broad-leaved Cumbungi

Family	Species	Common Name
Ulmaceae	*Trema tomentosa var. aspera*	Native Peach
Verbenaceae	*Verbena bonariensis* *	Purpletop *
Violaceae	*Hybanthus monopetalus* *Melicytus dentatus*	Slender Violet-bush Tree Violet
Viscaceae	*Notothixos cornifolius*	Kurrajong Mistletoe
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree
Zamiaceae	*Macrozamia reducta*	
Zygophyllaceae	*Tribulus micrococcus*	Spineless Caltrop

* = weed or non-endemic species
bold = significant plant species

7.2 Appendix - Species List: Grassland Plot Surveys

May 2012 - Summary of native, non-grass species recorded within eighteen 0.01ha (10 x 10m) plots sampled in May 2012. A minimum of 12 native non-grass species are required, including at least one 'important' species (#), to meet the definition for Box-Gum Woodland (qualifying plots shaded).

	Plot																	
Species	**BYL001**	**BYL002**	**BYL003**	**BYL004**	**BYL005**	**BYL006**	**BYL007**	**BYL008**	**BYL009**	**BYL010**	**BYL011**	**BYL012**	**BYL013**	**BYL014**	**BYL015**	**BYL016**	**BYL017**	**BYL018**
Alternanthera sp. A		√	√							√					√			
# Asperula conferta											√							
Atriplex semibaccata			√									√		√			√	
Boerhavia dominii					√											√		
Bursaria spinosa		√																
# Calotis lappulacea	√	√		√	√					√	√	√	√	√	√	√	√	√
Carex inversa	√			√		√		√		√		√			√		√	
Chamaesyce drummondii					√						√							
Cheilanthes sieberi									√		√	√	√	√				
Convolvulus erubescens											√		√				√	
Cymbonotus lawsonianus											√					√		√
Cyperus gracilis	√	√	√			√		√		√		√					√	
# Daucus glochidiatus					√													
# Desmodium varians					√				√									
Dichondra repens	√								√					√				
Dichondra sp. A		√	√	√	√			√	√		√	√	√	√		√	√	√
Einadia hastata		√								√					√			
Einadia nutans ssp. linifolia	√		√	√			√	√		√				√			√	
Euchiton sphaericus									√			√						
Gahnia aspera									√									
Galium propinquum		√										√						
Geranium solanderi											√							
Glycine canescens													√	√				
# Glycine clandestina									√									
# Glycine tabacina	√	√	√	√	√	√	√		√	√	√		√	√	√	√	√	
# Linum marginale											√							
Maireana enchylaenoides										√				√	√			
Mentha satureioides											√							
Oxalis chnoodes	√																	
Oxalis perennans	√	√	√		√			√	√		√	√	√		√	√	√	
# Pimelea curviflora			√															
Plantago debilis		√		√				√	√		√							
Plantago spp.	√																	
Rumex brownii		√			√	√	√		√		√				√		√	
# Sida corrugata	√	√	√	√	√		√	√		√	√	√	√	√			√	
Sida spinosa	√																	
Sida trichopoda				√									√		√			
Solanum cinereum										√			√					
Vittadinia cuneata										√	√					√	√	√
Vittadinia muelleri										√								
Wahlenbergia communis					√				√	√	√			√	√	√	√	
Wahlenbergia gracilis														√				
Total native non-grass spp	11	12	9	8	11	4	4	7	12	13	17	10	10	12	10	8	13	4

November 2013 - Summary of native, non-grass species recorded within ten 0.04ha (20 x 20m) plots sampled in November 2013. A minimum of 12 native non-grass species are required, including at least one 'important' species (#), to meet the definition for Box-Gum Woodland. No qualifying plots.

Species	Plot									
	1	2	3	4	5	6	7	8	9	10
Atriplex sp					√	√		√	√	√
Boehavia domini						√				
# Calotis lappulacea	√	√	√		√	√		√	√	√
Crassula sp							√			
# Desmodium varians	√	√	√		√		√	√		
Dichondra repens								√		
Dichondra sp A					√					
Einadia sp					√					
Enchylaena tomentosa	√	√	√		√	√			√	√
Erodium sp						√				
# Glycine tabacina							√			
Maireana microphylla	√			√					√	
Rumex brownii			√			√				
# Sida corrugata	√	√	√	√	√	√	√	√	√	
Sida filiformis (?)								√		
Vittadinia sp				√					√	
Total native non-grass spp	5	4	5	3	7	7	4	6	6	3

April 2014 - Summary of native, non-grass species recorded by Cumberland Ecology within fifteen 0.01ha (20 x 50m) plots sampled in April 2014. A minimum of 12 native non-grass species are required, including at least one 'important' species (#), to meet the definition for Box-Gum Woodland (qualifying plots shaded).

Species	G-Q1	G-Q2	G-Q3	G-Q4	G-Q5	G-Q6	G-Q7	G-Q8	G-Q9	G-Q10	G-Q11	G-Q12	G-Q13	G-Q14	G-Q15
# Calotis lappulacea	√	√	√		√		√					√	√	√	√
Boerhavia dominii			√									√	√		
Carex inversa				√			√			√		√		√	√
Chamaesyce drummondii							√	√		√		√	√		
Cheilanthes sieberi subsp. sieberi		√	√									√	√	√	√
# Chrysocephalum apiculatum			√			√						√		√	√
Convolvulus erubescens							√								√
# Cullen tenax										√					
Cyperus brevifolius	√	√													
Cyperus fulvus				√											√
Cyperus gracilis				√				√							
# Daucus glochidiatus															√
# Desmodium varians												√			
Dichondra repens				√				√		√	√		√		

Species	G-Q1	G-Q2	G-Q3	G-Q4	G-Q5	G-Q6	G-Q7	G-Q8	G-Q9	G-Q10	G-Q11	G-Q12	G-Q13	G-Q14	G-Q15
Dysphania pumilio	√	√	√	√	√		√	√	√			√	√	√	√
Einadia hastata														√	
Einadia nutans	√			√						√					
Einadia nutans subsp. nutans			√				√					√		√	
Einadia trigonos													√		
Erodium crinitum		√	√	√		√			√				√	√	√
Fimbristylis dichotoma						√						√		√	
Geranium solanderi											√			√	
# Glycine clandestina	√					√									√
# Glycine tabacina		√	√	√		√	√	√		√	√	√	√	√	
Juncus usitatus															√
Maireana microphylla		√													
Mentha satureioides														√	
Oxalis perennans	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Phyllanthus virgatus		√	√	√		√	√			√		√			
Rumex brownii			√	√						√				√	√
Sclerolaena muricata					√										
# Sida corrugata	√	√	√	√	√		√	√	√	√	√	√	√	√	√
Sida cunninghamii		√				√		√					√	√	√
Solanum campanulatum	√			√					√		√		√		
Solanum prinophyllum												√			√
# Stackhousia monogyna															√
# Tricoryne elatior												√			√
Tribulus micrococcus	√	√	√	√	√		√		√	√	√	√	√	√	
Vittadinia cuneata										√					
Vittadinia muelleri														√	
Wahlenbergia communis	√		√					√	√	√	√	√	√	√	√
Wahlenbergia luteola		√	√			√									
# Zornia dyctiocarpa var. dyctiocarpa												√		√	
Total native non-grass spp	10	13	15	14	6	9	11	9	7	13	8	19	15	20	19

7.3 Appendix - Vegetation Community Profiles

Community profiles of each vegetation community present within the Project Boundary have been developed to assist end-users in the interpretation of delineated map units.

For each vegetation community, a summary of the basic structural makeup of that unit is provided. The accuracy of structural information presented with each profile is governed by the sample size of each community (shown as "n" in the structural tables).

Diagnostic species for each community have been derived using the SIMPER routine in *Primer*. SIMPER analysis provides the relative contributions of each species to the Bray-Curtis similarity within each of the defined vegetation communities. Only those species contributing to a total cumulative contribution of 99% of the average similarity for each community are listed. These species can be described of as *typical* of that community, and have a consistently large presence within the data as reflected in the ratio of their contribution to the standard deviation (the Sim/SD field in each table) across the within-group similarities (the average similarity). Community groups with less than two samples (eg: Coastal Grey Box Woodland) cannot be analysed in this way. Instead, the full species list from the single plot in each community is shown, in decreasing cover abundance value.

In the *Key Diagnostic Species* tables in each profile:

- Average similarity — is the within-group similarity for all pairs of sample plots comprising the community. Higher average similarity indicates a better defined community.
- Av.Abund — is the average cover abundance of that species within sample plots comprising the community
- Av.Sim — is the average similarity (contribution) made by each species to the within-group similarity (the overall average similarity).
- Sim/SD — is the ratio of average similarity to standard deviation for each species across all pairs of samples. A high ratio represents a good discriminating species. At least three samples are required for this ratio to be calculated.
- Contrib % — is the percentage contribution of each species to the overall average similarity for the community.

Rusty Fig Dry Rainforest — Unit 1

Keith Class: Dry Rainforests

NSW VCA: no equivalent

GHV: Rusty Fig/ Native Quince/ Native Olive/ dry rainforest of the Central Hunter Valley (MU025)

Wollemi NP: Dry Ranges Rusty Fig Rainforest Scrub (S_RF15)

General Description:

A single location within 'Bylong Park' supports a stand of *Ficus rubiginosa* dry rainforest on a low rocky ridge. Associated with this vegetation is the emergent canopy species *Eucalyptus punctata*, and high amounts of sandstone and conglomerate rock outcrop. The rocky, conglomerate nature of this site contributes to niche development favoured by Figs through water retention capabilities.

Characteristic Features:

- very rocky ridgelines, with numerous crevices and boulders
- almost exclusively dominated by Figs
- low species diversity

Known Floristic/ Structural Variations:

No floristic or structural variations have been observed in this community.

Relationship to Other Communities:

The dominant presence of *Ficus rubiginosa* in this community is diagnostic, and separates this type from all others. Grey Myrtle Dry Rainforest (Unit 2) is the only other rainforest community present within the Project Boundary, but that is dominated by *Backhousia myrtifolia*, and *Ficus rubiginosa* is absent. Grey Myrtle Dry Rainforest also occurs in sheltered gullies on alluvial and colluvial soils, while Rusty Fig Dry Rainforest is present on a rocky ridgeline.

Distribution:

Within Project Boundary: 0.9 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed (may contain elements of Hunter Valley Vine Thicket)

Species Richness:

Number of plots: 1
Total native species: 18
Mean species / plot (+/- SD): 18 (+/- n/a)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	12.0	85.0	-	1
Middle 1	1.0	4.0	20.0	-	1
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	10.0	-	1

Key Diagnostic Species [Cover abundance values, based on 1 plot]:

Rusty Fig Dry Rainforest
Average similarity: Less than 2 samples

Habit	Species	C/A	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus punctata*	1.00	-	-	-
Small Tree	*Ficus rubiginosa*	6.00	-	-	-
	Brachychiton populneus subsp. populneus	1.00	-	-	-
Shrub	*Psydrax odorata*	2.00	-	-	-
	Notelaea microcarpa var. microcarpa	1.00	-	-	-
	Cassinia quinquefaria	1.00	-	-	-
Subshrub	*Abutilon oxycarpum*	1. 00	-	-	-
	Atriplex semibaccata	1.00	-	-	-
Grass	*Microlaena stipoides var. stipoides*	2.00	-	-	-
	Austrostipa verticillata	2.00	-	-	-
	Rytidosperma spp.	1.00	-	-	-
Herb/Forb	*Galium propinquum*	2.00	-	-	-
	Einadia hastata	2.00	-	-	-
	Calotis lappulacea	1.00	-	-	-
Sedge	*Gahnia aspera*	1.00	-	-	-
Vine	*Parsonsia eucalyptophylla*	2.00	-	-	-
	Parsonsia straminea	1.00	-	-	-
Fern	*Cheilanthes distans*	2.00	-	-	-

Grey Myrtle Dry Rainforest — Unit 2

Keith Class: Dry Rainforests

NSW VCA: No equivalent

GHV: Grey Myrtle/ Grey Gum gully dry rainforest on sandstone ranges, Sydney Basin (MU022)

Wollemi NP: Sydney Hinterland Grey Myrtle Dry Rainforest (S_RF11)

General Description:

A few well protected gullies and lower slopes south of Bylong State Forest and in Crown land in the east support narrow bands of Grey Myrtle Dry Rainforest. *Backhousia myrtifolia* typifies this community, but emergent *Eucalyptus punctata* and occasionally *Eucalyptus albens* also occur. Few understorey species are present in this type due to dense shading from *Backhousia*, but *Notelaea longifolia* is normally present, with *Gahnia aspera* common on the ground.

Characteristic Features:

- Canopy of Grey Myrtle, with occasional eucalypt emergents
- low diversity of other species, lacking shrubs and herbs
- bare ground layer, with boulders and rocks common

Known Floristic/ Structural Variations:

Two forms of this community are present within the Project Boundary, although floristically they are very similar. In sheltered gullies adjoined by sandstone clifflines, the 'typical' rainforest of gullies is present. This gully vegetation is rarely more than 20m in width. On sheltered southern slopes below rocky ridgelines, a more expansive sheltered forest where *Backhousia myrtifolia* forms a continuous mid-layer is present. This form often forms beneath a canopy of emergent ironbarks and boxes.

Relationship to Other Communities:

Distinct from all other defined communities in the Project Boundary due to the presence of *Backhousia myrtifolia* in the canopy or mid-layer. Rusty Fig Dry Rainforest (Unit 1) is broadly similar, but is dominated by *Ficus rubiginosa*.

Distribution:

Within Project Boundary: 5.4 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 3
Total native species: 24
Mean species / plot (+/- SD): 11.3 (+/- 2.89)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	18.0	25.0	23.0	11.54	3
Tallest	6.0	15.0	80.0	0.00	3
Middle 1	1.0	3.0	4.0	2.12	2
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	3.0	2.08	3

Key Diagnostic Species [99% contribution, based on 3 plots]:

Grey Myrtle Dry Rainforest
Average similarity: 43.69

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus punctata*	2.00	5.94	2.17	13.60
	Eucalyptus albens	1.67	2.72	0.58	6.23
Small Tree	*Backhousia myrtifolia*	6.00	26.56	14.61	60.78
Shrub	*Bursaria spinosa*	0.67	1.36	0.58	3.11
Grass	*Rytidosperma longifolium*	1.33	2.72	0.58	6.23
Herb/Forb	*Stellaria flaccida*	1.00	1.36	0.58	3.11
Sedge	*Gahnia aspera*	0.67	1.52	0.58	3.47
	Lepidosperma laterale	1.00	1.52	0.58	3.47

River Oak / Redgum Riparian Woodland Unit 3

Keith Class: Eastern Riverine Forests

NSW VCA: River Oak Riparian Woodland of the North Coast and Northern Sydney Basin

GHV: River Red Gum/ River Oak grassy riparian woodland of the Hunter Valley (MU215)

Wollemi NP: River Oak Forest (S_FoW13)

General Description:

High energy banks and riparian areas along the Bylong River and parts of Lee Creek support an intermittent gallery forest or woodland of *Casuarina cunninghamiana subsp. cunninghamiana* with occasional *Eucalyptus camaldulensis, Eucalyptus blakelyi* or *Angophora floribunda*. Associated shrub and ground layer species typically comprise a high proportion of weeds, and a long history of grazing has degraded many kilometres of this vegetation type. As a consequence, sampling opportunities are few and no detailed data has been collected.

Characteristic Features:

- Canopy of River Oak and/or red gums along river edges, and occasionally along old river terraces
- heavily weed infested, often with little or no native species
- heavily cleared in central Bylong Valley

Known Floristic/ Structural Variations:

No floristic or structural variations have been observed in this community.

Relationship to Other Communities:

Casuarina cunninghamiana subsp. *cunninghamiana* occurs in no other vegetation community, and is difficult to confuse with others. However, this community does grade into the adjacent Blakely's Redgum / Apple Riparian Forest (Unit 4), and because of the long history of disturbance in both communities, it can be difficult to differentiate the two. Generally, areas where *Casuarina cunninghamiana* subsp. *cunninghamiana* is present along creek lines represent the River Oak / Redgum Riparian Woodland.

Distribution:

Within Project Boundary: 39.5 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - Hunter Floodplain Red Gum Woodland

Species Richness:

Number of plots: 0
Total native species: n/a
Mean species / plot (+/- SD): n/a (+/- n/a)

Vegetation Structure: (not assessed)

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	-	-	-	-	-
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	-	-	-	-	-

Key Diagnostic Species [unsampled]:

River Oak/ Redgum Riparian Woodland Unsampled					
Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
-	-	-	-	-	-

Blakely's Redgum / Apple Riparian Forest — Unit 4

Keith Class: Eastern Riverine Forests

NSW VCA: no equivalent

GHV: Blakelys Red Gum/ Narrow-leaved Ironbark/ Rough-barked Apple shrub w'dland, upper Hunter (MU089)

Wollemi NP: Western Hunter Flats Rough-barked Apple Forest (S_FoW19)

General Description:

Areas where *Eucalyptus blakelyi* and/or *Angophora floribunda* dominate the canopy occur principally in areas associated with drainage lines, and adjacent to channel-restricted River Oak/ Redgum Riparian Woodland. Remnant trees along riparian areas and adjacent flats bear testament to a community now all but cleared. *Eucalyptus blakelyi* and *Angophora floribunda* would once have dominated these areas, over a grassy understorey of various grasses, herbs and forbs. In places, *Eucalyptus camaldulensis* is also present. Many such areas now support improved pastures. A minor variant of this community also occurs on an elevated hillslope that appears to have suffered a geomorphological landscape slump long ago allowing the development of a moist forest with good representation of grasses and herbs, and establishment of *Angophora floribunda* as the dominant canopy species.

Characteristic Features:

- Canopy of Blakely's Red Gum and/or Rough-barked Apple, on alluvial soils associated with creeklines
- variable shrub layer of Cassinia, Hop-Bush and Wattles
- highly diverse ground layer of herbs, forbs and grasses, at least where not heavily grazed

Known Floristic/ Structural Variations:

Best development in this community occurs towards the edges of its distribution, or in gully heads that have been less impacted by clearing and grazing. In these areas, a better structural composition is present than that evident along the main creek line alluvial flats, where few remnants remain. In some areas, *Eucalyptus camaldulensis* dominates or co-occurs with *Eucalyptus blakelyi*, with little *Angophora floribunda* present.

Relationship to Other Communities:

The combined presence of red gums (*Eucalyptus blakelyi* and/or *Eucalyptus camaldulensis*) with *Angophora floribunda*, on expansive alluvial soils, sufficiently distinguishes this community from all others. Along high-energy river banks, River

Oak/ Redgum Riparian Woodland (Unit 3) occurs as narrow strips, which merge into this community. Other communities dominated by *Eucalyptus blakelyi* include Blakely's Redgum/ Paperbark Forest (Unit 5), which occurs in small, narrow drainage lines in and around Bylong State Forest and supports a distinctive shrub layer of *Melaleuca thymifolia*, and Blakely's Redgum Woodland (Unit 8), which occurs on colluvial flats higher in the catchment.

Distribution:

Within Project Boundary: 166.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP); *Eucalyptus camaldulensis* (EP)

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed (may contain some minor elements of Hunter Floodplain Redgum Woodland).

Species Richness:

Number of plots: 2
Total native species: 63
Mean species / plot (+/- SD): 37.5 (+/- 6.36)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	12.0	25.0	30.0	7.07	2
Middle 1	2.0	10.0	30.0	14.14	2
Middle 2	1.0	3.0	20.0	-	1
Lowest	0.1	1.0	88.0	10.61	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Blakely's Redgum/ Apple Riparian Forest
Average similarity: 39.69

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Angophora floribunda*	3.50	4.58	-	11.54
Shrub	*Bursaria spinosa*	3.00	4.58	-	11.54
Grass	*Microlaena stipoides var. stipoides*	5.00	7.63	-	19.23
	Rytidosperma racemosum var. racemosum	2.00	3.05	-	7.69
	Austrostipa verticillata	1.00	1.53	-	3.85
Herb/Forb	*Dichondra repens*	2.00	3.05	-	7.69
	Veronica plebeia	2.00	3.05	-	7.69
	Galium propinquum	1.50	1.53	-	3.85
Sedge	*Carex inversa*	2.00	3.05	-	7.69
	Gahnia aspera	1.50	1.53	-	3.85
Vine	*Glycine tabacina*	2.00	3.05	-	7.69
Fern	*Cheilanthes sieberi subsp. sieberi*	2.00	3.05	-	7.69

Blakely's Redgum / Paperbark Forest — Unit 5

Keith Class: Western Slopes Dry Sclerophyll Forests

NSW VCA: no equivalent

GHV: no equivalent

Wollemi NP: no equivalent

General Description:

Minor drainage lines within and around the undulating topography of Bylong State Forest support narrow bands of *Eucalyptus blakelyi* over a distinct understorey of *Melaleuca thymifolia* and *Sannantha cunninghamii*, and the grasses *Aristida ramosa, Arundinella nepalensis* and *Aristida vagans*. Such vegetation is unusual in the region, and typically occupies highly restricted riparian habitats. A potential new species (*Sannantha* sp. aff. *cunninghamii*) also occurs in this vegetation type, and requires further study with fertile material.

Characteristic Features:

- Canopy of Blakely's Red Gum in narrow, indistinct drainage lines
- mid-storey of low Thyme Honey-Myrtle
- ground layer of clumpy grasses, often with many bare patches

Known Floristic/ Structural Variations:

The extent of the shrub layer within this community provides the most structural variation, but floristically all sampled sites support similar species. As the drainage lines supporting it are indistinct within gently undulating topography, floristic intrusion from adjacent communities is common.

Relationship to Other Communities:

Although supporting similar canopy dominants to Blakely's Redgum/ Apple Riparian Forest (Unit 4) and Blakely's Redgum Woodland (Unit 8), this community can be distinguished by the characteristic shrub layer of *Melaleuca thymifolia*. Unit 4 also only occurs on extensive alluvial flats with deeper soil profiles, while soils supporting Unit 8 are more colluvial in nature and have higher diversity of herbs and grasses.

Distribution:

Within Project Boundary: 14.6 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 4
Total native species: 46
Mean species / plot (+/- SD): 23.3 (+/- 2.87)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	10.0	22.0	31.0	4.79	4
Middle 1	1.0	12.0	45.0	38.07	4
Middle 2	1.0	2.0	55.0	7.07	2
Lowest	0.1	1.0	8.0	5.72	4

Key Diagnostic Species [99% contribution, based on 4 plots]:

Blakely's Redgum/ Paperbark Forest
Average similarity: 55.99

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus blakelyi*	3.25	7.76	20.76	13.85
Small Tree	*Acacia linearifolia*	2.00	2.90	0.87	5.18
	Callitris endlicheri	1.25	1.30	0.91	2.31
Shrub	*Melaleuca thymifolia*	4.75	10.79	7.69	19.28
	Sannantha cunninghamii	2.50	5.62	4.54	10.04
	Acacia buxifolia subsp. buxifolia	1.00	2.59	20.76	4.62
	Choretrum sp. Coxs Gap	1.00	2.59	20.76	4.62
	Persoonia linearis	1.00	2.59	20.76	4.62
	Dodonaea viscosa subsp. cuneata	1.25	1.70	0.84	3.04
	Sannantha sp. aff. cunninghamii	1.00	1.30	0.91	2.31
	Grevillea sp. aff. patulifolia/ sericea	0.75	0.46	0.41	0.82
Grass	*Aristida ramosa*	1.50	3.04	2.54	5.43
	Aristida vagans	1.50	3.00	3.13	5.35
	Digitaria diffusa	1.00	0.84	0.41	1.51
Graminoid	*Lomandra multiflora subsp. multiflora*	1.00	2.59	20.76	4.62
	Lomandra glauca	1.25	1.75	0.80	3.12
	Lomandra confertifolia subsp. rubiginosa	1.00	1.31	0.91	2.33
	Lomandra confertifolia subsp. pallida	0.75	0.46	0.41	0.82
	Dianella revoluta var. revoluta	0.50	0.42	0.41	0.75
Sedge	*Gahnia aspera*	1.25	2.59	20.76	4.62

Yellow Box Woodland

Unit 6

Keith Class:	**Western Slopes Grassy Woodlands**
NSW VCA:	**no equivalent**
GHV:	**Yellow Box grassy woodland on basalt soils of the upper Hunter (MU171)**
Wollemi NP:	**(?) Central Tableland Clay White Box Woodland (S_GW11)**

General Description:

Predominantly occurring on the basalt plateau and associated slopes within 'Bylong Station' and 'Bylong Park'. Dominated by *Eucalyptus melliodora* in the canopy, but understorey vegetation has been mostly cleared for grazing. A high diversity of grasses, herbs and forbs characterise this community. The bulk of the mapped area of Yellow Box Woodland is dominated by *Eucalyptus melliodora*, over a grassy understorey of various native grasses, herbs and forbs. Shrubs are sparse or absent. This grassy form occupies the bulk of the basalt plateau, and forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC. Some minor elements of Yellow Box Woodland along escarpment slopes support thickets of shrubs such as *Bursaria spinosa*, and occasionally *Dodonaea viscosa* var. *cuneata* or *Cassinia quinquefaria*. Ground layer vegetation is diverse across both forms, and supports numerous grasses, herbs and forbs.

Characteristic Features:

- Canopy of Yellow Box, very occasionally with White Box
- limited or no mid-story, except on steeper slopes where Hop-Bush, Wattle and Cassinia may be present
- generally an extensive grassy ground layer with high species diversity

Known Floristic/ Structural Variations:

Variation within this community is directly related to the extent of past disturbances for agricultural activities. In most cases, a variable ground layer of grasses and herbs is present, the composition of which is driven by stock grazing pressure. Some areas on the basalt plateau of 'Bylong Station' support standing dead *Eucalyptus melliodora*, possibly through ring-barking activities some years previously. On the steep escarpment slope near here, a shrub layer has developed but is patchy in nature. Elsewhere in the main Bylong Valley, this community is represented by small remnants and paddock trees, often over cultivated fields.

Relationship to Other Communities:

The dominant presence of *Eucalyptus melliodora* sufficiently distinguishes this community from all others. Structurally, it is similar to most other Box woodlands in the Project Boundary, but canopy species in each rarely occur together.

Distribution:

Within Project Boundary: 161.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP)

Community Conservation Status:

EPBC Act (1999) Status - White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland [except where present in cultivated fields]

TSC Act (1995) Status - White Box - Yellow Box - Blakely's Red Gum Woodland [except where present in cultivated fields]

Species Richness:

Number of plots: 2
Total native species: 58
Mean species / plot (+/- SD): 42.0 (+/- 4.24)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	15.0	25.0	0.00	2
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	85	7.07	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Yellow Box Woodland
Average similarity: 57.83

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus melliodora*	3.00	3.61	-	6.25
Subshrub	*Solanum cinereum*	1.50	1.20	-	2.08
Grass	*Aristida personata*	4.00	4.82	-	8.33
	Chloris truncata	3.00	3.61	-	6.25
	Austrostipa scabra subsp. falcata	2.00	2.41	-	4.17
	Bothriochloa decipiens var. decipiens	2.50	2.41	-	4.17
	Panicum effusum	2.50	2.41	-	4.17
	Sporobolus creber	2.50	2.41	-	4.17
Herb/Forb	*Boerhavia dominii*	2.00	2.41	-	4.17
	Calotis lappulacea	2.00	2.41	-	4.17
	Dichondra repens	2.50	2.41	-	4.17
	Dichondra sp. A	2.50	2.41	-	4.17
	Einadia hastata	2.50	2.41	-	4.17
	Geranium solanderi var. solanderi	2.00	2.41	-	4.17
	Sida corrugata	2.00	2.41	-	4.17
	Wahlenbergia communis	2.00	2.41	-	4.17

Yellow Box Woodland					
Average similarity: 57.83					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**
	Chenopodium pumilio	1.50	1.20	-	2.08
	Commelina cyanea	1.50	1.20	-	2.08
	Cymbonotus lawsonianus	1.00	1.20	-	2.08
	Einadia nutans subsp. linifolia	1.50	1.20	-	2.08
	Portulaca oleracea	1.50	1.20	-	2.08
	Rumex brownii	1.50	1.20	-	2.08
Sedge	*Cyperus gracilis*	2.00	2.41	-	4.17
Vine	*Desmodium brachypodum*	2.50	2.41	-	4.17
	Glycine clandestina	1.50	1.20	-	2.08
Fern	*Cheilanthes sieberi subsp. sieberi*	2.00	2.41	-	4.17

White Box Woodland Unit 7

Keith Class: **Western Slopes Grassy Woodlands**
NSW VCA: **no equivalent**
GHV: **White Box/ Black Cypress Pine shrubby woodland of the Western Slopes (MU092)**
Wollemi NP: **Western Hunter Footslopes Box Woodland (S_GW05)**

General Description:

White Box Woodland forms a mosaic pattern with the Slaty Box Woodland along all of the talus footslopes in the area, but also extending out onto some low rises on the plains. Two variants are present in the area, distinguished by the presence or absence of a shrub layer. Grassy areas are dominated by *Eucalyptus albens*, over an understorey of various native grasses, herbs and forbs. Shrubs are either widely scattered or absent. This form typically occurs on the undulating lands of the valley floor, where it changes into Coastal Grey Box Woodland, and forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC. Shrubby areas are also dominated by *Eucalyptus albens* in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata, Bursaria spinosa*, *Olearia elliptica* and *Cassinia quinquefaria*. Ground layer vegetation is diverse, and supports numerous grasses, herbs and forbs. The shrubby form predominates on the steeper sites along the escarpment footslopes, and can be excluded from the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC.

Characteristic Features:

- Canopy of White Box, rarely with other species but with Slaty Box on some escarpment slopes
- mid-storey of Hop-Bush, Blackthorn and Cassinia (in shrubby form), or sparse to absent (grassy form)
- rich ground layer of grasses, herbs and forbs

Known Floristic/ Structural Variations:

Two forms are recognised, driven primarily by the extent and diversity of a shrubby mid-layer. In general, footslopes ringing the Bylong Valley floor support the shrubby form of this community (Unit 7b), while the grassy form lacking shrubs occurs on the adjacent undulating lands (Unit 7a). Grassy woodlands have been subjected to ongoing stock grazing pressure for many decades, and under such management a shrub layer rarely develops. Conversely, the steeper footslopes that are rarely grazed retain an often dense shrub layer.

Relationship to Other Communities:

The characteristic *Eucalyptus albens* in the canopy defines the limits of this community. This species may occasionally also occur in Yellow Box Woodland (Unit 6), Slaty Box Woodland (Unit 9) or Coastal Grey Box Woodland (Unit 10), but only at the interface of adjacent communities. All Box communities are typified by grassy understoreys with many shared species, and grazing history drives floristic composition at individual sites.

Distribution:

Within Project Boundary: 1225.0 ha (Unit 7a – grassy; 722.0 ha); (Unit 7b – shrubby; 503.0 ha)

Significant Species:

- Threatened (EPBC Act) (?) *Tylophora linearis* (End)
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP); *Diuris tricolor* (Vul); *Tylophora linearis* (Vul)

Community Conservation Status:

EPBC Act (1999) Status - White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland [Grassy form, except where present in cultivated fields]

TSC Act (1995) Status - White Box - Yellow Box - Blakely's Red Gum Woodland [Grassy form, except where present in cultivated fields]

Species Richness:

Number of plots: 4 Grassy; 5 Shrubby
Total native species: 105 Grassy; 103 Shrubby
Mean species / plot (+/- SD): 50.5 (+/- 5.74) Grassy; 41.4 (+/- 12.16) Shrubby

Vegetation Structure: Grassy

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	20.0	33.0	2.89	4
Middle 1	1.0	12.0	8.0	8.43	4
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	79.0	8.54	4

Vegetation Structure: Shrubby

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	12.0	20.0	34.0	2.24	5
Middle 1	1.0	4.0	41.0	33.02	5
Middle 2	1.0	2.0	55.0	0.00	1
Lowest	0.1	1.0	42.0	36.67	5

Key Diagnostic Species [99% contribution, based on 9 plots (4 Grassy; 5 Shrubby)]:

White Box Woodland (Grassy: 4 plots)
Average similarity: 45.68

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus albens*	2.75	1.90	0.89	4.17
	Eucalyptus moluccana	1.50	0.36	0.41	0.79
Small Tree	*Brachychiton populneus subsp. populneus*	0.50	0.18	0.41	0.40

White Box Woodland (Grassy: 4 plots)
Average similarity: 45.68

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Shrub	*Acacia ixiophylla*	1.00	0.36	0.41	0.79
	Dodonaea viscosa subsp. cuneata	1.00	0.36	0.41	0.79
	Acacia implexa	0.75	0.18	0.41	0.40
	Cassinia quinquefaria	0.75	0.18	0.41	0.39
Subshrub	*Eremophila debilis*	1.00	0.36	0.41	0.79
	Solanum cinereum	0.75	0.20	0.41	0.43
	Hibiscus sturtii var. sturtii	0.75	0.18	0.41	0.40
	Solanum parvifolium subsp. parvifolium	0.75	0.18	0.41	0.40
Grass	*Austrostipa scabra subsp. falcata*	2.25	2.28	17.29	4.99
	Bothriochloa decipiens var. decipiens	1.75	1.17	0.91	2.57
	Aristida personata	1.75	1.16	0.91	2.54
	Chloris truncata	1.50	1.16	0.91	2.54
	Microlaena stipoides var. stipoides	1.50	1.08	0.91	2.37
	Paspalidium gracile	1.25	0.76	0.84	1.67
	Dichelachne micrantha	1.25	0.72	0.82	1.58
	Aristida vagans	1.00	0.54	0.91	1.19
	Rytidosperma caespitosum	1.25	0.41	0.41	0.90
	Panicum effusum	1.00	0.40	0.41	0.87
	Austrostipa verticillata	1.50	0.36	0.41	0.79
	Rytidosperma racemosum var. racemosum	1.25	0.35	0.41	0.77
	Sporobolus creber	0.75	0.20	0.41	0.43
	Dichanthium sericeum subsp. sericeum	1.00	0.18	0.41	0.40
	Poa labillardierei var. labillardierei	0.75	0.18	0.41	0.40
Graminoid	*Lomandra confertifolia subsp. pallida*	1.00	0.35	0.41	0.77
	Dianella tasmanica	0.50	0.18	0.41	0.40
Herb/Forb	*Calotis lappulacea*	2.00	2.28	17.29	4.99
	Dichondra repens	2.00	2.28	17.29	4.99
	Plantago debilis	2.00	2.28	17.29	4.99
	Sida corrugata	2.00	2.28	17.29	4.99
	Desmodium varians	1.75	1.73	2.51	3.78
	Einadia hastata	1.50	1.33	2.69	2.92
	Veronica plebeia	1.50	1.17	0.91	2.57
	Einadia nutans subsp. linifolia	1.50	1.16	0.91	2.54
	Wahlenbergia gracilis	1.50	1.16	0.91	2.54
	Vittadinia sulcata	1.00	1.14	17.29	2.49
	Sigesbeckia australiensis	1.50	1.08	0.91	2.37
	Enchylaena tomentosa	1.25	0.76	0.84	1.67
	Ajuga australis	1.25	0.72	0.82	1.57
	Desmodium gunnii	1.00	0.54	0.91	1.19
	Oxalis perennans	1.00	0.41	0.41	0.90
	Asperula conferta	1.00	0.37	0.41	0.81
	Scutellaria humilis	1.00	0.36	0.41	0.79
	Chamaesyce drummondii	0.75	0.19	0.41	0.43
	Cynoglossum australe	0.50	0.18	0.41	0.40
Sedge	*Cyperus gracilis*	1.50	1.34	2.60	2.93
	Carex inversa	1.25	0.77	0.80	1.68
	Gahnia aspera	1.00	0.36	0.41	0.79
	Scleria mackaviensis	1.00	0.35	0.41	0.77
Vine	*Glycine tabacina*	1.75	1.71	2.70	3.74
	Desmodium brachypodum	1.00	0.59	0.91	1.29

White Box Woodland (Grassy: 4 plots) Average similarity: 45.68					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
	Convolvulus erubescens	0.50	0.18	0.41	0.40
Fern	*Cheilanthes sieberi subsp. sieberi*	2.00	2.28	17.29	4.99
	Cheilanthes distans	1.00	0.35	0.41	0.77

White Box Woodland (Shrubby: 5 plots) Average similarity: 38.13					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
Tree	*Eucalyptus albens*	4.00	6.06	5.11	15.90
Small Tree	*Brachychiton populneus subsp. populneus*	0.80	0.97	1.12	2.54
Shrub	*Dodonaea viscosa subsp. cuneata*	2.00	2.39	2.89	6.26
	Cassinia quinquefaria	2.20	1.59	0.94	4.17
	Bursaria spinosa	1.60	1.05	0.98	2.74
	Acacia ixiophylla	1.40	0.99	0.61	2.59
	Olearia elliptica subsp. elliptica	1.40	0.97	0.51	2.54
	Senna artemisioides subsp. *zygophylla*	0.40	0.20	0.32	0.51
Subshrub	*Eremophila debilis*	0.60	0.38	0.62	1.00
	Pimelea latifolia subsp. elliptifolia	0.80	0.14	0.32	0.37
	Solanum brownii	0.40	0.14	0.32	0.37
Grass	*Austrostipa scabra subsp. falcata*	1.60	1.43	1.01	3.76
	Cymbopogon refractus	1.20	1.02	0.99	2.68
	Aristida personata	1.40	0.76	0.62	1.99
	Chloris ventricosa	1.00	0.63	0.59	1.66
	Aristida ramosa	0.80	0.49	0.61	1.29
	Austrostipa verticillata	0.60	0.46	0.62	1.21
	Rytidosperma fulvum	1.20	0.39	0.32	1.03
	Sporobolus creber	0.80	0.38	0.62	0.99
	Rytidosperma longifolium	1.00	0.35	0.32	0.93
	Panicum effusum	0.80	0.22	0.32	0.57
	Rytidosperma tenuius	0.40	0.18	0.32	0.46
	Panicum queenslandicum var. queenslandicum	0.40	0.18	0.32	0.46
	Austrostipa pubescens	1.20	0.15	0.32	0.40
	Aristida vagans	0.40	0.14	0.32	0.37
	Bothriochloa decipiens var. decipiens	0.40	0.11	0.32	0.29
Graminoid	*Lomandra confertifolia subsp. pallida*	1.20	0.87	0.61	2.29
	Lomandra multiflora subsp. multiflora	0.80	0.38	0.62	1.00
Herb/Forb	*Calotis lappulacea*	1.80	2.38	2.94	6.25
	Dichondra repens	1.60	1.94	1.12	5.09
	Sida corrugata	1.40	1.25	1.08	3.27
	Enchylaena tomentosa	1.00	0.60	0.58	1.59
	Wahlenbergia communis	1.00	0.51	0.60	1.34
	Cymbonotus lawsonianus	0.60	0.49	0.61	1.29
	Desmodium varians	1.00	0.49	0.60	1.28
	Einadia nutans subsp. linifolia	0.80	0.44	0.61	1.14
	Veronica plebeia	0.80	0.40	0.32	1.04
	Sigesbeckia australiensis	0.60	0.38	0.62	0.99
	Einadia hastata	0.80	0.26	0.32	0.68

White Box Woodland (Shrubby: 5 plots) Average similarity: 38.13					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
	Vittadinia sulcata	0.40	0.20	0.32	0.52
	Daucus glochidiatus	0.60	0.14	0.32	0.37
	Oxalis perennans	0.60	0.13	0.32	0.34
	Plantago debilis	0.60	0.13	0.32	0.34
	Asperula conferta	0.60	0.11	0.32	0.29
	Galium propinquum	0.60	0.11	0.32	0.29
Sedge	*Gahnia aspera*	1.40	0.98	1.11	2.57
Vine	*Glycine tabacina*	1.00	0.97	1.12	2.54
	Clematis glycinoides var. glycinoides	1.20	0.96	1.04	2.51
	Glycine clandestina	1.00	0.52	0.55	1.37
	Desmodium brachypodum	0.80	0.38	0.62	0.99
	Convolvulus erubescens	0.40	0.14	0.32	0.37
Fern	*Cheilanthes sieberi subsp. sieberi*	1.20	0.76	0.62	2.00

Blakely's Redgum Woodland Unit 8

Keith Class: **Western Slopes Grassy Woodlands**

NSW VCA: **(?) Blakely's Red Gum - White Box - Black Cypress Pine box grass/shrub w'land on clay loam soils in undulating hills of central NSW SWS Bioregion**

GHV: **no equivalent**

Wollemi NP: **(?) Western Hunter Footslopes Box Woodland (S_GW05)**

General Description:

Relatively minor areas of woodland dominated by *Eucalyptus blakelyi* are present in the Project Boundary. Where they occur, past management practices has generally determined the grassy or shrubby nature of them. Both varieties are recognised in the mapping, although nether have been sampled in detail. Grassy areas are dominated by *Eucalyptus blakelyi*, over a ground layer of native grasses, herbs and forbs. Shrubs are either widely scattered or absent. This form occurs as small patches mainly on the western rim of the Bylong Valley, but also in the southern central section at 'Harley Hill'. This unit forms a component of the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC. Shrubby areas are dominated by *Eucalyptus blakelyi* in the canopy, over a scattering of shrubs including *Dodonaea viscosa* var. *cuneata, Bursaria spinosa*, *Olearia elliptica* and *Cassinia quinquefaria*. Ground layer vegetation supports several grasses, herbs and forbs. The shrubby form occurs mainly in the east in the vicinity of Bylong State Forest, and can be excluded from the White Box - Yellow Box - Blakely's Redgum Grassy Woodland TEC.

Characteristic Features:

- Canopy of Blakely's Red Gum with few other species
- mid-storey of Blackthorn, Hop-Bush, Cassinia and Wattles
- ground layer of grasses, herbs and forbs

Known Floristic/ Structural Variations:

Two variations are recognised in Blakely's Redgum Woodland, again related to past management history. Areas where shrubs are sparse or absent support a grassy understorey (Unit 8a), and these typically occur where stock grazing has persisted over many decades. A small number of locations also support a shrubby version of this community (Unit 8b), where Hop-Bush and Blackthorn are characteristic, generally on the extreme edge of the main valley floor.

Relationship to Other Communities:

This community is one of three where *Eucalyptus blakelyi* characterises the canopy. The similar Blakely's Redgum / Apple Riparian Forest (Unit 4) occurs on deeper alluvial soils on the flats adjacent to major creek lines (Bylong River, Lee Creek), and *Angophora floribunda* co-dominates with *Eucalyptus blakelyi* there. In and around the Bylong State Forest, Blakely's Redgum / Paperbark Forest (Unit 5) is present in small narrow drainage lines, but supports a distinctive shrub layer of *Melaleuca thymifolia*.

Distribution:

Within Project Boundary: 37.8 ha (Unit 8a – grassy; 15.6 ha); (Unit 8b – shrubby; 22.2 ha)

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP)

Community Conservation Status:

EPBC Act (1999) Status - White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland [Grassy form, except where present in cultivated fields]

TSC Act (1995) Status - White Box - Yellow Box - Blakely's Red Gum Woodland [Grassy form, except where present in cultivated fields]

Species Richness:

Number of plots: 0
Total native species: n/a
Mean species / plot (+/- SD): n/a (+/- n/a)

Vegetation Structure: (not assessed)

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	-	-	-	-	-
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	-	-	-	-	-

Key Diagnostic Species [unsampled]:

Blakely's Redgum Woodland Unsampled					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
-	-	-	-	-	-

Slaty Box Woodland Unit 9

Keith Class: North-west Slopes Dry Sclerophyll Woodlands

NSW VCA: Slaty Box - Grey Gum Shrubby W'dland on Footslopes of the Upper Hunter, Syd Basin

GHV: Grey Box/ Slaty Box shrub/ grass w'dland on sandstone slopes of the upper Hunter & Syd Basin (MU137)

Wollemi NP: Hunter Escarpment Slaty Gum-Box Forest (S_DSF41)

General Description:

Common across most areas on talus footslopes on Permian sediments, and underlying the Triassic Narrabeen series. Dominated by *Eucalyptus dawsonii* and *Callitris endlicheri*, with *Eucalyptus albens* or *Eucalyptus moluccana* occurring occasionally. The mid-layer is distinct, comprising *Acacia ixiophylla, Olearia elliptica* subsp. *elliptica, Dodonaea viscosa* var. *cuneata* and *Cassinia quinquefaria*, over a sparse, often bare, ground layer. One location within the 'Helvetica' property supports dense stands of the regionally significant *Melaleuca lanceolata,* occurring on a lower slope within Slaty Box Woodland. In the data analysis, the single sample plot completed in this vegetation type did not differ significantly from all other vegetation, and grouped within the surrounding Slaty Box Woodland.

Characteristic Features:

- Canopy of Slaty Box, with few other canopy species, occurring on escarpment slopes
- mid-storey typically of Wattle, Hop-Bush, Cassinia and Sticky Daisy-Bush
- sparse ground layer of grasses, herbs and forbs, but often very bare with few species

Known Floristic/ Structural Variations:

Variation within this community is related to the extent of shrub development in the mid-layer. This can vary from very dense growth of *Acacia ixiophylla, Dodonaea viscosa* var. *cuneata* and *Olearia elliptica* subsp. *elliptica*, to very bare with little or no shrubs. Unlike other Box communities, these latter areas are not replaced by a well developed grass/herb layer, but remain open with much leaf mulch and fallen timber. In a few small and localised areas, a dense mid-layer of the regionally significant *Melaleuca lanceolata* is present.

Relationship to Other Communities:

Eucalyptus dawsonii rarely occurs in any other defined community, although where this community adjoins White Box Woodland (Unit 7) or Caley's Ironbark Forest (Unit 15) *Eucalyptus albens* or *Eucalyptus caleyi* subsp. *caleyi* may occur.

Generally, areas dominated by *Eucalyptus dawsonii* demarcate the limits of this community, which is rarely transgressed.

Distribution:

Within Project Boundary: 1144.0 ha

Significant Species:

- Threatened (EPBC Act) *Ozothamnus tesselatus* (Vul); *Tylophora linearis* (End)
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP); *Ozothamnus tesselatus* (Vul); *Tylophora linearis* (Vul)

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - Hunter Valley Footslopes Slaty Gum Woodland

Species Richness:

Number of plots: 10
Total native species: 120
Mean species / plot (+/- SD): 30.4 (+/- 7.65)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	12.0	25.0	31.0	8.10	10
Middle 1	1.0	12.0	28.0	21.21	10
Middle 2	1.0	3.0	18.0	10.61	2
Lowest	0.1	1.0	3.0	1.50	10

Key Diagnostic Species [99% contribution, based on 10 plots]:

Slaty Box Woodland
Average similarity: 36.67

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus dawsonii*	3.70	7.83	3.19	21.35
	Eucalyptus albens	0.70	0.24	0.26	0.66
Small Tree	*Brachychiton populneus subsp. populneus*	0.60	0.70	0.68	1.92
	Callitris endlicheri	0.60	0.58	0.53	1.57
	Acacia doratoxylon	0.20	0.06	0.15	0.18
	Acacia linearifolia	0.30	0.04	0.15	0.12
Shrub	*Dodonaea viscosa subsp. cuneata*	2.10	3.85	2.55	10.49
	Acacia ixiophylla	1.80	2.36	1.02	6.43
	Olearia elliptica subsp. elliptica	1.40	1.98	0.91	5.41
	Goodenia ovata	1.00	0.81	0.49	2.21
	Cassinia quinquefaria	0.60	0.28	0.26	0.77
	Myoporum montanum	0.30	0.17	0.26	0.46
	Senna artemisioides subsp. *zygophylla*	0.40	0.15	0.26	0.42
	Bursaria longisepala	0.30	0.14	0.26	0.39
	Choretrum sp. Coxs Gap	0.30	0.13	0.26	0.36
	Bursaria spinosa	0.30	0.12	0.26	0.31
	Acrotriche rigida	0.20	0.06	0.15	0.16
	Cassinia cunninghamii	0.20	0.06	0.15	0.15
	Acacia sertiformis	0.20	0.04	0.15	0.12

Slaty Box Woodland
Average similarity: 36.67

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
	Persoonia linearis	0.20	0.04	0.15	0.12
Subshrub	*Hibiscus sturtii var. sturtii*	0.90	0.70	0.48	1.92
	Solanum brownii	0.40	0.25	0.38	0.67
	Eremophila debilis	0.40	0.18	0.26	0.50
Mistletoe	*Amyema quandang var. quandang*	0.30	0.16	0.26	0.45
Grass	*Paspalidium gracile*	1.20	1.38	0.86	3.77
	Aristida ramosa	0.90	1.03	0.86	2.82
	Austrostipa scabra subsp. falcata	0.70	0.46	0.36	1.25
	Aristida vagans	0.60	0.28	0.38	0.76
	Rytidosperma fulvum	0.60	0.28	0.26	0.76
	Cleistochloa rigida	0.40	0.17	0.26	0.46
	Rytidosperma tenuius	0.50	0.17	0.25	0.46
	Chloris ventricosa	0.30	0.13	0.26	0.35
	Microlaena stipoides var. stipoides	0.30	0.06	0.15	0.16
	Digitaria ramularis	0.30	0.06	0.15	0.16
	Enteropogon acicularis	0.20	0.05	0.15	0.14
	Chloris truncata	0.20	0.05	0.15	0.14
	Cymbopogon refractus	0.20	0.05	0.15	0.14
	Rytidosperma racemosum var. racemosum	0.30	0.04	0.15	0.12
Graminoid	*Lomandra multiflora subsp. multiflora*	0.40	0.26	0.38	0.71
	Dianella tasmanica	0.30	0.14	0.26	0.37
	Lomandra glauca	0.40	0.13	0.26	0.36
	Lomandra confertifolia subsp. rubiginosa	0.30	0.06	0.15	0.18
Herb/Forb	*Enchylaena tomentosa*	1.60	2.71	1.66	7.40
	Einadia hastata	1.30	1.90	1.12	5.18
	Dichondra repens	1.20	1.40	0.68	3.81
	Calotis lappulacea	0.70	0.69	0.69	1.88
	Sida corrugata	0.70	0.52	0.50	1.41
	Einadia nutans subsp. linifolia	0.70	0.44	0.35	1.20
	Vittadinia sulcata	0.40	0.29	0.38	0.78
	Plantago debilis	0.50	0.17	0.25	0.47
	Desmodium gunnii	0.40	0.13	0.26	0.35
	Desmodium varians	0.30	0.12	0.26	0.32
	Einadia nutans subsp. nutans	0.30	0.06	0.15	0.16
Sedge	*Gahnia aspera*	1.00	1.36	1.21	3.72
	Lepidosperma laterale	0.50	0.15	0.26	0.42
	Cyperus gracilis	0.30	0.12	0.26	0.32
	Lepidosperma gunnii	0.20	0.06	0.15	0.15
Vine	*Marsdenia viridiflora subsp. viridiflora*	0.30	0.16	0.26	0.45
	Tylophora linearis	0.30	0.15	0.26	0.42
	Glycine clandestina	0.30	0.13	0.26	0.35

Coastal Grey Box Woodland — Unit 10

Keith Class: **Western Slopes Grassy Woodlands**

NSW VCA: **no equivalent**

GHV: Grey Box/ Slaty Box shrub/ grass w'dland on sandstone slopes of the upper Hunter & Syd Basin (MU137)

Wollemi NP: **(?) Western Hunter Footslopes Box Woodland (S_GW05)**

General Description:

Prior to clearing for agriculture, woodlands dominated by *Eucalyptus moluccana* appear to have predominated across the lower plains, changing to *Eucalyptus albens* woodlands on the adjacent steeper slopes. Data collected from a single site within the few remaining remnants of *Eucalyptus moluccana* dominated vegetation was significantly different to all other grassy woodland communities. As for those communities, Coastal Grey Box Woodland supports a range of grasses, herbs and forbs, in addition to a scattered shrub layer of *Maireana microphylla*.

Characteristic Features:

- Canopy of Coastal Grey Box, occasionally with scattered White Box or Fuzzy Box where White Box Woodland or Fuzzy Box Woodland adjoins
- scattered mid-storey of various species, but rarely is it well developed
- ground layer of grasses, herbs and forbs

Known Floristic/ Structural Variations:

Most of this community has been cleared from the Bylong Valley, such that only small remnants, paddock trees and fringe areas where it adjoins White Box Woodland (Unit 7) remain. As a consequence, apart from structural differences due to stock grazing history, little variation in this community occurs.

Relationship to Other Communities:

Coastal Grey Box Woodland is structurally similar to other Box-dominated communities. White Box Woodland (Unit 7) is dominated by *Eucalyptus albens* rather than *Eucalyptus moluccana* (the two do not intergrade), and that community occurs higher in the landscape. Fuzzy Box Woodland (Unit 11) supports a canopy of *Eucalyptus conica* and occurs lower in the landscape than Coastal Grey Box Woodland. Yellow Box Woodland (Unit 6) is also similar, but is dominated by *Eucalyptus melliodora* and occurs on elevated basalt soils or sporadically within White Box Woodland (Unit 7).

Distribution:

Within Project Boundary: 108.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Cymbidium canaliculatum* (EP)

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 1
Total native species: 46
Mean species / plot (+/- SD): 46 (+/- n/a)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	14.0	18.0	35.0	-	1
Middle 1	0.8	1.0	10.0	-	1
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	85	-	1

Key Diagnostic Species [Cover abundance values, based on 1 plot]:

Coastal Grey Box Woodland
Average similarity: Less than 2 samples

Habit	Species	C/A	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus moluccana*	4.00	-	-	-
Shrub	*Maireana microphylla*	3.00	-	-	-
Subshrub	*Atriplex semibaccata*	2.00	-	-	-
	Abutilon oxycarpum	1.00	-	-	-
	Eremophila debilis	1.00	-	-	-
Mistletoe	*Amyema miquelii*	1.00	-	-	-
Grass	*Austrostipa scabra subsp. falcata*	3.00	-	-	-
	Austrostipa verticillata	3.00	-	-	-
	Aristida ramosa	2.00	-	-	-
	Rytidosperma racemosum var. racemosum	2.00	-	-	-
	Rytidosperma tenuius	2.00	-	-	-
	Chloris ventricosa	2.00	-	-	-
	Enteropogon acicularis	2.00	-	-	-
	Eragrostis leptostachya	2.00	-	-	-
	Eragrostis sororia	2.00	-	-	-
	Sporobolus creber	2.00	-	-	-
	Aristida vagans	1.00	-	-	-
	Austrostipa scabra subsp. scabra	1.00	-	-	-
	Bothriochloa decipiens var. decipiens	1.00	-	-	-
	Elymus scaber	1.00	-	-	-

Coastal Grey Box Woodland
Average similarity: Less than 2 samples

Habit	Species	C/A	Av.Sim	Sim/SD	Contrib%
	Panicum queenslandicum var. queenslandicum	1.00	-	-	-
Graminoid	*Lomandra confertifolia subsp. pallida*	2.00	-	-	-
	Dianella longifolia var. longifolia	1.00	-	-	-
	Lomandra filiformis subsp. coriacea	1.00	-	-	-
	Lomandra multiflora subsp. multiflora	1.00	-	-	-
Herb/Forb	*Calotis lappulacea*	2.00	-	-	-
	Dichondra repens	2.00	-	-	-
	Dichondra sp. A	2.00	-	-	-
	Einadia hastata	2.00	-	-	-
	Einadia nutans subsp. linifolia	2.00	-	-	-
	Hypericum gramineum	2.00	-	-	-
	Plantago debilis	2.00	-	-	-
	Asperula conferta	1.00	-	-	-
	Chrysocephalum apiculatum	1.00	-	-	-
	Cymbonotus lawsonianus	1.00	-	-	-
	Enchylaena tomentosa	1.00	-	-	-
	Oxalis perennans	1.00	-	-	-
	Vernonia cinerea var. cinerea	1.00	-	-	-
	Vittadinia sulcata	1.00	-	-	-
Sedge	*Carex inversa*	2.00	-	-	-
	Cyperus gracilis	2.00	-	-	-
Vine	*Glycine tabacina*	2.00	-	-	-
	Convolvulus erubescens	1.00	-	-	-
	Desmodium brachypodum	1.00	-	-	-
Fern	*Cheilanthes distans*	1.00	-	-	-
	Cheilanthes sieberi subsp. sieberi	1.00	-	-	-

Fuzzy Box Woodland

Unit 11

Keith Class: **Western Slopes Grassy Woodlands**

NSW VCA: **Fuzzy Box - Inland Grey Box on Alluvial Brown Loam Soils, NSW SWS & Southern BBS**

GHV: **no equivalent**

Wollemi NP: **Western Hunter Flats Fuzzy Box Woodland (S_GW06)**

General Description:

Present in a few locations on gentle rises and slopes, on alluvial or colluvial soils associated with drainage lines on the floor of the main Bylong Valley, but formerly considerably more widespread. Dominated exclusively by *Eucalyptus conica,* over a sparse or non-existent shrub layer, and a diverse ground layer of various grasses, herbs and forbs. One plot sampled within 'Bylong Park' where a long history of heavy grazing has ground layer vegetation supporting the unpalatable *Austrostipa verticillata*, which dominates these areas. Other stands of Fuzzy Box woodland support a higher diversity of herbs, forbs and grasses.

Characteristic Features:

- Canopy of Fuzzy Box, often multi-stemmed regrowth following past clearing
- little or no mid-storey
- diverse ground layer of grasses, herbs and forbs

Known Floristic/ Structural Variations:

Most stands of Fuzzy Box Woodland within the Project Boundary are regrowth from past clearing, or are represented by paddock trees. The distribution of these paddock trees suggests that woodlands dominated by *Eucalyptus conica* were formerly widespread in the Bylong Valley. Consequently, floristic and structural variation is directly related to management history, particularly stock grazing pressure. Heavily grazed remnants support a tall grass layer of the unpalatable *Austrostipa verticillata*, while other stands have a more diverse grass and herb layer.

Relationship to Other Communities:

The dominance of *Eucalyptus conica* in Fuzzy Box Woodland distinguishes it from all other communities. Structurally, it is similar to other Box-dominated communities, but it is perhaps floristically most similar to the adjoining Coastal Grey Box Woodland (Unit 10). Limited data collection opportunities in both communities restrict more in-depth comparisons.

Distribution:

Within Project Boundary: 60.7 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 3
Total native species: 51
Mean species / plot (+/- SD): 27.7 (+/- 11.02)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	10.0	20.0	35.0	0.00	3
Middle 1	1.0	2.0	1.00	0.00	2
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	90.0	5.00	3

Key Diagnostic Species [99% contribution, based on 3 plots]:

Fuzzy Box Woodland
Average similarity: 45.69

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus conica*	4.00	8.25	5.57	18.06
Shrub	*Cassinia quinquefaria*	0.67	0.55	0.58	1.20
Subshrub	*Eremophila debilis*	0.67	0.78	0.58	1.70
Grass	*Aristida ramosa*	3.00	4.67	19.67	10.22
	Chloris ventricosa	2.00	2.61	4.48	5.71
	Austrostipa scabra subsp. falcata	2.00	1.64	0.58	3.59
	Bothriochloa decipiens var. decipiens	1.33	1.09	0.58	2.39
	Aristida vagans	1.00	0.55	0.58	1.20
Graminoid	*Lomandra confertifolia subsp. pallida*	1.33	1.09	0.58	2.39
Herb/Forb	*Dichondra repens*	2.67	4.67	19.67	10.22
	Veronica plebeia	1.67	2.61	4.48	5.71
	Ajuga australis	1.33	1.09	0.58	2.39
	Calotis lappulacea	1.33	1.09	0.58	2.39
	Plantago debilis	1.33	1.09	0.58	2.39
	Vittadinia sulcata	1.33	1.09	0.58	2.39
	Wahlenbergia communis	1.33	1.09	0.58	2.39
	Cotula australis	0.67	0.78	0.58	1.70

Fuzzy Box Woodland
Average similarity: 45.69

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
	Cymbonotus lawsonianus	1.00	0.74	0.58	1.62
	Oxalis perennans	0.67	0.74	0.58	1.62
	Geranium solanderi var. solanderi	1.00	0.55	0.58	1.20
	Stackhousia monogyna	0.67	0.55	0.58	1.20
Sedge	*Carex inversa*	2.00	4.12	5.57	9.03
	Gahnia aspera	0.67	0.55	0.58	1.20
Vine	*Glycine tabacina*	1.67	2.61	4.48	5.71
Fern	*Cheilanthes sieberi subsp. sieberi*	1.33	1.09	0.58	2.39

Calytrix Rockplate Heath — Unit 12

Keith Class: Western Slopes Dry Sclerophyll Forests
NSW VCA: No equivalent
GHV: (?) Dywer's Red Gum/ Fringe Myrtle heathy open woodland on sandstone plateau (MU161)
Wollemi NP: Western Hunter Rockplate Heath-Mallee (S_DSF62)

General Description:

Small, isolated patches of heath vegetation are present on the hard sandstone ridges of Crown land in the west and south-east. Species diversity is low here, with *Calytrix tetragona, Leptospermum parvifolium* and *Micromyrtus sessilis* the dominant species. In places, this community grades imperceptibly into the related Dwyer's Redgum Low Open Forest (Unit 14).

Characteristic Features:

- scattered layer of shrub species over hard, resistant sandstone rock outcropping
- low species diversity, particularly in the ground layer
- often well developed lichen growth on sandstone rockplates

Known Floristic/ Structural Variations:

This community is structurally and floristically very simple, but variation may be expected after the passage of fire. Some areas may also support low trees of *Eucalyptus dwyeri* where cracks in the rock have been exploited by roots.

Relationship to Other Communities:

Floristically similar to Dwyer's Redgum Low Open Forest (Unit 14), with which this community adjoins, but a more consistent low canopy of *Eucalyptus dwyeri*, and a better developed (taller) shrub layer distinguishes the two. Shrubby Regrowth (Unit 13) may also be considered similar, but that community occurs on Permian sediments of the valley floor, rather than on elevated sandstone ridges.

Distribution:

Within Project Boundary: 8.3 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 1
Total native species: 8
Mean species / plot (+/- SD): 8 (+/- n/a)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	1.0	2.0	40.0	-	1
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	1.0	-	1

Key Diagnostic Species [Cover abundance values, based on 1 plot]:

Calytrix Rockplate Heath
Average similarity: Less than 2 samples

Habit	Species	C/A	Av.Sim	Sim/SD	Contrib%
Small Tree	*Acacia crassa subsp. crassa*	1.00	-	-	-
Shrub	*Calytrix tetragona*	3.00	-	-	-
	Leptospermum parvifolium	3.00	-	-	-
	Micromyrtus sessilis	3.00	-	-	-
	Persoonia linearis	1.00	-	-	-
	Phebalium squamulosum subsp. gracile	1.00	-	-	-
Grass	*Aristida ramosa*	1.00	-	-	-
Sedge	*Lepidosperma concavum*	2.00	-	-	-

Shrubby Regrowth Unit 13

Keith Class:	**no equivalent**
NSW VCA:	**no equivalent**
GHV:	**no equivalent**
Wollemi NP:	**Regenerating Vegetation (S_RGS)**

General Description:

Some low hills and gentle undulations that have been previously cleared for grazing and then left to regenerate now support dense shrub stands of species such as *Acacia ixiophylla, Dodonaea viscosa* var. *cuneata* and *Bursaria spinosa*. In most cases, these areas are likely to have formerly supported Slaty Box Woodland. Shrubby Regrowth has not been sampled in any detail during this study.

Characteristic Features:

- mixed composition of regrowing shrub species, such as Wattles, Hop-Bush, Blackthorn and Cassinia
- very few or no emergent eucalypts
- adjacent to or surrounded by cleared grazing lands

Known Floristic/ Structural Variations:

Considerable structural and floristic variation is present in this community, given the range of disturbance histories associated with lands in the Project Boundary. No attempt has been made to document this.

Relationship to Other Communities:

Elements of a range of other vegetation communities are represented in Shrubby Regrowth, and a site-by-site assessment may be required to ascertain most likely parent community. In general, Shrubby Regrowth mostly occurs in areas formerly occupied by White Box Woodland (Unit 7) or Slaty Box Woodland (Unit 9), and shrub species common to both are present.

Distribution:

Within Project Boundary: 200.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - site by site assessment required

Species Richness:

Number of plots: 0
Total native species: n/a
Mean species / plot (+/- SD): n/a (+/- n/a)

Vegetation Structure: (not assessed)

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	-	-	-	-	-
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	-	-	-	-	-

Key Diagnostic Species [unsampled]:

Shrubby Regrowth Unsampled					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
-	-	-	-	-	-

Dwyer's Redgum Low Open Forest — Unit 14

Keith Class: Western Slopes Dry Sclerophyll Forests

NSW VCA: No equivalent

GHV: Dywer's Red Gum/ Fringe Myrtle heathy open woodland on sandstone plateau (MU161)

Wollemi NP: Western Hunter Dwyer's Red Gum-Cypress Woodland (S_DSF61)

General Description:

Typified by a low and widely spaced canopy of *Eucalyptus dwyeri, Callitris endlicheri* and *Acacia doratoxylon*, this community occurs along narrow rocky ridgelines in Crown land in the west and south-east, and also in and around Bylong State Forest. Typical shrub species present include *Leptospermum parvifolium, Philotheca salsolifolia, Leucopogon muticus* and *Calytris tetragona*, with *Cleistochloa rigida* and *Lomandra confertifolia* dominating the ground layer.

Characteristic Features:

- low, scattered canopy of Dwyer's Redgum and/or Black Cypress Pine
- open to dense mid-layer of Tea-Trees, Beard-Heaths and *Philotheca*
- scattered ground layer of Lomandra and *Cleistochloa rigida*

Known Floristic/ Structural Variations:

Structural and floristic variation in this community is related to fire history, with the more rocky areas tending to support lower shrub heights and lower diversity, while dense shrubs are present in more fire-prone habitats.

Relationship to Other Communities:

Several species present in the Calytrix Rockplate Heath (Unit 12) also occur in Dwyer's Redgum Low Open Forest, but that community lacks a consistent low canopy of *Eucalyptus dwyeri,* and/ or *Callitris endlicheri* and *Acacia doratoxylon*. Communities dominated by *Eucalyptus dwyeri* do not occur elsewhere in the Project Boundary.

Distribution:

Within Project Boundary: 69.5 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 5
Total native species: 39
Mean species / plot (+/- SD): 15.8 (+/- 3.56)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	4.0	16.0	17.0	12.05	5
Middle 1	1.0	7.0	54.0	20.43	5
Middle 2	1.0	2.0	70.0	-	1
Lowest	0.1	1.0	2.0	1.00	5

Key Diagnostic Species [99% contribution, based on 5 plots]:

Dwyers Redgum Low Open Forest
Average similarity: 44.16

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus dwyeri*	3.00	9.62	7.37	21.78
Small Tree	*Callitris endlicheri*	1.80	3.43	1.01	7.76
	Acacia doratoxylon	1.20	2.38	1.06	5.40
Shrub	*Leptospermum parvifolium*	2.00	4.71	1.08	10.65
	Philotheca salsolifolia subsp. salsolifolia	1.40	3.78	6.64	8.55
	Leucopogon muticus	1.60	3.66	0.98	8.30
	Calytrix tetragona	2.00	3.01	0.57	6.82
	Cassinia cunninghamii	0.80	1.07	0.62	2.41
	Melichrus erubescens	0.60	1.04	0.62	2.36
	Phebalium squamulosum subsp. gracile	1.20	0.83	0.32	1.89
	Leptospermum trinervium	1.20	0.74	0.32	1.68
	Persoonia linearis	0.40	0.32	0.32	0.73
Grass	*Cleistochloa rigida*	1.80	5.84	3.99	13.23
Graminoid	*Lomandra confertifolia subsp. rubiginosa*	1.00	2.07	1.15	4.68
	Dianella revoluta var. revoluta	0.80	0.95	0.62	2.15
	Lomandra glauca	0.60	0.40	0.32	0.91

Caley's Ironbark Forest Unit 15

Keith Class: **Western Slopes Dry Sclerophyll Forests**

NSW VCA: **no equivalent**

GHV: **Caley's Ironbark/ Red Ironbark/ Currawang shrubby w'dland on sandstone ranges, Syd Basin (MU159)**

Wollemi NP: **Western Hunter Caley's Ironbark Low Forest (S_DSF57)**

General Description:

Caley's Ironbark Forest dominates on the higher sandstone ridges, where it forms a mosaic with Blue-leaf Ironbark / Cypress Forest (Unit 16). This community is clearly dominated by *Eucalyptus caleyi* subsp. *caleyi*, with scattered occurrences of *Callitris endlicheri* and *Acacia linearifolia*. A shrubby mid-layer comprising *Cassinia quinquefaria, Persoonia linearis, Dodonaea viscosa* var. *cuneata* and *Leucopogon muticus* is present over a sparse ground layer. In the east, Caley's Ironbark Forest is the dominant ridgetop forest, but in the west this community forms a complex mosaic with Blue-leaf Ironbark / Cypress Forest (Unit 16).

Characteristic Features:

- Canopy of the characteristic glaucous and drooping Caley's Ironbark
- shrubby mid-storey of a range of species
- sparse ground layer of grasses, herbs and forbs

Known Floristic/ Structural Variations:

Variation within this community is mainly related to fire history, with long unburnt areas supporting denser and taller mid-storeys. Where this community adjoins Blue-Leaf Ironbark / Cypress Forest (Unit 16), scattered individuals of *Eucalyptus nubila* may also occur. Similarly, *Eucalyptus dawsonii* may occur sporadically in areas immediately above Slaty Box Woodland (Unit 9).

Relationship to Other Communities:

The characteristic *Eucalyptus caleyi* subsp. *caleyi* dominates this community, and separates it from all other defined communities within the Project Boundary. Floristically, the Blue-leaf/ Cypress Forest (Unit 16) shares many understorey species with Caley's Ironbark Forest, but that community is dominated by *Eucalyptus nubila*, and *Eucalyptus caleyi* subsp. *caleyi* occurs rarely. In the western parts of the area, these two communities form a complex mosaic and have not been distinguished in associated mapping. Red Ironbark / Cypress Forest (Unit 17) is also similar, but is dominated by *Eucalyptus fibrosa* in the canopy.

Distribution:

Within Project Boundary: 514.0 ha (some additional areas also mapped with Blue-leaf Ironbark / Cypress Forest, Unit 16)

Significant Species:

- Threatened (EPBC Act) *Ozothamnus tesselatus* (Vul)
- Threatened (TSC Act) *Ozothamnus tesselatus* (Vul)

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 6
Total native species: 90
Mean species / plot (+/- SD): 31.8 (+/- 5.67)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	20.0	35.0	3.16	6
Middle 1	1.0	12.0	30.0	28.11	6
Middle 2	1.0	2.0	53.0	15.28	3
Lowest	0.1	1.0	11.0	3.76	6

Key Diagnostic Species [99% contribution, based on 6 plots]:

Caley's Ironbark Forest
Average similarity: 41.07

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus caleyi subsp. caleyi*	4.00	8.04	9.03	19.57
	Eucalyptus dwyeri	0.50	0.16	0.26	0.38
	Eucalyptus punctata	0.50	0.14	0.26	0.33
Small Tree	*Acacia linearifolia*	2.00	2.71	1.30	6.60
	Callitris endlicheri	1.67	2.23	1.16	5.43
	Acacia doratoxylon	0.67	0.47	0.48	1.15
Shrub	*Dodonaea viscosa subsp. cuneata*	2.17	2.57	0.98	6.26
	Persoonia linearis	1.67	1.91	1.08	4.64
	Leucopogon muticus	0.67	0.88	0.79	2.15
	Cassinia quinquefaria	1.33	0.80	0.47	1.95
	Choretrum sp. Coxs Gap	0.83	0.75	0.78	1.82
	Acrotriche rigida	1.00	0.54	0.46	1.31
	Cassinia cunninghamii	1.00	0.46	0.44	1.13
	Boronia anethifolia	0.50	0.43	0.48	1.04
	Melichrus erubescens	0.50	0.41	0.48	1.00
	Bursaria spinosa	0.33	0.11	0.26	0.27
Subshrub	*Pomax umbellata*	1.33	1.79	1.14	4.36

Caley's Ironbark Forest
Average similarity: 41.07

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
	Solanum prinophyllum	0.83	1.31	1.34	3.18
	Astroloma humifusum	0.83	0.80	0.78	1.94
	Goodenia stephensonii	0.83	0.48	0.46	1.18
	Solanum parvifolium subsp. parvifolium	0.67	0.22	0.26	0.54
	Sida trichopoda	0.50	0.13	0.26	0.33
Grass	*Microlaena stipoides var. stipoides*	1.33	1.63	1.24	3.97
	Digitaria ramularis	0.83	0.81	0.78	1.98
	Aristida vagans	0.83	0.80	0.78	1.94
	Digitaria diffusa	0.83	0.53	0.44	1.29
	Rytidosperma fulvum	0.67	0.39	0.48	0.94
	Cleistochloa rigida	0.83	0.27	0.26	0.66
	Paspalidium gracile	0.67	0.27	0.26	0.66
	Paspalidium criniforme	0.83	0.23	0.26	0.55
	Austrostipa scabra subsp. scabra	0.50	0.16	0.26	0.38
	Aristida ramosa	0.33	0.12	0.26	0.30
	Rytidosperma longifolium	0.50	0.12	0.26	0.30
	Austrostipa scabra subsp. falcata	0.50	0.11	0.26	0.27
Graminoid	*Lomandra glauca*	0.67	0.41	0.48	0.99
	Lomandra confertifolia subsp. rubiginosa	0.33	0.16	0.26	0.39
	Lomandra multiflora subsp. multiflora	0.33	0.14	0.26	0.34
Herb/Forb	*Einadia hastata*	0.67	0.24	0.26	0.58
	Dichondra repens	0.67	0.22	0.26	0.54
Sedge	*Gahnia aspera*	1.33	2.12	5.23	5.17
	Lepidosperma laterale	0.67	0.39	0.48	0.95
Vine	*Glycine clandestina*	0.33	0.14	0.26	0.33
	Marsdenia viridiflora subsp. viridiflora	0.33	0.13	0.26	0.32
Fern	*Cheilanthes sieberi subsp. sieberi*	2.00	4.02	9.03	9.78

Blue-leaf Ironbark / Cypress Forest Unit 16

Keith Class: **Western Slopes Dry Sclerophyll Forests**

NSW VCA: **no equivalent**

GHV: **Caley's Ironbark/ Red Ironbark/ Currawang shrubby w'land on sandstone ranges, Sydney Basin (MU159)**

Wollemi NP: **Western Hunter Caley's Ironbark Low Forest (S_DSF57)**

General Description:

Blue-leaf Ironbark / Cypress Forest occurs on higher sandstone ridges, particularly in the west but also present in the south-east. This community forms a mosaic with Caley's Ironbark Forest (Unit 16) on ridges in the west. Blue-leaf Ironbark / Cypress Forest is dominated in the canopy by *Eucalyptus nubila* and *Callitris endlicheri*, with the shrubs *Persoonia linearis, Acacia crassa* subsp. *crassa, Acrotriche rigida* and *Dodonaea viscosa* var. *cuneata* commonly occurring. The sparse ground layer usually includes *Cleistochloa rigida*, *Lepidosperma gunnii* and *Phyllanthus hirtellus.*

Characteristic Features:

- Canopy of Blue-leaf Ironbark and Black Cypress Pine
- sparse mid-storey of Geebung, Wattles and Hop-Bush
- sparse ground layer of grasses and herbs, often quite bare

Known Floristic/ Structural Variations:

Few variations were noted for this community, although as with all elevated landscapes on sandstone geology, fire frequency and intensity dictates species composition. Many areas supporting this community are devoid of ground vegetation, while others show a well-developed mid-layer.

Relationship to Other Communities:

Most closely related to Red Ironbark / Cypress Forest (Unit 17) and Caley's Ironbark Forest (Unit 15), both through a sharing of 'ironbarks' in the canopy and several commonly occurring understorey species. However, *Eucalyptus fibrosa* dominates Unit 17, while *Eucalyptus caleyi* subsp. *caleyi* dominates Unit 15. Blue-leaf Ironbark / Cypress Forest (Unit 16) is dominated by *Eucalyptus nubila*. Some areas of Blue-leaf Ironbark / Cypress Forest have been mapped collectively with Caley's Ironbark Forest in the western Crown land. Bloodwood / Ironbark Forest (Unit 19) also supports *Eucalyptus* *nubila* and *Callitris endlicheri* in the canopy, but the obvious presence of *Corymbia trachyphloia* subsp. *amphistomatica* distinguishes the two.

Distribution:

Within Project Boundary: 911.0 ha (includes some Caley's Ironbark Forest, Unit 15)

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 2
Total native species: 32
Mean species / plot (+/- SD): 23.5 (+/- 2.12)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	14.0	35.0	0.00	2
Middle 1	1.0	3.0	10.0	7.07	2
Middle 2	-	-	-	-	-
Lowest	0.1	1.0	3.0	0.00	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Blue-leaf Ironbark/ Cypress Forest
Average similarity: 60.53

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus nubila*	4.00	10.53	-	17.39
	Eucalyptus dwyeri	1.00	2.63	-	4.35
Small Tree	*Callitris endlicheri*	2.50	5.26	-	8.70
	Acacia crassa subsp. crassa	1.50	2.63	-	4.35
Shrub	*Persoonia linearis*	2.00	5.26	-	8.70
	Acrotriche rigida	1.00	2.63	-	4.35
	Dodonaea viscosa subsp. cuneata	1.50	2.63	-	4.35
	Hovea lanceolata	1.00	2.63	-	4.35
	Leptospermum trinervium	1.50	2.63	-	4.35
	Styphelia triflora	1.50	2.63	-	4.35
Grass	*Cleistochloa rigida*	2.00	5.26	-	8.70
Graminoid	*Lomandra confertifolia subsp. rubiginosa*	1.50	2.63	-	4.35
	Lomandra multiflora subsp. multiflora	1.00	2.63	-	4.35
Herb/Forb	*Phyllanthus hirtellus*	2.00	5.26	-	8.70
Sedge	*Lepidosperma gunnii*	2.00	5.26	-	8.70

Red Ironbark / Cypress Forest

Unit 17

Keith Class: **Western Slopes Dry Sclerophyll Forests**

NSW VCA: **(?) Grey Gum - Narrow-leaved Stringybark - Ironbark Woodland on Ridges, Upper Hunter Valley, Sydney Basin**

GHV: **Caley's Ironbark/ Red Ironbark/ Currawang shrubby woodland on sandstone ranges of the Sydney Basin (MU159)**

Wollemi NP: **Goulburn River Ranges Cypress-Ironbark Forest (S_DSF48)**

General Description:

Small areas of forest dominated by *Eucalyptus fibrosa* and *Callitris endlicheri* are present on the higher grounds in the east of the Project Boundary, in and around Bylong State Forest. *Eucalyptus fibrosa* and *Callitris endlicheri* dominate the canopy here, with *Dodonaea viscosa* var. *cuneata, Choretrum* sp. Coxs Gap, and *Acacia buxifolia* subsp. *buxifolia* typifying the shrub layer. Common ground species include *Aristida ramosa, Pomax umbellata* and *Cheilanthes sieberi* subsp. *sieberi*.

Characteristic Features:

- Red Ironbark dominates the canopy, with some Black Cypress Pine
- mid-storey of Hop-Bush, Wattles and *Choretrum*
- sparse ground layer of grasses and herbs

Known Floristic/ Structural Variations:

No floristic or structural variations have been observed in this community. Fire history will, however, determine composition at any particular location.

Relationship to Other Communities:

Communities dominated by ironbarks may be superficially similar to Red Ironbark / Cypress Forest, however they are dominated by different species. Caley's Ironbark Forest (Unit 15) supports mostly monotypic stands of *Eucalyptus caleyi*, while Blue-leaf Ironbark / Cypress Forest (Unit 16) comprise *Eucalyptus nubila* with *Callitris endlicheri*. Understorey composition is broadly similar across all three communities.

Distribution:

Within Project Boundary: 154.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 3
Total native species: 43
Mean species / plot (+/- SD): 21.3 (+/- 3.06)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	15.0	30.0	0.0	3
Middle 1	1.0	10.0	12.0	15.88	3
Middle 2	1.0	2.0	25.0	25.36	2
Lowest	0.1	1.0	3.00	2.08	3

Key Diagnostic Species [99% contribution, based on 3 plots]:

Red Ironbark/ Cypress Forest
Average similarity: 41.89

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus fibrosa*	4.00	12.29	13.79	29.34
Small Tree	*Callitris endlicheri*	2.67	5.19	1.38	12.39
Shrub	*Dodonaea viscosa subsp. cuneata*	2.00	4.01	2.85	9.58
	Choretrum sp. Coxs Gap	1.00	3.07	13.79	7.33
	Acacia buxifolia subsp. buxifolia	0.67	1.08	0.58	2.57
	Acrotriche rigida	1.00	1.06	0.58	2.53
	Persoonia linearis	0.67	1.06	0.58	2.53
Cycad	*Macrozamia reducta*	0.67	1.06	0.58	2.53
Subshrub	*Pomax umbellata*	1.33	3.07	13.79	7.33
	Astroloma humifusum	0.67	1.06	0.58	2.53
Grass	*Aristida ramosa*	1.33	3.07	13.79	7.33
Graminoid	*Dianella revoluta var. revoluta*	0.67	0.94	0.58	2.24
	Lomandra confertifolia subsp. rubiginosa	0.67	0.94	0.58	2.24
Sedge	*Lepidosperma gunnii*	1.33	1.88	0.58	4.48
Fern	*Cheilanthes sieberi subsp. sieberi*	1.33	2.12	0.58	5.05

Cypress Pine Forest

Unit 18

Keith Class: Western Slopes Grassy Woodlands

NSW VCA: (?) Ironbark - Grey Gum shrubby w'land of sandy gullies, upper Hunter Valley, Syd Basin

GHV: Black Pine/Red Ironbark/Brown Bloodwood shrubby w'land on sandstone ranges, Syd Basin (MU155)

Wollemi NP: Goulburn River Ranges Cypress-Ironbark Forest (S_DSF48)

General Description:

Stands of vegetation characterised by *Callitris gracilis* subsp. *gracilis* and *Callitris endlicheri* occur within a surrounding matrix of Caley's Ironbark Forest (Unit 15) and other ridgeline vegetation. Understorey species typically present include *Prostanthera prunelloides, Leucopogon muticus, Persoonia linearis, Acrotriche divaricata, Astroloma humifusum* and *Choretrum* sp. Coxs Gap, all at low abundances. Small stands of Cypress Pine Forest also occur in some locations on the valley floor, but these represent probable regrowth following past clearing, and have developed after long periods of fire suppression.

Characteristic Features:

- dense canopy of cypress pines, with very occasional emergent eucalypts
- little or no mid-storey
- little or no ground layer

Known Floristic/ Structural Variations:

This community is floristically and structurally very simple, and no variations are recognised. With more detailed sampling, some differences may become apparent between stands occurring in elevated sandstone country and those minor regenerating stands on the Permian valley floor.

Relationship to Other Communities:

The dominance of *Callitris endlicheri* and/or *Callitris gracilis* subsp. *gracilis* characterises this community, a feature unrepeated elsewhere in the Project Boundary. Both species do occur within other communities on the sandstone ranges, but they do not form dense stands with little or no other vegetation present. Cypress Pine Forest is likely to have developed in fire refuge areas, or have escaped wildfire for a long period of time.

Distribution:

Within Project Boundary: 82.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 2
Total native species: 17
Mean species / plot (+/- SD): 9.5 (+/- 3.54)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	10.0	15.0	25.0	21.21	2
Middle 1	3.0	8.0	43.0	53.03	2
Middle 2	1.0	1.5	2.0	-	1
Lowest	0.1	1.0	1.0	0.00	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Cypress Pine Forest
Average similarity: 29.41

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Small Tree	*Callitris gracilis subsp. gracilis*	5.00	23.53	-	80.00
Shrub	*Prostanthera prunelloides*	1.00	5.88	-	20.00

Bloodwood / Ironbark Forest Unit 19

Keith Class: Western Slopes Dry Sclerophyll Forests

NSW VCA: no equivalent

GHV: (?) Red Ironbark / Brown Bloodwood/ Black Pine heathy open forest on sandstone ranges of the Sydney Basin

Wollemi NP: Western Hunter Caley's Ironbark Low Forest (S_DSF57)

General Description:

Present only in the north-east of the Project Boundary, this community is typified by *Corymbia trachyphloia* subsp. *amphistomatica* in the canopy, where it occurs with *Callitris endlicheri* and *Eucalyptus nubila*. Common understorey species include the shrubs *Gompholobium aspalathoides, Grevillea mucronulata, Hibbertia circumdans* and *Leucopogon muticus*. *Lomandra glauca, Platysace ericoides* and *Aristida ramosa* are common ground layer species.

Characteristic Features:

- Canopy of White Bloodwood, Cypress Pine and Blue-leaf Ironbark
- sparse mid-storey of Leafy Wedge Pea, *Grevillea*, *Hibbertia* and Beard-Heath
- sparse ground layer of grasses and Lomandras

Known Floristic/ Structural Variations:

No floristic or structural variations have been observed in this community.

Relationship to Other Communities:

The presence of *Callitris endlicheri* and *Eucalyptus nubila* links this community to Blue-leaf Ironbark / Cypress Forest (Unit 16). However, *Corymbia trachyphloia* subsp. *amphistomatica*, characteristic in Bloodwood / Ironbark Forest, does not occur in Unit 16, or any other delineated community.

Distribution:

Within Project Boundary: 28.7 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 2
Total native species: 39
Mean species / plot (+/- SD): 29.5 (+/- 7.78)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	8.0	15.0	28.0	3.54	2
Middle 1	2.0	8.0	13.0	3.54	2
Middle 2	1.0	2.0	8.0	3.54	2
Lowest	0.1	1.0	4.0	1.41	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Bloodwood/ Ironbark Forest
Average similarity: 67.35

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Corymbia trachyphloia subsp. amphistomatica*	4.00	8.16	-	12.12
	Eucalyptus nubila	2.50	4.08	-	6.06
Small Tree	*Callitris endlicheri*	3.00	6.12	-	9.09
Shrub	*Gompholobium aspalathoides*	2.00	4.08	-	6.06
	Grevillea mucronulata	2.00	4.08	-	6.06
	Hibbertia circumdans	2.00	4.08	-	6.06
	Leucopogon muticus	2.00	4.08	-	6.06
	Persoonia linearis	2.00	4.08	-	6.06
	Acrotriche rigida	1.00	2.04	-	3.03
	Allocasuarina gymnanthera	1.50	2.04	-	3.03
	Brachyloma daphnoides subsp. daphnoides	1.00	2.04	-	3.03
	Leptospermum trinervium	1.50	2.04	-	3.03
	Melichrus erubescens	1.50	2.04	-	3.03
Subshrub	*Platysace ericoides*	2.00	4.08	-	6.06
	Dampiera adpressa	1.50	2.04	-	3.03
Grass	*Aristida ramosa*	1.00	2.04	-	3.03
	Cleistochloa rigida	1.00	2.04	-	3.03
Graminoid	*Lomandra glauca*	2.00	4.08	-	6.06
	Dianella revoluta var. revoluta	1.50	2.04	-	3.03
Sedge	*Lepidosperma laterale*	1.50	2.04	-	3.03

Scribbly Gum / Grey Gum Forest

Unit 20

Keith Class: Southern Tablelands Dry Sclerophyll Forests

NSW VCA: No equivalent

GHV: No equivalent

Wollemi NP: Growee Ranges Grey Gum-Scribbly Gum Forest (S_DSF49)

General Description:

Two restricted locations of Scribbly Gum / Grey Gum Forest are present within the Project Boundary; one in the north-east and the other in the south-east. Both support the characteristic *Eucalyptus rossii* in the canopy, along with *Eucalyptus punctata* and *Callitris endlicheri*. The shrub species *Leucopogon muticus, Monotoca scoparia, Persoonia linearis* and *Boronia anethifolia* are common, while *Lomandra confertifolia* subsp. *rubiginosa, Goodenia hederacea* subsp*. hederacea* and *Lomandra glauca* typify the ground layer.

Characteristic Features:

- canopy dominated by Inland Scribbly Gum and Grey Gum
- diverse mid-storey of Beard-Heaths, Peas, Boronias and Wattles
- ground layer of grasses, herbs and forbs, with Grasstree prominent

Known Floristic/ Structural Variations:

Only two areas of this community were detected within the Project Boundary, hence observations on variation are limited. Both supported well developed mid-storey vegetation, and canopy composition was consistent. The location in Bylong State Forest occurred on sandy soils in a gully infill area below a small sandstone ridgeline, while the stand in the south-east was on an upper drainage line immediately below a sandstone ridge.

Relationship to Other Communities:

Eucalyptus rossii occurs in no other defined community within the Project Boundary, and allows ready identification of this type. *Eucalyptus punctata* is also an important component of Exposed Grey Gum/ Stringybark Forest (Unit 21) and Exposed Grey Gum / Stringybark Forest (Unit 22), but *Eucalyptus agglomerata* co-dominates these communities, and a suite of different understorey species also separates them. These two communities occur in different habitats, Unit 21 only ever present on exposed ridges and slopes within the higher sandstone hills, while Unit 22 occurs in well protected gullies in this same rugged landscape.

Distribution:

Within Project Boundary: 5.8 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 2
Total native species: 52
Mean species / plot (+/- SD): 32.5 (+/- 0.71)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	15.0	20.0	35.0	0.00	2
Middle 1	1.0	5.0	18.0	10.61	2
Middle 2	1.0	2.0	25.0	-	1
Lowest	0.1	1.0	25.0	14.14	2

Key Diagnostic Species [99% contribution, based on 2 plots]:

Scribbly Gum/ Grey Gum Forest
Average similarity: 38.89

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib%
Tree	*Eucalyptus rossii*	3.50	5.56	-	14.29
	Eucalyptus punctata	2.50	3.70	-	9.52
Small Tree	*Callitris endlicheri*	2.00	3.70	-	9.52
Shrub	*Leucopogon muticus*	2.50	3.70	-	9.52
	Monotoca scoparia	2.00	3.70	-	9.52
	Persoonia linearis	2.00	3.70	-	9.52
	Boronia anethifolia	1.00	1.85	-	4.76
	Styphelia triflora	1.00	1.85	-	4.76
Cycad	*Macrozamia reducta*	1.50	1.85	-	4.76
Subshrub	*Platysace ericoides*	2.00	1.85	-	4.76
Graminoid	*Lomandra confertifolia subsp. rubiginosa*	2.00	3.70	-	9.52
	Lomandra glauca	1.50	1.85	-	4.76
Herb/Forb	*Goodenia hederacea subsp. hederacea*	1.50	1.85	-	4.76

Exposed Grey Gum / Stringybark Forest Unit 21

Keith Class: Southern Tablelands Dry Sclerophyll Forests
NSW VCA: No equivalent
GHV: No equivalent
Wollemi NP: (?) Growee Ranges Grey Gum Sheltered Forest (S_DSF50)

General Description:

The higher rocky landscapes in the south-east and west are typified by *Eucalyptus agglomerata* and *Eucalyptus punctata*. Shrub species here include *Dodonaea viscosa* var. *cuneata, Phebalium squamulosum* subsp. *gracile, Leucopogon muticus* and *Hovea lanceolata*, with *Cleistochloa rigida, Lomandra confertifolia* subsp. *rubiginosa* and *Lomandra glauca* common ground species. This community is closely related to Sheltered Grey Gum / Stringybark Forest (Unit 22), and both share many species. Both are mapped collectively.

Characteristic Features:

- canopy dominated by Blue-leaf Stringybark and Grey Gum
- sparse mid-storey with grasses and Lomandras common
- most often occurs on steep slopes exposed to the western sky

Known Floristic/ Structural Variations:

Variation in this community relates to fire history, although areas inspected during field investigations supported a consistent suite of plant species. The localised dominance of *Eucalyptus punctata* and *Eucalyptus agglomerata* varies from site to site.

Relationship to Other Communities:

This community is closely related to Sheltered Grey Gum / Stringybark Forest (Unit 22), and the two have been shown collectively in the associated mapping. Both are dominated by *Eucalyptus agglomerata* and *Eucalyptus punctata* in the canopy, but differ markedly in understorey composition. In Exposed Grey Gum / Stringybark Forest, (Unit 21) shrubs such as *Dodonaea viscosa* var. *cuneata, Phebalium squamulosum* subsp. *gracile, Leucopogon muticus* and *Hovea lanceolata* predominate, while in Unit 22 *Bursaria spinosa, Acacia linearifolia, Goodenia stephensonii* and *Macrozamia reducta* co-occur with *Dodonaea viscosa* var. *cuneata*.

Distribution:

Within Project Boundary: 296.0 ha (mapped with Sheltered Grey Gum/ Stringybark Forest)

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 5
Total native species: 58
Mean species / plot (+/- SD): 23.0 (+/- 7.78)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	10.0	24.0	35.0	0.00	5
Middle 1	1.0	3.0	27.0	16.01	5
Middle 2	1.0	1.5	2.0	-	1
Lowest	0.1	1.0	21.0	24.85	5

Key Diagnostic Species [99% contribution, based on 5 plots]:

Exposed Grey Gum/ Stringybark Forest
Average similarity: 45.73

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus agglomerata*	3.40	8.05	6.43	17.61
	Eucalyptus punctata	3.00	7.83	6.02	17.13
Small Tree	*Acacia linearifolia*	0.60	0.90	0.61	1.98
Shrub	*Dodonaea viscosa subsp. cuneata*	1.60	3.52	1.95	7.69
	Phebalium squamulosum subsp. gracile	2.00	2.83	0.89	6.18
	Leucopogon muticus	1.40	2.82	4.49	6.17
	Hovea lanceolata	1.40	2.39	1.01	5.22
	Persoonia linearis	1.00	1.38	1.16	3.03
	Philotheca salsolifolia subsp. salsolifolia	1.40	1.37	0.62	2.99
	Calytrix tetragona	1.20	1.00	0.61	2.18
	Leptospermum trinervium	1.20	0.89	0.59	1.96
	Bursaria spinosa	0.60	0.25	0.32	0.55
	Podolobium ilicifolium	0.60	0.23	0.32	0.50
	Logania albiflora	0.40	0.22	0.32	0.48
	Acacia obtusata	0.40	0.21	0.32	0.46
	Allocasuarina gymnanthera	0.40	0.21	0.32	0.46
	Boronia angustisepala	0.60	0.21	0.32	0.46
	Gompholobium aspalathoides	0.60	0.21	0.32	0.46
	Hakea dactyloides	0.40	0.21	0.32	0.46

Exposed Grey Gum/ Stringybark Forest
Average similarity: 45.73

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Grass	*Cleistochloa rigida*	2.40	4.21	2.59	9.21
	Joycea pallida	1.00	0.45	0.32	0.99
Graminoid	*Lomandra confertifolia subsp. rubiginosa*	1.80	3.52	1.95	7.69
	Lomandra glauca	1.20	1.37	0.62	2.99
	Dianella revoluta var. revoluta	0.40	0.29	0.32	0.64
Herb/Forb	*Phyllanthus hirtellus*	0.40	0.22	0.32	0.48
Sedge	*Lepidosperma gunnii*	0.80	0.51	0.32	1.11

Sheltered Grey Gum/ Stringybark Forest Unit 22

Keith Class:	**Southern Tablelands Dry Sclerophyll Forests**
NSW VCA:	**No equivalent**
GHV:	**No equivalent**
Wollemi NP:	**Growee Ranges Grey Gum Sheltered Forest (S_DSF50)**

General Description:

Sheltered drainage lines and slopes within the higher rocky landscapes in the west and south-east support moist forest of *Eucalyptus punctata* and *Eucalyptus agglomerata*. Understorey development tends to be better structured than the related Exposed Grey Gum / Stringybark Forest (Unit 21), with *Bursaria spinosa, Acacia linearifolia, Goodenia stephensonii, Macrozamia reducta* and *Dodonaea viscosa* var. *cuneata* dominating, and *Lomandra confertifolia* subsp. *rubiginosa, Microlaena stipoides* var. *stipoides* and *Cheilanthes sieberi* subsp. *sieberi* in the ground layer.

Characteristic Features:

- canopy dominated by Blue-leaf Stringybark and Grey Gum
- moderately dense mid-storey of Blackthorn, Wattles and Hop-Bush
- occurs in sheltered gullies, often below sandstone outcropping

Known Floristic/ Structural Variations:

No floristic or structural variations have been observed in this community. One location in Crown land in the south-east supports a small stand of *Eucalyptus sideroxylon*, a species otherwise absent from the entire Project Boundary.

Relationship to Other Communities:

Closely related to Exposed Grey Gum / Stringybark Forest (Unit 21) through a sharing of *Eucalyptus agglomerata* and *Eucalyptus punctata* in the canopy. Both have been shown collectively in the associated mapping. Differences in understorey composition separate the two, with Unit 21 characterised by shrubs such as *Dodonaea viscosa* var. *cuneata, Phebalium squamulosum* subsp. *gracile, Leucopogon muticus* and *Hovea lanceolata*, while *Bursaria spinosa, Acacia linearifolia, Goodenia stephensonii* and *Macrozamia reducta* co-occur with *Dodonaea viscosa* var. *cuneata* in Sheltered Grey Gum / Stringybark Forest (Unit 22).

Distribution:

Within Project Boundary: 296.0 ha (mapped with Exposed Grey Gum/ Stringybark Forest)

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Pomaderris queenslandica* (End)

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness:

Number of plots: 3
Total native species: 66
Mean species / plot (+/- SD): 31.7 (+/- 6.66)

Vegetation Structure:

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	18.0	30.0	32.0	2.89	3
Middle 1	1.0	12.0	46.0	33.28	3
Middle 2	1.0	4.0	35.0	7.07	2
Lowest	0.1	1.0	8.0	5.77	3

Key Diagnostic Species [99% contribution, based on 3 plots]:

Sheltered Grey Gum/ Stringybark Forest
Average similarity: 45.03

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Tree	*Eucalyptus punctata*	3.33	5.25	8.40	11.66
	Eucalyptus agglomerata	2.00	1.98	0.58	4.40
	Eucalyptus nubila	1.33	1.32	0.58	2.93
Small Tree	*Acacia linearifolia*	2.33	3.50	8.40	7.77
Shrub	*Bursaria spinosa*	4.33	7.00	8.40	15.55
	Dodonaea viscosa subsp. cuneata	2.00	2.31	2.43	5.14
	Persoonia linearis	2.00	2.31	2.43	5.14
	Acrotriche rigida	1.33	1.13	0.58	2.51
	Cassinia cunninghamii	0.67	0.66	0.58	1.47
	Gonocarpus longifolius	1.00	0.66	0.58	1.47
	Prostanthera prunelloides	0.67	0.66	0.58	1.47
	Melichrus erubescens	0.67	0.56	0.58	1.25
Cycad	*Macrozamia reducta*	2.00	3.50	8.40	7.77
Subshrub	*Goodenia stephensonii*	2.33	3.50	8.40	7.77
	Solanum prinophyllum	0.67	0.52	0.58	1.17
Grass	*Microlaena stipoides var. stipoides*	2.00	3.50	8.40	7.77
Graminoid	*Lomandra confertifolia subsp. rubiginosa*	2.33	3.50	8.40	7.77

Sheltered Grey Gum/ Stringybark Forest **Average similarity: 45.03**					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
Herb/Forb	*Dichondra repens*	1.33	1.05	0.58	2.33
	Opercularia hispida	1.33	1.05	0.58	2.33
Fern	*Cheilanthes sieberi subsp. sieberi*	1.33	1.05	0.58	2.33

Derived Native Grassland Unit DNG

Keith Class: **No equivalent**
NSW VCA: **No equivalent**
GHV: **No equivalent**
Wollemi NP: **No equivalent**

General Description:

Derived Native Grasslands throughout the Bylong Valley formerly supported open grassy woodlands of various forms. Following clearing for agriculture, a suite of native grasses, herbs and forbs remain while canopy species may be sparse or very widely spaced. Under current legislation, some components of Derived Native Grasslands conform to some TECs, particularly the National *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* and the NSW *White Box - Yellow Box - Blakely's Red Gum Woodland*. Reconstruction of the pre-settlement distribution of the Bylong Valley in map form (see Section 4.1.1) allows these derived grasslands to be attributed to either Yellow Box Woodland (Unit 6), White Box Woodland (Unit 7), Blakely's Redgum Woodland (Unit 8), Slaty Box Woodland (Unit 9), Coastal Grey Box Woodland (Unit 10), Fuzzy Box Woodland (Unit 11), or a riparian complex comprising River Oak/ Apple Riparian Forest (Unit 3) and Blakely's Redgum/ Apple Riparian Forest (Unit 4). Only derived grasslands attributable to Units 6, 7a, and 8a conform to listed TECs.

Characteristic Features:

- canopy very sparse or absent
- mid-storey very sparse or absent
- ground layer comprised of a variety of native grasses, herbs and forbs, and including weed species

Known Floristic/ Structural Variations:

A full assessment of all grasslands has not been undertaken; however, species composition and height of swards are related to history and intensity of stock grazing, and recent stocking rates. Some areas may also have been subject to additional seed broadcasting of native species, such as *Bothriochloa* spp. Based on the extent of native plant species recorded in plot and rapid assessment data, DNG have been divided up into 3 classes:

- *DNG_TSC&EPBC* - grasslands supporting >12 native non-grass species, plus at least 1 'important' species;
- *DNG_TSC* - grasslands supporting <12 native non-grass species (low diversity native grasslands)

- *DNG_unassessed* - potential TSC or EPBC grasslands, but lacking in detailed assessment

Relationship to Other Communities:

Derived Native Grasslands are structurally different to all other defined communities, with the exception of Cultivated Lands (Unit CC). In general, that community supports a greater diversity of weed ('cropping') species, and less native grasses and herbs.

Distribution:

Within Project Boundary: 625.0 ha (DNG_TSC&EPBC); 671.0 ha (DNG_TSC); 1676.0 ha (DNG_unassessed)

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *Diuris tricolor* (Vul)

Community Conservation Status:

EPBC Act (1999) Status - *some components included in* White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

TSC Act (1995) Status - *some components included in* White Box - Yellow Box - Blakely's Red Gum Woodland.

Species Richness:

Number of plots: 43
Total native species: 90
Mean species / plot (+/- SD): 90 (+/- n/a)

Vegetation Structure: (not assessed)

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	-	-	-	-	-
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	-	-	-	-	-

Key Diagnostic Species [species presence, based on 43 plots]:

Derived Native Grasslands
Average similarity: not assessed (species presence only)

Habit	Species	Av.Abund	Av.Sim	Sim/SD	Contrib %
Shrub	*Bursaria spinosa*	-	-	-	-
	Maireana microphylla	-	-	-	-
	Sclerolaena muricata	-	-	-	-
Subshrub	*Atriplex semibaccata*	-	-	-	-
	Boerhavia dominii	-	-	-	-
	Dysphania pumilio	-	-	-	-
	Pimelea curviflora var. sericea	-	-	-	-
	Polygonum aviculare	-	-	-	-
	Sida cunninghamii	-	-	-	-
	Sida filiformis	-	-	-	-
	Sida spinosa	-	-	-	-
	Sida trichopoda	-	-	-	-
	Solanum campanulatum	-	-	-	-
	Solanum cinereum	-	-	-	-
	Solanum prinophyllum	-	-	-	-

Derived Native Grasslands Average similarity: not assessed (species presence only)					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
Grass	*Aristida ramosa*	-	-	-	-
	Austrostipa scabra	-	-	-	-
	Austrostipa verticillata	-	-	-	-
	Bothriochloa decipiens var. decipiens	-	-	-	-
	Chloris truncata	-	-	-	-
	Chloris ventricosa	-	-	-	-
	Cynodon dactylon	-	-	-	-
	Dichanthium sericeum	-	-	-	-
	Digitaria brownii	-	-	-	-
	Digitaria coenicola	-	-	-	-
	Enneapogon gracilis	-	-	-	-
	Enteropogon acicularis	-	-	-	-
	Eragrostis brownii	-	-	-	-
	Eragrostis leptostachya	-	-	-	-
	Eriochloa pseudoacrotricha	-	-	-	-
	Panicum effusum	-	-	-	-
	Paspalidium criniforme	-	-	-	-
	Paspalidium distans	-	-	-	-
	Paspalidium jubiflorum	-	-	-	-
	Rytidosperma setaceum	-	-	-	-
	Rytidosperma tenuius	-	-	-	-
	Sporobolus creber	-	-	-	-
	Sporobolus elongatus	-	-	-	-
	Tragus australianus	-	-	-	-
	Urochloa piligera	-	-	-	-
Herb/Forb	*Asperula conferta*	-	-	-	-
	Calotis lappulacea	-	-	-	-
	Chamaesyce drummondii	-	-	-	-
	Chrysocephalum apiculatum	-	-	-	-
	Crassula sp	-	-	-	-
	Cullen tenax	-	-	-	-
	Cymbonotus lawsonianus	-	-	-	-
	Daucus glochidiatus	-	-	-	-
	Desmodium varians	-	-	-	-
	Dichondra repens	-	-	-	-
	Dichondra sp A	-	-	-	-
	Einadia hastata	-	-	-	-
	Einadia nutans subsp. linifolia	-	-	-	-
	Einadia nutans subsp. nutans	-	-	-	-
	Einadia trigonos	-	-	-	-
	Enchylaena tomentosa	-	-	-	-
	Erodium crinitum	-	-	-	-
	Euchiton sphaericus	-	-	-	-
	Galium propinquum	-	-	-	-
	Geranium solanderi var. solanderi	-	-	-	-
	Linum marginale	-	-	-	-
	Maireana enchylaenoides	-	-	-	-
	Mentha satureioides	-	-	-	-
	Oxalis chnoodes	-	-	-	-
	Oxalis perennans	-	-	-	-
	Phyllanthus virgatus	-	-	-	-
	Plantago debilis	-	-	-	-
	Rumex brownii	-	-	-	-
	Sida corrugata	-	-	-	-

Derived Native Grasslands Average similarity: not assessed (species presence only)					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
	Stackhousia monogyna	-	-	-	-
	Tricoryne elatior	-	-	-	-
	Vittadinia cuneata var. cuneata	-	-	-	-
	Vittadinia muelleri	-	-	-	-
	Wahlenbergia communis	-	-	-	-
	Wahlenbergia gracilis	-	-	-	-
	Wahlenbergia luteola	-	-	-	-
	Zornia dyctiocarpa var. dyctiocarpa	-	-	-	-
Sedge	*Carex inversa*	-	-	-	-
	Cyperus fulvus	-	-	-	-
	Cyperus gracilis	-	-	-	-
	Fimbristylis dichotoma	-	-	-	-
	Gahnia aspera	-	-	-	-
	Juncus usitatus	-	-	-	-
Vine	*Convolvulus erubescens*	-	-	-	-
	Glycine canescens	-	-	-	-
	Glycine clandestina	-	-	-	-
	Glycine tabacina	-	-	-	-
	Tribulus micrococcus	-	-	-	-
Fern	*Cheilanthes sieberi subsp. sieberi*	-	-	-	-

Cultivated Lands

Unit CC

Keith Class: No equivalent

NSW VCA: No equivalent

GHV: No equivalent

Wollemi NP: No equivalent

General Description:

The bulk of the alluvial flats along the Bylong River and Lee Creek have been heavily cleared and cropped over several decades. These areas currently support few native species, although in some areas scattered canopy trees remain (eg: *Angophora floribunda, Eucalyptus blakelyi, Eucalyptus camaldulensis*). Depending on the season and the extent of grassland management, cultivated lands can support high densities of weed species (such as the paddock of *Bidens pilosa* shown in the image above). Other areas now support extensive paddocks of improved pastures, such as Kikuyu Grass (*Pennisetum clandestinum*).

Characteristic Features:

- canopy very sparse or absent
- mid-storey absent
- ground layer comprised of weed species or crops, with little or no native species

Known Floristic/ Structural Variations:

Variation in this unit is extensive, but has not been assessed in any detail. Management history drives all variation present.

Relationship to Other Communities:

Structurally, Cultivated Lands resemble Derived Native Grasslands (Unit DNG), but that community generally supports a higher diversity of native species and fewer weeds.

Distribution:

Within Project Boundary: 2019.0 ha

Significant Species:

- Threatened (EPBC Act) *none recorded*
- Threatened (TSC Act) *none recorded*

Community Conservation Status:

EPBC Act (1999) Status - not currently listed.

TSC Act (1995) Status - not currently listed.

Species Richness: (not assessed)

Number of plots: 0
Total native species: n/a
Mean species / plot (+/- SD): n/a (+/- n/a)

Vegetation Structure: (not assessed)

Stratum	Min height (m)	Max height (m)	Mean cover (%)	Sdev	n
Emergent	-	-	-	-	-
Tallest	-	-	-	-	-
Middle 1	-	-	-	-	-
Middle 2	-	-	-	-	-
Lowest	-	-	-	-	-

Key Diagnostic Species [unsampled]:

Cultivated Lands Unsampled					
Habit	**Species**	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib %**
-	-	-	-	-	-

7.4 Appendix – Agricultural Consultants Report

Scott Barnett & Associates

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Agricultural Business Management & Production Consultants

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Pasture improvement history on land previously owned by the Wallings' family earmarked to be used for PEA's for Bylong Coal Project.

Scott Barnett of Scott Barnett & Associates met with and interviewed Mr Andrew Wallings on 13 June 2014. Mr Andrew Wallings provided the following information by reference to records and from memory.

North West OEA

- This area under went a pasture improvement program approximately 20 years ago.
- This included the use of fertilisers and the introduction improved (exotic) species of pasture plants being primarily:
    - Various varieties of subterranean clover (*Trifolium subterranean*);
    - Various varieties of white clover (*Trifolium repens*);
    - Various varieties of Phalaris (*Phalaris spp.*);
    - Lucerne (*Medicago sativa*); and
    - Other temperate grasses which Mr Wallings was unsure of which species.
- Since then the area has been fertilised every 2 - 3 years with Single Super (Superphosphate – 0%N:8.8%P:0%K:11%S) with every third application including molybdenum (0.02 -0.04%).
- In 2012 a high analysis fertiliser (14.3%N:12.0%P:0%K:10.5%S) was applied at a rate of 90kg per ha.

South East OEA

- The last pasture improvement program on this area had perennial winter pasture species rough sown into native and naturalised pasture in 2007.
- Perennial pastures used were:
    - Various varieties of subterranean clover (*Trifolium subterranean*);
    - Various varieties of white clover (*Trifolium repens*);
    - Various varieties of Phalaris (*Phalaris spp.*); and
    - Lucerne (*Medicago sativa*).
- The fertiliser program as is above for the North West OEA including the use of the high analysis fertiliser in 2012.

Scott Barnett & Associates

Scott Barnett
Principal
16 June 2015

Appendix C

Flora Species List

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Acanthaceae		*Adiantum aethiopicum*	Common Maidenhair		
Acanthaceae		*Adiantum hispidulum*	Rough Maidenhair		
Adiantaceae		*Brunoniella australis*	Blue Trumpet		
Adiantaceae		*Cheilanthes distans*	Bristly Cloak Fern		
Adiantaceae		*Cheilanthes sieberi subsp. sieberi*	Poison Rock Fern		
Adiantaceae		*Rostellularia adscendens*			
Aizoaceae		*Tetragonia tetragonioides*	New Zealand Spinach		
Amaranthaceae		*Alternanthera denticulata*	Lesser Joyweed		
Amaranthaceae	*	*Alternanthera pungens*	Khaki Weed		
Amaranthaceae		*Alternanthera sp. A*			
Amaranthaceae	*	*Amaranthus retroflexus*	Redroot Amaranth		
Amaranthaceae	*	*Gomphrena celosioides*	Gomphrena Weed		
Amaranthaceae		*Ptilotus polystachyus var. polystachyus*	Long Tails		
Anacardiaceae	*	*Schinus areira*	Pepper Tree		
Anthericaceae		*Arthropodium sp.*			
Anthericaceae		*Arthropodium minus*	Small Vanilla Lily		
Anthericaceae		*Arthropodium sp. B*			
Anthericaceae		*Laxmannia gracilis*	Slender Wire Lily		
Anthericaceae		*Tricoryne elatior*	Yellow Autumn-lily		
Apiaceae	*	*Cyclospermum leptophyllum*	Slender Celery		
Apiaceae		*Daucus glochidiatus*	Native Carrot		
Apiaceae		*Hydrocotyle laxiflora*	Stinking Pennywort		
Apiaceae		*Hydrocotyle tripartita*	Pennywort		
Apiaceae		*Platysace ericoides*			
Apiaceae		*Platysace lanceolata*	Shrubby Platysace		
Apocynaceae	*	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush		
Apocynaceae		*Marsdenia rostrata*	Milk Vine		
Apocynaceae		*Marsdenia viridiflora subsp. viridiflora*	Native Pear		
Apocynaceae		*Parsonsia eucalyptophylla*	Gargaloo		
Apocynaceae		*Parsonsia lanceolata*	Rough Silkpod		
Apocynaceae		*Parsonsia straminea*	Common Silkpod		
Apocynaceae		*Parsonsia velutina (?)*			
Apocynaceae		*Tylophora linearis*		V	E
Araliaceae		*Astrotricha longifolia f. 'Inland'*			
Asphodelaceae		*Bulbine bulbosa*	Bulbine Lily		
Aspleniaceae		*Asplenium flabellifolium*	Necklace Fern		
Asteraceae	*	*Arctotheca calendula*	Capeweed		
Asteraceae	*	*Aster subulatus*	Wild Aster		
Asteraceae	*	*Bidens pilosa*	Cobblers Pegs		
Asteraceae	*	*Bidens subalternans*	Greater Beggar's Ticks		
Asteraceae		*Brachyscome ?sieberi*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Asteraceae		*Brachyscome dentata*			
Asteraceae		*Calocephalus citreus*	Lemon Beauty-heads		
Asteraceae		*Calotis lappulacea*	Yellow Burr-daisy		
Asteraceae	*	*Carthamus lanatus*	Saffron Thistle		
Asteraceae		*Cassinia arcuata*	Sifton Bush		
Asteraceae		*Cassinia cunninghamii*			
Asteraceae		*Cassinia decipiens*			
Asteraceae		*Cassinia quinquefaria*			
Asteraceae		*Cassinia uncata*	Sticky Cassinia		
Asteraceae	*	*Centaurea calcitrapa*	Star Thistle		
Asteraceae		*Chrysocephalum apiculatum*	Common Everlasting		
Asteraceae		*Chrysocephalum semipapposum*	Clustered Everlasting		
Asteraceae	*	*Cineraria lyratiformis*	African Marigold		
Asteraceae	*	*Cirsium vulgare*	Spear Thistle		
Asteraceae	*	*Conyza bonariensis*	Flaxleaf Fleabane		
Asteraceae	*	*Conyza spp.*	A Fleabane		
Asteraceae	*	*Conyza sumatrensis*	Tall Fleabane		
Asteraceae		*Cotula australis*	Common Cotula		
Asteraceae		*Cymbonotus lawsonianus*	Bears-ear		
Asteraceae		*Euchiton involucratus*	Star Cudweed		
Asteraceae		*Euchiton sphaericus*	Star Cudweed		
Asteraceae		*Glossocardia bidens*	Cobbler's Tack		
Asteraceae	*	*Hypochaeris glabra*	Smooth Catsear		
Asteraceae	*	*Hypochaeris microcephala*	White Flatweed		
Asteraceae	*	*Hypochaeris radicata*	Catsear		
Asteraceae		*Lagenophora stipitata*	Common Lagenophora		
Asteraceae		*Leiocarpa panaetioides*	Wooly Buttons		
Asteraceae		*Leptorhynchos squamatus subsp. squamatus*			
Asteraceae		*Minuria leptophylla*			
Asteraceae		*Olearia elliptica*	Sticky Daisy-bush		
Asteraceae		*Olearia elliptica subsp. elliptica*			
Asteraceae		*Ozothamnus diosmifolius*	White Dogwood		
Asteraceae		*Ozothamnus tesselatus*		V	V
Asteraceae		*Podolepis jaceoides*	Showy Copper-wire Daisy		
Asteraceae	*	*Schkuhria pinnata var. abrotanoides*			
Asteraceae	*	*Senecio madagascariensis*	Fireweed		
Asteraceae		*Senecio pinnatifolius var. pinnatifolius*			
Asteraceae		*Senecio prenanthoides*			
Asteraceae		*Senecio quadridentatus*	Cotton Fireweed		
Asteraceae		*Sigesbeckia australiensis*			
Asteraceae		*Sigesbeckia orientalis subsp. orientalis*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Asteraceae	*	*Silybum marianum*	Variegated Thistle		
Asteraceae		*Solenogyne bellioides*			
Asteraceae	*	*Soliva sessilis*	Bindyi		
Asteraceae	*	*Sonchus asper*	Prickly Sowthistle		
Asteraceae	*	*Sonchus oleraceus*	Common Sowthistle		
Asteraceae	*	*Tagetes minuta*	Stinking Roger		
Asteraceae	*	*Taraxacum officinale*	Dandelion		
Asteraceae		*Triptilodiscus pygmaeus*	Common Sunray		
Asteraceae		*Vernonia cinerea var. cinerea*			
Asteraceae		*Vittadinia cuneata*	Fuzzweed		
Asteraceae		*Vittadinia cuneata var. cuneata*	A Fuzzweed		
Asteraceae		*Vittadinia muelleri*			
Asteraceae		*Vittadinia sulcata*			
Asteraceae	*	*Xanthium spinosum*	Bathurst Burr		
Asteraceae	*	*Xanthium spp.*			
Asteraceae		*Xerochrysum bracteatum*	Golden Everlasting		
Asteraceae		*Xerochrysum viscosum*	Sticky Everlasting		
Bignoniaceae		*Pandorea pandorana*	Wonga Wonga Vine		
Boraginaceae		*Cynoglossum australe*			
Boraginaceae	*	*Echium plantagineum*	Paterson's Curse		
Boraginaceae		*Halgania brachyrhyncha*			
Brassicaceae	*	*Capsella bursa-pastoris*	Shepherd's Purse		
Brassicaceae	*	*Hirschfeldia incana*	Hairy Brassica		
Brassicaceae	*	*Lepidium africanum*			
Brassicaceae	*	*Raphanus raphanistrum*	Wild Radish		
Brassicaceae	*	*Sisymbrium officinale*	Hedge Mustard		
Cactaceae	*	*Opuntia stricta*	Common Prickly Pear		
Cactaceae	*	*Opuntia aurantiaca*	Tiger Pear		
Campanulaceae		*Wahlenbergia communis*	Tufted Bluebell		
Campanulaceae		*Wahlenbergia gracilis*	Sprawling Bluebell		
Campanulaceae		*Wahlenbergia luteola*			
Capparaceae		*Capparis mitchellii*	Wild Orange		
Caryophyllaceae	*	*Cerastium glomeratum*	Mouse-ear Chickweed		
Caryophyllaceae	*	*Arenaria serpyllifolia*	Thyme-leaved Sandwort		
Caryophyllaceae	*	*Paronychia brasiliana*	Chilean Whitlow Wort		
Caryophyllaceae	*	*Petrorhagia nanteuilii*	Proliferous Pink		
Caryophyllaceae	*	*Petrorhagia sp.*			
Caryophyllaceae	*	*Spergularia rubra*	Sandspurry		
Caryophyllaceae		*Stellaria flaccida*			
Caryophyllaceae	*	*Stellaria media*	Common Chickweed		
Caryophyllaceae		*Stellaria pungens*	Prickly Starwort		
Casuarinaceae		*Casuarina cunninghamiana subsp. cunninghamiana*	River Oak		
Casuarinaceae		*Allocasuarina gymnanthera*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Casuarinaceae		*Allocasuarina luehmannii*	Bulloak		
Casuarinaceae		*Allocasuarina rigida subsp. rigida*			
Chenopodiaceae		*Atriplex semibaccata*	Creeping Saltbush		
Chenopodiaceae	*	*Chenopodium album*	Fat Hen		
Chenopodiaceae		*Chenopodium desertorum subsp. microphyllum*			
Chenopodiaceae		*Chenopodium pumilio*	Small Crumbweed		
Chenopodiaceae		*Dysphania pumilio*			
Chenopodiaceae		*Einadia hastata*	Berry Saltbush		
Chenopodiaceae		*Einadia nutans*	Climbing Saltbush		
Chenopodiaceae		*Einadia nutans subsp. linifolia*	Climbing Saltbush		
Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush		
Chenopodiaceae		*Einadia polygonoides*			
Chenopodiaceae		*Einadia trigonos*	Fishweed		
Chenopodiaceae		*Enchylaena tomentosa*	Ruby Saltbush		
Chenopodiaceae		*Maireana enchylaenoides*	Wingless Bluebush		
Chenopodiaceae		*Maireana microphylla*	Small-leaf Bluebush		
Chenopodiaceae		*Salsola australis*			
Chenopodiaceae		*Sclerolaena muricata*	Black Rolypoly		
Chenopodiaceae		*Sclerolaena muricata var. semiglabra*	Black Rolypoly		
Clusiaceae		*Hypericum gramineum*	Small St John's Wort		
Clusiaceae	*	*Hypericum perforatum*	St. Johns Wort		
Commelinaceae		*Commelina cyanea*	Native Wandering Jew		
Convolvulaceae	*	*Convolvulus arvensis*	Field Bindweed		
Convolvulaceae		*Convolvulus erubescens*	Blushing Bindweed		
Convolvulaceae		*Cuscuta australis*	Australian Dodder		
Convolvulaceae		*Dichondra repens*	Kidney Weed		
Convolvulaceae		*Dichondra sp. A*	Kidney Weed		
Convolvulaceae		*Evolvulus alsinoides var. decumbens*			
Crassulaceae		*Crassula sieberiana*	Australian Stonecrop		
Cupressaceae		*Callitris endlicheri*	Black Cypress Pine		
Cupressaceae		*Callitris gracilis subsp. gracilis*			
Cyperaceae		*Carex inversa*	Knob Sedge		
Cyperaceae	*	*Cyperus brevifolius*	Mullumbimby Couch		
Cyperaceae		*Cyperus fulvus*	Sticky Sedge		
Cyperaceae		*Cyperus gracilis*	Slender Flat-sedge		
Cyperaceae		*Fimbristylis dichotoma*	Common Fringe-sedge		
Cyperaceae		*Gahnia aspera*	Rough Saw-sedge		
Cyperaceae		*Lepidosperma concavum*			
Cyperaceae		*Lepidosperma gunnii*			
Cyperaceae		*Lepidosperma laterale*			
Cyperaceae		*Lepidosperma urophorum*			
Cyperaceae		*Schoenus ericetorum*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Cyperaceae		*Scleria mackaviensis*			
Dilleniaceae		*Hibbertia linearis*			
Dilleniaceae		*Hibbertia circumdans*			
Dilleniaceae		*Hibbertia pedunculata*			
Dilleniaceae		*Hibbertia pilifera*			
Dilleniaceae		*Hibbertia riparia*			
Dilleniaceae		*Hibbertia sp. aff. acicularis*			
Ericaceae		*Acrotriche rigida*			
Ericaceae		*Brachyloma daphnoides*	Daphne Heath		
Ericaceae		*Epacris coriacea*			
Ericaceae		*Leucopogon muticus*	Blunt Beard-heath		
Ericaceae		*Melichrus erubescens*	Ruby Urn Heath		
Ericaceae		*Melichrus urceolatus*	Urn Heath		
Ericaceae		*Monotoca scoparia*			
Ericaceae		*Styphelia triflora*	Pink Five-Corners		
Ericaceae (Styphelioideae)		*Astroloma humifusum*	Native Cranberry		
Euphorbiaceae		*Chamaesyce drummondii*	Caustic Weed		
Euphorbiaceae		*Amperea xiphoclada var. xiphoclada*			
Euphorbiaceae		*Bertya linearifolia*			
Eupomatiaceae		*Eupomatia laurina*	Bolwarra		
Fabaceae (Caesalpinioideae)		*Senna artemisioides subsp. zygophylla*			
Fabaceae (Caesalpinioideae)		*Senna coronilloides*			
Fabaceae (Faboideae)		*Bossiaea prostrata*			
Fabaceae (Faboideae)		*Chorizema parviflorum*	Eastern Flame Pea		
Fabaceae (Faboideae)		*Cullen tenax*	Tough Scurf-pea		
Fabaceae (Faboideae)		*Daviesia genistifolia*	Broom Bitter Pea		
Fabaceae (Faboideae)		*Daviesia ulicifolia subsp. ulicifolia*			
Fabaceae (Faboideae)		*Desmodium brachypodum*	Large Tick-trefoil		
Fabaceae (Faboideae)		*Desmodium gunnii*	Slender Tick-trefoil		
Fabaceae (Faboideae)		*Desmodium varians*	Slender Tick-trefoil		
Fabaceae (Faboideae)		*Dillwynia acicularis*			
Fabaceae (Faboideae)		*Dillwynia rudis*			
Fabaceae (Faboideae)		*Glycine canescens*	Silky Glycine		
Fabaceae (Faboideae)		*Glycine clandestina*			
Fabaceae (Faboideae)		*Glycine microphylla*	Small-leaf Glycine		
Fabaceae (Faboideae)		*Glycine tabacina*			
Fabaceae (Faboideae)		*Gompholobium aspalathoides*			
Fabaceae (Faboideae)		*Hovea apiculata*			
Fabaceae (Faboideae)		*Hovea lanceolata*			
Fabaceae (Faboideae)		*Indigofera adesmiifolia*	Tick Indigo		
Fabaceae (Faboideae)		*Indigofera australis*	Australian Indigo		
Fabaceae (Faboideae)		*Lotus australis*	Australian Trefoil		
Fabaceae (Faboideae)	*	*Medicago lupulina*	Black Medic		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Fabaceae (Faboideae)	*	*Medicago minima*	Woolly Burr Medic		
Fabaceae (Faboideae)	*	*Medicago polymorpha*	Burr Medic		
Fabaceae (Faboideae)	*	*Medicago sativa*	Lucerne		
Fabaceae (Faboideae)	*	*Medicago truncatula*	Barrel Medic		
Fabaceae (Faboideae)		*Oxylobium pulteneae*	Wiry Shaggy Pea		
Fabaceae (Faboideae)		*Podolobium ilicifolium*	Prickly Shaggy Pea		
Fabaceae (Faboideae)		*Pultenaea ferruginea*			
Fabaceae (Faboideae)		*Rhynchosia minima*			
Fabaceae (Faboideae)		*Swainsona galegifolia*	Smooth Darling Pea		
Fabaceae (Faboideae)		*Templetonia stenophylla*	Leafy Templetonia		
Fabaceae (Faboideae)	*	*Trifolium arvense*	Haresfoot Clover		
Fabaceae (Faboideae)	*	*Trifolium repens*	White Clover		
Fabaceae (Faboideae)		*Zornia dyctiocarpa var. dyctiocarpa*	Zornia		
Fabaceae (Mimosoideae)		*Acacia amblygona*	Fan Wattle		
Fabaceae (Mimosoideae)		*Acacia brownii*	Heath Wattle		
Fabaceae (Mimosoideae)		*Acacia buxifolia subsp. buxifolia*	Box-leaved Wattle		
Fabaceae (Mimosoideae)		*Acacia crassa subsp. crassa*			
Fabaceae (Mimosoideae)		*Acacia deanei subsp. deanei*	Deane's Wattle		
Fabaceae (Mimosoideae)		*Acacia decora*	Western Silver Wattle		
Fabaceae (Mimosoideae)		*Acacia doratoxylon*	Currawang		
Fabaceae (Mimosoideae)		*Acacia hakeoides*	Hakea Wattle		
Fabaceae (Mimosoideae)	*	*Acacia harpophylla*	Brigalow		
Fabaceae (Mimosoideae)		*Acacia implexa*	Hickory Wattle		
Fabaceae (Mimosoideae)		*Acacia ixiophylla*	Sticky Leaved Wattle		
Fabaceae (Mimosoideae)		*Acacia linearifolia*	Narrow-leaved Wattle		
Fabaceae (Mimosoideae)		*Acacia lunata*	Lunate-leaved Acacia		
Fabaceae (Mimosoideae)		*Acacia obtusata*	Blunt-leaf Wattle		
Fabaceae (Mimosoideae)	*	*Acacia pendula*	Weeping Myall	EP	
Fabaceae (Mimosoideae)		*Acacia penninervis var. penninervis*	Mountain Hickory		
Fabaceae (Mimosoideae)		*Acacia piligera*			
Fabaceae (Mimosoideae)		*Acacia salicina*	Cooba		
Fabaceae (Mimosoideae)		*Acacia sertiformis*			
Fabaceae (Mimosoideae)		*Acacia subulata*	Awl-leaved Wattle		
Fabaceae (Mimosoideae)		*Acacia ulicifolia*	Prickly Moses		
Gentianaceae	*	*Centaurium erythraea*	Common Centaury		
Geraniaceae	*	*Erodium cicutarium*	Common Storksbill		
Geraniaceae		*Erodium crinitum*	Blue Storksbill		
Geraniaceae		*Geranium solanderi*	Native Geranium		
Geraniaceae		*Geranium solanderi var. solanderi*			
Goodeniaceae		*Dampiera adpressa*	Purple Beauty Bush		
Goodeniaceae		*Dampiera purpurea*			
Goodeniaceae		*Goodenia bellidifolia*			
Goodeniaceae		*Goodenia hederacea*	Forest Goodenia		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Goodeniaceae		*Goodenia hederacea subsp. hederacea*			
Goodeniaceae		*Goodenia ovata*	Hop Goodenia		
Goodeniaceae		*Goodenia pinnatifida*	Scrambles Eggs		
Goodeniaceae		*Goodenia sp.*			
Goodeniaceae		*Goodenia stephensonii*			
Goodeniaceae		*Scaevola albida var. pallida*			
Goodeniaceae		*Scaevola humilis*			
Haloragaceae		*Gonocarpus elatus*	A Raspwort		
Haloragaceae		*Gonocarpus longifolius*			
Haloragaceae		*Haloragis heterophylla*	Variable Raspwort		
Iridaceae	*	*Romulea rosea var. australis*	Onion Grass		
Juncaceae		*Juncus usitatus*			
Juncaceae		*Juncus spp.*	A Rush		
Lamiaceae		*Ajuga australis*	Austral Bugle		
Lamiaceae	*	*Lamium amplexicaule*	Henbit		
Lamiaceae	*	*Marrubium vulgare*	White Horehound		
Lamiaceae		*Mentha satureioides*	Native Pennyroyal		
Lamiaceae		*Prostanthera howelliae*	Prostanthera		
Lamiaceae		*Prostanthera ovalifolia*			
Lamiaceae		*Prostanthera prunelloides*			
Lamiaceae	*	*Salvia reflexa*	Mintweed		
Lamiaceae	*	*Salvia verbenaca*	Vervain		
Lamiaceae		*Scutellaria humilis*	Dwarf Skullcap		
Lamiaceae		*Spartothamnella juncea*	Bead Bush		
Lamiaceae	*	*Stachys arvensis*	Stagger Weed		
Lamiaceae		*Teucrium corymbosum*	Forest Germander		
Lauraceae		*Cassytha glabella f. glabella*			
Linaceae		*Linum marginale*	Native Flax		
Lindsaeaceae		*Lindsaea linearis*	Screw Fern		
Lobeliaceae		*Pratia purpurascens*	Whiteroot		
Loganiaceae		*Logania albiflora*			
Lomandraceae		*Lomandra confertifolia subsp. pallida*	Matrush		
Lomandraceae		*Lomandra confertifolia subsp. rubiginosa*			
Lomandraceae		*Lomandra filiformis subsp. coriacea*	Wattle Matt-rush		
Lomandraceae		*Lomandra filiformis subsp. filiformis*	Wattle Mat-rush		
Lomandraceae		*Lomandra glauca*	Pale Mat-rush		
Lomandraceae		*Lomandra longifolia*	Spiny-headed Mat-rush		
Lomandraceae		*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush		
Loranthaceae		*Amyema miquelii*	Box Mistletoe		
Loranthaceae		*Amyema quandang var. quandang*	Grey Mistletoe		
Luzuriagaceae		*Eustrephus latifolius*	Wombat Berry		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Malvaceae		*Abutilon oxycarpum*	Straggly Lantern-bush		
Malvaceae		*Brachychiton populneus*	Kurrajong		
Malvaceae		*Hibiscus sturtii var. sturtii*	Hill Hibiscus		
Malvaceae	*	*Malva parviflora*	Small-flowered Mallow		
Malvaceae	*	*Malvastrum americanum*	Spiked Malvastrum		
Malvaceae	*	*Modiola caroliniana*	Red-flowered Mallow		
Malvaceae	*	*Sida acuta*	Spinyhead Sida		
Malvaceae		*Sida corrugata*	Corrugated Sida		
Malvaceae		*Sida cunninghamii*	Ridged Sida		
Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne		
Malvaceae	*	*Sida spinosa*			
Malvaceae		*Sida trichopoda*	High Sida		
Meliaceae		*Melia azedarach*	White Cedar		
Moraceae		*Ficus rubiginosa*	Port Jackson Fig		
Myoporaceae		*Myoporum platycarpum*	Sugarwood		
Myoporaceae		*Myoporum montanum*	Western Boobialla		
Myoporaceae		*Myoporum platycarpum subsp. platycarpum*			
Myrsinaceae	*	*Anagallis arvensis*	Scarlet Pimpernel		
Myrtaceae		*Angophora floribunda*	Rough-barked Apple		
Myrtaceae		*Backhousia myrtifolia*	Grey Myrtle		
Myrtaceae		*Calytrix tetragona*	Common Fringe-myrtle		
Myrtaceae		*Corymbia trachyphloia subsp. amphistomatica*	White Bloodwood		
Myrtaceae		*Eucalyptus agglomerata*	Blue-leaved Stringybark		
Myrtaceae		*Eucalyptus albens*	White Box		
Myrtaceae		*Eucalyptus blakelyi*	Blakely's Red Gum		
Myrtaceae		*Eucalyptus caleyi subsp. caleyi*	Caley's Ironbark		
Myrtaceae		*Eucalyptus camaldulensis*	River Red Gum	EP	
Myrtaceae		*Eucalyptus cannonii (outside of Study Area)*	Capertee Stringybark	V	
Myrtaceae		*Eucalyptus conica*	Fuzzy Box		
Myrtaceae		*Eucalyptus crebra*	Narrow-leaved Ironbark		
Myrtaceae		*Eucalyptus dawsonii*	Slaty Gum		
Myrtaceae		*Eucalyptus dwyeri*	Dwyer's Red Gum		
Myrtaceae		*Eucalyptus eugenioides*	Thin-leaf Stringybark		
Myrtaceae		*Eucalyptus fibrosa*	Red Ironbark		
Myrtaceae		*Eucalyptus melliodora*	Yellow Box		
Myrtaceae		*Eucalyptus microcarpa*	Western Grey Box		
Myrtaceae		*Eucalyptus moluccana*	Grey Box		
Myrtaceae		*Eucalyptus nubila*	Blue-leaved Ironbark		
Myrtaceae		*Eucalyptus punctata*	Grey Gum		
Myrtaceae		*Eucalyptus rossii*	Inland Scribbly Gum		
Myrtaceae		*Eucalyptus sideroxylon*	Mugga Ironbark		
Myrtaceae		*Eucalyptus sparsifolia*	Narrow-leaf Stringybark		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Myrtaceae		*Harmogia densifolia*			
Myrtaceae		*Homoranthus cernuus*			
Myrtaceae		*Leptospermum arachnoides*			
Myrtaceae		*Leptospermum parvifolium*			
Myrtaceae		*Leptospermum sphaerocarpum*			
Myrtaceae		*Leptospermum trinervium*	Slender Tea-tree		
Myrtaceae		*Melaleuca lanceolata*	Moonah		
Myrtaceae		*Melaleuca thymifolia*	Thyme Honey-myrtle		
Myrtaceae		*Melaleuca uncinata*	Broombush		
Myrtaceae		*Micromyrtus sessilis*			
Myrtaceae		*Sannantha cunninghamii*			
Myrtaceae		*Sannantha sp. aff. cunninghamii*			
Nyctaginaceae		*Boerhavia dominii*	Tarvine		
Oleaceae	*	*Ligustrum lucidum*	Large-leaved Privet		
Oleaceae	*	*Ligustrum sinense*	Small-leaved Privet		
Oleaceae		*Notelaea microcarpa*	Native Olive		
Oleaceae		*Notelaea microcarpa var. microcarpa*			
Oleaceae	*	*Olea europaea subsp. cuspidata*	African Olive		
Ophioglossaceae		*Ophioglossum lusitanicum*	Adders Tongue		
Orchidaceae		*Acianthus fornicatus*	Pixie Caps		
Orchidaceae		*Acianthus spp.*	Mosquito Orchid		
Orchidaceae		*Caladenia catenata*	White Caladenia		
Orchidaceae		*Caladenia curtisepala*			
Orchidaceae		*Calochilus sp.*			
Orchidaceae		*Cyanicula caerulea*	Blue Caladenia		
Orchidaceae		*Cymbidium canaliculatum*	Tiger Orchid	EP	
Orchidaceae		*Dendrobium speciosum*	Rock Lily		
Orchidaceae		*Diuris aurea*			
Orchidaceae		*Diuris sulphurea*	Tiger Orchid		
Orchidaceae		*Diuris tricolor*	Pine Donkey Orchid	V	
Orchidaceae		*Glossodia ?major*			
Orchidaceae		*Microtis unifolia*	Common Onion Orchid		
Orchidaceae		*Pterostylis bicolor*	Black-tip Greenhood		
Orchidaceae		*Pterostylis concinna*	Trim Greenhood		
Orchidaceae		*Pterostylis mutica*	Midget Greenhood		
Orchidaceae		*Pterostylis sp.*			
Orchidaceae		*Thelymitra spp.*			
Orchidaceae		*Unknown*			
Oxalidaceae		*Oxalis chnoodes*			
Oxalidaceae		*Oxalis perennans*			
Phormiaceae		*Dianella longifolia*			
Phormiaceae		*Dianella longifolia var. longifolia*	A Blue Flax Lily		
Phormiaceae		*Dianella prunina*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Phormiaceae		*Dianella revoluta*	Blueberry Lily		
Phormiaceae		*Dianella revoluta var. revoluta*	A Blue Flax Lily		
Phormiaceae		*Dianella tasmanica*			
Phormiaceae		*Stypandra glauca*	Nodding Blue Lily		
Phyllanthaceae		*Breynia oblongifolia*	Coffee Bush		
Phyllanthaceae		*Phyllanthus hirtellus*	Thyme Spurge		
Phyllanthaceae		*Phyllanthus occidentalis*			
Phyllanthaceae		*Phyllanthus virgatus*	Wiry Spurge		
Phyllanthaceae		*Poranthera corymbosa*			
Pittosporaceae		*Bursaria spinosa*	Blackthorn		
Pittosporaceae		*Billardiera scandens*	Hairy Apple Berry		
Pittosporaceae		*Bursaria longisepala*			
Pittosporaceae		*Rhytidosporum procumbens*			
Plantaginaceae		*Plantago debilis*			
Plantaginaceae		*Plantago gaudichaudii*	Narrow Plantain		
Plantaginaceae	*	*Plantago lanceolata*	Lamb's Tongues		
Plantaginaceae		*Veronica plebeia*	Trailing Speedwell		
Poaceae		*Aristida ramosa*	Purple Wiregrass		
Poaceae		*Agrostis spp.*			
Poaceae		*Aristida calycina var. calycina*			
Poaceae		*Aristida personata*			
Poaceae		*Aristida vagans*	Threeawn Speargrass		
Poaceae		*Arundinella nepalensis*	Reedgrass		
Poaceae		*Austrostipa aristiglumis*	Plains Grass		
Poaceae		*Austrostipa pubescens*			
Poaceae		*Austrostipa scabra*	Speargrass		
Poaceae		*Austrostipa scabra subsp. falcata*	Rough Speargrass		
Poaceae		*Austrostipa scabra subsp. scabra*	Speargrass		
Poaceae		*Austrostipa verticillata*	Slender Bamboo Grass		
Poaceae	*	*Axonopus fissifolius*	Narrow-leaf Carpet Grass		
Poaceae		*Bothriochloa biloba*			
Poaceae		*Bothriochloa decipiens var. decipiens*	Red Grass		
Poaceae	*	*Bromus catharticus*	Praire Grass		
Poaceae	*	*Bromus sp.*			
Poaceae		*Cenchrus caliculatus*	Hillside Burrgrass		
Poaceae	*	*Chloris gayana*	Rhodes Grass		
Poaceae		*Chloris truncata*	Windmill Grass		
Poaceae		*Chloris ventricosa*	Tall Chloris		
Poaceae		*Cleistochloa rigida*			
Poaceae		*Cymbopogon refractus*	Barbed Wire Grass		
Poaceae		*Cynodon dactylon*	Couch		
Poaceae	*	*Cynodon incompletus*			
Poaceae		*Dactyloctenium radulans*	Button Grass		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Poaceae		*Dichanthium sericeum*	Queensland Bluegrass		
Poaceae		*Dichanthium sericeum subsp. sericeum*	Queensland Bluegrass		
Poaceae		*Dichelachne micrantha*	Shorthair Plumegrass		
Poaceae		*Digitaria brownii*	Cotton Panic Grass		
Poaceae		*Digitaria coenicola*	Finger Panic Grass		
Poaceae		*Digitaria diffusa*	Open Summer-grass		
Poaceae		*Digitaria parviflora*	Small-flower Finger Grass		
Poaceae		*Digitaria ramularis*	Finger Panic Grass		
Poaceae		*Echinochloa colona*	Awnless Barnyard Grass		
Poaceae	*	*Echinochloa esculenta*	Japanese Millet		
Poaceae		*Echinopogon caespitosus var. caespitosus*	Tufted Hedgehog Grass		
Poaceae	*	*Eleusine tristachya*	Goose Grass		
Poaceae		*Elymus scaber var. scaber*	Common Wheatgrass		
Poaceae		*Enneapogon gracilis*	Slender Bottle-washers		
Poaceae		*Enneapogon truncatus*	Bottlewashers		
Poaceae		*Enteropogon acicularis*			
Poaceae		*Entolasia stricta*	Wiry Panic		
Poaceae		*Eragrostis alveiformis*			
Poaceae		*Eragrostis brownii*	Brown's Lovegrass		
Poaceae	*	*Eragrostis cilianensis*	Stinkgrass		
Poaceae	*	*Eragrostis curvula*	African Lovegrass		
Poaceae		*Eragrostis elongata*	Clustered Lovegrass		
Poaceae		*Eragrostis leptostachya*	Paddock Lovegrass		
Poaceae		*Eragrostis sororia*			
Poaceae		*Eriochloa pseudoacrotricha*	Early Spring Grass		
Poaceae	*	*Lolium perenne*	Perennial Ryegrass		
Poaceae		*Microlaena stipoides*	Weeping Grass		
Poaceae		*Microlaena stipoides var. stipoides*	Weeping Grass		
Poaceae		*Notodanthonia longifolia*	Long-leaf Wallaby Grass		
Poaceae		*Panicum effusum*	Hairy Panic		
Poaceae		*Panicum queenslandicum var. queenslandicum*	Yabila Grass		
Poaceae		*Panicum simile*	Two-colour Panic		
Poaceae		*Paspalidium aversum*			
Poaceae		*Paspalidium criniforme*			
Poaceae		*Paspalidium distans*			
Poaceae		*Paspalidium gracile*	Slender Panic		
Poaceae		*Paspalidium jubiflorum*	Warrego Grass		
Poaceae	*	*Paspalum dilatatum*	Paspalum		
Poaceae	*	*Pennisetum clandestinum*	Kikuyu Grass		
Poaceae	*	*Phalaris minor*	Lesser Canary Grass		
Poaceae		*Phragmites australis*	Common Reed		
Poaceae		*Poa affinis*			

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Poaceae		*Poa labillardierei var. labillardierei*	Tussock		
Poaceae		*Rytidosperma caespitosa*	Ringed Wallaby Grass		
Poaceae		*Rytidosperma fulva*	Wallaby Grass		
Poaceae		*Rytidosperma indutum*			
Poaceae		*Rytidosperma monticola*			
Poaceae		*Rytidosperma pallidum*	Silvertop Wallaby Grass		
Poaceae		*Rytidosperma racemosum*			
Poaceae		*Rytidosperma racemosum var. racemosum*			
Poaceae		*Rytidosperma setaceum*	Smallflower Wallaby Grass		
Poaceae		*Rytidosperma sp.*			
Poaceae		*Rytidosperma spp.*	A Wallaby Grass		
Poaceae		*Rytidosperma tenuius*			
Poaceae	*	*Setaria parviflora*			
Poaceae		*Sporobolus caroli*	Fairy Grass		
Poaceae		*Sporobolus creber*	Slender Rat's Tail Grass		
Poaceae		*Sporobolus elongatus*	Slender Rat's Tail Grass		
Poaceae		*Themeda australis*	Kangaroo Grass		
Poaceae		*Tragus australianus*	Small Burrgrass		
Poaceae	*	*Urochloa panicoides*	Urochloa Grass		
Poaceae		*Urochloa piligera*	Hairy Armgrass		
Polygonaceae	*	*Polygonum aviculare*	Wireweed		
Polygonaceae		*Polygala japonica*	Dwarf Milkwort		
Polygonaceae		*Rumex brownii*	Swamp Dock		
Polygonaceae	*	*Rumex conglomeratus*	Clustered Dock		
Portulacaceae		*Calandrinia eremaea*	Small Purslane		
Portulacaceae	*	*Portulaca oleracea*	Pigweed		
Proteaceae		*Grevillea mucronulata*			
Proteaceae	*	*Grevillea robusta*	Silky Oak		
Proteaceae		*Grevillea sp. aff. patulifolia/sericea*			
Proteaceae		*Grevillea triternata*			
Proteaceae		*Hakea dactyloides*	Finger Hakea		
Proteaceae		*Hakea tephrosperma*	Hooked Needlewood		
Proteaceae		*Isopogon dawsonii*	Nepean Conebush		
Proteaceae		*Persoonia linearis*	Narrow-leaved Geebung		
Ranunculaceae		*Clematis glycinoides var. glycinoides*	Headache Vine		
Rhamnaceae		*Pomaderris intermedia*			
Rhamnaceae		*Pomaderris prunifolia*	Plum-leaf Pomaderris		
Rhamnaceae		*Pomaderris queenslandica*	Scant Pomaderris	E	
Rosaceae	*	*Rosa rubiginosa*	Sweet Briar		
Rosaceae		*Acaena echinata*			
Rosaceae		*Acaena echinata var. subglabricalyx*			
Rosaceae		*Acaena ovina*	Acaena		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Rosaceae	*	*Rubus fruticosus sp. agg.*	Blackberry complex		
Rosaceae		*Rubus parvifolius*	Native Raspberry		
Rubiaceae		*Asperula conferta*	Common Woodruff		
Rubiaceae		*Galium propinquum*	Maori Bedstraw		
Rubiaceae		*Opercularia diphylla*	Stinkweed		
Rubiaceae		*Opercularia hispida*	Hairy Stinkweed		
Rubiaceae		*Pomax umbellata*	Pomax		
Rubiaceae		*Psydrax odorata*	Shiny-leaved Canthium		
Rutaceae		*Boronia anethifolia*			
Rutaceae		*Boronia angustisepala*			
Rutaceae		*Correa reflexa var. reflexa*	Native Fuschia		
Rutaceae		*Eriostemon australasius*			
Rutaceae		*Phebalium glandulosum subsp. angustifolium*			
Rutaceae		*Phebalium squamulosum subsp. gracile*			
Rutaceae		*Philotheca myoporoides subsp. myoporoides*			
Rutaceae		*Philotheca salsolifolia subsp. salsolifolia*			
Rutaceae		*Zieria cytisoides*	Downy Zieria		
Rutaceae		*Zieria pilosa*	Pilose-leafed Zieria		
Salicaceae	*	*Salix sp.*			
Salicaceae	*	*Salix babylonica*	Weeping Willow		
Santalaceae		*Choretrum sp. Coxs Gap*			
Santalaceae		*Exocarpos strictus*	Dwarf Cherry		
Santalaceae		*Santalum lanceolatum*	Northern Sandalwood		
Sapindaceae		*Alectryon oleifolius*	Western Rosewood		
Sapindaceae		*Dodonaea sinuolata subsp. sinuolata*			
Sapindaceae		*Dodonaea viscosa subsp. cuneata*	Wedge-leaf Hop-bush		
Sapindaceae		*Alectryon subcinereus*	Wild Quince		
Sapindaceae		*Dodonaea multijuga*			
Sapindaceae		*Dodonaea triangularis*	Hopbush		
Sapindaceae		*Dodonaea truncatiales*	Angular Hop-bush		
Scrophulariaceae		*Eremophila debilis*	Winter Apple		
Scrophulariaceae		*Gratiola pedunculata*			
Scrophulariaceae	*	*Verbascum virgatum*	Twiggy Mullein		
Solanaceae	*	*Datura stramonium*	Common Thornapple		
Solanaceae	*	*Lycium ferocissimum*	African Boxthorn		
Solanaceae	*	*Physalis peruviana*	Cape Gooseberry		
Solanaceae	*	*Solanum americanum*	Glossy Nightshade		
Solanaceae		*Solanum brownii*	Violet Nightshade		
Solanaceae		*Solanum campanulatum*			
Solanaceae	*	*Solanum chenopodioides*	Whitetip Nightshade		
Solanaceae		*Solanum cinereum*	Narrawa Burr		

CUMBERLAND ECOLOGY

Table C.1 Flora species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status
Solanaceae	*	*Solanum nigrum*	Black-berry Nightshade		
Solanaceae		*Solanum parvifolium subsp. parvifolium*	Nightshade		
Solanaceae		*Solanum prinophyllum*	Forest Nightshade		
Stackhousiaceae		*Stackhousia monogyna*	Creamy Candles		
Stackhousiaceae		*Stackhousia viminea*	Slender Stackhousia		
Stackhousiaceae		*Stackhousia muricata*	Stackhousia		
Sterculiaceae		*Brachychiton populneus subsp. populneus*			
Sterculiaceae		*Rulingia dasyphylla*	Kerrawang		
Thymelaeaceae		*Pimelea curviflora var. divergens*			
Thymelaeaceae		*Pimelea latifolia subsp. elliptifolia*			
Thymelaeaceae		*Pimelea curviflora var. sericea*			
Thymelaeaceae		*Pimelea linifolia subsp. linifolia*			
Typhaceae		*Typha orientalis*	Broad-leaved Cumbungi		
Ulmaceae		*Trema tomentosa var. aspera*	Native Peach		
Urticaceae		*Urtica incisa*	Stinging Nettle		
Verbenaceae	*	*Verbena bonariensis*	Purpletop		
Violaceae		*Hybanthus monopetalus*	Slender Violet-bush		
Violaceae		*Melicytus dentatus*	Tree Violet		
Viscaceae		*Notothixos cornifolius*	Kurrajong Mistletoe		
Xanthorrhoeaceae		*Xanthorrhoea johnsonii*	Johnson's Grass Tree		
Zamiaceae		*Macrozamia reducta*			
Zygophyllaceae		*Tribulus micrococcus*	Yellow Vine		

** denotes exotic and introduced native species*

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, EP = Endangered population

Appendix D

Threatened Flora Likelihood of Occurrence

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Apocynaceae	*Tylophora linearis*		V	E	0		Occurs in dry scrub and open forest and has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii*.	Present. Recorded at four locations within the Study Area. Potential to occur at other locations within the Study Area.
Araucariaceae	*Wollemia nobilis*	Wollemi Pine	E	E	0		Occurs in warm temperate rainforest and rain forest margins in remote sandstone canyons.	Unlikely to occur. No suitable habitat, not within known distribution and no records in the locality
Asteraceae	*Ozothamnus tesselatus*		V	V	43	1951-2012	Occurs in eucalypt woodland and the distribution is known to overlap with Box Gum Woodland and Derived Native Grassland.	Present. Recorded at a few locations in the northern portion of the Study Area on talus footslopes and in habitat considered typical for this species. Potential to occur at other locations within the Study Area.
Ericaceae (Styphelioideae)	*Leucopogon confertus*	Torrington Beard-heath	E	E	0		Possibly occurs in open forest and woodland on rocky granite areas. Known only from an early record near Torrington.	Unlikely to occur. No suitable habitat, outside of known distribution and no records in the locality.
Fabaceae (Mimosoideae)	*Acacia flocktoniae*	Flockton wattle	V	V	0		Grows in dry sclerophyll forest on sandstone. Found only in the Southern Blue Mountains (at Mt Victoria, Megalong Valley and Yerranderie).	Unlikely to occur. Some suitable habitat, however not within known distribution and no records in the locality.
Fabaceae	*Acacia pendula*	Acacia pendula	EP		0		Typically occurs on heavy soils, sometimes on the	Present. Recorded at two locations

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
(Mimosoideae)		population in the Hunter catchment					margins of small floodplains, but also in more undulating locations.	within the Study Area, however they not considered to be natural components of the landscape.
Geraniaceae	*Pelargonium sp. (G.W. Carr 10345 (syn. Pelargonium sp. striatellum)*		E	E	0		Has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Unlikely to occur. No suitable habitat, not within known distribution and no records in the locality
Lamiaceae	*Prostanthera cryptandroides subsp. cryptandroides*	Wollemi Mint-bush	V	V	0		Associated communities include: Narrabeen Rocky Heath, Narrabeen Acacia Woodland, Narrabeen Exposed Woodland; Open Heath of Calytrix tetragona, Leptospermum parviflorum and Isopogon dawsonii; and Open Scrubland of *Eucalyptus dwyeri, Baeckea densifolia, Dillwynia floribunda, Aotus ericoides* and *Hemigenia cuneifolia*.	Potential to occur. Some suitable habitat present at higher elevations within the Study Area. Recorded within the locality.
Lamiaceae	*Prostanthera discolor*		V	V	19	1948-2009	Grows in dry sclerophyll forest in the side gullies of main creeklines, often on rocky or well-drained alluvial substrates.	Potential to occur. Some suitable habitat present within the Study Area.
Malvaceae	*Commersonia rosea (syn. Androcalva rosea)*		E	E	0		Occurs on skeletal sandy soils in scrub or heath vegetation with occasional emergents of *Eucalyptus crebra, Callitris endlicheri* or *Eucalyptus caleyi* subsp. *caleyi*.	Potential to occur. Some suitable habitat present within the Study Area at higher elevations. No records within the locality.
Myrtaceae	*Eucalyptus camaldulensis*	Eucalyptus camaldulensis	EP		66	2006-2010	Occurs along western flowering rivers within the Hunter catchment. It may occur with Euca*lyptus tereticornis,*	Present. Recorded at three broad locations within the Study Area.

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
		population in the Hunter catchment					*Eucalyptus melliodora, Casuarina cunninghamiana* subsp. *cunninghamiana* and *Angophora floribunda*.	
Myrtaceae	*Eucalyptus cannonii*	Capertee Stringybark	V		2	1983	Associated eucalypt species are diverse*: Eucalyptus viminalis, Eucalyptus mannifera, Eucalyptus polyanthemos, Eucalyptus rossii, Eucalyptus blakelyi, Eucalyptus oblonga, Eucalyptus sparsifolia, Eucalyptus bridgesiana, Eucalyptus dalrympleana, Eucalyptus melliodora, Eucalyptus dives* and *Angophora floribunda*. Has a broad altitudinal range, from around 450m to 1,050m. Within this range, the species appears to tolerate most situations except the valley floors.	Potential to occur. Recorded to the south of the Study Area. Potential to occur within the Study Area at higher elevations.
Myrtaceae	*Homoranthus darwinioides*		V	V	27	1951-2003	Grows in in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Associated species include *Callitris endlicheri, Eucalyptus crebra, Eucalyptus fibrosa, Eucalyptus trachyphloia, Eucalyptus beyeri* subsp. *illaquens, Eucalyptus dwyeri, Eucalyptus rossii, Leptospermum divaricatum, Melaleuca uncinata, Calytrix tetragona, Allocasuarina* sp. and *Micromyrtus* sp.	Potential to occur. Habitat present at higher elevations within the Study Area. Recorded within the locality.
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue-orchid	V	V	0		Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	Unlikely to occur. Some suitable habitat, however not within known distribution and no records in the locality.

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Orchidaceae	*Cymbidium canaliculatum*	Cymbidium canaliculatum population in the Hunter Catchment	EP		38	2006-2012	Most commonly found in Eucalyptus albens dominated woodlands and has also been found less commonly on *Eucalyptus dawsonii, Eucalyptus crebra, Eucalyptus moluccana, Angophora floribunda, Acacia salicina* and on some other species, including dead stags.	Present. Recorded at numerous locations within the Study Area. Potential to occur at other locations within the Study Area.
Orchidaceae	*Diuris tricolor*	Pine Donkey Orchid	V		108	2010-2012	Grows in sclerophyll forest among grass, often with native Callitris species and is found in sandy soils, either on flats or small rises. Associated species include Callitris *glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and Acacia shrubland.	Present. Recorded at one location within the Study Area. Potential to occur at other locations within the Study Area.
Orchidaceae	*Prasophyllum sp. Wybong*			E	0		Known to occur in open eucalypt woodland and grassland. Known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield	Possible, but unlikely. Some suitable habitat present, however not within known distribution and no records in the locality.
Rhamnaceae	*Pomaderris brunnea*	Brown Pomaderris	E	V	0		Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. Has been found in association with *Eucalyptus amplifolia, Angophora floribunda, Acacia parramattensis, Bursaria spinosa* and *Kunzea ambigua*. Found in a very limited area around the Colo, Nepean and Hawkesbury Rivers.	Unlikely to occur. No suitable habitat, not within known distribution and no records in the locality.
Rhamnaceae	*Pomaderris queenslandica*	Scant Pomaderris	E		2	1955-2010	Occurs in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Present. Recorded at one location within the Study Area. Potential to occur at other locations within the

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
								Study Area.
Rhamnaceae	*Pomaderris reperta*	Denman Pomaderris	CE	CE	0		Occupies woodland in association *with Eucalyptus crebra , Eucalyptus blakelyi, Notelaea microcarpa* and *Allocasuarina littoralis*. Associated soil is a sandy loam on sandstone or conglomerate. Recorded at a small number of sites along a single ridgeline near Denman	Possible, but unlikely. Some suitable habitat present, however not within known distribution and no records in the locality.
Rhamnaceae	*Pomaderris sericea*	Silky Pomaderris	E	V	1	1997	Both records in NSW are from open forest on sandstone.	Potential to occur. Habitat present at higher elevations. Recorded within the locality.
Rutaceae	*Philotheca ericifolia*			V	0		Specific microclimates include damp sandy flats, alluvial deposits of coarse gravel in dry creek beds and along a spur receiving soakage from high ground. Associated species include *Eucalyptus crebra, Beyeria viscosa* and *Philotheca australis*.	Potential to occur. Some suitable habitat present at higher elevations within the Study Area. Recorded within the locality.
Rutaceae	*Zieria ingramii*		E	E	0^		The species is known only from a geographic range of 25 km, within Goonoo SF, 35-60 km north-north-east of Dubbo on the western plains of NSW. Occurs on gentle rocky slopes or near the crests of low rises in undulating terrain, above 390 m altitude. It grows in woodland dominated by *Eucalyptus fibrosa* subsp. *nubila* and *Callitris endlicheri* with a heath or shrub understorey.	Possible, but unlikely. Some suitable habitat present, however not within known distribution and no records in the locality.

Table D.1 Likelihood of occurrence within the Study Area of threatened flora known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	0		Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with *Themeda triandra*.	Potential to occur. Some suitable habitat present. Not recorded in the locality.
Scrophulariaceae	*Euphrasia arguta*		CE	CE	0		Occurs in eucalypt forest with a mixed grass and shrub understorey. Recorded from Nundle, Hastings River and Barrington Tops.	Unlikely to occur. Some suitable habitat, however not within known distribution and no records in the locality.

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, EP = Endangered population, CE = Critically Endangered

**Data obtained from the Atlas of NSW Wildlife (OEH, 2014b)*

^Species not known from locality (Atlas of NSW Wildlife) or predicted to occur (Protected Matters Search Tool). This species has been specifically referred to within the list of species to be considered within the EIS by DoE.

Appendix E

Fauna Species List

CUMBERLAND ECOLOGY

Table E.1 Fauna species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Detection Method
Amphibia						
Hylidae		*Litoria caerulea*	Green Tree Frog			IC
Hylidae		*Litoria latopalmata*	Broad-palmed Frog			SP
Hylidae		*Litoria peronii*	Peron's Tree Frog			SP
Myobatrachidae		*Crinia signifera*	Common Eastern Froglet			SP, IC
Myobatrachidae		*Limnodynastes tasmaniensis*	Spotted Grass Frog			SP
Myobatrachidae		*Uperoleia laevigata*	Smooth Toadlet			IC
Aves						
Acanthizidae		*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill			BC, IC
Acanthizidae		*Acanthiza nana*	Yellow Thornbill			BC, IC
Acanthizidae		*Acanthiza pusilla*	Brown Thornbill			BC, IC
Acanthizidae		*Acanthiza reguloides*	Buff-rumped Thornbill			BC, IC
Acanthizidae		*Aphelocephala leucopsis*	Southern Whiteface			IC
Acanthizidae		*Chthonicola sagittata*	Speckled Warbler	V		BC, IC
Acanthizidae		*Gerygone albogularis*	White-throated Gerygone			BC
Acanthizidae		*Origma solitaria*	Rockwarbler			BC, IR, IC
Acanthizidae		*Sericornis frontalis*	White-browed Scrubwren			BC, IC
Acanthizidae		*Smicrornis brevirostris*	Weebill			BC, IC
Accipitridae		*Accipiter fasciatus*	Brown Goshawk			IR
Accipitridae		*Aquila audax*	Wedge-tailed Eagle			BC, IC
Accipitridae		*Circus assimilis*	Spotted Harrier	V		IC
Accipitridae		*Elanus axillaris*	Black-shouldered Kite			IC
Accipitridae		*Hieraaetus morphnoides*	Little Eagle	V		BC
Aegothelidae		*Aegotheles cristatus*	Australian Owlet-nightjar			BC, SP
Alaudidae		*Mirafra javanica*	Horsfield's Bushlark			BC
Alcedinidae		*Dacelo novaeguineae*	Laughing Kookaburra			BC, IR, IC
Alcedinidae		*Todiramphus sanctus*	Sacred Kingfisher			BC
Anatidae		*Anas gracilis*	Grey Teal			IC
Anatidae		*Anas superciliosa*	Pacific Black Duck			BC, IR, IC
Anatidae		*Chenonetta jubata*	Australian Wood Duck			BC, SP, IC
Ardeidae		*Ardea pacifica*	White-necked Heron			BC, IC
Ardeidae		*Egretta novaehollandiae*	White-faced Heron			BC, IC
Artamidae		*Artamus cyanopterus*	Dusky Woodswallow			BC, IC
Artamidae		*Artamus superciliosus*	White-browed Woodswallow			IC
Artamidae		*Cracticus nigrogularis*	Pied Butcherbird			BC, IR, IC
Artamidae		*Cracticus tibicen*	Australian Magpie			BC, IR, IC
Artamidae		*Cracticus torquatus*	Grey Butcherbird			BC, IC
Artamidae		*Strepera graculina*	Pied Currawong			BC, IR, IC
Cacatuidae		*Cacatua galerita*	Sulphur-crested Cockatoo			BC, IR, IC
Cacatuidae		*Cacatua sanguinea*	Little Corella			BC, IC
Cacatuidae		*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		BC
Cacatuidae		*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo			BC
Cacatuidae		*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		EV

CUMBERLAND ECOLOGY

Table E.1 Fauna species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Detection Method
Cacatuidae		*Eolophus roseicapillus*	Galah			BC, IC
Campephagidae		*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			BC, IC
Campephagidae		*Coracina papuensis*	White-bellied Cuckoo-shrike			BC, IC
Charadriidae		*Elseyornis melanops*	Black-fronted Dotterel			IC
Charadriidae		*Vanellus miles*	Masked Lapwing			BC, IC
Climacteridae		*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V		BC, IC
Climacteridae		*Cormobates leucophaea*	White-throated Treecreeper			BC, IC
Columbidae		*Geopelia cuneata*	Diamond Dove			IC
Columbidae		*Geopelia humeralis*	Bar-shouldered Dove			BC
Columbidae		*Geopelia striata*	Peaceful Dove			BC, IC
Columbidae		*Leucosarcia melanoleuca*	Wonga Pigeon			IR
Columbidae		*Ocyphaps lophotes*	Crested Pigeon			BC, IC
Columbidae		*Phaps chalcoptera*	Common Bronzewing			BC, IR, IC
Corcoracidae		*Corcorax melanorhamphos*	White-winged Chough			BC, IR, IC
Corcoracidae		*Struthidea cinerea*	Apostlebird			IC
Corvidae		*Corvus coronoides*	Australian Raven			BC, IR, IC
Cuculidae		*Cacomantis flabelliformis*	Fan-tailed Cuckoo			BC, IC
Cuculidae		*Chalcites lucidus*	Shining Bronze-Cuckoo			BC
Estrildidae		*Neochmia modesta*	Plum-headed Finch			BC, IC
Estrildidae		*Neochmia temporalis*	Red-browed Finch			BC, IC
Estrildidae		*Stagonopleura guttata*	Diamond Firetail	V		BC, IC
Estrildidae		*Taeniopygia bichenovii*	Double-barred Finch			BC, IC
Estrildidae		*Taeniopygia guttata*	Zebra Finch			BC, IC
Falconidae		*Falco berigora*	Brown Falcon			IC
Falconidae		*Falco cenchroides*	Nankeen Kestrel			BC, IC
Falconidae		*Falco longipennis*	Australian Hobby			IC
Falconidae		*Falco peregrinus*	Peregrine Falcon			IC
Hirundinidae		*Hirundo neoxena*	Welcome Swallow			BC, IC
Hirundinidae		*Petrochelidon nigricans*	Tree Martin			BC, IC
Maluridae		*Malurus cyaneus*	Superb Fairy-wren			BC, IC
Megaluridae		*Cincloramphus mathewsi*	Rufous Songlark			BC, IC
Meliphagidae		*Acanthorhynchus tenuirostris*	Eastern Spinebill			BC, IC
Meliphagidae		*Anthochaera carunculata*	Red Wattlebird			BC
Meliphagidae		*Anthochaera phrygia*	Regent Honeyeater	CE	E	IC
Meliphagidae		*Entomyzon cyanotis*	Blue-faced Honeyeater			BC, IC
Meliphagidae		*Lichenostomus chrysops*	Yellow-faced Honeyeater			BC, IC
Meliphagidae		*Lichenostomus fuscus*	Fuscous Honeyeater			BC, IC
Meliphagidae		*Lichenostomus leucotis*	White-eared Honeyeater			BC, IR, IC
Meliphagidae		*Lichenostomus melanops*	Yellow-tufted Honeyeater			BC, IR, IC
Meliphagidae		*Lichenostomus penicillatus*	White-plumed Honeyeater			BC, IC
Meliphagidae		*Manorina melanocephala*	Noisy Miner			BC, IR, IC
Meliphagidae		*Manorina melanophrys*	Bell Miner			BC, IC
Meliphagidae		*Melithreptus brevirostris*	Brown-headed Honeyeater			BC, IC
Meliphagidae		*Melithreptus gularis gularis*	Black-chinned Honeyeater	V		BC, IC

CUMBERLAND ECOLOGY

Table E.1 Fauna species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Detection Method
			(eastern subspecies)			
Meliphagidae		*Melithreptus lunatus*	White-naped Honeyeater			BC, IC
Meliphagidae		*Philemon citreogularis*	Little Friarbird			IC
Meliphagidae		*Philemon corniculatus*	Noisy Friarbird			BC, IC
Meliphagidae		*Plectorhyncha lanceolata*	Striped Honeyeater			BC, IC
Menuridae		*Menura novaehollandiae*	Superb Lyrebird			BC, IR, IC
Meropidae		*Merops ornatus*	Rainbow Bee-eater		M	BC, IC
Monarchidae		*Grallina cyanoleuca*	Magpie-lark			BC, IR, IC
Monarchidae		*Myiagra inquieta*	Restless Flycatcher			BC, IC
Monarchidae		*Myiagra rubecula*	Leaden Flycatcher			BC
Motacillidae		*Anthus novaeseelandiae*	Australian Pipit			BC, IC
Nectariniidae		*Dicaeum hirundinaceum*	Mistletoebird			BC, IC
Oriolidae		*Oriolus sagittatus*	Olive-backed Oriole			BC, IC
Pachycephalidae		*Colluricincla harmonica*	Grey Shrike-thrush			BC, IR, IC
Pachycephalidae		*Pachycephala pectoralis*	Golden Whistler			BC, IR, IC
Pachycephalidae		*Pachycephala rufiventris*	Rufous Whistler			BC, IC
Pardalotidae		*Pardalotus punctatus*	Spotted Pardalote			BC, IC
Pardalotidae		*Pardalotus striatus*	Striated Pardalote			BC, IC
Passeridae	*	*Passer domesticus*	House Sparrow			IC
Petroicidae		*Eopsaltria australis*	Eastern Yellow Robin			BC, IR, IC
Petroicidae		*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V		BC, IC
Petroicidae		*Microeca fascinans*	Jacky Winter			BC, IC
Petroicidae		*Petroica rosea*	Rose Robin			IC
Phalacrocoracidae		*Microcarbo melanoleucos*	Little Pied Cormorant			IC
Phalacrocoracidae		*Phalacrocorax sulcirostris*	Little Black Cormorant			IC
Phasianidae		*Coturnix pectoralis*	Stubble Quail			BC, IC
Phasianidae		*Coturnix ypsilophora*	Brown Quail			BC
Podargidae		*Podargus strigoides*	Tawny Frogmouth			SP
Podicipedidae		*Tachybaptus novaehollandiae*	Australasian Grebe			IC
Pomatostomidae		*Pomatostomus superciliosus*	White-browed Babbler			BC, IC
Pomatostomidae		*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V		BC, IR, IC
Psittacidae		*Alisterus scapularis*	Australian King-Parrot			BC, IC
Psittacidae		*Glossopsitta concinna*	Musk Lorikeet			BC, IC
Psittacidae		*Glossopsitta pusilla*	Little Lorikeet	V		BC, IC
Psittacidae		*Melopsittacus undulatus*	Budgerigar			IC
Psittacidae		*Neophema pulchella*	Turquoise Parrot	V		IR, IC
Psittacidae		*Platycercus elegans*	Crimson Rosella			BC, IC
Psittacidae		*Platycercus eximius*	Eastern Rosella			BC, IR, IC
Psittacidae		*Psephotus haematonotus*	Red-rumped Parrot			BC, IC
Psophodidae		*Cinclosoma punctatum*	Spotted Quail-thrush			BC, IC
Ptilonorhynchidae		*Ptilonorhynchus violaceus*	Satin Bowerbird			IR
Rallidae		*Fulica atra*	Eurasian Coot			IC
Rallidae		*Gallinula tenebrosa*	Dusky Moorhen			BC, IC

CUMBERLAND ECOLOGY

Table E.1 Fauna species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Detection Method
Rallidae		*Porphyrio porphyrio*	Purple Swamphen			BC, IC
Rhipiduridae		*Rhipidura albiscapa*	Grey Fantail			BC, IR, IC
Rhipiduridae		*Rhipidura leucophrys*	Willie Wagtail			BC, IR, IC
Strigidae		*Ninox novaeseelandiae*	Southern Boobook			SP, IC
Sturnidae	*	*Sturnus tristis*	Common Myna			IC
Sturnidae	*	*Sturnus vulgaris*	Common Starling			BC, IC
Threskiornithidae		*Threskiornis spinicollis*	Straw-necked Ibis			IC
Timaliidae		*Zosterops lateralis*	Silvereye			BC, IC
Tytonidae		*Tyto javanica*	Eastern Barn Owl			SP, IC
Mammalia						
Bovidae	*	*Bos taurus*	European cattle			SP, IC
Bovidae	*	*Capra hircus*	Goat			IR, IC
Canidae	*	*Canis lupus*	Dingo, domestic dog			IR
Canidae	*	*Vulpes vulpes*	Fox			SP, IR, IC
Cervidae	*	*Dama dama*	Fallow Deer			IR
Dasyuridae		*Antechinus flavipes*	Yellow-footed Antechinus			TL, IC
Dasyuridae		*Sminthopsis murina*	Common Dunnart			TL, IR
Emballonuridae		*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V		AB
Equidae	*	*Equus caballus*	Horse			IC
Felidae	*	*Felis catus*	Cat			IR
Leporidae	*	*Oryctolagus cuniculus*	Rabbit			SP, IR, IC
Macropodidae		*Macropus giganteus*	Eastern Grey Kangaroo			SP, IR, IC
Macropodidae		*Macropus robustus*	Common Wallaroo			SP, IR, IC
Macropodidae		*Macropus rufogriseus*	Red-necked Wallaby			SP, IR, IC
Macropodidae		*Petrogale penicillata*	Brush-tailed Rock-wallaby	E	V	IC
Macropodidae		*Wallabia bicolor*	Swamp Wallaby			SP, IR, IC
Molossidae		*Austronomus australis*	White-striped Freetail-bat			SP, AB
Molossidae		*Mormopterus "Species 4" (big penis)*				AB
Muridae	*	*Mus musculus*	House Mouse			TL
Muridae		*Pseudomys novaehollandiae*	New Holland Mouse		V	TL
Muridae		*Rattus fuscipes*	Bush Rat			TL, IR
Petauridae		*Petaurus breviceps*	Sugar Glider			TL
Phalangeridae		*Trichosurus vulpecula*	Common Brushtail Possum			SP, IR
Pseudocheiridae		*Pseudocheirus peregrinus*	Common Ringtail Possum			SP, IR
Rhinolophidae		*Rhinolophus megaphyllus*	Eastern Horseshoe-bat			AB
Suidae	*	*Sus scrofa*	Pig			SP, IR, IC
Tachyglossidae		*Tachyglossus aculeatus*	Short-beaked Echidna			IR
Vespertilionidae		*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	HT, AB
Vespertilionidae		*Chalinolobus morio*	Chocolate Wattled Bat			AB
Vespertilionidae		*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		AB
Vespertilionidae		*Nyctophilus geoffroyi*	Lesser Long-eared Bat			HT
Vespertilionidae		*Nyctophilus gouldi*	Gould's Long-eared Bat			HT, AB

CUMBERLAND ECOLOGY

Table E.1 Fauna species list

Family	*	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Detection Method
Vespertilionidae		*Nyctophilus sp.*				AB
Vespertilionidae		*Scotorepens balstoni*	Inland Broad-nosed Bat			AB
Vespertilionidae		*Vespadelus pumilus*	Eastern Forest Bat			HT
Vespertilionidae		*Vespadelus vulturnus*	Little Forest Bat			HT
Vombatidae		*Vombatus ursinus*	Common Wombat			SP, IR
Reptilia						
Chelidae		*Emydura macquarii*	Macquarie Turtle			AS
Gekkonidae		*Diplodactylus vittatus*	Wood Gecko			SP
Scincidae		*Carlia tetradactyla*	Southern Rainbow-skink			AS
Scincidae		*Ctenotus robustus*	Robust Ctenotus			IC
Scincidae		*Ctenotus taeniolatus*	Copper-tailed Skink			SP
Scincidae		*Lampropholis delicata*	Dark-flecked Garden Sunskink			AS
Scincidae		*Lerista bougainvillii*	South-eastern Slider			AS
Scincidae		*Morethia boulengeri*	South-eastern Morethia Skink			AS
Varanidae		*Varanus varius*	Lace Monitor			TL, IR

** denotes exotic species*

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

Detection Method: AB = Anabat, AS = Active search, BC = Bird Census, IC = Incidental, HT = Harp Trap, IR = IR Camera, SP = Spotlighting, TL = trapping (Elliot A, Elliot B or Cage)

Appendix F

Threatened Fauna Likelihood of Occurrence

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Amphibia								
Hylidae	*Litoria booroolongensis*	Booroolong Frog	E	E	0		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.	Unlikely to occur. Not suitable habitat and no records in the locality.
Myobatrachidae	*Pseudophryne australis*	Red-crowned Toadlet	V		1	2006	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings.	Unlikely to occur. No suitable habitat and few records in the locality.
Aves								
Acanthizidae	*Chthonicola sagittata*	Speckled Warbler	V		51	1963-2013	Inhabits a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and forest communities.
Accipitridae	*Circus assimilis*	Spotted Harrier	V		1	1982	Inhabits grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and grassland communities.

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle		M	1	1997	Inhabits coastal habitats, particularly those close to the sea-shore, and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. Its habitat is characterised by the presence of large areas of open water including larger rivers, swamps, lakes and the sea, and have been recorded flying over a variety of terrestrial habitats.	Potential to occur as part of a larger foraging range surrounding Goulburn River. Potential habitat present within the woodland and forest habitats within the Study Area.
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V		2	2006-2010	Inhabits open eucalypt forest, woodland or open woodland, she-oak woodlands, acacia woodlands, and riparian woodland, which have an abundance of prey.	Present. Recorded at one location within the Study Area. Species expected to forage and breed within woodland, forest and grassland communities.
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V		2	1985-2000	Inhabits coastal and subcoastal eucalypt-dominated open forests and woodlands, and inland riparian woodland.	Potential to occur. Potential foraging and breeding habitat within the woodland and forest communities of the Study Area.
Apodidae	*Apus pacificus*	Fork-tailed Swift		M	2	2006	Almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher, mostly over inland plains but sometimes above foothills or in coastal areas.	Potential to occur above the Study Area, foraging aerially.
Apodidae	*Hirundapus caudacutus*	White-throated Needletail		M	11	1997-2006	This species is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground, occurring above a wide range of habitats.	Present. The Atlas of NSW Wildlife holds one record of this species within the Study Area. Species is expected to

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
								forage aerially above the Study Area.
Ardeidae	*Ardea ibis*	Cattle Egret		M	0		Inhabits tropical and temperate grasslands, wooded lands and terrestrial wetlands and often forages away from water on low lying grasslands, improved pastures and croplands. Within Australia the principal breeding sites of the Cattle Egret are along the central east coast from Newcastle to Bundaberg.	Potential to occur. Potential foraging habitat on the valley floor in agricultural areas.
Ardeidae	*Ardea modesta*	Eastern Great Egret		M	1	1993	Occur a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial).	Potential to occur. Potential foraging habitat on the valley floor in agricultural areas.
Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	E	E	0		Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* sp.) and spikerushes (*Eleocharis* sp.)	Unlikely to occur. No suitable habitat and no records in the locality.
Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		26	1992-2010	Inhabits eucalypt open forests and woodlands with an Acacia understorey. In summer, generally found in tall mountain forests and woodlands. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, particularly in box-ironbark assemblages.	Present. Recorded at two locations within the Study Area. Species expected to forage across stands of Allocasuarinas within woodland and forest vegetation and roost in hollow-bearing trees.
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		35	1980-2010	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of She-oak occur.	Present. Recorded at two locations within the Study Area. Species expected to forage and breed within

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
								woodland and forest communities, particularly during winter.
Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V		79	1963-2013	Inhabits eucalypt woodlands (including box-gum woodland) and dry open forest. The woodlands and forests are usually dominated by stringybarks or other rough-barked eucalypts, typically with an open grassy understorey and sometimes with one or more shrub species.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and forest communities, favouring areas dominated by rough-barked species.
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V		38	1963-2012	Inhabits eucalypt woodlands, forests and mallee where there is a grassy understorey.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and grassland communities, favouring ecotonal habitat.
Falconidae	*Falco subniger*	Black Falcon	V		1	1982	Inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees and usually associated with streams or wetlands.	Possible, but unlikely to occur. Study Area located outside of known distribution and few records in the locality.
Megapodiidae	*Leipoa ocellata*	Malleefowl	E	V	1	1989	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Less frequently found in other eucalypt woodlands.	Unlikely to occur. No suitable habitat and no recent records in the locality.

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Meliphagidae	*Anthochaera phrygia*	Regent Honeyeater	CE	E	15	1984-2010	Inhabits eucalypt open forests and woodlands, particularly box-ironbark vegetation as well as River Oak gallery forest. Feeds on the nectar of eucalypts and key species include Eucalyptus sideroxylon, Eucalyptus albens and Eucalyptus melliodora as well as the mistletoe Amyema cambagei which grows on Casuarina cunninghamiana.	Present. Recorded at one location within the Study Area by Eastcoast Flora Survey. Numerous nectar producing trees occur within the Study Area, as well as mistletoes, which could be used on occasion by this species for foraging.
Meliphagidae	*Grantiella picta*	Painted Honeyeater	V		3	2006	Inhabits Boree, Brigalow and box-gum woodlands and box-ironbark forests. The species feeds on the fruits of mistletoes, particularly those in the Amyema genus, growing on woodland eucalypts and acacias.	Potential to occur. Potential foraging and breeding habitat present within the woodland and forest communities of the Study Area, particularly areas containing mistletoes from the Amyema genus.
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	V		28	1998-2010	Inhabits woodlands containing box-ironbark associations and Eucalyptus camaldulensis and some open forests. Commonly associated species include *Eucalyptus sideroxylon, Eucalyptus albens, Eucalyptus microcarpa, Eucalyptus melliodora, Eucalyptus blakelyi* and *Eucalyptus tereticornis*.	Present. Recorded at a few locations within the Study Area. Species expected to forage and breed within woodland and forest communities.
Meropidae	*Merops ornatus*	Rainbow Bee-eater		M	10	1963-2006	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation, often in proximity to permanent water.	Present. Recorded at a few locations within the Study Area. Species expected to forage and breed within grassland, woodland and forest

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
								communities.
Monarchidae	*Monarcha melanopsis*	Black-faced Monarch		M			Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest.	Unlikely to occur. No suitable habitat and Study Area occurs outside of the known distribution and there are no records in the locality.
Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher		M	1	2005	Mainly inhabit eucalypt forests, often near wetlands or watercourses.	Potential to occur. Potential foraging and breeding habitat present within the woodland and forest communities of the Study Area.
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V		24	1993-2010	Inhabits eucalypt forests and woodlands, especially where rough-barked species and mature smooth-barked gums with dead branches are present, as well as mallee and Acacia woodland.	Potential to occur. Potential foraging and breeding habitat present within the woodland and forest communities of the Study Area, particularly areas containing rough-barked species.
Petroicidae	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V		15	1963-2010	Inhabits lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas.	Present. Recorded at a few locations within the Study Area. Species expected to forage and breed within woodland and grassland communities, favouring ecotonal habitat where fallen logs are present and in proximity to water resources.

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
Petroicidae	*Petroica boodang*	Scarlet Robin	V		6	1993-1997	Inhabits dry eucalypt forests and woodlands, usually in areas where the understorey is open and grassy with few scattered shrubs.	Potential to occur as a vagrant. Potential foraging and breeding within the woodland and forest communities of the Study Area, particularly areas containing abundant logs and fallen timber.
Petroicidae	*Petroica phoenicea*	Flame Robin	V		2	1993-2010	Inhabits upland tall moist eucalypt forests and woodlands, often on ridges and slopes during breeding season and migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains).	Potential to occur as a vagrant. Potential foraging habitat present within the woodland and forest communities of the Study Area, particularly areas containing perching material.
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V		5	1993-2012	Inhabits box-gum woodlands on the slopes and box-Cypress Pine and open box woodlands on alluvial plains. Woodlands typically have regenerating trees, tall shrubs and an intact ground cover of grass and forbs.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and forest communities.
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		48	1963-2012	Occurs in dry, open eucalypt forests and woodlands. Feeds 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.	Present. Recorded at numerous locations within the Study Area. Species expected to forage and breed within woodland and forest communities, particuarly in areas of profusely flowering eucalypts.
Psittacidae	*Lathamus discolor*	Swift Parrot	E	E	1	1995	Migrates from its Tasmanian breeding grounds to	Potential to occur. Potential foraging

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							overwinter in the box-ironbark forests and woodlands of Victoria, NSW and southern Queensland. They occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations. Favoured feed trees include *Eucalyptus robusta, Corymbia maculata, Corymbia gummifera, Eucalyptus sideroxylon* and *Eucalyptus albens*.	habitat present within the woodland and forest communities of the Study Area. The occurrence of the species would be influenced by the presence of winter-flowering eucalypts.
Psittacidae	*Neophema pulchella*	Turquoise Parrot	V		29	1980-2013	Inhabits eucalypt and cypress-pine open forests and woodlands, particularly box or box-ironbark woodlands, often in undulating or rugged country.	Present. Recorded at a few locations within the Study Area. Species expected to forage and breed within woodland, forest and grassland communities.
Psittacidae	*Polytelis swainsonii*	Superb Parrot	V	V	0		Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.	Unlikely to occur. Outside of typical distribution corridor. No records in the locality.
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail		M	1	2006	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as *Eucalyptus microcorys, Eucalyptus cypellocarpa, Eucalyptus radiata, Eucalyptus regnans, Eucalyptus delegatensis, Eucalyptus pilularis* or *Eucalyptus resinifera*, usually with a dense shrubby understorey often including ferns.	Potential to occur. Potential foraging habitat present within the woodland and forest communities of the Study Area.
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	E	E, M	0		Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low	Unlikely to occur. No suitable habitat and no records in the locality.

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							scrub or open timber.	
Strigidae	*Ninox connivens*	Barking Owl	V		1	1983	Inhabits forests and woodlands of tropical, temperate and semi arid zones that are typically dominated by eucalypts, often red gum species. Roosts in or under dense foliage in large trees including rainforest species of streamside gallery forests, Casuarina cunninghamiana, other Casuarina and Allocasuarina species, Eucalypt, Angophora or Acacia species. For breeding, this species required hollows in large eucalypts or paperbarks, usually near watercourses or wetlands.	Present. The Atlas of NSW Wildlife holds one record of this species within the Study Area. This species is expected to both forage and breed within the woodland and forest communities.
Strigidae	*Ninox strenua*	Powerful Owl	V		9	1983-2010	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. Roosting occurs in groves of dense mid-canopy trees or tall shrubs in sheltered gullies, typically on wide creek flats and at the heads of minor drainage lines. This species nests in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines.	Present. The Atlas of NSW Wildlife holds one record of this species within the Study Area. This species is expected to both forage and breed within the woodland and forest communities.
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V		2	2010	Inhabits dry eucalypt forests of the tablelands, western slopes and the undulating wet-dry forests of the coast. Optimal habitat includes an open understorey and a mosaic of sparse (grassy) and dense (shrubby) ground cover on gentle terrain. This species nests in old hollow	Potential to occur. Potential foraging and breeding habitat within the woodland and forest communities of the Study Area.

CUMBERLAND ECOLOGY

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							eucalypts, live or dead but commonly live, in a variety of topographic positions from gully to upper slope.	
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe		M	0		Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. Usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies).	Possible, but unlikely to occur. Some limited habitat present, however the Study Area occurs outside of the known distribution and there are no records in the locality.
Mammalia								
Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	3	2004-2005	Inhabits a wide range of forest habitat types, although all appear to be characterised by relatively high (>600 mm/year) and predictable seasonal rainfall. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	Present. The Atlas of NSW Wildlife holds one record of this species within the Study Area. This species is expected to both forage and breed within the woodland and forest communities.
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V		4	2006-2010	Inhabits a range of habitats including wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and deserts. This species is known to roost in tree hollows and buildings, and in treeless areas they are known to utilise mammal burrows.	Present. Recorded at few locations within the Study Area. Species expected to forage within woodland and forest communities, roosting in hollow-bearing trees.
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E	V	34	1993-2010	Inhabits rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. A range of vegetation	Present. Recorded at one location within the Study Area by Eastcoast Flora Survey. Species expected to

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							types are associated with the habitat of this species, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	occur in close proximity to cliff line habitat that have little disturbance and fewer predators.
Petauridae	*Petaurus australis*	Yellow-bellied Glider	V		14	2005-2006	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Den, often in family groups, in hollows of large trees.	Unlikely to occur. No suitable habitat (in the form of tall mature eucalypt forest) present within the Study Area.
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V		4	2006	Inhabits mature or old-growth box / box-ironbark woodland, *Eucalyptus camaldulensis* forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heathy understorey in coastal areas. The presence of large trees with abundant hollows are critical elements for nesting habitat.	Potential to occur. Potential foraging and breeding habitat within the Study Area, particularly mature woodland dominated by box species.
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V	2	1957-1980	Inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalyptus species. Feeds almost entirely on the foliage of species of the Eucalyptus genus.	Potential to occur and transient individuals. Potential habitat present within woodland and forest communities containing Eucalyptus punctata, Eucalyptus camaldulensis or Eucalyptus albens.
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	0		Inhabits subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. The primary food source is blossom from eucalypts (genera Eucalyptus, Corymbia and Angophora), melaleucas	Potential to occur occasionally. Potential foraging habitat within the woodland and forest communities within the Study Area.

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							and banksias.	
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	29	1997-2010	Inhabits a range of vegetation types including dry and wet sclerophyll forest, Callitris glaucophylla dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country. The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging.	Present. Recorded at numerous few locations within the Study Area. Species expected to roost within the cliff line habitat and forage within adjoining woodland and forest.
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		1	2006	Inhabits wet sclerophyll and coastal mallee, preferring tall and wet forests where trees are more than 20m in height and the understorey is dense. Typically roosts in tree hollows, however there are a few records in caves and old buildings.	Potential to occur. Potential foraging and breeding within the Study Area, particularly open forest habitats with hollow-bearing trees.
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V		2	2010	Inhabits well timbered areas including rainforest, vine thicket, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. A cave-dwelling species with roosting occurring in caves, abandoned mines, tunnels, stormwater drains and occasionally buildings.	Potential to occur. Potential foraging and breeding habitat present within woodland and forest communities in proximity to caves within the Study Area.
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		20	1997-2010	Inhabits a variety of habitats including rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, melaleuca forests and open grasslands.	Present. Recorded at several few locations within the Study Area. Species expected to roost within the

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
							Caves are the primary roosting habitat, but they also use derelict mines, storm-water tunnels, buildings and other man-made structures.	cliff line habitat and forage within adjoining woodland and forest.
Vespertilionidae	*Nyctophilus corbeni*	Corben's Long-eared Bat	V	V	3	2000-2010	Inhabits a wide variety of vegetation types including *Eucalyptus camaldulensis, Eucalyptus largiflorens*, Allocasuarina, *Casuarina cristata*, mallee, open woodlands and savannahs. Roosting occurs in hollow-bearing trees where hollows and is also known to roost in tree crevices and under loose bark.	Present. The Atlas of NSW Wildlife holds one record of this species within the Study Area. Species expected to forage within woodland and forest communities, roosting in hollow-bearing trees.
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		13	2006-2010	Inhabits a variety of habitats including moist gullies in mature coastal forest, rainforest, open woodland, Melaleuca swamp woodland, wet and dry sclerophyll forests, cleared paddocks with remnant trees and tree-lines creeks in open areas. Roosts in tree hollows, cracks and fissures in trucks and dead branches, under exfoliating bark, as well as the roofs of old buildings.	Potential to occur. Potential foraging and breeding habitat present within woodland and forest communities containing hollow-bearing trees within the Study Area.
Vespertilionidae	*Vespadelus troughtoni*	Eastern Cave Bat	V		11	1997-2010	Inhabits tropical mixed woodland, wet and dry sclerophyll forest located in close proximity to sandstone or volcanic escarpments. Roosting can take place in sandstone overhang caves, boulder piles, mines and occasionally in buildings. Maternity colonies have been observed in shallow sandstone caves.	Potential to occur. Potential foraging and breeding habitat present within woodland and forest communities in proximity to caves within the Study Area.
Muridae	*Pseudomys*	New Holland		V	0		Inhabits open heathland, open woodland with a	Present. Recorded at one location

Table F.1 Likelihood of occurrence within the Study Area of threatened fauna known or predicted to occur within the locality

Family	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Locality Count*	Date Range*	Habitat Requirements	Likelihood of Occurrence
	novaehollandiae	Mouse					heathland understorey and vegetated sand dunes with peak abundances during the early to mid stages of vegetation succession three to five years after fire.	within the Study Area. Species expected to forage and breed within woodland vegetation with a shrubby understorey.
Reptilia								
Elapidae	*Hoplocephalus bungaroides*	Broad-headed Snake	E	V	1	2005	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. In summer it moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments.	Potential to occur. Potential foraging and breeding habitat present within the Study Area in proximity to cliff lines.
Pygopodidae	*Aprasia parapulchella*	Pink-tailed Legless Lizard	V	V	1	2000	Occurs in primary and secondary grassland, grassy woodland and woodland communities including mallee, and box-ironbark forest.	Potential to occur. Potential foraging and breeding habitat present within some portions of derived native grassland and grassy woodlands within the Study Area.
Varanidae	*Varanus rosenbergi*	Rosenberg's Goanna	V		2	2006	Inhabits heath, open forest and woodland and shelters in hollow logs, rock crevices and in burrows.	Potential to occur. Potential foraging and breeding habitat within woodland and open forest vegetation where hollow logs are abundant within the Study Area.

**Data obtained from the Atlas of NSW Wildlife (OEH, 2014b)*

TSC Act / EPBC Act Status: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

Appendix G

Macro-invertebrate List

CUMBERLAND ECOLOGY

Table G.1 Macro-invertebrates recorded at aquatic sampling sites

Family	AS1	AS2	AS3	AS4	AS6	AS9
Acarina	0	0	0	1	8	0
Atyidae	0	2	0	0	5	0
Baetidae	5	4	32	4	5	0
Caenidae	0	20	0	0	0	0
Ceratopogonidae	0	4	1	0	1	0
Chironominae	35	12	11	47	3	0
Coenagrionidae	6	6	0	0	0	0
Cordulephyidae	1	1	0	0	0	0
Culicidae	0	1	0	0	0	13
Dixidae	0	0	0	3	0	0
Dytiscidae	1	12	14	27	6	2
Hirudinea	0	1	0	1	0	0
Hydrophilidae	0	0	0	4	5	0
Leptoceridae	0	6	0	0	0	0
Leptophlebidae	1	2	0	19	0	0
Libellulidae	4	1	6	1	0	0
Nepidae	0	0	0	1	0	0
Notonectidae	0	0	8	1	0	3
Orthocladiinae	0	22	0	0	2	0
Ostracoda	1	2	5	0	0	0
Physidae	1	0	0	0	0	0
Planorbidae	0	2	10	0	0	0
Pleidae	22	0	0	1	0	0
Protoenuridae	0	6	0	0	0	0
Staphylinidae	0	3	0	0	0	0
Tabanidae	1	1	0	0	0	0
Tanyderidae	0	0	0	1	0	0
Tanypodinae	43	7	4	2	0	0
Tipulidae	0	0	0	0	0	14

Appendix H

Assessment of Significance (State)

CUMBERLAND ECOLOGY

H.1 Introduction

This appendix contains formal Assessments of Significance required under Section 5A of the EP&A Act that have been prepared in accordance of the *Threatened Species Assessment Guidelines* (DECC (NSW), 2007). The Assessments of Significance provide a means by which to gauge the significance of predicted impacts to threatened species, populations and ecological communities listed under the TSC Act. They have been prepared to help examine the magnitude of impacts to local occurrences of threatened biota.

Both direct and indirect impacts are taken into account within these assessments. Direct impacts have been quantified within the assessments and are represented by the Project Disturbance Boundary. Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of species, such impacts cannot be mapped or accurately calculated in advance. However, subsidence impacts can be and the impacts have been predicted and mapped as occurring within an area defined as the Subsidence Study Area. An important consideration in these assessments is that the direct and indirect impacts are not proposed to take place at one time; rather they will take place progressively.

Assessments of Significance have been provided for communities and species listed as vulnerable, endangered or critically endangered under the TSC Act. Each Assessment of Significance is a series of questions (shown as italicised text below) for which a response has been supplied beneath in plain text.

H.1.1 Terminology

The *Threatened Species Assessment Guidelines* (DECC (NSW), 2007) utilise and define a number of key terms that are used within an Assessment of Significance, including subject site, study area, direct impacts, indirect impacts, life cycle, viable, local population, risk of extinction, local occurrence, composition, habitat, extent, importance and locality. The Assessments of Significance present below have been prepared in consideration of these terms and the definitions provided in the guidelines.

For the purposes of the Assessments of Significance prepared for the Project, the Project Disturbance Boundary is used as an alternative term for ‘subject site’, which is the area directly affected by the Project. The Study Area defined by the Project includes the area directly impacted by the Project (the Project Disturbance Boundary), the area mapped as being indirectly impacted by subsidence (the Subsidence Study Area) and the remaining areas within the Authorisations. The extent of the Study Area defined within this report is considered an appropriate extent to encompass areas directly and indirectly impacted by the Project, which is equivalent to the term ‘study area’ defined within the guidelines.

H.1.2 Consideration of Ameliorative and Compensation Measures

Each Assessment of Significance has been prepared without considering the ameliorative and compensatory measures proposed for the Project as instructed under the *Threatened Species Assessment Guidelines* (DECC (NSW), 2007):

"Proposed measures that mitigate, improve or compensate for the action, development or activity should not be considered in determining the degree of the effect on threatened species, populations or ecological communities, unless the measure has been used successfully for that species in a similar situation".

However, it is noted that the Project includes substantial mitigation (see **Chapter 7**) and offset measures (see **Chapter 8**). The ultimate conclusions to this EIA take such measures into consideration when assessing the long term implications for TSC Act listed biota.

H.2 Ecological Communities

H.2.1 Hunter Valley Footslopes Slaty Gum Woodland

Although the preparation of an Assessment of Significance is not required for VECs, one has been prepared for Hunter Valley Footslopes Slaty Gum Woodland as a precautionary measure.

Assessment of Significance

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

Not applicable.

(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.

(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

Hunter Valley Footslopes Slaty Gum Woodland occurs extensively within the Study Area and surrounding land. The local occurrence of this community extends beyond the Study Area. This community is known to be widespread across the northern perimeter of Wollemi National Park, immediately to the east of the Study Area (OEH, 2012j). Of the 1,144 ha occurring within the Study Area, 11 ha will be removed by the Project and a further 124 ha occurs within the Subsidence Study Area and has the potential to be impacted by subsidence.

Within the Project Disturbance Boundary, a substantial change will occur to the composition of the community, as it will be entirely removed. There is potential for changes to species composition in the area of this community above the Subsidence Study Area as a result of subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in species composition.

Given the extent of this community within the Study Area, locality and conservation reserves, the removal and potential modification of vegetation through direct and indirect impacts is not considered to place the local occurrence of the community at risk of extinction.

(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

A total of 1,144 ha of Hunter Valley Footslopes Slaty Gum Woodland occurs within the Study Area. Of this extent, a total of 11 ha of this community will be cleared within the Project Disturbance Boundary. A further 124 ha of this community occurs above the Subsidence Study Area and may be impacted by subsidence. The potential changes to the community resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in the extent of the community.

The Project is not considered to significantly increase fragmentation of Hunter Valley Footslopes Slaty Gum Woodland within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Some isolation of retained patches of this community will occur in the vicinity of the Project Disturbance Boundary. However, these areas are already isolated from other patches of this community within the Study Area.

Studies within the wider region have indicated that this community occupies 11,857 ha within north-western Wollemi National Park and surrounds (OEH, 2012j) and a further 2,644 ha within the Central Hunter region (Peake, 2006). A significant proportion of the extant distribution of Hunter Valley Footslopes Slaty Gum Woodland occurs within conservation reserves (OEH, 2012j). The habitat to be cleared or modified represents a small portion of the available habitat within the Study Area and locality. The area of this community directly and indirectly impacted by the Project is not considered important for the long-term survival of the community in the locality.

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

No critical habitat for Hunter Valley Footslopes Woodland has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for Hunter Valley Footslopes Slaty Gum Woodland and no threat abatement plans are relevant to this community within the Study Area.

(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 KTPs are relevant to Hunter Valley Footslopes Slaty Gum Woodland occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this community;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ that readily invade disturbed sites and communities as they can dominate and suppress native flora species;
- Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

A total of 1,144 ha of Hunter Valley Footslopes Slaty Gum Woodland occurs within the Study Area. Of this extent, a total of 11 ha of this community will be cleared within the Project Disturbance Boundary. A further 124 ha of this community occurs above the Subsidence Study Area and may be impacted by subsidence. Given the extent of this community within the Study Area, locality and conservation reserves, the removal and potential modification of vegetation is not considered to result in a significant impact to the community in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to Hunter Valley Footslopes Slaty Gum Woodland. The measures will assist in addressing the impacts to this community.

H.2.2 Hunter Floodplain Red Gum Woodland

Assessment of Significance

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

Not applicable.

(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.

(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

Hunter Floodplain Red Gum Woodland has previously been substantially cleared and or modified within the Study Area. The local occurrence of this community is considered to be contained within the Study Area given the fragmented nature of the current extent. Of the 39 ha occurring within the Study Area, no area of the community occurs within the Project Disturbance Boundary or Subsidence Study Area. The Project is not considered to have an adverse effect on the extent of the community such that its local occurrence is placed at risk of extinction.

Previous land uses has resulted in a modification of the composition of the community within the Study Area. As this community has the potential to be partially dependent on particular hydrological processes, alteration to the hydrology through open cut and underground mining has the potential to indirectly impact the community. Within the Study Area, portions of this community exist in areas upstream of mining areas, which are not considered to be impacted by such potential changes. The potential modification of vegetation through indirect impacts is not considered to place the local occurrence of the community at risk of extinction.

(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

A total of 39 ha of Hunter Floodplain Red Gum Woodland occurs within the Study Area. No area of the community occurs within the Project Disturbance Boundary or Subsidence Study Area. As this community has the potential to be partially dependent on particular hydrological processes, alteration to the hydrology through open cut and underground mining has the potential to indirectly impact the community. Within the Study Area, portions of this community exist in areas upstream of mining areas, which are not considered to be impacted by such potential changes.

The Project is not considered to significantly increase fragmentation of Hunter Floodplain Red Gum Woodland within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between remaining isolated patches of treed vegetation, including scattered trees on the valley floor. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of areas of habitat for this community.

Studies within the wider region have indicated that this community occupies 436 ha within the Central Hunter region (Peake, 2006). The habitat potentially modified represents a portion of the available habitat within the Study Area. The area of this community indirectly impacted by the Project is not considered important for the long-term survival of the community in the locality.

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

No critical habitat for Hunter Floodplain Red Gum Woodland has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for Hunter Floodplain Red Gum Woodland and no threat abatement plans are relevant to this community within the Study Area.

(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 KTPs are relevant to Hunter Floodplain Red Gum Woodland occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this community;
- ‘Invasion of native plant communities by exotic perennial grasses’ that readily invade disturbed sites and communities as they can dominate and suppress native flora species;
- Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

A total of 39 ha of Hunter Floodplain Red Gum Woodland occurs within the Study Area. No area of the community occurs within the Project Disturbance Boundary or Subsidence Study Area. Given that no area of this community is proposed to be cleared and the high level of groundwater recharge, the Project is not considered to result in a significant impact to the community in the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to Hunter Floodplain Red Gum Woodland. The measures will assist in addressing the impacts to this community.

H.2.3 White Box Yellow Box Blakely’s Red Gum Woodland

Assessment of Significance

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

Not applicable.

(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.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The local occurrence of this community extends beyond the Study Area. Of the 2,030 ha occurring within the Study Area, 206 ha will be removed by the Project and a further 839 ha occurs within the Subsidence Study Area and has the potential to be impacted by subsidence. The habitat to be cleared within the Project Disturbance Boundary represents a small portion of the available habitat within the immediate locality. The habitat occurring above the Subsidence Study Area is 839 ha in size and represents a larger portion of the available habitat. Due to the already reduced extent and degraded nature of this community, and as the community remains poorly represented in the national conservation reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants are critical to the recovery of the community.

Within the Project Disturbance Boundary, a substantial change will occur to the species composition of Box Gum Woodland and Derived Native Grassland, as it will be entirely removed. There is potential for changes to species composition in the area of this community above the Subsidence Study Area as a result of subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in species composition.

(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

A total of 2,030 ha of Box Gum Woodland and Derived Native Grassland occurs within the Study Area. A total of 206 ha of Box Gum Woodland and Derived Native Grassland will be cleared within the Project Disturbance Boundary, including 61 ha of woodland form and 144 ha of grassland form. A further 839 ha of this community occurs above the Subsidence Study Area, including 518 ha of woodland form and 321 ha of grassland form, and may be impacted by subsidence. The potential changes to the community resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in the extent of the community.

The Project is not considered to significantly increase fragmentation of Box Gum Woodland and Derived Native Grassland within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of areas of habitat for this community.

Although poorly represented in conservation reserves, Box Gum Woodland and Derived Native Grassland is known within the locality and wider region from Wollemi National Park, Goulburn River National Park and Manobalai Nature Reserve (NSW Scientific Committee, 2002b). The habitat to be cleared represents a small portion of the available habitat within the locality. The habitat occurring above the Subsidence Study Area represents a larger portion of the available habitat. Box Gum Woodland and Derived Native Grassland has previously been substantially cleared and or modified within the Study Area. The habitat within the Study Area is considered to be critical to the survival of the community in immediate locality, given the historic clearance and modification.

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

No critical habitat for Box Gum Woodland and Derived Native Grassland has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECCW, 2011) has an overall aim to promote the recovery and prevent the extinction of Box Gum Woodland and Derived Native Grassland. The direct removal of 206 ha of Box Gum Woodland and Derived Native Grassland, and additional indirect impacts on the community, are actions that are not consistent with the recovery plan.

No threat abatement plans are relevant to Box Gum Woodland and Derived Native Grassland within the Study Area.

(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 KTPs are relevant to Box Gum Woodland and Derived Native Grassland occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this community;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ that readily invade disturbed sites and communities as they can dominate and suppress native flora species;
- Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

A total of 2,030 ha of Box Gum Woodland and Derived Native Grassland occurs within the Study Area. A total of 206 ha of Box Gum Woodland and Derived Native Grassland will be cleared within the Project Disturbance Boundary, including 61 ha of woodland form and 144 ha of grassland form. A further 839 ha of this community occurs above the Subsidence Study Area, including 518 ha of woodland form and 321 ha of grassland form, and may be impacted by subsidence. The community is recognised to have suffered a large reduction in extent through past clearing. The Project would be considered likely to have a significant impact on the long-term viability of the community in the locality by directly and indirectly impacting remaining Box Gum Woodland and Derived Native Grassland.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project. Without the implementation of such measures the Project is expected to result in a significant impact to the Box Gum Woodland and Derived Native Grassland community.

H.3 Flora Species

H.3.1 Tylophora linearis

Assessment of Significance

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

The presence of *Tylophora linearis* within the Study Area represents the first records for the Hunter Valley. This species has been recorded at locations within the Study Area and land extending to the east. The local population of this species is considered to extend beyond the Study Area. The local population of this species was observed flowering during surveys and is considered to form a viable population.

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha of Slaty Box Woodland, within which this species has been recorded within the Study Area. An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area, however the potential subsidence-related impacts within this area are not expected to significantly impact this species. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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*

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha of Slaty Box Woodland, within which this species has been recorded within the Study Area. An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area, however the potential subsidence-related impacts within this area are not expected to significantly impact this species.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices. The locations of *Tylophora linearis* within the Study Area are currently separated by agricultural land.

The presence of this species within the Study Area represents the first records for the Hunter Valley and the occurrence of this species represents a sizeable extension range to the east of the known distribution around Dubbo and Moree. The habitat in which the species occurs within the Study Area is considered to be important for long-term survival of the species in the locality. Potential habitat for the species that may be removed or modified represents a portion of the available habitat within the Study Area.

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

No critical habitat for *Tylophora linearis* has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to *Tylophora linearis* occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this species;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ and ‘Invasion and establishment of exotic vines and scramblers’ that these species can compete with native flora species;
- ‘Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)’, ‘Competition and habitat degradation by feral goats (*Capra hircus*)’, ‘Herbivory and environmental degradation caused by feral deer’ and ‘Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)’ these species can cause direct disturbance to habitats and may increase erosion; and

- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha of Slaty Box Woodland, a community in which this species has been recorded within the Study Area. Additional areas of this community and its associated habitat may also be indirectly impacted by subsidence.

The Project is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Tylophora linearis*.

H.3.2 Ozothamnus tesselatus

Assessment of Significance

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

Ozothamnus tesselatus has been recorded at locations within the Study Area and land extending to the north west. The local population of this species is considered to extend beyond the Study Area. The local population of this species is considered to be viable.

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and 15 individuals of the species occur within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence are considered unlikely to impact the viability of the local population. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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*

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and six individuals were recorded within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence may also impact 124 ha of Slaty Box Woodland and 86 ha of Blue-leaf Ironbark / Cypress Forest within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat to be removed or modified is not considered to be important for the long-term survival of this species in the locality. It is known from a number of locations within the Study Area and locality, including within conservation reserves.

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

No critical habitat for *Ozothamnus tesselatus* has been identified by OEH.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

CUMBERLAND ECOLOGY

(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 KTPs are relevant to *Ozothamnus tesselatus* occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this species;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ and ‘Invasion and establishment of exotic vines and scramblers’ that these species can compete with native flora species;
- ‘Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)’, ‘Competition and habitat degradation by feral goats (*Capra hircus*)’, ‘Herbivory and environmental degradation caused by feral deer’ and ‘Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)’ these species can cause direct disturbance to habitats and may increase erosion; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, locality and conservation reserves, the removal and possible modification of habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Ozothamnus tesselatus*.

H.3.3 Acacia pendula population in the Hunter catchment

Assessment of Significance

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

Not applicable.

(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*

This species has been recorded at two locations within the Study Area. A single, small planted garden specimen of *Acacia pendula* (Weeping Myall) is present adjacent to the Project field office, while the second location comprises three plants which occur on elevated land in grazing paddocks in the north east of the Study Area. It is likely that these latter plants have naturalised from past introductions, as this species occurs in alluvial soils near drainage depressions elsewhere in its range in NSW. The local population of this species is considered to be contained within the Study Area.

The Project will remove one planted individual within the Project Disturbance Boundary. Potential indirect impacts resulting from subsidence may also impact to three naturalised individuals within the Subsidence Study Area. Although under current legislation these four plants form part of the endangered '*Acacia pendula* population in the Hunter catchment', they are not considered to be natural components of the landscape within the Study Area. As such the removal of one of these individuals and the potential indirect impacts to the remaining individuals are not considered to result in a significant impact to the population in the locality.

(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.

(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

One planted individual of *Acacia pendula* (Weeping Myall) will be removed within the Project Disturbance Boundary. Potential indirect impacts resulting from subsidence may also impact to three naturalised individuals within the Subsidence Study Area. The potential changes to the habitat in which the individuals occur resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in the habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat to be removed or modified is not considered to be important for the long-term survival of this species in the locality. Although under current legislation these four plants form part of the endangered '*Acacia pendula* population in the Hunter catchment', they are not considered to be natural components of the landscape within the Study 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 '*Acacia pendula* population in the Hunter catchment' has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to the *Acacia pendula* population in the Hunter catchment occurring within the Study Area:

- 'Clearing of native vegetation' as this reduces the area habitat available for this species; and
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease.

Conclusion

The Project will remove one planted individual of *Acacia pendula* (Weeping Myall) within the Project Disturbance Boundary. Potential indirect impacts resulting from subsidence may also impact to three naturalised individuals within the Subsidence Study Area. The potential changes to the habitat in which the individuals occur resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in the habitat.

Although under current legislation these four plants form part of the endangered '*Acacia pendula* population in the Hunter catchment', they are not considered to be natural components of the landscape within the Study Area. As such the removal of one of these individuals and the potential indirect impacts to the remaining individuals are not considered to result in a significant impact to the population in the locality.

H.3.4 Eucalyptus camaldulensis population in the Hunter catchment

Assessment of Significance

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

Not applicable.

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

Eucalyptus camaldulensis (River Red Gum) has been recorded at locations within the Study Area and land extending to the north west. The local population of this species is considered to extend beyond the Study Area. The local population of this species is considered to be viable.

No individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the Project Disturbance Boundary or Subsidence Study Area. Groundwater exaction from the alluvium has the potential to influence the baseflow within the waterways on and downstream of the Study Area, include areas where the '*Eucalyptus camaldulensis* population in the Hunter catchment' occurs. Given that the watercourses within the Study Area are typically ephemeral and historically have been degraded due to surrounding land use and water extraction, it is likely that *Eucalyptus camaldulensis* (River Red Gum) trees have a moderate reliance, but not a complete dependence, on groundwater. As such, it is unlikely that the Project will have a significant impact on this endangered population as a result of alteration to groundwater levels.

Additional occurrences of this species in the southern portion of the Study Area are not considered to be impacted by the Project. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

CUMBERLAND ECOLOGY

(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

No individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the Project Disturbance Boundary or Subsidence Study Area. Groundwater exaction from the alluvium has the potential to influence the baseflow within the waterways on and downstream of the Study Area.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat within the Study Area is important for the local population. Some of this habitat may be impacted as a result of groundwater exaction from the alluvium which has the potential to influence the baseflow within the waterways on and downstream of the Study Area. Given that the watercourses within the Study Area are typically ephemeral and historically have been degraded due to surrounding land use and water extraction, it is likely that *Eucalyptus camaldulensis* (River Red Gum) trees have a moderate reliance, but not a complete dependence, on groundwater. As such, it is unlikely that the Project will have a significant impact on this endangered population as a result of alteration to groundwater levels.

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

No critical habitat for the *Eucalyptus camaldulensis* population in the Hunter catchment has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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

CUMBERLAND ECOLOGY

The following KTPs are relevant to the *Eucalyptus camaldulensis* population in the Hunter catchment occurring within the Study Area:

- ‘Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands’ as this may impact the quality of the habitat for the endangered population; and‘
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease.

Conclusion

No individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the Project Disturbance Boundary or Subsidence Study Area. Groundwater exaction from the alluvium has the potential to influence the baseflow within the waterways on and downstream of the Study Area. Although this species is not considered to have complete dependence on groundwater within the Study Area, there may be some potential impacts to the habitat of this species. Additional occurrences of this species in the southern portion of the Study Area are not considered to be impacted by the Project.

The Project is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to the ‘*Eucalyptus camaldulensis* population in the Hunter catchment’.

H.3.5 Cymbidium canaliculatum population in the Hunter catchment

Assessment of Significance

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

Not applicable.

(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

Cymbidium canaliculatum (Tiger Orchid) has been recorded at locations within the Study Area and land extending beyond this boundary. The local population of this species is considered to extend beyond the Study Area. The local population of this species is considered to be viable.

No individuals of *Cymbidium canaliculatum* (Tiger Orchid) were recorded within the Project Disturbance Boundary and 15 individuals occur within the Subsidence Study Area. Individuals of this population were recorded at numerous locations within the Study Area, including outside of the Project Disturbance Boundary and Subsidence Study Area. The

Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

(c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

(i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

(ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable.

(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*

No individuals of *Cymbidium canaliculatum* (Tiger Orchid) were recorded within the Project Disturbance Boundary and 15 individuals occur within the Subsidence Study Area. Direct impacts to this species is the removal of potential habitat in the form of Yellow Box Woodland, Slaty Box Woodland and White Box Woodland (Grassy), within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence may also impact these communities within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat to be removed or modified is not considered to be important for the long-term survival of this species. It is known from a number of locations within the Study Area and locality, including within conservation reserves.

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

No critical habitat for the '*Cymbidium canaliculatum* population in the Hunter catchment' has been identified by OEH.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to the '*Cymbidium canaliculatum* population in the Hunter catchment' occurring within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of habitat available for the species;
- 'Loss of hollow-bearing trees' as this reduces the area of habitat available for the species;
- 'Removal of dead wood and dead trees' as this reduces the area of habitat available for the species;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, locality and conservation reserves, the removal and possible modification of potential habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the '*Cymbidium canaliculatum* population in the Hunter catchment'.

CUMBERLAND ECOLOGY

H.3.6 Diuris tricolour

Assessment of Significance

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

Diuris tricolor (Pine Donkey Orchid) has been recorded at locations within the Study Area and land to the west. The local population of this species is considered to extend beyond the Study Area. The local population of this species is considered to be viable.

No individuals of *Diuris tricolor* (Pine Donkey Orchid) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 524 ha of Derived Native Grasslands and 98 ha of grassy woodlands. It is known from a location within the Study Area outside of the Project Disturbance Boundary and an extensive population occurs within the locality. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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

CUMBERLAND ECOLOGY

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

No individuals of *Diuris tricolor* (Pine Donkey Orchid) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 524 ha of Derived Native Grasslands and 98 ha of grassy woodlands. Potential indirect impacts resulting from subsidence may also impact these communities within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat to be removed or modified is not considered to be important for the long-term survival of this species in the locality. It is known from a location within the Study Area outside of the Project Disturbance Boundary and an extensive population occurs within the locality. The habitat for this species within the Project Disturbance Boundary is not considered important for the long-term survival of the species.

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

No critical habitat for *Diuris tricolor* (Pine Donkey Orchid) has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to *Diuris tricolor* (Pine Donkey Orchid) occurring within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this species;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ and ‘Invasion and establishment of exotic vines and scramblers’ that these species can compete with native flora species;

- ‘Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)’, ‘Competition and habitat degradation by feral goats (*Capra hircus*)’, ‘Herbivory and environmental degradation caused by feral deer’ and ‘Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)’ these species can cause direct disturbance to habitats and may increase erosion; and

- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

No individuals of *Diuris tricolor* (Pine Donkey Orchid) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 524 ha of Derived Native Grasslands and 98 ha of grassy woodlands. The removal and possible modification of potential habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Diuris tricolor*.

H.3.7 Pomaderris queenslandica

Assessment of Significance

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

Pomaderris queenslandica (Scant Pomaderris) has been recorded at locations within the Study Area and land extending beyond this boundary. The local population of this species is considered to extend beyond the Study Area. The local population of this species is considered to be viable.

No individuals of *Pomaderris queenslandica* (Scant Pomaderris) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The habitat available for this species occurs at higher elevations, with only a relatively small portion of habitat occurring within the Subsidence Study Area. It is known from a number of locations within the Study Area and locality, including within conservation reserves. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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

No individuals of *Pomaderris queenslandica* (Scant Pomaderris) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The habitat available for this species occurs at higher elevations, with only a relatively small portion occurring within the Subsidence Study Area. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

The habitat to be modified is not considered to be important for the long-term survival of this species in the locality. It is known from a number of locations within the Study Area and locality, including within conservation reserves.

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

No critical habitat for *Pomaderris queenslandica* (Scant Pomaderris) has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to *Pomaderris queenslandica* (Scant Pomaderris) occurring within the Study Area:

- 'Clearing of native vegetation' as this reduces the area habitat available for this species;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease;
- 'Invasion of native plant communities by exotic perennial grasses' and 'Invasion and establishment of exotic vines and scramblers' that these species can compete with native flora species;
- 'Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)', 'Competition and habitat degradation by feral goats (*Capra hircus*)', 'Herbivory and environmental degradation caused by feral deer' and 'Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' these species can cause direct disturbance to habitats and may increase erosion; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, the possible modification of potential habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Pomaderris queenslandica* (Scant Pomaderris).

H.3.8 Prostanthera discolor

Assessment of Significance

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

Prostanthera discolor has not been recorded within the Study Area, however there are known locations of this species to the west and north west. Should this species occur within the Study Area, it would be considered to form a local population that extends beyond the Study Area. A local population of this species has been considered to be viable.

No individuals of *Prostanthera discolor* were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest vegetation, particularly those occurring in gullies and along creek lines. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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

No individuals of *Prostanthera discolor* were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest vegetation, particularly those occurring in gullies and along creek lines. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

Given that no individuals of *Prostanthera discolor* were recorded within the Study Area, the habitat present is not considered to be important for the long-term survival of the species.

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

No critical habitat for *Prostanthera discolor* has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to potentially occurring *Prostanthera discolor* within the Study Area:

- 'Clearing of native vegetation' as this reduces the area habitat available for this species;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease;
- 'Invasion of native plant communities by exotic perennial grasses' and 'Invasion and establishment of exotic vines and scramblers' that these species can compete with native flora species;
- 'Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)', 'Competition and habitat degradation by feral goats (*Capra hircus*)', 'Herbivory and environmental degradation caused by feral deer' and 'Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' these species can cause direct disturbance to habitats and may increase erosion; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

No individuals of *Prostanthera discolor* were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest vegetation, particularly those occurring in gullies and along creek lines. Given that no individuals of this species have been recorded within the Study Area and the extent of potential habitat, the removal and possible modification of habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Prostanthera discolor*.

H.3.9 Thesium australe

Assessment of Significance

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

Thesium australe (Austral Toadflax) has not been recorded within the Study Area and there are no known locations in the immediate vicinity of the Study Area. Should this species occur within the Study Area, it would be considered to form a local population that extends beyond the Study Area. A local population of this species has been considered to be viable.

No individuals of *Thesium australe* (Austral Toadflax) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. The Project is not considered to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of 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.

(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.

(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

CUMBERLAND ECOLOGY

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

No individuals of *Thesium australe* (Austral Toadflax) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

The Project is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices. There will be some further fragmentation of grassland areas.

Given that no individuals of *Thesium australe* (Austral Toadflax) were recorded within the Study Area, the habitat present is not considered to be important for the long-term survival of the species.

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

No critical habitat for *Thesium australe* (Austral Toadflax) has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to potentially occurring *Thesium australe* (Austral Toadflax) within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area habitat available for this species;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease;
- ‘Invasion of native plant communities by exotic perennial grasses’ and ‘Invasion and establishment of exotic vines and scramblers’ that these species can compete with native flora species;
- ‘Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)’, ‘Competition and habitat degradation by feral goats (*Capra hircus*)’, ‘Herbivory and

environmental degradation caused by feral deer' and 'Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' these species can cause direct disturbance to habitats and may increase erosion; and

- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of habitat.

Conclusion

No individuals of *Thesium australe* (Austral Toadflax) were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Given that no individuals of this species have been recorded within the Study Area and the extent of potential habitat, the removal and possible modification of habitat is not considered to result in a significant impact to the species in the locality. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Thesium australe* (Austral Toadflax).

H.4 Fauna Species

H.4.1 Birds

i. Blossom-dependent Birds

The following Assessment of Significance has been prepared as a composite test for nectarivorous bird species listed under the TSC Act that are known to or are likely to occur within the Study Area. These include the following:

- Regent Honeyeater (known to occur);
- Black-chinned Honeyeater (known to occur);
- Little Lorikeet (known to occur);
- Painted Honeyeater (potential to occur); and
- Swift Parrot (potential to occur).

Assessment of Significance

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

The Regent Honeyeater, Black-chinned Honeyeater and Little Lorikeet have been recorded within the Study Area. These species, as well as the Swift Parrot and Painted Honeyeater have also been recorded in connected areas of habitat. The local populations of these

CUMBERLAND ECOLOGY

species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove and area known habitat for the Regent Honeyeater, Black-chinned Honeyeater and Little Lorikeet, including foraging and breeding habitat. Additionally, the Project will remove potential foraging habitat for the Swift Parrot and Painted Honeyeater, and breeding habitat for the Painted Honeyeater. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for these species, with the exception of the Swift Parrot which breeds in Tasmania. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact to each of these species is shown below. Of the area of suitable habitat for the Regent Honeyeater, approximately 169 ha comprises woody vegetation that is dominated or co-dominated by nectar producing trees identified as key food sources for the Regent Honeyeater within the OEH (2014t) and DoE (2014a) profiles for the species and the recovery plan (Menkhorst *et al.*, 1999). The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Regent Honeyeater, Little Lorikeet and Black-chinned Honeyeater and potential habitat for the Painted Honeyeater and Swift Parrot. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

Species	**Occurrence within Study Area**	**Area of habitat within Project Disturbance Boundary (ha)**	**Area of habitat within Subsidence Study Area (ha)**	**Residual Area within the Study Area (ha)**
Regent Honeyeater	Known	229	1,347	3,631
Little Lorikeet	Known	229	1,347	3,631
Black-chinned Honeyeater	Known	229	1,347	3,631
Painted Honeyeater	Potential	229	1,347	3,631
Swift Parrot	Potential	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for a number of these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Some of the habitat to be removed comprises Box Gum Woodland and Derived Native Grassland TEC, which is a community considered important for the survival of the Regent Honeyeater. As such, the Project will remove important habitat for the Regent Honeyeater. For the other species, extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *Regent Honeyeater Recovery Plan 1999-2003* (Menkhorst *et al.*, 1999) contains a number of objectives including those relating to the maintenance and enhancement of the value of habitat at key sites, monitoring and research. Although the Study Area is not located within key breeding areas for the species, some of the foraging habitat to be removed within the Project Disturbance Boundary constitutes important habitat.

CUMBERLAND ECOLOGY

The *National Recovery Plan for the Swift Parrot Lathamus discolor* (Saunders and Tzaros, 2011) aims to address knowledge gaps and ongoing conservation issues to ensure the Swift Parrot population is self-sustainable in the long-term. Although potential habitat for this species will be removed within the Project Disturbance Boundary, the consideration of impacts to this species is consistent with the plan.

Recovery plans have not been developed for the Black-chinned Honeyeater, Painted Honeyeater or the Little Lorikeet, and no threat abatement plans are relevant to these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to these species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and nesting habitat available for the species;
- ‘Loss of hollow-bearing trees’ as this reduces the abundance of nesting habitat for some species;
- ‘Removal of dead wood and dead trees’ as this reduces the abundance of important ground foraging and nesting habitat;
- ‘Invasion of native plant communities by exotic perennial grasses’ as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- ‘Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa*’ as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- ‘Competition and grazing by the feral European rabbit, *Oryctolagus cuniculus*’ as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- ‘Competition from feral honey bees (*Apis mellifera*)’ as they compete with native fauna for tree hollows and floral resources;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for Regent Honeyeater, Black-chinned Honeyeater and Little Lorikeet, and potential habitat for the Painted Honeyeater and Swift Parrot. Additional areas of this habitat may also be indirectly impacted by subsidence.

Given that the species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges. The removal and possible modification of habitat for the Black-chinned Honeyeater and Little Lorikeet, and potential habitat for the Painted Honeyeater and Swift Parrot is not considered to result in a significant impact to these species in the locality. The Project will however result in the loss of important habitat for the Regent Honeyeater in the form of 169 ha of woody vegetation that is dominated or co-dominated by nectar producing trees identified as key food sources for the Regent Honeyeater within the OEH (2014t) and DoE (2014a) profiles for the species and the recovery plan (Menkhorst *et al.*, 1999).

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of Box Gum Woodland and Derived Native Grassland (woodland form) for the Regent Honeyeater.

ii. Woodland Birds

The following Assessment of Significance has been prepared as a composite test for woodland bird species listed under the TSC Act that are known to or are likely to occur within the Study Area. These include the following:

- Turquoise Parrot (known to occur);
- Speckled Warbler (known to occur);
- Brown Treecreeper (eastern subspecies) (known to occur);
- Hooded Robin (south-eastern form) (known to occur);
- Grey-crowned Babbler (eastern subspecies) (known to occur);
- Diamond Firetail (known to occur);
- Varied Sittella (potential to occur);
- Scarlet Robin (potential to occur); and
- Flame Robin (potential to occur).

CUMBERLAND ECOLOGY

Assessment of Significance

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

The Turquoise Parrot, Speckled Warbler, Brown Treecreeper, Hooded Robin, Grey-crowned Babbler and Diamond Firetail have been recorded within the Study Area. These species, as well as the Varied Sittella, Scarlet Robin and Flame Robin. have also been recorded in connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove known habitat for the Turquoise Parrot, Speckled Warbler, Brown Treecreeper, Hooded Robin, Grey-crowned Babbler and Diamond Firetail, including foraging and breeding habitat. Additionally, the Project will remove potential habitat for the Varied Sittella, Scarlet Robin and Flame Robin. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for these species. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact to each of these species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Turquoise Parrot, Speckled Warbler, Brown Treecreeper, Hooded Robin, Grey-crowned Babbler and Diamond Firetail. Additionally, it forms potential habitat for the Varied Sittella, Scarlet Robin and Flame Robin. A number of these known and potential woodland birds are reliant on grassy woodlands, and the interface between these woodlands and adjacent grassland. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

Species	**Occurrence within Study Area**	**Area of habitat within Project Disturbance Boundary (ha)**	**Area of habitat within Subsidence Study Area (ha)**	**Residual Area within the Study Area (ha)**
Turquoise Parrot	Known	229	1,347	3,631
Speckled Warbler	Known	224	1,317	3,445
Brown Treecreeper	Known	229	1,347	3,631
Hooded Robin	Known	628	902	2,725
Grey-crowned Babbler	Known	229	1,347	3,631
Diamond Firetail	Known	749	1,078	4,304
Varied Sittella	Potential	229	1,347	3,631
Scarlet Robin	Potential	229	1,347	3,631
Flame Robin	Potential	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. The Project will also result in the loss of some ecotonal habitat. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

CUMBERLAND ECOLOGY

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

No critical habitat for these species has been identified by OEH.

(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 developed for these species. The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is relevant to some assessed species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to these species within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of forage and nesting habitat available for the species;
- 'Loss of hollow-bearing trees' as this reduces the abundance of nesting habitat for some species;
- 'Removal of dead wood and dead trees' as this reduces the abundance of important ground foraging and nesting habitat;
- 'Invasion of native plant communities by exotic perennial grasses' as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Predation by the European Red Fox, *Vulpes vulpes* as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa*' as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- 'Competition and grazing by the feral European rabbit, *Oryctolagus cuniculus*' as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- 'Competition from feral honey bees (*Apis mellifera*)' as they compete with native fauna for tree hollows and floral resources;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and

- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for Turquoise Parrot, Speckled Warbler, Brown Treecreeper, Hooded Robin, Grey-crowned Babbler and Diamond Firetail, and potential habitat for the Varied Sittella, Scarlet Robin and Flame Robin. Additional areas of habitat may also be indirectly impacted by subsidence. Given that these species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of woodland and forest habitat.

iii. *Cockatoos*

The following Assessment of Significance has been prepared as a composite test for Cockatoos listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Glossy Black-cockatoo; and
- Gang-gang Cockatoo.

Assessment of Significance

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

The Glossy Black-cockatoo and Gang-gang Cockatoo have been recorded within the Study Area as well as in adjoining connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove an area of known habitat for the Glossy Black-cockatoo and Gang-gang Cockatoo. Large hollow-bearing trees within the Project Disturbance Boundary may provide breeding habitat for the Glossy Black-cockatoo. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Glossy Black-cockatoo species. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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*

A breakdown of the areas of impact to each of these species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Glossy Black-cockatoo and Gang-gang Cockatoo. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Glossy Black-cockatoo	Known	130	824	3,196
Gang-gang Cockatoo	Known	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered important in the locality for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(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 developed for these species, and no threat abatement plans are relevant.

(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 KTPs are relevant to these species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and nesting habitat available for the 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 nesting habitat;
- ‘Competition from feral honey bees (*Apis mellifera*)’ as they compete with native fauna for tree hollows and floral resources;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss known habitat for the Glossy Black-cockatoo and Gang-gang Cockatoo. Additional areas of habitat may also be indirectly impacted by subsidence. Given that the species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of woodland and forest habitat.

iv. Raptors

The following Assessment of Significance has been prepared as a composite test for raptor bird species (birds of prey) listed under the TSC Act that are known to or are likely to occur within the Study Area. These include the following:

- Spotted Harrier (known to occur);
- Little Eagle (known to occur); and
- Square-tailed Kite (potential to occur).

Assessment of Significance

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

The Spotted Harrier and Little Eagle have been recorded within the Study Area. These species, as well as the Square-tailed Kite have also been recorded in connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove an area of known habitat for the Spotted Harrier and Little Eagle, as well as potential habitat for the Square-tailed Kite. Large remnant trees within the Project Disturbance Boundary may provide breeding habitat for these species. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Spotted Harrier, Little Eagle and Square-tailed Kite. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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*

A breakdown of the areas of impact to each of these species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Spotted Harrier and Little Eagle, and potential habitat for the Square-tailed Kite. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Spotted Harrier	Known	1,014	902	4,363
Little Eagle	Known	1,096	1,076	5,776
Square-tailed Kite	Potential	1,096	1,076	5,776

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes, as well as between grassland patches. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(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 developed for these species, and no threat abatement plans are relevant.

(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 KTPs are relevant to these species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and nesting habitat available for the species;
- ‘Removal of dead wood and dead trees’ as this reduces the abundance of important nesting habitat;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for the Spotted Harrier and Little Eagle, and potential habitat for the Square-tailed Kite. Additional areas of habitat may also be indirectly impacted by subsidence. Given that the species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of woodland and forest habitat.

v. Forest Owls

The following Assessment of Significance has been prepared as a composite test for owls listed under the TSC Act that are known to or are likely to occur within the study area. These include the following:

- Barking Owl (known to occur);
- Powerful Owl (known to occur); and
- Masked Owl (potential to occur).

Assessment of Significance

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

The Barking Owl and Powerful Owl have been recorded within the Study Area. These species, as well as the Masked Owl have also been recorded in connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove an area of known habitat for the Barking Owl and Powerful Owl, as well as potential habitat for the Masked Owl. Large hollow-bearing trees within the Project Disturbance Boundary may provide breeding habitat for these species, however it is expected that breeding habitat is primarily located outside of the Project Disturbance Boundary. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Barking Owl, Powerful Owl and Masked Owl. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact to each of these species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Barking Owl and Powerful Owl and potential habitat for the Masked Owl. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Barking Owl	Known	229	1,347	3,631
Powerful Owl	Known	229	1,347	3,631
Masked Owl	Potential	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *Draft Recovery Plan for the Barking Owl Ninox connivens* (NSW NPWS, 2003) contains a number of objectives with the overall aim to recover the species to a position of viability in nature in NSW. The Project will remove known habitat for this species which is inconsistent with threat abatement and mitigation.

The *Recovery Plan for Large Forest Owls* (DEC (NSW), 2006), which include the Powerful Owl and Masked Owl, contains a number of objectives with the overall aim to ensure that viable populations of the large forest owls continue in the wild in NSW in each region where they presently occur. Although potential habitat for this species will be removed within the Project Disturbance Boundary, the consideration of impacts to this species is consistent with the plan.

No threat abatement plans are relevant to these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to these species within the Study Area:

- 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;
- Competition and grazing by the feral European rabbit, *Oryctolagus cuniculus* as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for the Barking Owl and Powerful Owl and potential habitat for the Masked Owl. Additional areas of habitat may also be indirectly impacted by subsidence. Given that the species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of woodland and forest habitat.

H.4.2 Mammals

i. Terrestrial Mammals

a. Spotted-tailed Quoll

Assessment of Significance

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

The Spotted-tailed Quoll has been recorded within the Study Area as well as in adjoining connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove an area of known habitat for the Spotted-tailed Quoll, including foraging and breeding habitat. Areas of habitat within the Project Disturbance Boundary may provide suitable breeding habitat for this species, however it is expected that breeding habitat is primarily located outside of the Project Disturbance Boundary. This species is highly mobile and is considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Spotted-tailed Quoll. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Spotted-tailed Quoll. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Spotted-tailed Quoll	Known	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for this species has been identified by OEH.

(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 has been prepared. The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is relevant to some assessed species.

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

The following KTPs are relevant to these species within the Study Area:

- 'Loss of hollow-bearing trees' as this reduces the abundance of den habitat;
- 'Removal of dead wood and dead trees' as this reduces the abundance of important ground foraging and den habitat;
- 'Invasion of native plant communities by exotic perennial grasses' as this results in the loss of key food plants and habitat;
- 'Competition and grazing by the feral European rabbit (Oryctolagus cuniculus)' as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- 'Predation by the European Red Fox (Vulpes vulpes)' as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- 'Predation, habitat degradation, competition and disease transmission by Feral Pigs (Sus scrofa)' as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and
- Anthropogenic climate change; as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for the Spotted-tailed Quoll. Additional areas of habitat may also be indirectly impacted by subsidence. Given that the species is highly mobile and are likely to utilise numerous habitat resources within the locality, this species are considered to remain viable within the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. The measures will assist in addressing the impacts to this species, including addressing the loss of woodland and forest habitat.

b. Brush-tailed Rock-wallaby

Assessment of Significance

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

The Brush-tailed Rock-wallaby has been recorded within the Study Area as well as in adjoining connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove habitat for the Brush-tailed Rock-wallaby which is known to occur within the Study Area. This species is considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. The life cycle of this species may be impacted by the Project in the short-term; however it is 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.

(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.

(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

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(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

A breakdown of the areas of impact to this species is shown below. Of the area of habitat within the Project Disturbance Boundary, <1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary.

The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Brush-tailed Rock-wallaby. Additional impacts are considered likely to occur as a result of subsidence, which will modify cliff line structures. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species. There may be additional short-medium term impacts from operational impacts.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Brush-tailed Rock-wallaby	Known	125	795	3,022

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Habitat for this species is largely connected. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(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 brush-tailed rock-wallaby (Petrogale penicillata)* (DECC (NSW), 2008a) contains a number of objectives with the overall aim is to halt the decline of the species and to recover it from its status as threatened. The Project will remove an area of habitat for the Brush-tailed Rock-wallaby and has the potential to increase feral species as a result of a change land management practices.

The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is 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 KTPs are relevant to this species within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of forage and shelter habitat available for the species;
- 'Invasion of native plant communities by exotic perennial grasses' as this results in the loss of key food plants and habitat;
- 'Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)' as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- 'Predation by the European Red Fox (*Vulpes vulpes*)' as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- 'Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*)' as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of habitat for the Brush-tailed Rock-wallaby. Less than 1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. The area in which this species was recorded occurs outside of the Project Disturbance Boundary. Areas of habitat may also be indirectly impacted by subsidence and the operational impacts of the Project. The long-term viability of these species in the locality is unlikely to be impacted. A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species.

ii. Arboreal Mammals

a. Koala

Assessment of Significance

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

No individuals of the Koala have been recorded within the Study Area and there are only two records in the locality of the Study Area from 1957 and 1980. The Koala is expected to occur within the Study Area as transient individuals. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove an area of potential habitat for the Koala, including foraging and breeding habitat. This species is highly mobile and is considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Koala. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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*

A breakdown of the areas of impact this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Koala. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Koala	Potential	229	1,347	3,625

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for this species has been identified by OEH.

(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 koala (Phascolarctos cinereus)* (DECC (NSW), 2008b) contains a number of objectives with the overall aim is to reverse the decline of the Koala in NSW, to ensure adequate protection, management and restoration of koala habitat, and to maintain healthy breeding populations of koalas throughout their current range. The Project will remove an area of potential habitat for this species, however it is not considered important to its survival.

The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is relevant to some assessed species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to potential habitat for this species within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of forage habitat available for this species;
- 'Predation by the European Red Fox (*Vulpes vulpes*)' as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- 'Alteration of habitat following subsidence due to longwall mining' as the quality of the habitat may decrease; and
- 'Anthropogenic climate change' as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of potential habitat for the Koala. Additional areas of habitat may also be indirectly impacted by subsidence. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. The measures will assist in addressing the impacts to this species, including addressing the loss of woodland and forest habitat.

b. Squirrel Glider

Assessment of Significance

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

The Squirrel Glider has not been recorded within the Study Area; however this species has been recorded in connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Squirrel Glider will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Squirrel Glider. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Squirrel Glider	Potential	189	1,345	3,465

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for this species has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been developed for this species, and no threat abatement plans are relevant.

(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 KTPs are relevant to potential habitat for this species within the Study Area:

- ‘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 structural complexity and the abundance of important nesting habitat;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of potential habitat for the Squirrel Glider. Additional areas of habitat may also be indirectly impacted by subsidence. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. The measures will assist in addressing the impacts to this species, including addressing the loss of woodland and forest habitat.

iii. Grey-headed Flying-fox

Assessment of Significance

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

The Squirrel Glider has not been recorded within the Study Area; however this species has been recorded in connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Grey-headed Flying-fox will primarily be impacted by the Project through direct removal of habitat within the Project Disturbance Boundary. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. It is expected that this species occasionally forages within the Study Area. Sufficient habitat will be retained within the Study Area and an extensive area of habitat is conserved in the locality. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

CUMBERLAND ECOLOGY

(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

A breakdown of the areas of impact this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Squirrel Glider. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Grey-headed Flying-fox	Potential	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for this species has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been developed for this species, and no threat abatement plans are relevant.

(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 KTPs are relevant to potential habitat for this species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage habitat available for the species; and
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of potential habitat for the Grey-headed Flying-fox. Additional areas of habitat may also be indirectly impacted by subsidence. The habitat to be impacted within the Project Disturbance Boundary is not considered important for the long-term survival of the species within the locality. This species is only expected to occasionally forage within the Study Area as part of a much wider foraging range.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. The measures will assist in addressing the impacts to this species, including addressing the loss of woodland and forest habitat.

iv. Cave-dependent Bats

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. These include the following:

- Large-eared Pied Bat (known to occur);
- Eastern Bentwing-bat (known to occur);
- Little Bentwing-bat (potential to occur); and
- Eastern Cave Bat (potential to occur).

Assessment of Significance

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

CUMBERLAND ECOLOGY

The Large-eared Pied Bat and Eastern Bentwing-bat have been recorded within the Study Area. These species, as well as the Little Bentwing-bat and Eastern Cave Bat, have also been recorded in connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove known habitat for the Large-eared Pied Bat and Eastern Bentwing-bat, including foraging and roosting. Additionally, the Project will remove potential habitat for the Little Bentwing-bat and Eastern Cave Bat. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. The life cycle of these species may be impacted by the Project in the short-term; however it is 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.

(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.

(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.

(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

A breakdown of the areas of impact to each of these species is shown below. No areas of identified cliff lines occur within the Project Disturbance Boundary. A total of 100 ha of woody vegetation occurs within 500 m of identified cliff lines within the Project Disturbance Boundary. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for the Large-eared Pied Bat and Eastern Bentwing-bat. Additionally, it forms potential habitat for the Little Bentwing-bat and Eastern Cave Bat. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats, will modify cave structures and has the potential to impact on maternity roosting habitat. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species. There may be additional short-medium term impacts from operational impacts.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Large-eared Pied Bat	Known	229	1,347	3,631
Eastern Bentwing-bat	Known	229	1,347	3,631
Little Bentwing-bat	Potential	229	1,347	3,631
Eastern Cave Bat	Potential	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *National recovery plan for the Large-eared Pied Bat Chalinolobus dwyeri* (DERM, 2011) contains a number of objectives with the overall aim to ensure the persistence of viable populations of the Large-eared Pied Bat throughout its geographic range. The Project will remove and modify known habitat for the Large-eared Pied Bat which is known extensively within the locality.

No recovery plans have been prepared for the other cave-dependent species assessed. No threat abatement plans are relevant to these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to these species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and nesting habitat available for the species;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for the Large-eared Pied Bat and Eastern Bentwing-bat, and potential habitat for the Little Bentwing-bat and Eastern Cave Bat. Additional areas of habitat may also be indirectly impacted by subsidence. Given that these species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges. A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species.

v. Hollow-dependent Bats

The following Assessment of Significance has been prepared as a composite test for a number of hollow-roosting microbat species that known or considered to have potential to occur within the Study Area. These include the following:

- Corben’s Long-eared Bat (known to occur);
- Yellow-bellied Sheathtail-bat (known to occur);
- Eastern False Pipistrelle (potential to occur); and
- Greater Broad-nosed Bat (potential to occur).

Assessment of Significance

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

The Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat have been recorded within the Study Area. These species, as well as the Eastern False Pipistrelle and Greater Broad-nosed Bat, have also been recorded in connected areas of habitat. The local populations of these species are considered to extend beyond the Study Area. The local populations of these species have been assessed as viable.

The Project will remove known habitat for Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat, including foraging and roosting habitat, and potential habitat for the Eastern False Pipistrelle and Greater Broad-nosed Bat. These species are highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for these species. Accordingly, the Project is not considered to have an adverse effect on the life cycle of these species such that a viable local population is 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.

(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.

(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

A breakdown of the areas of impact to each of these species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents known habitat for

Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat, including foraging and roosting habitat. Additionally, it forms potential habitat for the Eastern False Pipistrelle and Greater Broad-nosed Bat. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species. There may be additional short-medium term impacts from operational impacts.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Corben's Long-eared Bat	Known	229	1,347	3,631
Yellow-bellied Sheathtail-bat	Known	229	1,347	3,631
Eastern False Pipistrelle	Known	229	1,347	3,631
Greater Broad-nosed Bat	Known	229	1,347	3,631

The Project is not considered to significantly increase fragmentation of habitat for these species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for these species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(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 Corben's Long-eared has been prepared. No recovery plans have been prepared for the other hollow-dependent species assessed. No threat abatement plans are relevant to these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The following KTPs are relevant to these species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and roosting habitat available for the species;
- ‘Loss of hollow-bearing trees’ as this reduces the abundance of roosting habitat for some species;
- ‘Removal of dead wood and dead trees’ as this reduces the abundance of important roosting habitat;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources; and
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of known habitat for Corben’s Long-eared Bat and Yellow-bellied Sheathtail-bat, including foraging and roosting habitat, and potential habitat for the Eastern False Pipistrelle and Greater Broad-nosed Bat. Additional areas of habitat may also be indirectly impacted by subsidence and operational impacts. Given that these species are highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality and their ranges.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to these species. The measures will assist in addressing the impacts to these species, including addressing the loss of woodland and forest habitat.

H.4.3 Reptiles

i. Broad-headed Snake

Assessment of Significance

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

The Broad-headed Snake has not been recorded within the Study Area; however this species has been recorded in connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove potential habitat for the Broad-headed Snake, including winter and summer habitat. This species is considered likely to utilise habitat resources throughout the

CUMBERLAND ECOLOGY

locality and within adjacent conservation reserves. The life cycle of these species may be impacted by the Project in the short-term; however it is unlikely to place a viable local population of either species at risk of extinction. Cliff line habitat is abundant in the locality of the Study Area.

(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.

(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.

(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

A breakdown of the areas of impact to this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Broad-headed Snake. No areas of identified cliff lines occur within the Project Disturbance Boundary. Additional impacts are considered likely to occur as a result of subsidence, which will modify cliff line structures. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. There may be additional short-medium term impacts from operational impacts.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Broad-headed Snake	Potential	125	795	3,016

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Habitat for this species is largely connected. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

The habitat to be removed or indirectly impacted by the Project is not considered locally important for this species as extensive areas of suitable habitat occur within other areas of the Study Area and the locality. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for these species has been identified by OEH.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

No recovery plan has been prepared for this species and no threat abatement plans are relevant.

(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 KTPs are relevant to this potentially occurring species within the Study Area:

- ‘Clearing of native vegetation’ as this reduces the area of forage and shelter habitat available for the species;
- Loss of hollow-bearing trees as this reduces the abundance of shelter;
- ‘Removal of dead wood and dead trees’ as this reduces the abundance of important roosting habitat;
- ‘Alteration of habitat following subsidence due to longwall mining’ as the quality of the habitat may decrease; and
- ‘Anthropogenic climate change’ as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project will result in the direct loss of potential habitat for the Broad-headed Snake. Additional areas of habitat may also be indirectly impacted by subsidence. The long-term viability of this species in the locality is unlikely to be impacted. A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species.

ii. Pink-tailed Legless Lizard

Assessment of Significance

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

The Pink-tailed Legless Lizard has not been recorded within the Study Area and is only known from one record in the locality. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Extensive areas of suitable habitat occur within the Study Area and wider locality. Given that this species hasn't been recorded within the Study Area it is not considered that the Project will result in the extinction of a viable local population of this 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*

Not applicable.

(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.

(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*

A breakdown of the areas of impact to this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for the Pink-tailed Legless Lizard. Additional impacts are considered likely to occur as a result of subsidence effects. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Pink-tailed Legless Lizard	Potential	710	1,076	4,138

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation and grassland areas. Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

Given that no individuals of the Pink-tailed Legless Lizard were recorded within the Study Area, the habitat present is not considered to be locally important for the long-term survival of the species. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

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

No critical habitat for the Pink-tailed Legless Lizard has been identified by OEH.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

A recovery plan has not been prepared for the Pink-tailed Legless Lizard. The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is 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 KTPs are relevant to potentially occurring Pink-tailed Legless Lizard within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of forage and shelter habitat available for this species;

- ‘Removal of dead wood and dead trees’ as this reduces structural complexity and the abundance of important ground foraging and shelter habitat;
- ‘Invasion of native plant communities by exotic perennial grasses’ as this structural complexity and results in the loss of key habitat;
- ‘Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)’ as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- ‘Predation by feral cats (*Felis catus*)’ as this can cause mortality of individuals;
- ‘Predation by the European Red Fox (*Vulpes vulpes*)’ as this can cause mortality of individuals;
- ‘Predation, habitat degradation, competition and disease transmission by Feral Pigs, (*Sus scrofa*)’ as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

No individuals of the Pink-tailed Legless Lizard were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the Pink-tailed Legless Lizard.

iii. Rosenberg’s Goanna

Assessment of Significance

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

Rosenberg’s Goanna has not been recorded within the Study Area; however this species has been recorded in connected areas of habitat. The local population of this species is considered to extend beyond the Study Area. The local population of this species has been assessed as viable.

The Project will remove potential habitat in the form of grassland and forest vegetation. Extensive areas of suitable habitat occur within the Study Area and wider locality. Given that this species hasn’t been recorded within the Study Area it is not considered that the Project will result in the extinction of a viable local population of this 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*

Not applicable.

(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.

(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*

A breakdown of the areas of impact to this species is shown below. The area of habitat to be removed within the Project Disturbance Boundary represents potential habitat for Rosenberg's Goanna. Additional impacts are considered likely to occur as a result of subsidence effects. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

Species	Occurrence within Study Area	Area of habitat within Project Disturbance Boundary (ha)	Area of habitat within Subsidence Study Area (ha)	Residual Area within the Study Area (ha)
Rosenberg's Goanna	Potential	125	795	3,022

The Project is not considered to significantly increase fragmentation of habitat for this species within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation and remnant patches.

Habitat connectivity will be maintained within the Study Area and with adjacent conservation reserves.

Given that no individuals of Rosenberg's Goanna were recorded within the Study Area, the habitat present is not considered to be locally important for the long-term survival of the species. Extensive areas of suitable habitat will remain and connect to adjacent conserved habitat.

(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 OEH.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan has not been prepared for Rosenberg's Goanna. The threat abatement plan for the KTP of 'Predation by the European Red Fox (*Vulpes vulpes*)' is 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 KTPs are relevant to potentially occurring Rosenberg's Goanna within the Study Area:

- 'Clearing of native vegetation' as this reduces the area of forage and shelter habitat available for this species;
- 'Removal of dead wood and dead trees' as this reduces structural complexity and the abundance of important ground foraging and shelter habitat;
- 'Invasion of native plant communities by exotic perennial grasses' as this structural complexity and results in the loss of key habitat;
- 'Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)' as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- 'Predation by feral cats (*Felis catus*)' as this can cause mortality of individuals;
- 'Predation by the European Red Fox (*Vulpes vulpes*)' as this can cause mortality of individuals;
- 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, (*Sus scrofa*)' as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

No individuals of Rosenberg's Goanna were recorded within the Project Disturbance Boundary and Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest vegetation. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to Rosenberg's Goanna.

Appendix I

Assessment of Significance (Commonwealth)

I.1 Introduction

This appendix contains assessments of significance according to the MNES *Significant Impact Guidelines 1.1* (DoE, 2013). They are intended to assist in determining whether the impacts of the Project on any MNES are likely to be significant. They provide a means by which to gauge the significance of predicted impacts to threatened species, populations and ecological communities and have been prepared to examine the magnitude of impacts to threatened biota.

Both direct and indirect impacts are taken into account within these assessments. Direct impacts have been quantified within the assessments and are represented by the Project Disturbance Boundary. Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of MNES, such impacts cannot be mapped or accurately calculated in advance. However, subsidence impacts can be and the impacts have been predicted and mapped as occurring within an area defined as the Subsidence Study Area. An important consideration in these assessments is that the direct and indirect impacts are not proposed to take place at one time; rather they will take place progressively.

Each assessment of significance reproduces the significant impact criteria in italicised text, beneath which a response is supplied in plain text. The responses have been prepared under the scenario that no mitigation or compensatory measures are applied. That is, to determine the significance of impacts, the assessments of significance consider the impacts without amelioration. The Project does however include substantial mitigation and offset measures. The ultimate conclusions to this EIA take such measures into consideration when assessing the long term implications for MNES. Assessment of avoidance, mitigation and compensatory measures for MNES considered the relevant Threat Abatement Plans, Conservation/Listing Advices and Recovery Plans (see ***Section I.5***).

I.2 Ecological Communities

I.2.1 White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to Box Gum Woodland and Derived Native Grassland. Where possible, the Project design has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure designs (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to Box Gum Woodland and Derived Native Grassland. Approximately 13 ha of the woodland form of this community was further avoided; however the overall avoidance from the latest amendments is 5 ha.

Mitigation measures to be implemented for the Project that are relevant to this community include dust minimisation, management of surface water, erosion and sedimentation, feral animal and overabundant native animal management, clearing protocols, subsidence monitoring, mine rehabilitation and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project.

A number of these mitigation and management measures are in line with the threat abatement plans relevant to this community, including the 'Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi'* (DoE, 2014u), 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' (DEH, 2005), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a) and 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b).

The Listing Advice for Box Gum Woodland and Derived Native Grassland (Threatened Species Scientific Committee, 2006) includes a number of priority recovery and threat abatement actions. A number of the actions suggested for this community are addressed by the avoidance, mitigation and offset measures proposed to be implemented for the Project, including protection of remnants, management of weeds, revegetation works and expansion and connection of existing remnants.

The BOS for the Project will provide and allow for the ongoing management of land for conservation which will assist in meeting a number of the objectives of the National Recovery Plan for Box Gum Woodland and Derived Native Grassland (DECCW, 2011). This includes achieving no net loss in the extent of Box Gum Woodland and Derived Native Grassland, increasing protection of sites with recovery potential, increasing landscape functionality of the ecological community through management and restoration of degraded sites, and increasing transitional areas around remnants and linkages between remnants. Additionally, KEPCO is committed to establishing and managing biodiversity offset lands to increase the extent, integrity and function of the ecosystems on this land, which comprise vast areas of Box Gum Woodland and Derived Native Grassland.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

> *reduce the extent of an ecological community*

The Project will result in the clearing of 135 ha of Box Gum Woodland and Derived Native Grassland. In the absence of appropriate mitigation measures, this will reduce the extent of this community in the locality.

> *fragment or increase fragmentation of an ecological community*

The Project is not considered to significantly increase fragmentation of Box Gum Woodland and Derived Native Grassland within the Study Area. The majority of the Project Disturbance Boundary has previously been cleared of treed vegetation through agricultural practices. Some fragmentation will occur between isolated patches of treed vegetation, including scattered trees on the valley floor, and the adjacent intact vegetation on the footslopes. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat.

> *adversely affect habitat critical to the survival of an ecological community*

Box Gum Woodland and Derived Native Grassland has previously been substantially cleared and or modified within the Study Area. The habitat within the Study Area is considered to be critical to the survival of the community in immediate locality, given the historic clearance and modification. The habitat to be cleared represents a small portion of the available habitat within the immediate locality. The habitat occurring above the Subsidence Study Area represented a larger portion of the available habitat. Although potentially impacted through subsidence, the impacts are not conserved to adversely affect the survival of the community.

> *modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns*

Within the Project Disturbance Boundary, the extent of Box Gum Woodland and Derived Native Grassland will be entirely removed. The portions of this community occurring at this interface have the potential to be indirectly impact. Clearing of vegetation at this interface will increase edge effects on the retained portion of Box Gum Woodland and Derived Native Grassland and as a result, the community may be impacted by altered microclimates, weed invasion and soil erosion.

Box Gum Woodland and Derived Native Grassland also has the potential to be indirectly impacted by subsidence. Subsidence movements include the vertical and horizontal displacement of ground, which may change the slope of the ground surface or cause fracturing and deformations in the bedrock or overlying strata. Changes in the ground slope may also cause alterations in the alignments of drainage lines, ponding and increased flooding. However, the impacts resulting from subsidence are not expected to significantly impact the occurrence of this community within the Study Area.

> *cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species*

Within the Project Disturbance Boundary, a substantial change will occur to the species composition of Box Gum Woodland and Derived Native Grassland, as it will be entirely removed. There is potential for changes to species composition in the area of this community above the Subsidence Study Area as a result of subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in species composition.

CUMBERLAND ECOLOGY

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- assisting invasive species, that are harmful to the listed ecological community, to become established, or

- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

Box Gum Woodland and Derived Native Grassland has previously been substantially cleared and or modified within the Study Area. Although invasive flora species are known to occur within this community, there is the potential for an increase of such species if left un-mitigated due to changing land uses and management.

The Project will not result in the regular mobilisation of chemicals that kill or inhibit the growth of plant species into Box Gum Woodland and Derived Native Grassland.

interfere with the recovery of an ecological community.

The Project will remove approximately 135 ha of Box Gum Woodland and Derived Native Grassland, including 74 ha of woodland form and 66 ha of grassland form. A further 672 ha of this community occurs above the Subsidence Study Area, including 518 ha of woodland form and 154 ha of grassland form, and may be impacted by subsidence. In the absence of mitigation measures, the Project has the potential to interfere with the recovery of this community within the Study Area.

Conclusion

The Project will result in the direct loss of 135 ha of Box Gum Woodland and Derived Native Grassland, which will impact on this community, the extent of which has already been significantly reduced due to past clearing. Additional areas of this community may also be indirectly impacted by subsidence.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans, Listing Advice and Recovery Plan relevant to this community. Without the implementation of such measures the Project is expected to result in a significant impact to the Box Gum Woodland and Derived Native Grassland community.

I.3 Flora Species

I.3.1 Tylophora linearis

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to *Tylophora linearis*. The Project mine plan (and associated Project Disturbance Boundary) has been specifically refined to avoid direct disturbance to all known occurrences of this species within the Study Area. The largest known patch of *Tylophora linearis* within the Study Area was specifically avoided by an adjustment to the footprint of the north western OEA. Impacts to suitable habitat comprising Slaty Gum Woodland have also been reduced through amendments to the Project Disturbance Boundary via refinements to infrastructure and mine plan designs.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, feral animal and overabundant native animal management, clearing protocols, species monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a) and 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs' (DEH, 2005).

The Conservation Advice for *Tylophora linearis* (Threatened Species Scientific Committee, 2008f) includes a number of regional and local priority recovery and threat abatement actions. A number of these actions suggested for this species are addressed by the avoidance, mitigation and compensation measures proposed to be implemented for the Project, including protection of known sites from disturbance, species monitoring and weed management.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

> *lead to a long-term decrease in the size of a population*

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. .This species is known to occur at few locations within the Study Area and areas immediately adjacent.

> *reduce the area of occupancy of the species*

No individuals of *Tylophora linearis* were recorded within the Project Disturbance Boundary or within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha of Slaty Box Woodland, within which this species has been recorded within the Study Area. An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area, however the potential subsidence-related impacts within this area are not expected to significantly impact this species. This species is known to occur at a few locations within the Study Area and areas immediately adjacent.

fragment an existing population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices. The locations of *Tylophora linearis* within the Study Area are currently separated by agricultural land.

adversely affect habitat critical to the survival of a species

The action will remove 11 ha of Slaty Box Woodland, the community within which this species has been recorded. An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area. The potential subsidence-related impacts within this area are not expected to significantly impact this species. Known habitat within similar vegetation occurs outside of the Study Area. Large areas of similar habitat occur in the locality outside of the Study Area that will not be affected by the Project.

disrupt the breeding cycle of a population

The majority of individuals occur at one location within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Additional individuals from this local population occur immediately adjacent to the Project Disturbance Boundary and Study Area. Therefore the action will not remove the entire extent of this local population and it is expected that the species will persist within the local area. This species is known to occur at other locations within the Study Area outside of the Project Disturbance Boundary and Subsidence Study Area.

modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The action will remove 11 ha of Slaty Box Woodland, the community within which this species has been recorded. An additional 124 ha of Slaty Box Woodland occurs above the Subsidence Study Area. The potential subsidence-related impacts within this area are not expected to significantly impact this species.

result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

There is a potential for exotic flora species to spread into the habitat within which this species occurs. Additionally, changes in land management practices may result in an increase in abundance of feral animals which have the potential to modify habitat for this species.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause a population of *Tylophora linearis* to decline.

interfere with the recovery of the species.

Tylophora linearis will primarily be impacted by the Project through direct removal of potential habitat within the Project Disturbance Boundary. Approximately 11 ha of Slaty Box Woodland, the community within which this species has been recorded in, will be removed within the Project Disturbance Boundary. As the largest known population within the Study Area occurs outside of the Project Disturbance Boundary, the action is unlikely to interfere with the recovery of this species.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, locality and conservation reserves, the removal and possible modification of potential habitat is not considered to result in a significant impact to this species. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Tylophora linearis*. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

I.3.2 Ozothamnus tesselatus

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to *Ozothamnus tesselatus*. The Project Disturbance Boundary avoids all known occurrences of this species within the Study Area, however a number of individuals occur within the Subsidence Study Area.

Mitigation measures relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, feral animal and overabundant native animal management, clearing protocols, species monitoring, subsidence monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the ‘Threat abatement plan for competition and land degradation by unmanaged goats’ (DEWHA, 2008b), ‘Threat abatement plan for competition and land degradation by rabbits’ (DEWHA, 2008a) and ‘Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs’ (DEH, 2005).

The Conservation Advice for *Ozothamnus tesselatus* (Threatened Species Scientific Committee, 2008b) includes a number of regional and local priority recovery and threat abatement actions. A number of these are actions suggested for this species are addressed by the avoidance, mitigation and compensation measures proposed to be implemented for the Project for this species, including protection of known sites, species monitoring, subsidence monitoring, managing access and managing any observed impacts.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The population of *Ozothamnus tesselatus* occurring within the Study Area is not considered as an important population. This species is known from numerous locations within the locality. No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and 15 individuals of the species were detected within the Subsidence Study Area. The species has been recorded within the Study Area outside of the Project Disturbance Boundary and Subsidence Study Area. As it considered that the Study Area does not support and important population of *Ozothamnus tesselatus*, and that the species will continue to occur within the Study Area, it is considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support an important population of *Ozothamnus tesselatus*, it is also considered unlikely that the action will reduce the area of occupancy of an important population. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence may also impact six individuals of the species, 124 ha of Slaty Box Woodland and 86 ha of Blue-leaf Ironbark / Cypress Forest within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

fragment an existing important population into two or more populations

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and 15 individuals were identified within the Subsidence Study Area. As it is considered that the Study Area does not support an important population of *Ozothamnus tesselatus*, and that habitat connectivity and individuals will continue to occur within the Study Area, it is considered unlikely that the action will fragment an existing important population into two or more populations.

The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species?

The habitat occurring within the Study Area is not considered to be critical to the survival of the species. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence may also impact 124 ha of Slaty Box Woodland and 86 ha Blue-leaf Ironbark / Cypress Forest within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

disrupt the breeding cycle of an important population

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and 15 individuals were detected within the Subsidence Study Area. This species is known to occur at locations within the Study Area outside of the Project Disturbance Boundary and Subsidence Study Area. The life cycle of this species is not considered to be disrupted as a result of the Project.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and six individuals were detected within the Subsidence Study Area. The direct impact to this species is the removal of potential habitat in the form of 11 ha Slaty Box Woodland, within which this species has been recorded within the Study Area. Potential indirect impacts resulting from subsidence may also impact six individuals of the species, 124 ha of Slaty Box Woodland and 86 ha of Blue-leaf Ironbark / Cypress Forest within the Subsidence Study Area. The potential changes to these communities resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

Extensive areas of suitable habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. However, the action is unlikely to introduce invasion species that may harm *Ozothamnus tesselatus*.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause the local population of *Ozothamnus tesselatus* to decline.

interfere substantially with the recovery of the species

No individuals of *Ozothamnus tesselatus* were recorded within the Project Disturbance Boundary, and 15 individuals of the species occur within the Subsidence Study Area. Known habitat for this species within the Study Area occurs outside of these areas. Extensive areas of suitable habitat also occur within the locality, including within conservation reserves.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area, locality and conservation reserves, the removal and possible modification of potential habitat is not considered to result in a significant impact to this species. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Ozothamnus tesselatus*. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

I.3.3 Prostanthera discolor

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of potential impacts to *Prostanthera discolor*. Although no individuals of this species have been identified within the Study Area, the refinement of the mine plan and infrastructure design to minimise direct impacts to woodland effectively results in the avoidance of potential habitat relevant to this species.

Mitigation measures relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, feral animal and overabundant native animal management, clearing protocols, subsidence monitoring, species monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a) and 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs' (DEH, 2005).

The Conservation Advice for *Prostanthera discolor* (Threatened Species Scientific Committee, 2008e) includes a number of regional and local priority recovery and threat abatement actions; however a number of these relate to sites where the species is known to occur. Despite no individuals of this species having been detected within the Study Area, some of these actions are addressed by the mitigation measures relevant to this species, including weed management and management of run-off, sedimentation or pollution.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, despite surveys appropriate for the detection of the species being undertaken. As it considered that the Study Area does not support and important population of *Prostanthera discolor* it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of *Prostanthera discolor* it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will remove potential habitat in the form of woodland and forest communities, particularly those in gullies and along creek lines. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of *Prostanthera discolor* it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species?

Prostanthera discolor has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival. Areas of similar habitat occur within the Study Area, outside of the Project Disturbance Boundary. Extensive areas of similar habitat also occur within the locality.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of *Prostanthera discolor* it is also considered unlikely that the action will disrupt the life cycle of an important population. Areas of similar habitat occur within the Study Area, outside of the Project Disturbance Boundary. Extensive areas of similar habitat also occur within the locality.

> *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

No individuals of *Prostanthera discolor* were recorded within the Project Disturbance Boundary or Subsidence Study Area. The Project will remove potential habitat in the form of woodland and forest communities, particularly those in gullies and along creek lines. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

> *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

The action will generate indirect impacts associated with the construction and operation of the Project. Although exotic flora species and some feral animals that may cause habitat destruction currently occur within the Study Area, there is the potential for the Project to increase such impacts if left un-mitigated due to changing land uses and management.

> *introduce disease that may cause the species to decline*

The Project is considered unlikely to introduce disease that may cause the local population of *Prostanthera discolor* to decline.

> *interfere substantially with the recovery of the species*

Prostanthera discolor has not been recorded within the Study Area and therefore no known populations will be affected. The Project will remove potential habitat in the form of woodland and forest communities, particularly those in gullies and along creek lines. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area and locality, the removal and possible modification of potential habitat is not considered to result in a significant impact to this species. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Prostanthera discolor*. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

I.3.4 Thesium australe

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of potential impacts to *Thesium australe*. Although no individuals of this species have been identified within the Study Area, the refinement of the mine plan and infrastructure design to minimise direct impacts to woodland effectively results in the avoidance of potential habitat relevant to this species.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, feral animal and overabundant native animal management, clearing protocols, species monitoring, subsidence monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a) and 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs' (DEH, 2005).

The Conservation Advice for *Thesium australe* (Threatened Species Scientific Committee, 2013) includes a number of regional and local priority recovery and threat abatement actions; however a number of these relate to sites where the species is known to occur. Despite no individuals of this species having been detected within the Study Area, some of the actions suggested for this species are addressed by the mitigation measures relevant to this species, including weed management. Additionally, survey work undertaken within the Study Area is in line with one of the local actions for the species, which requires surveys to be undertaken within suitable habitat to locate new populations of the species.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, despite surveys appropriate for the detection of the species being undertaken. As it considered that the Study Area does not support and important population of *Thesium australe* (Austral Toadflax) it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of *Thesium australe* (Austral Toadflax) it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of *Thesium australe* (Austral Toadflax) it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species?

Thesium australe (Austral Toadflax) has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival. Areas of similar habitat occur within the Study Area, outside of the Project Disturbance Boundary. Extensive areas of similar habitat also occur within the locality.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of *Thesium australe* (Austral Toadflax) it is also considered unlikely that the action will disrupt the life cycle of an important population. Areas of similar habitat occur within the Study Area, outside of the Project Disturbance Boundary. Extensive areas of similar habitat also occur within the locality.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No individuals of *Thesium australe* (Austral Toadflax) were recorded within the Project Disturbance Boundary or Subsidence Study Area. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Potential indirect impacts resulting from subsidence may also impact the habitat within the Subsidence Study Area. The potential changes to habitat resulting from subsidence are expected to be localised and overall are not considered to cause a substantial change in potential habitat.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although exotic flora species and some feral animals that may cause habitat destruction currently occur within the Study Area, there is the potential for the Project to increase such impacts if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause the local population of *Thesium australe* (Austral Toadflax) to decline.

interfere substantially with the recovery of the species

Thesium australe (Austral Toadflax) has not been recorded within the Study Area and therefore no known populations will be affected. The Project will remove potential habitat in the form of grassland and grassy woodland vegetation. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

Given that no individuals of this species have been recorded within the Project Disturbance Boundary and the extent of potential habitat within the Study Area and locality, the removal and possible modification of potential habitat is not considered to result in a significant impact to this species. Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to *Thesium australe* (Austral Toadflax). These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

I.4 Fauna Species

I.4.1 Birds

i. Regent Honeyeater (Anthochaera phrygia)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Regent Honeyeater. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to Box Gum Woodland and Derived Native Grassland (woodland form) which is recognised as critical to the survival of this species.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, clearing protocols, species monitoring, subsidence monitoring, mine rehabilitation and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' (DEH, 2005), which is listed as relevant to this species, as well as other threat abatement plans for feral animals.

The current Conservation Advice for the Regent Honeyeater (Threatened Species Scientific Committee, 2015) includes a number of conservation actions. Actions from the Conservation Advice which will be addressed by the mitigation and offset measures proposed for the Project which includes improving the extent and quality of habitat for this species within the locality by implementing the BOS.

The BOS for the Project will provide and allow for the ongoing management of land for conservation which will assist in meeting some of the relevant objectives of the recovery plan for the Regent Honeyeater (Menkhorst *et al.*, 1999). This includes, maintenance and enhancement of the value of habitat for this species on the land contained within the BOS and monitoring of this species within the Study Area. The value of the habitat within the Study Area will be improved through conservation of vegetation within the offset sites, habitat management and improving connectivity of woodland vegetation within the locality.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of a population

Approximately 229 ha of suitable foraging habitat will be removed, which is represented by woody vegetation. Of this area, approximately 169 ha comprises woody vegetation that is dominated or co-dominated by nectar producing trees identified within the OEH (2014t) and DoE (2014a) profiles for the species and the recovery plan (Menkhorst *et al.*, 1999). A portion of the habitat to be removed within the Project Disturbance Boundary represents important habitat for this species. Other potential areas of habitat for this species occur within the Study Area and locality.

reduce the area of occupancy of the species

The Project will remove 229 ha of habitat for the Regent Honeyeater, including 169 ha of vegetation that is dominated or co-dominated by key nectar producing trees. A portion of the habitat to be removed within the Project Disturbance Boundary represents important habitat for this species.

fragment an existing population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

The Project will remove 229 ha of habitat for the Regent Honeyeater, including 169 ha of vegetation that is dominated or co-dominated by key nectar producing trees. A portion of the habitat to be removed within the Project Disturbance Boundary represents important habitat for this species. Box Gum Woodland and Derived Native Grassland (woodland form) is recognised as critical to the survival of this species.

disrupt the breeding cycle of a population

As the Study Area occurs outside of the known breeding areas of the Regent Honeyeater within NSW, the Project is not anticipated to impact breeding habitat for this species. Breeding habitat for the species is not known to occur within the Study Area, however potential future breeding habitat in the form of old-growth and *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) may exist in the future.

modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will remove 229 ha of habitat for the Regent Honeyeater, including 169 ha of vegetation that is dominated or co-dominated by key nectar producing trees. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species.

This species is highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves.

result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Changes in land management practices may result in an increase in abundance of overabundant native species which may impact the Regent Honeyeater.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the local population of Regent Honeyeater to decline.

interfere with the recovery of the species.

As Box Gum Woodland and Derived Native Grassland (woodland component) is recognised as important habitat for this species, removal of 61 ha of this community is considered to impact the Regent Honeyeater.

Conclusion

The Project will result in the direct loss of known habitat for Regent Honeyeater. Additional areas of this habitat may also be indirectly impacted by subsidence. The species is highly mobile and is likely to utilise numerous habitat resources within the locality. The Project will remove 229 ha of habitat for the Regent Honeyeater, including 169 ha of vegetation that is dominated or co-dominated by key nectar producing trees. The Project will result in the loss of important habitat for the Regent Honeyeater in the form of 61 ha of Box Gum Woodland and Derived Native Grassland (woodland form).

A range of impact avoidance, mitigation and compensation measures have been developed for the Project. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans, Conservation Advice and Recovery Plan relevant to this species. In the absence of appropriate mitigation and offset measures, the removal of this habitat would represent the loss of an important habitat for this species.

ii. Swift Parrot (Lathamus discolor)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Swift Parrot. Although no individuals of this species have been identified within the Study Area, the refinement of the mine plan and infrastructure design to minimise direct impacts to woodland effectively results in the avoidance of potential habitat relevant to this species. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, clearing protocols, species monitoring, subsidence monitoring, mine rehabilitation and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the 'Threat abatement plan for predation by feral cats' (DoE, 2015), which is listed as relevant to this species. Another plan, the 'Threat abatement plan for beak and feather disease affecting endangered psittacine species' is also relevant to this species. The Project is not considered to be inconsistent with the objectives of this plan.

No regional and local priority recovery and threat abatement actions are listed within the Conservation Advice for the Swift Parrot (Threatened Species Scientific Committee, 2012). A national recovery plan has been prepared for the Swift Parrot (Saunders and Tzaros, 2011) which lists a number of recovery objectives and actions. The provision and management of offsets will also assist in meeting some of the actions outlined within this plan. This includes, identifying, managing and monitoring the extent and quality of habitat for this species.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

> *lead to a long-term decrease in the size of a population*

The Project will remove 229 ha of habitat for the Swift Parrot. This habitat represents foraging habitat only. This species is highly mobile, thus are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves.

> *reduce the area of occupancy of the species*

The Project will remove 229 ha of habitat for the Swift Parrot. The loss of foraging habitat will result in a net decrease in the amount of suitable habitat available to this species within the Study Area. The Swift Parrot is particularly reliant on mass flowering events to fuel its migration to the next resource patch. Drought periods and poor flowering seasons can increase the significance of remaining patches of intact woodland and forest.

> *fragment an existing population into two or more populations*

The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

> *adversely affect habitat critical to the survival of a species*

The Project will remove 229 ha of habitat for the Swift Parrot. This habitat represents foraging habitat only. This species has only been recorded once in the locality from 1995. The habitat within the Study Area is not considered critical to the survival of the species.

> *disrupt the breeding cycle of a population*

The Swift Parrot breeds in Tasmania, as such, the action will not impact the breeding cycle of the species.

> *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

CUMBERLAND ECOLOGY

The action will remove 229 ha of habitat for the Swift Parrot. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for these species. This species is highly mobile and are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves.

> *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

Changes in land management practices may result in an increase in abundance of overabundant native species which may impact the Swift Parrot.

> *introduce disease that may cause the species to decline, or*

The Project is considered unlikely to introduce disease that may cause the local population of Swift Parrot to decline.

> *interfere with the recovery of the species.*

The action will remove 229 ha of habitat for the Swift Parrot. As this species is not known to occur frequently within the locality, it is not expected to rely on the habitat within the Study Area. As such the removal of habitat within the Project Disturbance Boundary is not considered to interfere with the recovery of the species.

Conclusion

The Project will result in the direct loss of potential habitat for the Swift Parrot. Additional areas of this habitat may also be indirectly impacted by subsidence. Given that the species is highly mobile and are likely to utilise numerous habitat resources within the locality, the species are considered to remain viable within the locality

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

iii. Migratory Species

The following Assessment of Significance has been prepared as a composite test for migratory species listed under the EPBC Act that are known to or are likely to occur within the Study Area. These include the following:

- Rainbow Bee-eater (known to occur);
- White-throated Needletail (known to occur);
- White-bellied Sea-eagle (potential to occur);

- Fork-tailed Swift (potential to occur);
- Cattle Egret (potential to occur);
- Eastern Great Egret (potential to occur);
- Satin Flycatcher (potential to occur); and
- Rufous Fantail (potential to occur).

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the assessed migratory species. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. The Project Disturbance Boundary is predominantly located within cleared land.

Mitigation measures to be implemented for the Project that are relevant to these species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, clearing protocols, subsidence monitoring, species monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to these species, including the 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c) and 'Threat abatement plan for predation by feral cats' (DoE, 2015).

No conservation advice or recovery plan has been prepared for any of the assessed migratory species.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

> *substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*

The area of habitat within the Study Area to be impacted by the Project is not considered important habitat for these migratory species and it represents a relatively small area of suitable habitat within a regional context. As such, the action will not substantially modify, destroy or isolate an area of important habitat for these species.

result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The action will generate indirect impacts associated with the construction and operation of the Project. Species such as Cats (*Felis catus*) and Foxes (*Vulpes vulpes*) which may predate on the species have the potential to increase as a result of the construction of the Project. The change to land use and tenure (i.e. from agriculture to mining) may lead to an increase in these feral species due to changes to land management practices, such as less regular suppression of exotic species.

seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The action will not seriously disrupt the lifecycle of an ecologically significant proportion of these species. A relatively small amount of suitable habitat will be directly impacted by the Project, however this is a small area in the broader scale of the species' range, and significant areas of suitable foraging and breeding habitat will continue to exist within the Study Area and with the locality.

Conclusion

The habitat occurring within the Project Disturbance Boundary and Subsidence Study Area is not considered important for the known and potentially occurring Migratory species. The area of suitable habitat is considered small compared to the amount of suitable habitat within the species' range, thus no significant impact is predicted to occur to these species as a result of the Project. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans relevant to these species.

I.4.2 Mammals

i. Spotted-tailed Quoll (Dasyurus maculatus)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Spotted-tailed Quoll. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to woodland habitats within the Study Area.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c) and 'Threat abatement plan for predation by feral cats' (DoE, 2015).

No regional and local priority recovery and threat abatement actions are listed within the Listing Advice for the Spotted-tailed Quoll. A draft national recovery plan has been prepared for the Spotted-tailed Quoll (Long and Nelson, 2010), which lists a number of recovery objectives. The provision and management of offsets will assist in meeting some of the actions outlined within this plan including managing the threat posed by introduced predators.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of a population

The Project will remove 229 ha of habitat for the Spotted-tailed Quoll, and an additional 1,347 ha occurs within the Subsidence Study Area. Extensive areas of suitable habitat occur within the Study Area. This species is highly mobile, thus are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. The removal of some potential habitat within the Study Area is not expected to lead to a long-term decrease in the size of the population.

reduce the area of occupancy of the species

The Project will remove 229 ha of habitat for the Spotted-tailed Quoll, and an additional 1,347 ha occurs within the Subsidence Study Area. Extensive areas of suitable habitat occur within the Study Area. This species is highly mobile, thus are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves.

fragment an existing population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

The Project will remove 229 ha of habitat for the Spotted-tailed Quoll. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. The habitat within the Study Area is not considered critical to the survival of the species. This species is highly mobile, thus are considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. The removal of some potential habitat within the Study Area is not expected to lead to a long-term decrease in the size of the population.

disrupt the breeding cycle of a population

The Project will remove an area of known habitat for the Spotted-tailed Quoll, including foraging and breeding habitat. Areas of habitat within the Project Disturbance Boundary may provide suitable breeding habitat for this species, however it is expected that breeding habitat is primarily located outside of the Project Disturbance Boundary. This species are highly mobile and is considered likely to utilise habitat resources throughout the locality and within adjacent conservation reserves. These areas will continue to provide breeding habitat for the Spotted-tailed Quoll.

modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The action will remove 229 ha of habitat for the Spotted-tailed Quoll. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species.

result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*), Foxes (*Vulpes vulpes*) and Pigs (*Sus scrofa*), which could impact the Spotted-tailed Quoll through predation or habitat destruction, currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the local population of the Spotted-tailed Quoll to decline.

interfere with the recovery of the species.

The Project will directly impact approximately 229 ha of suitable habitat for the species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 229 ha of potential habitat for the Spotted-tailed Quoll. This includes the removal of potential forage, shelter and breeding habitat. Additionally, feral species may increase as a result of the Project. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

ii. New Holland Mouse (Pseudomys novaehollandiae)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the New Holland Mouse. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to woodland habitats. The Project Disturbance Boundary avoids the known occurrence of this species within the Study Area.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the ‘Threat abatement plan for predation by European red fox’ (DEWHA, 2008c) and ‘Threat abatement plan for predation by feral cats’ (DoE, 2015).

The Conservation Advice for the New Holland Mouse (DEWHA, 2010a) includes a number of regional and local priority recovery and threat abatement actions. A number of these are actions are addressed by the avoidance, mitigation and compensation measures relevant to this species, including monitoring of the known occurrence of the species, conservation and management of habitat, managing access, managing impacts, weed management and feral animal management.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

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lead to a long-term decrease in the size of an important population of a species

The species was recorded at one location within the Study Area. The individuals occurring within the Study Area form part of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality. This species is considered likely to persist within the Study Area.

reduce the area of occupancy of an important population

The action will involve the removal of approximately 125 ha of foraging and breeding habitat for this species, with an additional area impacted indirectly. Whilst there may be some movement of this species within the Study Area, it is not considered that the Project will result in a significant reduction in the area of occupancy for this species. Extensive areas of similar habitat for these species are located within the locality and protected within conservation reserves.

fragment an existing important population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area, as the majority of the Project Disturbance Boundary has previously been modified through agricultural practices. The proposed action will result in the reduction of available habitat for the New Holland Mouse. However this reduction is not considered to result in further fragmentation of such habitat.

adversely affect habitat critical to the survival of a species

The Project will remove 125 ha of habitat for the New Holland Mouse. Additional areas of habitat occur within the Subsidence Study Area and may be impacted by subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. The habitat within the Study Area is not considered critical to the survival of the species. The removal of some potential habitat within the Study Area is not expected to lead to a long-term decrease in the size of the population.

disrupt the breeding cycle of an important population

Direct and indirect impacts of the Project are not considered to result in the disruption of the breeding cycle of the New Holland Mouse.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 125 ha of suitable habitat for this species. Additional impacts are considered likely to occur as a result of subsidence. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. There may be additional short-medium term impacts from operational impacts.

Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

> *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*), Foxes (*Vulpes vulpes*) and Pigs (*Sus scrofa*), which could impact the New Holland Mouse through predation or habitat destruction, currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

> *introduce disease that may cause the species to decline*

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the New Holland Mouse to decline.

> *interfere substantially with the recovery of the species*

The Project will directly impact approximately 125 ha of suitable habitat for the species. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 125 ha of potential habitat for the New Holland Mouse and indirectly impact additional areas. The long-term viability of these species in the locality is unlikely to be impacted.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

iii. Brush-tailed Rock-wallaby (Petrogale penicillata)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Brush-tailed Rock-wallaby. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to woodland habitats and significant cliff line habitats.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, subsidence monitoring, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a), 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c) and 'Threat abatement plan for predation by feral cats' (DoE, 2015).

The BOS for the Project will provide and allow for the ongoing management of land for conservation which will assist in meeting a number of the objectives of the National Recovery Plan for the Brush-tailed Rock-wallaby (Menkhorst and Hynes, 2010). This includes, managing threats to the species (such as predation from feral animals) and monitoring of the species.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species was recorded one location within the Study Area. The individuals occurring within the Study Area form part of an important population that occurs within Wollemi National Park. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality. This species is considered likely to persist within the Study Area.

reduce the area of occupancy of an important population

The action will involve the removal of approximately 125 ha of foraging and breeding habitat for this species. Less than 1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. Whilst there may be some movement of this species within the Study Area, it is not considered that the Project will result in a significant reduction in the area of occupancy for this species. Extensive areas of similar habitat for this species are located within the locality and protected within conservation reserves.

fragment an existing important population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area, as the majority of the Project Disturbance Boundary has previously been modified through agricultural practices. The Brush-tailed Rock-wallaby is a mobile species. The removal and modification of habitat for this species as a result of the proposed action is therefore not considered to fragment a population of this species.

adversely affect habitat critical to the survival of a species

The presence of caves and their associated features are important habitat features for the Brush-tailed Rock-wallaby. Less than 1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. The Project may result in the modification of cave habitat above the Subsidence Study Area. The Brush-tailed Rock-wallaby has not been recorded within this area and is likely the result of previous disturbance of the habitat, the presence of predators and the existence of better quality habitat elsewhere in the immediate locality.

Due to the location and scale of impacts, it is not considered that the Project will significantly affect habitat critical to the survival of the Brush-tailed Rock-wallaby within the Study Area. Similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

The habitat to be removed represents a small portion of the available habitat for this species within the Study Area. There is potential for the Project to indirectly impact breeding habitat for this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 125 ha of suitable habitat for this species. Additional impacts are considered likely to occur as a result of subsidence, which modify cave structures. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. There may be additional short-medium term impacts from operational impacts.

The potential modification of habitat above the Subsidence Study Area is considered unlikely to result in a significant decrease in the availability of habitat within this area. The loss of foraging and roosting habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area, however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,022 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*), Foxes (*Vulpes vulpes*) Pigs (*Sus scrofa*) and Goats (*Capra hircus*), which could impact the Brush-tailed Rock-wallaby through predation or habitat destruction, currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Brush-tailed Rock-wallaby to decline.

interfere substantially with the recovery of the species

The Project will directly impact approximately 125 ha of suitable habitat for the species. Less than 1 ha of native vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. Approximately 3,022 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 125 ha of potential habitat for the Brush-tailed Rock-wallaby and indirectly impact additional areas. Given that this species are mobile and is likely to utilise numerous habitat resources within the locality, the species is considered to remain viable within the locality. The long-term viability of this species in the locality is unlikely to be impacted.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

iv. Koala (Phascolarctos cinereus)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Koala. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to woodland habitats.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, subsidence monitoring, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c).

The Conservation Advice for the Koala includes a number of priority recovery and threat abatement actions. A number of the actions suggested for this species are addressed by the avoidance, mitigation and compensation measures proposed for the Project, including conservation of habitat for the species, increasing connected habitat and feral animal management.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, and only two records of this species occurs within the locality from 1957 and 1980. As it considered that the Study Area does not support and important population of the Koala it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of the Koala it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will directly impact approximately 229 ha of suitable potential habitat for the species. Approximately 3,625 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of the Koala it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

CUMBERLAND ECOLOGY

The Koala has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival. Approximately 3,625 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of the Koala it is also considered unlikely that the action will disrupt the breeding cycle of an important population. Approximately 3,625 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 229 ha of suitable potential habitat for the species. The potential modification of habitat above the Subsidence Study Area is considered unlikely to results in a decrease in the availability of habitat within this area. The loss of foraging and breeding habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area, however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,625 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*) and Foxes (*Vulpes vulpes*), which could impact the Koala, currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Koala to decline.

interfere substantially with the recovery of the species

The Koala has not been recorded within the Study Area and there are no recent records of this species within the locality. The Project will directly impact approximately 229 ha of suitable potential habitat for the species. Approximately 3,625 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study

Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 229 ha of suitable potential habitat for the Koala. Additionally, feral species may increase as a result of the Project. The species is known from two records within the locality from 1957 and 1980. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

v. Grey-headed Flying-fox (Pteropus poliocephalus)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Grey-headed Flying-fox. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design (and associated Project Disturbance Boundary) have resulted in a reduction to the impacts on areas of woodland habitat.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, feral animal and overabundant native animal management, subsidence monitoring, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c).

A draft national recovery plan has been prepared for the Grey-headed Flying-fox (DECCW, 2009), which lists a number of recovery objectives. The BOS for the Project will provide and allow for the ongoing management of land for conservation which will assist in meeting some of the actions outlined within this plan, including protecting and extending the extent of winter and spring foraging habitat and species monitoring.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

CUMBERLAND ECOLOGY

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, and no records occur within the locality. The Study Area occurs to the west of the main distribution of this species. As it considered that the Study Area does not support and important population of the Grey-headed Flying-fox it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of the Grey-headed Flying-fox it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will directly impact approximately 229 ha of suitable potential habitat for the species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of the Grey-headed Flying-fox it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

The Grey-headed Flying-fox has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival. The Study Area occurs to the west of the main distribution of this species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of the Grey-headed Flying-fox it is also considered unlikely that the action will disrupt the breeding cycle of an important population. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 229 ha of suitable potential habitat for the species. The potential modification of habitat above the Subsidence Study Area is considered unlikely to results in a decrease in the availability of habitat within this area. The loss of foraging and breeding habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area, however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Grey-headed Flying-fox to decline.

interfere substantially with the recovery of the species

The Grey-headed Flying-fox has not been recorded within the Study Area and there are no records of this species within the locality. The Project will directly impact approximately 229 ha of suitable potential habitat for the species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 229 ha of suitable potential habitat for the Grey-headed Flying-fox. Additionally, feral species may increase as a result of the Project. The species is not known from the locality, with the Study Area occurring to the west of the main distribution of this species. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

vi. Large-eared Pied Bat (Chalinolobus dwyeri)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Large-eared Pied Bat. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design (and associated Project Disturbance Boundary) have resulted in a reduction to the impact on woodland habitats and significant cliff line habitats.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, due diligence site inspections for proposed disturbance areas, visual and lighting management, subsidence monitoring, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b),

A national recovery plan has been prepared for the Large-eared Pied Bat (DERM, 2011), which lists a number of management practices that will assist in the protection of populations of this species. The BOS for the Project will provide and allow for the ongoing management of land for conservation will assist in meeting some of the actions outlined within this plan, including management of access, protection of vegetation in the vicinity of roosting habitat and feral animal management.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species was recorded at a number of locations within the Study Area. The individuals occurring within the Study Area form part of an important population of the species across the sandstone escarpments of the Hunter Valley, Sydney Basin and Southern Tablelands of NSW. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality. This species is considered likely to persist within the Study Area.

reduce the area of occupancy of an important population

The action will involve the removal of approximately 229 ha of foraging habitat for this species, and some roosting habitat. A total of 100 ha of woody vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. A further 1,347 ha may be indirectly impacted through subsidence effects. The action may also impact roosting habitat for this species in the form of caves above the Subsidence Study Area. , Whilst there may be some movement of this species within the Study Area, it is not considered that the Project will result in a significant reduction in the area of occupancy for this species. Extensive areas of similar habitat for this species are located within the locality and protected within conservation reserves.

fragment an existing important population into two or more populations

The action is not considered to significantly increase fragmentation within the Study Area, as the majority of the Project Disturbance Boundary has previously been modified through agricultural practices. The Large-eared Pied Bat is a highly mobile species. The removal and modification of habitat for this species as a result of the proposed action is therefore not considered to fragment a population of this species.

adversely affect habitat critical to the survival of a species

The presence of caves and their associated features are important habitat features for the Large-eared Pied Bat. The Project may result in the modification of cave habitat above the Subsidence Study Area, which is known to support this species.

Due to the location and scale of impacts, it is not considered that the Project will significantly affect habitat critical to the survival of the Large-eared Pied Bat within the Study Area. Similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

The Large-eared Pied Bat requires specialised habitat for breeding areas. The closest known breeding site occurs to the north west of the Study Area at Ulan. It is not known if the Study Area supports breeding habitat for the Large-eared Pied Bat.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 229 ha of suitable habitat for this species. A total of 100 ha of woody vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. A further 1,347 ha may be indirectly impacted through subsidence effects. Additional impacts are considered likely to occur as a result of subsidence, which may injure roosting bats, will modify cave structures and has the potential to impact on maternity roosting habitat. These changes are expected to be localised and overall are not considered to cause a substantial change in habitat quality for this species. There may be additional short-medium term impacts from operational impacts.

The potential modification of habitat above the Subsidence Study Area is considered unlikely to result in a significant decrease in the availability of habitat within this area. The loss of foraging and roosting habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area, however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,631 ha of similar foraging habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Large-eared Pied Bat to decline.

interfere substantially with the recovery of the species

The Project will directly impact approximately 229 ha of suitable foraging habitat for the species. A further 1,347 ha may be indirectly impacted through subsidence effects. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 229 ha of foraging habitat for the Large-eared Pied Bat and indirectly impact additional areas. A total of 100 ha of woody vegetation occurs within 200 m of identified cliff lines within the Project Disturbance Boundary. A further 1,347 ha may be indirectly impacted through subsidence effects. Given that this species are highly mobile and is likely to utilise numerous habitat resources within the locality, the species is considered to remain viable within the locality. The long-term viability of this species in the locality is unlikely to be impacted.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

vii. Corben's Long-eared Bat (Nyctophilus corbeni)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Corben's Long-eared Bat. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design (and associated Project Disturbance Boundary) have resulted in a reduction in impacts to woodland habitats.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, due diligence site inspections for proposed disturbance areas, visual and lighting management, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)' (DEH, 2005), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a), 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c) and 'Threat abatement plan for predation by feral cats' (DoE, 2015).

The BOS for the Project will provide and allow for the ongoing management of land for conservation which will assist in meeting some of the relevant objectives of the draft national recovery plan for the Corben's Long-eared Bat (Schulz and Lumsden, 2010). This includes protection of existing habitat to prevent habitat loss and fragmentation, increases to habitat connectivity and feral animal management.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species was not recorded within the Study Area during surveys, despite appropriate surveys being undertaken. However, the Atlas of NSW Wildlife holds one record of this species within the Study Area from 2010. As it considered that the Study Area does not support and important population of Corben's Long-eared Bat it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of Corben's Long-eared Bat it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will directly impact approximately 229 ha of suitable potential habitat for the species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of the Corben's Long-eared Bat it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

The habitat to be removed within the Project Disturbance Boundary represents a small portion of the available habitat for Corben's Long-eared Bat within the Study Area and locality. As such, potential habitat to be removed is not considered to be critical to its survival. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of Corben's Long-eared Bat it is also considered unlikely that the action will disrupt the breeding cycle of an important population. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 229 ha of suitable potential habitat for the species. The potential modification of habitat above the Subsidence Study Area is considered unlikely to results in a decrease in the availability of habitat within this area. The loss of foraging and breeding habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area, however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study

Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of Corben's Long-eared Bat to decline.

interfere substantially with the recovery of the species

The Project will directly impact approximately 229 ha of suitable habitat for the species. Approximately 3,631 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 229 ha of suitable potential habitat for Corben's Long-eared Bat. Additionally, feral species may increase as a result of the Project. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project, some of which are relevant to this species. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Recovery Plan relevant to this species.

I.4.3 Reptiles

i. Broad-headed Snake (Hoplocephalus bungaroides)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Broad-headed Snake. Where possible, the Project has sought to avoid direct impacts on remnant woodland and to reduce further fragmentation of remaining woodland remnants. Refinements to the mine plan and infrastructure design plans (and associated Project

Disturbance Boundary) have resulted in a reduction to the impacts to woodland habitats and significant cliff line habitats.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence site inspections for proposed disturbance areas, visual and lighting management, subsidence monitoring, clearing protocols and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for predation by European red fox' (DEWHA, 2008c) and 'Threat abatement plan for predation by feral cats' (DoE, 2015).

The Conservation Advice for the Broad-headed Snake (Threatened Species Scientific Committee, 2014b) includes a number of regional and local priority recovery and threat abatement actions. A number of these are actions are in line with the avoidance, mitigation and compensation measures proposed for the Project are relevant to this species, including protection of potential habitat, feral animal management and access management,

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, despite surveys in appropriate seasons and habitat types. As it considered that the Study Area does not support and important population of the Broad-headed Snake it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of the Broad-headed Snake it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will directly impact approximately 125 ha of suitable potential habitat for the species, and a further 795 ha may be indirectly impacted through subsidence. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of the Broad-headed Snake it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area as it predominantly requires clearing at the edge of treed habitat rather than creating fragmented habitat patches.

adversely affect habitat critical to the survival of a species

The Broad-headed Snake has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival. The Project will directly impact approximately 125 ha of suitable potential habitat for the species, and a further 795 ha may be indirectly impacted through subsidence. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area, including both summer and winter habitat. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of the Broad-headed Snake it is also considered unlikely that the action will disrupt the breeding cycle of an important population. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact 125 ha of suitable habitat for the species, and a further 795 ha may be indirectly impacted through subsidence. The cliff line habitat indirectly impacts will however be retained, albeit in a modified form. The loss of foraging and breeding habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area; however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*) and Foxes (*Vulpes vulpes*) which could impact the Broad-headed Snake through predation currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

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The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Broad-headed Snake to decline.

interfere substantially with the recovery of the species

The Broad-headed Snake has not been recorded within the Study Area and therefore no known populations will be affected. The Project will directly impact 125 ha of suitable habitat for the species, and a further 795 ha may be indirectly impacted through subsidence. Approximately 3,016 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project will directly impact 125 ha of suitable habitat for the species, and a further 795 ha may be indirectly impacted through subsidence. The direct impact to this species is predominantly summer habitat (in the form of vegetation containing hollow bearing trees within a 200 m radius of cliff lines). Both summer and winter habitat (sandstone rocks) has the potential to be indirectly impacted. Additionally, feral species may increase as a result of the Project. The species is only known from one record within the locality (at the far southern end of the locality) and it has not been recorded within the Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the Broad-headed Snake. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans and Conservation Advice relevant to this species.

ii. Pink-tailed Legless Lizard (Aprasia parapulchella)

Avoidance, Mitigation and Compensation Measures

A range of avoidance, mitigation and offset measures that have been or are proposed to be implemented for the Project are relevant to the management of impacts to the Pink-tailed Legless Lizard. Although no individuals of this species have been identified within the Study Area, the refinement of the mine plan and infrastructure design to minimise direct impacts to woodland effectively results in the avoidance of potential habitat relevant to this species.

Mitigation measures to be implemented for the Project that are relevant to this species include dust minimisation, management of surface water, erosion and sedimentation, due diligence inspections for proposed disturbance areas, feral animal and overabundant native animal management, clearing protocols, subsidence monitoring, species monitoring and the implementation of a BMP which will describe the mitigation and management measures to be implemented to the Project. A number of these measures are in line with the threat abatement plans relevant to this species, including the 'Threat abatement plan for competition and land degradation by unmanaged goats' (DEWHA, 2008b), 'Threat abatement plan for competition and land degradation by rabbits' (DEWHA, 2008a) and 'Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs' (DEH, 2005).

No conservation advice or recovery plan has been prepared for the Pink-tailed Legless Lizard.

Assessment of Significance

The assessment of significance presented below has been prepared under the scenario that no mitigation or offset measures are applied.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The species has not been recorded within the Study Area, despite surveys appropriate for the detection of the species being undertaken. As it considered that the Study Area does not support and important population of the Pink-tailed Legless Lizard it is also considered unlikely that the action will lead to a long-term decrease in the size of an important population of the species. The amount of suitable potential habitat for the species within the Project Disturbance Boundary represents a small portion of the available habitat within the Study Area and locality.

reduce the area of occupancy of an important population

As it is considered that the Study Area does not support and important population of the Pink-tailed Legless Lizard it is also considered unlikely that the action will reduce the area of occupancy of an important population. The Project will directly impact approximately 710 ha of suitable potential habitat for the species. Approximately 4,138 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

fragment an existing important population into two or more populations

As it is considered that the Study Area does not support and important population of the Pink-tailed Legless Lizard it is also considered unlikely that the action will fragment an existing important population into two or more populations. The action is not considered to significantly increase fragmentation within the Study Area. The majority of the Project Disturbance Boundary has previously been modified through agricultural practices.

adversely affect habitat critical to the survival of a species

The Pink-tailed Legless Lizard has not been recorded from within the Study Area and therefore the potential habitat to be removed is not considered to be critical to its survival.

Approximately 4,138 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

disrupt the breeding cycle of an important population

As it is considered that the Study Area does not support and important population of the Pink-tailed Legless Lizard it is also considered unlikely that the action will disrupt the breeding cycle of an important population. Approximately 4,138 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project will directly impact approximately 710 ha of suitable potential habitat for the species. The potential modification of habitat above the Subsidence Study Area is considered unlikely to results in a decrease in the availability of habitat within this area. The loss of foraging and breeding habitat within the Project Disturbance Boundary will result in a net decrease in the amount of suitable habitat available to this species within the Study Area; however it is not considered that the scale of decrease will impact the survival of the species in the locality or across its range. Approximately 4,138 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action will generate indirect impacts associated with the construction and operation of the Project. Although feral fauna species such as Cats (*Felis catus*), Foxes (*Vulpes vulpes*) and Pigs (*Sus scrofa*), which could impact the Pink-tailed Legless Lizard through predation or habitat destruction, currently occur within the Study Area, there is the potential for an increase in the abundance of such species if left un-mitigated due to changing land uses and management.

introduce disease that may cause the species to decline

The Project is considered unlikely to introduce disease that may cause a potentially occurring population of the Pink-tailed Legless Lizard to decline.

interfere substantially with the recovery of the species

The Pink-tailed Legless Lizard has not been recorded within the Study Area and therefore no known populations will be affected. The Project will directly impact approximately 710 ha of suitable potential habitat for the species. Approximately 4,138 ha of similar habitat occurs within the Study Area, outside of the Project Disturbance Boundary and Subsidence Study

Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to directly impact on approximately 710 ha of suitable potential habitat for the Pink-tailed Legless Lizard in the form of grassland and grassy woodland. This includes the removal of potential forage and shelter habitat in the form of ground debris and woodland. Additionally, feral species may increase as a result of the Project. The species is only known from one record within the locality (within Goulburn River National Park), and it has not been recorded within the Study Area. Extensive areas of similar habitat also occur within the locality, including within conservation reserves. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

Despite this, a range of impact avoidance, mitigation and compensation measures have been developed for the Project, a number of which are relevant to the Pink-tailed Legless Lizard. These proposed measures are considered to be generally consistent with the objectives and principles as provided within the Threat Abatement Plans relevant to this species.

I.5 Relevant Advice and Plans

Assessment of impacts to MNES required consideration of the relevant Threat Abatement Plans, Conservation/Listing Advices and Recovery Plans. Within this section, the following is provided:

- **Table I.1**: Objectives of the Threat Abatement Plans considered in this assessment;
- **Table I.2**: Priority recovery and threat abatement actions (or equivalent) outlined within Conservation/Listing Advices that have been considered within this assessment; and
- **Table I.3**: Objectives of the Recovery Plans considered in this assessment.

Table I.1 Objectives of threat abatement plans relevant to the Project

Plan	Objectives
Threat abatement plan for beak and feather disease affecting endangered psittacine species	1. To coordinate a national approach to managing beak and feather disease 2. To promote and conduct activities that lead to increased knowledge of the disease and to support research that addresses gaps in current knowledge about beak and feather disease 3. To monitor beak and feather disease and psittacine populations and to analyse the resultant data to inform better management strategies 4. To identify and implement management actions and strategies to reduce the impacts of beak and feather disease 5. To share information with Australian, State and Territory Government management agencies, recovery teams, field workers, veterinarians and wildlife carers, so as to achieve better beak and feather disease management outcomes.
Threat abatement plan for competition and land degradation by unmanaged goats	1. Prevent unmanaged goats occupying new areas in Australia and eradicate them from high-conservation-value ‘islands’ 2. Promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats 3. Improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes 4. Improve the effectiveness, target specificity and humaneness of control options for unmanaged goats, and 5. Increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control unmanaged goats.
Threat abatement plan for competition and land degradation by rabbits	1. Prevent rabbits from occupying new areas in Australia and eradicate rabbits from high- conservation-value ‘islands’ 2. Promote the maintenance and recovery of native species and ecological communities that are affected by rabbit competition and land degradation 3. Improve knowledge and understanding of rabbit impacts and interactions with other species and other ecological processes 4. Improve the effectiveness, target specificity, integration and humaneness of control options for rabbits, and 5. Increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control and manage rabbits.
Threat abatement plan for disease in natural ecosystems	1. Identify and prioritise for protection: • Biodiversity assets

Table I.1 Objectives of threat abatement plans relevant to the Project

Plan	Objectives
caused by Phytophthora cinnamomi	• Areas where there is potential for P. cinnamomi to cause native species or ecological communities not yet listed to become eligible for listing under the EPBC Act (in any category, other than conservation dependent). 2. Reduce the spread of P. cinnamomi to, and reduce its impacts on: • Identified priority biodiversity assets • Areas where there is potential for P. cinnamomi to cause native species or ecological communities not yet listed to become eligible for listing under the EPBC Act (in any category, other than conservation dependent). 3. Communicate information about P. cinnamomi, its impacts on biodiversity and actions under this TAP.
Threat abatement plan for predation by European red fox	1. Prevent foxes occupying new areas in Australia and eradicate foxes from high-conservation-value 'islands' 2. Promote the maintenance and recovery of native species and ecological communities that are affected by fox predation 3. Improve knowledge and understanding of fox impacts and interactions with other species and other ecological processes 4. Improve the effectiveness, target specificity, integration and humaneness of control options for foxes, and 5. Increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control and manage foxes.
Threat abatement plan for predation by feral cats	1. Effectively control feral cats in different landscapes; 2. Improve effectiveness of existing control options for feral cats; 3. Develop or maintain alternative strategies for threatened species recovery; 4. Increase public support for feral cat management and promote responsible cat ownership.
Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs	1. To prevent feral pigs from establishing in areas where they currently do not occur or are in low eradicable numbers, and where they are likely to pose a threat to biodiversity; especially where they would impact on nationally listed threatened species and ecological communities 2. To integrate feral pig management plans and their implementation into natural resource planning and investment at the regional, state and territory, and national level through consultation and liaison with key stakeholders 3. To increase awareness and understanding of land managers and the general community about the damage that feral pigs cause and management options

Table I.1 Objectives of threat abatement plans relevant to the Project

Plan	Objectives
	4. To quantify the impacts feral pigs have on biodiversity (especially nationally listed threatened species and ecological communities) and determine the relationship between feral pig density and the level of damage 5. To improve the effectiveness, efficiency and humaneness of techniques and strategies for managing the environmental impact due to feral pigs.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
Box Gum Woodland and Derived Native Grassland	The priority recovery and threat abatement actions required for the listed ecological community include: • Protection of remnants of the listed ecological community through the development of conservation agreements and covenants; • Protection of remnants from weeds, particularly Coolatai Grass, by preventing soil disturbance in and around remnants, and the speedy eradication of any new invasion; • Avoid the use of fertilisers in or near remnants • Avoid soil disturbance in or near remnants, such as ripping planting lines and road grading; • In very small derived grassland sites, avoid planting trees as they may reduce the floral diversity through competition for light, nutrients and water; • Planting and other rehabilitation-focussed disturbance should focus on the edges of patches, expanding them, rather than within the patches; • Expansion and connection of existing remnants; • Exclusion of continuous grazing from remnants is important, coupled with weed management and control; • Use strategic grazing (incorporating rest at appropriate times) in areas still containing a diverse native understorey; • Burning or slashing if native tussock grasses have built up to a high level, to open intertussock spaces for tree seedlings, forbs and shrubs to establish; and, • For assistance and advice in implementing any of these suggested actions, land managers can contact the Grassy Woodlands Conservation Management Network.
Tylophora linearis	**Regional and Local Priority Actions** The following regional and local priority recovery and threat abatement actions can be done to support the recovery of T. linearis. <u>Habitat Loss, Disturbance and Modification</u> • Protect all known sites from disturbance (fire, grazing, forestry activities, etc.) until conservation status is fully established and recovery actions are better developed (DECC, 2005b).

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	• Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Ensure local government, Department of Primary Industries, and other planning agencies are informed of all known populations in order to assist in planning decisions regarding clearing, forestry, and other development activities (DECC, 2005b). • Ensure track widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance in areas where T. linearis occurs do not adversely impact on known populations. <u>Fire</u> • Develop and implement a suitable fire management strategy for T. linearis. • Provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigative measures in bush fire risk management plans, risk register and/or operation maps. <u>Trampling, Browsing or Grazing</u> • Manage known sites to ensure appropriate grazing regimes occur. • Prevent grazing pressure at known sites through exclusion fencing or other barriers. <u>Invasive Weeds</u> • Implement the threat abatement strategies and priority actions for the control of Lantana in the local region (DECC, 2005c). <u>Conservation Information</u> • Raise awareness of T. linearis within the local community. • Liaise with local indigenous groups to determine the cultural importance or relevance of T. linearis and seek assistance in understanding its ecology and in developing recovery actions (DECC, 2005b). <u>Enable Recovery of Additional Sites and/or Populations</u> • Undertake appropriate seed collection and storage for NSW Seedbank and develop collection program of multiple provenances of T. linearis in collaboration with the Botanic Gardens Trust (DECC, 2005b).

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	• Implement national translocation protocols (Vallee et al., 2004) if establishing additional populations is considered necessary and feasible.
Ozothamnus tesselatus	**Regional and Local Priority Actions** The following priority recovery and threat abatement actions can be done to support the recovery of O. tesselatus. Habitat Loss, Disturbance and Modification • Monitor known populations to identify key threats. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Identify populations of high conservation priority. • Ensure track widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance in areas where O. tesselatus occurs do not adversely impact on known populations. • Control access routes to suitably constrain public access to known sites on public land. • Suitably control and manage access on private land. • Minimise adverse impacts from land use at known sites. • Protect populations of this species through the development of further conservation agreements and/or covenants. • Prepare and implement site management statements to address threats at sites on DECC estate (DECC, 2005b). Conservation Information • Raise awareness of O. tesselatus within the local community, particularly adjacent landholders. Enable Recovery of Additional Sites and/or Populations • Undertake appropriate seed collection and storage. • Investigate options for linking, enhancing or establishing additional ex-situ populations (DECC, 2005b). • Implement national translocation protocols (Vallee et al., 2004) if establishing additional populations is considered necessary and feasible.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
Prostanthera discolor	**Regional and Local Priority Actions** The following priority recovery and threat abatement actions can be done to support the recovery of P. discolor. <u>Habitat Loss, Disturbance and Modification</u> • Monitor known populations to identify key threats. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Identify populations of high conservation priority. • Manage threats to areas of vegetation that contain populations/occurrences of P. discolor. • Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on P. discolor. • Ensure road widening or development activities in areas where P. discolor occurs do not adversely impact on known populations. • Manage any changes to hydrology that may result in changes to the water table levels, increased run-off, sedimentation or pollution. • Manage any disruptions to water flows. • Investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure. <u>Fire</u> • Develop and implement a suitable fire management strategy for P. discolor. • Identify appropriate intensity and interval of fire to promote seed germination and allow replenishment of the soil seed bank. A fire interval of greater than eight years is recommended (NSW NPWS, 2000a). • Provide maps of known occurrences to local and state rural fire services and seek inclusion of mitigative measures in bush fire risk management plans, risk register and/or operation maps. • It may be important to maintain unburnt 'refuge' areas containing large numbers of P. cryptandroides for long periods of time to assist in assuring the survival of the as yet unknown specific pollination vector (NSW NPWS, 2000a). <u>Diseases, Fungi and Parasites</u>

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	• Develop and implement suitable hygiene protocols to protect known sites from outbreaks of water-borne or soil pathogens, such as dieback caused by Phytophthora cinnamomi. Conservation Information • Raise awareness of P. discolor within the local community. Enable Recovery of Additional Sites and/or Populations • Undertake appropriate seed collection and storage. • Investigate options for linking, enhancing or establishing additional populations. • Implement national translocation protocols (Vallee et al., 2004) if establishing additional populations is considered necessary and feasible.
Thesium australe	**Regional Priority Actions** The following regional priority recovery and threat abatement actions can be done to support the recovery of the austral toadflax. Habitat Loss, Disturbance and Modification • Identify populations of high conservation priority. • Ensure there is no disturbance in areas where the austral toadflax occurs, excluding necessary actions to manage the conservation of the species. • Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible. Trampling, Browsing or Grazing • Develop and implement a stock management plan for roadside verges and travelling stock routes. Fire • Develop and implement a suitable fire management strategy for the habitat of the austral toadflax that inhibits canopy thickening. • Where appropriate provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigative measures in bush fire risk management plan/s, risk register and/or operation maps.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	Conservation Information • Raise awareness of the austral toadflax within the local community. • Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions. Population Recruitment and Translocation • Enable recovery of additional sites and/or populations. • Undertake appropriate seed collection and storage. • Investigate options for linking, enhancing or establishing additional populations. • Maintain existing ex situ populations (Scarlett et al., 2003). **Local Priority Actions** The following local priority recovery and threat abatement actions can be done to support the recovery of the austral toadflax. Habitat Loss, Disturbance and Modification • Monitor known populations to identify key threats. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants (OEH, 2013). • Mark sites and potential habitat onto maps used for planning (OEH, 2013). • Minimise adverse impacts from land use at known sites. • Do not undertake road works, pasture modification and other land use changes that will impact on this listed species (OEH, 2013). • Protect populations of the listed species through the development of conservation agreements and/or covenants.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	<u>Invasive Weeds</u> • Identify and remove weeds in the local area that could become a threat to the austral toadflax, using appropriate methods. • Manage site/s to prevent introduction of invasive weeds that could become a threat to the austral toadflax, using appropriate methods. <u>Trampling, Browsing or Grazing</u> • If livestock grazing occurs in the area, ensure land owners/managers use an appropriate management regime and density that does not detrimentally affect this species and limit the overgrazing of grassland species. • Where appropriate, manage total grazing pressure at important sites through exclusion fencing or other barriers. <u>Fire</u> • Implement an appropriate fire management regime for local populations.
Regent Honeyeater	**Conservation and Management Actions** 1. Improve the extent and quality of regent honeyeater habitat. 2. Bolster the wild population with captive-bred birds until the wild population becomes self sustaining. 3. Maintain and increase community awareness, understanding and involvement in the recovery program
Swift Parrot	n/a
Migratory Species	n/a
Spotted-tailed Quoll	n/a
New Holland Mouse	**Priority Actions** The following regional priority recovery and threat abatement actions can be done to support the recovery of the New Holland Mouse. <u>Regional Planning Approach</u> • Consider appropriate landscape scale management strategies that take into account appropriate fire regimes, management of predator / prey relationships and the enhancement of landscape function through connectivity, water balance and other related ecological drivers.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	• Regional planning to maintain connectivity Habitat Loss, Disturbance and Modification • Monitor known populations to identify key threats. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Ensure that fire management is undertaken so that populations have access to appropriate age classes of vegetation and areas of suitable habitat. • Identify populations of high conservation priority. • Ensure there is no disturbance in areas where the New Holland Mouse occurs, excluding necessary actions to manage the conservation of the species. • Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate inclusion in reserve tenure if possible to halt the removal and fragmentation of suitable habitat. • Control access routes to suitably constrain public access to known sites on public land. • Suitably control and manage access on private land and other land tenure. • Manage total grazing pressure in areas known to be utilised by the species • Consider acquisition of private or leasehold land containing populations of the New Holland Mouse. • Minimise adverse impacts from land use at known sites. Invasive Weeds • Identify and remove weeds which could become a threat to the New Holland Mouse, using appropriate methods. • Manage sites to prevent introduction of invasive weeds, which could become a threat to the New Holland Mouse, using appropriate methods. • Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the New Holland Mouse. Animal Predation or Competition • Implement actions outlined in the Threat Abatement Plan for Predation by Feral Cats and the Threat Abatement Plan for Predation by European red fox

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	for the control and eradication of feral cats and red foxes in areas where the species occurs. Fire • Identify appropriate intensity and interval of fire to create patches of habitat of different successions for the New Holland Mouse. • Implement suitable fire management strategies for the habitat of the New Holland Mouse. • Where appropriate provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigative measures in bush fire risk management plan(s), risk register and/or operation maps. Diseases, Fungi and Parasites • Develop and implement suitable hygiene protocols to protect known sites from further outbreaks of dieback caused by Phytophthora cinnamomi. • Implement appropriate management actions to minimise the adverse impacts of existing Phytophthora cinnamomi infestations Conservation Information • Raise awareness of the New Holland Mouse within the local community through fact sheets/information brochures / field days in conjunction with known industry or community interest groups. • Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.
Brush-tailed Rock-wallaby	n/a
Koala	**Priority Management Actions** The following priority recovery and threat abatement actions will support the recovery of the koala in Queensland, New South Wales and the Australian Capital Territory. It should be noted that the status of, and threats to, individual koala populations vary over their range and thus so too will the priority actions. Additionally, koala populations are subject to a range of management prescriptions in different areas in response to varying circumstances. The actions identified below do not seek to reproduce the intent or detail of the relevant management plans. Rather, they identify at a broad level the important actions that are applicable over most of the koala's range in Queensland, New South Wales and the Australian Capital Territory. Persons or agencies

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	responsible for koala conservation should consult the relevant plans at all scales when determining their own priority actions. A recovery plan has been recommended under the EPBC Act and will be prepared for the combined koala populations in Queensland, New South Wales and the Australian Capital Territory. The recovery plan will commence following the expiration of the National Koala Conservation and Management Strategy in 2014 for the combined populations of Queensland, New South Wales and the Australian Capital Territory. <u>Habitat Loss, Disturbance and Modification</u> • Develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, koala populations or connectivity options. • Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, koala habitat. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Identify populations of high conservation priority. • Investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible. • Manage any other known, potential or emerging threats such a Bell Miner Associated Dieback or Eucalyptus rust. • Develop and implement options of vegetation recovery and re-connection in regions containing fragmented koala populations, including inland regions in which koala populations were diminished by drought and coastal regions where development pressures have isolated koala populations. <u>Animal Predation</u> • Develop and implement a management plan to control the adverse impacts of predation on koalas by dogs in urban, peri-urban and rural environments. <u>Conservation Information</u> • Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.
Grey-headed Flying-fox	n/a

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
Large-eared Pied Bat	n/a
Corben's Long-eared Bat	n/a
Broad-headed Snake	**Regional Priority Actions** The following regional priority recovery and threat abatement actions can be done to support the recovery of the broad-headed snake: <u>Habitat Loss, Disturbance and Modification</u> • Establish the conservation priorities of the species to identify populations of high conservation priority. • Ensure there is no disturbance in areas where the broad-headed snake occurs, excluding necessary actions to manage the conservation of the species. • Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible. <u>Trampling, Browsing or Grazing</u> • Develop and implement a management plan for the control and eradication of feral goats in the region. <u>Fire</u> • Develop and implement a suitable fire management strategy for habitat of the broad-headed snake. • Where appropriate provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigative measures in bush fire risk management plan/s, risk register and/or operation maps. <u>Conservation Information</u> • Raise awareness of the broad-headed snake within the local community. • Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions. • Maintain colonies in captivity for future re-introduction to depleted sites or sites undergoing restoration (OEH, 2012). • Investigate options for linking, enhancing or establishing additional populations.

Table I.2 Recovery and threat abatement actions of Conservation/Listing Advice relevant to the Project

MNES	Priority Recovery and Threat Abatement Actions
	• Review licensed broad-headed snake keepers and establish a database of the genetics of held specimens (OEH, 2012). • Report suspected illegal reptile collection or sale (OEH, 2012). **Local Priority Actions** The following local priority recovery and threat abatement actions can be done to support the recovery of the broad-headed snake: Habitat Loss, Disturbance and Modification • Limit vehicle and pedestrian access to and recreational use of sandstone escarpments where this species occurs (OEH, 2012). • Control access routes to suitably constrain public access to known sites on public land, possibly through gating of tracks (NSW NPWS, 1999). • Suitably control and manage access on private land and other land tenure. • Include appropriate measures in forestry prescriptions, including reduced ridgetop disturbance, appropriate track creation and tree hollow retention. • Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants. • Restore rocky habitat to escarpments that have been disturbed (OEH, 2012). • Conduct habitat restoration trials using a variety of methods including: vegetation manipulation (canopy thinning, see Pike et al., 2011) and rock replacement using natural, artificial and quarried rock (OEH, 2012). • Limit the impact of bushrock removal through regulation and promote the use of quarried sandstone (OEH, 2012). • Retain woodland adjacent to sandstone escarpments, particularly large hollow-bearing trees (OEH, 2012). Animal Predation or Competition • Control introduced pests (European red foxes) and feral animals (cats) to manage threats at known sites.
Pink-tailed Legless Lizard	n/a

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
Box Gum Woodland and Derived Native Grassland	**Recovery Plan Objectives** The overall objective of this recovery plan is to promote the recovery and prevent the extinction of the critically endangered ecological community, known as Box-Gum Grassy Woodland. The specific objective to be achieved within the life-span of this recovery plan is to minimise the risk of extinction of the ecological community through: • achieving no net loss in extent and condition of the ecological community throughout its geographic distribution; • increasing protection of sites with high recovery potential; • increasing landscape functionality of the ecological community through management and restoration of degraded sites; • increasing transitional areas around remnants and linkages between remnants; and • bringing about enduring changes in participating land manager attitudes and behaviours towards environmental protection and sustainable land management practices to increase extent, integrity and function of Box-Gum Grassy Woodland. This objective will be achieved across the geographic distribution of Box-Gum Grassy Woodland and within five years of the adoption of this recovery plan.
Tylophora linearis	n/a
Ozothamnus tesselatus	n/a
Prostanthera discolor	n/a
Thesium australe	n/a
Regent Honeyeater	**Long-Term Objectives** • To ensure that the species persists in the wild. • To achieve a down-listing from nationally endangered to vulnerable by stabilising the population and securing habitat extent and quality in the main areas of occupancy.

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	• Achieve increasing reporting rates (5%) in areas previously used regularly, eg Munghorn Gap, Bendigo, north-east Melbourne, Eildon area. **Specific Objectives** Objective 1. Effectively organise and administer the recovery effort to ensure that recovery plan objectives are met. Objective 2. Maintain and enhance the value of Regent Honeyeater habitat at the key sites and throughout the former range, by active participation in land-use planning processes and by active vegetation rehabilitation at strategic sites Objective 3. Monitor trends in the Regent Honeyeater population size and dispersion across its range to allow assessment of the efficacy of management actions. Objective 4. Facilitate research on strategic questions which will enhance the capacity to achieve the long-term objectives. In particular, determine the whereabouts of Regent Honeyeaters during the non-breeding season and during breeding season absences from known sites. Identify important sites and habitat requirements at these times. Objective 5. Maintain and increase community awareness, understanding and involvement in the recovery effort. Objective 6. Maintain the captive population of Regent Honeyeaters at a size which will provide adequate stock to: provide insurance against the demise of the wild population; continuously improve captive-breeding and husbandry techniques; provide adequate stock for trials of release strategies; and maintain 90% of the wild heterozygosity in the captive population.
Swift Parrot	**Recovery Actions** Action 1 - Identify the extent and quality of habitat. Action 2 - Manage and protect Swift Parrot habitat at the landscape scale. Action 3 - Monitor and manage the impact of collisions, competition and disease. Action 4 - Monitor population and habitat. **Supporting actions**

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	Action 5 - Increase community involvement in, and awareness of, the recovery program. Action 6 - Coordinate, review and report on recovery process.
Migratory Species	n/a
Spotted-tailed Quoll	**Overall Objective** To increase knowledge of the distribution, ecology, status of populations, and impact of threatening processes on Spotted-tailed Quoll populations and to reduce the impact of threatening processes throughout the species' range and subsequently halt the current decline in its distribution and abundance. **Specific Objectives** 1. Assemble a recovery team to direct the implementation of the Recovery Plan. 2. Implement survey and monitoring programs to clarify the distribution and status of populations throughout the range, and determine abundance (or an index of abundance) at selected sites. 3. Increase knowledge of the biology and ecology of the Spotted-tailed Quoll throughout its range to refine management of the species and its habitat. 4. Investigate and manage threats to Spotted-tailed Quoll populations through integrated research and the development and implementation of threat abatement strategies. 4.1. Reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat. 4.2. Reduce direct killings of Spotted-tailed Quolls. 4.3. Quantify and manage the threat posed by introduced predators (foxes, cats and wild dogs) and of predator control practices on Spotted-tailed Quoll populations. 4.4. Evaluate and manage the risk posed by silvicultural practices. 4.5. Clarify and minimise the impact of fire regimes on Spotted-tailed Quoll populations. 4.6. Reduce the frequency of Spotted-tailed Quoll road mortality. 4.7. Assess the risk posed by Cane Toads, and develop threat abatement actions if necessary.

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	4.8. Reduce the impact of urban development on Spotted-tailed Quoll populations. 4.9. Identify the risk that climate change poses to Spotted-tailed Quoll populations and ameliorate this risk where possible. 5. Increase awareness of the Spotted-tailed Quoll within the wider community and incorporate their involvement in the recovery of species. 6. Develop an interface with captive management institutions with the aim of promoting public awareness and education, investigating research opportunities and the role of captive breeding programs in future conservation strategies.
New Holland Mouse	n/a
Brush-tailed Rock-wallaby	**Specific Objectives** 1. Determine and manage threats to the Brush-tailed Rock-wallaby and its habitat. 2. Determine distribution, abundance, population trends and viability for the Brush-tailed Rock-wallaby. 3. Establish and maintain separate, viable captive populations derived from the Southern and Central ESUs. 4. Undertake translocations to improve the genetic and demographic robustness of populations and to establish new colonies of Brush-tailed Rock-wallabies. 5. Investigate key aspects of Brush-tailed Rock-wallaby biology and ecology for conservation management. 6. Increase community awareness and support for Brush-tailed Rock-wallaby conservation.
Koala	n/a
Grey-headed Flying-fox	**Overall Objectives** The overall objectives of recovery are: • to reduce the impact of threatening processes on Grey-headed Flying-foxes and arrest decline throughout the species' range • to conserve the functional roles of Grey-headed Flying-foxes in seed dispersal and pollination • to improve the standard of information available to guide recovery of the Grey-headed Flying-fox, in order to increase community knowledge of the species and reduce the impact of negative public attitudes on the species.

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	Specific Objectives Specific objectives to be met in the 5-year timeframe of this recovery plan are listed below, not in priority order. Initiatives to meet these objectives will incorporate principles of sustainable development and promote procedures to minimise significant adverse social and economic impacts, such as the use of environmental incentive schemes and equitable cost-sharing arrangements. • Objective 1. To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range • Objective 2. To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes • Objective 3. To identify roosting habitat critical to the survival of Grey-headed Flying-foxes • Objective 4. To protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes • Objective 5. To substantially reduce deliberate destruction of Grey-headed Flying-foxes in fruit crops • Objective 6. To reduce negative public attitudes toward Grey-headed Flying-foxes and reduce conflict with humans • Objective 7. To increase public awareness and understanding of Grey-headed Flying-foxes and the recovery program, and to involve the community in recovery actions, where appropriate, to reduce the threat of negative public attitudes and conflict with humans • Objective 8. To monitor population trends in Grey-headed Flying-foxes so as to monitor the species' national distribution and status • Objective 9. To assess and reduce the impact on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and on barbed-wire • Objective 10. To improve knowledge of the demographics and population structure of Greyheaded Flying-foxes in order to increase understanding of the ecological requirements of the species • Objective 11. To increase the effectiveness and efficiency of recovery initiatives for Greyheaded Flying-foxes by working cooperatively with conservation and management programs with overlapping objectives to remove or reduce the impact of threatening processes on the species • Objective 12. To maintain an effective Grey-headed Flying-fox National Recovery Team to oversee the implementation of the Grey-headed Flying-fox

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	National Recovery Plan to remove or reduce the impact of threatening processes on the species. • Objective 13. To provide long-term economic benefits associated with the protection of ecosystem services, promotion of sustainable forest management, improved crop protection regimes, promotion of sustainable agricultural practices and increased viability of some commercial fruit industries.
Large-eared Pied Bat	**Overall Objective** To ensure the persistence of viable populations of the large-eared pied bat throughout its geographic range. **Specific objectives** Specific Objective 1: Identify priority roost and maternity sites for protection Specific Objective 2: Implement conservation and management strategies for priority sites Specific Objective 3: Educate the community and industry to understand and participate in the conservation of the large-eared pied bat Specific objective 4: Research the large-eared pied bat to augment biological and ecological data to enable conservation management Specific objective 5: Determine the meta-population dynamics throughout the distribution of the large-eared pied bat
Corben's Long-eared Bat	**Overall Objective** The overall objective of this plan is to achieve down-listing of the South-eastern Long-eared Bat from 'Vulnerable' nationally to a lower threat category, based on the 2001 IUCN Red List criteria of population size and trends. This down-listing is to be achieved by securing the long-term protection of the species through a reduction in the impact of threatening processes and to improve the standard of information available to guide recovery. **Specific objectives** Within the life span of this Recovery Plan, the specific objectives of recovery for the South-eastern Long-eared Bat are to: • Clarify the current fine-scale distribution patterns and habitat requirements across the species' range. • Increase the understanding of critical aspects of the biology and ecology of the South-eastern Long-eared Bat that will assist in the long-term management of the species.

Table I.3 Objectives of recovery plans relevant to the Project

MNES	Objectives
	• Identify key populations and protect these from habitat loss and fragmentation. • Identify and alter inappropriate fire regimes. • Identify and minimise forestry practices that may impact this species. • Reduce exposure to agrichemicals. • Identify the extent of population fragmentation and instigate measures to increase habitat connectivity where recent isolation has occurred. • Identify and reduce the potential impact of feral species on key populations. • Identify the key threats to the conservation of the species. • Build community support for the conservation of the species.
Broad-headed Snake	n/a
Pink-tailed Legless Lizard	n/a