MALABAR COAL

MAXWELL PROJECT

APPENDIX E

Biodiversity Development Assessment Report

MALABAR COAL

MAXWELL PROJECT

BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

HUNTER ECO

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DEFINITIONS

BAM: *the Biodiversity Assessment Method.*

BC Act: *the NSW Biodiversity Conservation Act, 2016.*

BC Regulation: *the NSW Biodiversity Conservation Regulation, 2017.*

Benchmarks: *quantitative measures that represent the 'best-attainable' condition, which acknowledges that native vegetation within the contemporary landscape has been subject to both natural and human-induced disturbance. Benchmarks are defined for specified variables for each Plant Community Type. Vegetation with relatively little evidence of modification generally has minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic weed cover, minimal grazing and trampling by introduced or overabundant native herbivores, minimal soil disturbance, minimal canopy dieback, no evidence of recent fire or flood, is not subject to high frequency burning, and has evidence of recruitment of native species.*

Biodiversity Credit Report: *the report produced by the Credit Calculator that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site.*

Biodiversity Development Assessment Report (BDAR): *a report prepared by an accredited person in relation to proposed development or activity that would be authorised by a planning approval, or proposed clearing that would be authorised by a vegetation clearing approval, that:*

(a) assesses in accordance with the BAM the biodiversity values of the land subject to the proposed development, activity or clearing;

(b) assesses in accordance with the BAM the impact of proposed development, activity or clearing on the biodiversity values of that land;

(c) sets out the measures that the proponent of the proposed development, activity or clearing proposes to take to avoid or minimise the impact of the proposed development, activity or clearing; and

(d) specifies in accordance with the BAM the number and class of biodiversity credits that are required to be retired to offset the residual impacts on biodiversity values of the actions to which the biodiversity offsets scheme applies.

Biodiversity Offsets: *management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development.*

Biodiversity Stewardship Agreement: *means a biodiversity stewardship agreement made under Division 2 of Part 5 of the BC Act.*

Biodiversity Stewardship Site: *means the land that is designated by a biodiversity stewardship agreement to be a biodiversity stewardship site for the purposes of the BC Act.*

Biodiversity Stewardship Site Assessment Report (BSSAR): *the report that must be prepared in accordance with the BAM and submitted as part of an application for a biodiversity stewardship agreement.*

Broad Condition State: *areas of the same Plant Community Type that are in relatively homogenous condition. Broad condition is used for stratifying areas of the same Plant Community Type into a vegetation zone for the purpose of determining the vegetation integrity score.*

Credit Calculator: *the computer program that provides decision support to assessors and proponents by applying the BAM, in particular by using the data required to be entered and the equations in Appendix 6 and Appendix 9 to calculate the number and class of biodiversity credits required to offset the impacts of a development or created at a biodiversity stewardship site.*

Credit Class: *the class of biodiversity credits calculated by the BAM Credit Calculator. Ecosystem Credits are determined on an assumed presence basis based on Plant Community Type associated. Species Credits are determined for species known to occur or determined to occur by way of an expert report.*

Derived Vegetation: *Plant Community Types that have changed to an alternative stable state as a consequence of land management practices since European settlement. Derived communities can have one or more structural components of the vegetation entirely removed or severely reduced (e.g. over-storey of Grassy Woodland), or have developed new structural components where they were previously absent (e.g. shrubby mid-storey in an open woodland system).*

Development Footprint: *the area of land that is directly impacted on by a proposed development, including access roads, and areas used to store construction materials.*

Ecosystem credits: *a measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT, and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at a biodiversity stewardship site.*

EPBC Act: *the Commonwealth Environment Protection and Biodiversity Conservation Act, 1999.*

High Threat Exotic Plant Cover: *plant cover composed of vascular plants not native to Australia that if not controlled will invade and outcompete native plant species. Also referred to as high threat weeds.*

Linear Shaped Development: *development that is generally narrow in width and extends across the landscape for a distance greater than 3.5 kilometres in length.*

Native Vegetation Cover: *the percentage of native vegetation cover on the subject land and the surrounding buffer area. Cover estimates are based on the cover of native woody and non-woody vegetation relative to the approximate benchmarks for the Plant Community Type, taking into account vegetation condition and extent. Native over-storey vegetation is used to determine the percent cover in woody vegetation types, and native ground cover is used to assess cover in non-woody vegetation types.*

Plant Community Type (PCT): *a NSW plant community type identified using the Plant Community Type classification system.*

Project Area: *the development footprint and the area subject to subsidence.*

Retirement of Credits: *the retirement of biodiversity credits from a biobank site or a biodiversity stewardship site secured by a biodiversity stewardship agreement.*

Site-based Development: *a development other than a linear shaped development, or a multiple fragmentation impact development.*

Species Credit Species: *are threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits.*

Species Credits: *the class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection.*

Subject Land: *is land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land. It includes land that may be a development site, clearing site, proposed for biodiversity certification or land that is proposed for a biodiversity stewardship agreement.*

Serious and Irreversible Impacts (SAII): *impacts likely to contribute significantly to the risk of extinction of a threatened species or ecological community in NSW.*

Vegetation Class: *a level of classification of vegetation communities defined in Keith (2004). There are 99 vegetation classes in NSW.*

Vegetation Formation: *a broad level of vegetation classification as defined in Keith (2004). There are 16 vegetation formations and sub-formations in NSW.*

Vegetation Integrity (VI): *the condition of native vegetation assessed for each vegetation zone against the benchmark for the Plant Community Type.*

Vegetation Integrity (VI) Score*: the measure of Vegetation Integrity as calculated in the BAM Credit Calculator using input from plot data.*

Vegetation Zone: *a relatively homogenous area of native vegetation on a development site, land to be biodiversity certified or a biodiversity stewardship site that is the same Plant Community Type and broad condition state.*

EXECUTIVE SUMMARY

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project). The Project is in the central Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook.

Malabar is seeking approval for the Project under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

This Biodiversity Development Assessment Report was prepared by Dr Colin Driscoll (Hunter Eco) to assess the likely biodiversity impacts from the Project. This document was prepared in accordance with the NSW *Biodiversity Assessment Method* (BAM) and the Secretary's Environmental Assessment Requirements (SEARs) for the Project.

For the purpose of this Biodiversity Development Assessment Report, the proposed surface disturbance areas (herein referred to as the Biodiversity Assessment Development Footprint) have been assessed in two development stages. Stage 1 of the development includes:

- a mine entry area at the Maxwell Underground;
- a transport and services corridor between the Maxwell Underground and Maxwell Infrastructure;
- an extension to the existing product coal stockpile area and additional ROM stockpile at Maxwell Infrastructure; and
- two areas of potential ponding impacts associated with subsidence.

The potential Edderton Road realignment has been assessed as a second stage of the development.

Landscape Features

The Biodiversity Assessment Development Footprint is located within a broader study area (herein referred to as the Subject land) which also covers the Maxwell Underground and areas of potential subsidence impacts.

The majority of the Subject land (with exception of the Maxwell Infrastructure area that has been mined since 1983) has been mostly cleared (over 75%) and used for agricultural grazing purposes for well over 100 years. The landform above the Maxwell Underground consists of undulating foothills to moderately-sloping hills drained by a number of smaller, unnamed watercourses. The extant woodland/forest vegetation habitat is fragmented due to past land clearance.

Native Vegetation

Native vegetation on the Subject land was identified and mapped in accordance with the Biodiversity Assessment Method (BAM) and *BioNet Vegetation Classification.* This involved collecting floristic and condition data from 109 plots located in the Subject land, reviewing previous vegetation mapping, ground-truthing boundaries and statistical analysis of the data.

Due to historic and present land use, the Biodiversity Assessment Development Footprint is mostly derived native grassland (approximately 136 ha, 42.4%) with some fragmented native woodland/forest vegetation (totalling approximately 25.6 ha, 7%). In addition, approximately 64.5 ha of the Biodiversity Assessment Development Footprint is located within post-mine landforms undergoing mine rehabilitation.

Despite the degraded nature of the vegetation present compared to the woodland/forest vegetation that were once present, most of the vegetation to be cleared (147.3 ha, 46 %) is listed as threatened ecological communities under the NSW *Biodiversity Conservation Act, 2016* (BC Act) and/or the EPBC Act. Threatened ecological communities that occur within the Biodiversity Assessment Development Footprint are listed in Table ES-1.

Table ES-1
Threatened Ecological Communities

Threatened Ecological Community	Conservation Status	Plant Community Type	Description
Threatened Ecological Communities listed under the BC Act			
White Box Yellow Box Blakely's Red Gum Woodland	E	1606	Woodland and derived grassland
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	1655	Woodland
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E	1604	Woodland
Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	1691	Woodland
Threatened Ecological Communities listed under the EPBC Act			
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1606	Woodland
Central Hunter Valley Eucalypt Forest and Woodland	CE	1604, 1691, 1655	Woodland

V = Vulnerable; E = Endangered; CE = Critically Endangered.

Threatened Species

Threatened species surveys were conducted by Hunter Eco and Future Ecology in consideration of the relevant State and Commonwealth survey guidelines and included targeted searches for potentially occurring threatened species and communities listed under the BC Act and EPBC Act.

Four 'species credit species' (as defined by the *Threatened Biodiversity Data Collection*) were present in habitat located either within or adjoining the Biodiversity Assessment Development Footprint during the present surveys, namely the:

- Pink-tailed Legless Lizard (*Aprasia parapulchella*);
- Striped Legless Lizard (*Delmar impar*);
- Squirrel Glider (*Petaurus norfolcensis*); and
- Southern Myotis (*Myotis macropus*).

No threatened flora species or populations listed under the BC Act or EPBC Act were recorded in the Biodiversity Assessment Development Footprint. Two endangered flora populations listed under the BC Act, *Cymbidium canaliculatum* population in the Hunter Catchment and *Acacia pendula* population in the Hunter Catchment (also listed as a threatened ecological community under the BC Act and EPBC Act) were recorded within the wider Subject land. The threatened flora species *Diuris tricolor*, which is also an endangered population within the Muswellbrook Local Government Area, has previously been recorded within the wider Subject land.

Commonwealth Assessment

The Project is to be assessed under the EPBC Act pursuant to the assessment bilateral agreement with the NSW Government. Therefore, this BDAR provides an assessment of potential impacts to EPBC Act listed threatened species and communities, applying the Biodiversity Assessment Method.

Based on the information available in the EPBC Act Referral, the Commonwealth Department of the Environment and Energy (DEE) considered (in the input into the SEARs) that the Project is likely to have a significant impact on:

- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*;
- *Central Hunter Valley Eucalypt Forest and Woodland*;
- Swift Parrot (*Lathamus discolor*); and
- Regent Honeyeater (*Anthochaera phrygia*).

The Project may not have a material adverse impact on the Swift Parrot and Regent Honeyeater as either species has not been recorded in the Biodiversity Assessment Development Footprint, no breeding habitat for these species is present, and the NSW Office of Environment and Heritage do not recognise the Subject land as important habitat for these species (negating the need for species credits). To be conservative and consistent with the DEE input into the SEARs, the BDAR assesses the Swift Parrot and Regent Honeyeater as if the Project could significantly impact the species.

Following submission of the EPBC Act referral, the following species which could be significantly impacted were found in the Subject land:

- Striped Legless Lizard; and
- Pink-tailed Legless Lizard.

Measures to Avoid, Minimise, Mitigate and Manage Impacts

The location of the Project has been selected based upon the presence of coal seams able to be economically mined within Malabar's existing tenements and the extensive geological and geotechnical data available within the target area in EL 5460.

Malabar is committed to developing the Project solely as an underground mining operation. Underground mining methods significantly reduce environmental impacts, including vegetation and habitat disturbance, in comparison to open cut mining methods.

In addition to the use of underground mining methods, Project elements have been located and designed to avoid or minimise impacts to vegetation and habitat disturbance such as:

- using existing Maxwell Infrastructure facilities for coal handling and despatch;
- emplacement of reject material in existing mine voids; and
- maximising placement of infrastructure in derived grassland areas with a low condition score.

This BDAR provides a number of measures to mitigate and manage impacts, such as a vegetation clearance protocol and commitments to fence environmentally sensitive areas.

Offset Strategy

The result of running the Biodiversity Assessment Method Credit Calculator is that the Project requires a total of 1,952 ecosystem credits and 2,250 species credits (Table ES-2).

Table ES-2
Credit Requirements

Credit Type	Biodiversity Assessment Development Footprint	Credit Requirement
Ecosystem Credits	226.1 ha of native vegetation (of which approximately 90% is derived native grassland)	1,952
Pink-tailed Legless Lizard Species Credits	38.7 ha of potential habitat#*	423
Striped Legless Lizard Species Credits	152.8 ha of potential habitat#	1,225
Squirrel Glider Species Credits	43 ha of potential habitat#	557
Southern Myotis Species Credits	1.9 ha of potential habitat#	45

The species habitats overlap (i.e. the habitats are not mutually exclusive).

* Comprising 12.5 ha of rocky areas and a 50 m zone around the rocky areas.

Malabar commits to satisfying the credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits, ecological mine rehabilitation and/or contribution to the Biodiversity Conservation Fund).

Conclusion

The impact avoidance, mitigation and offset hierarchy has been applied to the Project resulting in some unavoidable impacts. The credit calculation has determined the offset requirement for clearance of native vegetation (woodland, forest and derived native grasslands) (ecosystem credit requirement) and the offset requirement for clearance of habitat for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis (species credit requirements). It is proposed that these offset requirements would be met through retirement of biodiversity credits, ecological mine rehabilitation and/or contribution to the Biodiversity Conservation Fund.

The direct loss of habitat associated with the Project in combination with offset provisions (Section 8) would result in no net loss in biodiversity. This is because the biodiversity offset would be a greater area of land, multiple times the size of the Biodiversity Assessment Development Footprint, which will be conserved and managed to achieve a gain in biodiversity values.

1 INTRODUCTION

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project). The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook (Figure 1).

Underground mining is proposed within Exploration Licence (EL) 5460, which was acquired by Malabar in February 2018. Malabar also acquired existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395, known as the "Maxwell Infrastructure". The Project would include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure (Figure 2).

This assessment forms part of an Environmental Impact Statement (EIS) which has been prepared to accompany a Development Application for the Project in accordance with Part 4 of the NSW *Environmental Planning and Assessment Act, 1979*.

1.1 PROJECT DESCRIPTION

The Project would involve an underground mining operation that would produce high quality coals over a period of approximately 26 years. At least 75% of coal produced by the Project would be capable of being used in the making of steel (coking coals). The balance would be export thermal coals suitable for the new generation High Efficiency, Low Emissions power generators.

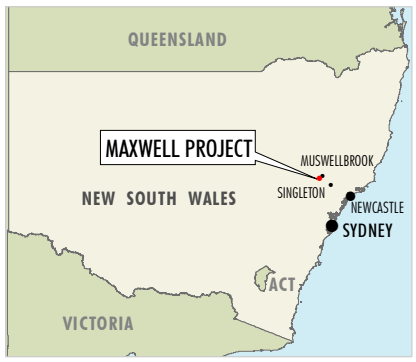
The Project would involve extraction of run-of-mine (ROM) coal from four seams within the Wittingham Coal Measures using the following underground mining methods:

- underground bord and pillar mining with partial pillar extraction in the Whynot Seam; and
- underground longwall extraction in the Woodlands Hill Seam, Arrowfield Seam and Bowfield Seam.

The substantial existing Maxwell Infrastructure would be used for handling, processing and transportation of coal for the life of the Project. Maxwell Infrastructure includes an existing coal handling and preparation plant (CHPP), train load-out facilities and other infrastructure and services (including water management infrastructure, administration buildings, workshops and services). A mine entry area (MEA) would be developed for the Project in a natural valley in the north of EL 5460 to support underground mining and coal handling activities and provide for personnel and materials access.

ROM coal brought to the surface at the MEA would be transported to the Maxwell Infrastructure area. Early ROM coal would be transported via internal roads during the construction and commissioning of a covered overland conveyor system. Subsequently, ROM coal would be transported to the Maxwell Infrastructure area via the covered overland conveyor system.

The existing product coal stockpile area at Maxwell Infrastructure would be extended to allow for better management of different product coal blends. An additional ROM stockpile would also be developed adjacent to the CHPP to cater for delivery of ROM coal via the covered overland conveyor.



LEGEND

- Mining Operation
- Proposed Mining Operation
- Railway
- Local Government Boundary
- State Forest
- National Parks and Wildlife Service Estate
- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services and Innovation (2019); Office of Environment and Heritage NSW (2019)

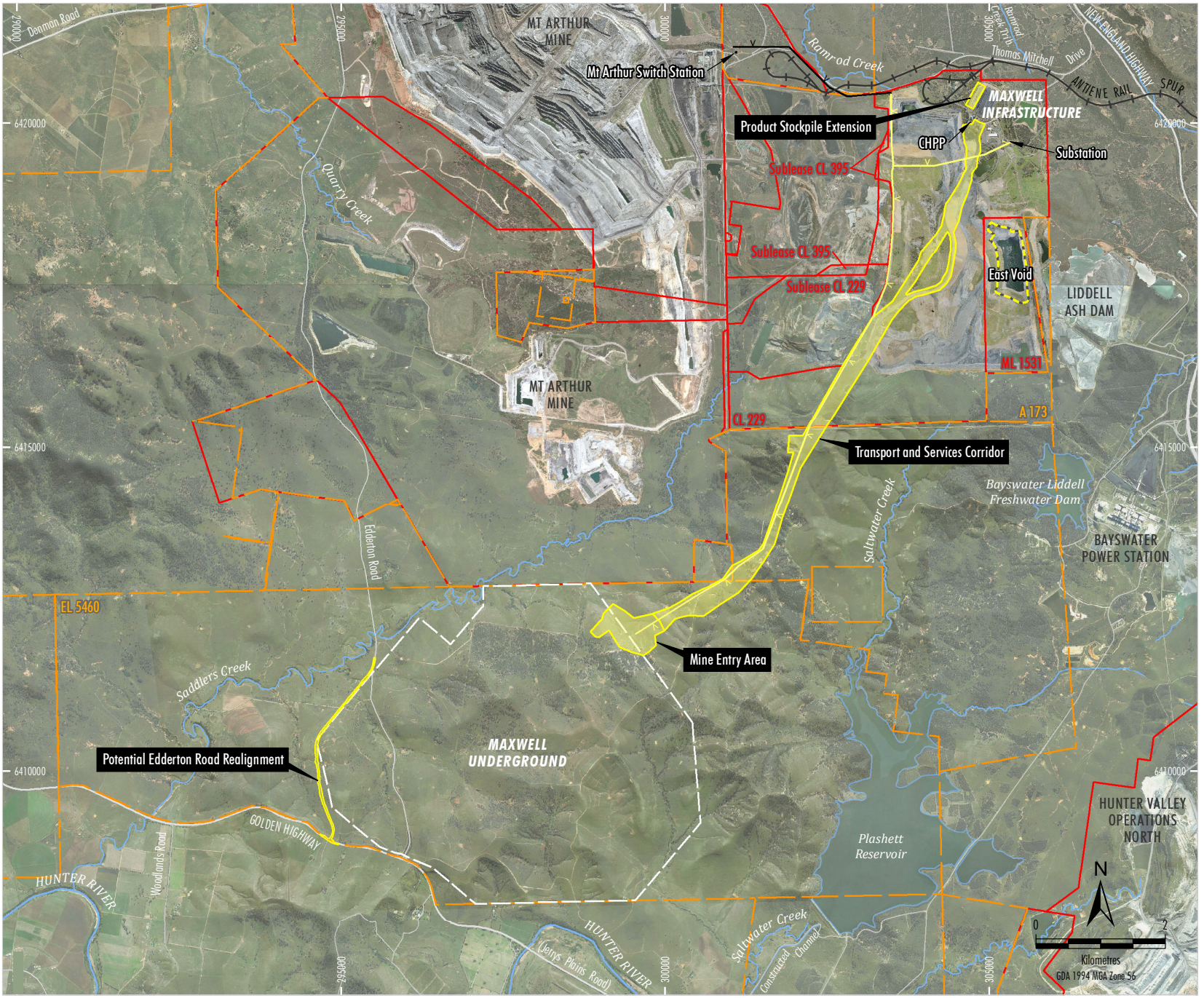
MALABAR COAL

MAXWELL PROJECT

Regional Location

Figure 1

SHM-18-03 Maxwell_EIS_App_Figure 1_Rev D



LEGEND

- Railway
- Exploration Licence Boundary
- Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Indicative Surface Development Area
- CHPP Reject Emplacement Area
- Proposed 66 kV Power Supply
- Proposed Ausgrid 66 kV Power Supply Extension#

Subject to separate assessment and approval.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Project General Arrangement

Figure 2

SHM-18-03 Maxwell_EIS_App_BDAR_250A

The Project would support continued rehabilitation of previously mined areas and overburden emplacements areas within CL 229, ML 1531 and CL 395. The volume of the East Void would be reduced through the emplacement of reject material generated by Project coal processing activities and would be capped and rehabilitated at the completion of mining.

An indicative Project general arrangement is shown on Figure 2. The Project area comprises the following main domains:

- Maxwell Underground – comprising the proposed area of underground mining operations and the MEA within EL 5460.
- Maxwell Infrastructure – the area within existing mining leases comprising the substantial existing infrastructure (including the CHPP) and previous mining areas.
- The transport and services corridor between the Maxwell Underground and Maxwell Infrastructure – this would comprise a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services.
- A potential realignment of Edderton Road.

A detailed description of the Project is provided in the main document of the EIS.

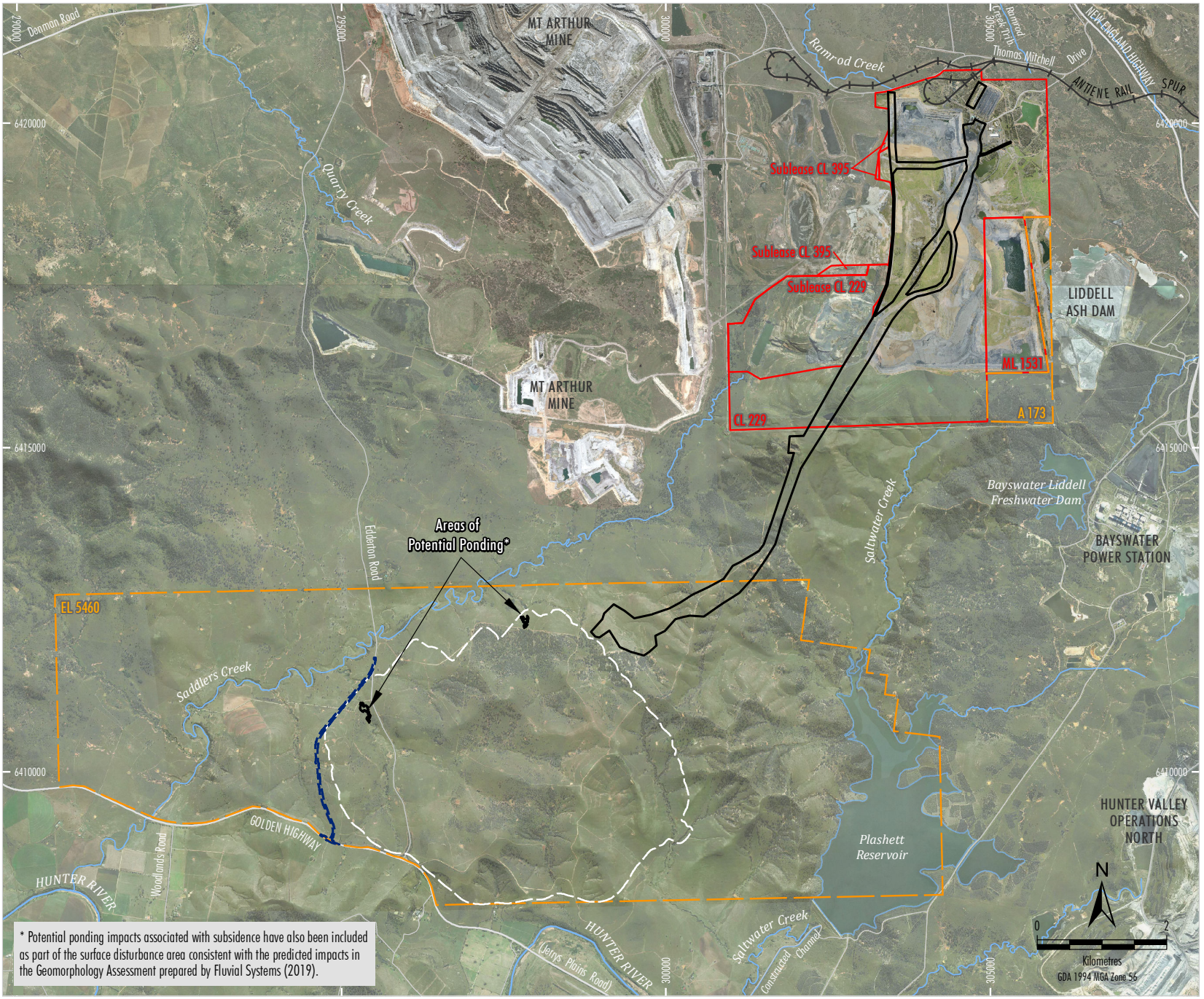
1.2 ASSESSMENT REQUIREMENTS/APPROACH

This Biodiversity Development Assessment Report (BDAR) was prepared by Dr Colin Driscoll (Hunter Eco), who is an accredited assessor under the NSW *Biodiversity Conservation Act, 2016* (BC Act) (assessor accreditation BAAS17004). This BDAR was prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the EIS. This BDAR provides:

- estimates of vegetation to be cleared within the Biodiversity Assessment Development Footprint (Figure 3);
- an assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with *Biodiversity Assessment Method Order, 2017* (BAM: Office of Environment and Heritage [OEH] 2017a) established under section 6.7 of the BC Act;
- a strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme; and
- a summary of any potential resource sterilisation in relation to proposed biodiversity offset areas.

A delegate of the Commonwealth Minister for the Environment and Energy (now Minister of the Environment) determined on 12 November 2018 that the proposed action[1] is a "controlled action" and, therefore, the Project requires approval under section 75 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). The controlling provisions are "listed threatened species and communities" (sections 18 and 18A of the EPBC Act) and "a water resource, in relation to coal seam gas development and large coal mining development" (sections 24D and 24E of the EPBC Act).

[1] The Maxwell Infrastructure across the existing post-mine landform was excluded from the description of the proposed action referred under the EPBC Act (Figure 4).



* Potential ponding impacts associated with subsidence have also been included as part of the surface disturbance area consistent with the predicted impacts in the Geomorphology Assessment prepared by Fluvial Systems (2019).

LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 1
- Biodiversity Assessment Development Footprint Stage 2

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

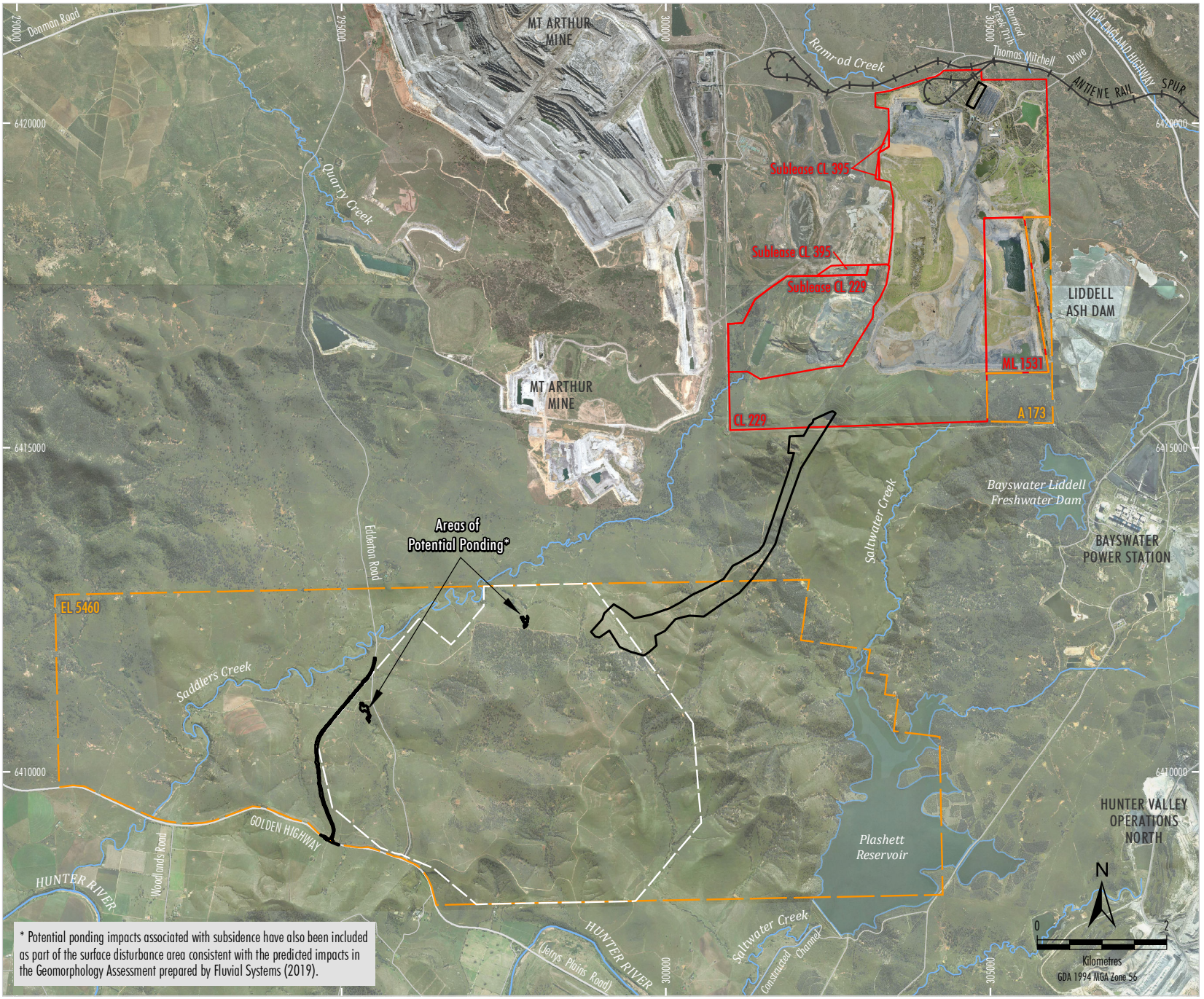
MALABAR COAL

MAXWELL PROJECT

Biodiversity Assessment Development Footprint

Figure 3

SHM-18-03 Maxwell_EIS_App_BDAR_201H



* Potential ponding impacts associated with subsidence have also been included as part of the surface disturbance area consistent with the predicted impacts in the Geomorphology Assessment prepared by Fluvial Systems (2019).

LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Commonwealth Action Area Footprint (2018/8287)

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Commonwealth Action Area Footprint

Figure 4

SHM-18-03 Maxwell_EIS_App_BDAR_2026

The Project is to be assessed pursuant to the assessment bilateral agreement with the NSW Government[2]. Therefore, this BDAR provides an assessment of potential impacts (in accordance with the supplementary SEARs dated 20 November 2018) to EPBC Act listed threatened species and communities.

This BDAR provides a terrestrial ecology assessment. In regard to aquatic ecology values, a separate report titled *Maxwell Project – Aquatic Ecology and Stygofauna Assessment* has been prepared by Eco Logical Australia (2019) and deals with the potential impacts of the Project on the aquatic ecology values (including aquatic threatened species and communities). Eco Logical Australia (2019) concludes that the Project is unlikely to have a significant impact on aquatic ecology in the surrounding waterways.

1.3 BIODIVERSITY ASSESSMENT DEVELOPMENT FOOTPRINT

The Biodiversity Assessment Development Footprint (construction and operation) is approximately 320 hectares (ha) in size (Figure 3). Malabar propose to manage the impacts in two stages. The Stage 1 Biodiversity Assessment Development Footprint includes:

- the MEA at the Maxwell Underground;
- the transport and services corridor between the Maxwell Underground and Maxwell Infrastructure;
- the extension to the existing product coal stockpile area and additional ROM stockpile at the Maxwell Infrastructure; and
- two areas of potential ponding impacts associated with subsidence (Figure 3) consistent with the predicted impacts in the Geomorphology Assessment prepared by Fluvial Systems (2019).

The potential Edderton Road realignment has been assessed as a second stage of the development (Figure 3). It has been assessed as a separate stage as the potential subsidence impacts on Edderton Road would be managed through either: (i) road maintenance along the existing alignment; (ii) or the realignment of the road around the Maxwell Underground area.

1.4 STRUCTURE OF THIS ASSESSMENT

This BDAR is structured as follows:

Section 2 Provides landscape features relevant to Stages 1 and 2.

Section 3 Describes native vegetation and threatened species assessment for Stage 1.

Section 4 Describes native vegetation and threatened species assessment for Stage 2.

Section 5 Provides an assessment of how potential impacts would be avoided and/or minimised.

Section 6 Presents a summary of the NSW Assessment and credit requirements.

Section 7 Provides an assessment for Commonwealth Matters of National Environmental Significance.

Section 8 Describes the biodiversity offset strategy.

[2] A draft assessment bilateral agreement with the NSW Government is currently proposed.

1.5 FIELD SURVEYS

Flora and vegetation surveys were conducted across a study area encompassing the Project area by Hunter Eco in 2017, 2018 and 2019 (Hunter Eco 2019). The detailed baseline flora survey report is provided in Attachment A. Fauna surveys were conducted across the same study area by Future Ecology in 2017 and 2018 (Future Ecology 2019). The detailed baseline fauna survey report is provided in Attachment B.

1.6 PUBLISHED DATABASES

Published databases used in this assessment include:

- *Threatened Biodiversity Data Collection* (OEH 2019a)[3];
- *BioNet Vegetation Classification* (OEH 2019b);
- *BioNet Atlas* (OEH 2019c)[4]; and
- *Directory of Important Wetlands of Australia* (Department of the Environment and Energy [DEE] 2018a).

A full reference list of all information sources used in this BDAR is provided in Section 10.

1.7 LOCAL DATA

It was not necessary to use local data or deviate from the OEH databases (OEH 2019a, 2019b).

1.8 BAM CREDIT CALCULATOR

BAM Credit Calculator Version 1.2.4.00 (last updated 4 July 2019) was used in this assessment. On the 29 April 2019, OEH confirmed that there is an error with the BAM Credit Calculator and that it should not indicate that PCT 1655 is a potential Serious and Irreversible Impact (SAII) Entity. This is further discussed in Section 6.1.

A number of inconsistencies between the BAM Credit Calculator and *Threatened Biodiversity Data Collection* (OEH 2019a) were noted. The *Threatened Biodiversity Data Collection* (OEH 2019a) was taken to be correct as advised by OEH.

[3] This website is titled 'Profiles'.

[4] This website is titled 'Species Sightings Search'.

2 LANDSCAPE FEATURES

The BAM refers to 'Subject land' as the land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land. For the Project, the Subject land consists of a wider biodiversity study area that includes proposed surface disturbance areas and the land over the longwall panels including areas of potential subsidence impacts.

Clearing of vegetation in the Hunter Valley commenced in the early 1800's. The earliest available aerial photographs from 1958 show that the Subject land was almost totally cleared and that there has been a substantial amount of natural regeneration since (Hunter Eco 2019, Attachment A). Other than for the Maxwell Infrastructure area that has been mined since 1983, the remainder of the Subject land has been mostly cleared (over 75%) and used for agricultural purposes, primarily grazing, for well over 100 years.

This section provides a description of the landscape features relevant to the Subject land in accordance with the BAM (OEH 2017a).

2.1 REGIONAL SETTING

In accordance with the BAM (OEH 2017a), the Site Map is shown on Figure 5 and the Location Map for the Stage 1 Biodiversity Assessment Development Footprint is shown on Figure 6. The Location Map for the Stage 2 Biodiversity Assessment Development Footprint is presented in Section 4.

The Project area lies within the:

- Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion, Hunter IBRA sub-region;
- Muswellbrook Local Government Area (Figure 6); and
- Central Hunter Foothills (predominantly), Upper Hunter Channels and Floodplain and Hunter River Basalts Mitchell landscapes (Mitchell 2002) (Figures 5 and 6).

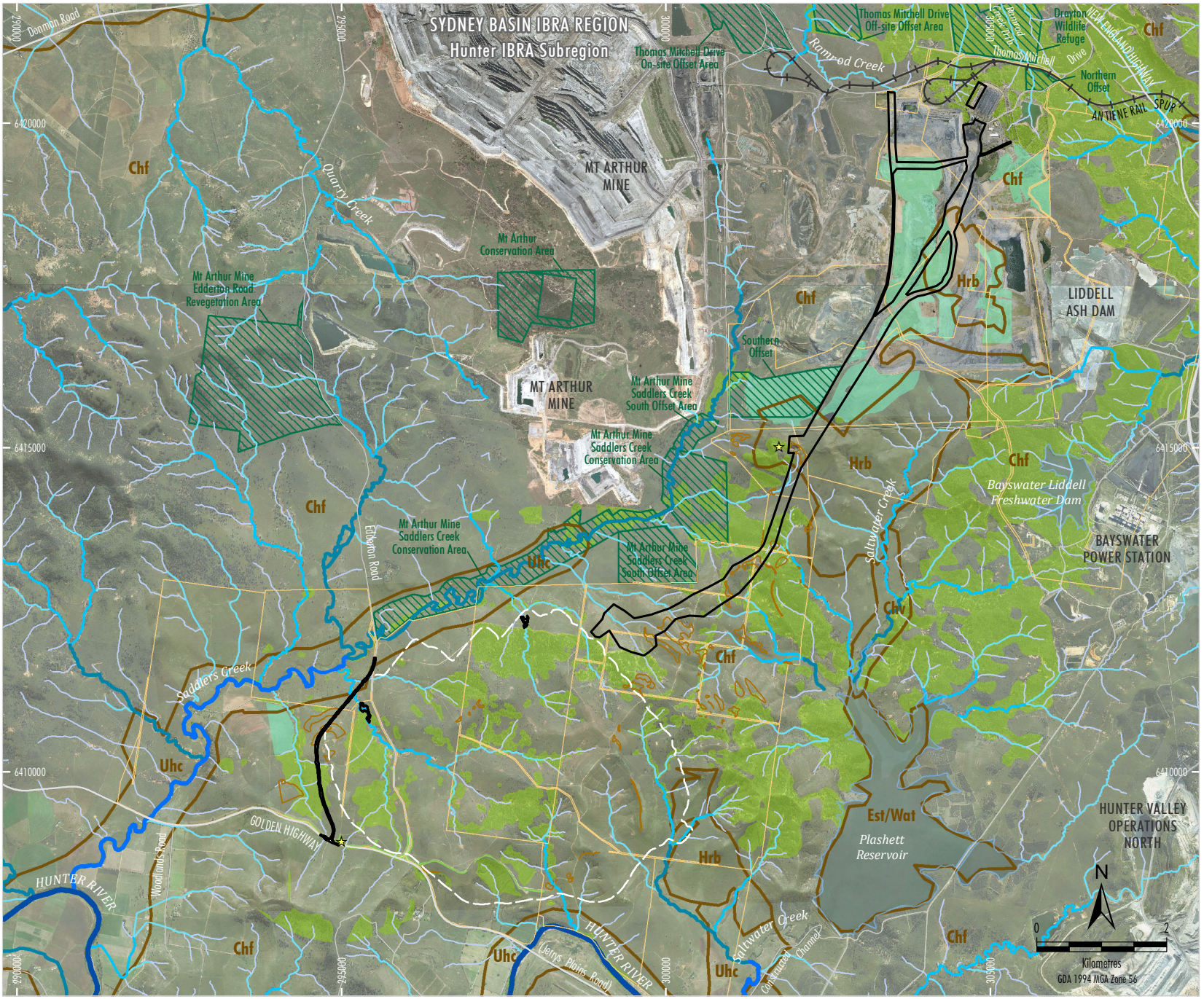
The IBRA regional boundaries (Department of the Environment [DotE] 2012) do not occur near the Subject land and hence are not shown on Figures 5 and 6.

2.2 HABITAT CONNECTIVITY FEATURES

Native vegetation extent and habitat connectivity were determined by site survey (Hunter Eco 2019, Attachment A) and current aerial photography (Nearmap 2019). Connectivity of woodland/forest habitat was assessed where gaps between discrete patches were 100 metres (m) or less and native grassland habitat where gaps were 30 m or less. The woodland/forest habitat is fragmented due to past land clearance.

2.3 RIVERS AND STREAMS

Rivers and streams (and riparian buffer distances based on Strahler stream ordering [Department of Primary Industries – Water 2017]) are shown on Figure 5. The Hunter River, Saltwater Creek and Ramrod Creek are downstream of the Subject land. The upper reaches of Saddlers Creek are immediately north of the underground mining area with the creek continuing south-west to the Hunter River. There are a number of smaller, unnamed watercourses within the Subject land. Potential impacts on rivers and streams are described in Section 5.3.7.



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Subject Land Cadastral Boundary
- Existing Conservation/Offset Area
- Habitat Connectivity Area
- Non-native Vegetation
- Rocky Area
- Approximate Location of Crevice

Strahler Stream Order

- 1st Order (Riparian Corridor Width 10 m)
- 2nd Order (Riparian Corridor Width 20 m)
- 3rd Order (Riparian Corridor Width 30 m)
- 4th Order (Riparian Corridor Width 40 m)
- 5th Order (Riparian Corridor Width 40 m)
- 9th Order (Riparian Corridor Width 50 m)

Mitchell Landscapes

- Chv Central Hunter Alluvial Plains
- Chf Central Hunter Foothills
- Est/Wat Estuary/Water Added
- Hrb Hunter River Basalts
- Uhc Upper Hunter Channels and Floodplain

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Office of Environment and Heritage NSW (2019); MSEC (2019) Orthophoto Mosaic: 2018, 2016, 2011

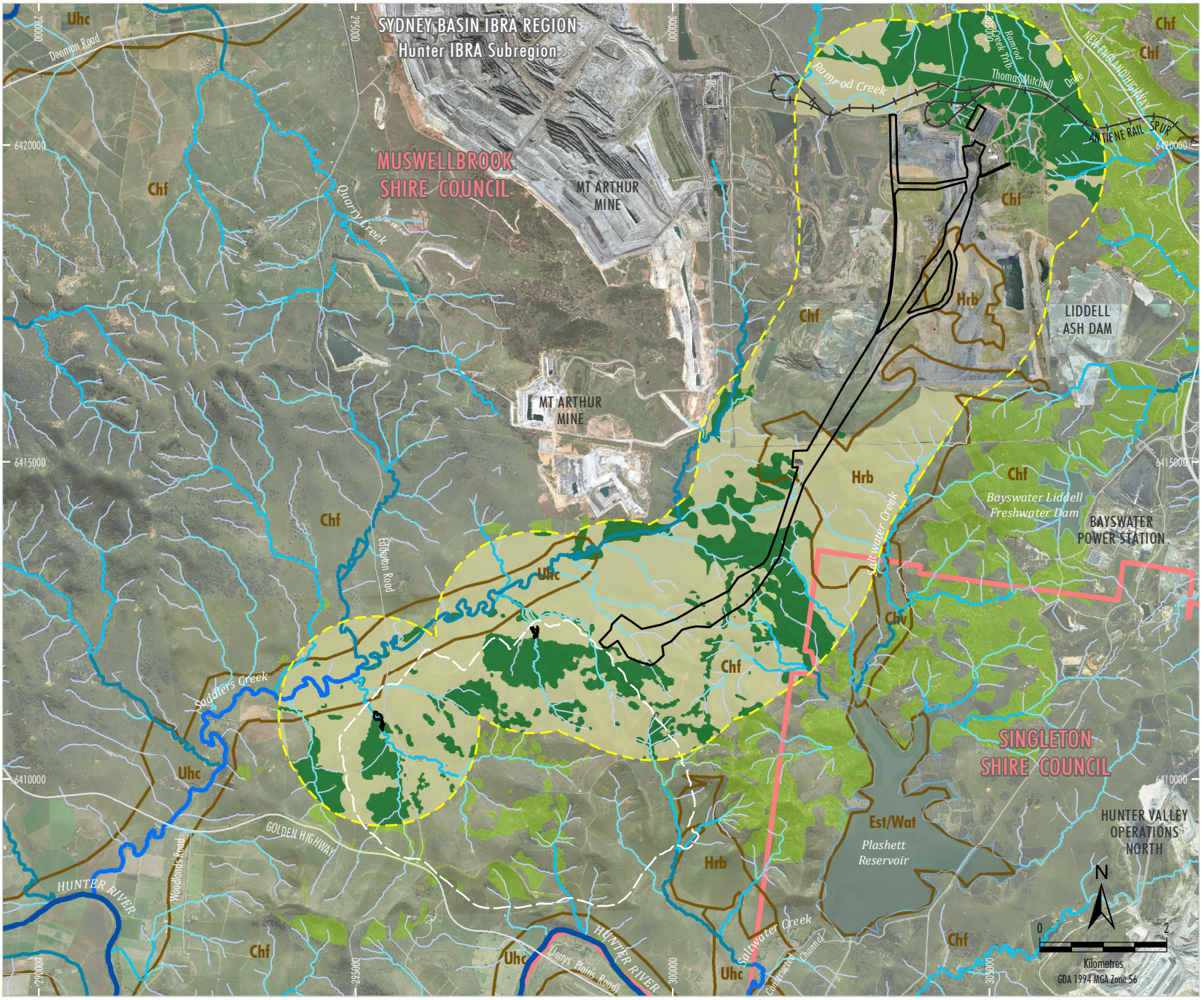
MALABAR COAL

MAXWELL PROJECT

Site Map

Figure 5

SHM-18-03 Maxwell_EIS_App_BDAR_206H



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 1
- 1500 m Buffer Area
- Woodland within the Buffer
- Derived Native Grassland within the Buffer
- Habitat Connectivity Area outside the Buffer
- Local Government Area

Strahler Stream Order

- 1st Order (Riparian Corridor Width 10 m)
- 2nd Order (Riparian Corridor Width 20 m)
- 3rd Order (Riparian Corridor Width 30 m)
- 4th Order (Riparian Corridor Width 40 m)
- 5th Order (Riparian Corridor Width 40 m)
- 9th Order (Riparian Corridor Width 50 m)

Mitchell Landscapes

- Chv Central Hunter Alluvial Plains
- Chf Central Hunter Foothills
- Est/Wat Estuary/Water Added
- Hrb Hunter River Basalts
- Uhc Upper Hunter Channels and Floodplain

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Office of Environment and Heritage NSW (2019); MSEC (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Location Map - Biodiversity Assessment Development Footprint Stage 1

Figure 6

SHM-18-03 Maxwell_EIS_App_BDAR_207F

2.4 WETLANDS

There are no important or local wetlands on or, adjacent to the Subject land (after DEE 2018a). The closest important wetland is too far away (over 50 kilometres [km]) to be shown on Figure 6.

2.5 AREAS OF GEOLOGICAL SIGNIFICANCE AND SOIL HAZARD FEATURES

There are no karst, caves, cliffs or other areas of geological significance on, or in the vicinity of, the Subject land. Rock crevices are present at an old quarry and nearby rocky hill to the south of Maxwell Infrastructure, and a small rocky escarpment at the southern end of the Maxwell Underground (Attachment B) (Figure 5). No threatened species are known to be associated with these areas.

2.6 AREAS OF OUTSTANDING BIODIVERSITY VALUE

There are no Areas of Outstanding Biodiversity Value listed under the NSW *Biodiversity Conservation Regulation, 2017* (BC Regulation) associated with the Project.

2.7 MIGRATORY SPECIES POTENTIAL FLYWAYS

There are no defined potential flyways for migratory species listed under the EPBC Act that pass over the Project land. However migratory birds could fly over that land similar to most areas in NSW, e.g. Rainbow Bee-eater (*Merops ornatus*) or White-throated Needletail (*Hirundapus caudacutus*). Migratory species are not a relevant EPBC Act controlling provision for the Project (Section 1.2).

2.8 SITE CONTEXT COMPONENTS

A site-based assessment method described in the BAM, whereby a 1,500 m buffer is placed around the development site, was applied to each development stage. Edderton Road realignment is less than 3.5 km in length and therefore does not meet the definition of linear shaped development in the BAM (OEH 2017a); it is therefore assessed as a site-based development.

The extent of native vegetation cover and patch size has been assessed for each development stage (Table 1). OEH advised (27 March 2019) that derived grasslands were to be considered as part of the native vegetation extent and patch size in the buffer area.

Table 1
Native Vegetation Extent in the Buffer Area

Component	Native Vegetation Extent in the Buffer Area (%)	Patch Size (ha)
Stage 1 Biodiversity Assessment Development Footprint	67	>100
Stage 2 Biodiversity Assessment Development Footprint	96	>100

Areas not covered by native vegetation cover on the Site Map are cleared of native vegetation. These cleared areas are further identified in Sections 3.1.1 and 4.1.1.

There were no notable differences between mapped vegetation extent and aerial imagery. However, it was noted that some areas with isolated paddock trees that appeared connected on the aerial imagery were, in fact, shadows of the isolated paddock trees.

There are no additional features required to be assessed from the SEARs.

3 NSW BIODIVERSITY ASSESSMENT STAGE 1

This section provides a description of the native vegetation and threatened species relevant to the Stage 1 Biodiversity Assessment Development Footprint (Figure 6). Section 4 provides a description of the native vegetation and threatened species relevant to Stage 2 (i.e. the potential Edderton Road realignment).

3.1 NATIVE VEGETATION

This section provides a description of the native vegetation relevant to Stage 1 of the Biodiversity Assessment Development Footprint.

3.1.1 PLANT COMMUNITY TYPES

Hunter Eco (2019) (Attachment A) identified and mapped Plant Community Types (PCT) on the Subject land and surrounding area in accordance with the BAM and *BioNet Vegetation Classification* (OEH 2019b) (Figures 7a and 7b) (Table 2). The PCTs are assigned to a vegetation class in Table 2. Table 2 also includes the Percent Cleared Values from the *BioNet Vegetation Classification* (OEH 2019b) and the Vegetation Integrity (VI) Scores (Section 3.2.3).

Hunter Eco (2019) justifies the PCT and vegetation zone mapping (including the species relied upon for identification of PCTs) in Attachment A. The vegetation mapping method specifically included review of previous vegetation mapping, including that by Cumberland Ecology (2015).

The presence of Fuzzy Box (*Eucalyptus microcarpa*) necessitated selection of PCT 201 which lies in the South-west Slopes Bioregion as there was no Fuzzy Box PCT within the Sydney Basin Bioregion despite numerous records of Fuzzy Box for the bioregion in BioNet (OEH 2019c).

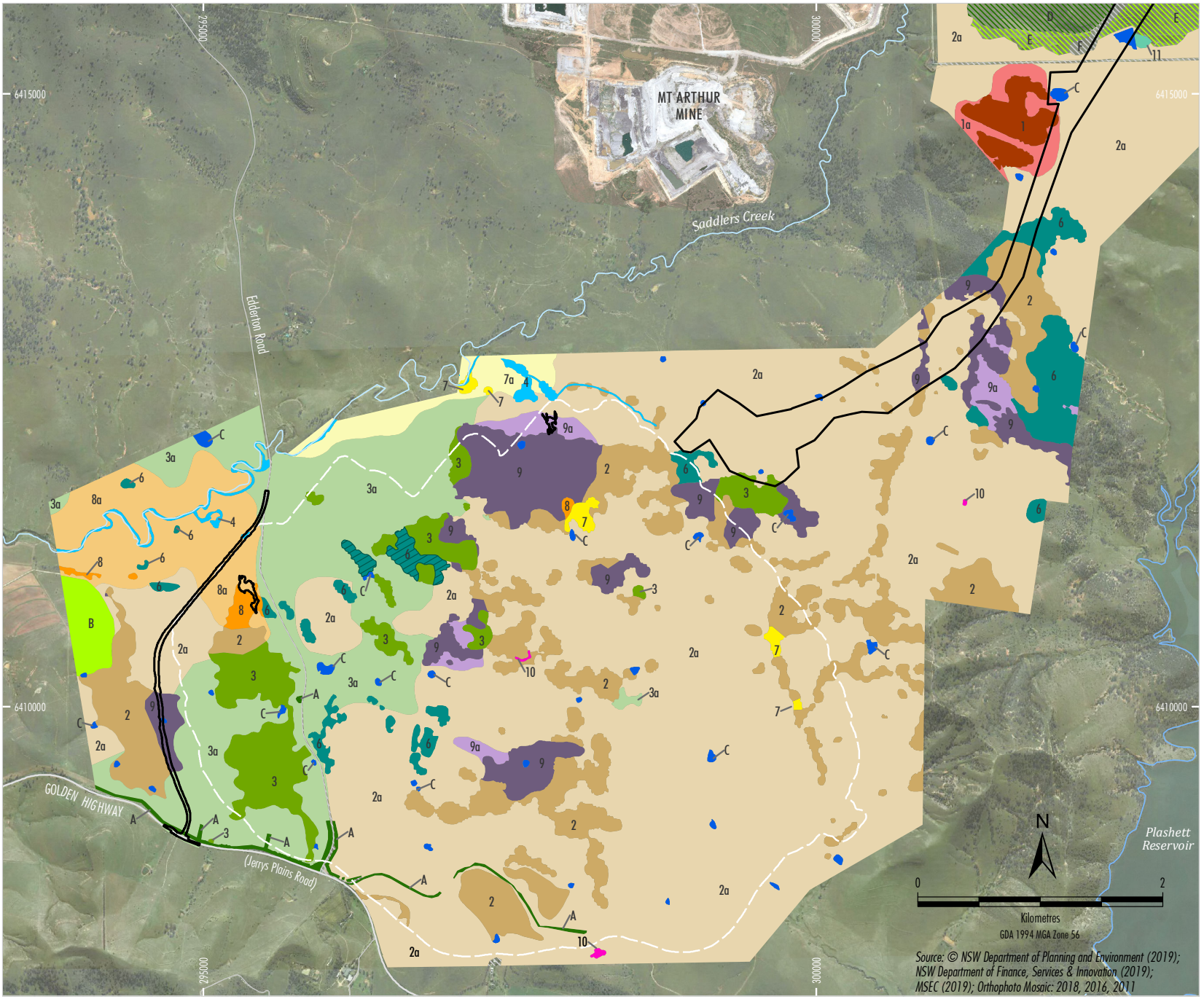
As already mentioned, a portion of the Biodiversity Assessment Development Footprint lies over areas of previous open cut mining activity and overburden emplacement, some of which has been rehabilitated to either pasture or woodland (herein referred to as mine site rehabilitation). OEH advised (5 September 2018) that mine rehabilitation that includes native flora species is required to be assessed by selecting the most likely pre-existing PCT and adding the vegetation zone into the BAM Credit Calculator.

In order for the ecological values of this habitat to be assessed through the BAM Credit Calculator, these areas were assigned to PCT 1604. This was considered to be the most likely predominant community existing prior to mining.

The Stage 1 Biodiversity Assessment Development Footprint is approximately 310.8 ha in size comprising (Figures 7a and 7b):

- 23.3 ha of fragmented (i.e. not continuous) native woodland/forest vegetation;
- 128.9 ha of derived native grassland (DNG);
- 90.3 ha is infrastructure/cleared land;
- 49.3 ha is pasture rehabilitation associated with Maxwell Infrastructure;
- 15.2 ha is woodland rehabilitation associated with Maxwell Infrastructure; and
- 3.8 ha is covered by various mine waterbodies and farm dams.

The location of vegetation integrity (site condition) plots used in the BAM Credit Calculator for the Stage 1 Biodiversity Assessment Development Footprint are shown on Figures 8a and 8b. Vegetation composition, structure and function data are provided in Attachment A.



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 2a White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3 Slaty Box Shrubby Woodland (PCT1655) [2]
- 3a Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4 Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 6 Bull Oak Grassy Woodland (PCT1692) [3]
- 7 Yellow Box - Apple Grassy Woodland (PCT1693) [1]
- 7a Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693) [1]
- 8 Fuzzy Box Woodland (PCT201)
- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9 Ironbark - Grey Box Grassy Woodland (PCT1691) [4]
- 9a Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 10 Weeping Myall Woodland (PCT116) [5]
- 11 Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]

Other

- A Planted Trees
- B Cultivation
- C Waterbody/Dam
- D Woodland Rehabilitation
- E Pasture Rehabilitation
- F Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland

[2] Listed BC Act, Hunter Valley Footslopes Slaty Gum Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[3] The hatched portions of this PCT is Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[4] Listed BC Act, Central Hunter Grey Box - Ironbark Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[5] Listed BC Act, Hunter Valley Weeping Myall Woodland; Listed EPBC Act, Hunter Valley Weeping Myall (Acacia pendula) Woodland

[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

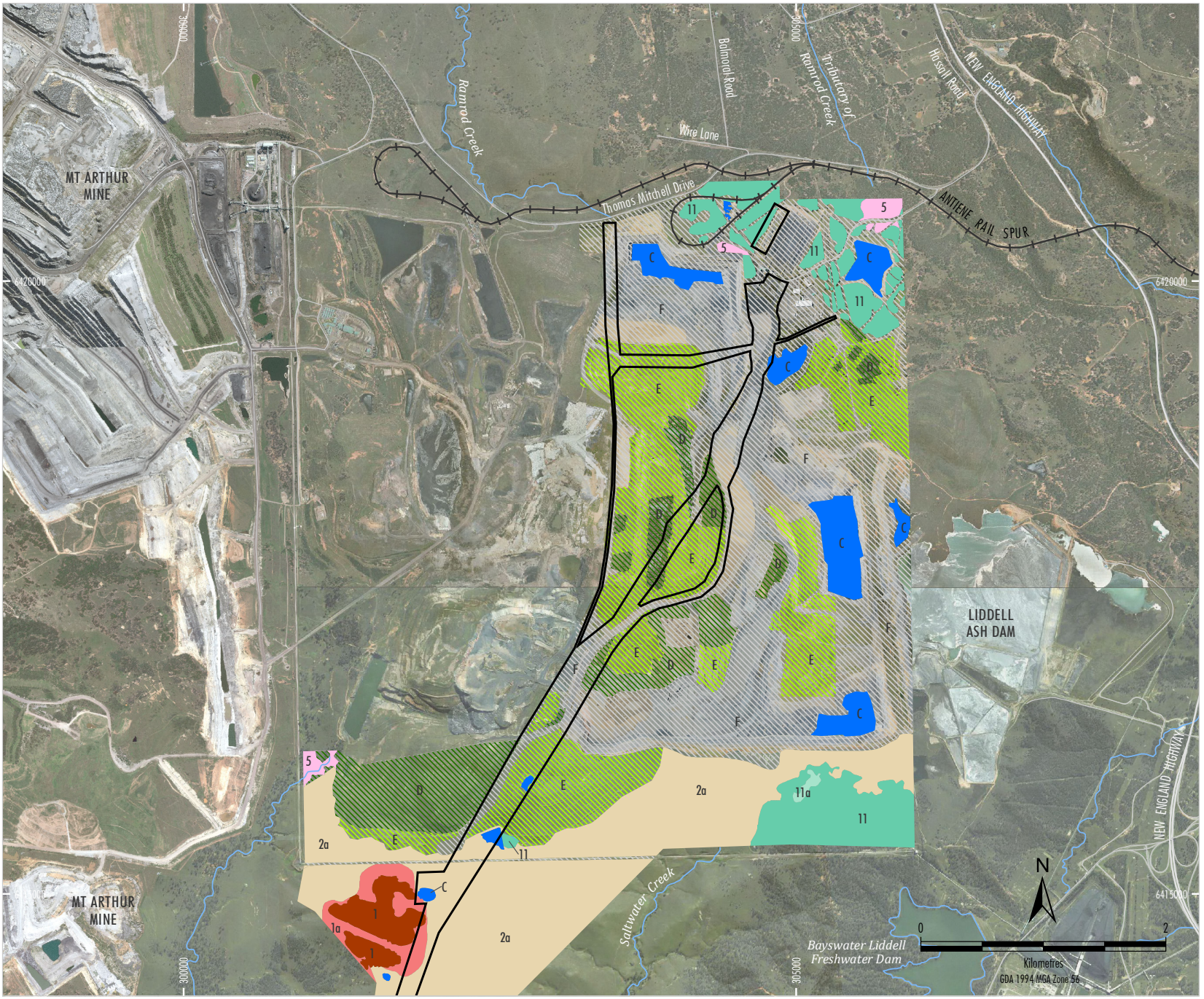
MALABAR COAL

MAXWELL PROJECT

Vegetation Mapping - Maxwell Underground

Figure 7a

SHM-18-03 Maxwell_EIS_App_BDAR_208E



LEGEND

- Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 — Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a — Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2a — White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Forested Wetlands

- 5 — Hunter Lowland Red Gum Forest (PCT1598) [7]

Grassy Woodlands

- 11 — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]
- 11a — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland - Derived Native Grassland (PCT1604)

Other

- C — Waterbody/Dam
- D — Woodland Rehabilitation
- E — Pasture Rehabilitation
- F — Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland
[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[7] Listed BC Act, Hunter Lowland Redgum Forest

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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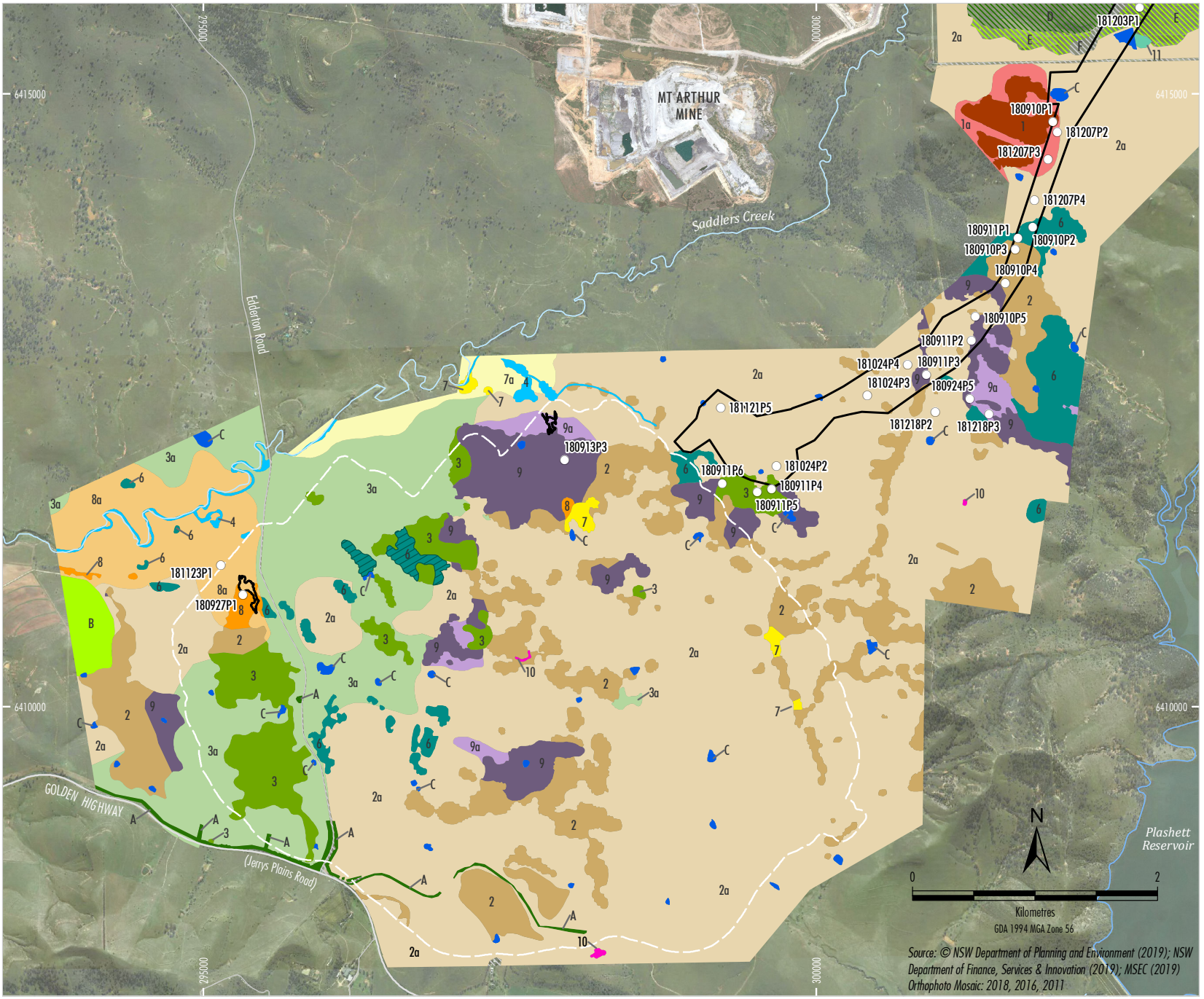
Vegetation Mapping - Maxwell Infrastructure

Figure 7b

SHM-18-03 Maxwell_EIS_App_BDAR_209B



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 1
- Vegetation Integrity Plot Location

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 2a White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3 Slaty Box Shrubby Woodland (PCT1655) [2]
- 3a Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4 Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 6 Bull Oak Grassy Woodland (PCT1692) [3]
- 7 Yellow Box - Apple Grassy Woodland (PCT1693) [1]
- 7a Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693) [1]
- 8 Fuzzy Box Woodland (PCT201)
- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9 Ironbark - Grey Box Grassy Woodland (PCT1691) [4]
- 9a Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 10 Weeping Myall Woodland (PCT116) [5]
- 11 Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]

Other

- A Planted Trees
- B Cultivation
- C Waterbody/Dam
- D Woodland Rehabilitation
- E Pasture Rehabilitation
- F Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland

[2] Listed BC Act, Hunter Valley Footslopes Slaty Gum Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[3] The hatched portions of this PCT is Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[4] Listed BC Act, Central Hunter Grey Box - Ironbark Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[5] Listed BC Act, Hunter Valley Weeping Myall Woodland; Listed EPBC Act, Hunter Valley Weeping Myall (Acacia pendula) Woodland

[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

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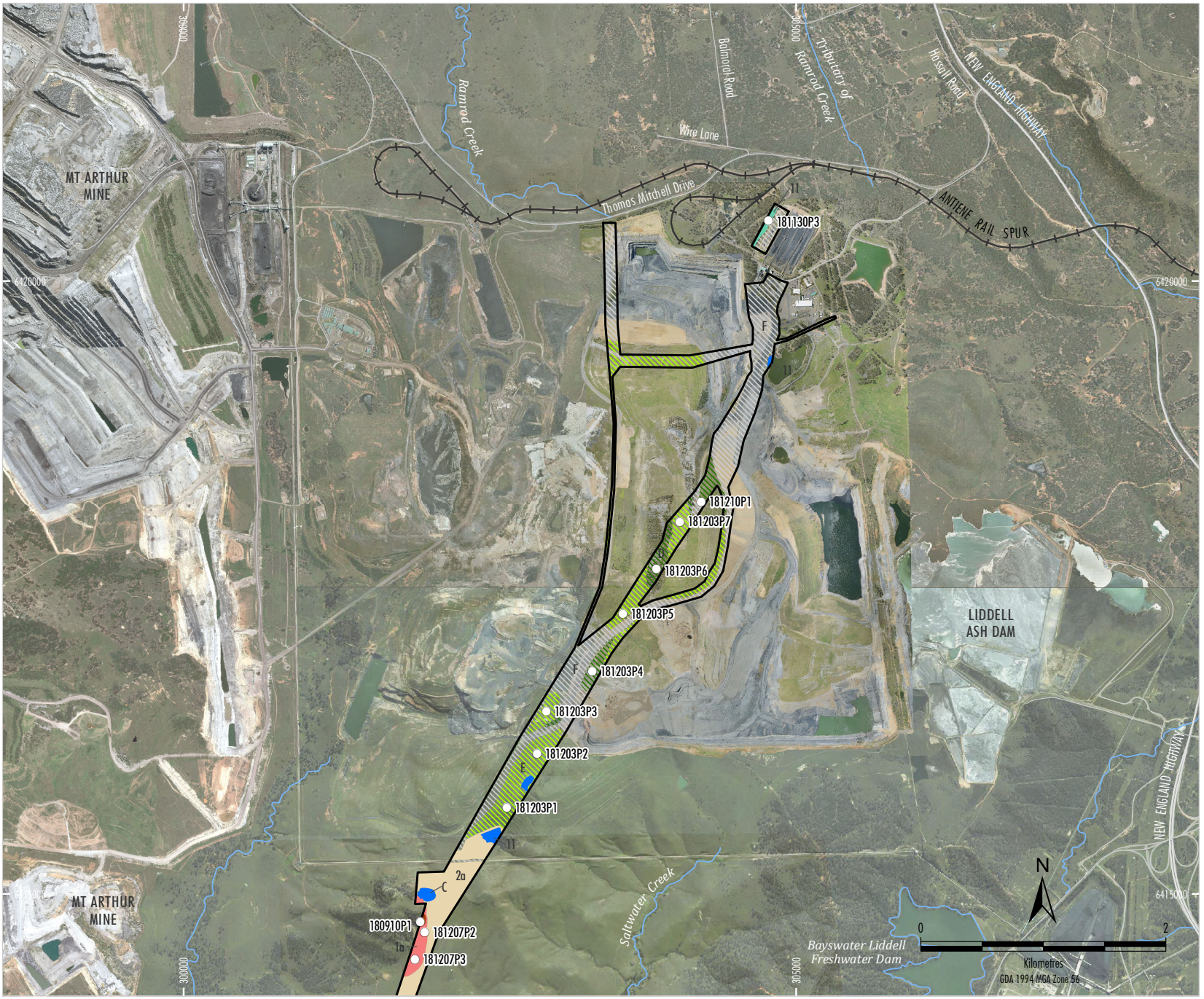
Vegetation Integrity Plot Locations - Biodiversity Assessment Development Footprint Stage 1

Figure 8a

SHM-18-03 Maxwell_EIS_App_BDAR_210G



LEGEND

- Biodiversity Assessment
- Development Footprint Stage 1
- Vegetation Integrity Plot Location

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 — Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a — Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2a — White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Grassy Woodlands

- 11 — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]

Other

- C — Waterbody/Dam
- D — Woodland Rehabilitation
- E — Pasture Rehabilitation
- F — Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland

[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

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Vegetation Integrity Plot Locations - Biodiversity Assessment Development Footprint Stage 1

Figure 8b

SHM-18-03 Maxwell_EIS_App_BDAR_211D

Table 2
Plant Community Type Data - Stage 1

Vegetation Zone	PCT	PCT Name	Class	Generic Name (Attachment A)	Area (ha)	Percent Cleared	Sensitivity Class^	VI Score~
Dry Sclerophyll Forests (Shrub/grass sub-formation)								
1	1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	1. Red Gum - Ironbark - Apple Shrubby Woodland	0.4	51	High	50.5
2	1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter - DNG	North-west Slopes Dry Sclerophyll Woodlands	1a. Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	4.9	51	High	27.6
3	1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter[1]	North-west Slopes Dry Sclerophyll Woodlands	2. White Box - Ironbark - Red Gum Shrubby Forest	9.5	29	High	45.4
4	1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG[1]	North-west Slopes Dry Sclerophyll Woodlands	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)	122.7 [A]	29	High	15.8
Dry Sclerophyll Forests (Shrubby sub-formation)								
5	1655	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin[2]	Western Slopes Dry Sclerophyll Forests	3. Slaty Box Shrubby Woodland	1.2	36	High	46.5
Grassy Woodlands								
6	1692	Bull Oak Grassy Woodland of the central Hunter Valley*	Coastal Valley Grassy Woodlands	6. Bull Oak Grassy Woodland	2.8	53	High	36.9
7	201	Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Western Slopes Grassy Woodlands	8. Fuzzy Box Woodland	0.5 [B]	94	High	47.5
8	201	Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion - DNG	Western Slopes Grassy Woodlands	8a. Fuzzy Box Woodland (DNG)	1 [C]	94	High	23.1

Vegetation Zone	PCT	PCT Name	Class	Generic Name (Attachment A)	Area (ha)	Percent Cleared	Sensitivity Class^	VI Score~
9	1691	Narrow-leaved Ironbark - Grey Box Grassy Woodland of the central and upper Hunter[3]	Coastal Valley Grassy Woodlands	9. Ironbark - Grey Box Grassy Woodland	7.6 [D]	79	High	48.3
10	1691	Narrow-leaved Ironbark - Grey Box Grassy Woodland of the central and upper Hunter - DNG	Coastal Valley Grassy Woodlands	9a. Ironbark - Grey Box Grassy Woodland (DNG)	0.3 [E]	79	High	40.7
11	1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter[4]	Coastal Valley Grassy Woodlands	11 Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland	1.3	71	High	68.4
Mine Site Rehabilitation								
12	1604	As above	As above	Pasture Rehabilitation	49.3	-	High	3.8
13	1604	As above	As above	Woodland Rehabilitation	15.2	-	High	28.1
				Total Woodland/Forest	23.3	-		-
				Total Derived Native Grassland	128.9	-		-
				Total Rehabilitated Vegetation	64.5	-		-
				Total	216.7	-		-

[1] Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[2] Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[3] Listed BC Act, E: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[4] Listed BC Act, E: Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

* This occurrence of PCT 1692 does not meet the criteria for the EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

^ The sensitivity class is set for each PCT by OEH (2019b).

~ BAM Credit Calculator.

[A] <0.1 ha of PCT 1606 DNG is associated with potential subsidence ponding impacts (Figure 3).

[B] Approximately 0.5 ha of PCT 201 is associated with potential subsidence ponding impacts (Figure 3).

[C] Approximately 1 ha of PCT 201 DNG is associated with potential subsidence ponding impacts (Figure 3).

[D] <0.3 ha of PCT 1691 is associated with potential subsidence ponding impacts (Figure 3).

[E] <0.3 ha of PCT 1691 DNG is associated with potential subsidence ponding impacts (Figure 3).

3.1.2 THREATENED ECOLOGICAL COMMUNITIES

Hunter Eco (2019) (Attachment A) undertook targeted surveys for potentially occurring threatened ecological communities (TEC) listed under the BC Act or the EPBC Act. Threatened ecological communities listed under the BC Act are shown on Figure 9 and threatened ecological communities listed under the EPBC Act are shown on Figure 10.

Threatened ecological communities within the Stage 1 Biodiversity Assessment Development Footprint are listed in Table 3. Table 2 shows the TEC and associated PCT listed under the BC Act for this Stage 1 assessment.

Table 3
Threatened Ecological Communities - Stage 1

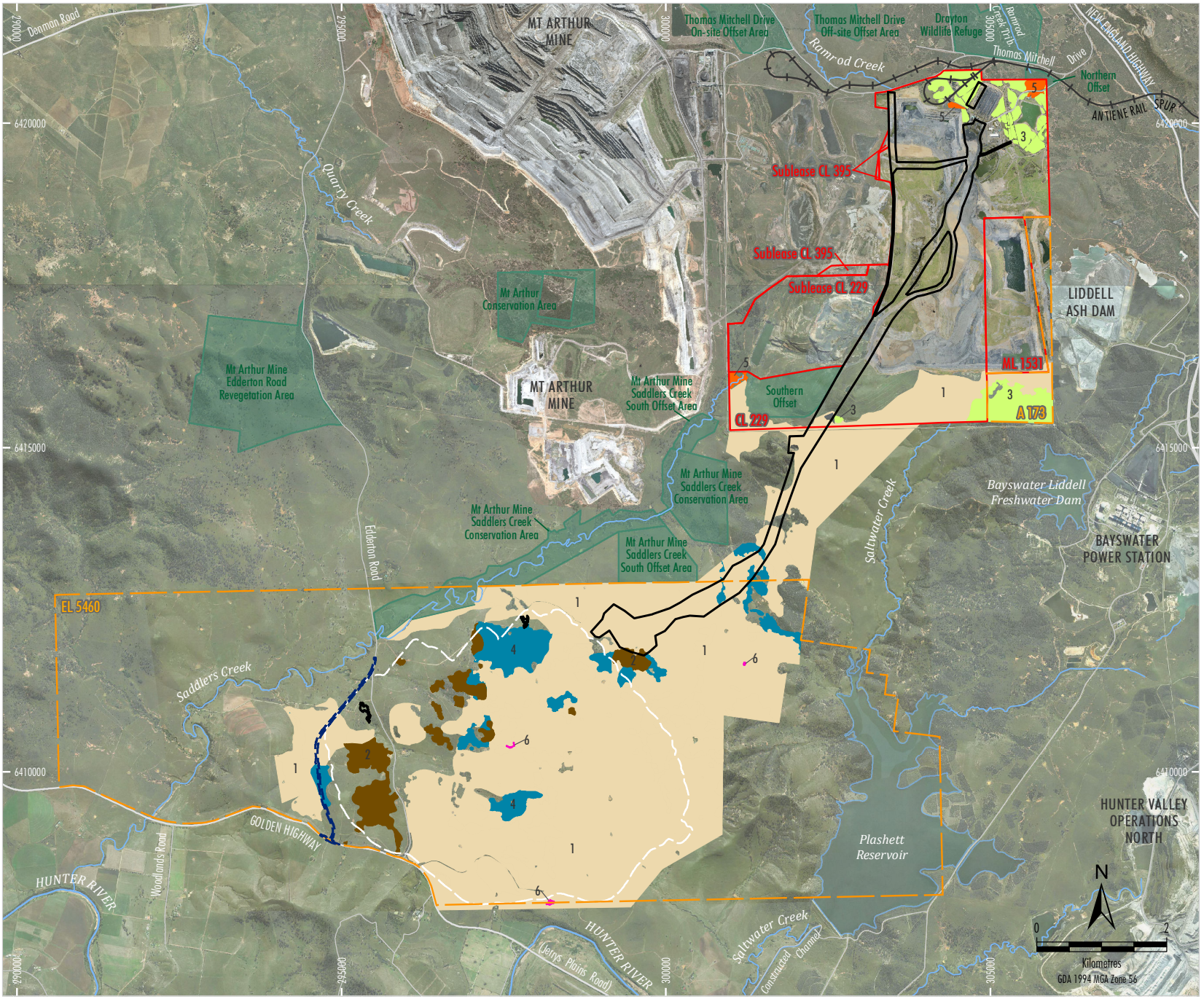
Threatened Ecological Community	Conservation Status*	Associated PCT	Area (ha)
Threatened Ecological Communities listed under the BC Act			
White Box Yellow Box Blakely's Red Gum Woodland	E	1606	132.2 ha (comprising 9.5 ha of woodland and 122.7 ha of DNG)
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	1655	1.2 ha (woodland)
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E	1604	1.3 ha (woodland)
Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	1691	7.6 ha (woodland)
Threatened Ecological Communities listed under the EPBC Act			
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1606	132.2 ha (comprising 9.5 ha of woodland and 122.7 ha of DNG)
Central Hunter Valley Eucalypt Forest and Woodland	CE	1604, 1655, 1691	10.1 ha (woodland)

* Threatened ecological community status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

The mine site rehabilitation assigned to PCT 1604 does not qualify as either TEC shown in Table 3 on two counts, first the relevant determinations exclude derived grassland and second, the rehabilitated woodland does not contain typical canopy or shrub species.

3.1.3 PLANT COMMUNITY TYPES PERCENT CLEARED VALUE

The BAM defines 'Percent Cleared Value' as the percentage of a PCT that has been cleared as a proportion of its pre-1750 extent, as identified in the *BioNet Vegetation Classification* (OEH 2019b). Percent cleared values for each PCT are shown in Table 2.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 1
- Biodiversity Assessment Development Footprint Stage 2
- Existing Conservation/Offset Area

Threatened Ecological Communities

- 1 White Box Yellow Box Blakely's Red Gum Woodland
- 2 Hunter Valley Footslopes Slaty Gum Woodland
- 3 Central Hunter Ironbark-Spotted Gum-Grey Box Forest
- 4 Central Hunter Grey Box-Ironbark Woodland
- 5 Hunter Lowland Redgum Forest
- 6 Hunter Valley Weeping Myall Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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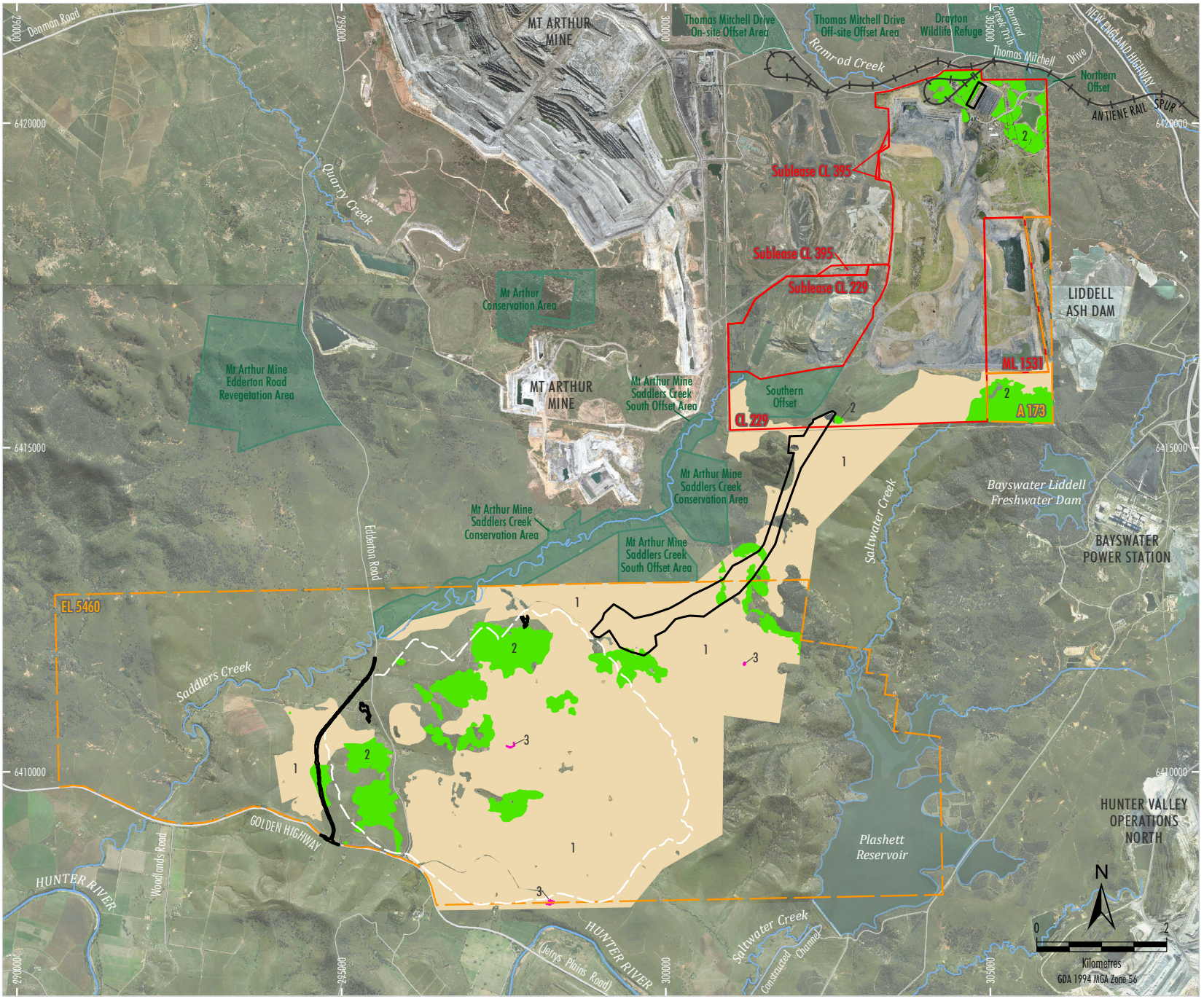
Threatened Ecological Communities Listed under the BC Act

Figure 9

SHM-18-03 Maxwell_EIS_App_BDAR_204G



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Commonwealth Action Area Footprint (2018/8287)
- Existing Conservation/Offset Area

Threatened Ecological Communities

- 1 White Box - Yellow Box - Blakely's Red Gum Woodland
- 2 Central Hunter Valley Eucalypt Forest and Woodland
- 3 Weeping Myall *(Acacia pendula)* Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Threatened Ecological Communities Listed under the EPBC Act

Figure 10

SHM-18-03 Maxwell_EIS_App_BDAR_205E

3.2 VEGETATION INTEGRITY ASSESSMENT

3.2.1 VEGETATION ZONES

Thirteen vegetation zones (i.e. areas of native vegetation that are the same PCT and similar broad condition states) were mapped (Table 2; Figures 7a and 7b). Vegetation condition states recognised were: woodland, DNG and mine site rehabilitation (pasture and woodland).

3.2.2 PATCH SIZE

The BAM defines 'Patch Size' as:

> *An area of **intact native vegetation** that:*
>
> *a) occurs on the development site or biodiversity stewardship site, and*
>
> *b) includes native vegetation that has a gap of less than 100m from the next area of moderate to good condition native vegetation (or ≤30m for non-woody ecosystems).*
>
> *Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site.*

OEH advised (27 March 2019) that DNGs were to be considered 'non-woody vegetation types', where patch size equals the areas of moderate to good native vegetation[5] with gaps of <= 30m to the next patch of native vegetation (regardless if the patches are woody or non-woody), and derived native vegetation areas are included in the patch size calculation.

Patch size for the Stage 1 Biodiversity Assessment Development Footprint for both woodland and DNG PCT was >100 ha (Figures 5 and 6).

3.2.3 VEGETATION INTEGRITY SCORE

The flora surveys (Attachment A) collected data from 109 plots located to sample the vegetation zones present with the number of plots meeting or exceeding the requirements per area of each zone. The plots located outside of the Biodiversity Assessment Development Footprint were located in the same vegetation zone that was continuous with the vegetation in the Biodiversity Assessment Development Footprint. The plots were considered to be representative of the vegetation in the Biodiversity Assessment Development Footprint.

The BAM Credit Calculator was used to determine the VI Scores for each PCT in the development area (Tables 2 and 4).

According to the BAM Credit Calculator, all of the vegetation zones (except the Pasture Rehabilitation – Vegetation Zone 12) have a VI Score requiring an offset (Table 4). This is because the VI Scores are greater than 17 for PCTs associated with species habitat and greater than 15 for PCTs representative of an endangered ecological community (i.e. Vegetation Zone 4).

The low VI Score for Vegetation Zone 12 is expected because overburden areas have been rehabilitated predominantly with pasture species resulting in low native species diversity and high weed diversity.

[5] Moderate to good native vegetation is not defined by the BAM (OEH 2017a).

Table 4
Vegetation Integrity Score Detail – Stage 1

Vegetation Zone	PCT	PCT-condition class	Composition Condition Score	Structure Condition Score	Function Condition Score	Trees with Hollows	Vegetation Integrity Score	Threshold for Requiring an Offset	Offset Required?
1	1607	Moderate	61.5	46.4	45	32	50.5	>17	Yes
2	1607	Derived Native Grassland	49.3	24.8	17.2	0	27.6	>17	Yes
3	1606	Moderate	44	40.1	53	0	45.4	>15	Yes
4	1606	Derived Native Grassland	58.2	26.2	2.6	0	15.8	>15	Yes
5	1655	Moderate	32.2	37.3	83.6	4	46.5	>15	Yes
6	1692	Moderate	31.6	35.4	45	114	36.9	>17	Yes
7	201	Moderate	38.6	81.9	34	0	47.5	>17	Yes
8	201	Derived Native Grassland	27.4	29.9	15	0	23.1	>17	Yes
9	1691	Moderate	47.4	43.3	54.9	0	48.3	>17	Yes
10	1691	Derived Native Grassland	66.7	42.6	23.8	0	40.7	>17	Yes
11	1604	Moderate	73.7	90.7	47.9	0	68.4	>15	Yes
12	1604	Low RP*	10.9	0.3	14.8	0	3.8	>17	No
13	1604	Low RW#	17.4	65.8	19.4	0	28.1	>17	Yes

* Pasture Rehabilitation.

\# Woodland Rehabilitation.

3.2.4 LOCAL DATA

It was not necessary to use local data to deviate from the OEH databases (OEH 2019a, 2019b).

3.3 THREATENED SPECIES

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are pre-determined by OEH in the BAM Credit Calculator and *Threatened Biodiversity Data Collection* (OEH 2019a). The BAM (OEH 2017a) states:

> *Threatened species where the likelihood of occurrence of a species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection, are identified in the Threatened Biodiversity Data Collection as ecosystem credit species. Targeted survey is not required for these species.*
> …
> *'Species credit species' are threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits*.
> …

'In some circumstances, the Threatened Biodiversity Data Collection may identify that a species requires assessment for ecosystem credits and species credits. This occurs where part of the habitat is assessed as a species credit (e.g. breeding habitat, or mapped locations identified as important area that is used by a species). The remaining part of the habitat is assessed as an ecosystem credit (e.g. foraging habitat, unmapped locations used by a species).'

3.3.1 Ecosystem Credit Species - Habitat Suitability Assessment

In accordance with the BAM (OEH 2017a), assessing habitat suitability for an ecosystem credit species involves the following steps:

Step 1: Identify threatened species for assessment; and

Step 2: Assessment of the habitat constraints and vagrant species on the Subject land.

These steps are applied below.

3.3.1.1 Step 1: Identify Ecosystem Species for Assessment

A total of 33 ecosystem credit species for assessment are listed in Table 5 from the BAM Credit Calculator. Species shaded in Table 5 are species with records in the Subject land (i.e. species without shading in Table 5 have not been recorded in the Subject land).

Table 5
Ecosystem Species from the BAM Credit Calculator – Stage 1

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Sensitivity to Gain Class
		BC Act	EPBC Act		
Birds					
Ninox connivens	Barking Owl	V	-	S/E	High
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	E	Moderate
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	E	High
Stagonopleura guttata	Diamond Firetail	V	-	E	Moderate
Petroica phoenicea	Flame Robin	V	-	E	Moderate
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Breeding: High Foraging: Moderate
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	High
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	E	Moderate
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	E	Moderate
Hieraaetus morphnoides	Little Eagle	V	-	S/E	Moderate
Glossopsitta pusilla	Little Lorikeet	V	-	E	High
Tyto novaehollandiae	Masked Owl	V	-	S/E	High
Grantiella picta	Painted Honeyeater	V	V	E	Moderate
Ninox strenua	Powerful Owl	V	-	S/E	High

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Sensitivity to Gain Class
		BC Act	EPBC Act		
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	High
Petroica boodang	Scarlet Robin	V	-	E	Moderate
Chthonicola sagittata	Speckled Warbler	V	-	E	High
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Moderate
Lathamus discolor	Swift Parrot	E	CE	S/E	Moderate
Neophema pulchella	Turquoise Parrot	V	-	E	High
Daphoenositta chrysoptera	Varied Sittella	V	-	E	Moderate
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	MA	S/E	High
Mammals					
Phascolarctos cinereus	Koala	V	V	S/E	High
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	High
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E	High
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E	Breeding: Very High Foraging: High
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	E	High
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	E	High
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	E	High
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	High
Miniopterus australis	Little Bentwing-bat	V	-	S/E	Breeding: Very High Foraging: High
Petaurus australis	Yellow-bellied Glider	V	-	E	High
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	E	High

Shaded species are species with records in the Subject land.

[1] Threatened fauna species status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered; MA = Marine.

[2] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019). E = Ecosystem; S = Species.

3.3.1.2 Step 2: Assessment of Habitat Constraints and Vagrant Species on the Disturbance Area

The BAM (OEH 2017a) states:

> *the assessor may opt to undertake an additional assessment of the habitat constraints on the Subject land for the threatened species predicted for assessment.*

No ecosystem credit species listed in Table 5 were removed from the BAM Credit Calculator due to habitat constraints.

3.3.2 Species Credit Species - Habitat Suitability Assessment

Assessing the habitat suitability for a species credit species involves the following steps:

Step 1: Identify species credit species for assessment.

Step 2: Assessment of the habitat constraints for species credit species on the Subject land.

Step 3: Identify candidate species credit species for further assessment.

Step 4: Determine presence or absence of a candidate species credit species.

Step 5: Determine the area or count, and location of suitable habitat for a species credit species.

Step 6: Determine the habitat condition within the species polygon for species assessed by area.

3.3.2.1 Step 1: Identify Species Credit Species for Assessment

A total of 51 species credit species are listed in Table 6 for assessment, including: (i) 49 species credit species from the BAM Credit Calculator (which uses information from the *Threatened Biodiversity Data Collection* [OEH 2019a]); (ii) no additional species based on records by past surveys on the Subject land (e.g. Cumberland Ecology 2015); and (iii) two additional species recorded by Future Ecology (2019) (Attachment B), namely the Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Striped Legless Lizard (*Delma impar*). Species shaded in Table 6 are species with records in the Subject land.

Table 6
Species Credit Species for Assessment - Stage 1

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]
		BC Act	EPBC Act	
Flora				
Acacia bynoeana	Bynoe's Wattle	E	V	S
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	E	-	S
Callistemon linearifolius	Netted Bottle Brush	V	-	S
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S
Cymbidium canaliculatum – endangered population	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	S
Cynanchum elegans	White-flowered Wax Plant	E	E	S
Diuris praecox	Rough Doubletail	V	V	S
Diuris tricolor	Pine Donkey Orchid	V	-	S
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	E	-	S
Eucalyptus castrensis	Singleton Mallee	E	-	S
Eucalyptus glaucina	Slaty Red Gum	V	V	S
Eucalyptus parramattensis subsp. *decadens*	*Eucalyptus parramattensis* subsp. *decadens*	V	V	S
Eucalyptus pumila	Pokolbin Mallee	V	V	S
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	S

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]
		BC Act	EPBC Act	
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S
Ozothamnus tesselatus	Ozothamnus tesselatus	V	V	S
Persoonia pauciflora	North Rothbury Persoonia	CE	CE	S
Pomaderris bodalla	Bodalla Pomaderris	V	-	S
Pomaderris queenslandica	Scant Pomaderris	E	-	S
Pomaderris reperta	Denman Pomaderris	CE	CE	S
Prostanthera cineolifera	Singleton Mint Bush	V	V	S
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	S
Rutidosis heterogama	Heath Wrinklewort	V	V	S
Amphibians				
Litoria aurea	Green and Golden Bell Frog	E	V	S
Litoria brevipalmata	Green-thighed Frog	V	-	S
Reptiles				
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S
Delma impar	Striped Legless Lizard	V	V	S
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S
Birds				
Lophoictinia isura	Square-tailed Kite	V	-	S/E
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E
Hieraaetus morphnoides	Little Eagle	V	-	S/E
Burhinus grallarius	Bush Stone-curlew	E	-	S
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E
Lathamus discolour	Swift Parrot	E	CE	S/E
Tyto novaehollandiae	Masked Owl	V	-	S/E
Ninox strenua	Powerful Owl	V	-	S/E
Ninox connivens	Barking Owl	V	-	S/E
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E
Mammals				
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S
Planigale maculata	Common Planigale	V	-	S
Phascolarctos cinereus	Koala	V	V	S/E
Cercartetus nanus	Eastern Pygmy-possum	V	-	S
Petaurus norfolcensis	Squirrel Glider	V	-	S
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E
Miniopterus australis	Little Bentwing-bat	V	-	S/E
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]
		BC Act	EPBC Act	
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S
Myotis macropus	Southern Myotis	V	-	S
Vespadelus troughtoni	Eastern Cave Bat	V	-	S

Shaded species are species with records in the Subject land.

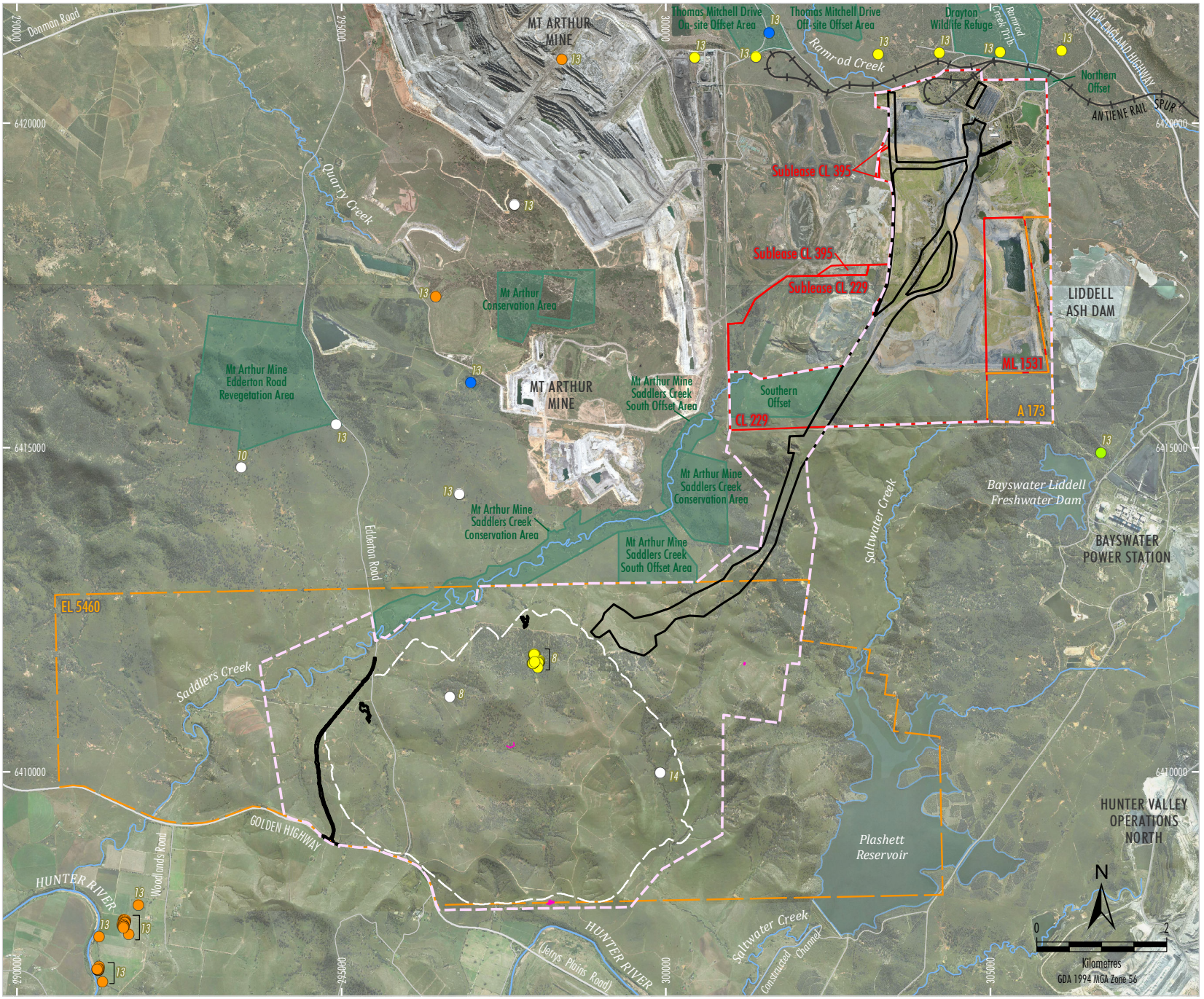
[1] Threatened flora species status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

[2] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019).
E = Ecosystem; S = Species.

The following databases and reports were reviewed for any nearby potentially occurring threatened species records (including species credit species):

- *Birdlife Australia Atlas Database* (Birdlife Australia 2018);
- *BioNet Atlas* (OEH 2019c);
- *Protected Matters Search Tool* (DEE 2018b); and
- *Atlas of Living Australia* (Atlas of Living Australia [ALA] 2018).

Table 7 provides a summary of the threatened species records in the locality from survey records or database records (threatened species shaded in Table 7 are species with records in the Subject land). Threatened species records are shown on Figures 11 to 15.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- *Diuris tricolor*
- *Eucalyptus glaucina*
- *Eucalyptus nicholii*

Endangered Populations

- *Cymbidium canaliculatum* population in the Hunter Catchment
- *Acacia pendula* population in the Hunter Catchment #
- *Diuris tricolor* Fitzg., the Pine Donkey Orchid, in the Muswellbrook Local Government Area
- *Eucalyptus camaldulensis* in the Hunter Catchment

Note *Acacia pendula* is also listed as a threatened ecological community under the BC Act (Hunter Valley Weeping Myall Woodland) and the EPBC Act (Weeping Myall [*Acacia pendula*] Woodland).

Note: OEH (2019) also contains records for the Cumberland Ecology and Hunter Eco records of *Cymbidium canaliculatum* population in the Hunter Catchment, but the co-ordinates are less precise and are therefore not shown on this figure.

Reference:
8. Cumberland Ecology (2012)
10. Hunter Eco (2012)
13. OEH (2019)
14. Hunter Eco (2019)
Note: There are no references 1 - 7, 9, 11 and 12 on this figure.

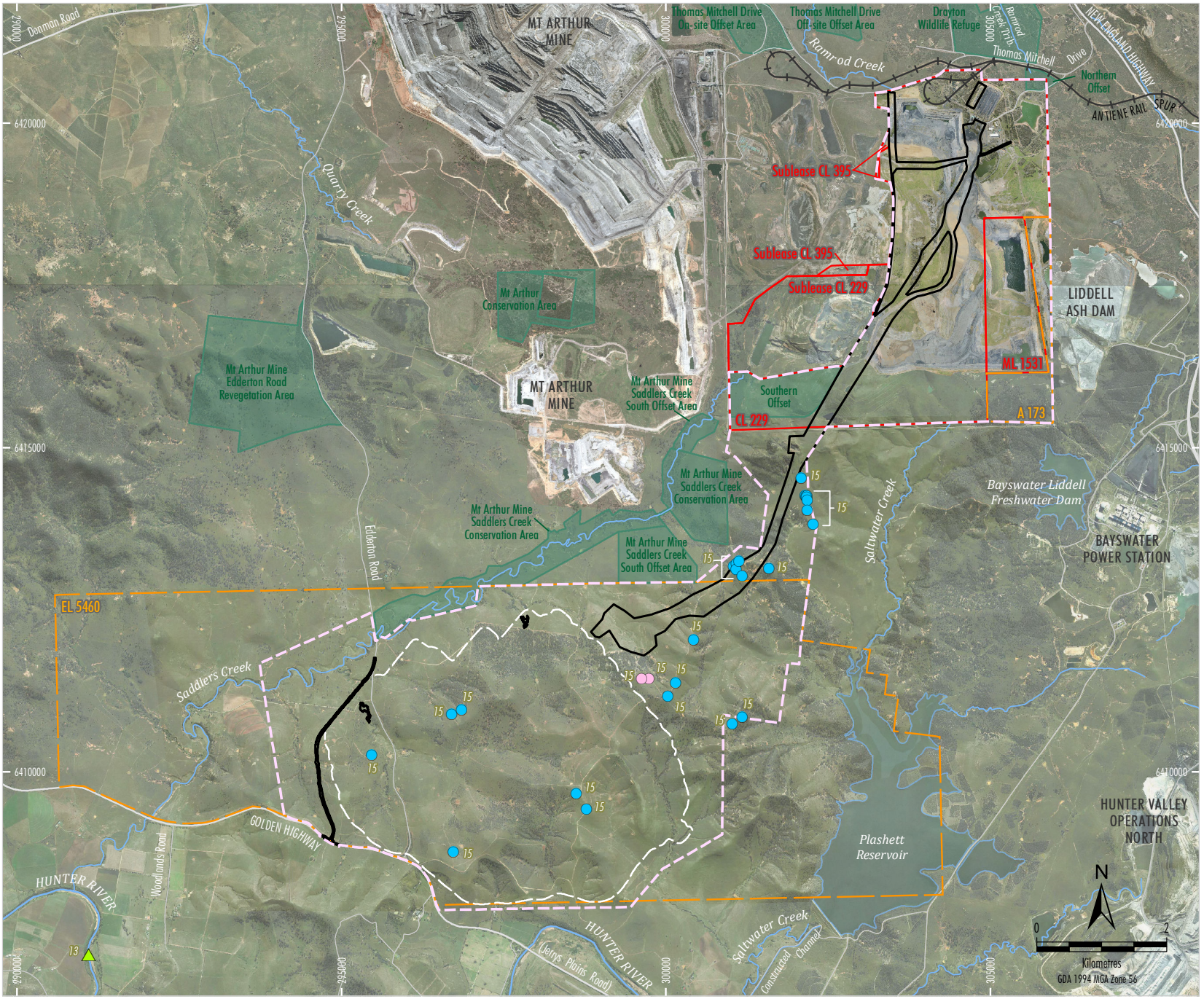
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Flora Species/ Endangered Populations

Figure 11



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Green and Golden Bell Frog
- Pink-tailed Legless Lizard
- Striped Legless Lizard

Reference:

13. OEH (2019)
15. Future Ecology (2019)

Note: There are no references 1 - 12 and 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

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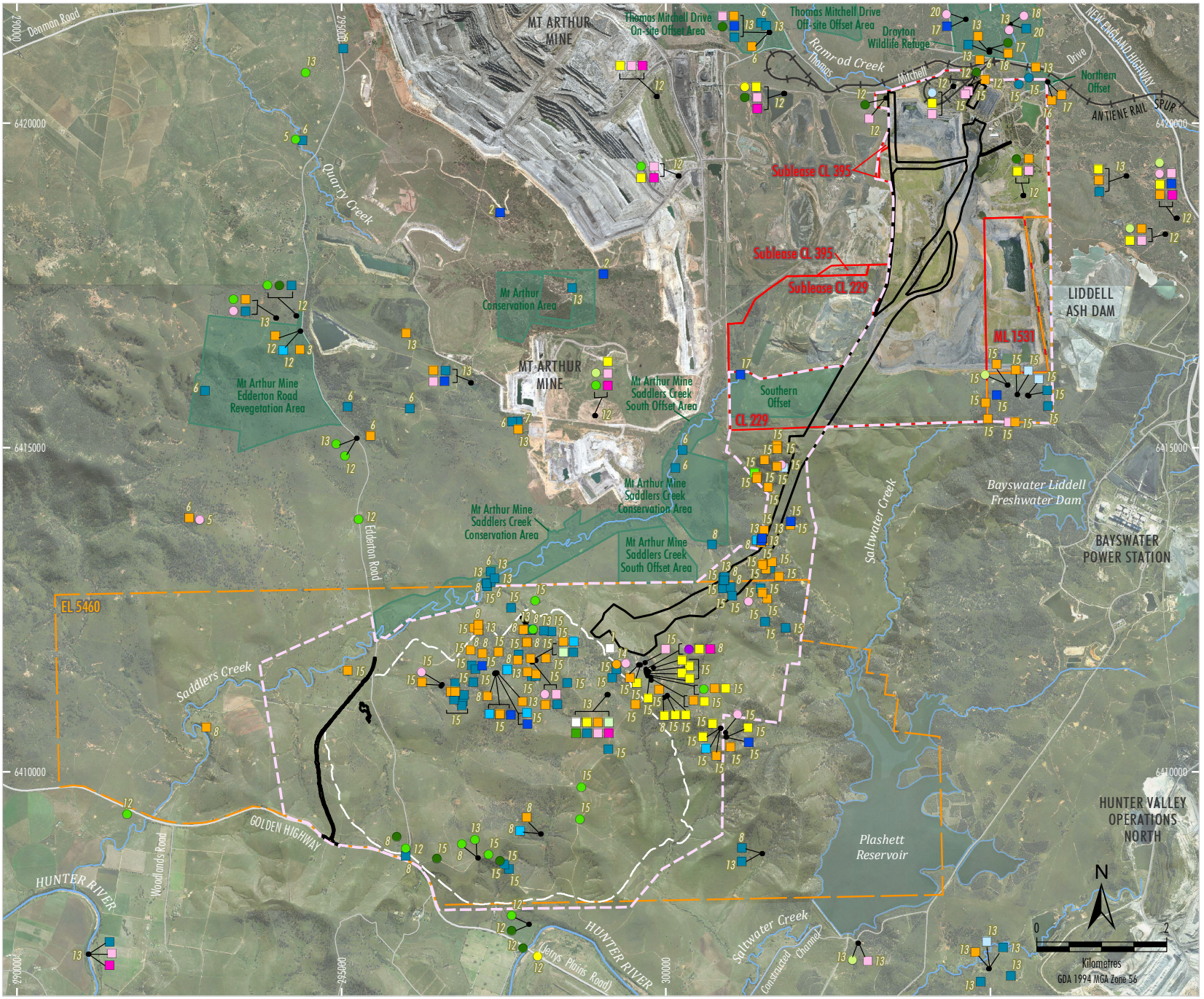
Threatened Reptiles and Amphibians

Figure 12

SHM-18-03 Maxwell_EIS_App_BDAR_213D



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Black Falcon
- Square-tailed Kite
- White-bellied Sea-Eagle
- Spotted Harrier
- Little Eagle
- Bush Stone-curlew
- Glossy Black-Cockatoo
- Little Lorikeet
- Swift Parrot
- Barking Owl
- Brown Treecreeper (eastern subspecies)
- Speckled Warbler
- Black-chinned Honeyeater (eastern subspecies)
- Painted Honeyeater
- Hooded Robin (south-eastern form)
- Flame Robin
- Scarlet Robin
- Grey-crowned Babbler (eastern subspecies)
- Varied Sittella
- Dusky Woodswallow
- Diamond Firetail

Reference:

1. Ecotone (2000)
2. Umwelt (2005)
3. Umwelt (2006b)
5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
8. Cumberland Ecology (2012)
12. Birdlife Australia (2017)
13. OEH (2019)
14. Hunter Eco (pers. comm. (2019))
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
17. Eco Logical Australia (2015)
18. Eco Logical Australia (2016a)
20. Eco Logical Australia (2016b)

Note: There are no references 4, 9 - 11 and 19 on this figure.

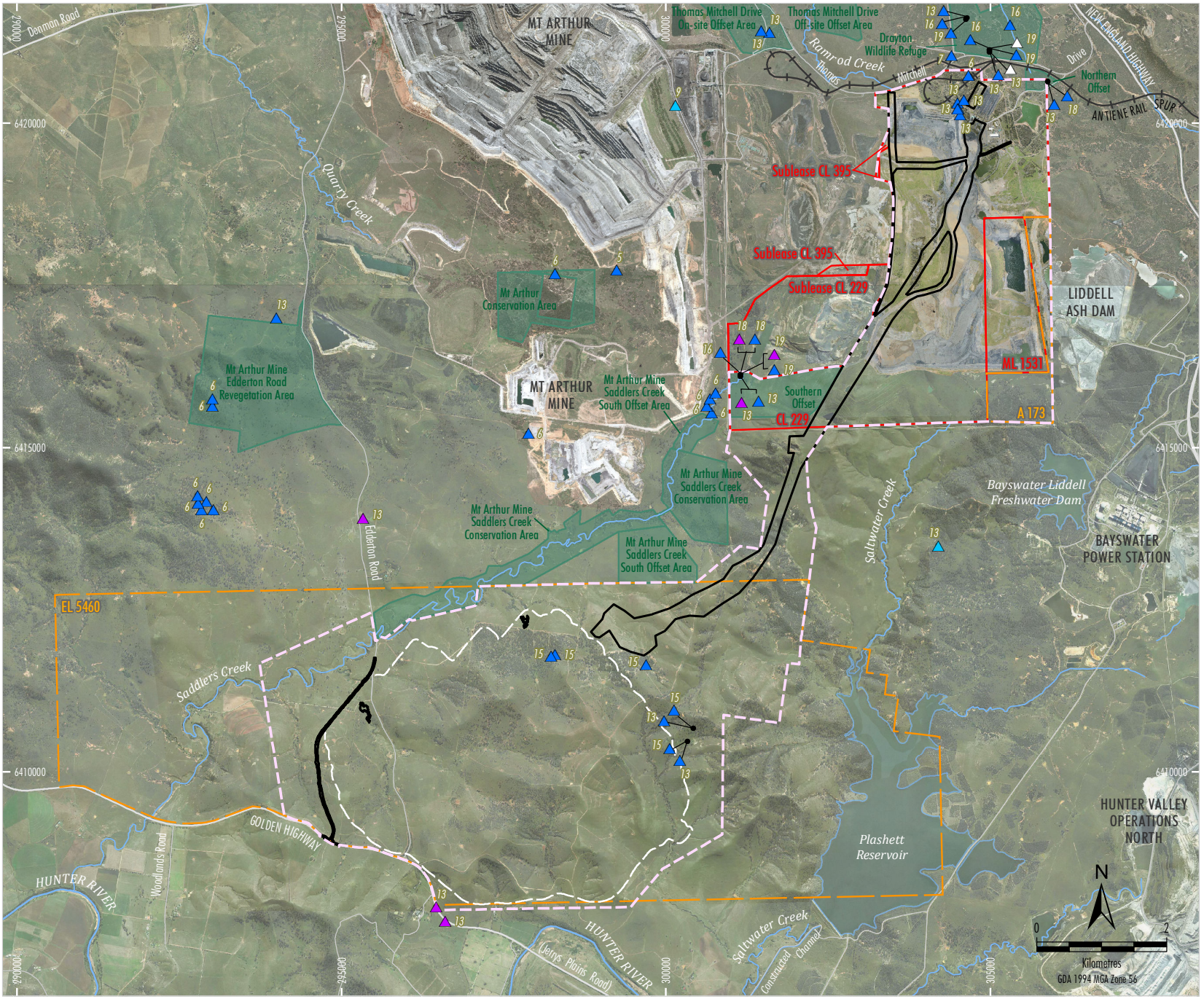
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Birds

Figure 13



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Spotted-tailed Quoll
- Brush-tailed Phascogale
- Koala
- Squirrel Glider

Reference:

5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
9. HVEC (pers. Comm. (2012))
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)

Note: There are no references 1 - 4, 8, 10 - 12, 14 and 17 on this figure.

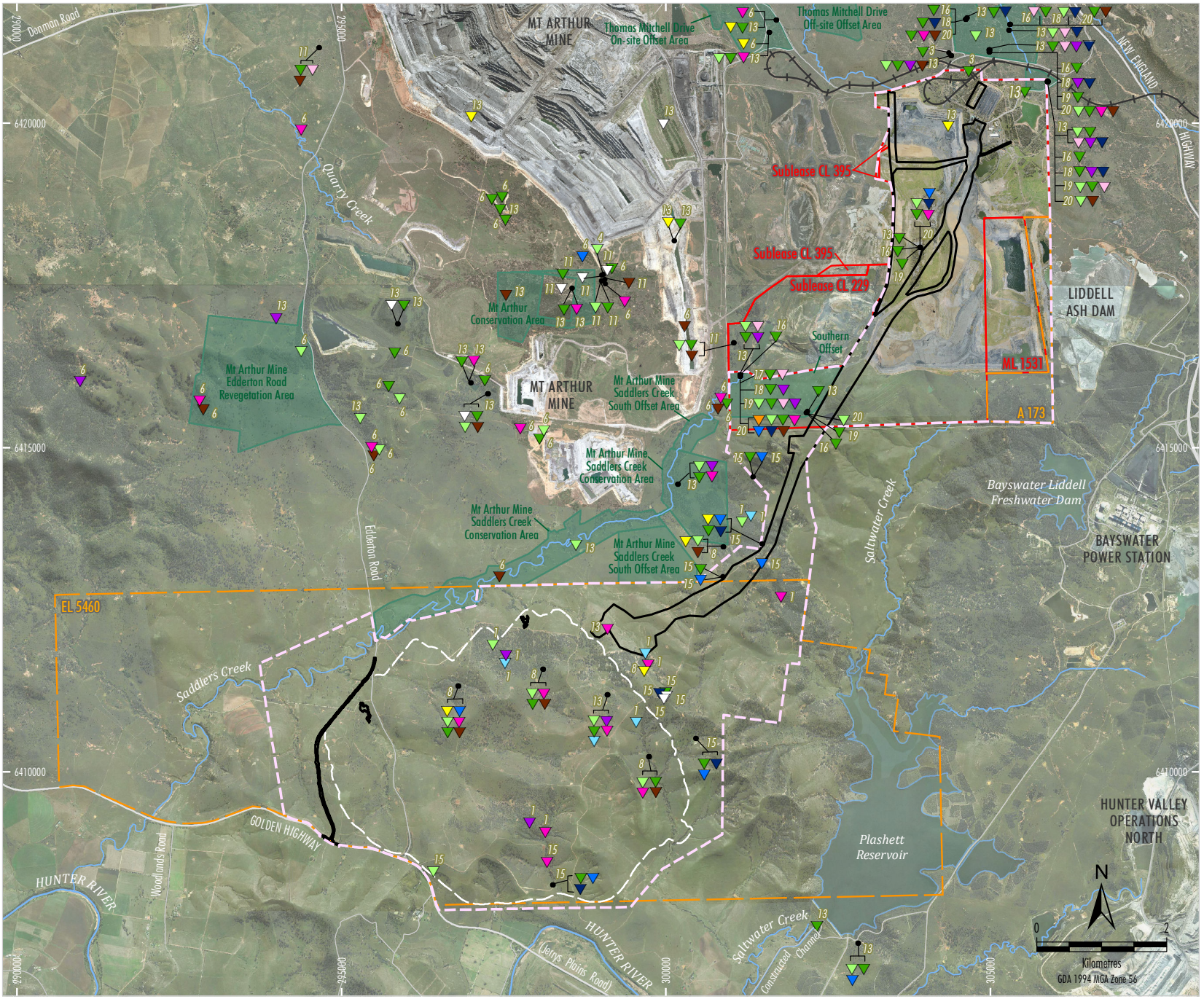
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Mammals

Figure 14



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Grey-headed Flying-fox
- Yellow-bellied Sheathtail-bat
- Northern Freetail Bat
- Eastern Freetail-bat
- Eastern Bentwing-bat
- Corben's Long-eared Bat
- Large-eared Pied Bat
- Little Bentwing-bat
- Eastern False Pipistrelle
- Southern Myotis
- Greater Broad-nosed Bat
- Eastern Cave Bat

Reference:

1. Ecotone (2000)
3. Umwelt (2006b)
4. Umwelt (2007a)
6. Cumberland Ecology (2009a)
8. Cumberland Ecology (2012)
11. Niche (2012)
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
17. Eco Logical Australia (2015)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)
20. Eco Logical Australia (2017)

Note: There are no references 2, 5, 7, 9, 10, 12 and 14 on this figure. (Some records by Niche (2012) were possible/probable records).

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Bats

Figure 15

Table 7
Threatened Flora and Fauna Species Known or Predicted to occur in the Locality

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Subject land[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Flora									
White-flowered Wax Plant	*Cynanchum elegans*	E	E	S	Yes	Predicted	Yes	-	-
-	*Ozothamnus tesselatus*	V	V	S	Yes	-	Yes	Yes	-
Large-leafed Monotaxis	*Monotaxis macrophylla*	-	E	S	Yes	-	-	-	-
Bynoe's Wattle	*Acacia bynoeana*	V	E	S	Yes	-	-	-	-
Acacia pendula population in the Hunter Catchment	*Acacia pendula – endangered population*	-	E	S	Yes	-	Yes	-	K*
Singleton Mint Bush	*Prostanthera cineolifera*	V	V	S	Yes	-	-	-	-
Wollemi Mint-bush	*Prostanthera cryptandroides subsp. cryptandroides*	V	V	S	Yes	Predicted	-	-	-
Netted Bottle Brush	*Callistemon linearifolius*	-	V	S	Yes	-	-	-	-
Eucalyptus parramattensis subsp. *decadens*	*Eucalyptus parramattensis* subsp. *decadens*	V	V	S	Yes	-	-	-	-
Eucalyptus camaldulensis population in the Hunter catchment	*Eucalyptus camaldulensis – endangered population*	-	E	S	-	-	-	-	K
Slaty Red Gum	*Eucalyptus glaucina*	V	V	S	Yes	Predicted	Yes	-	-
Leafless Tongue-orchid	*Cryptostylis hunteriana*	V	V	S	Yes	Predicted	-	-	-
Cymbidium canaliculatum in the Hunter Catchment	*Cymbidium canaliculatum – endangered population*	-	E	S	Yes		Yes	-	K, L
Pine Donkey Orchid	*Diuris tricolor*	-	V	S	Yes	-	Yes	-	K
Pine Donkey Orchid population in the Muswellbrook local government area	*Diuris tricolor – endangered population*	-	E	S	Yes	-	Yes	-	K

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Subject land[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Tarengo Leek Orchid	*Prasophyllum petilum* (sp. Wybong)	E	E	S	Yes	Predicted	-	-	-
-	*Pterostylis chaetophora*	-	V	S	Yes	-	-	-	-
Illawarra Greenhood	*Pterostylis gibbosa*	E	E	S	-	Predicted	-	-	-
-	*Euphrasia arguta*	CE	CE	S	-	Predicted	-	-	-
Small-flower Grevillea	*Grevillea parviflora* subsp. *parviflora*	V	V	S	Yes	-	-	-	-
Bodalla Pomaderris	*Pomaderris bodalla*	-	V	S	Yes	-	-	-	-
Scant Pomaderris	*Pomaderris queenslandica*	-	E	S	Yes	-	-	-	-
Denman Pomaderris	*Pomaderris reperta*	CE	CE	S	Yes	-	-	-	-
Trailing Woodruff	*Asperula asthenes*	V	V	S	-	-	-	-	-
-	*Philotheca ericifolia*	V	-	S	Yes	-	-	-	-
Austral Toadflax	*Thesium australe*	V	V	S	-	Predicted	-	-	-
Amphibians									
Green and Golden Bell Frog	*Litoria aurea*	V	E	S	Yes	Predicted	Yes	Yes	-
Booroolong Frog	*Litoria booroolongensis*	E	E	S	-	Predicted	-	-	-
Green-thighed Frog	*Litoria brevipalmata*	-	V	S	Yes	-	-	-	-
Reptiles									
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	-	-	-	-	M
Striped Legless Lizard	*Delma impar*	V	V	S	Yes	-	-	-	M
Pale-headed Snake	*Hoplocephalus bitorquatus*	-	V	S	Yes	-	-	-	-
Birds									
Freckled Duck	*Stictonetta naevosa*	-	V	E	-	-	-	Yes	-
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	-	Predicted	-	-	-
Black Falcon	*Falco subniger*	-	V	E	-	-	-	Yes	-
Square-tailed Kite	*Lophoictinia isura*	-	V	S/E	Yes	-	Yes	Yes	M
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	MA	V	S/E	Yes	-	Yes	Yes	M

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Subject land[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Spotted Harrier	*Circus assimilis*	-	V	E	Yes	-	Yes	Yes	A, M
Red Goshawk	*Erythrotriorchis radiatus*	V	CE	S	-	Predicted	-	-	-
Little Eagle	*Hieraaetus morphnoides*	-	V	S/E	Yes	-	Yes	Yes	A, I
Bush Stone-curlew	*Burhinus grallarius*	-	E	S	Yes	-	-	Yes	-
Australian Painted Snipe	*Rostratula australis*	E	E	E	-	Predicted	-	-	-
Eastern Curlew	*Numenius madagascariensis*	CE	-	S/E	-	Predicted	-	-	-
Curlew Sandpiper	*Calidris ferruginea*	CE	E	S/E	-	Predicted	-	-	-
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	-	V	S/E	Yes	-	-	-	M
Gang-gang Cockatoo	*Callocephalon fimbriatum*	-	V	S/E	Yes	-	-	Yes	-
Little Lorikeet	*Glossopsitta pusilla*	-	V	E	Yes	-	Yes	Yes	J, M
Turquoise Parrot	*Neophema pulchella*	-	V	E	Yes	-	-	Yes	-
Swift Parrot	*Lathamus discolor*	CE	E	S/E	Yes	Predicted	-	-	A
Eastern Grass Owl	*Tyto longimembris*	-	V	E	Yes	-	-	-	-
Masked Owl	*Tyto novaehollandiae*	-	V	S/E	Yes	-	-	-	-
Powerful Owl	*Ninox strenua*	-	V	S/E	Yes	-	Yes	Yes	-
Barking Owl	*Ninox connivens*	-	V	S/E	Yes	-	Yes	Yes	B
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	-	V	E	Yes	-	Yes	Yes	A, M
Speckled Warbler	*Chthonicola sagittata*	-	V	E	Yes	-	Yes	Yes	A, M
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	-	V	E	Yes	-	Yes	-	M
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E	Yes	Predicted	-	-	-
Painted Honeyeater	*Grantiella picta*	V	V	E	Yes	Predicted	-	-	-M
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	-	V	E	Yes	-	Yes	-	-
Flame Robin	*Petroica phoenicea*	-	V	E	Yes	-	-	Yes	M
Scarlet Robin	*Petroica boodang*	-	V	E	Yes	-	Yes	-	A, M

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Subject land[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	-	V	E	Yes	-	Yes	-	A, M
Varied Sittella	*Daphoenositta chrysoptera*	-	V	E	Yes	-	Yes	Yes	C, M
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	-	V	E	Yes	-	Yes	Yes	M
Diamond Firetail	*Stagonopleura guttata*	-	V	E	Yes	-	Yes	Yes	A, B, J
Mammals									
Spotted-tailed Quoll	*Dasyurus maculatus maculatus (south-eastern mainland population)*	E	V	E	Yes	Predicted	Yes	Yes	D, E
Brush-tailed Phascogale	*Phascogale tapoatafa*	-	V	S	Yes	-	Yes	-	-
Common Planigale	*Planigale maculata*	-	V	S	Yes	-	-	-	-
Koala	*Phascolarctos cinereus*	V	V	S/E	Yes	Predicted	Yes	-	-
Eastern Pygmy-possum	*Cercartetus nanus*	-	V	S	Yes	-	-	-	-
Yellow-bellied Glider	*Petaurus australis*	-	V	E	Yes	-	-	-	-
Squirrel Glider	*Petaurus norfolcensis*	-	V	S	Yes	-	Yes	-	A, D, E, F, J, M
Greater Glider	*Petauroides volans*	V	-	S	-	Predicted	-	-	-
Brush-tailed Rock-wallaby	*Petrogale penicillata*	V	E	S	Yes	Predicted	Yes	-	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	S/E	Yes	Predicted	Yes	-	J, M
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	-	V	E	Yes	-	Yes	-	A, G, J, M
Eastern Freetail-bat	*Mormopterus norfolkensis*	-	V	E	Yes	-	Yes	-	A, B, C, E, G, J, M
Northern Freetail-bat	*Mormopterus lumsdenae*	-	V	E	No	-	-	-	G
Little Bentwing-bat	*Miniopterus australis*	-	V	S/E	Yes	-	Yes	-	G, M
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	-	V	S/E	Yes	-	Yes	-	A, C, D, E, F, G, H, J, M
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E	Yes	Predicted	Yes	-	B
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S	Yes	Predicted	Yes	-	A, C, G, M

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Subject land[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	-	V	E	Yes	-	Yes	-	E, F
Southern Myotis	*Myotis macropus*	-	V	S	Yes	-	Yes	-	A, B, G, M
Greater Broad-nosed Bat	*Scoteanax rueppellii*	-	V	E	Yes	-	Yes	-	B, D, E, J
Eastern Cave Bat	*Vespadelus troughtoni*	-	V	S	Yes	-	Yes	-	A, G, J
New Holland Mouse	*Pseudomys novaehollandiae*	V	-	E	-	Predicted	-	-	-

Shaded species are species with records in the Subject land.

1 Conservation status under the EPBC Act (current as at May 2019). V = Vulnerable; E = Endangered; CE = Critically Endangered; MA = Migratory.

2 Conservation status under the BC Act (current as at May 2019). V = Vulnerable; E = Endangered; CE = Critically Endangered.

3 Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019). E = Ecosystem; S = Species.

4 OEH (2019a).

5 DEE (2018a).

6 OEH (2019c).

7 Atlas of Living Australia (2018).

8 A – Cumberland Ecology (2009a) and/or Cumberland Ecology (2012).
B – Ecotone (2000).
C – Eco Logical Australia (2015).
D – Eco Logical Australia (2016a).
E – Eco Logical Australia (2016b).
F – Eco Logical Australia (2014).
G– Eco Logical Australia (2017).
H – Umwelt Environmental Consultants (Umwelt) (2006).
I – Umwelt (2007).
J – Hansen Bailey (2007).
K – Cumberland Ecology (2015).
L = Hunter Eco (2019) (Attachment A).
M = Future Ecology (2019) (Attachment B).

* Note that the location of the *Acacia pendula* reported by Cumberland Ecology (2015) was re-surveyed by Hunter Eco (2019) and was found to be *Acacia melvillei*.

The main constraint for threatened flora species is that their geographic range must include the IBRA zone (Sydney Basin) and sub-zone (Hunter) in which the development is occurring. For some threatened flora species there are geographic constraints within the Hunter sub-zone and these are described in Table 8. Four flora species (shaded in Table 8) are excluded from further assessment as species credit species, namely the Rough Doubletail (*Diuris praecox*), Singleton Mallee (*Eucalyptus castrensis*), North Rothbury Persoonia (*Persoonia pauciflora*) and Heath Wrinklewort (*Rutidosis heterogama*).

Table 8
Flora Species Credit Species – Geographic Constraints

Scientific Name	Common Name	Geographic Constraint within the Hunter Sub-zone in the BAM Calculator	Assessment
Acacia bynoeana	Bynoe's Wattle	*None*	-
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	*None*	-
Callistemon linearifolius	Netted Bottle Brush	*None*	-
Cryptostylis hunteriana	Leafless Tongue Orchid	*None*	-
Cymbidium canaliculatum – endangered population	*Cymbidium canaliculatum* in the Hunter Catchment	*Must be within Hunter catchment as defined by Australia's River Basins (Geoscience Australia 1997)*	-
Cynanchum elegans	White-flowered Wax Plant	*None*	-
Diuris praecox	Rough Doubletail	*East of Maitland*	The Subject land is north-west of Maitland
Diuris tricolor	Pine Donkey Orchid	*None*	-
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	*None*	-
Eucalyptus castrensis	Singleton Mallee	*Singleton Training Area*	The Subject land is not in the Singleton Training Area
Eucalyptus glaucina	Slaty Red Gum	*None*	-
Eucalyptus parramattensis subsp. *decadens*	*Eucalyptus parramattensis* subsp. *decadens*	*None*	-
Eucalyptus pumila	Pokolbin Mallee	*None*	-
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	*None*	-
Monotaxis macrophylla	Large-leafed Monotaxis	*None*	-
Ozothamnus tesselatus	Ozothamnus tesselatus	*None*	-
Persoonia pauciflora	North Rothbury Persoonia	*Within 10 km of North Rothbury*	The Subject land is >50 km from North Rothbury
Pomaderris bodalla	Bodalla Pomaderris	*None*	-
Pomaderris queenslandica	Scant Pomaderris	*None*	-

Scientific Name	Common Name	Geographic Constraint within the Hunter Sub-zone in the BAM Calculator	Assessment
Pomaderris reperta	Denman Pomaderris	*None*	-
Prostanthera cineolifera	Singleton Mint Bush	*None*	-
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	*None*	-
Rutidosis heterogama	Heath Wrinklewort	*South and east of Jerrys Plains*	The Subject land is north of Jerrys Plains

Shaded species are species that have geographical constraints within the Hunter sub-zone.

3.3.2.2 Step 2: Assessment of Habitat Constraints for Species Credit Species on the Disturbance Area

Habitat constraints are identified in the *Threatened Biodiversity Data Collection* (OEH 2019e) for some species credit species, and the absence of identified habitat precludes the species from further assessment (Table 9). Five species (shaded in Table 9) are excluded from further assessment as species credit species, namely the Pokolbin Mallee (*Eucalyptus pumila*), Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*), Brush-tailed Rock-wallaby (*Petrogale penicillata*) and Grey-headed Flying-fox (*Pteropus poliocephalus*).

Table 9
Species Credit Species Habitat Constraints - Stage 1

Common Name	Credit Class	Habitat Constraints identified in the ***Threatened Biodiversity Data Collection*** **(OEH 2019a)**	Assessment Prior to the Surveys (Attachment A and B)
Flora			
Pokolbin Mallee	Species	*Sandstone slopes*	*Habitat absent*
Amphibians			
Green and Golden Bell Frog	Species	*Semi-permanent/ephemeral wet areas (within 1km of wet areas).* *Swamps (within 1km of swamp).* *Waterbodies (within 1km of waterbody).*	*Dams (waterbodies) present*
Green-thighed Frog	Species	*None.*	-
Reptiles			
Pink-tailed Legless Lizard	Species	*Rocky areas or within 50 m of rocky areas.*	*Habitat present*
Striped Legless Lizard	Species	*None.*	-
Pale-headed Snake	Species	*None.*	-
Birds			
Square-tailed Kite	Species/Ecosystem	** Breeding constraint: Other (Nest trees).*	*Breeding habitat potentially present*

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH 2019a)	Assessment Prior to the Surveys (Attachment A and B)
White-bellied Sea-Eagle	Species/Ecosystem	** Breeding constraint: Other (Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines).* ** Foraging constraint: Waterbodies (Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines).*	*Breeding habitat potentially present* *Foraging habitat potentially present*
Little Eagle	Species/Ecosystem	** Breeding constraint: Other (Nest trees - live (occasionally dead) large old trees within vegetation).*	*Breeding habitat potentially present*
Bush Stone-curlew	Species	*Fallen/standing dead timber including logs.*	*Habitat potentially present*
Glossy Black-Cockatoo	Species/Ecosystem	** Breeding constraint: Hollow-bearing trees (Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground).* ** Foraging constraint: Other (Presence of Allocasuarina and Casuarina species).*	*Breeding habitat potentially present* *Foraging habitat potentially present*
Gang-gang Cockatoo	Species/Ecosystem	** Breeding constraint: Hollow-bearing trees (Eucalypt tree species with hollows greater than 9 cm diameter).*	*Breeding potentially habitat present*
Swift Parrot	Species/Ecosystem	** Breeding constraint: Other (As per mapped important areas – contact OEH for information).* *Foraging constraint: none.*	*Not a mapped important area as confirmed by OEH*
Masked Owl	Species/Ecosystem	** Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).*	*Breeding potentially habitat present*
Powerful Owl	Species/Ecosystem	** Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).*	*Breeding potentially habitat present*
Barking Owl	Species/Ecosystem	** Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20 cm diameter and greater than 4m above the ground).*	*Breeding potentially habitat present*
Regent Honeyeater	Species/Ecosystem	** Breeding constraint: Other (As per mapped areas; contact OEH).*	*Not a mapped important area as confirmed by OEH*
Mammals			
Brush-tailed Phascogale	Species	*Hollow-bearing trees.*	*Breeding potentially habitat present*
Common Planigale	Species	*None.*	*-*
Koala	Species/Ecosystem	** Breeding constraint: Other (Areas identified via survey as important habitat).* *Foraging constraint: none.*	*Assumed no relevant constraints as OEH (2019a) does not define important habitat* *No Koalas were recorded within the Subject land*

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH 2019a)	Assessment Prior to the Surveys (Attachment A and B)
Eastern Pygmy-possum	Species	*None.*	-
Squirrel Glider	Species	*None*	-
Brush-tailed Rock-wallaby	Species	*Other (Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines).*	*Habitat absent*
Grey-headed Flying-fox	Species/Ecosystem	** Breeding constraint: Other (Breeding camps).*	*Breeding habitat absent*
Little Bentwing-bat	Species/Ecosystem	** Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).*	*Breeding habitat potentially present* *No caves*
Eastern Bentwing-bat	Species/Ecosystem	** Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).*	*Breeding habitat potentially present* *No caves*
Large-eared Pied Bat	Species	*Cliffs (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels).*	*Habitat potentially present within 2 km* *No caves*
Southern Myotis	Species	*Hollow-bearing trees (Within 200 m of riparian zone).* *Other (Bridges, caves or artificial structures within 200 m of riparian zone).*	*Habitat potentially present*
Eastern Cave Bat	Species	*Caves (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds).*	*Habitat potentially present within 2 km* *No caves*

Shaded species are species that have habitat constraints as identified in the *Threatened Biodiversity Data Collection* (OEH 2019a).

* Habitat Constraints not in the BAM Calculator.

The *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH 2018) provides further detail on potential bat habitat (constraints) as described in Attachment B.

3.3.2.3 Step 3: Identify Candidate Species Credit Species for Further Assessment

A candidate species credit species is considered unlikely to occur on the Subject land (or specific vegetation zones) if after carrying out a field assessment of the habitat constraints or microhabitats on the Subject land, the assessor determines that the habitat is substantially degraded such that the species is unlikely to utilise the Subject land (or specific vegetation zones) (OEH 2017a).

Large-leafed Monotaxis

Large-leafed Monotaxis (*Monotaxis macrophylla*) is a known fire-ephemeral species. There are no recent records of fire within or near the Biodiversity Assessment Development Footprint. This species is reported as growing on rocky ridges and hillsides (OEH 2019a).

Within the Subject land the most likely similar suitable habitat would be on the rocky hill just south of the AGL Energy Limited (AGL) coal conveyor in PCT 1607 *Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the Upper Hunter*. This habitat is outside of the Biodiversity Assessment Development Footprint.

Green-thighed Frog

The *Threatened Biodiversity Data Collection* (OEH 2019a) recognises PCT 1604 as potential habitat for the Green-thighed Frog (*Litoria brevipalmata*). Approximately 1.3 ha of PCT 1604 occurs in the extension to the existing product coal stockpile area and additional ROM stockpile at Maxwell Infrastructure. Future Ecology (2019) (Attachment B) inspected the occurrence of PCT 1604 and concluded that it would not provide potential habitat for the Green-thighed Frog. The closest record of this frog is approximately 74 km south-east of the Subject land (OEH 2019c).

After considering the geographic constraints (Step 1) and habitat constraints (Step 2), candidate species credit species for further assessment are listed in Table 10.

3.3.2.4 Step 4: Determine Presence or Absence of a Candidate Species Credit Species

Hunter Eco (2019) (Attachment A) undertook targeted surveys for candidate flora species credit species and Future Ecology (2019) (Attachment B) undertook targeted surveys for candidate fauna species credit species to determine presence or absence of the species within the survey periods required by the *Threatened Biodiversity Data Collection* (OEH 2019a) (Table 10). The timing, survey techniques and effort of the flora and fauna surveys are detailed in Attachments A and B respectively. Months in which targeted surveys were undertaken are shaded in Table 10.

Threatened Flora

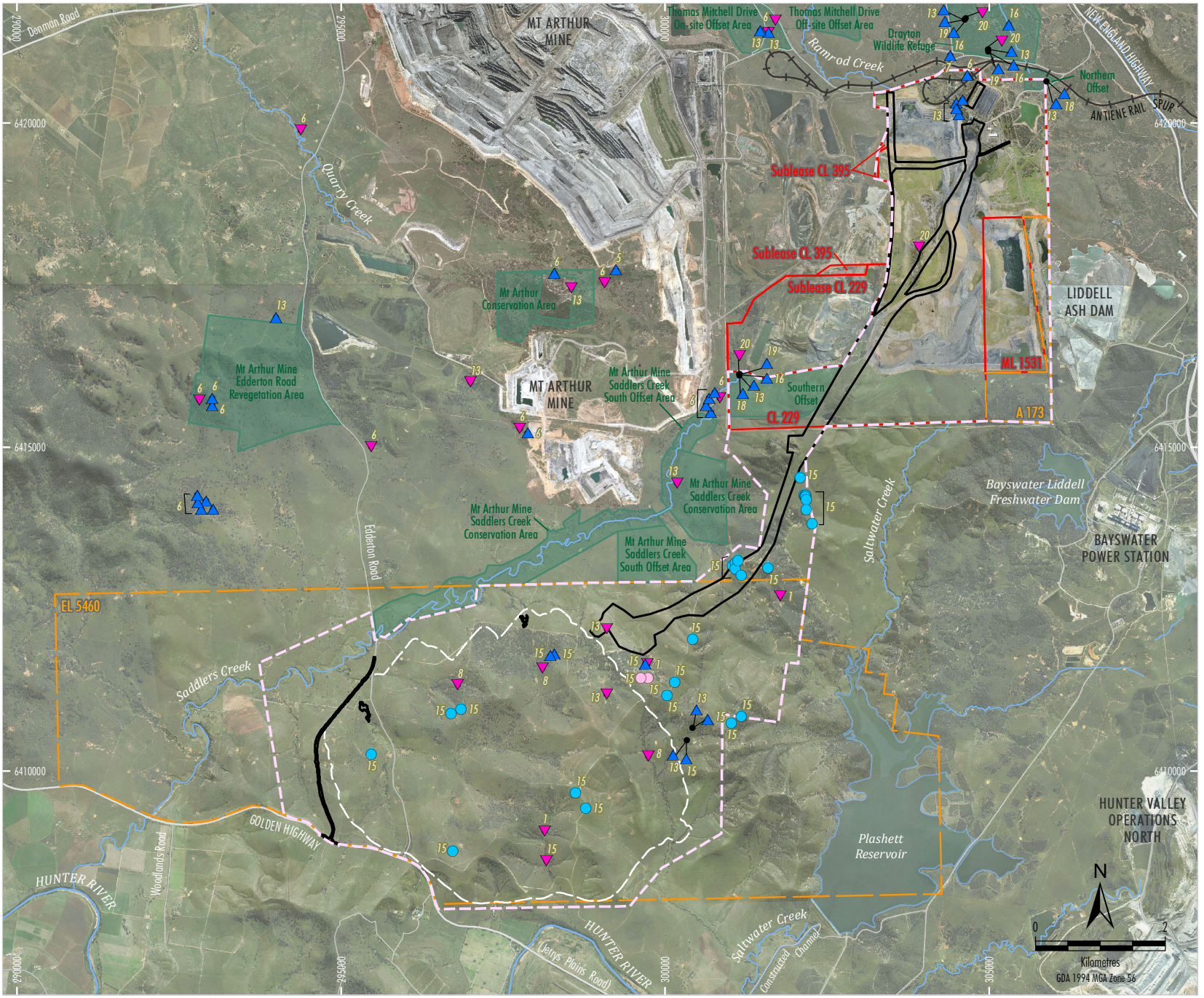
No threatened flora species were recorded by Hunter Eco (2019) (Attachment A) in the Biodiversity Assessment Development Footprint (Figure 11).

Threatened Fauna

The following species credit fauna species were present in habitat located either within or adjoining the Biodiversity Assessment Development Footprint (Figure 16):

- Pink-tailed Legless Lizard (listed as vulnerable under the BC Act and EPBC Act);
- Striped Legless Lizard (listed as vulnerable under the BC Act and EPBC Act);
- Squirrel Glider (listed as vulnerable under the BC Act); and
- Southern Myotis (listed as vulnerable under the BC Act).

The Pink-tailed Legless Lizard, Squirrel Glider and Southern Myotis have a biodiversity risk weighting of '2', and the Striped Legless Lizard has a biodiversity risk weighting of '1.5'. None of these species are Potential SAII Entities.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Pink-tailed Legless Lizard
- Striped Legless Lizard
- Squirrel Glider
- Southern Myotis

Reference:

1. *Ecotone (2000)*
5. *Umwelt (2007b)*
6. *Cumberland Ecology (2009a)*
7. *Cumberland Ecology (2010)*
8. *Cumberland Ecology (2012)*
13. *OEH (2019)*
15. *Future Ecology (2019)*
16. *Eco Logical Australia (2014)*
18. *Eco Logical Australia (2016a)*
19. *Eco Logical Australia (2016b)*
20. *Eco Logical Australia (2017)*

Note: There are no references 2 - 4, 9 - 12, 14 and 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Species Credit Species Relevant to the Project

Figure 16

Table 10
Species Credit Species Requiring Survey and Timing – Stage 1

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	April	May	June	July	August	Sep	Oct	Nov	Dec
Flora																
Acacia bynoeana	Bynoe's Wattle	E	V	S	-	-	-	-	-	-	-	-	Yes	Yes	Yes	-
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Callistemon linearifolius	Netted Bottle Brush	V	-	S	Yes	Yes	Yes	-	-	-	-	-	Yes	Yes	Yes	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	Yes	Yes	-	-	-	-	-	-	-	-	Yes	Yes
Cymbidium canaliculatum – endangered population	*Cymbidium canaliculatum* in the Hunter Catchment	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Cynanchum elegans	White-flowered Wax Plant	E	E	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diuris tricolor	Pine Donkey Orchid	V	-	S	-	-	-	-	-	-	-	-	Yes	Yes	-	-
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	E	-	S	-	-	-	-	-	-	-	-	Yes	Yes	-	-
Eucalyptus glaucina	Slaty Red Gum	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	April	May	June	July	August	Sep	Oct	Nov	Dec
Eucalyptus parramattensis subsp. *decadens*	*Eucalyptus parramattensis* subsp. *decadens*	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus pumila	Pokolbin Mallee	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Monotaxis macrophylla[3]	Large-leafed Monotaxis	E	-	S	Yes[3]	Yes[3]	-	-	-	-	-	Yes	Yes[3]	Yes[3]	Yes[3]	Yes[3]
Ozothamnus tesselatus	Ozothamnus tesselatus	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	-	-	-	-	-	-	-	-	Yes	Yes	Yes	-
Pomaderris queenslandica	Scant Pomaderris	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris reperta	Denman Pomaderris	CE	CE	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rutidosis heterogama	Heath Wrinklewort	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Amphibians																
Litoria aurea	Green and Golden Bell Frog	E	V	S	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Litoria brevipalmata	Green-thighed Frog	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes[4]	Yes[4]
Reptiles																

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	April	May	June	July	August	Sep	Oct	Nov	Dec
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	-	-	-	-	-	-	-	-	Yes	Yes	Yes	-
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Delma impar	Striped Legless Lizard	V	V	S	-	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes
Birds																
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Yes	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	-	-	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes
Hieraaetus morphnoides	Little Eagle	V	-	S/E	-	-	-	-	-	-	-	Yes	Yes	Yes	-	-
Burhinus grallarius	Bush Stone-curlew	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	-	-	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-	-
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Yes	-	-	-	-	-	-	-	-	Yes	Yes	Yes
Tyto novaehollandiae	Masked Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	-	-	-	-
Ninox strenua	Powerful Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	-	-	-	-
Ninox connivens	Barking Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mammals																
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Planigale maculata	Common Planigale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phascolarctos cinereus	Koala	V	V	S/E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	April	May	June	July	August	Sep	Oct	Nov	Dec
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes
Petaurus norfolcensis	Squirrel Glider	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Miniopterus australis	Little Bentwing-bat	V	-	S/E	Yes	Yes	-	-	-	-	-	-	-	-	-	Yes
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E	Yes	Yes	-	-	-	-	-	-	-	-	Yes	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	Yes	-	-	-	-	-	-	-	-	-	Yes	Yes
Myotis macropus	Southern Myotis	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	Yes	-	-	-	-	-	-	-	-	-	Yes	Yes

Note: Months in which surveys for the species are to be conducted in accordance with the *Threatened Biodiversity Data Collection* (OEH 2019a) are denoted with 'Yes'. The shaded month is the month in which targeted surveys were undertaken for the relevant species.

1 Threatened species status under the BC Act and/or EPBC Act (current as at May 2019). V = Vulnerable; E = Endangered; CE = Critically Endangered.

2 Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019). E = Ecosystem; S = Species.

3 A habitat assessment was undertaken. *Monotaxis macrophylla* is a fire-ephemeral plant only appearing for a few months after fire. There have been no fires on the Subject land for several years.

4 A habitat assessment was undertaken. Future Ecology (2019) (Attachment B) inspected the occurrence of PCT 1604 and concluded that it would not provide potential habitat for the Green-thighed Frog. The closest record of this frog is approximately 74 km south-east of the Subject land (OEH 2019c).

Pink-tailed Legless Lizard

The Pink-tailed Legless Lizard has not been recorded within the Biodiversity Assessment Development Footprint (Figure 16). A single adult specimen of Pink-tailed legless Lizard was recorded underneath a rock in grassland approximately 500 m south of the MEA in November 2018. In addition, a slough (shed skin) was also recorded under a rock in a nearby location. This represents the first record of this species in the Muswellbrook LGA.

Striped Legless Lizard

The Striped Legless Lizard has been recorded within the Biodiversity Assessment Development Footprint and wider surrounds (Figure 16). A total of 26 observations of Striped Legless Lizard were recorded within the Subject land, 16 of which were live specimens and 10 were sloughs. Most observations were scattered throughout the Maxwell Underground and along or near the proposed transport and services corridor between Maxwell Infrastructure and Maxwell Underground. The Striped Legless Lizard was recorded under rocks, dumped material and dried cow manure. This species is known to occur at Muswellbrook (OEH 2019c).

Squirrel Glider

The Squirrel Glider has not been recorded within the Biodiversity Assessment Development Footprint (Figure 16). The Squirrel Glider has been observed by Future Ecology twice just outside of the Maxwell Underground to the east, twice in the north of the Maxwell Underground and twice (of one individual) just south of the MEA. It is not clear how many other Squirrel Gliders have been recorded by other groups in the past, however this number is expected to be relatively numerous (Umwelt 2006, 2007; Cumberland Ecology 2009a, 2010; OEH 2019b). There have also been several observations of this species outside of the Subject land by other groups.

Southern Myotis

Two individuals of the Southern Myotis were observed over a dam to the south of the Maxwell Underground (Figure 16). It was not observed with confidence anywhere else within the Subject land. The Southern Myotis has also been recorded at various locations throughout the Subject land by others in previous years (Cumberland Ecology 2012; Ecotone 2000; OEH 2019b). Additionally, there are records of this species outside the Subject land by various other groups (Cumberland Ecology 2012; Eco Logical Australia 2017; OEH 2019b).

Other Species

None of the other species credit species in Table 6 have the relevant type of records (for example breeding habitat for a dual credit species) (in accordance with the OEH 2017a, 2018, 2019a) within or immediately adjacent to the Biodiversity Assessment Development Footprint. As such, no other species qualify as relevant species credit species.

Further detailed supporting information is provided in Attachments A and B.

3.3.2.5 Step 5: Determine the Area or Count, and Location of Suitable Habitat for a Species Credit Species

Species Polygons for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis were prepared by Future Ecology (2019) (Attachment B) as shown on Figures 17 to 20. The area of habitat in the Stage 1 Biodiversity Assessment Development Footprint is quantified in Table 11.

Table 11
Species Credit Species Presence – Stage 1

Generic Name	PCT	VI Score~	Area of Habitat (ha)			
			Pink-tailed Legless Lizard	Striped Legless Lizard	Squirrel Glider	Southern Myotis
1. Red Gum - Ironbark - Apple Shrubby Woodland PCT 1607	1607	50.5	0.1^	-	-	-
1a. Red Gum - Ironbark - Apple Shrubby Woodland PCT 1607 (DNG)	1607	27.6	0.4^	-	-	-
2. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606	1606	45.4	3.4^	9.5	9.5	-
2a. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606 (DNG)	1606	15.8	29.5^	122.7	28*	-
3. Slaty Box Shrubby Woodland PCT 1655	1655	46.5	-	1.2	1.2	-
6. Bull Oak Grassy Woodland PCT 1692	1692	36.9	-	2.8	-	0.5#
8. Fuzzy Box Woodland PCT 201	201	47.5	-	-	0.5	-
8a. Fuzzy Box Woodland PCT 201 (DNG)	201	23.1	-	-	0.2*	-
9. Ironbark - Grey Box Grassy Woodland PCT 1691	1691	48.3	2.6^	7.6	-	-
9a. Ironbark - Grey Box Grassy Woodland PCT 1691 (DNG)	1691	40.7	-	0.3	-	-
11 Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland PCT 1604	1604	68.4	-	1.3	1.3	-
Pasture Rehabilitation	1604	3.8	-	-	-	-
Woodland Rehabilitation	1604	28.1	-	-	-	-
		Total	**36^**	**145.4**	**40.7**	**0.5#**

~ Vegetation Integrity Score – refer to Table 2.

* Area covered by paddock trees.

^ Area associated with rocky areas in PCT 1606. A 50 m zone was added to the rocky areas in consideration of the habitat constraint (Table 9) and as directed by OEH (14 May 2019).

Area determined by application of OEH (2018).

3.3.2.6 Step 6: Determine the Habitat Condition within the Species Polygon for Species Assessed by Area

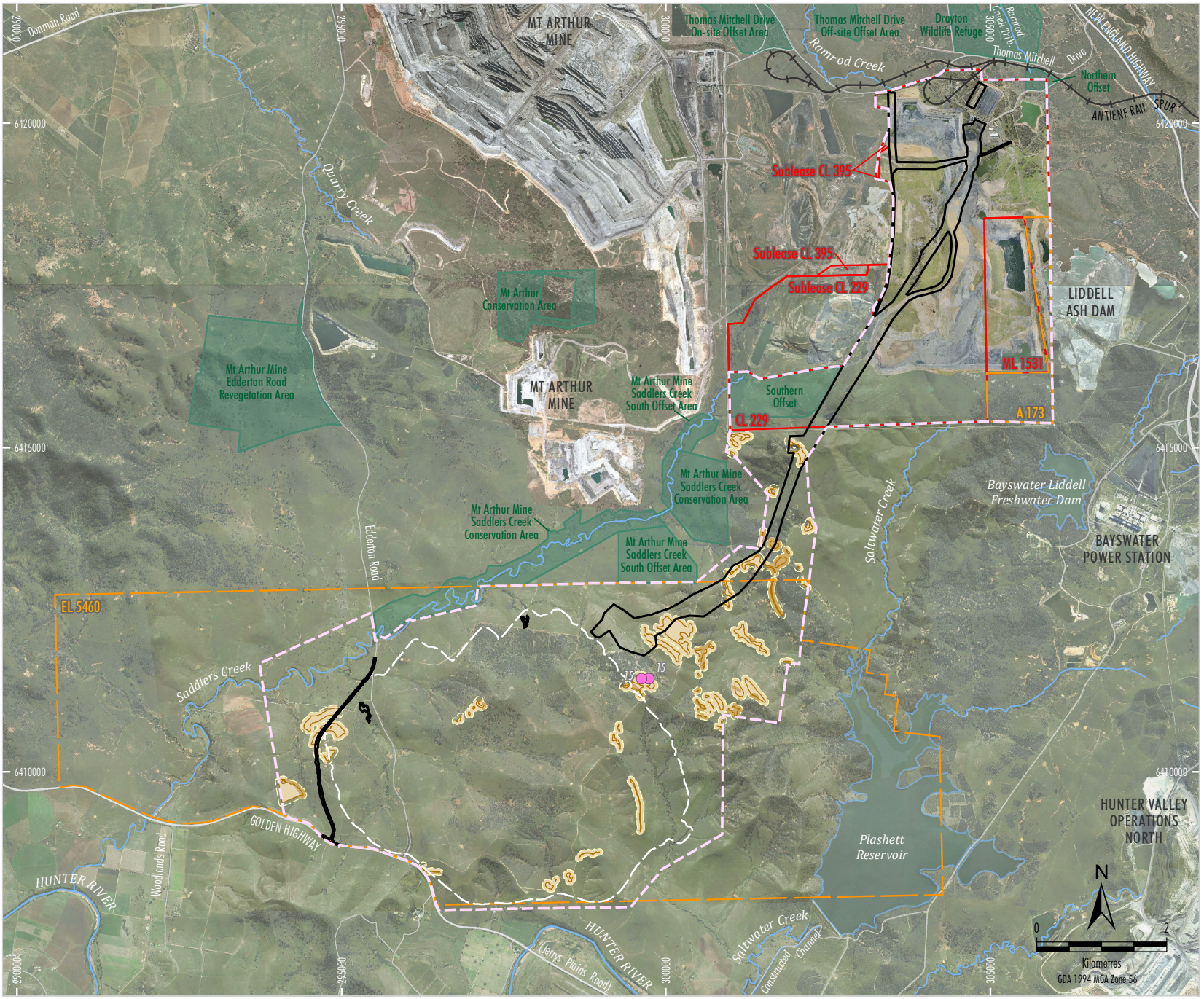
The VI Score for each vegetation zone associated with the Species Polygons for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis are listed in Table 11.

3.4 LOCAL DATA

It was not necessary to use local data to deviate from the OEH databases (OEH 2019a, 2019b).

3.5 EXPERT REPORTS

No Expert Reports are required.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Pink-tailed Legless Lizard

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Other

- Rocky Area
- Rocky Area 50 m Zone

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

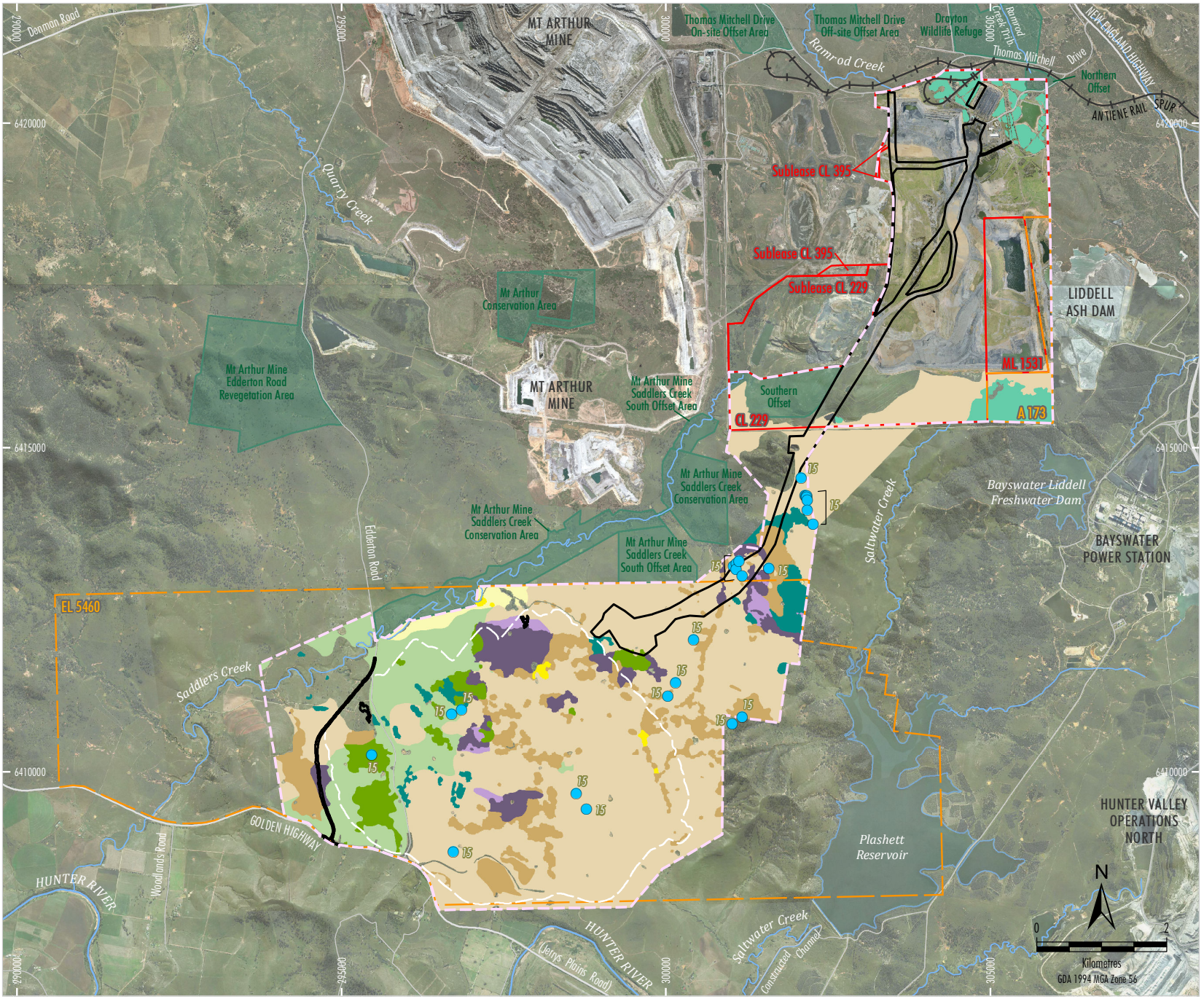
MALABAR COAL

MAXWELL PROJECT

Pink-tailed Legless Lizard Species Polygon

Figure 17

SHM-18-03 Maxwell_EIS_App_BDAR_218F



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Striped Legless Lizard

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)
- 3a. Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 7a. Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 9a. Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

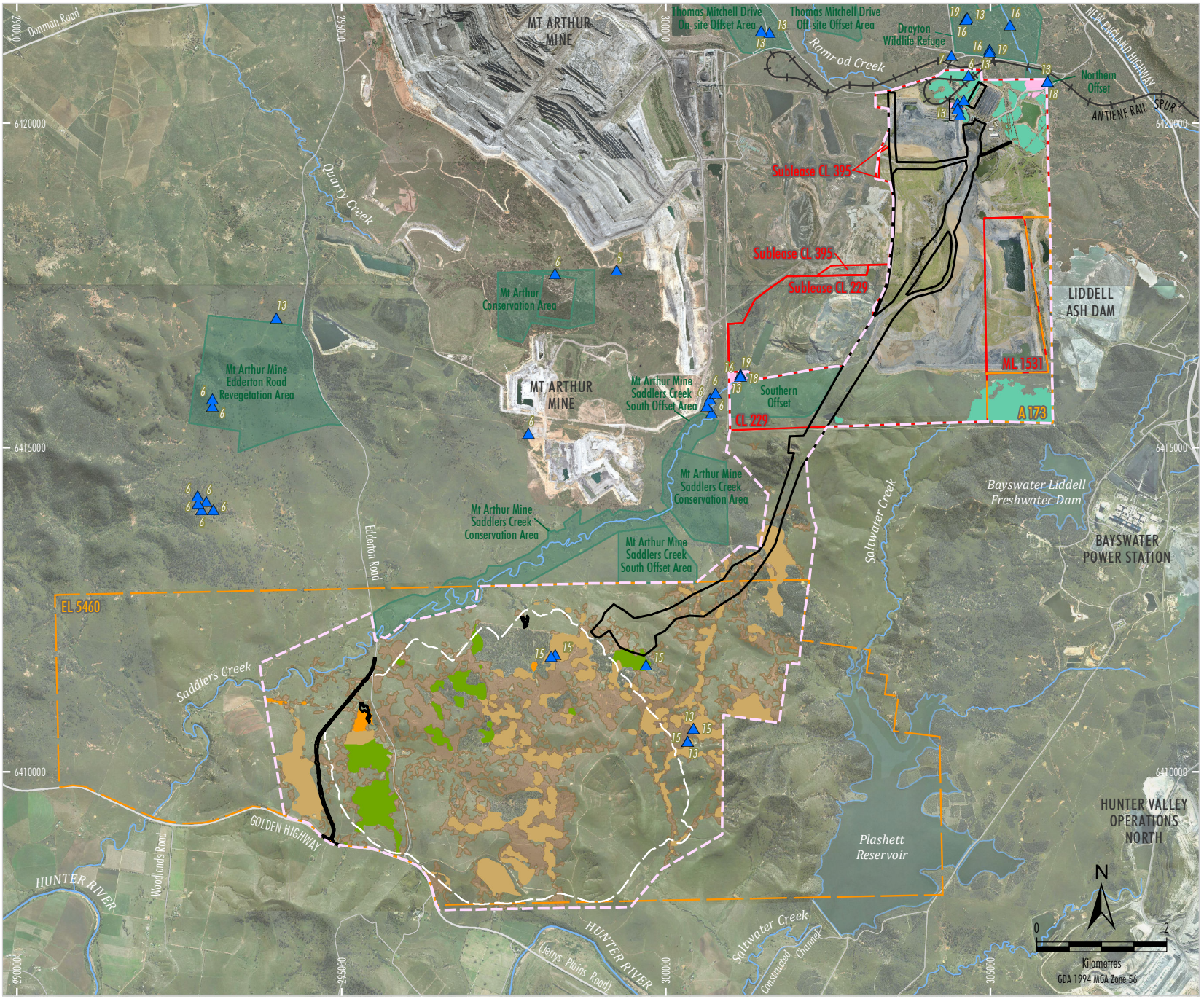
MALABAR COAL

MAXWELL PROJECT

Striped Legless Lizard Species Polygon

Figure 18

SHM-18-03 Maxwell_EIS_App_BDAR_219D



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Squirrel Glider

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Forested Wetlands

- 5. Hunter Lowland Red Gum Forest (PCT1598)

Grassy Woodlands

- 8. Fuzzy Box Woodland (PCT201)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Other

- Paddock Trees that may provide Potential Habitat

Reference:

5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)

Note: There are no references 1 - 4, 8 - 12, 14 and 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)

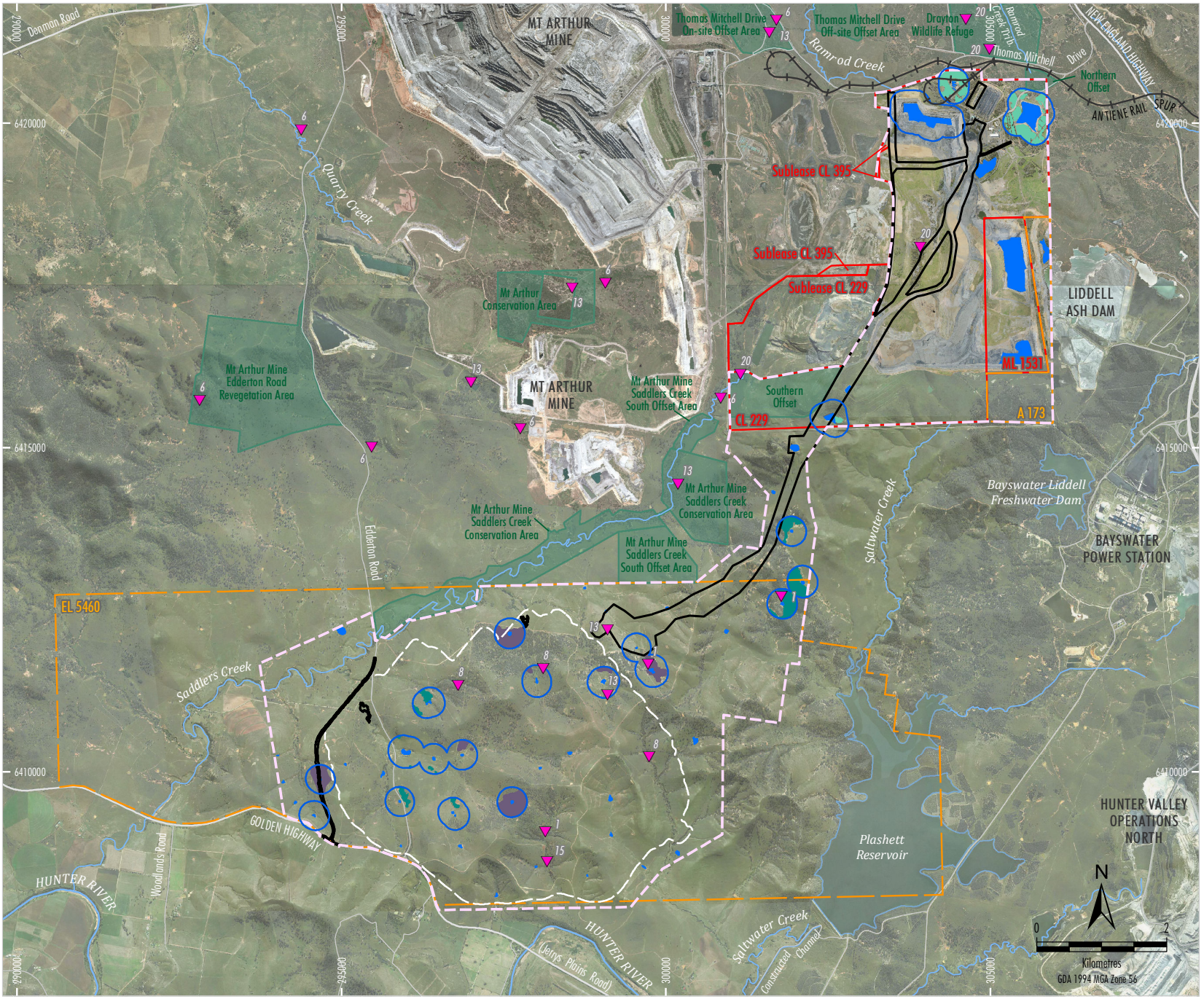
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Squirrel Glider Species Polygon

Figure 19



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Southern Myotis

SPECIES POLYGON MAPPING

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Other

- Waterbody/Dam
- Waterbody/Dam 200 m Buffer

Reference:

1. *Ecotone (2000)*
6. *Cumberland Ecology (2009a)*
8. *Cumberland Ecology (2012)*
13. *OEH (2019)*
15. *Future Ecology (2019)*
20. *Eco Logical Australia (2017)*

Note: There are no references 2 - 5, 7, 9 - 12, 14 and 16 - 19 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Southern Myotis Species Polygon

Figure 20

3.6 PRESCRIBED BIODIVERSITY IMPACT ENTITIES

Prescribed biodiversity impact entities are discussed below.

3.6.1 Karst, Caves, Crevices and Cliffs

There are no karst, caves, crevices or cliffs that provide habitat for threatened species in the Stage 1 Biodiversity Assessment Development Footprint.

3.6.2 Rock

Rocky areas providing potential habitat for the Pink-tailed Legless Lizard and Striped Legless Lizard are present in the Project area as mapped by Future Ecology (2019) (Attachment B). Rocky areas are shown on Figure 5. Individual rocks were mostly less than 50 cm long and wide and deep (Attachment B)

3.6.3 Human Made Structures and Non-native Vegetation

There are no human made structures that provide habitat for threatened species in the Stage 1 Biodiversity Assessment Development Footprint.

There are no areas of non-native vegetation that provide habitat for threatened species in the Stage 1 Biodiversity Assessment Development Footprint.

3.6.4 Hydrological Processes that Sustain and Interact with the Rivers, Streams and Wetlands

Hydrological processes in the vicinity of the Project have been characterised by WRM Water & Environment (WRM) (2019) in the Surface Water Assessment and Fluvial Systems (2019) in the Geomorphology Assessment.

Drainage features in the vicinity of the Project are shown on Figure 5. The Maxwell Infrastructure is located in the upper headwaters of the following tributaries of the Hunter River:

- Ramrod Creek;
- Bayswater Creek;
- Saltwater Creek; and
- Saddlers Creek.

The northern areas of Maxwell Infrastructure drain to, or previously drained to, the Ramrod Creek catchment. Ramrod Creek drains into the Hunter River approximately 10 km to the north-west of Maxwell Infrastructure, immediately downstream of Muswellbrook. The eastern areas of the existing Maxwell Infrastructure drain to or previously drained to Bayswater Creek (prior to mining operations). Almost all of the Bayswater Creek catchment within Maxwell Infrastructure is within previously mined areas and does not drain off-site. Bayswater Creek drains into Lake Liddell and the headwater dams upstream of the Liddell Ash Dam on land owned by AGL. The southern areas of Maxwell Infrastructure are located within the pre-mine Saltwater Creek and Saddlers Creek catchments. Saltwater Creek drains into Plashett Reservoir on land owned by AGL (WRM 2019).

The main drainage feature in the vicinity of Maxwell Underground is Saddlers Creek. Saddlers Creek is a first and second order watercourse at Maxwell Infrastructure under the Strahler stream classification system. It is a third, fourth and fifth order watercourse in the vicinity of Maxwell Underground. The eastern side of the Maxwell Underground area drains to Plashett Reservoir or directly to Saltwater Creek downstream of Plashett Reservoir (WRM 2019).

The streams in the Maxwell Underground area are classified as first, second or third order under the Strahler stream classification system (Fluvial Systems 2019).

The Liddell Gauging Station (210083) is the closest gauging station to Maxwell Underground on the Hunter River and is located approximately 9 km downstream, with a catchment area of 13,400 km^2. Data has been collected at the Liddell Gauging Station (210083) since 1969. The flow-duration relationship indicates that flow is non-zero all of the time, which is characteristic of regulated river systems. The median flow is approximately 240 megalitres per day (ML/d) and flows exceed 1,000 ML/d some 16% of the time (WRM 2019).

The flow-duration relationship for the recorded flows in Saddlers Creek has been determined from the Bowfield Gauge (2100043). The flow-duration relationship indicates Saddlers Creek flows intermittently, with flow recorded some 55% of the time (WRM 2019).

The streams in the Maxwell Underground area primarily have ephemeral flow regimes (i.e. a very short flow duration during storm events only). Two of the third order streams in the Maxwell Underground area would have more persistent flow following cessation of rain events but the flow regime would be ephemeral in most years, and seasonal only in wet years with a high frequency of closely-spaced storm events (Fluvial Systems 2019).

Baseline water quality monitoring for the Hunter River, Saddlers Creek and Ramrod Creek shows the following (WRM 2019):

- Hunter River is slightly alkaline with median pH ranging from 8.1 to 8.4;
- Hunter River median electrical conductivity (EC) ranges from 735 to 817 microSiemens per centimetre (µS/cm) and is typically below the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australian and New Zealand (ARMCANZ) default trigger values for irrigation, livestock drinking water and aquatic ecosystem protection, however the 80th percentile value for the upstream site exceeds the trigger value for irrigation;
- Saddlers Creek is slightly alkaline with median pH ranging from 7.4 to 8.3;
- Saddlers Creek EC and total dissolved solids (TDS) concentrations are very high and substantially exceed ANZECC and ARMCANZ default trigger values for irrigation, livestock drinking water and aquatic ecosystem protection with median EC values ranging from 5,280 to 7,510 µS/cm;
- Ramrod Creek is neutral with median pH ranging from 6.9 to 8.0; and
- Ramrod Creek EC is generally saline, with median EC ranging from 1,520 to 6,260 µS/cm.

Further detail regarding the hydrological processes in the vicinity of the Project, including a detailed review of water quality monitoring data from existing regional and local surface water monitoring sites, is provided in the Surface Water Assessment (WRM 2019) and Geomorphology Assessment (Fluvial Systems 2019).

3.7 STAGE 1 BIODIVERSITY ASSESSMENT DEVELOPMENT FOOTPRINT - SUMMARY OF RESULTS

Table 12 provides a summary of the ecosystem credits required for each PCT in the Stage 1 Biodiversity Assessment Development Footprint.

Table 12
Summary of the Ecosystem Credit Requirements - Stage 1

PCT	Generic Name	Area (ha)	Credits Required[1]
1607	1. Red Gum - Ironbark - Apple Shrubby Woodland	0.4	9
1607	1a. Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	4.9	59
	Subtotal	***5.3***	***68***
1606	2. White Box - Ironbark - Red Gum Shrubby Forest	9.5	216
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)	122.7	971
	Subtotal	***132.2***	***1,187***
1655	3. Slaty Box Shrubby Woodland	1.2	21
	Subtotal	***1.2***	***21***
1692	6. Bull Oak Grassy Woodland	2.8	45
	Subtotal	***2.8***	***45***
201	8. Fuzzy Box Woodland	0.5	15
201	8a. Fuzzy Box Woodland (DNG)	1	14
	Subtotal	***1.5***	***29***
1691	9. Ironbark - Grey Box Grassy Woodland	7.6	184
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	0.3	6
	Subtotal	***7.9***	***190***
1604	11. Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland	1.3	44
1604	Pasture Rehabilitation	49.3	0
1604	Woodland Rehabilitation	15.2	214
	Subtotal	***65.8***	***258***
	Total	***216.7***	***1,798***

[1] Refer to Attachment C.

Table 13 provides a summary of the habitat and credits required for species credit species within the Stage 1 Biodiversity Assessment Development Footprint.

Table 13
Summary of the Species Credit Requirements - Stage 1

Species Credit Species	Presence Status	Area of Habitat (ha)	Credits Required[1]
Pink-tailed Legless Lizard	Present outside of the Biodiversity Assessment Development Footprint	36	382
Striped Legless Lizard	Present inside and outside the Biodiversity Assessment Development Footprint	145.4	1,126
Squirrel Glider	Present outside of the Biodiversity Assessment Development Footprint	40.7	524
Southern Myotis	Present inside and outside the Biodiversity Assessment Development Footprint	0.5	9

[1] Refer to Attachment C.

4 BIODIVERSITY ASSESSMENT STAGE 2

This section provides a description of the native vegetation and threatened species relevant to the potential Edderton Road realignment (i.e. Stage 2 of the Biodiversity Assessment Development Footprint).

This realignment is a linear feature between 25 m and 40 m wide and 3.1 km long. There is a module within the BAM Calculator for linear features, however there is a minimum length of 3.5 km in the BAM (OEH 2017a). Consequently, the realignment was assessed using a 1,500 m buffer around the disturbance edge rather than a 500 m buffer around the linear disturbance centreline (Figure 21).

4.1 NATIVE VEGETATION

This section provides a description of the native vegetation relevant to Stage 2 of the Biodiversity Assessment Development Footprint.

4.1.1 PLANT COMMUNITY TYPES

As described in Section 3.1.1, Hunter Eco (2019) (Attachment A) identified and mapped PCT on the Subject land and surrounding area in accordance with the BAM and *BioNet Vegetation Classification* (OEH 2019b) (Figures 7a and 7b) (Table 14). The PCTs within Stage 2 of the Biodiversity Assessment Development Footprint are assigned to a vegetation class in Table 14. Table 14 also includes the Percent Cleared Values from the *BioNet Vegetation Classification* (OEH 2019b) and the VI Scores. Hunter Eco (2019) (Attachment A) justifies the PCT and vegetation zone mapping (including the species relied upon for identification of PCTs) in Attachment A.

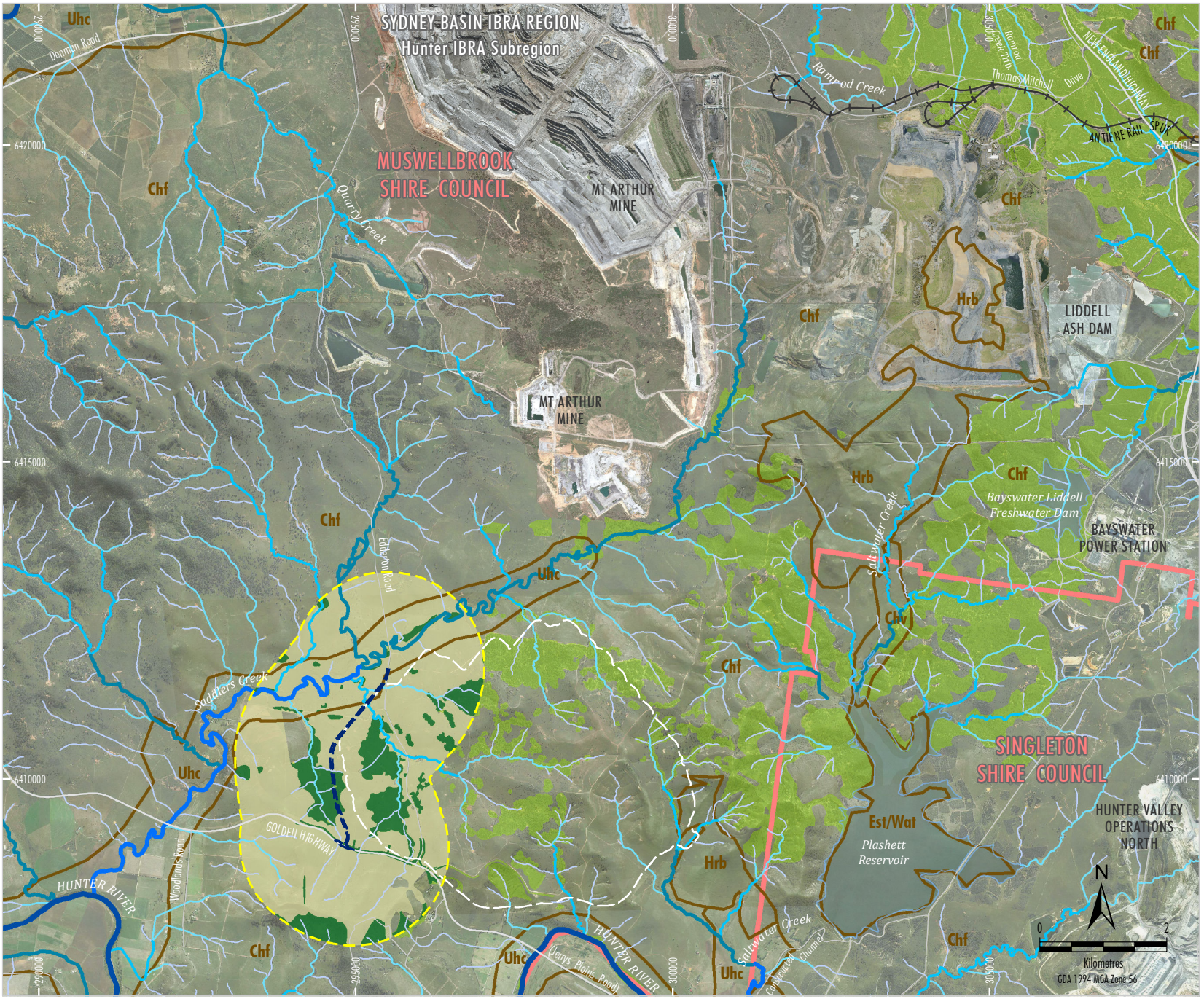
Again, the presence of Fuzzy Box (*Eucalyptus microcarpa*) necessitated selection of PCT 201 which lies in the South-west Slopes Bioregion as there was no Fuzzy Box PCT within the Sydney Basin Bioregion despite numerous records of Fuzzy Box for the bioregion in BioNet (OEH 2019c)

The Stage 2 Biodiversity Assessment Development Footprint is 10.2 ha in size comprising (Figures 7a and 7b):

- 2.3 ha of fragmented (i.e. not continuous) native woodland/forest vegetation;
- 7.1 ha of DNG;
- 0.2 ha of planted trees;
- 0.5 ha is infrastructure/cleared land; and
- 0.1 ha is covered by a farm dam.

The location of vegetation integrity (site condition) plots used in the BAM Credit Calculator for the Stage 2 Biodiversity Assessment Development Footprint are shown on Figure 22. Vegetation composition, structure and function data are provided in Attachment A.

A portion (0.2 ha) of the Stage 2 Biodiversity Assessment Development Footprint passes through a narrow, planted vegetation screen at the edge of the Golden Highway (Figure 22). In order for the ecological values of this habitat to be assessed through the BAM Credit Calculator this small area was assigned to PCT 1655, which was an adjoining community. The planted vegetation screen does contain a row of planted Slaty Box, which is present in PCT 1655.



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 2
- 1500 m Buffer Area
- Woodland within the Buffer
- Derived Native Grassland within the Buffer
- Habitat Connectivity Area outside the Buffer
- Local Government Area

Strahler Stream Order

- 1st Order (Riparian Corridor Width 10 m)
- 2nd Order (Riparian Corridor Width 20 m)
- 3rd Order (Riparian Corridor Width 30 m)
- 4th Order (Riparian Corridor Width 40 m)
- 5th Order (Riparian Corridor Width 40 m)
- 9th Order (Riparian Corridor Width 50 m)

Mitchell Landscapes

- Chv Central Hunter Alluvial Plains
- Chf Central Hunter Foothills
- Est/Wat Estuary/Water Added
- Hrb Hunter River Basalts
- Uhc Upper Hunter Channels and Floodplain

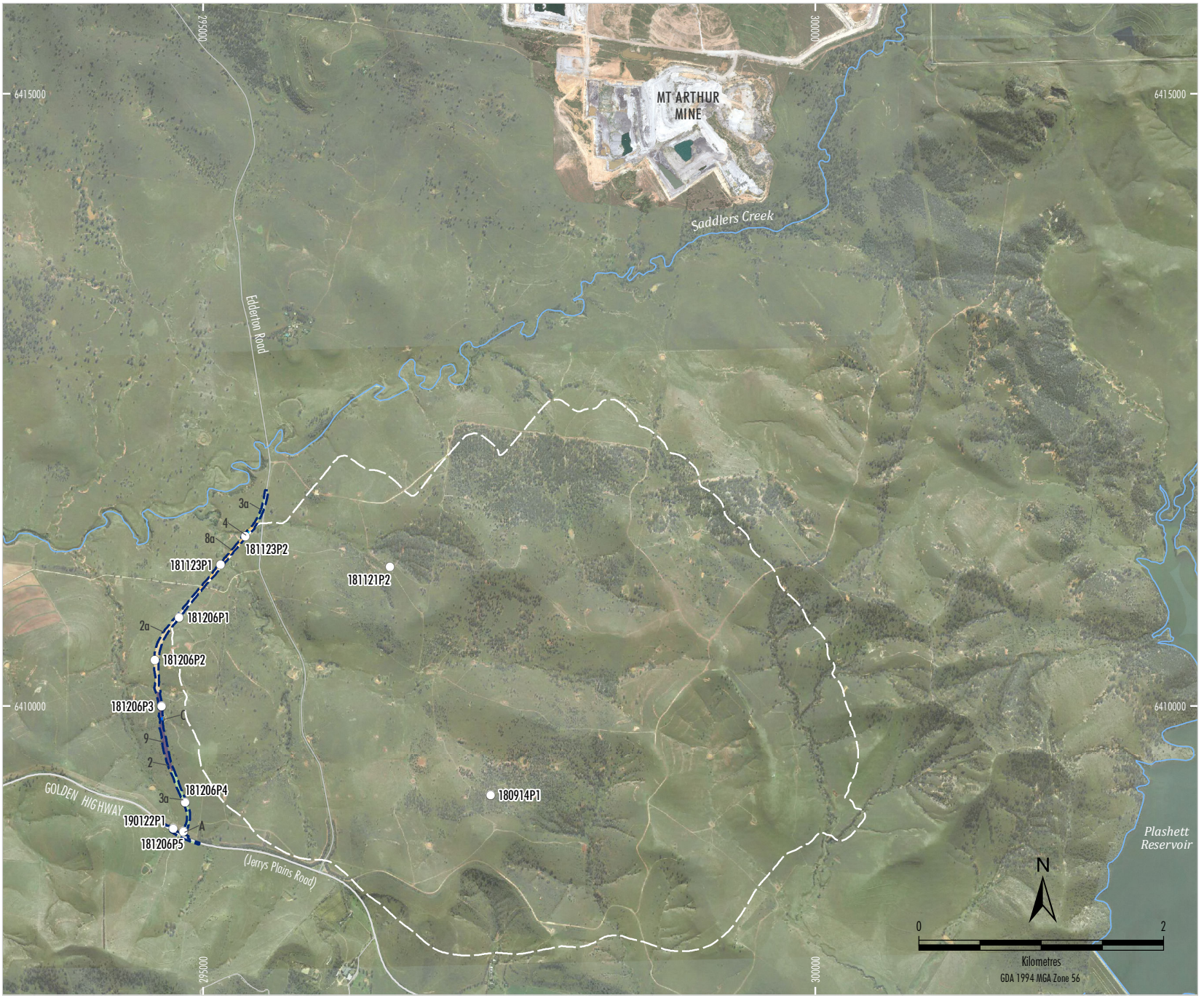
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Office of Environment and Heritage NSW (2019); MSEC (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Location Map - Biodiversity Assessment Development Footprint Stage 2

Figure 21



LEGEND

- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint Stage 2
- Vegetation Integrity Plot Location

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 2a White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3a Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4 Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9 Ironbark - Grey Box Grassy Woodland (PCT1691) [4]

Other

- A Planted Trees
- C Waterbody/Dam
- F Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland
[2] Listed BC Act, Hunter Valley Footslopes Slaty Gum Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed BC Act, Central Hunter Grey Box-Ironbark Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Vegetation Integrity Plot Locations - Biodiversity Assessment Development Footprint Stage 2

Figure 22

SHM-18-03 Maxwell_EIS_App_BDAR_223E

Table 14
Plant Community Type Data - Stage 2

Vegetation Zone	PCT	PCT Name	Class	Generic Name (Attachment A)	Area (ha)	Percent Cleared	Sensitivity Class^	VI Score~
Dry Sclerophyll Forests (Shrub/grass sub-formation)								
1	1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter[1]	North-west Slopes Dry Sclerophyll Woodlands	2. White Box - Ironbark - Red Gum Shrubby Forest	0.1	29	High	46.6
2	1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG[1]	North-west Slopes Dry Sclerophyll Woodlands	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)	2.9	-	High	31
Dry Sclerophyll Forests (Shrubby sub-formation)								
3	1655	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin - DNG	Western Slopes Dry Sclerophyll Forests	3a. Slaty Box Shrubby Woodland (DNG)	2.4	-	High	26.5
4	1655	Planted Trees	None	Planted Trees	0.2	-	High	31.2
Grassy Woodlands								
5	201	Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion - DNG	Western Slopes Grassy Woodlands	8a. Fuzzy Box Woodland (DNG)	1.8	-	High	23.1
6	1691	Narrow-leaved Ironbark - Grey Box Grassy Woodland of the central and upper Hunter[2]	Coastal Valley Grassy Woodlands	9. Ironbark - Grey Box Grassy Woodland	2	79	High	51.4
Forested Wetlands								
7	1731	Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Coastal Swamp Forests	4. Swamp Oak Forest	0.2	62	High	41.2
				Total Woodland/Forest	2.3	-	-	-
				Total Derived Native Grassland	7.1	-	-	-
				Total Planted Vegetation	0.2	-	-	-
				Total	9.6	-	-	-

[1] Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow-Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[2] Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

^ The sensitivity class is set for each PCT by OEH (2019b).

~ BAM Credit Calculator.

4.1.2 THREATENED ECOLOGICAL COMMUNITIES

Threatened ecological communities listed under the BC Act are shown on Figure 9 and threatened ecological communities listed under the EPBC Act are shown on Figure 10. Table 15 lists and quantifies threatened ecological communities in the Stage 2 Biodiversity Assessment Development Footprint.

Table 15
Threatened Ecological Communities - Stage 2

Threatened Ecological Community	Conservation Status*	Associated PCT	Area (ha)
Threatened Ecological Communities listed under the BC Act			
White Box Yellow Box Blakely's Red Gum Woodland	E	1606	3 ha (comprising 0.1 ha of woodland and 2.9 ha of DNG)
Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	1691	2 ha
Threatened Ecological Communities listed under the EPBC Act			
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1606	3 ha (comprising 0.1 ha of woodland and 2.9 ha of DNG)
Central Hunter Valley Eucalypt Forest and Woodland	CE	1691	2 ha

* Threatened ecological community status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

4.1.3 PLANT COMMUNITY TYPES PERCENT CLEARED VALUE

The BAM (OEH 2017a) defines 'Percent Cleared Value' as the percentage of a PCT that has been cleared as a proportion of its pre-1750 extent, as identified in the *BioNet Vegetation Classification* (OEH 2019b). Percent cleared values for each PCT are shown in Table 14.

4.2 VEGETATION INTEGRITY ASSESSMENT

4.2.1 VEGETATION ZONES

Seven vegetation zones (i.e. areas of native vegetation that is the same PCT and similar broad condition states) were mapped (Table 14; Figure 22). Vegetation condition states recognised were: woodland and DNG.

4.2.2 PATCH SIZE

Section 3.2.2 defines patch size as applied in this report. Patch size for the NSW and Commonwealth Stage 2 development site for both woodland and DNG PCT was >100 ha (Figure 21).

4.2.3 VEGETATION INTEGRITY SCORE

The BAM Credit Calculator was used to determine the VI Scores for each PCT in the development area (Table 14). According to the BAM Credit Calculator, all of the vegetation zones have a VI Score requiring an offset (Table 16). This is because the VI Scores are greater than 17 for PCTs associated with species habitat.

Table 16
Vegetation Integrity Score Detail – Stage 2

Vegetation Zone	PCT	PCT-condition class	Composition Condition Score	Structure Condition Score	Function Condition Score	Trees with Hollows	Vegetation Integrity Score	Threshold for Requiring an Offset	Offset Required?
1	1606	Moderate	40.6	40.8	61.3	0	46.6	>15	Yes
2	1606	Derived Native Grassland	48.3	25.7	24.1	0	31.0	>15	Yes
3	1655	Derived Native Grassland	44.4	18.9	22.1	0	26.5	>17	Yes
4	1655	Low	56.7	19.9	27	0	31.2	>17	Yes
5	201	Derived Native Grassland	27.4	29.9	15	0	23.1	>17	Yes
6	1691	Moderate	64.8	60.8	34.5	20	41.2	>17	Yes
7	1731	Moderate	68.6	24.5	41.8	0	41.2	>17	Yes

4.2.4 LOCAL DATA

It was not necessary to use local data to deviate from the OEH databases (OEH 2019a, 2019b).

4.3 THREATENED SPECIES

This section provides a description of the threatened species relevant to Stage 2 of the Biodiversity Assessment Development Footprint.

4.3.1 ECOSYSTEM CREDIT SPECIES - HABITAT SUITABILITY ASSESSMENT

The habitat suitability assessment for ecosystem credit species and Stage 2 of the Biodiversity Assessment Development Footprint is provided below.

4.3.1.1 Step 1: Identify Ecosystem Species for Assessment

A total of 34 ecosystem credit species for assessment are listed in Table 17 from the BAM Credit Calculator. Species shaded in Table 17 are species with records in the Subject land.

Table 17
Ecosystem Species from the BAM Credit Calculator – Stage 2

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Sensitivity to Gain Class
		BC Act	EPBC Act		
Birds					
Ninox connivens	Barking Owl	V	-	S/E	High
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	E	Moderate
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	E	High
Stagonopleura guttata	Diamond Firetail	V	-	E	Moderate
Tyto longimembris	Eastern Grass Owl	V	-	E	Moderate
Petroica phoenicea	Flame Robin	V	-	E	Moderate
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Breeding: High
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	Foraging: Moderate
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	S/E	High
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	E	Moderate
Hieraaetus morphnoides	Little Eagle	V	-	E	Moderate
Glossopsitta pusilla	Little Lorikeet	V	-	S/E	Moderate
Tyto novaehollandiae	Masked Owl	V	-	E	High
Grantiella picta	Painted Honeyeater	V	V	S/E	High
Ninox strenua	Powerful Owl	V	-	E	Moderate
Anthochaera phrygia	Regent Honeyeater	V	-	S/E	High
Petroica boodang	Scarlet Robin	CE	CE	S/E	High
Chthonicola sagittata	Speckled Warbler	V	-	E	Moderate
Circus assimilis	Spotted Harrier	V	-	E	High
Lophoictinia isura	Square-tailed Kite	V	-	E	Moderate
Lathamus discolor	Swift Parrot	V	-	S/E	Moderate
Neophema pulchella	Turquoise Parrot	E	CE	S/E	Moderate
Daphoenositta chrysoptera	Varied Sittella	V	-	E	High
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	E	Moderate
Mammals					
Phascolarctos cinereus	Koala	V	V	S/E	High
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	High
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E	High
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E	Breeding: Very High
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	E	High
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	E	High
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	E	High
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	High
Petaurus australis	Yellow-bellied Glider	V	-	E	High
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	E	High

Shaded species are species with records in the Subject land.

[1] Threatened fauna species status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

[2] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019). E = Ecosystem; S = Species.

4.3.1.2 Step 2: Assessment of Habitat Constraints and Vagrant Species on the Disturbance Area

No ecosystem credit species listed in Table 15 were removed from the BAM Credit Calculator due to habitat constraints.

4.3.2 SPECIES CREDIT SPECIES - HABITAT SUITABILITY ASSESSMENT

The habitat suitability assessment for species credit species and Stage 2 of the Biodiversity Assessment Development Footprint is provided below.

4.3.2.1 Step 1: Identify Species Credit Species for Assessment

A total of 42 species credit species are listed in Table 18 for assessment, including: (i) 40 species credit species from the BAM Credit Calculator; (ii) no additional species based on previous records (Table 7); and (iii) two additional species recorded in the Subject land by Future Ecology (2019) (Attachment B), namely the Pink-tailed Legless Lizard and Striped Legless Lizard. Species credit species shaded in Table 18 are species with records in the Subject land.

Table 18
Species Credit Species for Assessment – Stage 2

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]
		BC Act	EPBC Act	
Flora				
Acacia pendula - endangered population	Acacia pendula population in the Hunter catchment	E	-	S
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S
Cymbidium canaliculatum - endangered population	Cymbidium canaliculatum population in the Hunter Catchment	E	-	S
Cynanchum elegans	White-flowered Wax Plant	E	E	S
Diuris tricolor	Pine Donkey Orchid	V	-	S
Diuris tricolor - endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	E	-	S
Eucalyptus glaucina	Slaty Red Gum	V	V	S
Eucalyptus pumila	Pokolbin Mallee	V	V	S
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S
Ozothamnus tesselatus	Ozothamnus tesselatus	V	V	S
Persicaria elatior	Tall Knotweed	V	V	S
Pomaderris bodalla	Bodalla Pomaderris	V	-	S
Pomaderris queenslandica	Scant Pomaderris	E	-	S
Pomaderris reperta	Denman Pomaderris	CE	CE	S
Prostanthera cineolifera	Singleton Mint Bush	V	V	S
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	S
Amphibians				
Litoria aurea	Green and Golden Bell Frog	E	V	S
Reptiles				
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S
Delma impar	Striped Legless Lizard	V	V	S

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]
		BC Act	EPBC Act	
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S
Birds				
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E
Burhinus grallarius	Bush Stone-curlew	E	-	S
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E
Hieraaetus morphnoides	Little Eagle	V	-	S/E
Lathamus discolor	Swift Parrot	E	CE	S/E
Lophoictinia isura	Square-tailed Kite	V	-	S/E
Ninox connivens	Barking Owl	V	-	S/E
Ninox strenua	Powerful Owl	V	-	S/E
Tyto novaehollandiae	Masked Owl	V	-	S/E
Mammals				
Cercartetus nanus	Eastern Pygmy-possum	V	-	S
Petaurus norfolcensis	Squirrel Glider	V	-	S
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S
Phascolarctos cinereus	Koala	V	V	S/E
Planigale maculata	Common Planigale	V	-	S
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S/E
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E
Myotis macropus	Southern Myotis	V	-	S
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E
Vespadelus troughtoni	Eastern Cave Bat	V	-	S

Shaded species are species with records in the Subject land.

[1] Threatened species status under the BC Act and/or EPBC Act (current as at May 2019).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

[2] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019a) (current as at May 2019). E = Ecosystem; S = Species.

None of the species in Table 18, have geographic constraints identified in the BAM Calculator.

4.3.2.2 Step 2: Assessment of the Habitat Constraints for Species Credit Species on the Disturbance Area

Habitat constraints are identified in the *Threatened Biodiversity Data Collection* (OEH 2019a) for some species credit species, and the absence of identified habitat precludes the species from further assessment (Table 19). Five species (shaded in Table 19) are excluded from further assessment as species credit species, namely the Pokolbin Mallee, Swift Parrot, Regent Honeyeater, Brush-tailed Rock-wallaby and Grey-headed Flying-fox.

Table 19
Species Credit Species Habitat Constraints - Stage 2

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH 2019a)	Assessment Prior to the Surveys (Attachment A and B)
Flora			
Pokolbin Mallee	Species	*Sandstone slopes*	*Habitat absent*
Amphibians			
Green and Golden Bell Frog	Species	*Semi-permanent/ephemeral wet areas (within 1km of wet areas).* *Swamps (within 1km of swamp).* *Waterbodies (within 1km of waterbody).*	*Dams (waterbodies) present*
Green-thighed Frog	Species	*None.*	-
Reptiles			
Pink-tailed Legless Lizard	Species	*Rocky areas or within 50 m of rocky areas.*	*Habitat present*
Striped Legless Lizard	Species	*None.*	-
Pale-headed Snake	Species	*None.*	-
Birds			
Square-tailed Kite	Species/Ecosystem	** Breeding constraint: Other (Nest trees).*	*Breeding habitat potentially present*
White-bellied Sea-Eagle	Species/Ecosystem	** Breeding constraint: Other (Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines).* ** Foraging constraint: Waterbodies (Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines).*	*Breeding habitat potentially present* *Foraging habitat potentially present*
Little Eagle	Species/Ecosystem	** Breeding constraint: Other (Nest trees - live (occasionally dead) large old trees within vegetation).*	*Breeding habitat potentially present*
Bush Stone-curlew	Species	*Fallen/standing dead timber including logs.*	*Habitat potentially present*
Glossy Black-Cockatoo	Species/Ecosystem	** Breeding constraint: Hollow-bearing trees (Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground).* ** Foraging constraint: Other (Presence of Allocasuarina and Casuarina species).*	*Breeding habitat potentially present* *Foraging habitat potentially present*
Gang-gang Cockatoo	Species/Ecosystem	** Breeding constraint: Hollow-bearing trees (Eucalypt tree species with hollows greater than 9 cm diameter).*	*Breeding potentially habitat present*
Swift Parrot	Species/Ecosystem	** Breeding constraint: Other (As per mapped important areas – contact OEH for information).* *Foraging constraint: none.*	*Not a mapped important area as confirmed by OEH*
Masked Owl	Species/Ecosystem	** Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).*	*Breeding potentially habitat present*

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH 2019a)	Assessment Prior to the Surveys (Attachment A and B)
Powerful Owl	Species/Ecosystem	* *Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).*	*Breeding potentially habitat present*
Barking Owl	Species/Ecosystem	* *Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20 cm diameter and greater than 4m above the ground).*	*Breeding potentially habitat present*
Regent Honeyeater	Species/Ecosystem	* *Breeding constraint: Other (As per mapped areas; contact OEH).*	*Not a mapped important area as confirmed by OEH*
Mammals			
Brush-tailed Phascogale	Species	*Hollow-bearing trees.*	*Breeding potentially habitat present*
Common Planigale	Species	*None.*	-
Koala	Species/Ecosystem	* *Breeding constraint: Other (Areas identified via survey as important habitat.* *Foraging constraint: none.*	*Assumed no relevant constraints as OEH (2019a) does not define important habitat* *No Koalas were recorded within the Subject land*
Eastern Pygmy-possum	Species	*None.*	-
Squirrel Glider	Species	*None.*	-
Brush-tailed Rock-wallaby	Species	*Other (Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines).*	*Habitat absent*
Grey-headed Flying-fox	Species/Ecosystem	* *Breeding constraint: Other (Breeding camps)*	*Breeding habitat absent*
Little Bentwing-bat	Species/Ecosystem	* *Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).*	*Breeding habitat potentially present* *No caves*
Eastern Bentwing-bat	Species/Ecosystem	* *Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).*	*Breeding habitat potentially present* *No caves*
Large-eared Pied Bat	Species	*Cliffs (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels).*	*Habitat potentially present within 2 km* *No caves*
Southern Myotis	Species	*Hollow-bearing trees (Within 200 m of riparian zone).* *Other (Bridges, caves or artificial structures within 200 m of riparian zone).*	*Habitat potentially present*
Eastern Cave Bat	Species	*Caves (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds).*	*Habitat potentially present within 2 km* *No caves*

Shaded species are species that have habitat constraints as identified in the *Threatened Biodiversity Data Collection* (OEH 2019a).

* Habitat Constraints not in the BAM Calculator.

4.3.2.3 Step 3: Identify Candidate Species Credit Species for Further Assessment

A candidate species credit species is considered unlikely to occur on the Subject land (or specific vegetation zones) if after carrying out a field assessment of the habitat constraints or microhabitats on the Subject land, the assessor determines that the habitat is substantially degraded such that the species is unlikely to utilise the Subject land (or specific vegetation zones) (OEH 2017a).

Large-leafed Monotaxis (*Monotaxis macrophylla*) is a known fire-ephemeral species. There are no recent records of fire within or near the Biodiversity Assessment Development Footprint. This species is reported as growing on rocky ridges and hillsides (OEH 2019a). This habitat does not occur in Stage 2 of the Biodiversity Assessment Development Footprint.

After considering the geographic constraints (Step 1) and habitat constraints (Step 2), candidate species credit species for further assessment are listed in Table 20.

4.3.2.4 Step 4: Determine Presence or Absence of a Candidate Species Credit Species

Hunter Eco (2019) (Attachment A) undertook targeted surveys for candidate flora species credit species and Future Ecology (2019) (Attachment B) undertook targeted surveys for candidate fauna species credit species to determine presence or absence of the species within the survey periods required by the *Threatened Biodiversity Data Collection* (OEH 2019a) (Table 20). The timing, methods and effort of the flora and fauna surveys are detailed in Attachments A and B respectively. Months in which targeted surveys were undertaken are shaded in Table 20.

Further detail relevant to Stage 2 is as described for Stage 1 in Section 3.3.2.4.

4.3.2.5 Step 5: Determine the Area or Count, and Location of Suitable Habitat for a Species Credit Species

Species Polygons for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis were prepared by Future Ecology (2019) (Attachment B) as shown on Figures 17 to 20. The area of habitat in the Stage 2 Biodiversity Assessment Development Footprint is quantified in Table 21.

Table 20
Species Credit Species Requiring Survey and Timing – Stage 2

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flora																
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	Yes	-	-	-	-	-	-	-	-	-	Yes	Yes
Cymbidium canaliculatum – endangered population	*Cymbidium canaliculatum* in the Hunter Catchment	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Cynanchum elegans	White-flowered Wax Plant	E	E	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diuris tricolor	Pine Donkey Orchid	V	-	S	-	-	-	-	-	-	-	-	Yes	Yes	-	-
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	E	-	S	-	-	-	-	-	-	-	-	Yes	Yes	-	-
Eucalyptus pumila	Pokolbin Mallee	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus glaucina	Slated Red Gum	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Monotaxis macrophylla[3]	Large-leafed Monotaxis	E	-	S	Yes	Yes							Yes	Yes	Yes	Yes
Ozothamnus tesselatus	Ozothamnus tesselatus	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Persicaria elatior	Tall Knotweed	V	V	S	Yes	Yes	Yes	Yes	Yes	-	-	-	-	-	-	Yes
Pomaderris Bodalla	Bodalla Pomaderris	V	-	S	-	-	-	-	-	-	-	-	Yes	Yes	Yes	-
Pomaderris queenslandica	Scant Pomaderris	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris reperta	Denman Pomaderris	CE	CE	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rutidosis heterogama	Heath Wrinklewort	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Amphibians																
Litoria aurea	Green and Golden Bell Frog	E	V	S	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Reptiles																
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Birds																
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Yes	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	-	-	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes
Hieraaetus morphnoides	Little Eagle	V	-	S/E	-	-	-	-	-	-	-	Yes	Yes	Yes	-	-
Burhinus grallarius	Bush Stone-curlew	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	-	-	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-	-
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Yes	-	-	-	-	-	-	-	-	Yes	Yes	Yes
Tyto novaehollandiae	Masked Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	-	-	-	-
Ninox strenua	Powerful Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	-	-	-	-
Ninox connivens	Barking Owl	V	-	S/E	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mammals																
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Survey Months for Each Species											
		BC Act	EPBC Act		Jan	Feb	March	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planigale maculata	Common Planigale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phascolarctos cinereus	Koala	V	V	S/E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes
Petaurus norfolcensis	Squirrel Glider	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Miniopterus australis	Little Bentwing-bat	V	-	S/E	Yes	Yes	-	-	-	-	-	-	-	-	-	Yes
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	S/E	Yes	Yes	-	-	-	-	-	-	-	-	-	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	Yes	-	-	-	-	-	-	-	-	-	Yes	Yes
Myotis macropus	Southern Myotis	V	-	S	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	Yes	-	-	-	-	-	-	-	-	-	Yes	Yes

Note: Months in which surveys are to be conducted in accordance with the *Threatened Biodiversity Data Collection* (OEH 2019a) are denoted 'Yes'. The shaded month is the month in which targeted surveys were undertaken for the relevant species.

1 Threatened species status under the BC Act and/or EPBC Act (current as at May 2019). V = Vulnerable; E = Endangered; CE = Critically Endangered.

2 Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH 2019) (current as at May 2019).

3 *Monotaxis macrophylla* is a fire-ephemeral plant only appearing for a few months after fire. There have been no fires on the Subject land for several years.

Table 21
Species Credit Species Presence – Stage 2

Generic Name	PCT	VI Score~	Area of Habitat (ha)			
			Pink-tailed Legless Lizard	Striped Legless Lizard	Squirrel Glider	Southern Myotis
2. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606	1606	46.6	-	0.1	0.1	-
2a. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606 (DNG)	1606	31.0	2.5^	2.9	0.9*	-
3. Slaty Box Shrubby Woodland PCT 1655 (DNG)	1655	26.5	-	2.4	0.8	-
8a. Fuzzy Box Woodland PCT 201 (DNG)	201	23.1	0.2^	-	0.5*	-
9. Ironbark - Grey Box Grassy Woodland PCT 1691	1691	51.4	-	2	-	1.4#
		Total	**2.7^**	**7.4**	**2.3**	**1.4#**

~ Vegetation Integrity Score – refer Table 16.
^ Area associated with rocky areas in PCT 1606. A 50 m zone was added to the rocky areas in consideration of the habitat constraint (Table 9) and as directed by OEH (14 May 2019).
* Area covered by paddock trees.
# Area determined by application of OEH (2018).

4.3.2.6 Step 6: Determine the Habitat Condition within the Species Polygon for Species Assessed by Area

The VI Score for each vegetation zone associated with the Species Polygons for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis are listed in Table 21.

4.4 LOCAL DATA

It was not necessary to use local data to deviate from the OEH databases (OEH 2019a, 2019b).

4.5 EXPERT REPORTS

No Expert Reports are required.

4.6 PRESCRIBED BIODIVERSITY IMPACT ENTITIES

4.6.1 Karst, Caves, Crevices and Cliffs

There are no karst, caves, crevices or cliffs that provide habitat for threatened species in the Stage 2 Biodiversity Assessment Development Footprint.

4.6.2 Rock

Refer to Section 3.6.2.

4.6.3 Human Made Structures and Non-native Vegetation

There are no human made structures that provide habitat for threatened species in the Stage 2 Biodiversity Assessment Development Footprint.

There are no areas of non-native vegetation that provide habitat for threatened species in the Stage 2 Biodiversity Assessment Development Footprint.

4.6.4 Hydrological Processes that Sustain and Interact with the Rivers, Streams and Wetlands

The Stage 2 Biodiversity Assessment Development Footprint would not impact any hydrological processes that sustain and interact with the rivers, streams and wetlands.

4.7 STAGE 2 BIODIVERSITY ASSESSMENT DEVELOPMENT FOOTPRINT - SUMMARY OF RESULTS

Table 22 provides a summary of the ecosystem credits required for each PCT in the Stage 2 Biodiversity Assessment Development Footprint.

Table 22
Summary of the Ecosystem Credit Requirements - Stage 2

PCT	Generic Name	Area (ha)	Credits Required[1]
1606	2. White Box - Ironbark - Red Gum Shrubby Forest	0.1	2
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)	2.9	45
	Subtotal	***3***	***47***
1655	Planted Trees	0.2	2
1655	3a Slaty Box Shrubby Woodland (DNG)	2.4	24
	Subtotal	***2.6***	***26***
1731	4. Swamp Oak Forest	0.2	4
	Subtotal	***0.2***	***4***
201	8a. Fuzzy Box Woodland (DNG)	1.8	26
	Subtotal	***1.8***	***26***
1691	9. Ironbark - Grey Box Grassy Woodland	2	51
	Subtotal	***2***	***51***
	Total	***9.6***	***154***

[1] Refer to Attachment D.

Table 23 provides a summary of the habitat and credits required for species credit species within the Stage 2 Biodiversity Assessment Development Footprint.

Table 23
Summary of the Species Credit Requirements - Stage 2

Species Credit Species	Presence Status	Area of Habitat (ha)	Credits Required[1]
Pink-tailed Legless Lizard	Present outside of the Stage 2 Biodiversity Assessment Development Footprint	2.7	41
Striped Legless Lizard	Present outside the Stage 2 Biodiversity Assessment Development Footprint	7.4	99
Squirrel Glider	Present outside of the Stage 2 Biodiversity Assessment Development Footprint	2.3	33
Southern Myotis	Present outside the Stage 2 Biodiversity Assessment Development Footprint	1.4	36

[1] Refer to Attachment D.

5 AVOID AND MINIMISE IMPACTS

In accordance with the BAM (OEH 2017a), efforts made by Malabar to avoid and minimise impacts through Project location and design are documented and justified below. Other measures to mitigate and manage impacts are described in Section 5.6.

5.1 MEASURES TO AVOID AND MINIMISE IMPACTS

The location of the Project has been selected based upon the presence of coal seams able to be economically mined within Malabar's existing tenements and the extensive geological and geotechnical data available within the target area in EL 5460.

Malabar is committed to developing the Project solely as an underground mining operation. Underground mining methods significantly reduce environmental impacts, including vegetation and habitat disturbance, in comparison to open cut mining methods.

In addition to the use of underground mining methods, Project elements have been located and designed to avoid or minimise impacts to vegetation and habitat disturbance through:

- the use of the substantial existing Maxwell Infrastructure (including the CHPP and rail loop), limiting the requirement to develop new infrastructure;
- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- the emplacement of CHPP reject material from coal processing within existing mine voids left behind by previous mining activities at Maxwell Infrastructure;
- locating the MEA predominately within an area of DNG rather than woodland (i.e. an area with a lower vegetation integrity score);
- considering and avoiding the location of records of threatened flora species (i.e. the Pine Donkey Orchid [*Diuris tricolor*] – Figure 11) for the location of the MEA;
- reducing the disturbance footprint required for the MEA, including a reduction in the total MEA from approximately 75 ha in the EPBC Act Referral to approximately 48 ha proposed in the EIS;
- incorporating the continued rehabilitation of previous mining disturbance areas at Maxwell Infrastructure, and eventual relinquishment of areas not required to support the Project; and
- incorporating woodland and rocky area components in the final land use following decommissioning and rehabilitation of Project infrastructure.

As described in Section 1.3, the potential Edderton Road realignment has been assessed as a second stage of the development as the potential subsidence impacts on Edderton Road would be managed through either: (i) road maintenance along the existing alignment; (ii) or the realignment of the road around the Maxwell Underground area.

Prescribed biodiversity impacts, including measures to avoid and minimise prescribed biodiversity impacts, are described in Section 5.4.

5.2 DIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

Direct impacts on habitat and vegetation are assessed below in relation to the Project.

5.2.1 CLEARANCE OF HABITAT AND VEGETATION

Malabar anticipates that construction and operational activities associated with the Project would commence as soon as practicable after all necessary consents, approvals and licences for the Project have been obtained. The Project would extract coal over a period of approximately 26 years.

After applying the measures to avoid and/or minimise impacts on biodiversity values (Section 5.1), the Project would result in the clearance of approximately 161.6 ha of native vegetation (excluding mine site rehabilitation and planted trees) within the Biodiversity Assessment Development Footprint (Table 24). This quantification of clearance also includes approximately 2 ha to account for potential subsidence ponding impacts consistent with the predicted impacts in the Geomorphology Assessment prepared by Fluvial Systems (2019) (Table 24).

Table 24
Native Vegetation Clearance Summary

PCT	Generic Name	Stage 1	Stage 2	Total Area (ha)
Dry Sclerophyll Forests (Shrub/grass sub-formation)				
1607	1. Red Gum - Ironbark - Apple Shrubby Woodland	0.4	0	0.4
1607	1a. Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	4.9	0	4.9
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	9.5	0.1	9.6
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	122.7 [A]	2.9	125.6
Dry Sclerophyll Forests (Shrubby sub-formation)				
1655	3. Slaty Box Shrubby Woodland[2]	1.2	0	1.2
1655	3a. Slaty Box Shrubby Woodland (DNG)	0	2.4	2.4
Grassy Woodlands				
1692	6. Bull Oak Grassy Woodland	2.8	0	2.8
201	8. Fuzzy Box Woodland	0.5 [B]	0	0.5
201	8a. Fuzzy Box Woodland (DNG)	1 [C]	1.8	2.8
1691	9. Ironbark - Grey Box Grassy Woodland[3]	7.6 [D]	2	9.6
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	0.3 [E]	0	0.3
1604	11. Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland[4]	1.3	0	1.3
Forested Wetlands				
1731	4. Swamp Oak Forest	0	0.2	0.2
Other				
-	Pasture Rehabilitation	49.3	0	49.3
-	Woodland Rehabilitation	15.2	0	15.2
-	Planted Trees	0	0.2	0.2
Total Native Vegetation (excluding Mine Site Rehabilitation and Planted Trees)		152.2	9.4	161.6
Total Mine Site Rehabilitation Vegetation		64.5	0	64.5
Total Planted Vegetation		0	0.2	0.2
Total		**216.7**	**9.6**	**226.3**

[1] Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[2] Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[3] Listed BC Act, E: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[4] Listed BC Act, E: Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[A] <0.1 ha of PCT 1606 DNG is associated with potential subsidence ponding impacts (Figure 3).

[B] Approximately 0.5 ha of PCT 201 is associated with potential subsidence ponding impacts (Figure 3).

[C] Approximately 1 ha of PCT 201 DNG is associated with potential subsidence ponding impacts (Figure 3).

[D] <0.3 ha of PCT 1691 is associated with potential subsidence ponding impacts (Figure 3).

[E] <0.3 ha of PCT 1691 DNG is associated with potential subsidence ponding impacts (Figure 3).

The remainder of the 321 ha Biodiversity Development Assessment Footprint comprises:

- 90.8 ha is infrastructure/cleared land;
- 49.3 ha is pasture rehabilitation associated with the Maxwell Infrastructure;
- 15.2 ha is woodland rehabilitation associated with the Maxwell Infrastructure;
- 3.9 is covered by various mine waterbodies and farm dams; and
- 0.2 ha is planted trees in a vegetation screen at the edge of the Golden Highway.

Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified (Figures 23a and 23b). The final land use of the surface disturbance areas would include areas for agricultural land use and native vegetation, and would be developed in consultation with relevant stakeholders.

5.2.2 CLEARANCE OF THREATENED ECOLOGICAL COMMUNITIES

Table 24 (above) presents the total native vegetation to be cleared for the Project. Table 25 summarises the clearance required in terms of TECs.

Table 25
Threatened Ecological Community Clearance Summary

Threatened Ecological Community	Conservation Status	Associated PCT	Stage 1	Stage 2	Total
Threatened Ecological Communities listed under the BC Act					
White Box Yellow Box Blakely's Red Gum Woodland	E	1606	132.2 ha (comprising 9.5 ha of woodland and 122.7 ha[A] of DNG)	3 ha (comprising 0.1 ha of woodland and 2.9 ha of DNG)	**135.2 ha (comprising 9.6 ha of woodland and 125.6 ha of DNG)**
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	1655	1.2 ha (woodland)	0	**1.2 ha (woodland)**
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E	1604	1.3 ha (woodland)	0	**1.3 ha (woodland)**

Threatened Ecological Community	Conservation Status	Associated PCT	Stage 1	Stage 2	Total
Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	1691	7.6 ha[B] (woodland)	2 ha (woodland)	**9.6 ha (woodland)**
Hunter Valley Weeping Myall Woodland	CE	116	0	0	**0**
Hunter Lowland Redgum Forest in the Sydney Basin Bioregion	E	1598	0	0	**0**
Threatened Ecological Communities listed under the EPBC Act					
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1606	132.2 ha (comprising 9.5 ha of woodland and 122.7 ha of DNG)	3 ha (comprising 0.1 ha of woodland and 2.9 ha of DNG)	**135.2 ha (comprising 9.6 ha of woodland and 125.6 ha of DNG)**
Central Hunter Valley Eucalypt Forest and Woodland	CE	1604,1655, 1691	10.1 ha (woodland)	2 ha (woodland)	**12.1 ha (woodland)**
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE	116	0	0	**0**

[A] <0.1 ha of PCT 1606 DNG is associated with potential subsidence ponding impacts (Figure 3).

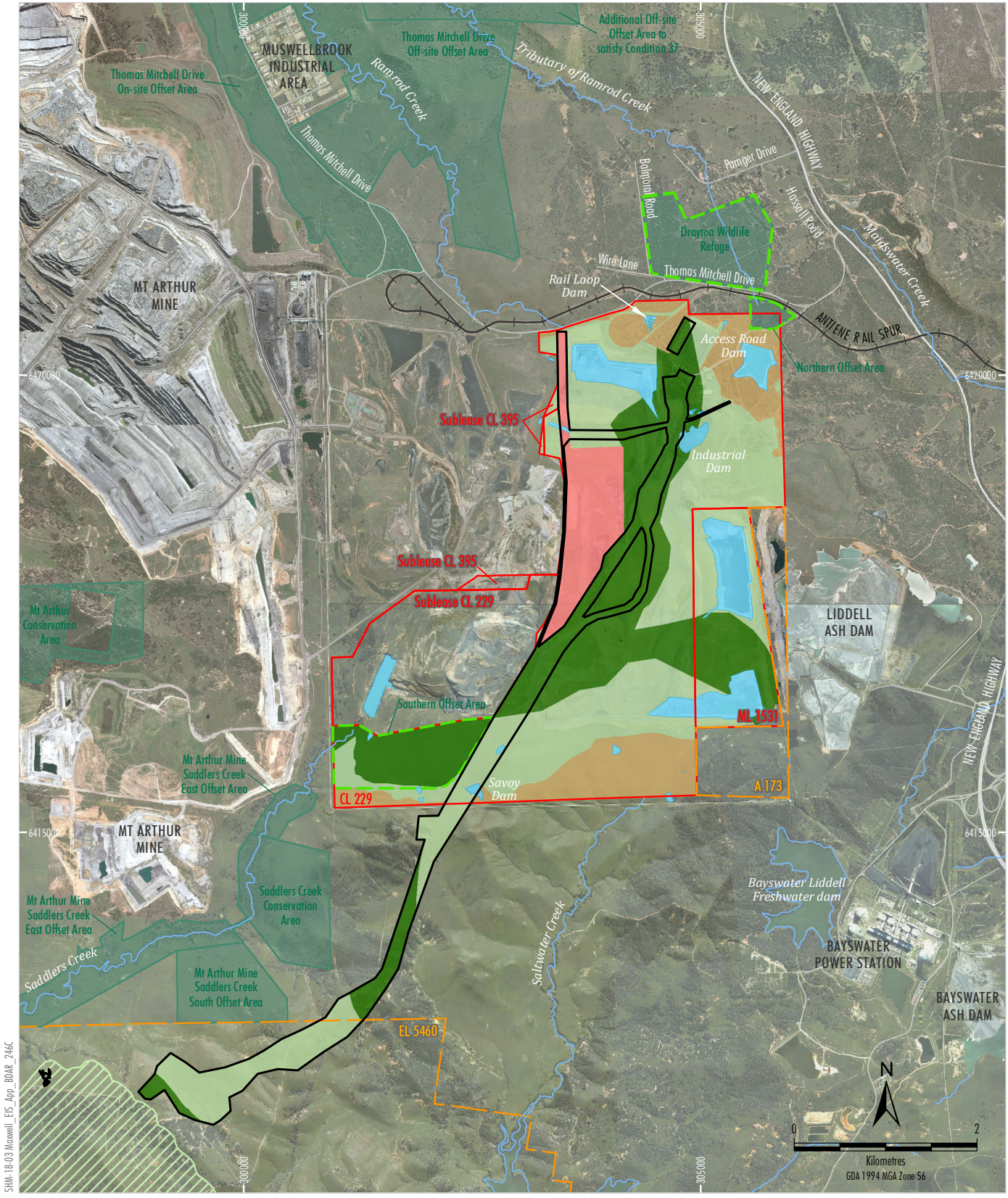
[B] <0.3 ha of PCT 1691 is associated with potential subsidence ponding impacts (Figure 3).

5.2.3 CLEARANCE OF THREATENED SPECIES HABITAT

Tables 11 and 21 provide details of the species credit species habitat to be cleared by the Project and these are summarised in Table 26.

Table 26
Threatened Species Habitat Clearance Summary

Assessment Stage	Species and total habitat cleared (ha)			
	Pink-tailed Legless Lizard	Striped Legless Lizard	Squirrel Glider	Southern Myotis
Stage 1	36	145.4	40.7	0.5
Stage 2	2.7	7.4	2.3	1.4
Total	**38.7**	**152.8**	**43.0**	**1.9**



SHM-18-03 Maxwell_EIS_App_BDAR_246C

LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Biodiversity Assessment Development Footprint
- Existing Conservation/Offset Area

Secondary Domains

- A Biodiversity Offset
- B Water Management
- C Pasture
- D Woodland
- E Buffer Land
- F Remediated Underground Mining Area
- G Maxwell Solar Project Infrastructure

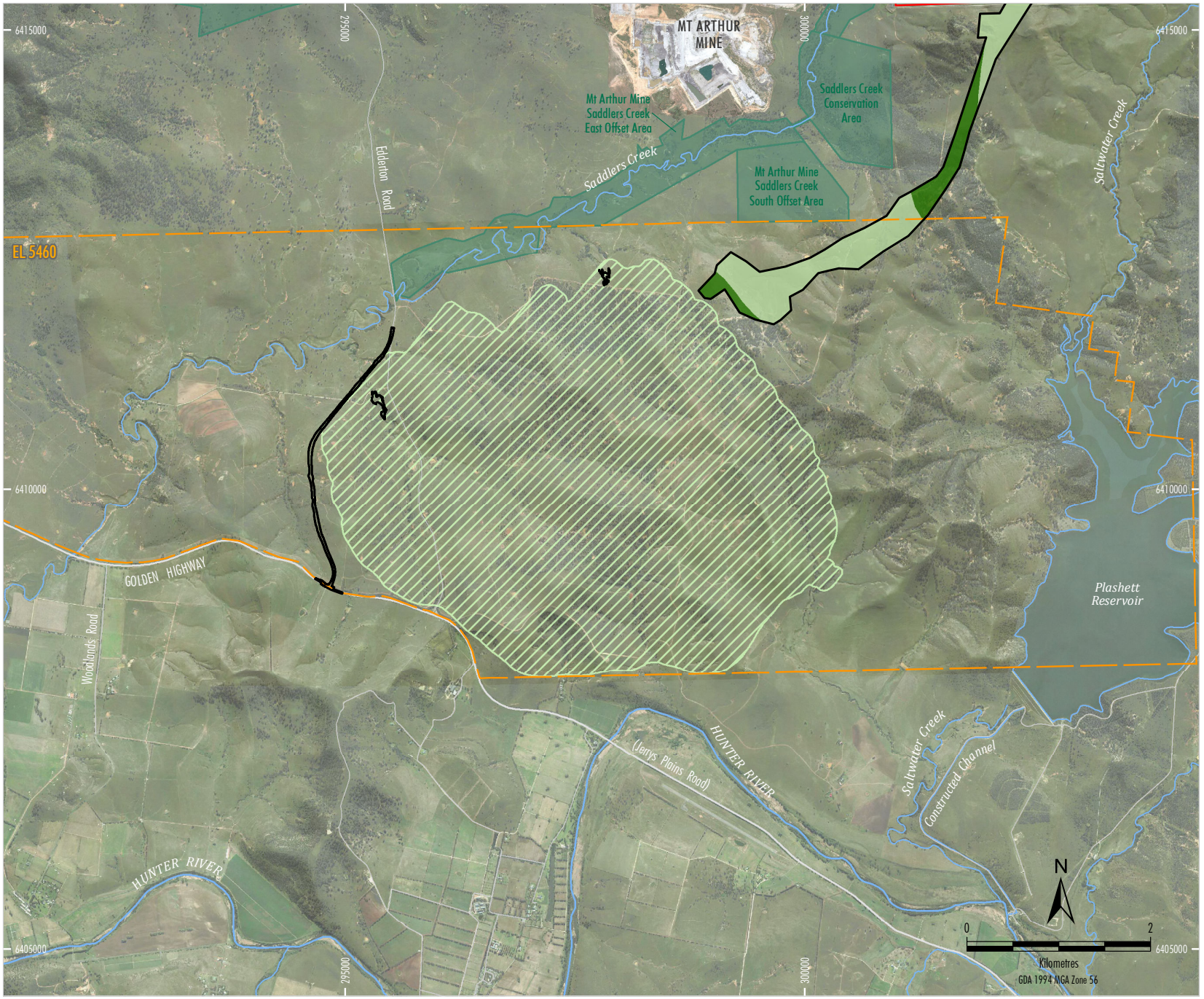
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Rehabilitation Domains - Maxwell Infrastructure

Figure 23a



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Biodiversity Assessment Development Footprint
- Existing Conservation/Offset Area

Secondary Domains

- C Pasture
- D Woodland
- F Remediated Underground Mining Area

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Rehabilitation Domains – Maxwell Underground

Figure 23b

SHM-18-03 Maxwell_EIS_App_BDAR_247C

5.2.4 CUMULATIVE IMPACTS

Cumulative impacts are considered to be the total impact on the environment that would result from the incremental impacts of the Project in addition to past, present and reasonably foreseeable planned developments that may interact with Project impacts. Cumulative impacts include both direct and indirect impacts. The earliest available aerial photographs from 1958 show that the Subject land was almost totally cleared and that there has been a substantial amount of natural regeneration since then (Section 2). Other than the Maxwell Infrastructure area (former Drayton Mine) that has been mined since 1983, the remainder of the Subject land has been mostly cleared (over 75%) and used for agricultural purposes, primarily grazing, for well over 100 years.

The former Drayton Mine commenced operations in 1983. The initial area of land gazetted for the Drayton Mine was approximately 1,300 ha in total (including the portion of CL 229, which Hunter Valley Energy Coal Pty Ltd [a subsidiary of BHP] now holds as a sublease) (Hansen Bailey 2007). Subsequent approvals for the Drayton Mine Extension (extension of open cut mining operations and increased extraction rate of ROM coal) and modifications in 2008 and 2009 resulted in approval for disturbance of approximately 266.5 ha of woodland, rehabilitation and grassland that had not yet been disturbed (Hansen Bailey 2007; Cumberland Ecology 2009a). Approximately 1,454 ha of land was disturbed by the Drayton Mine (including surface disturbance within the BHP sublease area) prior to its closure in 2016. To date, approximately 644 ha of the Maxwell Infrastructure area has been rehabilitated to a combination of woodland and pasture, with rehabilitation activities ongoing.

Existing offsets associated with the former Drayton Mine include the Drayton Wildlife Refuge, which contains approximately 114 ha of Hunter Lowland Redgum Forest (a listed endangered ecological community under the BC Act), and the Northern Offset Area, which comprises approximately 12 ha of Hunter Lowland Redgum Forest in the north-east corner of the Maxwell Infrastructure.

Furthermore, 88 ha of land in the south-east of the Maxwell Infrastructure area (the Southern Offset Area) would be rehabilitated to native vegetation communities, as required under Project Approval 06_0202, including endangered ecological communities and habitat for threatened birds and bats. In the long-term, the Southern Offset Area will augment the Saddlers Creek Catchment and the adjacent Conservation Area established by BHP and will also provide a link to the tree corridor that will be established in the rehabilitated BHP sublease area.

The Project would not result in a change to the nature or intensity of impacts on biodiversity values associated with the approved Maxwell Infrastructure, as areas approved to be cleared have been cleared and all additional clearance is assessed in this BDAR.

As a separate project, and in parallel with this Project, Malabar is planning to submit a development application for a solar farm, known as the "Maxwell Solar Project" (SSD 18_9820). The solar panels would be located within approximately 105 ha of previous open cut mining disturbance at Maxwell Infrastructure, of which 88 ha has been rehabilitated to woodland and pasture (Malabar 2018). There are no other reasonably foreseeable planned developments within the Project area. The management of cumulative biodiversity impacts at a broader scale is through NSW legislation and the EBPC Act.

The surface development for the Project would involve direct disturbance of approximately 25.6 ha of fragmented native woodland/forest and 136 ha of derived native grassland, including areas that would be impacted from ponding within the Maxwell Underground area. The total amount of area to be disturbed for the Project is approximately 161.6 ha, which is less than the total amount of the former Drayton Mine approved disturbance (approximately 1,454 ha in total).

The direct loss of habitat associated with the Project in combination with offset provisions (Section 8) would result in no net loss in biodiversity. This is because the biodiversity offset would be a greater area of land, multiple times the size of the Biodiversity Assessment Development Footprint, which will be conserved and managed to achieve a gain in biodiversity values.

5.3 INDIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

Native vegetation adjacent to the Biodiversity Assessment Development Footprint is shown on Figures 7a and 7b and threatened fauna records adjacent to the Biodiversity Assessment Development Footprint are shown on Figures 11 to 15. Threatened ecological communities listed under the BC Act are shown on Figure 9 and threatened ecological communities listed under the EPBC Act are shown on Figure 10.

Potential indirect impacts on habitat and vegetation listed in the BAM (OEH 2017a) are assessed below in relation to the Project. The BAM Credit Calculator only generates credits for clearing impacts

5.3.1 POTENTIAL SUBSIDENCE IMPACTS

Underground mining activities would result in surface subsidence (Mine Subsidence Engineering Consultants [MSEC] 2019). The extent of predicted conventional subsidence relative to native vegetation is shown on Figure 7a and is based on the predicted 20 millimetres (mm) subsidence contour in MSEC (2019). The native vegetation within the subsidence area is quantified in Table 27, noting that approximately 2 ha to account for potential subsidence ponding impacts is included as 'clearance' in Table 24.

Table 27
Native Vegetation within the Subsidence Area

PCT	Generic Name	Area (ha)
Dry Sclerophyll Forests (Shrub/grass sub-formation)		
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	207.1
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	1,025
Dry Sclerophyll Forests (Shrubby sub-formation)		
1655	3. Slaty Box Shrubby Woodland[2]	103.8
1655	3a. Slaty Box Shrubby Woodland (DNG)	247.3
Grassy Woodlands		
1692	6. Bull Oak Grassy Woodland[3]	35
1693	7. Yellow Box – Apple Grassy Woodland[1]	7.4
201	8. Fuzzy Box Woodland	7.7
201	8a. Fuzzy Box Woodland (DNG)	17.9
1691	9. Ironbark - Grey Box Grassy Woodland[4]	115.8
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	17.3
116	10. Weeping Myall Woodland[5]	0.4
Forested Wetlands		
1731	4. Swamp Oak Forest	<0.1
Other		
N/A	Planted Trees	7.3
	Total Woodland/Forest	**1,784.7**
	Total Planted Vegetation	**7.3**
	Total Subsidence Area	**1,792**

[1] Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[2] Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[3] Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland (only the part derived from PCT 1655).

[4] Listed BC Act, E: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

[5] Listed BC Act, CE: Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Hunter Valley Weeping Myall (*Acacia pendula*) Woodland.

Potential subsidence movements at the surface have been estimated by MSEC (2019) using a method called the Incremental Profile Method. The Incremental Profile Method has been calibrated using monitoring data from elsewhere in the Hunter Coalfield and multi-seam monitoring data from the NSW coalfields (MSEC 2019). The Incremental Profile Method has been found, in most cases, to give reasonable, if not slightly conservative, predictions of the maximum subsidence, tilt and curvature that would occur due to underground mining.

Subsidence movements may result in surface deformations, with cracking in flatter areas expected to be between 25 and 50 mm, with widths greater than 150 mm in some places (MSEC 2019). Surface cracking would be monitored and remediated as required. The Subsidence Assessment prepared by MSEC (2019) describes that surface cracks requiring remediation, are more likely to occur on steeper slopes directly above underground mining areas. Remediation of the larger surface cracks would generally be undertaken using conventional earthmoving equipment (such as backhoe or grader), and would involve ground disturbance associated with:

- in-filling of surface cracks by cultivation of the ground surface or in-filling with suitable soil or other material; and/or
- localised regrading or reshaping to limit the potential for water ponding.

Prior to any remediation of surface cracks, Malabar would undertake a review of environmental impacts that may result from the remediation at the specific location and consider if remediation of surface cracks is environmentally beneficial or if alternative methods of remediating the crack are warranted (e.g. without machinery). The review would consider, among other factors, the known locations of threatened flora species and populations as well as mapped rocky areas that may provide habitat for threatened lizards.

Minor cracks (i.e. less than 50 mm) that develop elsewhere are not expected to require remediation, as geomorphological processes would result in these cracks filling naturally over time.

The exact location of surface cracking and other potential subsidence impacts is unknown, however the nature and extent of potential subsidence impacts of the Project can be reasonably estimated and assessed based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley.

Potential ponding impacts associated with subsidence have also been included as part of the Biodiversity Assessment Development Footprint consistent with the predicted impacts in the Geomorphology Assessment prepared by Fluvial Systems (2019) (Figure 3).

Potential subsidence impacts on unnamed ephemeral and intermittent watercourses would be monitored and managed through a process of adaptive management. Under this process: (i) regular monitoring would detect if and where the threat occurs, (ii) an assessment would be made to determine the potential consequences of the observed threat, and then, (iii) appropriate control works would be put in place.

A subsidence monitoring program and adaptive management approach would be implemented to manage potential subsidence impacts from the Project and would be documented in Extraction Plans. If unpredicted subsidence impacts and/or environmental consequences occur, adaptive management involves the implementation of previously approved processes to consider and implement measures to prevent their re-occurrence. Further information on the Extraction Plan process and adaptive management strategy is provided in Section 5.6.

Overall, subsidence is unlikely to materially impact native vegetation within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting Australia Pty Ltd [SLR Consulting] 2019; Austar Coal Mine Pty Ltd [Austar Coal Mine] 2018; Ashton Coal Operations Pty Limited [Ashton Coal Operations] 2017; FloraSearch 2016).

Agricultural and other land management activities would continue on Malabar-owned properties irrespective of the Project.

Threatened Ecological Communities

Threatened ecological communities within the subsidence area are quantified in Table 28. As described above, subsidence is unlikely to materially impact native vegetation, including these TECs.

Table 28
Threatened Ecological Communities within the Subsidence Area

Threatened Ecological Community	Conservation Status	Subsidence Area (ha)
Listed under the BC Act		
White Box Yellow Box Blakely's Red Gum Woodland	E	1,239.5 ha (comprising of 214.5 ha of woodland and 1,025 ha of DNG)
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	103.8 ha (total comprising of woodland)
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	115.8 ha (total comprising of woodland)
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	CE	0.4 ha (total comprising of woodland)
	Subtotal	**1,459.5**
Listed under the EPBC Act		
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1.239.5 ha (comprising of 214.5 ha of woodland and 1,025 ha of DNG)
Central Hunter Valley Eucalypt Forest and Woodland	CE	231.6 ha[#] (total comprising of woodland)
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE	0.4 ha (total comprising of woodland)
	Subtotal	**1,471.5**

[#] Includes part of PCT 1692 that is listed under the EPBC Act as a TEC (approximately 12.0 ha).

Threatened Flora Species and Populations

Two endangered populations listed under the BC Act were recorded within the predicted subsidence area during the current surveys, *Cymbidium canaliculatum* population in the Hunter Catchment and *Acacia pendula* population in the Hunter Catchment (also listed as a TEC under the BC Act and EPBC Act - *Hunter Valley Weeping Myall (Acacia pendula) Woodland* [Table 28]) (Figure 11). The threatened flora species *Diuris tricolor*, which is also an endangered population in the Muswellbrook LGA, has previously been recorded within the predicted subsidence area.

The one *Cymbidium canaliculatum* reported by Cumberland Ecology (2015) (Figure 11) in the extent of predicted subsidence was inspected by Hunter Eco (2019) (Attachment A) and found to be dead. One other occurrence of the orchid was recorded by Hunter Eco (2019) in the extent of predicted subsidence. This threatened flora population is unlikely to be adversely impacted by the Project.

One *Acacia pendula* group of plants is located in an area modelled as experiencing approximately 4 m of subsidence (MSEC 2019) (Figure 11). This not in an area modelled to experience ponding and it is unlikely that subsidence would affect the viability of these plants. A further assessment on *Hunter Valley Weeping Myall (Acacia pendula) Woodland* is provided in Section 7.2.3.

Malabar would erect a livestock proof fence around a 20 m buffer from the *Hunter Valley Weeping Myall (Acacia pendula) Woodland*/*Acacia pendula* population in the Hunter Catchment. The area would be signed 'Environmental Protection Area'. The Project is likely to have a positive impact on the *Hunter Valley Weeping Myall (Acacia pendula) Woodland*/*Acacia pendula* population in the Hunter Catchment.

The small patch of *Diuris tricolor* reported by Cumberland Ecology (2015) but not subsequently confirmed by Hunter Eco (2019) is located within an area modelled to experience 1 m to 3 m subsidence (MSEC 2019) (Figure 11). This not in an area modelled to experience ponding and it is unlikely that subsidence would affect the viability of these plants.

Malabar would erect a livestock proof fence around a 20 m buffer from the *Diuris tricolor* records. The area would be signed 'Environmental Protection Area'. The Project is likely to have a positive impact on the *Diuris tricolor.*

Prior to any remediation of surface cracks, Malabar would undertake a review of environmental impacts that may result from the remediation at the specific location and consider if remediation of surface cracks is environmentally beneficial or if alternative methods of remediating the crack is warranted (e.g. without machinery). The review would consider, among other factors, the known locations of threatened flora species and populations.

Threatened Fauna Species

The predicted subsidence is unlikely to have any measurable impact on any threatened fauna species. It is possible that individual lizards could fall into subsidence cracks, however, it is unlikely as minor cracks (i.e. less than 50 mm) are likely to fill naturally over time and larger cracks would be remediated.

As described above, prior to any remediation of surface cracks, Malabar would undertake a review of environmental impacts that may result from the remediation at the specific location and consider if remediation of surface cracks is environmentally beneficial or if alternative methods of remediating the crack is warranted (e.g. without machinery). The review would consider, among other factors, mapped rocky areas that may provide habitat for threatened lizards.

5.3.2 INADVERTENT IMPACTS ON ADJACENT HABITAT OR VEGETATION

A vegetation clearance protocol would be adopted (Section 5.6) to minimise the risk of inadvertent impacts on adjacent habitat or native vegetation in the short-term during construction or operation of the Project, e.g. clearance of vegetation outside of approved disturbance limit.

5.3.3 IMPACTS ON ADJACENT HABITAT OR VEGETATION FROM A CHANGE IN LAND-USE PATTERN (INCREASED HUMAN ACTIVITY)

The Project would increase human activity in the locality during construction and operation of the Project in the short to medium term. No adverse impacts are likely to result on habitat and vegetation adjacent to the Biodiversity Assessment Development Footprint specifically due to the increase in human activity. Vehicle strike is assessed in Section 5.4.6.

5.3.4 REDUCED VIABILITY OF ADJACENT HABITAT DUE TO EDGE EFFECTS

Edge effects can occur from a change in physical and/or biological conditions at edges of habitat. No notable edge effects from noise, dust or light spill are likely to result on habitat and vegetation adjacent to the Biodiversity Assessment Development Footprint during construction or operation.

The potential impact of noise, dust or light spill is discussed further below in Section 5.3.5.

5.3.5 REDUCED VIABILITY OF ADJACENT HABITAT DUE TO NOISE, DUST OR LIGHT SPILL

Consideration of construction activities and their potential for noise generation and air quality impacts are provided in the Noise Impact Assessment (Wilkinson Murray 2019) and Air Quality and Greenhouse Gas Assessment (Todoroski Air Sciences 2019).

The Project is unlikely to reduce the viability of any adjacent habitat due to noise, dust or light spill during construction or operation.

From field observations, there is no evidence of dust from currently approved operations having impacted surrounding vegetation. It is unlikely that any flora species would be adversely impacted either directly or indirectly by any dust increase generated as a result of the Project. The site access road would be sealed during the first year of mining operations. Dust suppression would occur along the site access road, prior to it being sealed (Section 3 of the EIS).

Lighting is used at the existing Maxwell Infrastructure and would be used for the Project. Night-lighting of the Project surface facilities would be kept to a practicable minimum. Changes in night-lighting would primarily occur at the mine entry area and along the transport and services corridor (Van Pelt & Allen Visual Planning and Assessment 2019).

5.3.6 TERRESTRIAL GROUNDWATER DEPENDENT ECOSYSTEMS

The Project groundwater assessment (HydroSimulations 2019) shows that the alluvium under Saddlers and Saltwater Creeks receives water from the pressurised underlying coal seam, and that mining of the coal is predicted to result in slow drawdown of the alluvial water. The maximum depth of this drawdown was predicted to be up to 8 m with the majority being 2 m or less.

Groundwater drawdown in the alluvium would develop slowly over time, reaching a maximum 100s of years post-mining. The maximum predicted drawdown in Saddlers Creek would occur at a rate of approximately 1 m every 50 years (HydroSimulations 2019). HydroSimulations (2019) also found that stream baseflow would not be affected by this drawdown in the alluvium. In other words, the groundwater drawdown would not impact surface water flow in either creek.

Vegetation within the extent of predicted alluvial drawdown is shown on Figure 24.

Hunter Eco (2019) found that the riparian vegetation associated with Saddlers and Saltwater Creeks consists primarily of Swamp Oak (Figures 25a to 25d) that is restricted to the stream edge and immediate high bank to a width of between 10 and 30 m. Swamp Oak is a clonal suckering species and forms dense thickets that expand at the edges with suckering new growth. Plant height varies from less than a metre to approximately 10 – 15 m tall. Swamp Oak essentially forms a monoculture in the overstorey along Saddlers Creek which is likely a result of the very high recorded EC values (Section 3.6.4) that Swamp Oak can tolerate (Cramer et al 1999) but Eucalypts cannot.

Baseline groundwater monitoring within the predicted alluvial drawdown areas indicates the current depth to groundwater is approximately 3 m (HydroSimulations 2019). While there are no data on the root depth of Swamp Oak there are root depth data for some of its congeners. Canadell et al (1996) report maximum root depths for *Casuarina pusilla* (2.4 m) and *Casuarina muelleriana* (2 m). Stone and Kalisz (1991) report depths for *Casuarina cristata* (>2.5m) and *Casuarina equisetifolia* (4 m). Both *Casuarina equisetifolia* and *Casuarina cristata* are trees of approximately the same maximum size of Swamp Oak. It is therefore reasonable to assume for this assessment that the maximum root depth for Swamp Oak could be up to 4.5 metres. Cramer et al (1999) reported Swamp Oak in a different environment (in Queensland) accessing groundwater at depths of 1.6 m and 3 m at the two sites studied. Given the current depth to groundwater near Saddlers and Saltwater Creeks is approximately 3 m (HydroSimulations 2019), the larger swamp oak trees could potentially use the groundwater as part of the plant's water use. However, if the Swamp Oak were accessing the deeper water table, they would be more widely dispersed in the landscape away from the creeks.

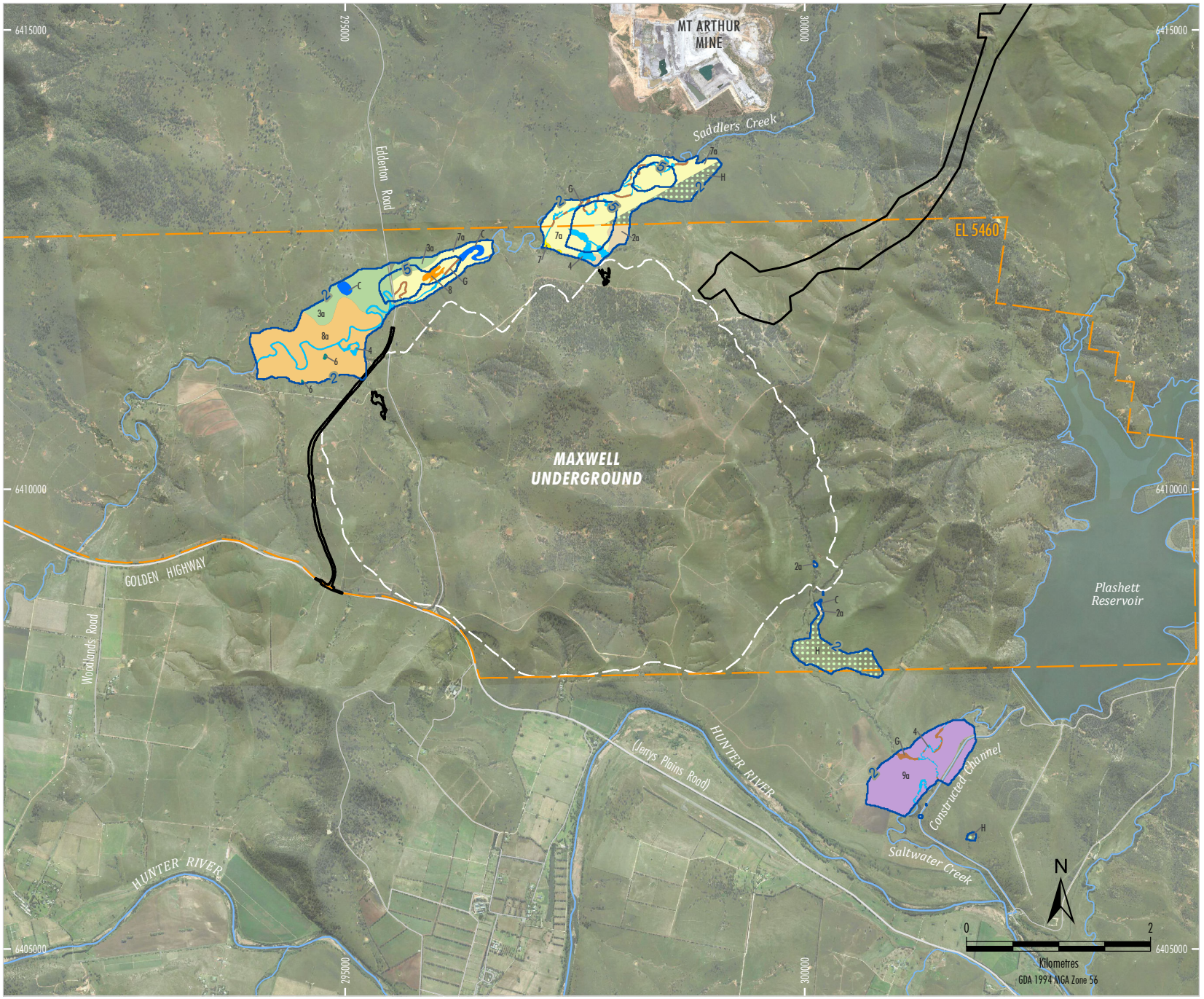
Along the length of both Saddlers and Saltwater Creeks the creek bed is often deeply incised to 3 m below the high bank. Swamp Oak grows from the stream bed level up to the high bank. The restriction of the Swamp Oak to the immediate streamline indicates that the Swamp Oak along Saddlers and Saltwater Creeks are primarily accessing the stream baseflow and seepage in the soil profile rather than the deeper groundwater. Accordingly, the Swamp Oak are considered to be a Type 2 groundwater dependent ecosystem (ecosystems dependent on the surface expression of groundwater) as defined in the *Australian Groundwater-Dependent Ecosystems Toolbox* (Richardson et al. 2011).

As stated above, HydroSimulations (2019) also found that stream baseflow (and surface water flow) would not be affected by the predicted Project groundwater drawdown in the alluvium. Consequently, it is unlikely that the predicted Project groundwater drawdown would adversely impact the Swamp Oak along either Saddlers or Saltwater Creeks.

5.3.7 POTENTIAL IMPACTS ON RIVERS AND STREAMS

Potential subsidence impacts on rivers and streams are assessed by MSEC (2019), WRM (2019) and Eco Logical Australia (2019). MSEC (2019) concludes there would be no adverse subsidence impacts to the surface channels of any named streams, including the Hunter River and Saddlers Creek, given the separation distance between these streams and Maxwell Underground.

WRM (2019) concludes the Project would result in a negligible reduction in flows in Saddlers Creek and the Hunter River.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Predicted Alluvial Drawdown Contour (m)

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3a. Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4. Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 7a. Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693)
- 8. Fuzzy Box Woodland (PCT201)
- 8a. Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9a. Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)

Other

- C Waterbody/Dam
- G Bare Soil
- H Derived Native Grassland - Not Surveyed

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); HydroSimulations (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

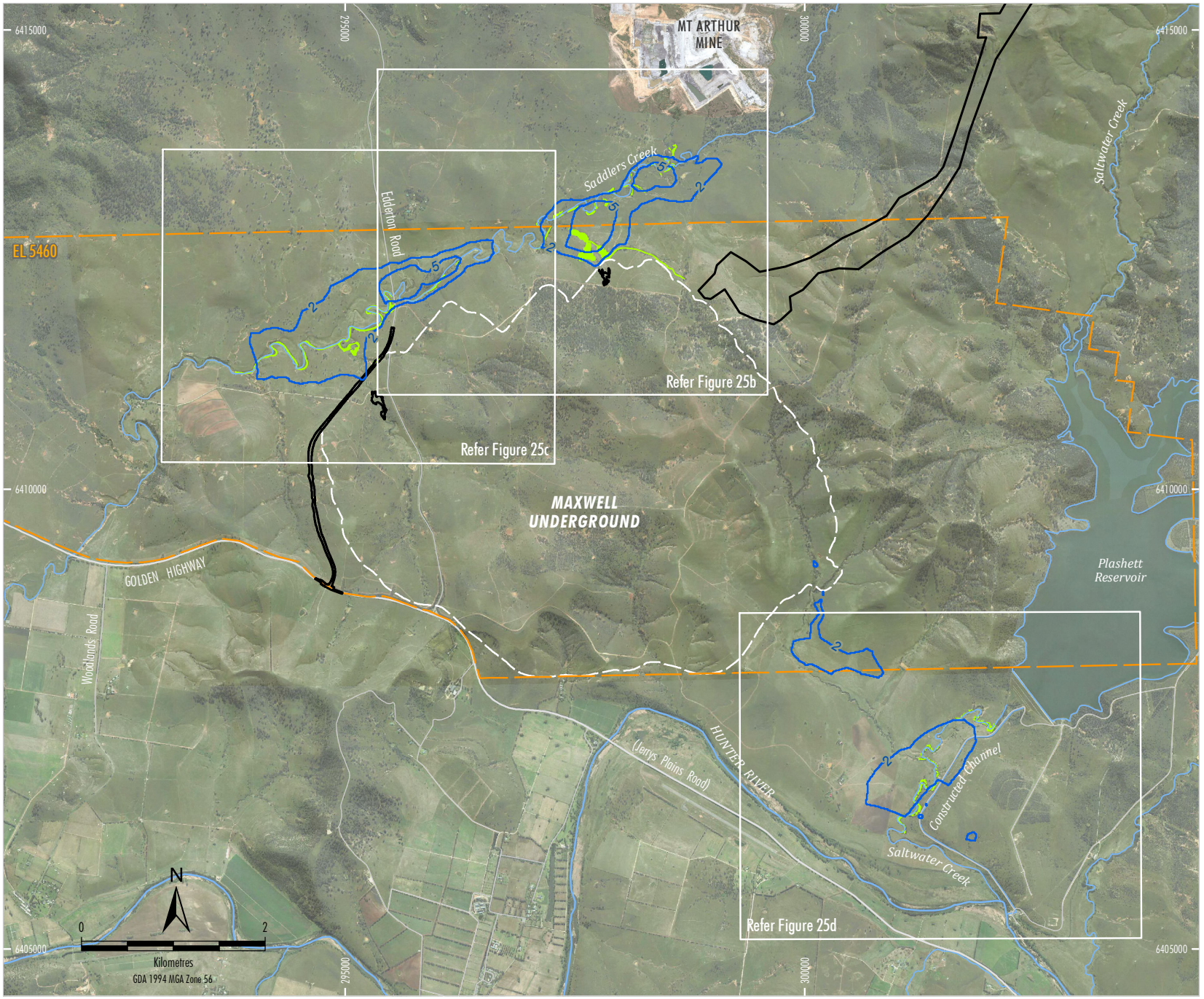
MALABAR COAL

MAXWELL PROJECT

Vegetation Mapping - Extent of Predicted Alluvial Drawdown

Figure 24

SHM-18-03 Maxwell_EIS_App_BDAR_251A



LEGEND

- Maxwell Project Exploration Licence Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Predicted Alluvial Drawdown Contour (m)
- Swamp Oak Forest (PCT 1731)

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Hunter Eco (2019); HydroSimulations (2019); MSEC (2019) Orthophoto Mosaic: 2018, 2016, 2011

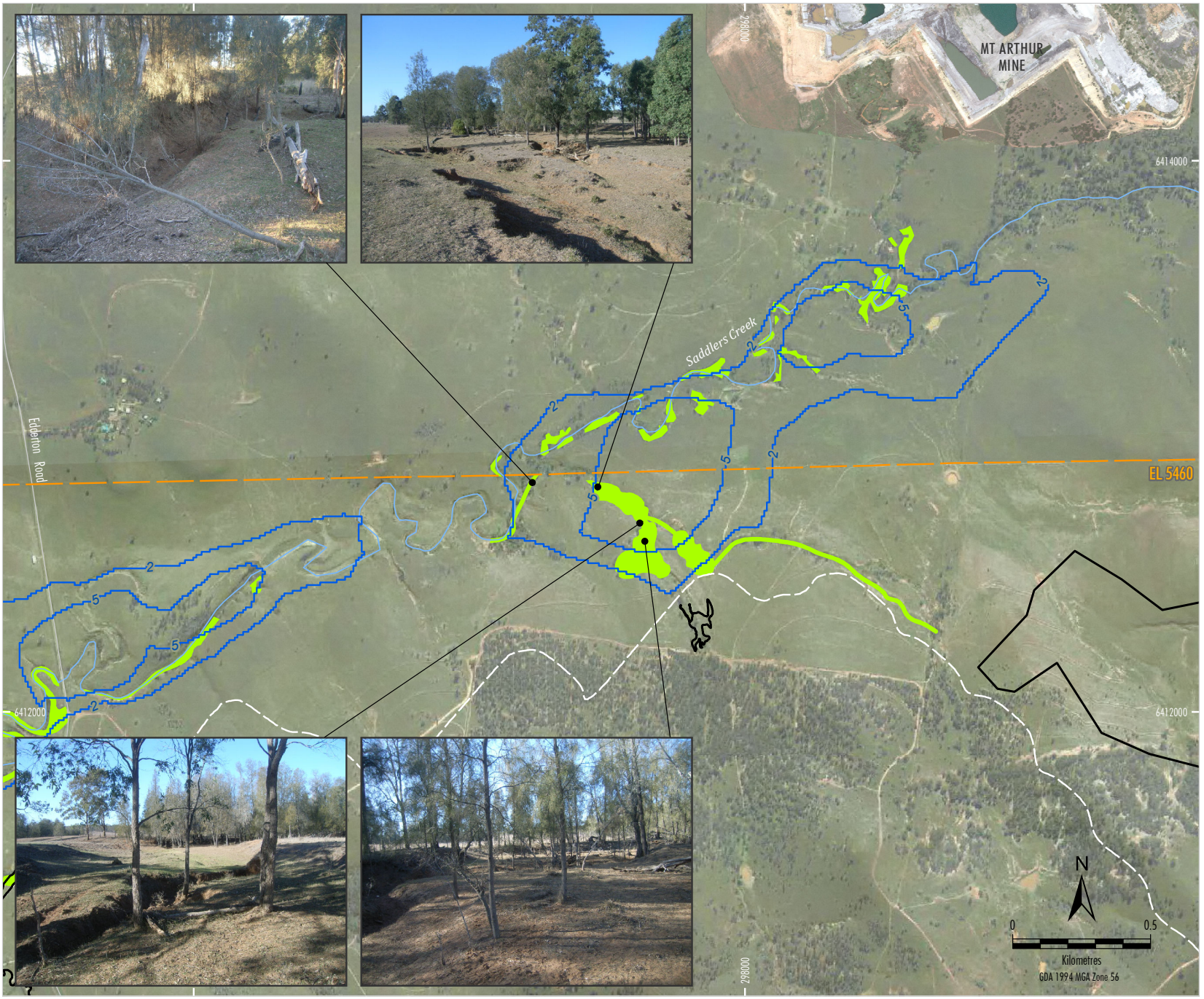
MALABAR COAL

MAXWELL PROJECT

Swamp Oak Forest Identified in the Vicinity of the Project

Figure 25a

SHM-18-03 Maxwell_EIS_App_BDAR_252A



LEGEND

- Maxwell Project Exploration Licence Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Predicted Alluvial Drawdown Contour (m)
- Swamp Oak Forest (PCT 1731)

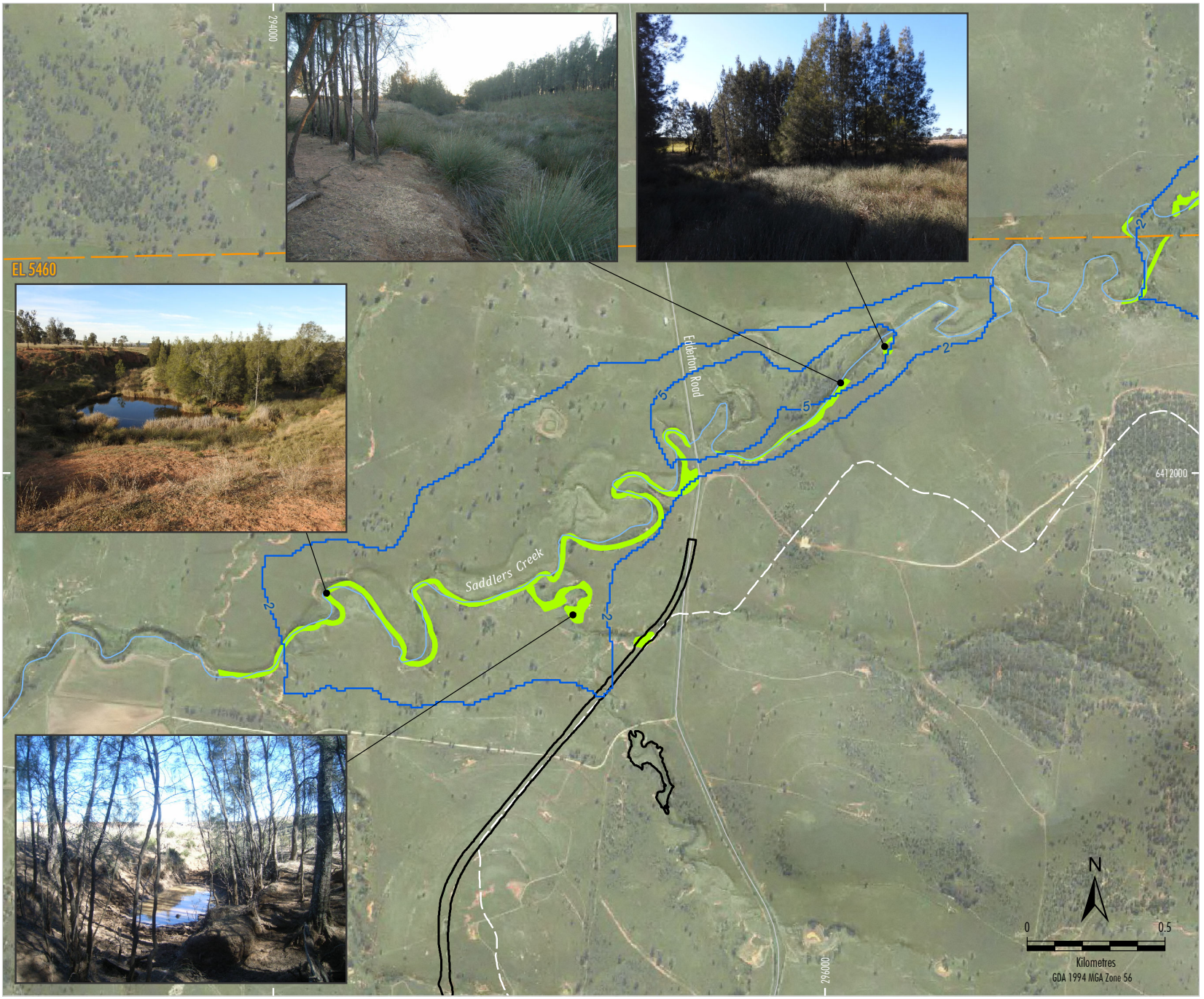
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019); Hunter Eco (2019); Fluvial Systems (2019); HydroSimulations (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Swamp Oak Forest - Saddlers Creek (North)

Figure 25b



LEGEND

- Maxwell Project Exploration Licence Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Predicted Alluvial Drawdown Contour (m)
- Swamp Oak Forest (PCT 1731)

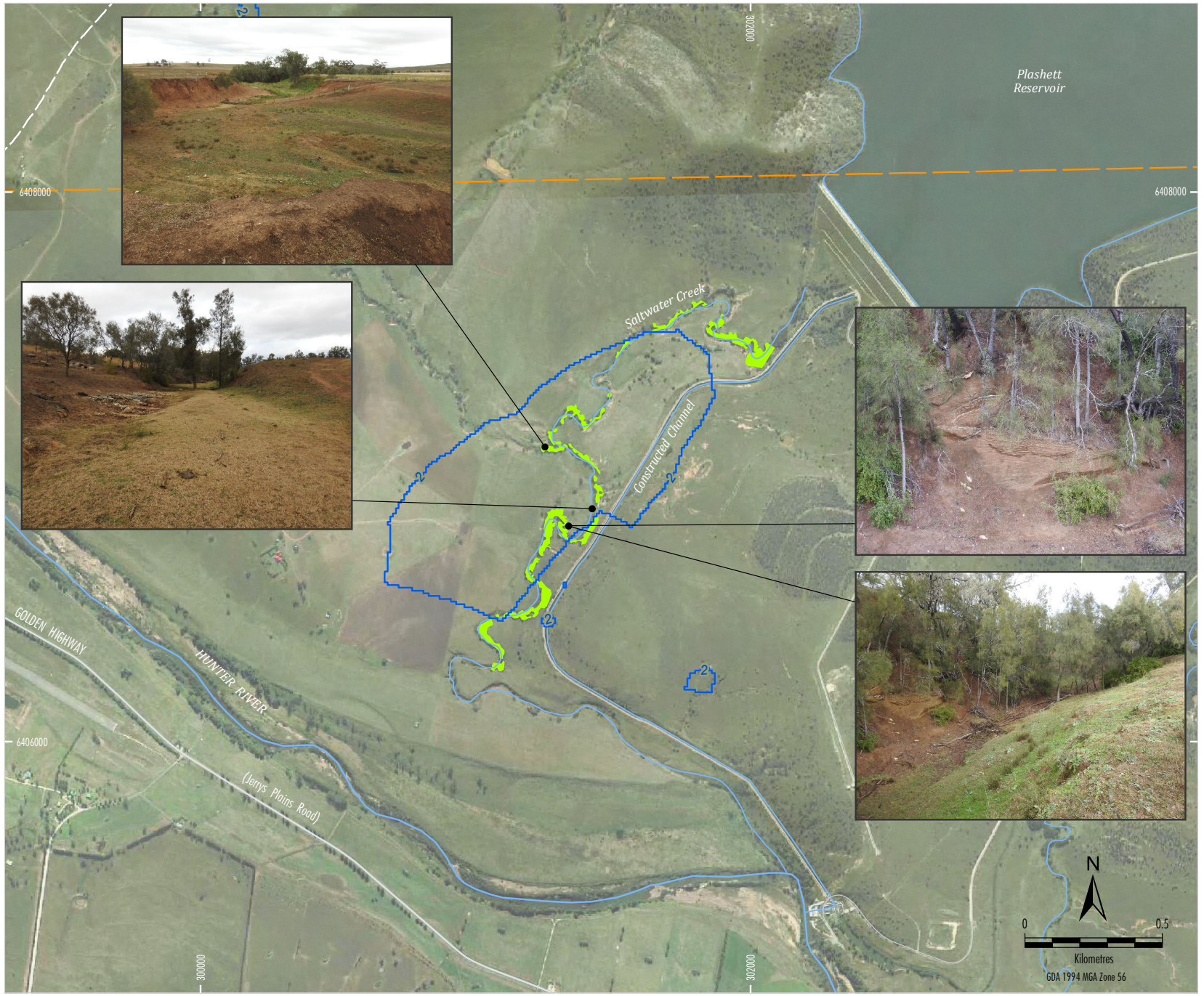
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019); Hunter Eco (2019); Fluvial Systems (2019); HydroSimulations (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Swamp Oak Forest - Saddlers Creek (South)

Figure 25c



LEGEND

- Maxwell Project Exploration Licence Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Predicted Alluvial Drawdown Contour (m)
- Swamp Oak Forest (PCT 1731)

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019); Hunter Eco (2019); Fluvial Systems (2019); HydroSimulations (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Swamp Oak Forest - Saltwater Creek

Figure 25d

SHM-18-03 Maxwell_EIS_App_BDAR_255A

Eco Logical Australia (2019) concludes that the Project is unlikely to have a significant impact on aquatic ecology in the surrounding waterways.

Prescribed biodiversity impacts, including measures to avoid and minimise prescribed biodiversity impacts, are described in Section 5.4.

5.3.8 TRANSPORT OF WEEDS AND PATHOGENS FROM THE SITE TO ADJACENT VEGETATION

Activities that could spread weeds during construction and operation include soil disturbance, vehicle movements and movement of soil. Disturbed areas (including those undergoing rehabilitation) provide a substrate in which weed species may grow.

A total of 85 weed species, including 14 High Threat Exotic species, were recorded in the Subject land (Attachment A). Weeds were relatively evenly distributed across the area which means that it is unlikely that there would be any dispersal of weeds from the Biodiversity Assessment Development Area that were not already present in the surrounds. The potential impacts from the Project to surrounding native vegetation associated with introduced flora is likely to be low. Section 5.6 describes mitigation measures.

Myrtle Rust (*Austropuccinia psidii*) is a fungal pathogen affecting new foliage of Myrtaceous species generally in moist coastal areas. It has not been recorded as far inland as the Project area (OEH 2011). *Phytophthora cinnamomi* is a fungal pathogen affecting the roots of trees or shrubs. There is a low probability of this pathogen occurring or establishing in or near the Project area. It prefers moist areas with rainfall >600 mm per year (DECC 2008). Muswellbrook median rainfall is 606.8 mm (Weatherzone 2019). The nearest record of *Phytophthora cinnamomi* is from the Maitland area (ALA 2019).

Some species are at risk of population decline with the introduction of a disease or exotic pathogen (e.g. *Chlamydia* spp. in Koalas, Beak and Feather Disease in *Psittacine* species, or the White-nosed Fungus in microbat species). The Project would not be likely to increase the risk of disease or exotic pathogen transfer to native fauna species.

5.3.9 INCREASED RISK OF FAUNA STARVATION, EXPOSURE AND LOSS OF SHADE OR SHELTER

In principle, native vegetation loss could result in displacement of resident fauna (leading to increased risk of fauna starvation and exposure). The woodland/forest habitat to be cleared by the Project is a small portion (2.6 %) of the woodland/forest habitat that occurs in the Subject land. Sufficient connectivity would remain around the Biodiversity Assessment Development Footprint such that no threatened species are likely to become isolated as a result of the Project. A vegetation clearance protocol would be adopted, which would include a pre-clearance survey to minimise impacts on displaced fauna during vegetation clearance activities (Section 5.6).

5.3.10 LOSS OF BREEDING HABITATS

Fauna breeding habitat resources adjacent to the Project area include trees with hollows and bush rock. The Project is not likely to directly or indirectly impact fauna breeding habitat resources.

5.3.11 TRAMPLING OF THREATENED FLORA SPECIES

No threatened flora species listed under the BC Act or EPBC Act have been located in areas at risk of trampling during construction or operation of the Project.

5.3.12 INHIBITION OF NITROGEN FIXATION AND INCREASED SOIL SALINITY

The Project would not inhibit nitrogen fixation or increase soil salinity.

5.3.13 FERTILISER DRIFT

The Project would not involve the use of fertiliser, except in small quantities to assist with revegetation works. Agricultural and other land management activities (which may involve use of fertilizer) would continue on Malabar-owned properties irrespective of the Project.

5.3.14 RUBBISH DUMPING

The Project would not involve rubbish dumping. Rubbish generated by the Project would be disposed of appropriately in designated areas.

5.3.15 WOOD COLLECTION

Collection of wood from surrounding native vegetation (for fires or other activities) would not be permitted for the Project. Agricultural and other land management activities would continue on Malabar-owned properties irrespective of the Project.

5.3.16 BUSH ROCK REMOVAL AND DISTURBANCE

Removal or disturbance of bush rock from surrounding native vegetation would not be permitted for the Project. Agricultural and other land management activities would continue on Malabar-owned properties irrespective of the Project.

5.3.17 INCREASE IN PREDATORY SPECIES POPULATIONS

The Project is unlikely to increase predatory species populations (such as Cat and Red Fox).

Agricultural activities would continue to occur both inside and outside the Project area, including control of pest animal populations. Section 5.6 describes mitigation measures.

5.3.18 INCREASE IN PEST ANIMAL POPULATIONS

A total of 12 pest species were identified by Future Ecology (2019) within the Subject land. These are the Common Starling (*Sturnus vulgaris*), Common Myna (*Sturnus tristis*), House Mouse (*Mus musculus*), Dog and Hybrid Dog (*Canis lupus familiaris*), Red Fox (*Vulpes vulpes*), Cat (*Felis catus*), Brown Hare (*Lepus capensis*), Rabbit (*Oryctolagus cuniculus*), Horse (*Equus caballus*), Pig (*Sus scrofa*) and European Cattle (*Bos taurus*).

The Project is unlikely to increase pest animal populations. Agricultural activities would continue to occur outside the Project area, including control of pest animal populations. Section 5.6 describes mitigation measures.

The Project would continue pest management activities (e.g. wild dogs and rabbits).

5.3.19 INCREASED RISK OF FIRE

Project activities are unlikely to increase fire risk. Bushfire risk would continue to be managed in accordance with Malabar's existing Bushfire Management Procedure, which applies to Maxwell Infrastructure and Maxwell Underground.

Bushfire management measures include the maintenance of fire breaks and access tracks, regular inspections of electricity transmission easements, restricted vehicle movements, and the prohibition of smoking in fire prone areas or the lighting of fires or fireworks. Fire-fighting equipment located on-site would continue to be regularly serviced and maintained (Section 5.6).

5.3.20 DISTURBANCE TO SPECIALIST BREEDING AND FORAGING HABITAT

The BAM (OEH 2017a) does not define 'specialist breeding and foraging habitat', although gives the example of 'beach nesting for shorebirds'. No specialist breeding and foraging habitat occurs in the Project area additional to that assessed above in Sections 5.3.1 to 5.3.19.

5.4 PRESCRIBED BIODIVERSITY IMPACTS

The BC Regulation identifies actions that are prescribed as impacts to be assessed under the Biodiversity Offsets Scheme. Prescribed Biodiversity Impacts are as follows:

(a) the impacts of development on the following habitat of threatened species or ecological communities:

(i) karst, caves, crevices, cliffs and other geological features of significance,

(ii) rocks,

(iii) human made structures,

(iv) non-native vegetation,

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range,

(c) the impacts of development on movement of threatened species that maintains their lifecycle,

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development),

(e) the impacts of wind turbine strikes on protected animals,

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community.

These impacts are assessed below in relation to the Project.

5.4.1 IMPACTS ON HABITAT RESOURCES OTHER THAN NATIVE VEGETATION

(a) the impacts of development on the following habitat of threatened species or ecological communities:

(i) karst, caves, crevices, cliffs and other geological features of significance,

As described in Section 2.5, there are no karst, caves, cliffs or other areas of geological significance on, or in the vicinity of, the Subject land. Rock crevices are present at an old quarry and nearby rocky hill to the south of Maxwell Infrastructure, and a small rocky escarpment at the southern end of the proposed Maxwell Underground site (Attachment B) (Figure 5).

No areas with rock crevices occur within the Biodiversity Assessment Development Footprint or predicted subsidence area, therefore the Project would not impact rock crevices.

(a) the impacts of development on the following habitat of threatened species or ecological communities:
(ii) rocks,

The BAM (OEH 2017a) states the following assessment requirements for habitat of threatened species associated with rocks:

> *The assessment of the impacts of development on the habitat of threatened species or ecological communities associated with rocks must:*
>
> *(a) identify the species and ecological communities likely to use the habitat*
>
> *(b) describe, with reference to relevant literature and other reliable published sources of information, the importance of scattered rock for connectivity and refuge*
>
> *(c) predict the nature, extent and duration of short and long-term impacts due to rock removal*
>
> *(d) predict the consequences of the impacts for the local and bioregional persistence of the suite of threatened species and communities likely to use these areas as habitat, with reference to relevant literature and other published sources of information.*

As described in Sections 3.6.2 and 4.6.2, rocky areas providing potential habitat for the Pink-tailed Legless Lizard and known habitat for the Striped Legless Lizard are present in the Project area. The occurrence of rocky areas is associated with *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* as shown on Figure 17.

Bush rocks are important habitat resources for the Pink-tailed Legless Lizard as the species is only known to occur under rocks and rocky areas is a habitat constraint (OEH 2019a, 2019d), rarely under other substrates (Wong et al. 2011). Rocky areas are not a habitat constraint for the Striped Legless Lizard (OEH 2019a), as described in Section 3.3.2.4, this species was recorded under rocks, dumped material and dried cow manure.

The spatial occurrence of the rocky areas is shown on Figure 17. The rocks occur in discrete patches mostly on slopes rather than on ridgetops or drainage flats (Attachment B).

As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Those measures that have specifically avoided clearance of rocky areas are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA, including a reduction in the total proposed MEA disturbance.

The Project would result in the loss of approximately 11.5 ha of rocky areas in the short-term for the proposed transport and services corridor as well as approximately 1 ha for the potential Edderton Road realignment (a total of approximately 12.5 ha[6]). In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated, and include species characteristic of the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* and rocky areas (i.e. placement of salvaged rocks for habitat enhancement). Surface facilities used for the Project would be decommissioned when they are no longer required or at the end of the mine life where no further ongoing beneficial use is identified.

[6] The species polygon for the Pink-tailed Legless Lizard is larger in size as it includes a 50 m buffer (Section 3.3.2.5).

There is a potential that some Pink-tailed Legless Lizard and Striped Legless Lizard individuals could be lost during land clearance for the Project (if they were to occur in the Biodiversity Assessment Development Footprint).

A vegetation clearance protocol would be undertaken to mitigate and manage vegetation clearance impacts as outlined in Section 5.6. In relation to these two lizards, this would involve pre-clearance surveys in rock areas by suitability qualified person and re-location of Pink-tailed Legless Lizard individuals to the nearest rocky area outside of the Biodiversity Assessment Development Footprint.

No indirect impacts are likely to occur on the rocky areas outside of the Biodiversity Assessment Development Footprint due to the Project, apart from surface cracking associated with subsidence. As described in Section 5.3.16, removal or disturbance of rocky areas from surrounding native vegetation would not be permitted for the Project.

The consequential impacts from the Project in the short to medium-term is the loss of 12.5 ha of rocky areas. Both the Pink-tailed Legless Lizard and Striped Legless Lizard are likely to persist in the local area (and bioregion) as greater areas of known habitat occur outside of the Biodiversity Assessment Development Footprint.

The impacts on the Pink-tailed Legless Lizard and Striped Legless Lizard would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits (Section 8.3).

(a) the impacts of development on the following habitat of threatened species or ecological communities:
(iii) human made structures,

There are no human made structures that provide habitat for threatened species that would be adversely impacted by the Project.

(a) the impacts of development on the following habitat of threatened species or ecological communities:
(iv) non-native vegetation,

There are no areas of non-native vegetation that provide habitat for threatened species that would be adversely impacted by the Project.

5.4.2 HABITAT FRAGMENTATION

(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range

The BAM (OEH 2017a) states the following assessment requirements for habitat connectivity:

> *The assessment of the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range must:*
>
> *(a) identify the area/s of connectivity joining different areas of habitat that intersect with the subject land and the areas of habitat that are connected according to Paragraph 4.2.1.3*
>
> *(b) identify the species and ecological communities likely to benefit from the connectivity*
>
> *(c) describe the nature, extent and duration of short and long-term impacts*

(d) describe, with reference to relevant literature and other reliable published sources of information, the importance of the area of connectivity within the bioregion

(e) predict the consequences of the impacts for the bioregional persistence of the suite of threatened species and communities currently benefitting from the connectivity with reference to relevant literature and other published sources of information and taking into consideration mobility, abundance, range and other relevant life history factors.

Habitat connectivity areas are shown on Figure 5 and woodland areas within the assessment buffer areas are shown on Figures 6 and 21. There are no defined woodland corridors in the Subject land, however, it is possible that the woodland areas facilitate the movement of species in the landscape. All threatened species and communities known to occur in the Subject land are likely to benefit from the current level of connectivity, in particular species that are known to use habitat linkages, such as the Squirrel Glider, and species that are unlikely to cross roads (e.g. Striped Legless Lizard [Dorrough et al. 1999]).

The Project would impact the current habitat connectivity through construction and operation of the transport and services corridor between the Maxwell Underground and Maxwell Infrastructure and may through construction and operation of the potential realignment of Edderton Road.

Despite the impact to habitat connectivity, sufficient connectivity would remain around the Biodiversity Assessment Development Footprint (Figure 5) such that no threatened species are likely to become isolated as a result of the Project.

The surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. The conceptual final rehabilitation plan is shown on Figures 23a and 23b. Revegetation would aim to increase the continuity of woodland vegetation by establishing links between woodland vegetation.

5.4.3 FAUNA MOVEMENT

(c) the impacts of development on movement of threatened species that maintains their lifecycle

The BAM (OEH 2017a) states the following assessment requirements for the movement of threatened species that maintains their life cycle:

The assessment of the impacts of the development on movement of threatened species that maintains their life cycle must:

(a) identify movement patterns key to the life cycle of relevant threatened species that intersect with the subject land

(b) describe the nature, extent and duration of short and long-term impacts

(c) describe, with reference to relevant literature and other reliable published sources of information, the importance of the movement of the threatened species to their life cycle

(d) predict the consequences of the impacts for the bioregional persistence of the threatened species, with reference to relevant literature and other published sources of information.

Movement patterns key to the life cycle of a threatened species could include seasonal movements between foraging and breeding habitats. The Project is not likely to impact a well-defined movement pattern for any particular threatened species.

As described in Section 5.4.2, all threatened species and communities known to occur in the Subject land are likely to benefit from the current level of connectivity. However, despite the impact to habitat connectivity, sufficient connectivity would remain around the Biodiversity Assessment Development Footprint (Figure 5) such that no threatened species are likely to become isolated as a result of the Project.

5.4.4 WATER QUALITY, WATER BODIES AND HYDROLOGICAL PROCESSES THAT SUSTAIN THREATENED SPECIES AND THREATENED ECOLOGICAL COMMUNITIES

(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development)

Potential impacts on rivers and streams are described in Section 5.3.7 and potential subsistence impacts are discussed in Section 5.3.1.

The Project would not impact water quality, water bodies or hydrological processes that are known to sustain a threatened species or TEC.

The Project groundwater assessment (HydroSimulations 2019) shows that the alluvium under Saddlers and Saltwater Creeks receives water from the pressurised underlying coal seam, and that mining of the coal is predicted to result in slow drawdown of the alluvial water. The maximum depth of this drawdown was predicted to be up to eight metres with the majority being two metres or less.

Groundwater drawdown in the alluvium would develop slowly over time, reaching a maximum 100s of years post-mining. The maximum predicted drawdown in Saddlers Creek would occur at a rate of approximately 1 m every 50 years (HydroSimulations 2019). HydroSimulations (2019) also found that stream baseflow would not be affected by this drawdown in the alluvium. In other words, the groundwater drawdown would not impact surface water flow in either creek.

As described in Section 5.3.6, it is unlikely that the Project predicted drawdown would adversely impact the Swamp Oak along either Saddlers or Saltwater Creeks.

Project elements have been located and designed to minimise subsidence impacts and to avoid or minimise impacts on water resources through:

- staggering the longwalls between seams so that the chain pillars would not align, so reducing total subsidence at the surface;
- avoiding direct subsidence impacts on the Hunter River, the Hunter River alluvium and Saddlers Creek through design of the mine layout;
- use of water treatment systems that maximise the re-use of water on-site and remove any requirement source water externally for mining operations (e.g. from the Hunter River); and
- development of a site water management system that avoids the need for controlled release of mine-affected water to the Hunter River.

5.4.5 WIND TURBINES

(e) the impacts of wind turbine strikes on protected animals

No wind turbines are planned for the Project.

5.4.6 VEHICLE STRIKE

(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community

The BAM (OEH 2017a) states the following assessment requirements for vehicle strike on threatened species of animals or on animals that are part of a TEC:

> *The assessment of the impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC must:*
>
> *(a) identify the range of threatened animal species or animals that are part of a TEC at risk of vehicle (or other transport mode) strike*
>
> *(b) predict the likelihood of vehicle strike to each relevant species, taking into consideration mobility, abundance, range and other relevant life history factors*
>
> *(c) estimate vehicle strike rates where supporting data or literature is available*
>
> *(d) predict the consequences of the impacts for the local and bioregional persistence of the suite of relevant species, with reference to relevant literature and other published sources of information.*

The transport and services corridor would include a site access road that is located adjacent to the following TECs listed under the BC Act (Figure 9):

- White Box Yellow Box Blakely's Red Gum Woodland;
- Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; and
- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions.

Threatened fauna records adjacent to the Biodiversity Assessment Development Footprint are shown on Figures 11 to 15. There is little likelihood of either of the legless lizards becoming road kill given their preference for covered habitat and low mobility. Given the width of the road it is also unlikely that Squirrel Gliders would attempt to cross by gliding or along the ground. The most likely animals to cross the road would be the numerous kangaroos present on the site.

The site access road would be used for personnel and visitor access and deliveries. The southern (internal) portion of the road from the MEA to Maxwell Infrastructure would also be used for haulage of early ROM coal (while the covered overland conveyor is constructed and commissioned) and material excavated during construction activities.

The potential impacts of vehicle strikes have been minimised for the Project through:

- use of the existing site access to Maxwell Infrastructure from Thomas Mitchell Drive, directing traffic to and from the Project site primarily along Thomas Mitchell Drive and the New England Highway, which are existing high volume traffic routes;
- use of a covered overland conveyor, rather than trucks, to transport longwall ROM coal from the MEA to the existing Maxwell Infrastructure;
- fencing along the length of the site access and transport roads to exclude kangaroos (and cattle) thus reducing the potential for vehicle, personnel or animal damage/loss; and
- imposing speed limits on internal roads.

Vehicle strike of animals along the site access road is possible, however, it is not expected to be of a magnitude that would threaten the local persistence of any species.

5.5 SEPP 44 – KOALA HABITAT PROTECTION

There are two relevant definitions that apply when considering Koala habitat under *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44):

- *'potential koala habitat' means areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component; and*
- *'core koala habitat' means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings and historical records of a population.*

Koala preferred feed tree species listed in SEPP 44 are:

- Grey Gum (*Eucalyptus punctata*);
- Forest Red Gum (*E. tereticornis*);
- Swamp Mahogany (*E. robusta*);
- Tallowwood (*E. microcorys*);
- Ribbon or Manna Gum (*E. viminalis*);
- River Red Gum (*E. camaldulensis*);
- Broad-leaved Scribbly Gum (*E. haemastoma*);
- Scribbly Gum (*E. signata*);
- White Box (*E. albens*); and
- Bimble Box or Poplar Box (*E. populnea*).

Koala Potential Habitat

Hunter Eco (2019) (Attachment A) undertook a survey of potential koala food trees in the Subject land. Of the SEPP 44 preferred feed trees, two occur in the Subject land, namely Forest Red Gum, which is part of PCT 1598 mapped in only a few small locations, and White Box, which is part of PCT 1606. PCT 1598 and PCT 1606 provide 'potential koala habitat' as defined by SEPP 44 because areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The following additional Koala food tree species (recognised by the Department of Planning and Environment 2018) were identified in the Subject land (Hunter Eco 2019) (Attachment A):

- Grey Box (*E. moluccana*) within PCT 1604;
- Yellow Box (*E. melliodora*) within PCT 1693;
- Blakely's Red Gum (*E. blakelyi*) within PCT 1607 and PCT 1606; and
- Fuzzy Box (*E. conica*) within PCT 201.

The *Threatened Biodiversity Data Collection* (OEH 2019a) also recognises PCT 1655 could provide potential habitat. However, the occurrence of PCT 1655 in the Subject land only contains Slaty Box which is not a recognised koala food tree. Potential koala habitat is mapped in Attachment B.

Koala Presence

No 'core koala habitat' occurs in the Subject land. Koala were not detected during the 2018 survey period by Future Ecology (2019) (Attachment B) and it has not been previously recorded within the Subject land during past studies. There are a few additional records of this species outside the Subject land including from:

- disturbed mining land at Mt Arthur Mine about 3 km west of the Subject land (HVEC Personnel pers. comms. 2012 in Hunter Eco 2013);
- disturbed native vegetation about 2.2 km north-east of Subject land dated 2006 and with an accuracy of 10 km (OEH 2019c); and
- disturbed native vegetation / cleared powerline easement about 1.9 km east of Subject land dated 1954 (OEH 2019c).

There are 24 records of this species within the Muswellbrook LGA (OEH 2019c). If this species does occur in the locality it is likely to be in very low numbers and/or only occurs occasionally.

5.6 MEASURES TO MITIGATE AND MANAGE IMPACTS

As described in Section 5.1, where possible the Project has been located and designed to avoid and minimise impacts on biodiversity values, including native vegetation and potentially occurring threatened species.

Table 29 provides measures to mitigate and manage impacts from the Project. Malabar would be responsible for implementing the measures. Table 29 includes:

- the potential impact to which the measure relates;
- the mitigation or management measure;
- the techniques used to implement the measure;
- the timing/frequency of when each measure would be undertaken;
- the potential risk of the measure failing; and
- the likelihood and consequence of residual impacts after the measure is undertaken.

In addition to the measures in Table 29, as described in Section 5.3.1, the following additional measures would be undertaken to conserve threatened flora not likely to be impacted by the Project:

- Malabar would erect a livestock proof fence around a 20 m buffer from the *Hunter Valley Weeping Myall (Acacia pendula) Woodland/Acacia pendula* population in the Hunter Catchment within the Subject land on Malabar-owned land (Figure 11). The area would be signed 'Environmental Protection Area'. The Project is likely to have a positive impact on the *Hunter Valley Weeping Myall (Acacia pendula) Woodland/Acacia pendula* population in the Hunter Catchment by excluding grazing livestock.
- Malabar would erect a livestock proof fence around a 20 m buffer from the *Diuris tricolor* records within the Subject land on Malabar-owned land (Figure 11). The area would be signed 'Environmental Protection Area'. The Project is likely to have a positive impact on the *Diuris tricolor* by excluding grazing livestock.

Further, the EIS provides a number of other measures to mitigation and manage potential impacts from the Project, such as measures to manage erosion and sediment, dust, noise, lighting and groundwater.

Extraction Plan

Prior to causing any subsidence, the Project would be required to prepare and submit an Extraction Plan for approval by the Department of Planning and Environment. This is an approval required by standard conditions of development consents for underground coal mines in NSW. Extraction Plans are prepared for a series of panels that are a subset of the approved mine layout. There is a process to review the adequacy and effectiveness of an Extraction Plan during the preparation of a new Extraction Plan for subsequent panels.

The BAM (2017a) states an adaptive management plan for impacts related to subsidence and upsidence resulting from underground mining should include details of:

- *measures to secure offsets proposed to fulfil the maximum predicted offset liability, in accordance with the Upland Swamp Policy*
- *a strategy for monitoring changes to groundwater and secondary environmental consequences in accordance with the Upland Swamp Policy*
- *a strategy for delivery of offsets commensurate with monitoring results in accordance with the Upland Swamp Policy*
- *any other measures proposed to mitigate potential impacts.*

The Upland Swamp Policy is not relevant to the Project.

Table 29
Measures to Mitigate and Manage Impacts

Potential Impact	Mitigation/Management Measure	Techniques	Timing/Frequency	Potential Risk of Failure	Likelihood and Consequence of Residual Impacts
Displacement of Fauna	Presence of a Trained Ecological or Licensed Wildlife Handler	Capture and release.	During native vegetation clearance and clearance of rocky areas.	Low.	Low risk of a smaller portion of resident fauna becoming displaced.
Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	During native vegetation clearance and clearance of rocky areas.	Low.	Low risk of a smaller portion of resident fauna becoming displaced or injured.
		Pre-clearance fauna surveys by suitably qualified personnel.	During native vegetation clearance and clearance of rocky areas.	Low.	
		Impacts on fauna are managed during clearing activities by suitably qualified personnel.	During native vegetation clearance and clearance of rocky areas.	Low.	
		Review of environmental impacts that may result from subsidence remediation (threatened flora species and populations, rocky areas that may provide habitat for threatened lizards) and consideration of whether alternative methods of remediation are warranted (e.g. without machinery).	Prior to any remediation of surface cracks.	Low.	Low.

Potential Impact	Mitigation/Management Measure	Techniques	Timing/Frequency	Potential Risk of Failure	Likelihood and Consequence of Residual Impacts
Clearance Impacts on Native Vegetation and Habitat (continued)	Vegetation Clearance Protocol (continued)	Restricting vegetation clearance to the slashing of vegetation where possible along power line easements (i.e. leaving the lower stem and roots in-situ to maximise the potential for natural regrowth).	During vegetation clearance.	Low.	Vegetation clearance is quantified in Table 24 (no reduction has been applied accounting for these measures).
		Lopping of branches, rather than the removal of trees where possible along power line easements.	During vegetation clearance.	Low.	
	Mine Site Rehabilitation and Revegetation	Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated.	Over the life of the Project. Surface facilities used for the Project would be decommissioned when they are no longer required or at the end of the mine life where no further ongoing beneficial use is identified.	Low.	None.
	Salvage and Re-Use of Material for Habitat Enhancement within the Mine Site Rehabilitation	Identification of habitat features (e.g. cleared trees, surface rocks) that would be beneficial for habitat enhancement.	During and after vegetation clearance.	Moderate.	Low.
	Site Induction	Where possible, encourage Malabar personnel to use existing tracks for site access to Project areas to minimise potential disturbance of soils and revegetated areas.	During construction and operational stages.	Low.	Low.
	Access	Use of defined tracks to access sites to minimise the disturbance of soils.	During construction and operational stages.	Low.	Low.

Potential Impact	Mitigation/Management Measure	Techniques	Timing/Frequency	Potential Risk of Failure	Likelihood and Consequence of Residual Impacts
Subsidence Impacts on Native Vegetation and Habitat	Remediation of Surface Cracks	Remediation of mine subsidence effects (e.g. surface cracking and minor erosion).	As required, where impacts are identified as part of the subsidence monitoring program.	Low.	Low.
Indirect Impacts on Native Vegetation and Habitat	Feral Animal Management	Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna.	During construction and operational stages.	Low.	Low.
	Weed Management	Where they have been off road, washdown of vehicles and mechanical equipment to minimise seed transport off the site.	During construction and operational stages.	Moderate.	Low.
		Identification of weeds requiring control.	Regular site inspections.	Moderate.	
		Mechanical removal of identified weeds and/or the application of approved herbicides.	During construction and operational stages.	Moderate.	
		Follow-up site inspections to determine the effectiveness of the eradication programs.	During construction and operational stages.	Moderate.	
	Bushfire Management	According to the Bushfire Management Procedure.	During construction and operational stages.	Low.	Low.
Vehicle Strike	Fencing	Fencing along the length of the site access road to exclude kangaroos (and cattle).	Installation during construction of the site access road.	Low.	Low.
	Speed Limits	Imposing a maximum 60 km per hour speed limit on internal roads and maximum 80 km per hour speed limit on the sealed site access road.	During the construction and operational stages.	Moderate.	Low.

The Extraction Plans would include performance measures for natural and built features, including watercourses, threatened ecological communities and threatened species. Malabar would implement an adaptive management approach to ensure the performance measures are achieved for the Project. Adaptive management would involve the monitoring and periodic evaluation of the environmental consequences against the performance measures, and adjustment (if necessary) of the management and control measures to achieve the adopted performance measures.

Extraction Plans prepared for the Project would include:

- a summary of relevant background or baseline data;
- a review of predictions of the potential subsidence effects, subsidence impacts and environmental consequences, incorporating any relevant information obtained since the EIS (such as monitoring results obtained during mining);
- a monitoring program to provide data to assist with the management of the risks associated with subsidence, validate subsidence predictions and analyse the relationship between subsidence effects and impacts and any ensuing environmental consequences;
- a plan to manage and remediate subsidence impacts and/or environmental consequences (e.g. remediation of observed cracking);
- trigger action response plans to identify risks and outline specific follow up actions to avoid exceedances of agreed performance measures;
- contingency plans that provide for adaptive management where monitoring indicates that there has been an exceedance of agreed performance measures; and
- reporting and review mechanisms.

Extraction Plans would include the following key component plans:

- Water Management Plan;
- Land Management Plan;
- Biodiversity Management Plan;
- Heritage Management Plan;
- Built Features Management Plan;
- Public Safety Management Plan; and
- Subsidence Monitoring Program.

6 IMPACT SUMMARY NSW ASSESSMENT

6.1 SERIOUS AND IRREVERSIBLE IMPACTS

6.1.1 INTRODUCTION

Under the BC Act, a determination of whether an impact is serious and irreversible must be made for 'potential SAII entities' identified in the BAM Credit Calculator. There is one 'potential SAII entity' relevant to the Project, namely the White Box Yellow Box Blakely's Red Gum Woodland/*White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Threatened Ecological Community* (collectively described in this section as Box-Gum TEC) (Figure 26).

6.1.2 White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Threatened Ecological Community

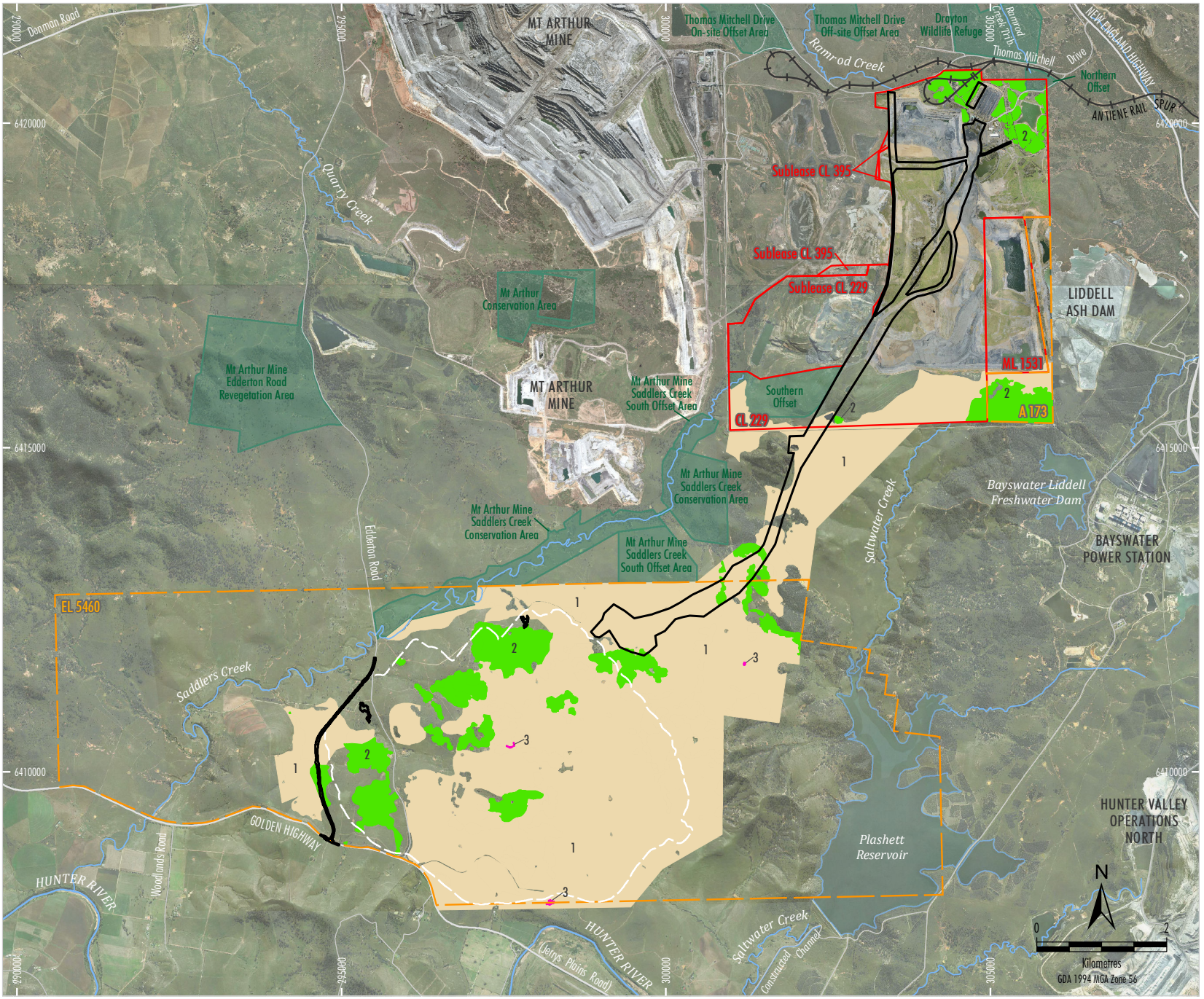
The Box-Gum TEC, represented by PCT 1606 in both woodland and DNG forms, is a SAII entity according to the BAM Credit Calculator. The amount of unavoidable loss of Box-Gum TEC from both development stages is provided in Table 30 showing total loss of 135.2 ha (comprising 92.9 % derived grassland).

Table 30
Unavoidable Loss of Box-Gum Woodland and Derived Native Grassland

Biodiversity Assessment Development Footprint	Clearance Area (ha) (Tables 2 and 15)			VI Scores (Tables 4 and 16)	
	PCT 1606 Woodland	PCT 1606 DNG	Total	PCT 1606 Woodland	PCT 1606 DNG
Stage 1	9.5	122.7	**132.2**	45.4	15.8
Stage 2	0.1	2.9	**3.0**	46.6	31.0
Totals	**9.6 (7.1%)**	**125.6 (92.9%)**	**135.2**	-	-

The BAM (OEH 2017a) requires the following information to be provided:

> *The assessor is required to provide the following further information in the BDAR or BCAR about potential ecological communities:*
>
> *(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII*
>
> *(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone*
>
> *(c) a description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact*
>
> *(d) the extent and overall condition of the potential TEC within an area of 1000ha, and then 10,000ha, surrounding the proposed development footprint*
>
> *(e) an estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the proposed development has been taken into consideration*
>
> *(f) an estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion*



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Existing Conservation/Offset Area

Threatened Ecological Communities

- 1 White Box - Yellow Box - Blakely's Red Gum Woodland
- 2 Central Hunter Valley Eucalypt Forest and Woodland
- 3 Weeping Myall *(Acacia pendula)* Woodland/ Hunter Valley Weeping Myall Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Serious and Irreversible Impact Entities

Figure 26

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(g) the development, clearing or biodiversity certification proposal's impact on:

(i) abiotic factors critical to the long-term survival of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns

(ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants

(iii) the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC

(h) direct or indirect fragmentation and isolation of an important area of the potential TEC

(i) the measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.

These are addressed below.

(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII

The following measures (outlined in Section 5.1) avoid the direct and indirect impact Box-Gum TEC:

- the use of the substantial existing Maxwell Infrastructure (including the CHPP and rail loop), limiting the requirement to develop new infrastructure;
- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- locating the MEA predominately within an area of DNG rather than woodland (i.e. an area with a lower vegetation integrity score); and
- reducing the disturbance footprint required for the MEA.

Measures to mitigate and manage impacts are described in Section 5.6.

(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone

The area and condition of the TEC is provided in Table 30.

(c) a description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact

OEH has not set any thresholds for impacts on potential SAII entities (OEH 2019b).

(d) the extent and overall condition of the potential TEC within an area of 1000ha, and then 10,000ha, surrounding the proposed development footprint

Examination of the regional vegetation mapping of Peake (2006) and Sivertsen et al. (2011) showed no communities meeting the description of Box-Gum TEC woodland and DNG within the Project area. Table 31 provides the amounts of Box-Gum Woodland mapped by local vegetation mapping projects.

Table 31
Amounts of Box-Gum Woodland Mapped within two Assessment Areas

Assessment Area	Vegetation Form	Source	Area (ha)
1,000 ha	DNG	Cumberland Ecology (2009b)	184
1,000 ha	DNG	Hunter Eco (2019)	327
		Total	**511**
10,000 ha	DNG	Cumberland Ecology (2009b)	1,298
10,000 ha	DNG	Hunter Eco (2013)	10
10,000 ha	DNG	Hunter Eco (2019)	1,513
		Total	**2,821**
1,000 ha	Woodland	Hunter Eco (2019)	54
		Total	**54**
10,000 ha	Woodland	Cumberland Ecology (2009b)	50
10,000 ha	Woodland	Hunter Eco (2013)	21
10,000 ha	Woodland	Hunter Eco (2019)	252
		Total	**323**

(e) an estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the proposed development has been taken into consideration

This information was obtained from Sivertsen et al. (2011) as this was a regional project, although incomplete in some areas. This mapping was completed prior to the development of PCTs so used a bespoke map unit coding system. All map units containing White Box, Blakely's Red Gum or Yellow Box were selected as likely representative of Box-Gum TEC. Table 32 shows the areas of vegetation likely representative of Box-Gum TEC mapped by Sivertsen et al. (2011) for the IBRA Sydney Basin Bioregion, Hunter sub-region. Table 30 shows 135.2 ha of vegetation likely representative Box-Gum TEC would be lost due to the Project which is 2% of the 6,561 ha mapped for the sub-region (noting that Sivertsen et al. [2011] did not map the Box-Gum TEC within the Project area).

Table 32
Box-Gum Woodland Communities Mapped for the Sydney Basin bioregion, Hunter Sub-region

Map Unit	Community Name	Area (ha)
MU088	White Box/ Narrow-leaved Ironbark/ Blakely's Red Gum shrubby open forest of the central and upper Hunter	4,942
MU089	Blakely's Red Gum/ Narrow-leaved Ironbark/ Rough-barked Apple shrubby woodland of the upper Hunter	922
MU091	White Box/ White Cypress Pine/ Native Olive woodland of upper Hunter and northern Wollemi	-
MU092	White Box/ Black Cypress Pine shrubby woodland of the Western Slopes	-
MU175	Yellow Box/ Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	593
MU176	White Box grassy woodland on basalt soils of the upper Hunter and Liverpool Plains	102
MU178	Blakely's Red Gum/ Rough-barked Apple shrubby woodland of central and upper Hunter	2
	Total	**6,561**

(f) an estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion

Table 33 lists the map units and total areas for the Sydney Basin Bioregion and Hunter sub-region limited to communities in the reserve system.

Table 33
Amounts of Box-Gum Woodland Mapped within the NSW Reserve System

Map Unit	Community	Reserve	Area (ha)	
			Sydney Basin	Hunter sub-region
MU088	White Box/ Narrow-leaved Ironbark/ Blakely's Red Gum shrubby open forest of the central and upper Hunter	Burning Mountain Nature Reserve	0.9	0.9
		Cameron's Gorge Nature Reserve	0.3	0.3
		Towarri National Park	2.9	2.9
MU089	Blakely's Red Gum/ Narrow-leaved Ironbark/ Rough-barked Apple shrubby woodland of the upper Hunter	Goulburn River National Park	1,056.7	
		Towarri National Park	25.5	25.5
		Wingen Maid Nature Reserve	154.8	154.8
		Wollemi National Park	353.1	19.3
MU091	White Box/ White Cypress Pine/ Native Olive woodland of upper Hunter and northern Wollemi	Goulburn River National Park	177.1	-
		Wollemi National Park	240.2	-
		Yengo National Park	77.5	-
MU092	White Box/ Black Cypress Pine shrubby woodland of the Western Slopes	Goulburn River National Park	35.5	-
		Munghorn Gap Nature Reserve	173.8	-
MU175	Yellow Box/ Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Burning Mountain Nature Reserve	0.9	0.9
		Goulburn River National Park	238.3	-
		Munghorn Gap Nature Reserve	1.2	-
		Towarri National Park	5.9	5.9
		Wollemi National Park	10.7	-
MU176	White Box grassy woodland on basalt soils of the upper Hunter and Liverpool Plains	Goulburn River National Park	13.8	-
		Wollemi National Park	4.2	-
MU178	Blakely's Red Gum/ Rough-barked Apple shrubby woodland of central and upper Hunter	Durridgere CCAZ3 State Conservation Area	34.4	-
		Goulburn River National Park	90.9	-
		Totals	**2,698.6**	**210.5**

(g) the development, clearing or biodiversity certification proposal's impact on:

(i) abiotic factors critical to the long-term survival of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns

(ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants

(iii) the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC

Clearing of Box-Gum TEC by the Project would be fundamentally surficial leading to no impact on any deep groundwater resources or surface flow patterns, with the latter being managed through the Water Management Plan.

The condition of the remaining Box-Gum TEC outside of the Biodiversity Assessment Development Footprint would be at least retained as it is currently. There would be no intrusion by firewood collectors or bush rock collectors for example. Invasion by weed species along the edges of the cleared areas would be managed through the Biodiversity Management Plan which would also provide controls for the use of herbicides and fertilisers.

(h) direct or indirect fragmentation and isolation of an important area of the potential TEC

Over 90% of the Box-Gum TEC to be cleared is the DNG form which for the larger Stage 1 (122.7 ha) had a low VI score of 15.8 (Table 4) and for Stage 2 (2.9 ha) a VI score of 31 (Table 16). While there would be some further fragmentation of Box-Gum TEC as a result of the Project, there would be no direct or indirect isolation of important areas of Box-Gum TEC as it would remain connected around the Biodiversity Assessment Development Footprint (Figures 9 and 10).

(i) the measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.

Adherence to the NSW Biodiversity Offset Scheme would result in the retirement of the required number and class of like-for-like biodiversity credits for the Box-Gum TEC (Section 8.3).

6.1.3 Impact Assessment

Section 6.7 (2) of the BC Regulation provides principles for the purposes of determining whether an impact on diversity values is a serious and irreversible impact for the purposes of the Biodiversity Offsets Scheme. It states:

(2) An impact is to be regarded as serious and irreversible if it is likely to contribute significantly to the risk of a threatened species or ecological community becoming extinct because:

(a) it will cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline, or

(b) it will further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size, or

(c) it is an impact on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution, or

(d) the impacted species or ecological community is unlikely to respond to measures to improve its habitat and vegetation integrity and therefore its members are not replaceable.

(3) For the purpose of this clause, a decline of a species or ecological community is a continuing or projected decline in:

(a) an index of abundance appropriate to the taxon, or

(b) the geographic distribution and habitat quality of the species or ecological community.

These are addressed below in consideration of the OEH (2017b) *Draft Guidance and Criteria To Assist A Decision Maker To Determine A Serious And Irreversible Impact*.

Will the Project cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline?

Adherence to the NSW Biodiversity Offset Scheme would result in the retirement of the required number and class of like-for-like biodiversity credits for the Box-Gum TEC (Section 8.3).

Will the Project further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size?

As shown in Table 32, Box-Gum TEC does not have a very small population size with approximately 6,561 ha being mapped within the Hunter sub-region, as well as being State-wide.

Will the Project impact on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution?

Box-Gum TEC is found across NSW so does not have a limited geographic distribution.

Is the community unlikely to respond to measures to improve its habitat and vegetation integrity and therefore its members are not replaceable?

The amount of unavoidable loss of Box-Gum TEC from both development stages is provided in Table 30 showing total loss of 135.2 ha (comprising 92.9 % of DNG form).

The occurrence of Box-Gum TEC in the Project area is comprised of flora species that readily seed and germinate under suitable conditions. The Box-Gum TEC has been shown to respond well to both natural regeneration where threats such as grazing and fire are managed, and to assisted natural regeneration with supplementary planting of appropriate species (NSW National Parks and Wildlife Service 2002).

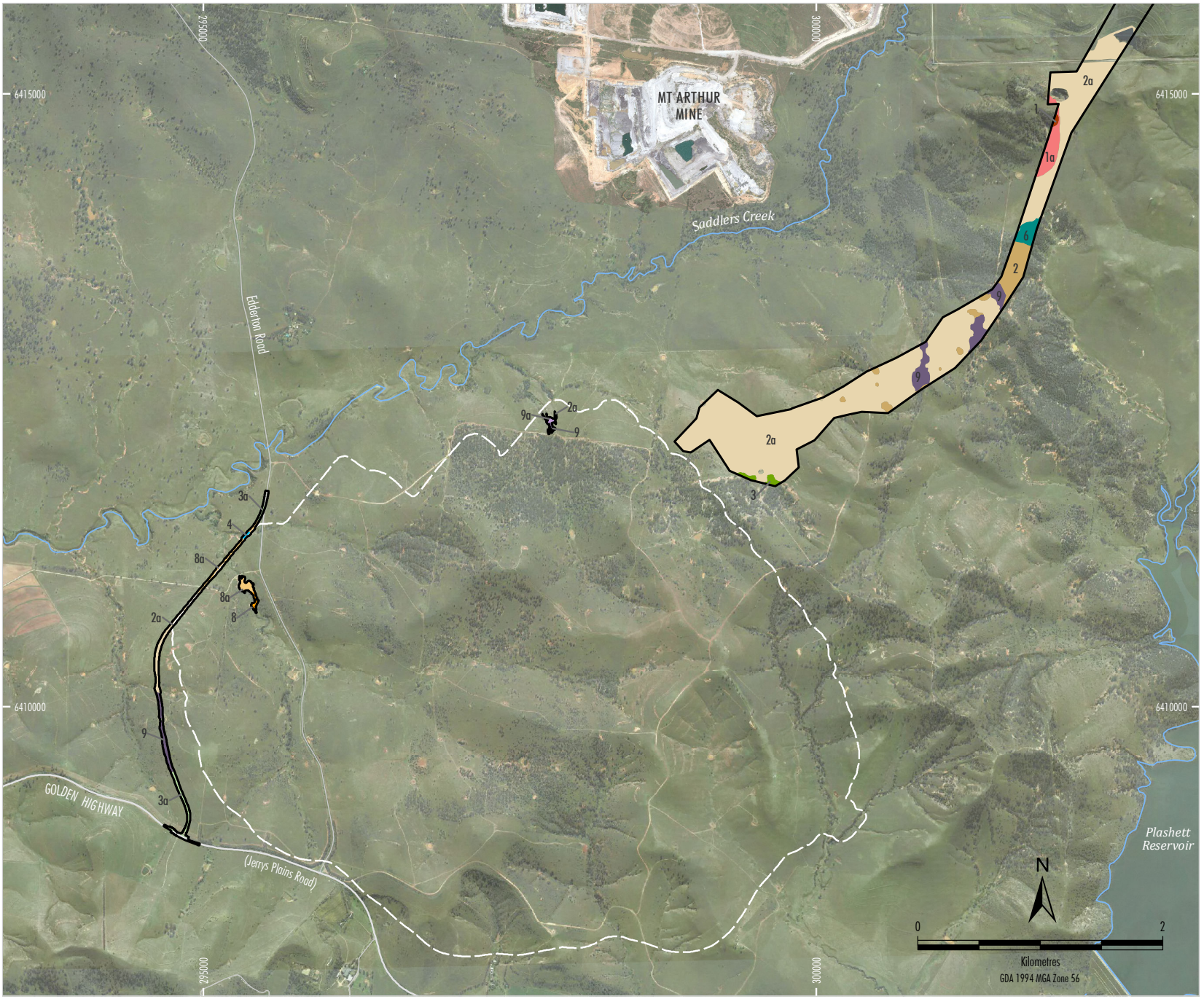
6.1.4 Conclusion

It is conservatively assumed that the vegetation clearance required for the Project would not be reversible, however for the reasons outlined in this section, the Project is unlikely to have a serious and irreversible impact on the Box-Gum TEC.

Adherence to the NSW Biodiversity Offset Scheme would result in the retirement of the required number and class of like-for-like biodiversity credits for the Box-Gum TEC (Section 8.3).

6.2 IMPACTS ON NATIVE VEGETATION (ECOSYSTEM CREDITS)

Figure 27a and 27b show the areas requiring an offset (i.e. native vegetation and woodland rehabilitation). Areas not requiring assessment are shown on Figures 28a and 28b. Areas of infrastructure/cleared land, pasture rehabilitation and waterbodies/dams do not require an offset (Figures 29a and 29b). Table 34 provides a summary of the ecosystem credits required for each PCT in the Biodiversity Assessment Development Footprint (Stage 1 and 2).



LEGEND

Extent of Conventional Subsidence (20 mm subsidence contour)

Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 2a White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3 Slaty Box Shrubby Woodland (PCT1655) [2]
- 3a Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4 Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 6 Bull Oak Grassy Woodland (PCT1692) [3]
- 8 Fuzzy Box Woodland (PCT201)
- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9 Ironbark - Grey Box Grassy Woodland (PCT1691) [4]
- 9a Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland
[2] Listed BC Act, Hunter Valley Footslopes Slaty Gum Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[3] The hatched portions of this PCT is Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed BC Act, Central Hunter Grey Box - Ironbark Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[5] Listed BC Act, Hunter Valley Weeping Myall

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

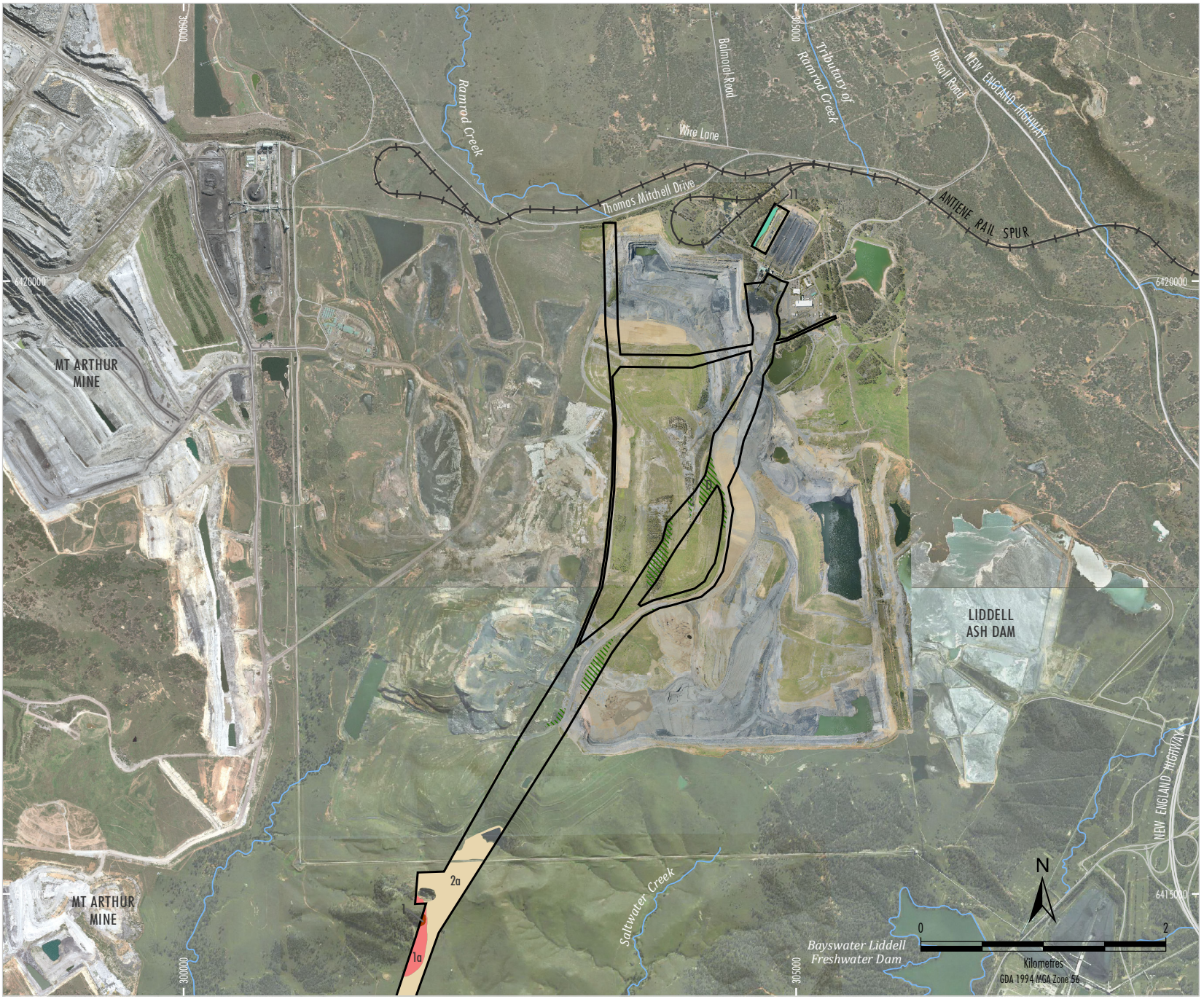
MALABAR COAL

MAXWELL PROJECT

Areas Requiring Offset

Figure 27a

SHM-18-03 Maxwell_EIS_App_BDAR_236C



LEGEND

- Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 — Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a — Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2a — White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Grassy Woodlands

- 11 — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]

Other

- R — Woodland Rehabilitation

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland

[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

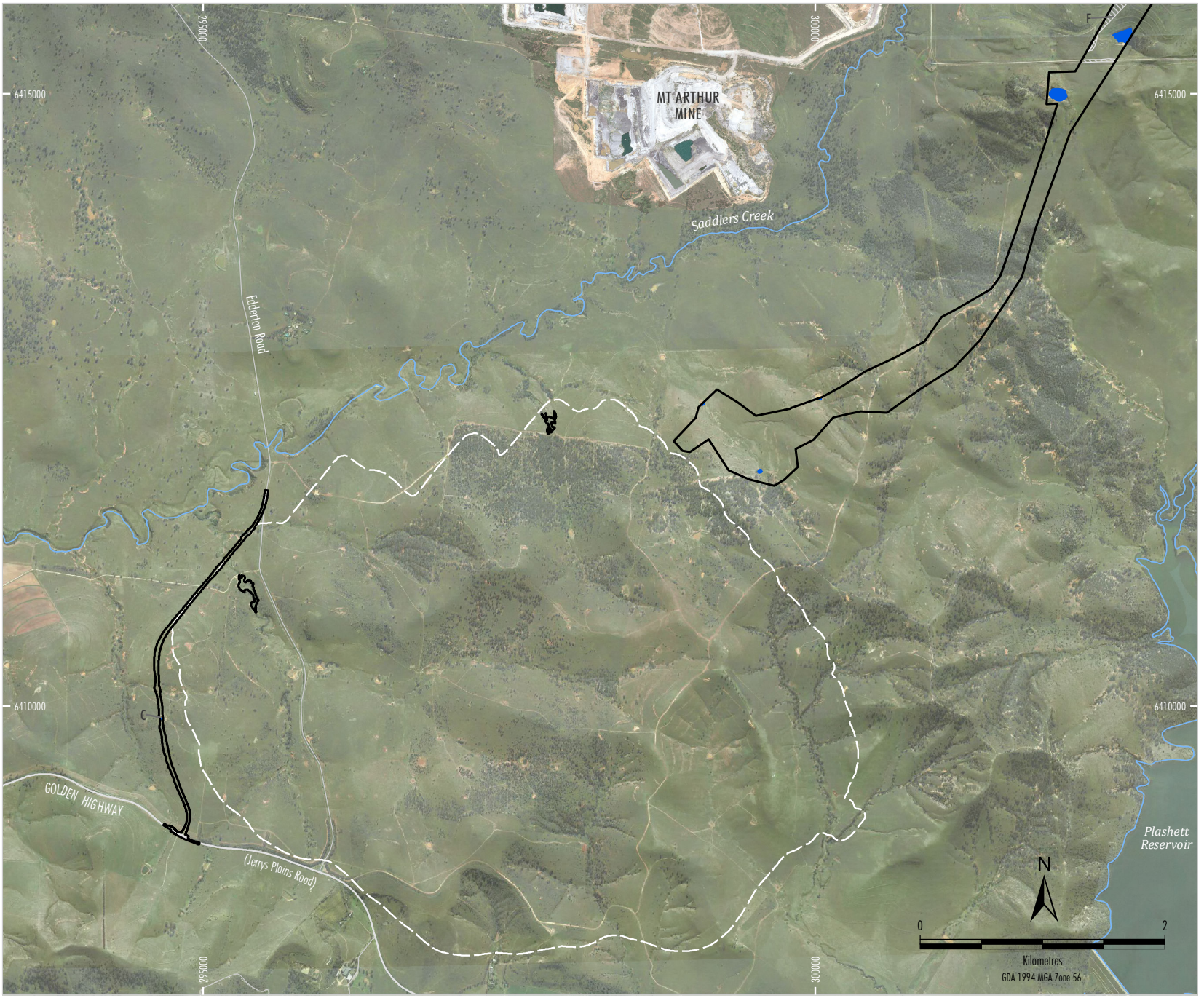
MALABAR COAL

MAXWELL PROJECT

Areas Requiring Offset

Figure 27b

SHM-18-03 Maxwell_EIS_App_BDAR_237B



LEGEND

Extent of Conventional Subsidence (20 mm subsidence contour)

Biodiversity Assessment Development Footprint

C Waterbody/Dam

F Infrastructure/Cleared Land

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

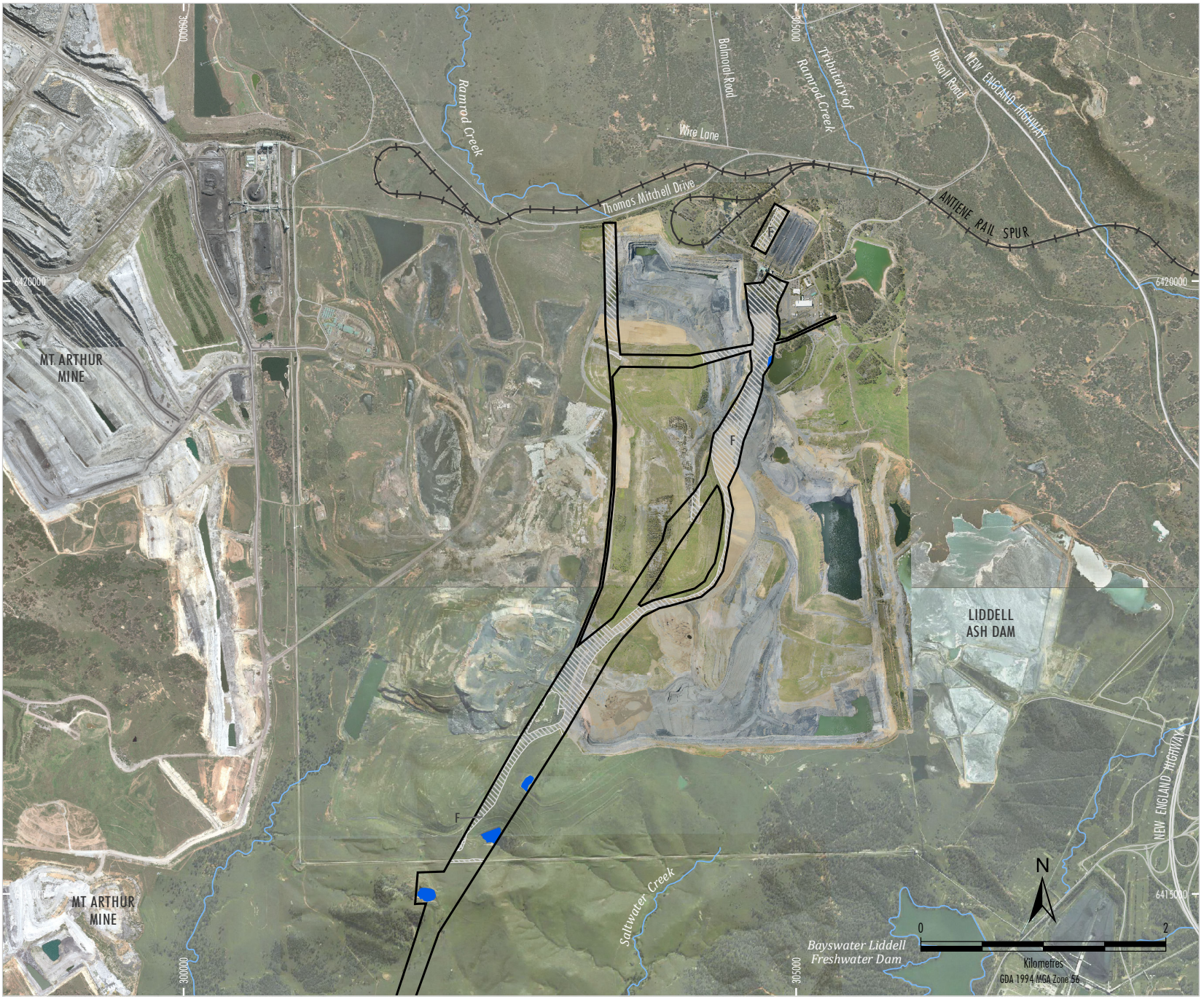
MALABAR COAL

MAXWELL PROJECT

Areas not Requiring Assessment

Figure 28a

SHM-18-03 Maxwell_EIS_App_BDAR_238B



LEGEND

Biodiversity Assessment Development Footprint

C Waterbody/Dam

F Infrastructure/Cleared Land

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

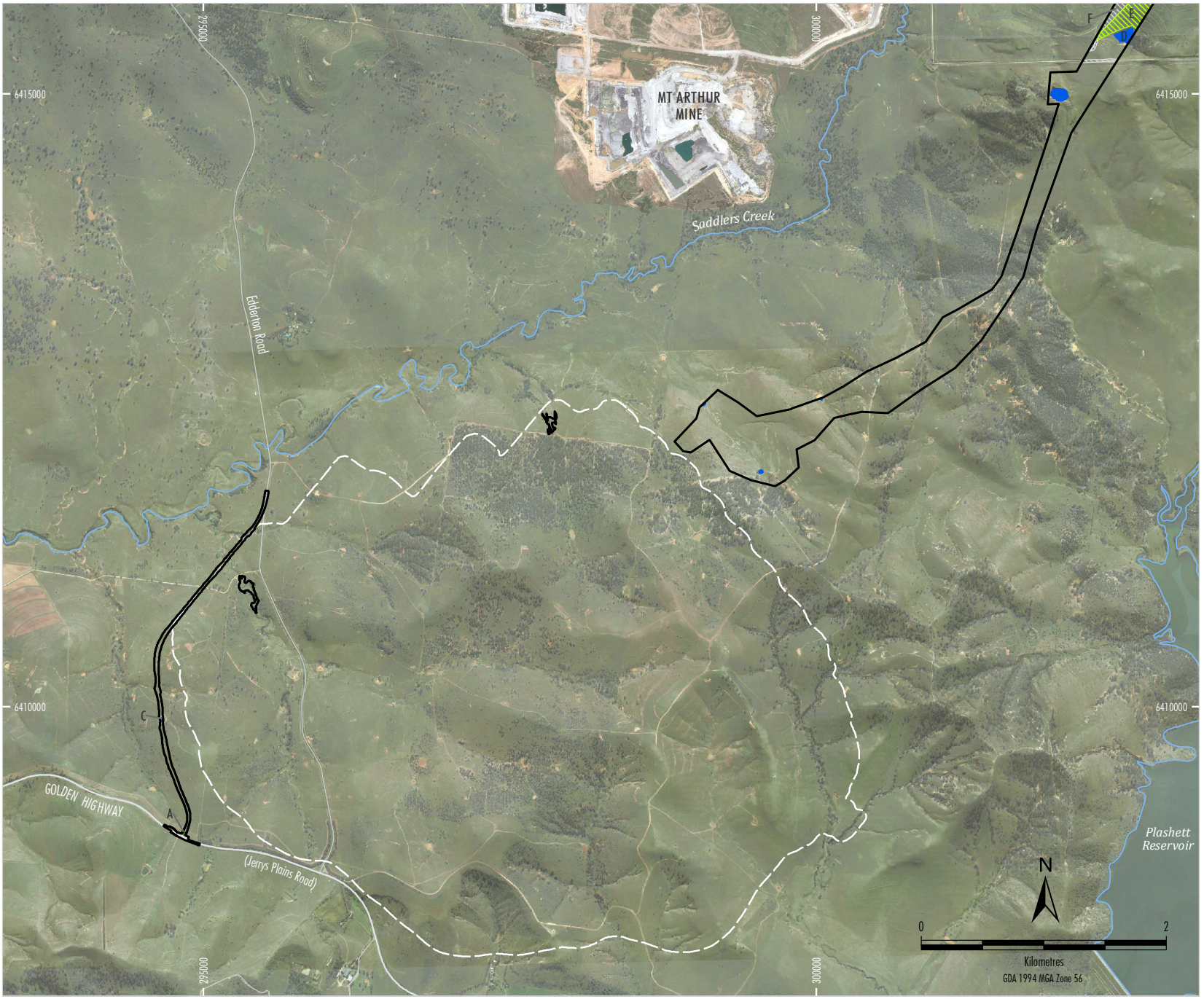
MALABAR COAL

MAXWELL PROJECT

Areas not Requiring Assessment

Figure 28b

SHM-18-03 Maxwell_EIS_App_BDAR_239B



LEGEND

Extent of Conventional Subsidence (20 mm subsidence contour)

Biodiversity Assessment Development Footprint

A Planted Trees

C Waterbody/Dam

E Pasture Rehabilitation

F Infrastructure/Cleared Land

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

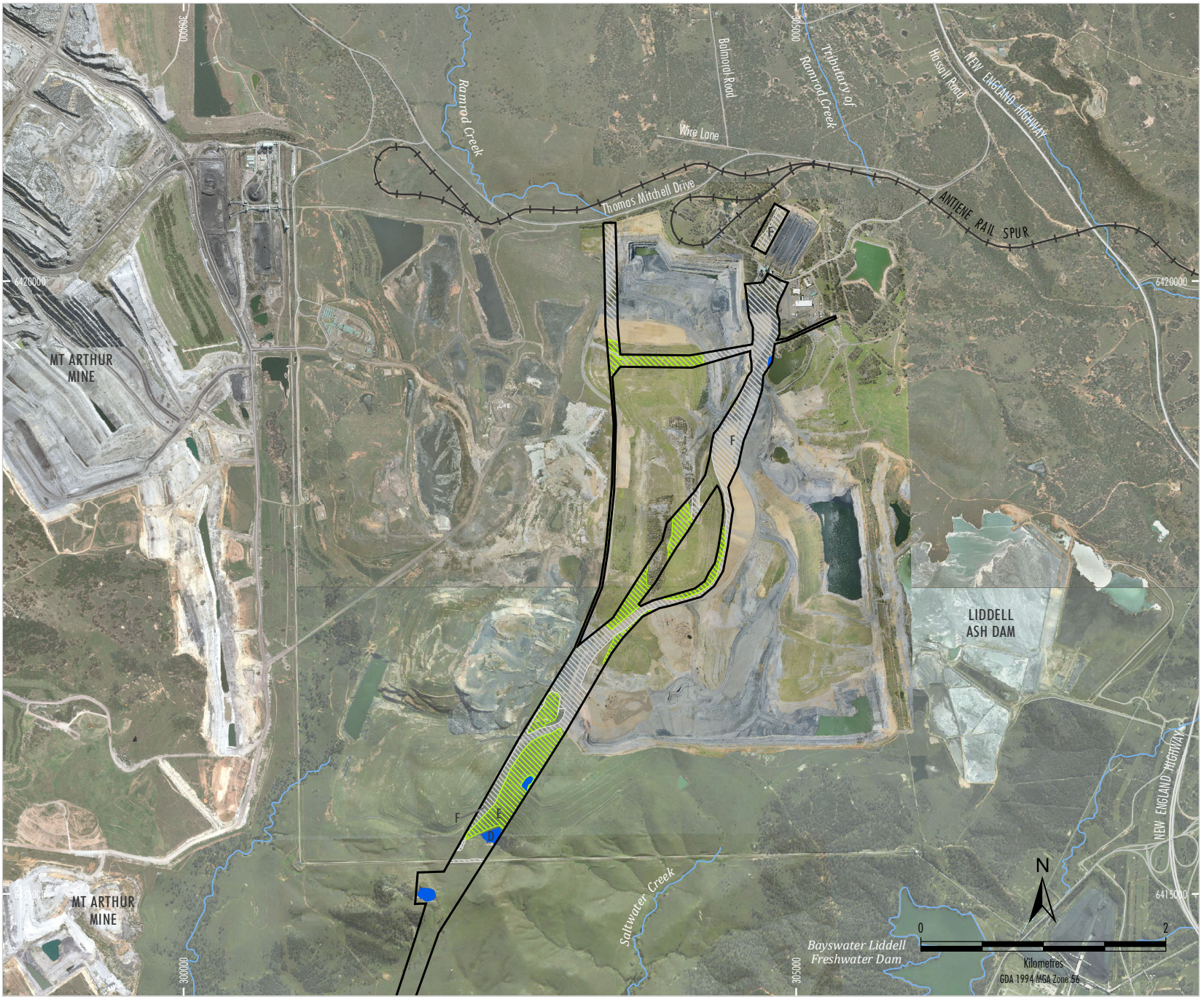
MALABAR COAL

MAXWELL PROJECT

Areas not Requiring Offset

Figure 29a

SHM-18-03 Maxwell_EIS_App_BDAR_240C



SHM-18-03 Maxwell_EIS_App_BDAR_241B

MALABAR COAL

MAXWELL PROJECT

Areas not Requiring Offset

Figure 29b

Table 34
Project Ecosystem Credit Requirements

PCT	PCT Name	Area (ha)			Credits Required[1]		
		Stage 1	Stage 2	Total	Stage 1	Stage 2	Total
1607	Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple Shrubby Woodland of the Upper Hunter	0.4	0	0.4	9	0	9
1607	Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple Shrubby Woodland of the Upper Hunter – DNG	4.9	0	4.9	59	0	59
Subtotal		***5.3***	***0***	***5.3***	***68***	***0***	***68***
1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum Shrubby Open Forest of the Central and Upper Hunter[2]	9.5	0.1	9.6	216	2	218
1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum Shrubby Open Forest of the Central and Upper Hunter – DNG[2]	122.7	2.9	125.6	971	45	1,016
Subtotal		***132.2***	***3***	***135.2***	***1,187***	***47***	***1,234***
1655	Grey Box – Slaty Box Shrub – Grass Woodland on Sandstone Slopes of the Upper Hunter Valley and Sydney Basin[3]	1.2	0.2	1.4	21	2	23
1655	Grey Box – Slaty Box Shrub – Grass Woodland on Sandstone Slopes of the Upper Hunter Valley and Sydney Basin – DNG	0	2.4	2.4	0	24	24
Subtotal		***1.2***	***2.6***	***3.8***	***21***	***26***	***47***
1731	Swamp Oak – Weeping Grass Grassy Riparian Forest of the Hunter Valley	0	0.2	0.2	0	4	4
Subtotal		***0***	***0.2***	***0.2***	***0***	***4***	***4***
1692	Bull Oak Grassy Woodland of the Central Hunter Valley*	2.8	0	2.8	45	0	45
Subtotal		***2.8***	***0***	***2.8***	***45***	***0***	***45***
201	Fuzzy Box Woodland on Alluvial Brown Loam Soils mainly in the NSW South Western Slopes Bioregion	0.5	0	0.5	15	0	15
201	Fuzzy Box Woodland on Alluvial Brown Loam Soils mainly in the NSW South Western Slopes Bioregion – DNG	1	1.8	2.8	14	26	40
Subtotal		***1.5***	***1.8***	***3.3***	***29***	***26***	***55***
1691	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter[4]	7.6	2	9.6	184	51	235

PCT	PCT Name	Area (ha)			Credits Required[1]		
		Stage 1	Stage 2	Total	Stage 1	Stage 2	Total
1691	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – DNG	0.3	0	0.3	6	0	6
Subtotal		***7.9***	***2***	***9.9***	***190***	***51***	***241***
1604	Narrow-leaved Ironbark – Grey Box – Spotted Gum Shrub – Grass Woodland of the Central and Upper Hunter[5]	1.3	0	1.3	44	0	44
1604	Pasture Rehabilitation	49.3	0	49.3	0	0	0
1604	Woodland Rehabilitation	15.2	0	15.2	214	0	214
Subtotal		***65.8***	***0***	***65.8***	***258***	***0***	***258***
Total		***216.7***	***9.6***	***226.3***	***1,798***	***154***	***1,952***

1 Refer to Attachments C and D.

2 Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

3 Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

4 Listed BC Act, E: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

5 Listed BC Act, E: Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

* This occurrence of PCT 1692 does not meet the criteria for the EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

6.3 IMPACTS ON THREATENED SPECIES (SPECIES CREDITS)

Table 35 provides a summary of the habitat and credits required for species credit species within the Biodiversity Assessment Development Footprint (Stage 1 and 2).

Table 35
Project Species Credit Requirements

Species Credit Species	Area of Habitat (ha)			Credits Required[1]			Required Offset Location*
	Stage 1	Stage 2	Total	Stage 1	Stage 2	Total	
Pink-tailed Legless Lizard	36	2.7	38.7	382	41	423	Anywhere in NSW
Striped Legless Lizard	145.4	7.4	152.8	1,126	99	1,225	Anywhere in NSW
Squirrel Glider	40.7	2.3	43	524	33	557	Anywhere in NSW
Southern Myotis	0.5	1.4	1.9	9	36	45	Anywhere in NSW

1 Refer to Attachments C and D.

* BAM Credit Calculator.

7 COMMONWEALTH ASSESSMENT

This section provides an assessment for EPBC Act listed threatened species and communities.

7.1 SURVEYS FOR THREATENED SPECIES AND COMMUNITIES LISTED UNDER THE EPBC ACT

Since the Project was referred under the EPBC Act, detailed surveys for EPBC Act listed threatened species and communities have been completed by Hunter Eco (2019) (Attachment A) and Future Ecology (2019) (Attachment B) across the Subject land.

7.1.1 Survey Scope, Timing and Methodology

EPBC Act listed threatened species and communities to target during the surveys were identified by undertaking database and literature reviews prior to field surveys (Hunter Eco 2019; Future Ecology 2019). Species were evaluated for their known presence or likelihood of occurring within the Subject land based on known habitat preferences. EPBC Act listed threatened species and communities targeted during the surveys are listed in Table 36.

Flora surveys were undertaken between December 2017 and January 2019 (Hunter Eco 2019) and fauna surveys were undertaken between January and December 2018 (Future Ecology 2019).

Table 36
EPBC Act Species and Communities Targeted for Survey

Common Name	Scientific Name	Conservation Status		
		EPBC Act	BC Act	Credit Class
Flora				
White-flowered Wax Plant	*Cynanchum elegans*	E	E	S
-	*Olearia cordata*	V	V	S
-	*Ozothamnus tesselatus*	V	V	S
Singleton Mint-bush	*Prostanthera cineolifera*	V	V	S
Wollemi Mint-bush	*Prostanthera cryptandroides subsp. cryptandroides*	V	V	S
-	*Lasiopetalum longistamineum*	V	V	S
-	*Eucalyptus parramattensis subsp. decadens*	V	V	S
Slaty Red Gum	*Eucalyptus glaucina*	V	V	S
Leafless Tongue-orchid	*Cryptostylis hunteriana*	V	V	S
Tarengo Leek Orchid	*Prasophyllum petilum (sp. Wybong)*	E	E	S
Illawarra Greenhood	*Pterostylis gibbosa*	E	E	S
-	*Euphrasia arguta*	CE	CE	S
Tall Knotweed	*Persicaria elatior*	V	V	S
Small-flower Grevillea	*Grevillea parviflora subsp. Parviflora*	V	V	S
Denman Pomaderris	*Pomaderris reperta*	CE	CE	S
Trailing Woodruff	*Asperula asthenes*	V	V	S
-	*Philotheca ericifolia*	V	-	S
Austral Toadflax	*Thesium australis*	V	V	S

Common Name	Scientific Name	Conservation Status		
		EPBC Act	BC Act	Credit Class
Fauna				
Amphibians				
Green and Golden Bell Frog	*Litoria aurea*	V	E	S
Reptiles				
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S
Striped Legless Lizard	*Delma impar*	V	V	S
Birds				
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	MA	V	S/E
Red Goshawk	*Erythrotriorchis radiatus*	V	CE	S
Australian Painted Snipe	*Rostratula australis*	E	E	E
Eastern Curlew	*Numenius madagascariensis*	CE	-	S/E
Curlew Sandpiper	*Calidris ferruginea*	CE	E	S/E
Swift Parrot	*Lathamus discolour*	CE	E	S/E
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E
Painted Honeyeater	*Grantiella picta*	V	V	E
Mammals				
Spotted-tailed Quoll (south-eastern mainland population)	*Dasyurus maculatus maculatus*	E	V	E
Koala	*Phascolarctos cinereus*	V	V	S/E
Greater Glider	*Petauroides volans*	V	-	S
Brush-tailed Rock-wallaby	*Petrogale penicillate*	V	E	S
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	E
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S
New Holland Mouse	*Pseudomys novaehollandiae*	V	-	E
Community				
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland		CE	CE	-
Central Hunter Valley Eucalypt Forest and Woodland		CE	-	-
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		CE	E	-

Surveys by Hunter Eco (2019) (Attachment A) and Future Ecology (2019) (Attachment B) were undertaken in accordance with published Commonwealth guidelines and policy statements and follow guidelines set in the BAM (OEH 2017a).

Further details of the survey scope, timing and methodology are provided in Attachment A and B.

7.1.2 Occurrence of Threatened Species and their Habitat

No threatened flora species listed under the EPBC Act were recorded in the Project area or immediate surrounds (Attachment A). Five threatened fauna species listed under the EPBC Act were recorded during the surveys, namely, the Pink-tailed Legless Lizard, Striped Legless Lizard, Painted Honeyeater, Grey-headed Flying-fox and Large-eared Pied Bat (Table 37) (Attachment B).

Two additional threatened fauna species listed under the EPBC Act were previously recorded in the Subject land during other surveys, namely, the Swift Parrot and Spotted-tailed Quoll (south-eastern mainland population).

Corben's Long-eared Bat may also have been recorded in the Subject land nearly 20 years ago but the record is uncertain as the detection method is not known. This species was not recorded with certainty during the present or recent past surveys.

Table 37
Threatened Species listed under the EPBC Act Recorded During Surveys

Common Name	Scientific Name	Conservation Status			Occurrence	Habitat
		EPBC Act	BC Act	Credit Class		
Reptiles						
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	Not previously recorded in the Subject land. Future Ecology (2019) recorded a single individual and a single slough in the same vicinity.	Rocky areas which provide potential habitat for the Pink-tailed Legless Lizard occur approximately 400 m south of the Biodiversity Assessment Development Footprint. The lizard was recorded in PCT 1606 within mapped rocky areas (Figure 17). It is assumed that this habitat would be suitable foraging and breeding habitat. The Project would result in the direct clearance of approximately 38.7 ha* of habitat for the Pink-tailed Legless Lizard, represented by rocky areas in PCT 1606 and a 50 m zone around the rocky area (Figure 17) (Section 5.2.1). Being part of a much wider landscape that will not be disturbed it is unlikely that this is an important population, or that the habitat to be lost would be critical to the survival of the species.
Striped Legless Lizard	*Delma impar*	V	V	S	Not previously recorded in the Subject land. Future Ecology (2019) recorded 16 individuals and 10 sloughs.	Future Ecology (2019) notes that the majority of Striped Legless Lizards were recorded in open grassland areas with good cover of grasses and herbs. Related PCT were 1606, 1655 and 1692, in both woodland and grassland. It is assumed that this habitat would be suitable foraging and breeding habitat. The Project would result in the direct clearance of approximately 152.8 ha of habitat for the Striped Legless Lizard (Figure 18) (Section 5.2.1). The habitat for the Striped Legless Lizard in the Subject land may represent 'habitat critical to the survival of the species' according to the Threatened Species Scientific Committee (TSSC) (2016a) because it provides foraging and breeding habitat and represents a newly discovered range extension.

Common Name	Scientific Name	Conservation Status			Occurrence	Habitat
		EPBC Act	BC Act	Credit Class		
Birds						
Painted Honeyeater	*Grantiella picta*	V	V	E	A single Painted Honeyeater was recorded by Future Ecology (2019).	Being a single individual, recorded in PCT 1607, it is likely that it was in foraging habitat only, and perhaps an itinerant individual. There have been no previous records of this bird in the Project area. The Project would result in the direct clearance of approximately 25.2 ha of potential foraging habitat for the Painted Honeyeater (Figure 32) (Section 5.2.1). Being part of a much wider landscape that will not be disturbed it is unlikely that this is an important population, or that the habitat to be lost would be critical to the survival of the species.
Mammals						
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	E	Future Ecology (2019) recorded a total of three individual Grey-headed Flying-foxes.	These bats were recorded across two locations both in PCT 1606 and were recorded in foraging habitat. No breeding camps were found in the Subject land. The Project would result in the direct clearance of approximately 24.5 ha of habitat for the Grey-headed Flying Fox (Figure 35) (Section 5.2.1). Being part of a much wider landscape that will not be disturbed it is unlikely that this is an important population, or that the habitat to be lost would be critical to the survival of the species.
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S	Future Ecology (2019) recorded this bat on several occasions and at several locations.	This bat was recorded in PCT 1606 and PCT 1607 and were recorded while foraging, with no breeding habitat evident. The Project would result in the direct clearance of approximately 25 ha of habitat for the Large-eared Pied Bat (Figure 36) (Section 5.2.1). Being part of a much wider landscape that will not be disturbed it is unlikely that this is an important population, or that the habitat to be lost would be critical to the survival of the species.

* The species polygon for the Pink-tailed Legless Lizard includes a 50 m zone around rocky areas in PCT 1606 (Section 3.3.2.5).

7.1.3 Occurrence of Threatened Ecological Communities

Three threatened ecological communities listed under the EPBC Act were recorded during the surveys (Table 38), two of which would be subject to clearing as part of the Project.

Table 38
Threatened Ecological Communities listed under the EPBC Act Recorded During Surveys

Threatened Ecological Community	Conservation Status EPBC Act	Clearance Area (ha)			Subsidence Area (ha)
		Stage 1	Stage 2	Total	
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	132.2 ha (comprising 9.5 ha of woodland and 122.7 ha of DNG)	3 ha (comprising 0.1 ha of woodland and 2.9 ha of DNG)	**135.2 ha (comprising 9.6 ha of woodland and 125.6 ha of DNG)**	**1,239.5 ha (comprising 214.5 ha of woodland and 1,025 ha of DNG)**
Central Hunter Valley Eucalypt Forest and Woodland	CE	10.1 ha (woodland)	2 ha (woodland)	**12.1 ha (woodland)**	**231.6 ha[#] (total comprising of woodland)**
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE	0	0	**0**	**0.4 ha (total comprising of woodland)**

[#] Includes part of PCT 1692 that is listed under the EPBC Act as a TEC (approximately 12.0 ha).

A description of the occurrence of each TEC is provided below. Further detail is provided in Attachment A.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606) was assessed as a component of the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, including the DNG variants. The main identifying characteristics were the presence of White Box and White Box x Grey Box in the canopy of PCT 1606.

Details provided in Appendices 2 and 4 of Hunter Eco (2019) show that PCT 1606 meets the condition thresholds (Department of the Environment [DotE] 2016a) for this TEC with a predominantly native understorey and over 12 native understorey species in any patch excluding grasses, with all patches >0.1 ha; there were also seven *Important Species* present.

Central Hunter Valley Eucalypt Forest and Woodland

Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter (PCT 1604), *Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin* (PCT 1655), *Narrow-leaved Ironbark – Grey Box Grassy Woodland of the central and upper Hunter* (PCT 1691) were assessed as components of the *Central Hunter Valley Eucalypt Forest and Woodland*. The primary canopy of each of the local communities was consistent with that of the TEC given the presence of *Eucalyptus crebra* (Narrow-leaved Ironbark), Grey Box and Spotted Gum in PCT 1604; Slaty Box in PCT 1655; and Narrow-leaved Ironbark and Grey Box for PCT 1691.

Areas dominated by Bull Oak (*Allocasuarina luehmannii*), PCT 1692, are specifically excluded from the determination except for sites where any of the key eucalypt canopy species were once dominant. This was the case for areas of PCT 1692 clearly derived from PCT 1655. Elsewhere PCT 1692 was derived from PCT 1606 which includes eucalypt canopy species not part of *Central Hunter Valley Eucalypt Forest and Woodland*.

The determination for *Central Hunter Valley Eucalypt Forest and Woodland* specifically excludes derived grasslands other than for narrow (30 m or less) strips around woodland areas or connection between woodland areas.

Details provided in Appendices 2 and 4 of Hunter Eco (2019) show that part of PCT 1655 meets the condition thresholds (DotE 2016b) for this TEC with over 50% of the perennial understorey vegetation being native plants and over 12 native understorey species in any patch, with all patches >0.5 ha.

Central Hunter Valley Eucalypt Forest and Woodland is dispersed throughout the proposed transport and services corridor, underground access area and stockpile expansion area (PCT 1655, PCT 1691, PCT 1692 and PCT 1604).

Hunter Valley Weeping Myall (*Acacia pendula*) Woodland

Weeping Myall – Coobah – Scrub Wilga shrubland of the Hunter Valley (PCT 116) was assessed as a component of the *Hunter Valley Weeping Myall (Acacia pendula) Woodland* due to the dominating presence of Weeping Myall.

Hunter Valley Weeping Myall (Acacia pendula) Woodland is present in three small, widely separate areas in the Subject land, with none being within the Biodiversity Assessment Development Footprint. Two patches are located within Maxwell Underground and one to the south-east of the proposed transport and services corridor (Figure 10).

7.2 IMPACTS ON THREATENED SPECIES AND COMMUNITIES LISTED UNDER THE EPBC ACT

Potential impacts on the following species and communities are assessed below:

- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*;
- *Central Hunter Valley Eucalypt Forest and Woodland*;
- *Hunter Valley Weeping Myall Woodland*;
- Pink-tailed Legless Lizard;
- Striped Legless Lizard;
- Swift Parrot;

- Regent Honeyeater;
- Painted Honeyeater;
- Spotted-tailed Quoll;
- Corben's Long-eared Bat;
- Grey-headed Flying-fox; and
- Large-eared Pied Bat.

The following species are not considered at risk of significant impact because the species are unlikely to be present in the Project area or surrounds:

- Green and Golden Bell Frog;
- Koala;
- New Holland Mouse;
- White-flowered Wax Plant;
- Slaty Red Gum;
- Tarengo Leek Orchid;
- Illawarra Greenhood; and
- Austral Toadflax.

Table 39 summarises the clearance of known and/or potential habitat for the threatened fauna species listed above based on Future Ecology (2019) (Attachment B).

As described in Section 5.3.1, the exact location of surface cracking and other potential subsidence impacts is unknown, however the nature and extent of potential subsidence impacts is reasonably predicted and assessed based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley. A subsidence monitoring program and adaptive management approach would be implemented to manage potential subsidence impacts (Section 5.6). It is conservatively assumed that the vegetation clearance required for the Project would not be reversible, however, surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include species characteristic of the vegetation to be cleared.

Table 39
Threatened Fauna Habitat Clearance Summary

PCT	Generic Name	Pink-tailed Legless Lizard	Striped Legless Lizard	Swift Parrot	Regent Honeyeater	Painted Honeyeater	Spotted-tailed Quoll	Corben's Long-eared bat	Grey-headed Flying-fox	Large-eared Pied Bat
Dry Sclerophyll Forests (Shrub/grass sub-formation)										
1607	1. Red Gum - Ironbark - Apple Shrubby Woodland	0.1^	-	-	-	0.4	0.4	-	-	-
1607	1a. Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	0.4^	-	-	-	-	4.9	-	-	-
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	3.4^	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	32^	125.6[A]	-	-	-	125.6[A]	-	-	-
Dry Sclerophyll Forests (Shrubby sub-formation)										
1655	3. Slaty Box Shrubby Woodland[2]	-	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
1655	3a. Slaty Box Shrubby Woodland (DNG)	-	2.4	-	-	-	2.4	-	-	-
Grassy Woodlands										
1692	6. Bull Oak Grassy Woodland	-	2.8	2.8	-	2.8	2.8	-	2.8	2.8
201	8. Fuzzy Box Woodland	-	-	0.5[B]	0.5[B]	0.5[B]	0.5[B]	0.5[B]	-	0.5[B]
201	8a. Fuzzy Box Woodland (DNG)	0.2^	-	-	-	-	2.8[C]	-	-	-
1691	9. Ironbark - Grey Box Grassy Woodland[3]	2.6^	9.6[D]	9.6[D]	9.6[D]	9.6[D]	9.6[D]	9.6[D]	9.6[D]	9.6[D]
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	-	0.3[E]	-	-	-	0.3[E]	-	-	-
1604	11. Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland[4]	-	1.3	1.3	1.3	1.3	1.3	-	1.3	1.3

PCT	Generic Name	Pink-tailed Legless Lizard	Striped Legless Lizard	Swift Parrot	Regent Honeyeater	Painted Honeyeater	Spotted-tailed Quoll	Corben's Long-eared bat	Grey-headed Flying-fox	Large-eared Pied Bat
Forested Wetlands										
1731	4. Swamp Oak Forest	-	-	-	-	-	0.2	-	-	-
	Total	**38.7**	**152.8**	**25**	**22.2**	**25.2**	**161.6**	**20.9**	**24.5**	**25**

^ Area associated with rocky areas in PCT 1606. A 50 m zone was added to the rocky areas in consideration of the habitat constraint (Table 9) and as directed by OEH (14 May 2019).

1 Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

2 Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

3 Listed BC Act, E: Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

4 Listed BC Act, E: Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

A <0.1 ha of PCT 1606 DNG is associated with potential subsidence ponding impacts (Figure 3).

B Approximately 0.5 ha of PCT 201 is associated with potential subsidence ponding impacts (Figure 3).

C Approximately 1 ha of PCT 201 DNG is associated with potential subsidence ponding impacts (Figure 3).

D <0.3 ha of PCT 1691 is associated with potential subsidence ponding impacts (Figure 3).

E <0.3 ha of PCT 1691 DNG is associated with potential subsidence ponding impacts (Figure 3).

7.2.1 White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

The Project would result in the direct clearance of approximately 135.2 ha of *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, comprising predominantly derived grassland (approximately 125.6 ha – PCT 1606 DNG) and various woodland patches of this community (totalling approximately 9.6 ha - PCT 1606) (Figures 7a, 7b and 10) (Table 38).

The clearance would occur in the short-term for the proposed transport and services corridor as well as the potential Edderton Road Realignment. As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Those measures that have specifically avoided clearance of *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- locating the MEA predominately within an area of DNG rather than woodland; and
- reducing the disturbance footprint required for the MEA, including a reduction in the total MEA disturbance.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include species characteristic of the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*.

The *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* adjacent to the Biodiversity Assessment Development Footprint (Figure 10) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, grazing, habitat fragmentation and weed invasion and lack of fire (Rawlings et al. 2010; TSSC 2006; Department of Environment, Climate Change and Water [DECCW] 2010). The Project is unlikely to indirectly impact the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* adjacent to the Biodiversity Assessment Development Footprint as potential indirect impacts (and edge effects) from environmental weeds, dust, erosion and sediment would be managed (Section 7.3). Potential indirect impacts from the Project on native vegetation and habitat are described in Section 5.3.

There is approximately 1,239.5 ha of Box-Gum woodland within the area subject to subsidence (Table 38) of which approximately 1,025 ha is the DNG form. Subsidence is unlikely to materially impact the native vegetation within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

No indirect impacts on the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).

Mitigation measures for the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* are outlined in Table 40 and include the following:

- implementation of a vegetation clearance protocol;
- remediation of surface cracks due to subsidence;
- weed management; and
- bushfire management.

As described earlier, based on the information available in the EPBC Act Referral, DEE considered (in the input into the SEARs) that the Project is likely to have a significant impact on the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. In consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013), the Project would reduce the extent of the community and result in some fragmentation.

The Project is unlikely to:

- modify or destroy abiotic factors (such as water, nutrients, or soil) necessary for an ecological community's survival;
- cause a substantial change in the species composition in the occurrence of the ecological community;
- cause a substance reduction in the quality or integrity of an occurrence of an ecological community (e.g. assist invasive species to become established or kill or inhibit the growth of species in the ecological community through the use of fertilisers, herbicides or other chemicals or pollutants); or
- interfere with the recovery of the ecological community.

The impacts on the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Section 8.3).

7.2.2 Central Hunter Valley Eucalypt Forest and Woodland

The Project would result in the direct clearance of *Central Hunter Valley Eucalypt Forest and Woodland*, comprising various woodland patches of this community (totalling approximately 12.1 ha – PCT 1604, PCT 1655 and PCT 1691) (Figures 7a, 7b and 10) (Table 38). The clearance would occur in the short term for the proposed transport and services corridor as well as the potential Edderton Road Realignment. As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of *Central Hunter Valley Eucalypt Forest and Woodland* are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA, including a reduction in the total MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include species characteristic of the *Central Hunter Valley Eucalypt Forest and Woodland*.

The *Central Hunter Valley Eucalypt Forest and Woodland* adjacent to the Biodiversity Assessment Development Footprint (Figure 10) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, livestock grazing, habitat fragmentation, weeds and lack of fire (DotE 2015a; DEE 2016a). The Project is unlikely to indirectly impact the *Central Hunter Valley Eucalypt Forest and Woodland* adjacent to the Biodiversity Assessment Development Footprint as potential indirect impacts (and edge effects) from environmental weeds, dust, erosion and sediment would be managed (Section 7.3). Potential indirect impacts from the Project on native vegetation and habitat are described in Section 5.3.

There is 231.6 ha of this TEC within the area subject to subsidence (Table 38). Other than for areas of potential subsidence ponding containing 0.25 ha of *Central Hunter Valley Eucalypt Forest and Woodland* (PCT 1691) changes in landform due to subsidence are unlikely to have an impact on this TEC. Subsidence is unlikely to materially impact the native vegetation within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

No indirect impacts on the *Central Hunter Valley Eucalypt Forest and Woodland* are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).

Mitigation measures for the *Central Hunter Valley Eucalypt Forest and Woodland* are outlined in Table 40 and include the following:

- implementation of a vegetation clearance protocol;
- remediation of surface cracks due to subsidence;
- weed management; and
- bushfire management.

As described earlier, based on the information available in the EPBC Act referral, DEE considered (in the input into the SEARs) that the Project is likely to have a significant impact on the *Central Hunter Valley Eucalypt Forest and Woodland*. In consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013), the Project would reduce the extent of the community and result in some fragmentation.

The Project is unlikely to:

- fragment or increase fragmentation of the ecological community;
- modify or destroy abiotic factors (such as water, nutrients, or soil) necessary for an ecological community's survival;
- cause a substantial change in the species composition in the occurrence of the ecological community;
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community (e.g. assist invasive species to become established or kill or inhibit the growth of species in the ecological community through the use of fertilisers, herbicides or other chemicals or pollutants); or
- interfere with the recovery of the ecological community.

The impacts on the *Central Hunter Valley Eucalypt Forest and Woodland* would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the *Central Hunter Valley Eucalypt Forest and Woodland* (Section 8.3).

7.2.3 Hunter Valley Weeping Myall (*Acacia pendula*) Woodland

The Project would not result in the clearance of the *Hunter Valley Weeping Myall (Acacia pendula) Woodland*.

There is 0.4 ha of *Hunter Valley Weeping Myall (Acacia pendula) Woodland* in the predicted subsidence area (Figure 7a) modelled as experiencing approximately 4 m of subsidence (MSEC 2019). This not in an area modelled to experience ponding and it is unlikely that subsidence would affect the viability of these plants.

Subsidence is unlikely to materially impact the native vegetation within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

It is considered that the Project is not likely to have a significant impact on the *Hunter Valley Weeping Myall (Acacia pendula) Woodland* in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

Despite the above, Malabar would erect a livestock proof fence around a 20 m buffer from the *Hunter Valley Weeping Myall (Acacia pendula) Woodland* within the Subject land on Malabar-owned land (Figure 11). The area would be signed 'Environmental Protection Area'. The Project is likely to have a positive impact on the *Hunter Valley Weeping Myall (Acacia pendula) Woodland/Acacia pendula* population in the Hunter Catchment by excluding grazing livestock.

7.2.4 Pink-tailed Legless Lizard

The Project would result in the direct clearance of approximately 38.7 ha of potential habitat for the Pink-tailed Legless Lizard, represented by 12.5 ha of rocky areas in PCT 1606 and a 50 m zone around the rocky areas (Figure 17) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Pink-tailed Legless Lizard are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial land use is identified, and would include habitat for the Pink-tailed Legless Lizard in the form of rocky areas.

Rocky areas which provide potential habitat for the Pink-tailed Legless Lizard also occur adjacent to the Biodiversity Assessment Development Footprint (Figure 17). The habitat is mostly located in an agricultural grazing property and as such is subject to potential habitat degradation (through livestock grazing and weeds) (TSSC 2015a; Wong 2013). The Project is unlikely to indirectly impact the Pink-tailed Legless Lizard adjacent to the Biodiversity Assessment Development Footprint as the Project would include measures to manage environmental weeds spreading from the Biodiversity Assessment Development Footprint (Section 7.3).

No indirect impacts on the Pink-tailed Legless Lizard are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified), including the placement of salvaged material rocks and wood.

It is possible that individual lizards could fall into subsidence cracks, however minor cracks (i.e. less than 50 mm) are likely to fill naturally over time and larger cracks would be remediated. The previously unrecorded population of this species would persist in the surrounding locality due to the amount of the known habitat and occurrence of the species outside the Biodiversity Assessment Development Footprint and subsidence extent (Figure 17).

Mitigation measures for the species are outlined in Table 40 and would include:

- implementation of a vegetation clearance protocol;
- minimising the potential for loss of individuals through pre-clearance fauna surveys, conducted by suitably qualified personnel; and
- a weed management control plan.

In accordance with the criteria set out in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013) it is conservatively considered that the Project is likely to have a significant impact on the Pink-tailed Legless Lizard in the short to medium-term, given the Project may reduce the area of occupancy of a population that may represent an 'important population' according to the DotE (2013) given the population is near the limit of the species range. The Pink-tailed Legless Lizard has not been previously recorded in the Muswellbrook Local Government Area and the closest record is near Goulburn River National Park approximately 80 km to the west of the Subject land and dated 2000 (OEH, 2019a).

The Project is unlikely to:

- lead to a long-term decrease in the size of the population
- fragment the population due to the species mobility and wider occurrence of potential habitat;
- adversely affect habitat critical to the survival of the species;
- disrupt the breeding cycle;
- impact habitat to the extent that the species is likely to decline;
- result in invasive species or disease harmful to species becoming established; or
- interfere substantially with the recovery of the species.

The impacts on the Pink-tailed Legless Lizard would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the Pink-tailed Legless Lizard (Section 8.3). This species is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a).

7.2.5 Striped Legless Lizard

The Project would result in the direct clearance of approximately 152.8 ha of known and potential habitat for the Striped Legless Lizard (Figure 18) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.5 ha) of potential subsidence ponding (Figure 18).

The habitat for the Striped Legless Lizard in the Subject land may represent 'Habitat critical to the survival of the species' according to the TSSC (2016a) because it provides foraging and breeding habitat and represents a newly discovered range extension. The Striped Legless Lizard has been previously recorded near Muswellbrook Common approximately 15 km north-east of the Project area (OEH, 2019a). The Muswellbrook Common population appears to be disjunct from other recorded populations which occur greater than approximately 200 km to the south (OEH, 2019a).

As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Striped Legless Lizard are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified and would include the placement of salvaged material rocks and wood.

The Project is unlikely to indirectly impact the Striped Legless Lizard adjacent to the Biodiversity Assessment Development Footprint as the Project would include measures to manage environmental weeds spreading from the Biodiversity Assessment Development Footprint (Section 7.3) considering that the Striped Legless Lizard is a grassland specialist (DEE 2019a).

It is possible that individual lizards could fall into subsidence cracks, however, minor cracks (i.e. less than 50 mm) are likely to fill naturally over time and larger cracks would be remediated.

Studies indicate that the Striped Legless Lizard only moves across short distances, having been recorded moving at least 20 m in one day (and up to 50 m over several weeks) (DEE 2019a). The creation of barriers to lizard movements can cause populations to become fragmented (DEE 2019a). The transport and services corridor (site access road and covered overland conveyor) and potential Edderton Road realignment could potentially limit the movement of the Striped Legless Lizard, however, this species was only recorded on the southern side of the transport and services corridor and eastern side of the potential Edderton Road realignment (Figure 18). Therefore, based on available data, the population is unlikely to be significantly fragmented.

No indirect impacts on the Striped Legless Lizard are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer require or at the end of the mine life where no further ongoing beneficial use is identified), including the placement of salvaged material rocks and wood.

The previously unrecorded population of this species would persist in the surrounding locality due to the amount of known habitat and the occurrence of the species outside the Biodiversity Assessment Development Footprint and subsidence extent (Figure 18).

Best practise mitigation measures as outlined in *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC] 2011) have been considered for the Striped Legless Lizard, and would include (Table 40):

- the salvage and re-use of material for habitat (e.g. surface rocks);
- weed management;

- feral animal management (e.g. feral cats); and
- remediation of surface cracks due to subsidence.

It is conservatively considered that the Project is likely to have a significant impact on the Striped Legless Lizard in the short to medium-term in consideration of the *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (SEWPaC 2011) and *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013). This conclusion is made considering that the local population of the Striped Legless Lizard in the Subject land represents a range extension for the species and therefore could be considered an important population (as defined by DotE 2013). In consideration of the criteria in DotE (2013), the Project may:

- reduce the area of occupancy of the population by excluding the population from the Biodiversity Assessment Development Footprint; and
- adversely affect habitat, that may represent 'habitat critical to the survival of the species' according to the TSSC (2016a) because it provides foraging and breeding habitat and represents a newly discovered range extension.

The Project is unlikely to:

- lead to a long-term decrease in the size of the population;
- fragment the population due to the species mobility and wider occurrence of potential habitat;
- disrupt the breeding cycle;
- impact habitat to the extent that the species is likely to decline;
- result in invasive species or disease harmful to species becoming established; or
- interfere substantially with the recovery of the species.

The impacts on the Striped Legless Lizard would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the Striped Legless Lizard (Section 8.3). This species is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a).

7.2.6 Swift Parrot

The Project would result in the direct clearance of approximately 25 ha of potential foraging habitat for the Swift Parrot (Figure 30) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 30). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Swift Parrot are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- locating the MEA predominately within an area of DNG rather than woodland; and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include potential habitat for the Swift Parrot in the form of woodland with species characteristic of the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*.

No recognised threats to the Swift Parrot (TSSC 2016b) are likely to occur indirectly as a result of the Project. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

No indirect impacts on the Swift Parrot are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer require or at the end of the mine life where no further ongoing beneficial use is identified).

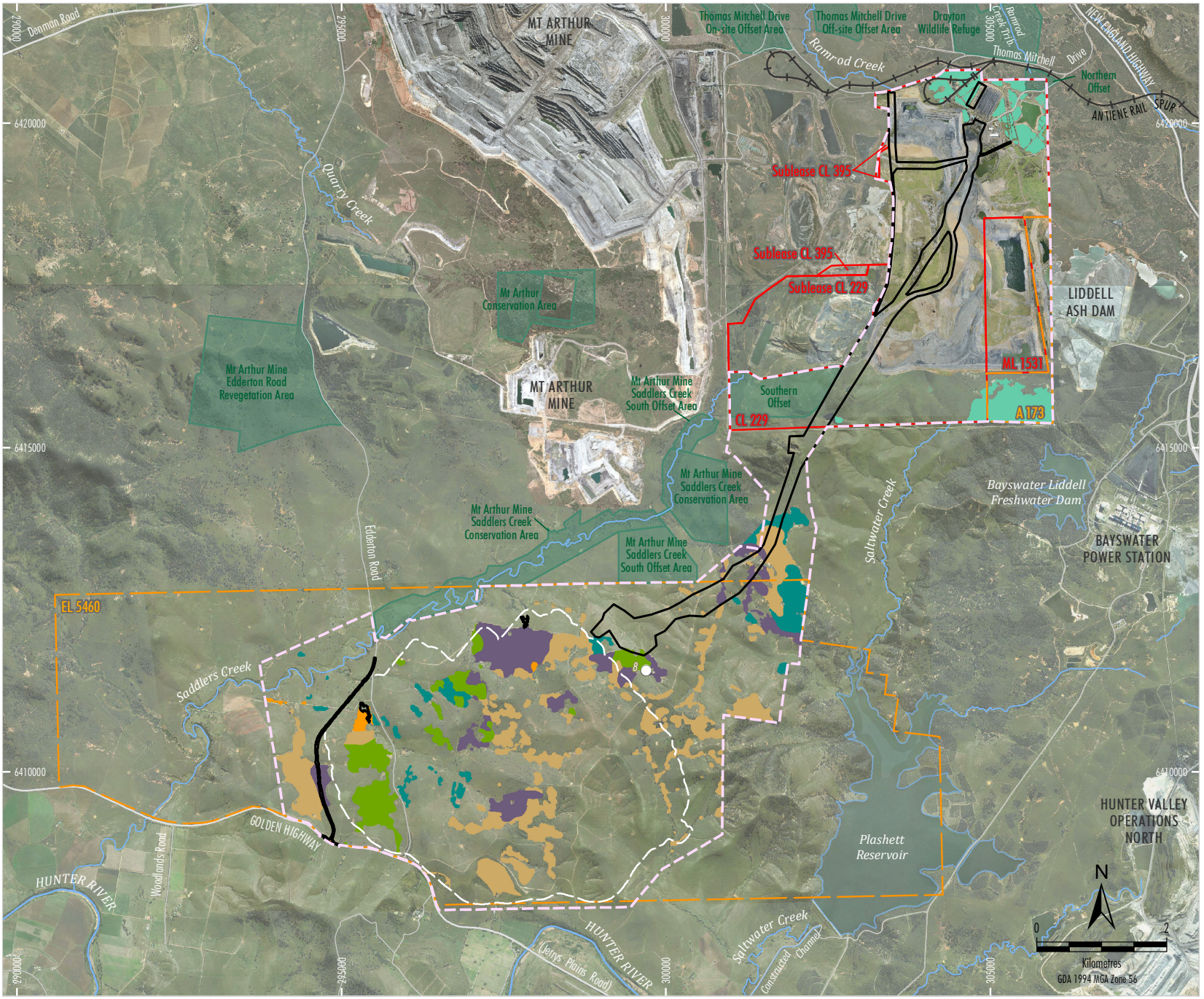
If the potential foraging habitat in the Biodiversity Assessment Development Footprint is removed, it is likely to be of little consequence to the Swift Parrot given the occurrence of similar potential habitat in the surrounding landscape.

Mitigation measures for the species are outlined in Table 40 and include the following:

- implementation of a vegetation clearance protocol; and
- surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated with recognised suitable feed trees (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).

As described earlier, based on the information available in the EPBC Act referral, DEE considered (in the input into the SEARs) that the Project is likely to have a significant impact on the Swift Parrot. The Project may not have a material adverse impact on the Swift Parrot as this species has not been recorded in the Biodiversity Assessment Development Footprint, no breeding habitat for this species is present (as it breeds in Tasmania), and OEH do not recognise the Subject land as important habitat for these species (negating the need for species credits). To be conservative and consistent with the DEE input into the SEARs, the BDAR assesses the Swift Parrot as if the Project could significantly impact the species.

The impacts on the Swift Parrot would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the Swift Parrot (Section 8.3). This species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) given OEH confirmed that there is no important habitat in the Project area (Table 9).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Swift Parrot

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
8. Cumberland Ecology (2012)
Note: There are no references 1 - 7 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Swift Parrot Potential Habitat

Figure 30

SHM-18-03 Maxwell_EIS_App_BDAR_228D

7.2.7 Regent Honeyeater

The Regent Honeyeater has not been recorded in the Subject land (Table 7).

The Project would result in the direct clearance of approximately 22.2 ha of potential foraging habitat for the Regent Honeyeater (Figure 31) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 31). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Regent Honeyeater are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- locating the MEA predominately within an area of DNG rather than woodland; and
- reducing the disturbance footprint required for the MEA.

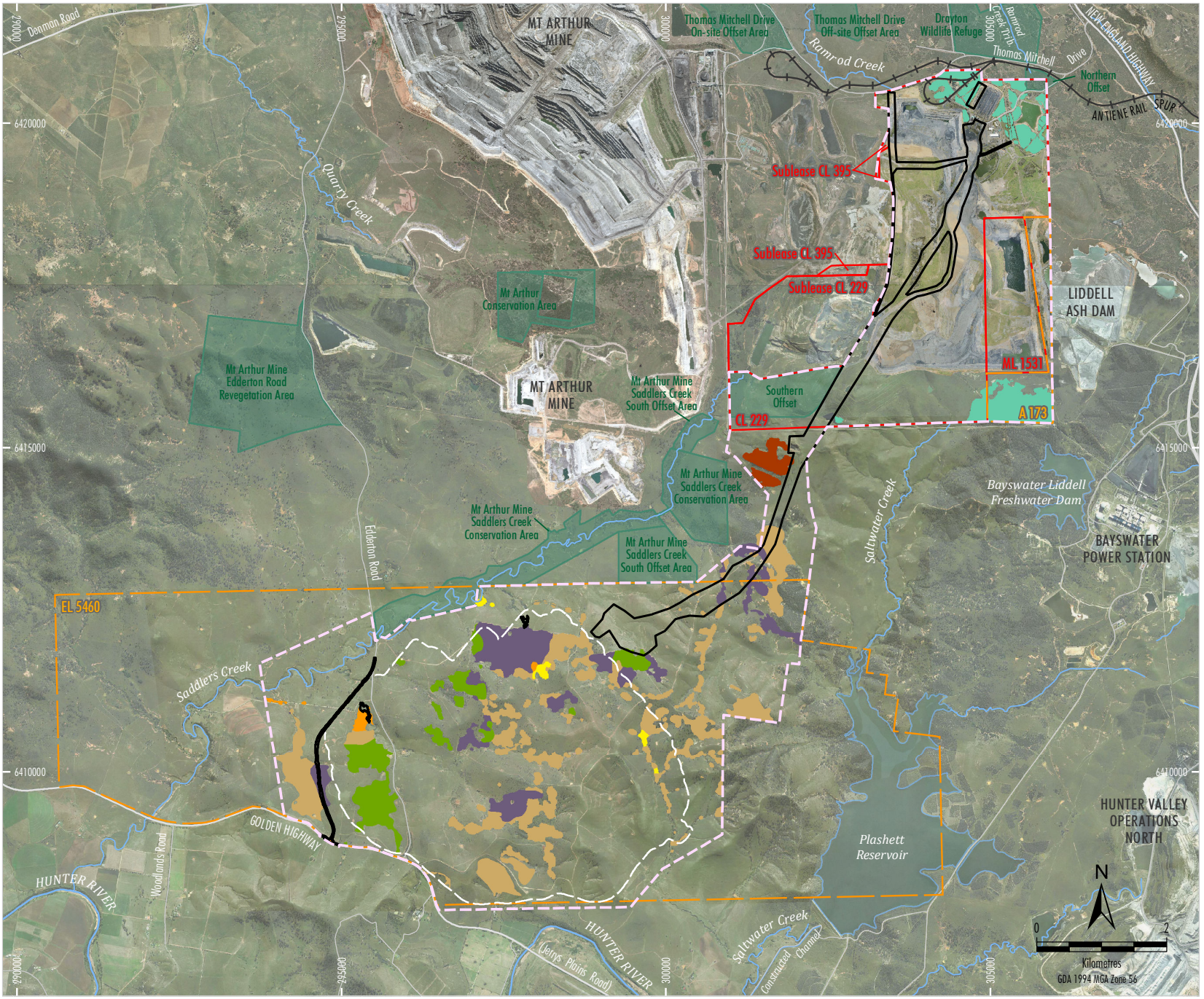
In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include habitat for the Regent Honeyeater in the form of woodland.

The Regent Honeyeater potential foraging habitat adjacent to the Biodiversity Assessment Development Footprint (Figure 31) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, livestock grazing, habitat fragmentation, weeds and lack of fire (DotE 2015b; DotE 2016c). The Project is unlikely to indirectly impact the Regent Honeyeater (were it to use the woodland potential habitat adjacent to the Biodiversity Assessment Development Footprint) as potential indirect impacts would be managed (Section 7.3).

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

No indirect impacts on the Regent Honeyeater are likely to occur in the long-term as the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).

If the potential foraging habitat in the Biodiversity Assessment Development Footprint is removed, it is likely to be of little consequence to the Regent Honeyeater given the occurrence of similar potential habitat in the surrounding landscape and absence of breeding habitat.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Note: There are no Regent Honeyeater records on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Regent Honeyeater Potential Habitat

Figure 31

SHM-18-03 Maxwell_EIS_App_BDAR_245D

Mitigation measures for the species are outlined in Table 40 and include the following:

- implementation of a vegetation clearance protocol; and
- surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).

As described earlier, based on the information available in the EPBC Act referral, DEE considered (in the input into the SEARs) that the Project is likely to have a significant impact on the Regent Honeyeater. The Project may not have a material adverse impact on the Regent Honeyeater as this species has not been recorded in the Biodiversity Assessment Development Footprint, no breeding habitat for this species is present, and the OEH do not recognise the Subject land as important habitat for these species (negating the need for species credits). To be conservative and consistent with the DEE input into the SEARs, the BDAR assesses the Regent Honeyeater as if the Project could significantly impact the species.

The impacts on Regent Honeyeater would be offset in accordance with the NSW Biodiversity Offset Scheme and would result in the retirement of the required number and class of like-for-like biodiversity credits for the Regent Honeyeater (Section 8.3). This species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) given OEH confirmed that there is no important habitat in the Project area (Table 9).

7.2.8 Painted Honeyeater

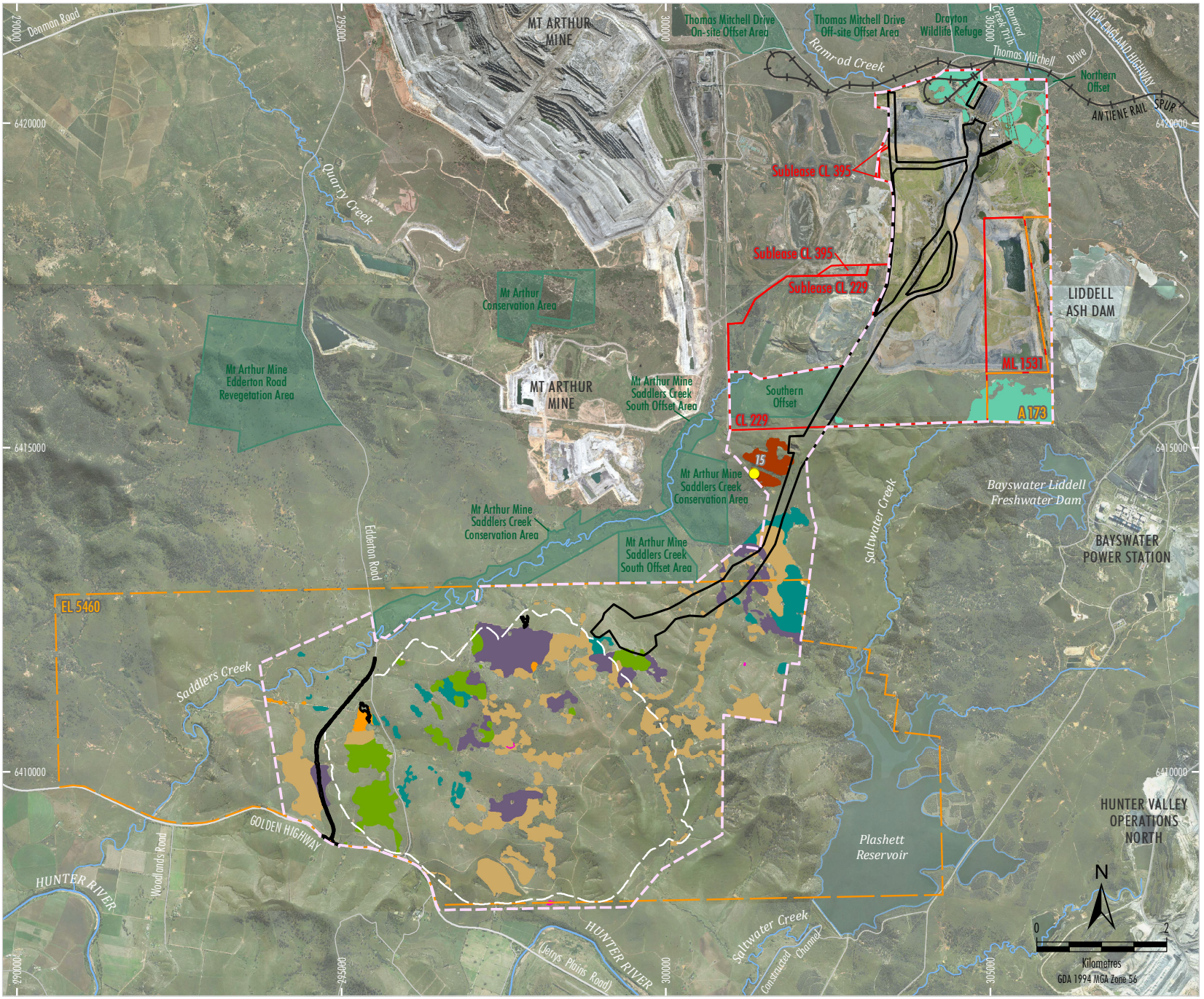
The Project would result in the direct clearance of approximately 25.2 ha of potential foraging habitat for the Painted Honeyeater (Figure 32) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 32). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Painted Honeyeater are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services);
- locating the MEA predominately within an area of DNG rather than woodland; and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include habitat for the Painted Honeyeater in the form of woodland.

No recognised threats to the Painted Honeyeater (DotE 2015c) are likely to occur indirectly as a result of the Project. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Painted Honeyeater

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 10. Weeping Myall Woodland (PCT116)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Painted Honeyeater Potential Habitat

Figure 32

SHM-18-03 Maxwell_EIS_App_BDAR_229D

If the potential foraging habitat in the Biodiversity Assessment Development Footprint is removed, it is likely to be of little consequence to the Painted Honeyeater given there have been no previous records of this bird in the Biodiversity Assessment Development Footprint. As a single individual was recorded in PCT 1607, it is likely that it was in foraging habitat only, and perhaps an itinerant individual. There is better potential habitat for these species outside the Biodiversity Assessment Development Footprint (e.g. along Saddlers Creek).

It is considered that the Project is not likely to have a significant impact on the Painted Honeyeater in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

No offset is required for this species. Notwithstanding, this species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) and as such has been included in the credit calculations for the Project (Tables 5 and 17).

7.2.9 Spotted-tailed Quoll (south-eastern mainland population)

The Project would result in the direct clearance of approximately 161.1 ha of potential habitat for the Spotted-tailed Quoll (Figure 33) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 2 ha) of potential subsidence ponding (Figure 33). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Spotted-tailed Quoll are:

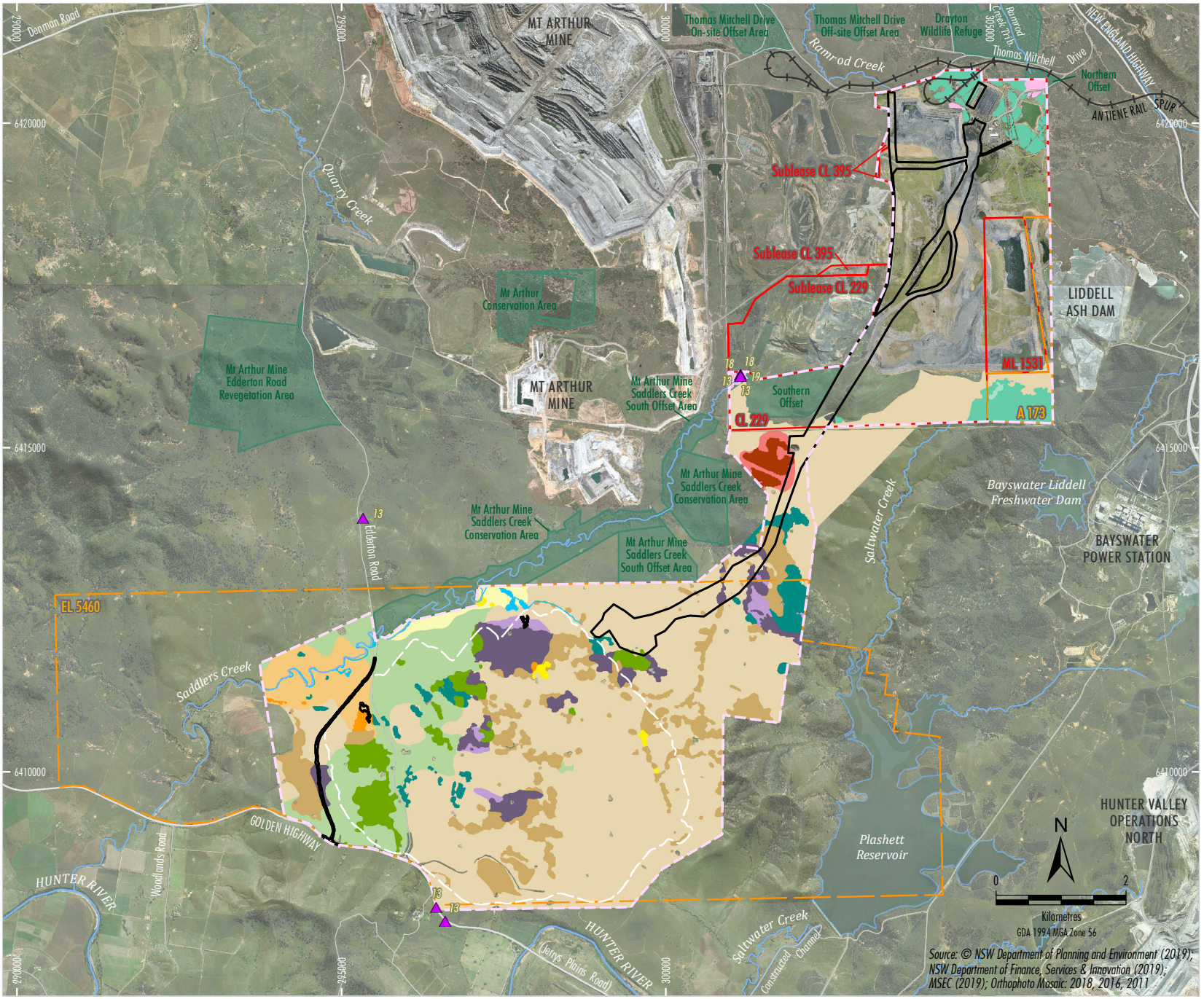
- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include habitat for the Spotted-tailed Quoll in the form of woodland.

The Spotted-tailed Quoll potential habitat adjacent to the Biodiversity Assessment Development Footprint (Figure 33) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, livestock grazing, habitat fragmentation, weeds and lack of fire (DotE 2015b; DEE 2016b). The Project is unlikely to indirectly impact the Spotted-tailed Quoll (were it to use the woodland potential habitat adjacent to the Biodiversity Assessment Development Footprint) as potential indirect impacts would be managed (Section 7.3).

Spotted-tailed Quoll are susceptible to vehicle strike (Department of Environment, Land, Water and Planning 2016; DEE 2019a). The potential impacts of vehicle strikes have been minimised for the Project through:

- use of the existing site access road to Maxwell Infrastructure from Thomas Mitchell Drive, directing traffic to and from the Project site primarily along Thomas Mitchell Drive and the New England Highway, which are existing high volume traffic routes;
- use of a covered overland conveyor, rather than trucks, to transport longwall ROM coal from the MEA to the existing Maxwell Infrastructure; and
- imposing speed limits on internal roads.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Spotted-tailed Quoll

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a. Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)
- 3a. Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4. Swamp Oak Forest (PCT1731)
- 5. Hunter Lowland Red Gum Forest (PCT1598)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 7a. Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693)
- 8. Fuzzy Box Woodland (PCT201)
- 8a. Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 9a. Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)
- 11a. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland - Derived Native Grassland (PCT1604)

Reference:
13. OEH (2019)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)
Note: There are no references 1 - 13 and 15 - 17 on this figure.

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Spotted-tailed Quoll Potential Habitat

Figure 33

Potential habitat for this species is widespread (Figure 33). It is considered that the Project is not likely to have a significant impact on the Spotted-tailed Quoll in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

No offset is required for the is species. Notwithstanding, this species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) and as such has been included in the credit calculations for the Project (Tables 5 and 17).

7.2.10 Corben's Long-eared Bat

As described in Section 7.1.2, Corben's Long-eared Bat may have been recorded in the Subject land nearly 20 years ago but the record is uncertain as the detection method is not known (Attachment B). This species was not recorded with certainty during the present or recent past surveys (Attachment B).

The Project would result in the direct clearance of approximately 20.9 ha of potential habitat (and a reduction in tree hollows [TSSC 2015b]) for Corben's Long-Eared Bat (Figure 34) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 34). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Corben's Long-Eared Bat are:

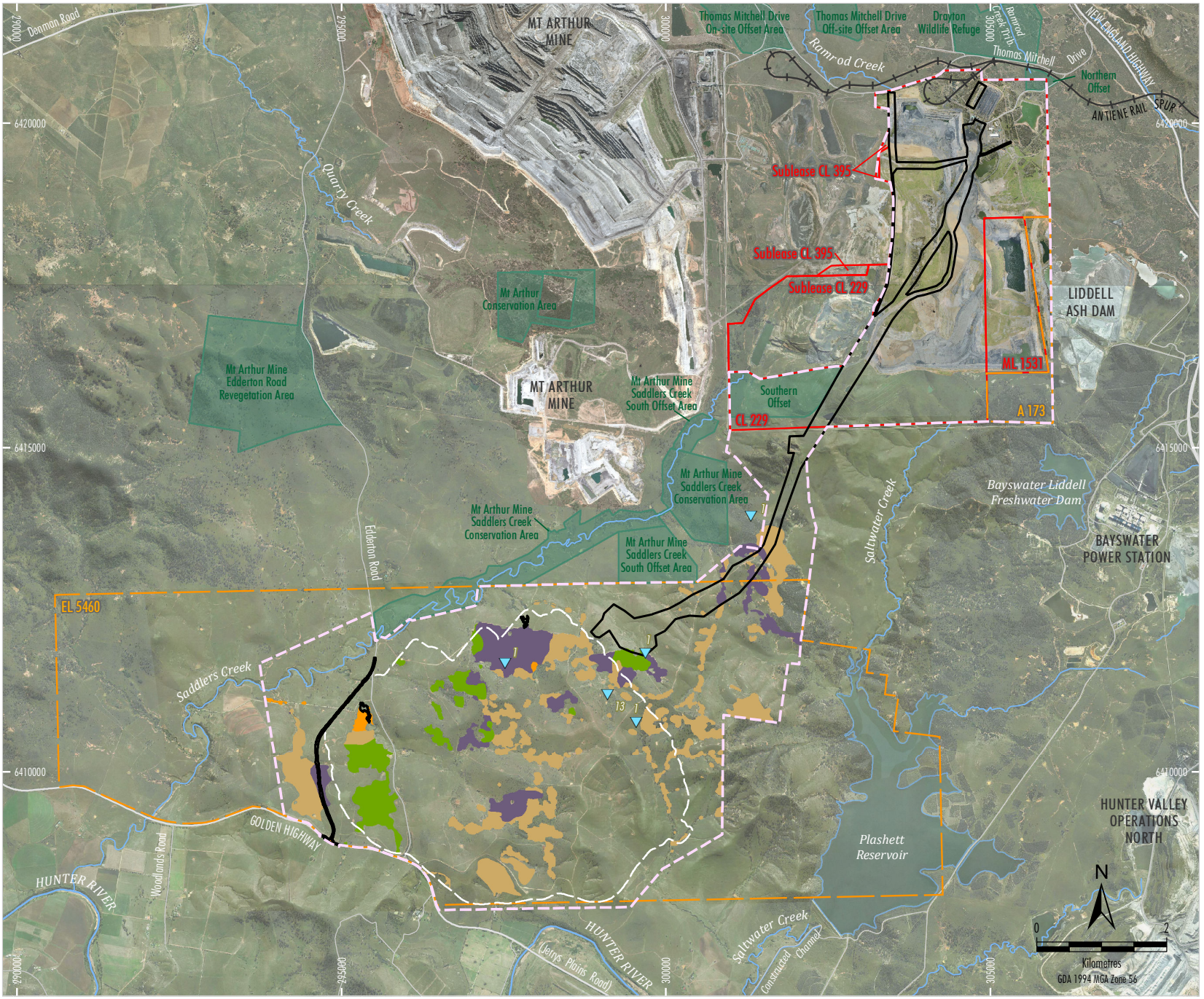
- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further beneficial use is identified. Revegetation would include habitat for the Corben's Long-Eared Bat in the form of woodland.

No recognised threats to Corben's Long-eared Bat (TSSC 2015b) are likely to occur indirectly as a result of the Project. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

The species may not use the potential habitat given, as stated above, this species was not recorded with certainty during the present or recent past surveys (Attachment B).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Corben's Long-eared Bat

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)

Reference:
1. Ecotone (2000)
13. OEH (2019)
Note: There are no references 2 - 12 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Corben's Long-eared Bat Potential Habitat

Figure 34

SHM-18-03 Maxwell_EIS_App_BDAR_248C

It is considered that the Project is not likely to have a significant impact on Corben's Long-Eared Bat in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

No offset is required for this species. Notwithstanding, this species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) and as such has been included in the credit calculations for the Project (Tables 5 and 17).

7.2.11 Grey-headed Flying-fox

No Grey-headed Flying-fox camps are located within the Project area or surrounds.

The Project would result in the direct clearance of approximately 24.5 ha of potential foraging habitat for the Grey-headed Flying Fox (Figure 35) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (<0.3 ha) of potential subsidence ponding (Figure 35). As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Grey-headed Flying Fox are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial is identified. Revegetation would include habitat for the Grey-headed Flying Fox in the form of woodland.

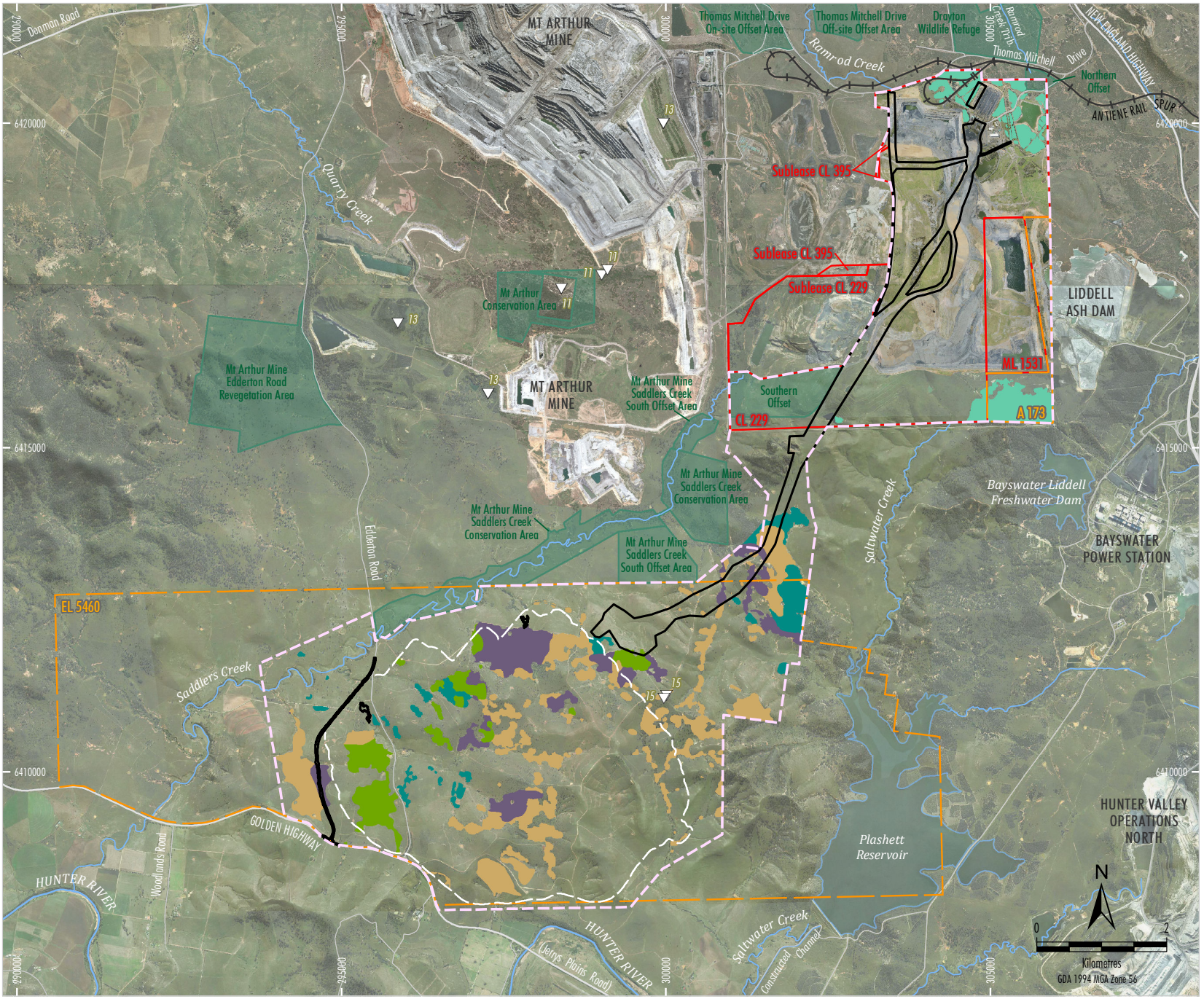
No recognised threats to the Grey-headed Flying-fox (DEE 2019a) are likely to occur indirectly as a result of the Project. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

No Grey-headed Flying-fox camps are located within the Project area or surrounds.

It is considered that the Project is not likely to have a significant impact on the Grey-headed Flying Fox in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

No offset is required for this species. Notwithstanding, this species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) and as such has been included in the credit calculations for the Project (Tables 5 and 17). This species was excluded as a species credit species due to no breeding camps in the Subject land (Table 9).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Grey-headed Flying-fox

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
11. Niche (2012)
13. OEH (2019)
15. Future Ecology (2019)
Note: There are no references 1 - 10, 12 and 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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MAXWELL PROJECT

Grey-headed Flying-fox Potential Habitat

Figure 35

SHM-18-03 Maxwell_EIS_App_BDAR_243C

7.2.12 Large-eared Pied Bat

No potential roosting habitat for the Large-eared Pied Bat (caves or similar structures) are located within the Project area or surrounds.

The Project would result in the direct clearance of approximately 25 ha of potential foraging habitat for the Large-eared Pied Bat (Figure 36) (Table 39). The clearance would be required for the proposed MEA, transport and services corridor and Edderton Road Realignment. The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 36).

As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Measures that have specifically avoided clearance of habitat for the Large-eared Pied Bat are:

- locating multiple infrastructure within the same transport and services corridor between the Maxwell Underground and Maxwell Infrastructure (a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services); and
- reducing the disturbance footprint required for the MEA.

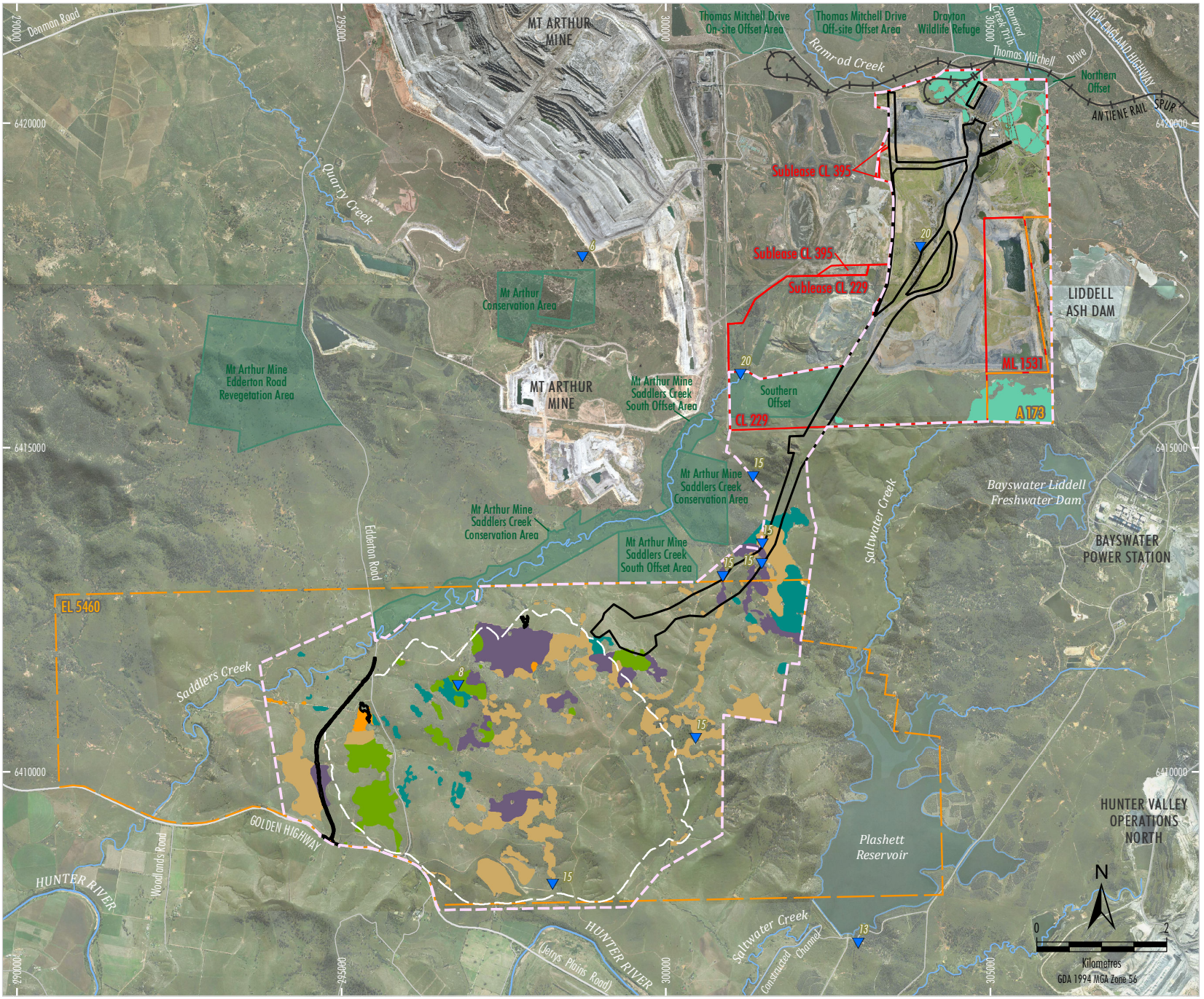
In the long-term, the surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified. Revegetation would include habitat for the Large-eared Pied Bat in the form of woodland foraging habitat.

Given the absence of roost habitat near the Project area, no recognised threats to the Large-eared Pied Bat (TSSC 2012; Department of Environment and Resource Management 2011) are likely to occur indirectly as a result of the Project.

Subsidence is unlikely to materially impact the potential habitat for this species within the predicted subsidence area as surface cracks would be remediated and potential impacts on trees (dieback or tree fall) is unlikely based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley (e.g. SLR Consulting 2019; Austar Coal Mine 2018; Ashton Coal Operations 2017; FloraSearch 2016).

It is considered that the Project is not likely to have a significant impact on the Large-eared Pied Bat in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013).

No offset is required for this species. Notwithstanding, this species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH 2019a) and as such has been included in the credit calculations for the Project (Tables 5 and 17).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Extent of Conventional Subsidence (20 mm subsidence contour)
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Large-eared Pied Bat

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:

6. Cumberland Ecology (2009a)
8. Cumberland Ecology (2012)
13. OEH (2019)
15. Future Ecology (2019)
20. Eco Logical Australia (2017)

Note: There are no references 1 - 10, 12 and 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Large-eared Pied Bat Potential Habitat

Figure 36

7.2.13 Summary

Based on the information available in the EPBC Act referral, DEE considered (in the input into the SEARs) that the Project is likely to have a significant impact on the:

- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*;
- *Central Hunter Valley Eucalypt Forest and Woodland*;
- Swift Parrot; and
- Regent Honeyeater.

The Project may not have a material adverse impact on the Swift Parrot and Regent Honeyeater as either species has not been recorded in the Biodiversity Assessment Development Footprint, no breeding habitat for these species is present, and the NSW Office of Environment and Heritage do not recognise the Subject land as important habitat for these species (negating the need for species credits). To be conservative and consistent with the DEE input into the SEARs, the BDAR assesses the Swift Parrot and Regent Honeyeater as if the Project could significantly impact the species.

Following submission of the EPBC Act referral, the following species were found in the Subject land, which could be significantly impacted:

- Striped Legless Lizard; and
- Pink-tailed Legless Lizard.

7.3 IMPACT AVOIDANCE AND MITIGATION MEASURES

As described in Sections 5.1 and 7.2, where possible the Project has been located and designed to avoid and minimise impacts on biodiversity values, including native vegetation and potentially occurring threatened species.

Table 40 provides information on proposed avoidance and mitigation measures to manage the relevant impacts of the Project for each of the relevant protected matters that are likely to be significantly impacted by the Project (Section 7.2.13). Included is a description and assessment of the expected or predicted effectiveness of the mitigation measures, and any statutory policy basis for the mitigation measures (e.g. conservation advice or recovery plan for the species or community, relevant threat abatement plans [e.g. DotE 2015d, 2016b; Department of the Environment, Water, Heritage and the Arts 2008]).

Proposed management plans are described in Section 5.6.

Table 40
Impact Mitigation Measures Relevant to Threatened Species and Communities listed under the EPBC Act

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage to adjoining areas during vegetation clearance activities or other works.	Effective if clearly delineated.	Rawlings et al. (2010), TSSC (2006) and DECCW (2010) describe protection of the TEC.
	Subsidence Impacts on Native Vegetation and Habitat	Remediation of surface cracks considered too large to naturally close	Remediation of mine subsidence effects (e.g. surface cracking and minor erosion). Preliminary assessment to minimise impact of remediation actions.	Effective when done in a controlled manner.	Rawlings et al. (2010), TSSC (2006) and DECCW (2010) describe protection of the TEC.
	Indirect Impacts on Native Vegetation and Habitat	Weed Management	Where they have been taken off road, washdown of vehicles and mechanical equipment to minimise seed transport off the site.	Effective when done in a controlled manner.	Rawlings et al. (2010), TSSC (2006) and DECCW (2010) describe weed management of the TEC.
			Identification of weeds requiring control.		
			Mechanical removal of identified weeds and/or the application of approved herbicides.		
			Follow-up site inspections to determine the effectiveness of the eradication programs.		
		Bushfire Management	According to the Bushfire Management Procedure.	Effective when applied.	Standard practice.

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
Central Hunter Valley Eucalypt Forest and Woodland	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	Effective if clearly delineated.	DotE (2015a) and DEE (2016a) describe protection of the TEC.
	Subsidence Impacts on Native Vegetation and Habitat	Remediation of surface cracks considered too large to naturally close	Remediation of mine subsidence effects (e.g. surface cracking and minor erosion).	Effective when done in a controlled manner.	DotE (2015a) and DEE (2016a) describe protection of the TEC.
	Indirect Impacts on Native Vegetation and Habitat	Weed Management	Where they have been taken off road, washdown of vehicles and mechanical equipment to minimise seed transport off the site.	Effective when done in a controlled manner.	DotE (2015a) and DEE (2016a) describe weed management of the TEC.
			Identification of weeds requiring control.		
			Mechanical removal of identified weeds and/or the application of approved herbicides.		
			Follow-up site inspections to determine the effectiveness of the eradication programs.		
		Bushfire Management	According to the Bushfire Management Procedure.	Effective when applied.	Standard practice.
Striped Legless Lizard	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	Effective if clearly delineated.	SEWPaC (2011).
	Loss of Individuals	Minimise Loss	Pre-clearance fauna surveys by suitably qualified personnel.	Relocation of captured individuals.	SEWPaC (2011).
			Impacts on fauna are managed during clearing activities by suitably qualified personnel.	Relocation of captured individuals.	

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
	Loss of Habitat	Mine Site Rehabilitation and Revegetation	Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).	Effective when applied.	SEWPaC (2011).
		Salvage and Re-Use of Material for Habitat Enhancement within Mine Site Rehabilitation	Identification of habitat features (e.g. surface rocks) that would be beneficial for habitat enhancement.	Effective when applied.	
	Subsidence Impacts on Native Vegetation and Habitat	Remediation of surface cracks considered too large to naturally close	Remediation of mine subsidence effects (e.g. surface cracking and minor erosion).	Effective when done in a controlled manner.	SEWPaC (2011).
	Indirect Impacts on Habitat	Feral Animal Management	Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna.	Effective if ongoing during development and operational stages.	SEWPaC (2011).
	Uncontrolled Spread of Weeds	Weed Management	Where they have been taken off road, washdown of vehicles and mechanical equipment to minimise seed transport off the site.	Effective when applied.	SEWPaC (2011).
			Identification of weeds requiring control.		
			Mechanical removal of identified weeds and/or the application of approved herbicides.		
			Follow-up site inspections to determine the effectiveness of the eradication programs.		

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
Pink-tailed Legless Lizard	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	Effective if clearly delineated.	TSSC (2015a).
	Loss of Individuals	Minimise	Pre-clearance fauna surveys by suitably qualified personnel.	Relocation of captured individuals.	TSSC (2015a).
			Impacts on fauna are managed during clearing activities by suitably qualified personnel.	Relocation of captured individuals.	TSSC (2015a).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation	Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).	Effective when applied	McDougall et al. and TSSC (2015a).
		Salvage and Re-Use of Material for Habitat Enhancement within Mine Site Rehabilitation	Identification of habitat features (e.g. surface rocks) that would be beneficial for habitat enhancement.	Effective when applied.	TSSC (2015a).
	Subsidence Impacts on Native Vegetation and Habitat	Remediation of surface cracks considered too large to naturally close	Remediation of mine subsidence effects (e.g. surface cracking and minor erosion).	Effective when done in a controlled manner.	TSSC (2015a).
	Indirect Impacts on Habitat	Feral Animal Management	Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna.	Effective if ongoing during development and operational stages.	TSSC (2015a).
	Uncontrolled Spread of Weeds	Weed Management	Where they have been taken off road, washdown of vehicles and mechanical equipment to minimise seed transport off the site.	Effective when applied.	Standard practice.

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
			Identification of weeds requiring control.		
			Mechanical removal of identified weeds and/or the application of approved herbicides.		
			Follow-up site inspections to determine the effectiveness of the eradication programs.		
		Bushfire Management	According to the Bushfire Management Procedure.	Effective when applied.	Standard practice.
Swift Parrot	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	Effective if clearly delineated.	TSSC (2016b) and Saunders and Tzaros (2011).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation	Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified). Include recognised suitable feed trees in rehabilitation.	Effective when applied.	TSSC (2016b) and Saunders and Tzaros (2011).
	Indirect Impacts on Native Vegetation and Habitat	Feral Animal Management	Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna.	Effective if ongoing during development and operational stages.	TSSC (2016b) and Saunders and Tzaros (2011).

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
Regent Honeyeater	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol	Areas to be cleared are delineated to prevent accidental damage during vegetation clearance activities or other works.	Effective if clearly delineated.	DotE (2015b and 2016c).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation	Surface disturbance areas associated with the Biodiversity Assessment Development Footprint would be rehabilitated and revegetated (when the surface facilities are no longer required or at the end of the mine life where no further ongoing beneficial use is identified).	Effective when applied.	DotE (2015b and 2016c).
	Indirect Impacts on Native Vegetation and Habitat	Feral Animal Management	Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by non-endemic fauna.	Effective if ongoing during development and operational stages.	DotE (2015b and 2016c).

7.4 COMMONWEALTH OFFSET

Section 8 describes the Offset Strategy for the Project in accordance with the NSW Biodiversity Offset Scheme. Malabar would retire like-for-like biodiversity credits for relevant EPBC Act listed threatened species and communities as required by the EPBC Act.

Table 41 provides an explanation on how the BAM was applied to EPBC Act species and communities.

Table 41
Application of the BAM to EPBC Act Species and Communities

	BAM Credit Calculation
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Ecosystem credits calculated for PCT 1606 (Woodland and DNG).
Central Hunter Valley Eucalypt Forest and Woodland	Ecosystem credits calculated for PCT 1604, 1655 and 1691 (Woodland only).
Striped Legless Lizard	Species credits.
Pink-tailed Legless Lizard	Species credits.
Swift Parrot	Ecosystem credits calculated for PCTs associated with potential habitat for this species, namely the woodland form of PCT 201, 1606, 1655, 1691 and 1692.
Regent Honeyeater	Ecosystem credits calculated for PCTs associated with potential habitat for this species, namely the woodland form of PCT 201, 1606, 1655 and 1691.

The conservation benefit associated for EPBC Act listed threatened species and communities with the proposed offset strategy is that larger areas of habitat (compared to that which would be cleared) would be conserved and enhanced under the NSW Biodiversity Offset Scheme in perpetuity.

Under the NSW Biodiversity Offset Scheme, offset areas are secured via Biodiversity Stewardship Site agreements which are administered by the NSW Biodiversity Conservation Trust. Credits would be retired (or payments made) according to the timing specified in the NSW and Commonwealth approvals to the satisfaction of the NSW Secretary of the Department of Planning and Environment and Commonwealth Minister of the Environment.

8 BIODIVERSITY OFFSET STRATEGY

The BAM (OEH 2017a) does not require a Biodiversity Offset Strategy to be presented in a BDAR, however, a Biodiversity Offset Strategy is required to be included in this BDAR in accordance with the SEARs for the EIS.

This Biodiversity Offset Strategy outlines how Malabar intends to offset the impacts of the Project on biodiversity.

8.1 NSW BIODIVERSITY OFFSET SCHEME

8.1.1 Offset Requirements

The NSW Biodiversity Offset Scheme is established under the BC Act and associated regulations. The scheme requires the credits calculated for the biodiversity impacts (Sections 6.2 and 6.3, Attachments C and D) to be retired via the offset rules.

8.1.2 Offset Rules

The offset rules established under the BC Regulation govern the types of biodiversity offsets that can be used to meet an offset requirement under the NSW Biodiversity Offset Scheme. In summary, impacts can be offset by one or a combination of the following options:

- the retirement of the required number and class of like-for-like biodiversity credits (Section 8.1.2);
- the retirement of the required biodiversity credits in accordance with the variation rules (Section 8.1.3);
- the funding of a biodiversity conservation action in accordance with ancillary rules;
- undertaking ecological mine rehabilitation of the impacted site; or
- the payment of an amount into the Biodiversity Conservation Fund determined in accordance with the BAM Credit Calculator.

8.1.3 Like-for-like Biodiversity Credits

Like-for-like biodiversity credits are defined under the BC Regulation as:

…

(2) In the case of impacts on threatened ecological communities, like-for-like biodiversity credits represent:

(a) the same threatened ecological community located in:

(i) the same or an adjoining Interim Biogeographic Regionalisation of Australia subregion as the impacted site, or

(ii) any such subregion that is within 100 kilometres of the outer edge of the impacted site, and

(b) if the threatened ecological community contains hollow bearing trees—vegetation that contains hollow bearing trees.

(3) In the case of impacts on the habitat of threatened species that are ecosystem credit species or other native vegetation (other than impacts on threatened ecological communities), like-for-like biodiversity credits represent:

(a) the same class of native vegetation located in:

(i) the same or an adjoining Interim Biogeographic Regionalisation of Australia subregion as the impacted site, or

(ii) any such subregion that is within 100 kilometres of the outer edge of the impacted site, and

(b) the same or a higher offset trading group, and

(c) if the impacted habitat contains hollow bearing trees—vegetation that contains hollow bearing trees.

(4) In the case of impacts on threatened species that are species credit species, like-for-like biodiversity credits represent the same threatened species.

A class of credits is defined in the BAM (OEH 2017a) as:

A class of credits is formed where the biodiversity credit shares the same attributes. For ecosystem credits, the attributes are as follows:

(a) name of the PCT impacted by development, clearing or conferral of biodiversity certification

(b) name of any CEEC or EEC or vulnerable ecological community (VEC) associated with the PCT identified in (a)

(c) name of the offset trading group for the PCT or TEC as identified in Table 5

(d) vegetation class of the PCT identified in (a)

(e) vegetation formation of the PCT identified in (a)

(f) presence or absence of hollow bearing trees

(g) IBRA subregion in which the development, clearing or biodiversity certification occurs.

…

For species credits, name of the threatened species being impacted at the development site, clearing site or land to be certified is the only attribute that needs to be shared in order to be in the same class of credits.

Trading groups for ecosystem credits are defined in the BAM (OEH 2017a) as:

Very high threat status
Tier 1: Name of the critically endangered ecological community
Tier 2: PCTs in the same vegetation class with a percent cleared value ≥90% (being the name of the vegetation class – percent cleared value ≥90%)

High threat status
Tier 3: Name of the endangered ecological community
Tier 4: PCTs in the same vegetation class with a percent cleared value ≥70% and <90% (being the name of the vegetation class – percent cleared value ≥70% and <90%)

Moderate threat status
Tier 5: Name of the vulnerable ecological community
Tier 6: PCTs in the same vegetation class with a percent cleared value ≥50% and <70% (being the name of the vegetation class – percent cleared value ≥50% and <70%)

Low threat status
Tier 7: PCTs in the same vegetation class with a percent cleared value <50% (being the name of the vegetation class – percent cleared value <50%)

The reports detailing the like-for-like credit requirements from the BAM Credit Calculator are provided in Attachments E and F, respectively.

8.1.4 Variation Rules

In some circumstances, like-for-like biodiversity credits are not able to be retired. The BC Regulation establishes the following variation rules:

> *(a) The proponent who is to retire the biodiversity credits has taken reasonable steps to obtain the requisite like-for-like biodiversity credits and requests the variation of the ordinary offset rules.*
>
> *(b) In the case of impacts on threatened ecological communities or on the habitat of threatened species that are ecosystem credit species or other native vegetation—the biodiversity credits to be retired need not represent the same threatened ecological community or the same class of vegetation or represent a location in the same or adjoining Interim Biogeographic Regionalisation of Australia subregion, so long as:*
>
> *(i) they represent the same vegetation formation, and*
>
> *(ii) they are in the same or a higher offset trading group, and*
>
> *(iii) they represent a location that is in:*
>
> *(A) the same Interim Biogeographic Regionalisation of Australia region as the impacted site, or*
>
> *(B) a subregion that is within 100 kilometres of the outer edge of the impacted site, and*
>
> *(iv) if the impacted habitat contains hollow bearing trees—they represent vegetation that contains hollow bearing trees or artificial hollows.*
>
> *(c) In the case of impacts on threatened species that are species credit species—the biodiversity credits to be retired need not represent the same threatened species, so long as:*
>
> *(i) if the impacted species is a plant—they represent a plant, and*
>
> *(ii) if the impacted species is an animal—they represent an animal, and*
>
> *(iii) they represent a species that has the same or a higher category of listing under Part 4 of the Act as a threatened species, and*
>
> *(iv) they represent a location that is in:*
>
> *(A) the same or an adjoining Interim Biogeographic Regionalisation of Australia subregion as the impacted site, or*
>
> *(B) any such subregion that is within 100 kilometres of the outer edge of the impacted site.*
>
> *(2) The variation rules do not apply in relation to impacts on threatened species or ecological communities that are excluded by the Environment Agency Head.*

The reports detailing the variation credit requirements from the BAM Credit Calculator are provided in Attachments G and H, respectively.

8.2 COMMONWEALTH OFFSET REQUIREMENTS

The DEE input into the SEARs states the following in relation to Commonwealth offsets:

> *It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same EEC or habitat being impacted, or funding to provide a direct benefit to the matter being impacted i.e. threat abatement, breeding and propagation programs or other relevant conservation measures.*

In February 2019, the Commonwealth Government released amendments to the NSW Bilateral Agreement in relation to Environmental Assessment. The DEE (2019b) website states:

> *The Australian Government intends to endorse NSW's new Biodiversity Offset Scheme (BOS), which includes the BAM, the offset rules, the Biodiversity Conservation Regulation 2017, and payments to the Biodiversity Conservation Trust…. NSW has committed to amending the NSW BOS offset rules, and is considering amending the related regulations, to align offsetting with Australian Government requirements and ensure like-for-like offsets are achieved for Commonwealth-listed threatened species and communities.*

8.3 BIODIVERSITY CREDITS REQUIRED TO BE RETIRED WITH LIKE-FOR-LIKE BIODIVERSITY CREDITS

If retiring credits, instead of making a payment (Section 8.5), Malabar would retire like-for-like biodiversity credits for relevant Commonwealth-listed threatened species and communities as required by the EPBC Act, and potentially as well for matters that are not EPBC Act listed.

Table 42 lists the biodiversity credits required to be retired with like-for like biodiversity credits. These are biodiversity credits associated with:

- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*;
- *Central Hunter Valley Eucalypt Forest and Woodland*;
- Striped Legless Lizard;
- Pink-tailed Legless Lizard;
- Swift Parrot; and
- Regent Honeyeater.

Table 42
Biodiversity Credits Required to be Retired with Like-For-Like Biodiversity Credits

PCT	Generic Name	Area (ha)			Credits Required[1]			Reason
		Stage 1	Stage 2	Total	Stage 1	Stage 2	Total	
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[2]	9.5	0.1	9.6	216	2	218	EPBC Act Listed TEC, Potential habitat for the Swift Parrot and Regent Honeyeater
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[2]	122.7	2.9	125.6	971	45	1,016	EPBC Act Listed TEC
1655	3. Slaty Box Shrubby Woodland[3]	1.2	0.2	1.4	21	2	23	EPBC Act Listed TEC, Potential habitat for the Swift Parrot and Regent Honeyeater
1692	6. Bull Oak Grassy Woodland*	2.8	0	2.8	45	0	45	Potential habitat for the Swift Parrot
201	8. Fuzzy Box Woodland	0.5	0	0.5	15	0	15	Potential habitat for the Swift Parrot and Regent Honeyeater
1691	9. Ironbark - Grey Box Grassy Woodland[4]	7.6	2	9.6	184	51	235	EPBC Act Listed TEC, Potential habitat for the Swift Parrot and Regent Honeyeater
1604	11. Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland[5]	1.3	0	1.3	44	0	44	EPBC Act Listed TEC
Pink-tailed Legless Lizard Species Credits		36	2.7	38.7	381	41	423	EPBC Act Listed
Striped Legless Lizard Species Credits		145.4	7.4	152.8	1,126	99	1,225	EPBC Act Listed

1 Refer to Attachments E and F.

2 Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

3 Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

4 Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

5 Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

* This occurrence of PCT 1692 does not meet the criteria for the EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland.

8.3.1 Biodiversity Stewardship Site Investigation

Malabar may choose to establish a Biodiversity Stewardship Site on land owned by Malabar. Biodiversity Stewardship Site Management Plan, including management actions to improve biodiversity values, is required for all Biodiversity Stewardship Sites.

Potential Resource Sterilisation

The SEARs for the EIS requested a summary of any potential resource sterilisation in relation to biodiversity offset areas. The Biodiversity Stewardship Site would be established in accordance with the BC Act requirements in relation to potential resource sterilisation.

Malabar may establish potential offset areas on land owned by Malabar within EL 5460 (held by Malabar) and EL 6812 (held by Dellworth Pty Limited, a subsidiary of NuCoal Resources Ltd [NuCoal]). Open cut mining within EL 5460 is prohibited under the Mining SEPP. Therefore, if Malabar were to establish offset areas within EL 5460 the offset areas would not result in any resource sterilisation. NuCoal has not released any public information regarding the extent or timing of any future mining in EL 6812, or proposed mining method. Malabar has consulted with NuCoal regarding the Project and potential offset areas. No concerns have been raised by NuCoal to date.

8.4 BIODIVERSITY CREDITS THAT COULD BE RETIRED IN ACCORDANCE WITH THE VARIATION RULES

If retiring credits, instead of making a payment (Section 8.5), the variation rules could be applied to the credit requirement listed in Table 43.

Table 43
Biodiversity Credits That Could be Retired in Accordance with the Variation Rules

PCT	Generic Name	Area (ha)			Credits Required[1]		
		Stage 1	Stage 2	Total	Stage 1	Stage 2	Total
1607	1. Red Gum - Ironbark - Apple Shrubby Woodland	0.4	0	0.4	9	0	9
1607	1a. Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	4.9	0	4.9	59	0	59
1655	3a Slaty Box Shrubby Woodland (DNG)	0	2.4	2.4	0	24	24
1731	4. Swamp Oak Forest	0	0.2	0.2	0	4	4
201	8a. Fuzzy Box Woodland (DNG)	1	1.8	2.8	14	26	40
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	0.3	0	0.3	6	0	6
1604	Pasture Rehabilitation	49.3	0	49.3	0	0	0
1604	Woodland Rehabilitation	15.2	0	15.2	214	0	214
Squirrel Glider Species Credits		40.7	2.3	43	524	33	557
Southern Myotis Species Credits		0.5	1.4	1.9	9	36	45

[1] Refer to Attachments G and H.

8.5 PAYMENTS

Payments could be made to the NSW Biodiversity Conservation Fund instead of, or as well as, retiring credits. The costs of the payment have been determined by the BAM Credit Calculator as approximately $7.3 million. The payment summary reports from the BAM Credit Calculator are provided in Attachments I and J, respectively.

8.6 ECOLOGICAL MINE REHABILITATION

OEH has not yet released the "ancillary rules for mine site ecological rehabilitation" (as of May 2019) so Malabar is unable to evaluate this option at this stage.

8.7 TIMING

Credits would be retired (or payments made) according to the timing specified in the NSW and Commonwealth approvals to the satisfaction of the NSW Secretary of the Department of Planning and Environment and Commonwealth Minister of the Environment.

As described in Section 1.3, the potential Edderton Road realignment has been assessed as a second stage of the development as the potential subsidence impacts on Edderton Road would be managed through either: (i) road maintenance along the existing alignment; (ii) or the realignment of the road around the Maxwell Underground area.

9 CONCLUSION

This Biodiversity Development Assessment Report was prepared in accordance with the NSW *Biodiversity Assessment Method* (BAM) and the Secretary's Environmental Assessment Requirements (SEARs) for the Project.

Being an underground mine, the Project has been shown to have minimal impact on threatened biodiversity compared with an open cut mine. For example, previously unrecorded populations of the Pink-tailed Legless Lizard and Striped Legless Lizard would persist in the surrounding locality.

The impact avoidance, mitigation and offset hierarchy has been applied to the Project and the credit calculation has determined the offset requirement for unavoidable clearance of native vegetation (woodland, forest and secondary/derived native grasslands) (ecosystem credit requirement) and the offset requirement for the unavoidable clearance of potential habitat for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis. It is proposed that these offset requirements would be met through retirement of biodiversity credits, ecological mine rehabilitation and/or contribution to the Biodiversity Conservation Fund.

The direct loss of habitat associated with the Project in combination with offset provisions (Section 8) would result in no net loss in biodiversity. This is because the biodiversity offset would be a greater area of land, multiple times the size of the Biodiversity Assessment Development Footprint, which will be conserved and managed to achieve a gain in biodiversity values.

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ATTACHMENT A
MAXWELL PROJECT BASELINE FLORA REPORT

MALABAR COAL

MAXWELL PROJECT

BASELINE FLORA REPORT

HUNTER ECO

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July 2019

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Cover: Looking south from the mid-eastern boundary of the underground mining area

EXECUTIVE SUMMARY

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project). The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook.

The Project would involve an underground mining operation that would produce high quality coals over a period of approximately 26 years. At least 75% of coal produced by the Project would be capable of being used in the making of steel (coking coals). The balance would be export thermal coals suitable for the new generation High Efficiency, Low Emissions power generators.

The Project would involve extraction of run-of-mine coal, from four seams within the Wittingham Coal Measures using the following underground mining methods:

- underground bord and pillar mining with partial pillar extraction in the Whynot Seam; and
- underground longwall extraction in the Woodlands Hill Seam, Arrowfield Seam and Bowfield Seam.

This is a baseline report of the flora and vegetation communities across a Study Area encompassing surface works associated with the Project along with the planned extent of surface subsidence resulting from the underground mining operation.

The objectives of this report were to:

- document plant species growing across the Study Area by drawing on the results of all past surveys and augmenting this information with that from contemporary surveys;
- classify and map the distribution of vegetation communities across the Study Area; and
- target species, communities and populations listed as threatened either in the NSW *Biodiversity Conservation Act, 2016* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

The surveys were conducted according to the methods and requirements of all relevant NSW and Commonwealth guidelines.

The Study Area is comprised of two different land use types. The northern area, Maxwell Infrastructure, consists of previous open cut mining areas and existing infrastructure, with some woodland areas. The larger southern area consists of a mosaic of grazing land and woodland. This area has been occupied for farming since the early 1800's with over 75% of the area having been cleared.

Eleven vegetation communities were mapped across the Study Area. Several of these communities were present in both remnant vegetation form and derived native grassland form. For the derived native grassland, scattered paddock tree species indicated the likely community that had been cleared.

For each of the vegetation communities, floristic content was compared with that listed in the various Scientific Committee Determinations and related advice to identify any threatened ecological communities listed under the BC Act and the EPBC Act. The threatened communities found to be present are listed in Table ES-1.

Table ES-1 Threatened Ecological Communities Recorded across the Study Area

Threatened Ecological Community	Conservation Status
Threatened Ecological Communities listed under the BC Act	
White Box Yellow Box Blakely's Red Gum Woodland	E
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E
Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E
Hunter Valley Weeping Myall Woodland	CE
Hunter Lowland Redgum Forest in the Sydney Basin Bioregion	E
Threatened Ecological Communities listed under the EPBC Act	
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE
Central Hunter Valley Eucalypt Forest and Woodland	CE
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE

V = Vulnerable E = Endangered CE = Critically Endangered.

One threatened flora species listed under the BC Act has been previously recorded in the Study Area, namely the Pine Donkey Orchid (*Diuris tricolor*). This species is also a component of the *Diuris tricolor* Fitzg*., the Pine Donkey Orchid in the Muswellbrook local government area* Endangered Population under the BC Act. No *Diuris tricolor* were found at locations of previous records or at any other location within the Study Area, all of which were surveyed during the documented flowering time for the species.

Two other flora species, representatives of Endangered Populations under the BC Act, have previously been recorded in the Study Area. These were:

- *Cymbidium canaliculatum,* a component of *Cymbidium canaliculatum* population in the Hunter catchment; and
- *Acacia pendula,* a component of *Acacia pendula* population in the Hunter catchment.

Cymbidium canaliculatum and *Acacia pendula* were both re-recorded in the current study.

No threatened flora species listed under the EPBC Act were recorded in the Study Area, and also had not been recorded in any past studies.

Preferred Koala feed trees White Box (*Eucalyptus albens*) and Grey Box (*Eucalyptus moluccana*) were present in sufficient quantity to meet the *State Environment Planning Policy 44 – Koala habitat protection* condition of *potential* Koala habitat.

The vegetation along Saddlers Creek and the lower parts of tributaries entering was consistent with a groundwater dependent ecosystem (GDE) being predominantly Swamp Oak (*Casuarina glauca*). However, across the rest of the Study Area the vegetation was dry sclerophyll woodland/forest, which is not groundwater dependent.

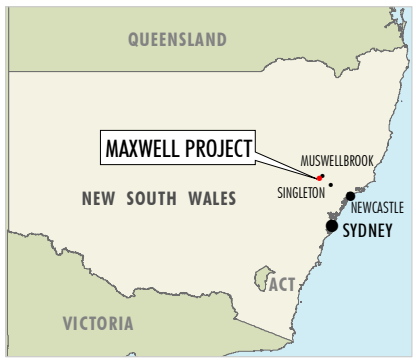
1 INTRODUCTION

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project).

The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook (Figure 1).

Underground mining is proposed within Exploration Licence (EL) 5460, which was acquired by Malabar in February 2018. Malabar also acquired existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395, known as "Maxwell Infrastructure". The Project would include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure (Figure 2).

This assessment forms part of an Environmental Impact Statement (EIS) which has been prepared to accompany a Development Application for the Project in accordance with Part 4 of the NSW *Environmental Planning and Assessment Act, 1979*.



LEGEND

- Mining Operation
- Proposed Mining Operation
- Railway
- Local Government Boundary
- State Forest
- National Parks and Wildlife Service Estate
- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development

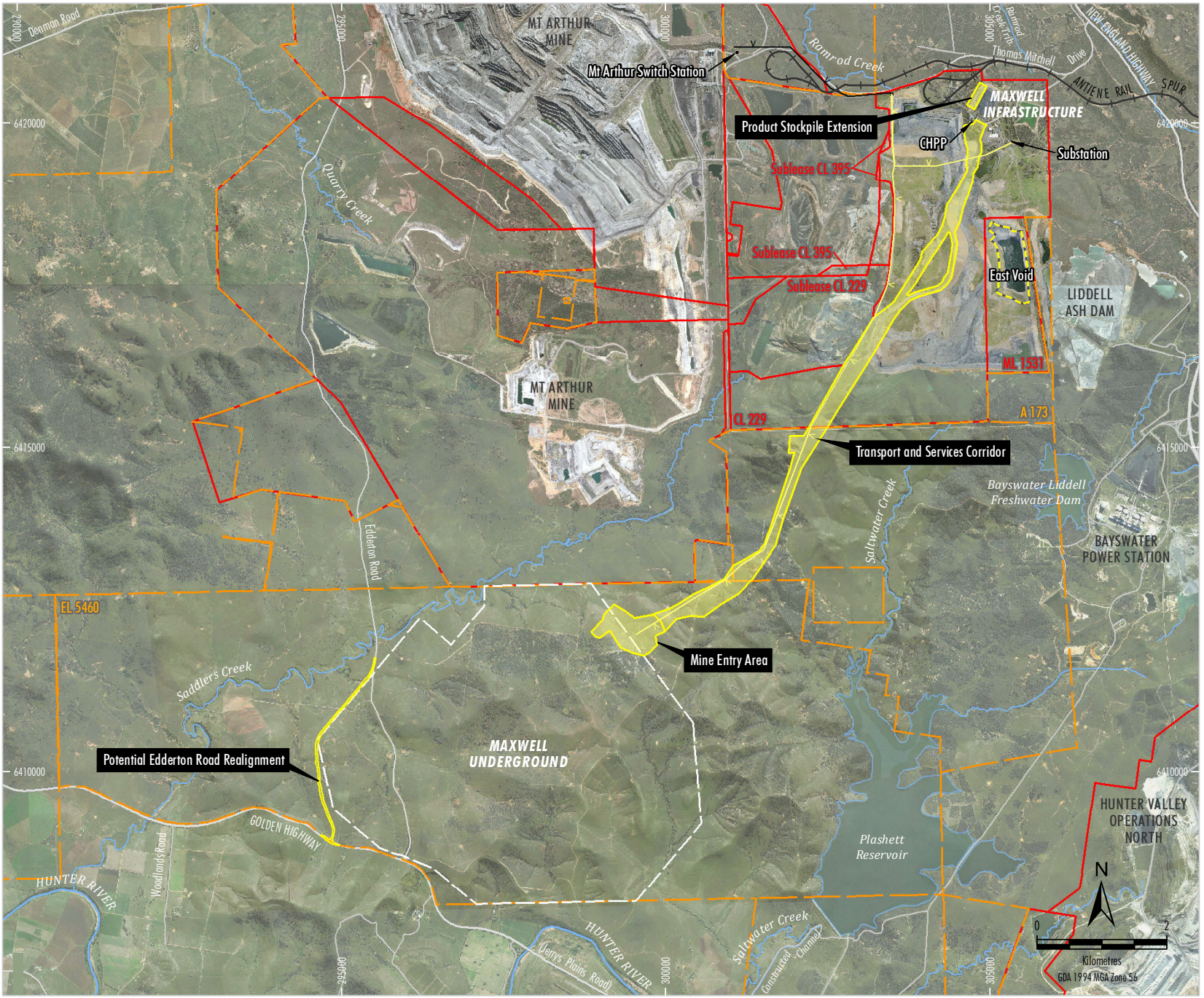
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services and Innovation (2019); Office of Environment and Heritage NSW (2019)

MALABAR COAL

MAXWELL PROJECT

The Project in a Regional Context

Figure 1



LEGEND

- Railway
- Exploration Licence Boundary
- Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Indicative Surface Development Area
- CHPP Reject Emplacement Area
- Proposed 66 kV Power Supply
- Proposed Ausgrid 66 kV Power Supply Extension#

Subject to separate assessment and approval.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

The Project General Arrangement

Figure 2

SHM-18-03 Maxwell_EIS_App Flora_203A

2 PROJECT DESCRIPTION

The Project would involve an underground mining operation that would produce high quality coals over a period of approximately 26 years. At least 75 percent (%) of coal produced by the Project would be capable of being used in the making of steel (coking coals). The balance would be export thermal coals suitable for the new generation High Efficiency, Low Emissions power generators.

The Project would involve extraction of run-of-mine (ROM) coal, from four seams within the Wittingham Coal Measures using the following underground mining methods:

- underground bord and pillar mining with partial pillar extraction in the Whynot Seam; and
- underground longwall extraction in the Woodlands Hill Seam, Arrowfield Seam and Bowfield Seam.

The substantial existing Maxwell Infrastructure would be used for handling, processing and transportation of coal for the life of the Project. Maxwell Infrastructure includes an existing coal handling and preparation plant (CHPP), train load-out facilities and other infrastructure and services (including water management infrastructure, administration buildings, workshops and services). A mine entry area would be developed for the Project in a natural valley north of EL 5460 to support underground mining and coal handling activities and provide for personnel and materials access.

ROM coal brought to the surface at the mine entry area would be transported to the Maxwell Infrastructure area. Early ROM coal would be transported via internal roads during the construction and commissioning of a covered overland conveyor system. Subsequently, ROM coal would be transported to the Maxwell Infrastructure area via the covered overland conveyor system.

The existing product coal stockpile area at Maxwell Infrastructure would be extended to allow for better management of different product coal blends. An additional ROM stockpile would also be developed adjacent to the CHPP to cater for delivery of ROM coal via the covered overland conveyor.

The Project would support continued rehabilitation of previously mined areas and overburden emplacements areas within CL 229, ML 1531 and CL 395. The volume of the East Void would be reduced through the emplacement of reject material generated by Project coal processing activities and would be capped and rehabilitated at the completion of mining.

An indicative Project general arrangement is provided on Figure 2. The Project area comprises the following main domains:

- Maxwell Underground – comprising the proposed area of underground mining operations and the MEA within EL 5460.
- Maxwell Infrastructure – the area within existing mining leases comprising the substantial existing infrastructure (including the CHPP) and previous mining areas.
- The transport and services corridor between Maxwell Underground and Maxwell Infrastructure – this would comprise a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services.
- A potential realignment of Edderton Road.

A detailed description of the Project is provided in the main document of the EIS.

3 OBJECTIVES, GUIDELINES AND SOURCES

The objectives of this report are to:

- document plant species growing across the Study Area by drawing on the results of all past surveys and augmenting this information with that from current surveys;
- classify and map the distribution of vegetation communities and Plant Community Types (PCTs) across the Study Area; and
- target species, communities and populations listed as threatened either in the NSW *Biodiversity Conservation Act, 2016* (BC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

The following methods, guidelines and policies were consulted in the methodology of this study:

- NSW *Biodiversity Assessment Method Order, 2017* (BAM) (Office of Environment and Heritage [OEH] 2017);
- *NSW Guide to Surveying Threatened Plants* (OEH 2016a);
- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NSW Office of Water [NOW] 2012);
- *State Environmental Planning Policy No.44 – Koala Habitat Protection* (SEPP 44);
- *Review of SEPP 44 (Koala Habitat Protection)* (Department of Planning and Environment [DP&E] 2018); and
- *Draft Survey Guidelines for Australia's Threatened Orchids* (Department of the Environment [DotE] 2013).

Threatened species and communities habitat and distribution data were drawn from:

- *BioNet Vegetation Classification* (OEH 2019a);
- *Threatened Biodiversity Data Collection* (OEH 2019b);
- *BioNet Atlas* (OEH 2019c);
- *PlantNET, The NSW Plant Information Network System* (Royal Botanic Gardens and Domain Trust [RBG] 2018);
- Commonwealth *Species Profile and Threats Database* (Department of the Environment and Energy [DEE] 2019); and
- *Atlas of Living Australia* (ALA) (ALA 2018).

4 REGIONAL SETTING

The Study Area is located in:

- Sydney Basin Bioregion;
- Central Western Slopes Botanical Division;
- Hunter Local Land Service Region; and
- Muswellbrook Local Government Area (LGA).

5 DESCRIPTION OF THE STUDY AREA AND SURROUNDS

In this report, the overall Study Area has been split into the Northern and Southern Study Areas reflecting the distinctly different character of each. The Northern Study Area includes Maxwell Infrastructure and consists primarily of previous open cut mining areas and existing infrastructure, with some woodland areas. The Southern Study Area consists of a mosaic of cleared grazing land and woodland. A narrow strip of land lying east-west is leased to AGL Energy Limited (AGL) and contains a coal conveyor supplying coal to Bayswater Power Station.

5.1 Landuse History

Agricultural industries within the surrounding locality include cattle grazing, horse breeding and viticulture. Freehold land within the Study Area is owned by Malabar, with the exception of a small area within the transport and services corridor in the north, which is owned by AGL.

At the time of an initial inspection of the Study Area in 2017 the property was stocked with cattle, particularly on the eastern side of Edderton Road, and it was apparent by the heavily eroded cattle tracks, and closely grazed ground cover, that this has been an ongoing practice. These agricultural activities are supported by farm dams, unsealed tracks, land contouring, cattle yards and fencing.

Land to the north of Maxwell Underground is associated with active or previous open cut coal mining activities (i.e. Mt Arthur Mine).

The land within the Study Area is primarily cleared, open paddock grazing land, with some areas of remnant forest and open woodland and mainly used for cattle grazing along with minor cropping. The Study Area and surrounds have been cleared of most of the original woodland/forest since the mid 1800's. The earliest available aerial photography (1958) shows that there was negligible remnant woodland within the Study Area at that time (Figure 3) with paddock trees of a varying density present.

AGL-owned land associated with Bayswater and Liddell Power Stations is located to the east of the Project. Plashett Reservoir serves as an off-river water storage for Bayswater Power Station and the township of Jerrys Plains.

5.2 Mitchell Landscapes

Mitchell Landscapes are mapped regions of NSW that collate areas having common attributes including an estimate of the amount cleared since 1750 (Mitchell 2002; OEH 2016b). Details of the Mitchell Landscapes contained within the Southern Study Area are provided in Table 1.

Table 1: Mitchell Landscapes across the Southern Study Area

Status	Landscape	% Cleared	Area (ha)
Over-cleared	Central Hunter Foothills	75	3009
Over-cleared	Hunter River Basalts	97	116
Over-cleared	Upper Hunter Channels and Floodplain	96	239

5.3 Topography and Drainage

Figure 4 shows the topography and drainage across the Southern Study Area. The landform consists of a ridge system extending from the north-east to the south west. The majority of the drainage flows north-west into Saddlers Creek and ultimately into the Hunter River. Elevation ranges from 100 metres (m) Australian Height Datum (AHD) in the Saddlers Creek floodplain to 240 m on the main ridges, and 300 m on a high ridge to the north-east, towards the Northern Study Area. The Northern Study Area includes Maxwell Infrastructure and consists of previous open cut mining areas and existing infrastructure.

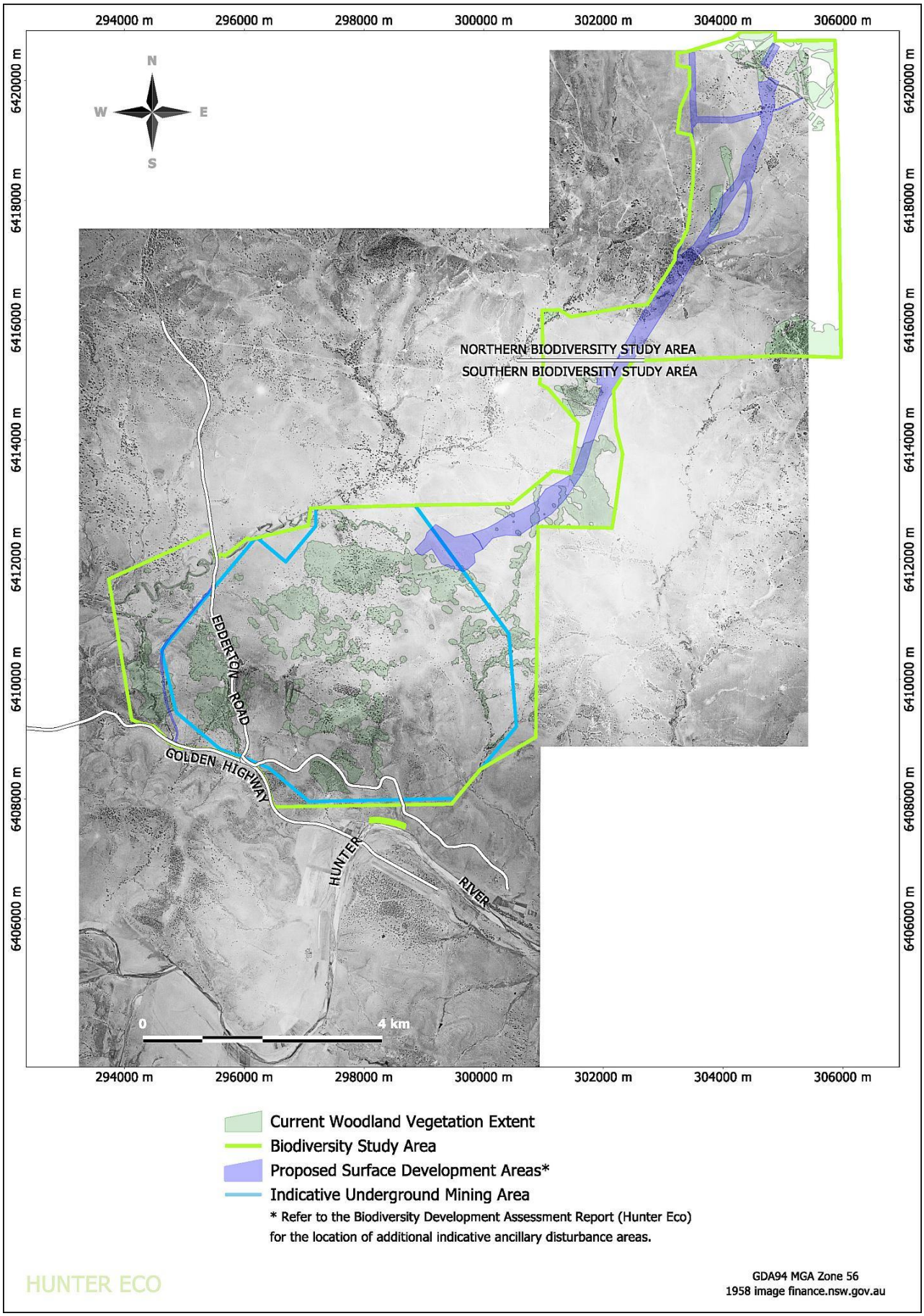


Figure 3: 1958 Aerial Image of the Study Area

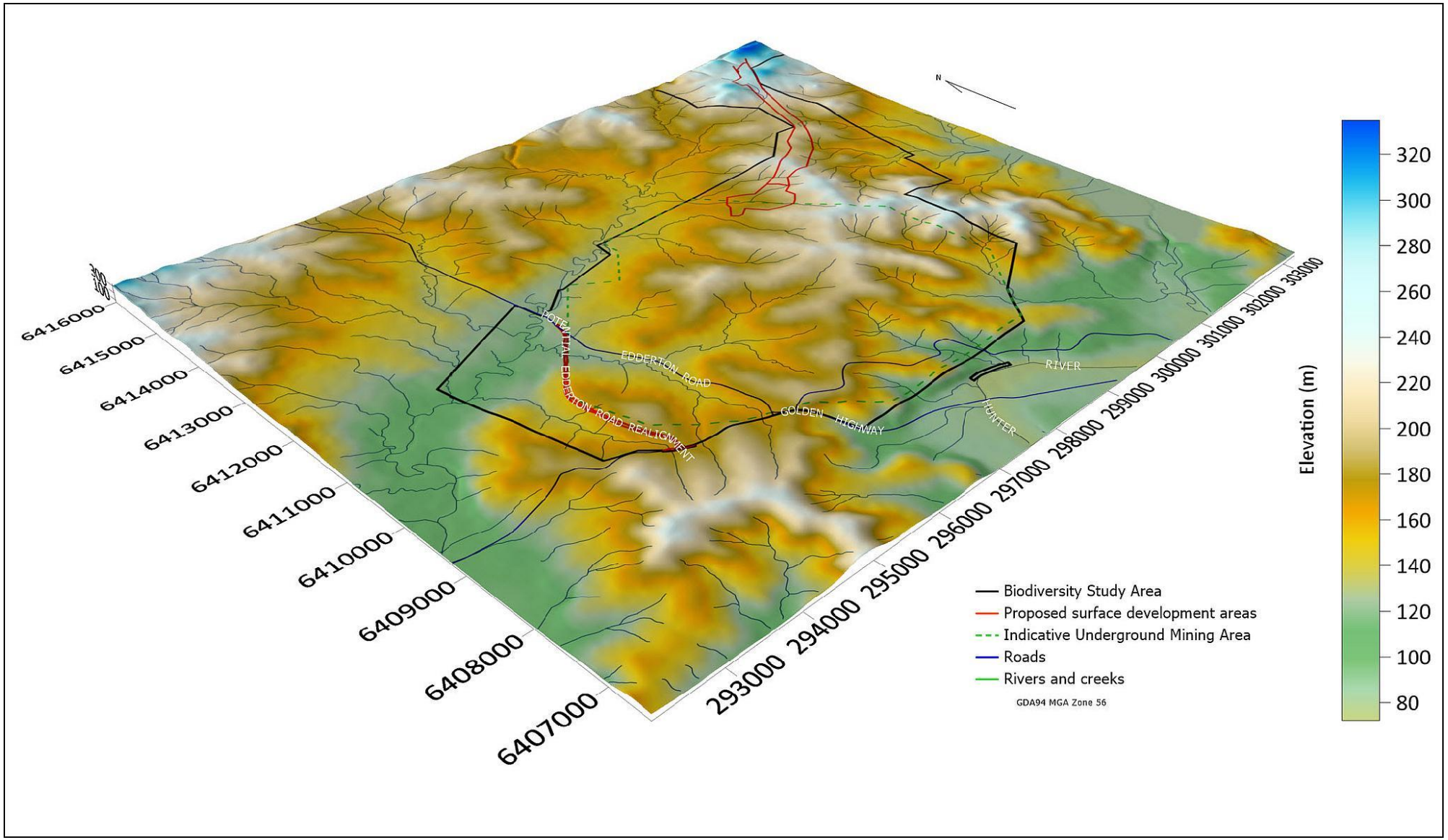


Figure 4: Topography and Drainage across the Southern Study Area

5.4 Geology and Soils

As expected for a coal-bearing area, the majority of the Study Area is of Permian age. A small amount of Quaternary sediments is located in the Saddlers Creek floodplain in the north-west and the Hunter River side channels in the south-east. Patches of Jurassic age basalt extrusions are in the north-east and south-east.

Across the elevated areas the dominant Australian Soil Classification (Isbell 2016) map shows soil types to be Vertosol and Chromosol. The floodplain soil type is shown as Sodosol with Kurosols, Natric in the north-east. Detailed soil mapping (SLR Consulting Australia Pty Ltd 2019) confirmed the presence of these general types with the exception of Kurosols, Natric.

5.5 Climate

Long-term climate data collected at the closest Bureau of Meteorology (BOM) weather station at Jerrys Plains Post Office (Station Number 061086) was used to characterise local climate. Jerrys Plains Post Office is approximately 7 kilometres (km) southeast of the Project.

Rainfall peaks during the summer months, with January having average rainfall of 77.1 millimetres (mm) over 6.4 days. August is the driest month, with an average rainfall of 36.1 mm over 5.2 days (BOM 2019a). Figure 5 shows the mean of the long-term average monthly rainfall at Jerrys Plains Post Office.

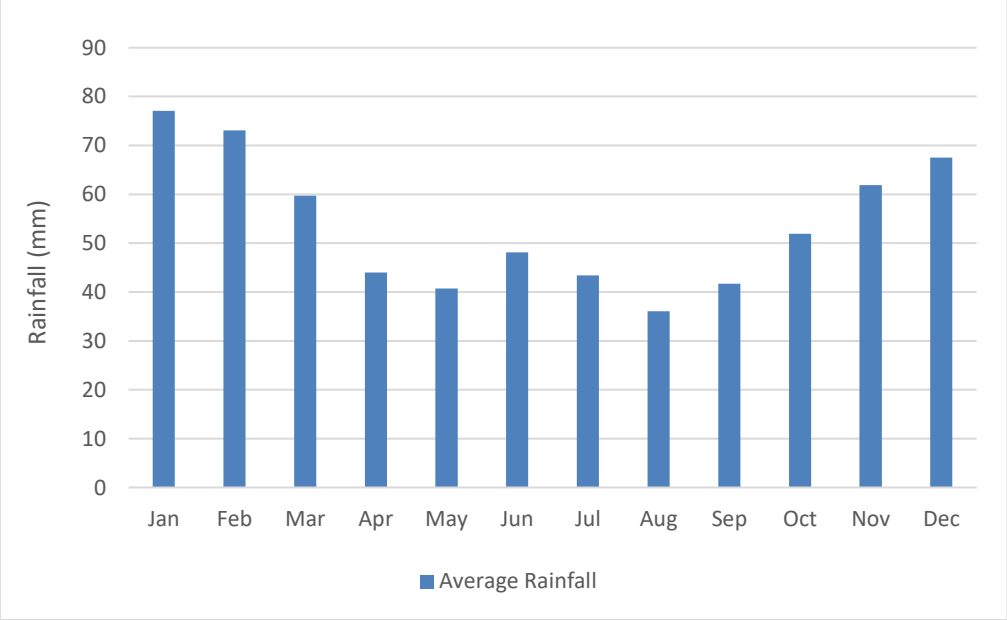


Figure 5: Long-term average monthly rainfall at Jerrys Plains Post Office (Station Number 061086)

January is the hottest month, with a mean maximum temperature of 31.8 degrees Celsius (ºC), and July is the coldest month with a mean minimum temperature of 3.8ºC (BOM 2019a). Figure 6 shows the long-term monthly average maximum and minimum temperatures.

Relative humidity levels fluctuate throughout the day and exhibit seasonal fluctuations. Mean 9.00 am relative humidity levels range from 59% in October to 80% in June. Mean 3.00 pm relative humidity levels vary from 42% in October, November and December, to 54% in June (BOM 2019a).

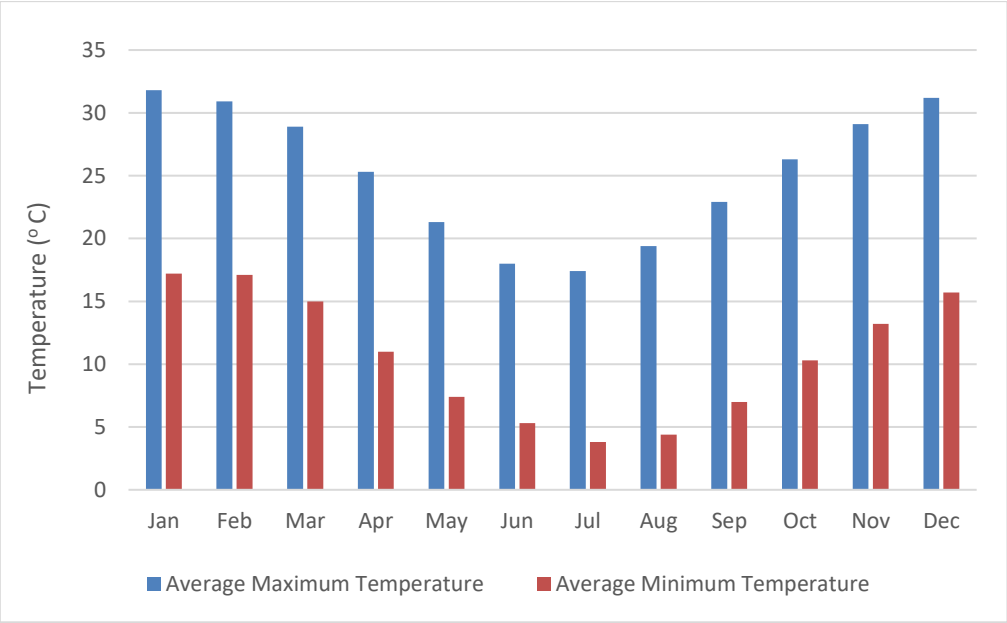


Figure 6: Long-term monthly average maximum and minimum temperatures at Jerrys Plains Post Office (Station Number 061086)

5.6 Vegetation

As indicated in Table 1, the Southern Study Area has been classed as an over-cleared landscape. Overall, 23 % of the area contains remnant or regenerating vegetation with the remaining 77% being cleared with only scattered paddock trees. Indications are that prior to clearing the majority of the Study Area would have consisted of woodland with the dominant canopy species being *Eucalyptus albens* (White Box), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus conica* (Fuzzy Box), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus dawsonii* (Slaty Box), *Eucalyptus moluccana* (Grey Box), *Eucalyptus melliodora* (Yellow Box) and *Angophora floribunda* (Rough-barked Apple). A scattered mid-storey of *Allocasuarina luehmannii* (Bulloak) and *Acacia salicina* (Cooba) would also have been present. Ground cover is likely to have been grassy.

A rocky basalt hill in the north-east is dominated by *Eucalyptus blakelyi* along with *Angophora floribunda*, *Ficus rubiginosa* (Rusty Fig) and *Notelaea microcarpa* (Native Olive).

6 BACKGROUND INFORMATION

6.1 Regional Surveys

There are two regional vegetation classification and mapping surveys that include the Study Area:

- Hunter Remnant Vegetation Project (HRVP) (Peake 2006) which mapped 374 hectares (ha) of vegetation; and
- Greater Hunter Native Vegetation Mapping (GHM) (Sivertsen et al. 2011) which mapped 650 ha of vegetation.

Table 2 shows the dominant vegetation communities mapped by each project across the Study Area and the proportion of the total area of mapped vegetation.

Table 2: Dominant Vegetation Communities Mapped over the Study Area by Regional Studies

Community	Contribution	
	HRVP	GHM
Central Hunter Box - Ironbark Woodland	41%	80%
Central Hunter Bulloak Forest Regeneration	12%	-
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	6%	19%
Narrabeen Footslopes Slaty Box Woodland	37%	-
Total Contribution	**96%**	**99%**

6.2 Local Surveys

Being located in the Hunter Valley coal precinct there have been a number of flora and fauna surveys in and around the Study Area, particularly for the Mt Arthur Mine immediately to the north of the Study Area. Surveys were also conducted over the Study Area and surrounds in support of the former application for the Drayton South open cut project. Table 3 provides a summary of all surveys.

Table 3: Summary of Ecology Reports from the Immediate Region of, and including, the Study Area

Report	Survey	General Location	Survey Type and Time
Dames and Moore (2000)	EIS flora and fauna report	Mt Arthur Mine	Flora – 15-21 November 1998 Fauna – 14-21 November 1998
Umwelt Environmental Consultants (Umwelt) (2003)	Monitoring	Mt Arthur Mine	Flora and Fauna – 1 April 2003; 7-9 May 2003
Umwelt (2005)	Monitoring	Mt Arthur Mine	Flora – December 2004; early January 2005 Fauna – 14-15 December 2004; 20-22 December 2004
Umwelt (2006a)	Flora and Fauna	Mt Arthur Mine	Flora – 16-18 February 2005; 30 November 2005 Fauna – 21-25 February 2005
Umwelt (2006b)	Monitoring	Mt Arthur Mine	Flora – November 2005 Fauna – December 2005
Umwelt (2006c)	Downcast Shaft Facility	Mt Arthur Mine	Flora and Fauna – 7 December 2005
Hansen Bailey (2007)	Drayton Mine Extension	Within the current Study Area	Flora and Fauna – 14-17 February 2006; 6 September 2006; 12-16 February 2007
Umwelt (2007a)	Monitoring	Mt Arthur Mine	Flora – November 2006 Fauna – December 2006
Umwelt (2007b)	Mt Arthur Underground Project	Mt Arthur Mine	Flora – 5 to 8 April 2005; 5-7 December 2005 Fauna – 7-11 March 2005; 5-7 December 2005
Cumberland Ecology (2009a)	Mt Arthur Consolidation	Mt Arthur Mine	Flora and Fauna – 28 August 2008; 21-23 September 2008; 30 September – 2 October 2008; 10-12 November 2008; 19-23 January 2009; 4 March 2009; 8-9 April 2009; 9-10 July 2009; and 13-14 July 2009
Cumberland Ecology (2009b)	Monitoring	Mt Arthur Mine	Flora and Fauna – 19-23 January 2009
Cumberland Ecology (2009c)	Ecological Assessment	Within the current Study Area	Flora and Fauna - May 2009
Cumberland Ecology (2010a)	EPBC Act referral	Mt Arthur Mine	Flora and Fauna – Drawn from other studies
Cumberland Ecology (2010b)	Monitoring	Mt Arthur Mine	Flora and Fauna – 19-22 January 2010; 27-29 January 2010
Cumberland Ecology (2010c)	Monitoring	Mt Arthur Mine	Flora and Fauna – 20-23 September 2010
Umwelt (2011)	Flora and fauna	Mt Arthur Mine	Vegetation Communities – 29 August 2011 - 2 September 2011
Cumberland Ecology (2011)	Monitoring *Diuris tricolor* (Pine Donkey Orchid)	Mt Arthur Mine	Flora – 29 September 2011
Niche (2012)	Fauna Survey	Mt Arthur Mine	Fauna – 1 May; 7-11 May 2012
Cumberland Ecology (2012)	Ecology Impact Assessment	Within the current Study Area	Flora and Fauna 2009 and 2011 (see Table 4.1 in the Cumberland Ecology report for details)

Report	Survey	General Location	Survey Type and Time
Hunter Eco (2013)	Ecological Assessment	Mt Arthur Mine	Flora – 16 April-9 May; 9-12 September; 19 September 2012
Cumberland Ecology (2015)	Biodiversity Assessment	Within the current Study Area	Flora and Fauna – 2009 - 2015

Cumberland Ecology (2015) mapped several communities in 750 ha across the Study Area, the dominant of which are shown in Table 4.

Table 4: Dominant Vegetation Communities Mapped over the Southern Study Area by Cumberland Ecology (2015)

Community	Contribution
Central Hunter Box-Ironbark Woodland	50%
Narrabeen Footslopes Slaty Box Woodland	16%
Upper Hunter White Box-Ironbark Grassy Woodland	10%
Total Contribution	**76%**

Cumberland Ecology (2015) also recorded the Pine Donkey Orchid (*Diuris tricolor*) and Tiger Orchid (*Cymbidium canaliculatum*) both representatives of endangered populations listed under the BC Act. The Pine Donkey Orchid is also listed as a 'vulnerable' threatened species under the BC Act.

7 METHODS

All field surveys were conducted by Dr Colin Driscoll of Hunter Eco who has been conducting biodiversity surveys in the Hunter Valley since the 1980's. Table 5 shows the survey days and on all occasions the weather was warm and mostly dry.

From 2017 into 2018 the Hunter Valley, in common with a lot of western NSW, was experiencing drought conditions. Despite this, woodland sampling produced acceptable results with the expected diversity although there were lower than expected numbers (abundance) of many ground species. Sampling of the open grassland was postponed until the grazing cattle had been removed and sufficient rainfall had occurred for ground species to recover to an identifiable condition. Consequently, there was no limitation and all grassland plots yielded high diversity and abundance.

Table 5: Floristic Survey Days

Date	Task	Rainfall (mm) (Maxwell Infrastructure AWS)
08-12-17	RDP data collection, vegetation mapping.	0.0
15-01-18	RDP data collection, vegetation mapping	0.0
16-01-18	RDP data collection, vegetation mapping	0.0
17-01-18	RDP data collection, vegetation mapping	0.0
18-01-18	RDP data collection, vegetation mapping	0.0
19-01-18	RDP data collection, vegetation mapping	0.0
08-02-18	RDP data collection, vegetation mapping	0.0
10-09-18	Plot data collection, vegetation mapping	0.0
11-09-18	Plot data collection, vegetation mapping	0.0
12-09-18	Plots and RDP data collection	0.0
13-09-18	Plot data collection, vegetation mapping	0.0
14-09-18	Plot data collection, vegetation mapping	0.0
24-09-18	Plot data collection, vegetation mapping	0.2
25-09-18	Plot data collection, vegetation mapping	0.0
27-09-18	Plot data collection, vegetation mapping	0.2
28-09-18	Orchid survey	0.0
17-10-18	Orchid survey and plot data collection	5.8
23-10-18	Plot data collection, vegetation mapping	0.0
24-10-18	Plot data collection, vegetation mapping	0.0
18-11-18	Plot data collection, vegetation mapping	0.0
19-11-18	Plot data collection, vegetation mapping	0.0
21-11-18	Plot data collection, vegetation mapping	1.2
23-11-18	Plot data collection, vegetation mapping	0.0
30-11-18	Plot data collection, vegetation mapping	0.0
03-12-18	Plot data collection, vegetation mapping	0.0
06-12-18	Plot data collection, vegetation mapping	0.0
07-12-18	Plot data collection, vegetation mapping	0.0
10-12-18	Plot data collection, vegetation mapping	0.6
18-12-18	Plot data collection, vegetation mapping	0.0
22-01-19	Plot data collection, vegetation mapping	0.0

RDP=Rapid Data Points, Plots=Floristic Plots (see Section 7.1).

7.1 Identifying Native Plant Community Types

PCTs are described in the *BioNet Vegetation Classification* (OEH 2019a). The PCT in the Study Area were identified by comparing the floristic composition recorded in the field with PCT descriptions provided in *BioNET Vegetation Classification*. This was an iterative process starting with matching dominant canopy species, followed by shrub and groundcover; any geographic limitations were also considered.

The likely PCTs associated with derived grassland were determined by floristic species composition, remnant trees and landscape position. Threatened Ecological Communities (TEC) associated with a PCT were also noted and mapped as described in Section 7.4.

Any existing information on native vegetation in the Study Area and surrounding locality was reviewed (Section 5) and the survey was designed to sample the entire Study Area and the expected environmental variation.

A plot-based vegetation survey was stratified according to the PCTs, their condition and then targeted to sample the expected environmental variation. The data collected were used to assist with the identification and mapping of PCTs.

The procedures for ground-truthed vegetation mapping were first published by S. Bell and C. Driscoll in Department of Environment and Climate Change (DECC) (2008a) and further elaborated in Bell (2013). There are several processes involved in preparing a ground-truthed vegetation community map:

- collection of ground-truth data where at numerous locations the dominant species present in the canopy, shrub and ground structural layers are recorded. These records are referred to as Rapid Data Points (RDP) and provide an understanding of floristic variation across the Study Area;
- detailed data collection from standard 0.04 ha (generally 20 m x 20 m) plots where all species are recorded and scored according to the amount of the sampled area covered by each species using the Braun-Blanquet[1] 1-6 scale for the purposes of later similarity analysis. Rather than being randomly located, these plots are placed to properly sample the variation observed during RDP collection;
- similarity analysis (hierarchical agglomerative clustering and non-metric multi-dimensional scaling [nMDS]) is then used to place the floristic plots into groups having similar floristic content. This process provides the information needed for dividing the vegetation across the Study Area into different local or generic communities; and
- finally, the RDP are coded according to the representative community and those data extrapolated across the Study Area to create a vegetation community map. Aerial Photo Interpretation is used to assist with determining community boundaries where changes in vegetation patterns are visible.

In a highly cleared landscape such as the Study Area it is necessary to distinguish between woodland, cleared grassland with woody regrowth and cleared grassland, perhaps with scattered paddock trees. For the Study Area, woodland was delineated at the boundary of trees with touching or near-touching canopies. Areas of scattered woody regrowth were evaluated for the abundance of trees having stem diameter at breast height over bark (DBHOB) of 20 centimetres (cm) or greater and the distance between these trees. Where woody regrowth was predominantly mid-storey species such as *Acacia* or *Allocasuarina* species the DBHOB and distance apart was assessed. The ground cover was also assessed as to whether it was mixed shrubs and grasses or predominantly grassy.

[1] Braun-Blanquet was not used to record the foliage cover score for a growth form group.

Areas were incorporated into the derived native grassland habitat type where woody regrowth consisted of mid-storey species having DBHOB <20 cm, with individuals well separated, and with sparse canopy species along with predominantly grassy ground cover. This was consistent with the BAM definition of derived vegetation which states:

Derived vegetation: *PCTs that have changed to an alternative stable state as a consequence of land management practices since European settlement. Derived communities can have one or more structural components of the vegetation entirely removed or severely reduced (e.g. over-storey of grassy woodland)…*

In this instance canopy trees have been severely reduced and normally scattered mid-storey species have proliferated. Floristic plots were placed to sample a representative cross section of the derived native grassland structural variation.

A paddock tree assessment for Squirrel Glider (*Petaurus norfolcensis*) connectivity from woodland patches was conducted using maximum separation between canopies of 50 m potential gliding distance. To achieve this paddock trees were digitally extracted from enhanced high-resolution aerial imagery into a vector drawing. A Distance Network with maximum distance 50 m was applied to the extracted canopies and those trees were grouped that were within 50 m or less from each other, and similarly connected to woodland patches. A limitation of this approach was that all paddock trees were extracted irrespective of height. This then would include regrowth trees that were likely to be too short for a Squirrel Glider to attain maximum gliding distance from.

A quantitative analysis of relevant survey data was used to define the likely PCTs. Spatial data and maps were prepared using Manifold System geographic information system (GIS: www.manifold.net) and Surfer 13 (www.goldensoftware.com). Similarity analysis of floristic plots (hierarchical agglomerative clustering and nMDS) was conducted using Primer 7 (Clarke and Gorley 2006). Primer 7 was also used for similarity percentage analysis which calculates the relative contributions of species to a community.

7.2 Assessing Vegetation Integrity (Site Condition)

All plot data were collected to meet the requirements of the BAM (OEH 2017).

The plots/transects were established to provide a representative assessment of the Vegetation Integrity (VI) of the vegetation zone, accounting for the level of variation in the broad condition state of the vegetation zone.

The plots/transects were randomly located within stratification units by walking a random distance into the vegetation zone. Plots were not located in or near ecotones that are readily distinguishable from the broad condition state of the vegetation zone. The plots were, however, spread across the separate areas of the vegetation zone.

Each plot consisted of a 20 m x 20 m floristic plot nested at one end of a 20 m x 50 m plot. The following data were collected in the 20 m x 20 m plot as per the BAM (OEH 2017):

- identification of all flora species, stratum in which each species occurs and growth form;
- a record the abundance of each species where the cover score is less than or equal to 5% (numbers above 20 are estimates only); and
- a record of whether each species is native or exotic (RBG 2018), or high threat exotic (OEH 2019d).

The following data were collected in the 20 m x 50 m plot:

- a record of the number of large trees[2], tree stem size class, tree regeneration[3], length of fallen logs[4], and number of trees with habitat hollows; and
- a record of the presence of trees having stem diameter at breast height (DBH) (1.4 m) <5 cm, 5 – 10 cm, 10 – 20 cm, 30 – 50 cm, 50 – 80 cm, and 80+ cm.

The following data were collected in five 1 m x 1 m sub-plots:

- a record of the percentage of litter cover[5] at five specified locations in the 20 m x 50 m plot.

These data were tabulated in a format suitable for entry into the BAM Credit Calculator which calculates VI scores from which ecosystem and species credits are calculated for each habitat type.

7.3 Groundwater Dependent Ecosystems

There are two types of Groundwater Dependent Ecosystem (GDE): ecosystems that are dependent in whole or in part on water reserves held in the ground; and those dependent on the surface expression of groundwater. Water reserves held in the ground form the saturated part of the aquifer soil matrix that sits below the 'water table' or 'phreatic surface', and are differentiated from water bound in the soil matrix in the unsaturated zone above the water table. Water in the soil aquifers originates from all or any of: rainfall directly on the aquifer surface; runoff from areas immediately adjacent to the aquifer; or sub-surface inflow. The quantity of rainfall that stays in the unsaturated zone and the quantity that makes it into the water reserves is a function of unsaturated zone soil moisture dynamics.

Structure of these water reserves or aquifers is significant for plant use of the available water. For root access to water the aquifer needs to be unconstrained by any impenetrable rock layers. Unconstrained aquifers consist of a lower saturated zone above which lies an unsaturated zone, referred to as the capillary fringe or vadose zone. The surface of the saturated zone where water pressure equals atmospheric pressure is the phreatic zone (from the Greek 'phrear' meaning spring or well).

Vegetation making up a GDE, termed phreatophytic and consisting of phreatophytes, can have varying degrees of dependency on the groundwater. Obligate GDEs are made up of species that depend entirely on the groundwater and are capable of living with their roots continually wet or at least for seasonal periods of inundation. Facultative GDEs contain species that access the groundwater via the capillary fringe and also take up water from within the soil matrix above this area (Hatton and Evans 1998). These plants cannot cope with having their roots inundated with water.

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2 The number of large trees is a count of all living stems with a diameter at breast height (DBH) equal to or greater than the large tree benchmark for the relevant PCT.

3 Regeneration is based on the presence or absence of living trees with stems <5 cm DBH (OEH 2017).

4 Total length in metres of all woody material greater than 10 cm in diameter that is dead and entirely or in part on the ground (OEH 2017).

5 Litter cover includes leaves, seeds, twigs, branchlets and branches (<10 cm in diameter). The assessment of litter cover must include all plant material that is detached from a living plant. Dead material still attached to a living plant (such as a grass) is assessed as litter cover where it is in contact with the ground. Dead material still attached to a living plant that is not in contact with the ground, or litter suspended in the canopies of other plants is not assessed as litter cover (OEH 2017).

Depth to water is an important consideration for identifying potential GDE and in this context plant rooting depth is relevant. While some plants are capable of sending roots tens of metres into the soil, generally the plants in dry sclerophyll woodland, including trees, would have maximum root depth of approximately five m (Canadell et al. 1996).

The time scale of availability of water to GDEs also needs to be considered and this has been shown to vary from annual seasonal to as infrequently as 6 months in 10 – 20 years (Eamus et al. 2006).

A GDE can also be in a perched system where the soil matrix holds water and prevents this water from penetrating the deeper soil layers. In these perched systems, the vegetation will consist of species that are dependent on a generally permanently wet environment. There can be a link between perched GDEs and an underlying aquifer where the replenishing of the water in the perched system occurs when, as a result of sufficient rainfall, the ground water overflows into the perched system.

Initially the GDE Atlas (BOM 2019b), which provides a model of potential GDE across Australia, was consulted for the Hunter catchment. Figure 7 shows an extract from the Atlas for the Study Area that indicates vegetation with a low potential for GDE. A final determination of GDE presence is based on an assessment of whether species within each mapped vegetation community are known to be typically groundwater dependent as well as a heuristic assessment of where accessible groundwater might occur.

To assess the potential GDE presence along Saddlers and Saltwater Creeks, a detailed survey of the vegetation associated with the creeks was conducted in July 2019. The survey included collecting floristic data at a number of points along the creeklines and wider margins to map the PCTs and likely groundwater dependence.

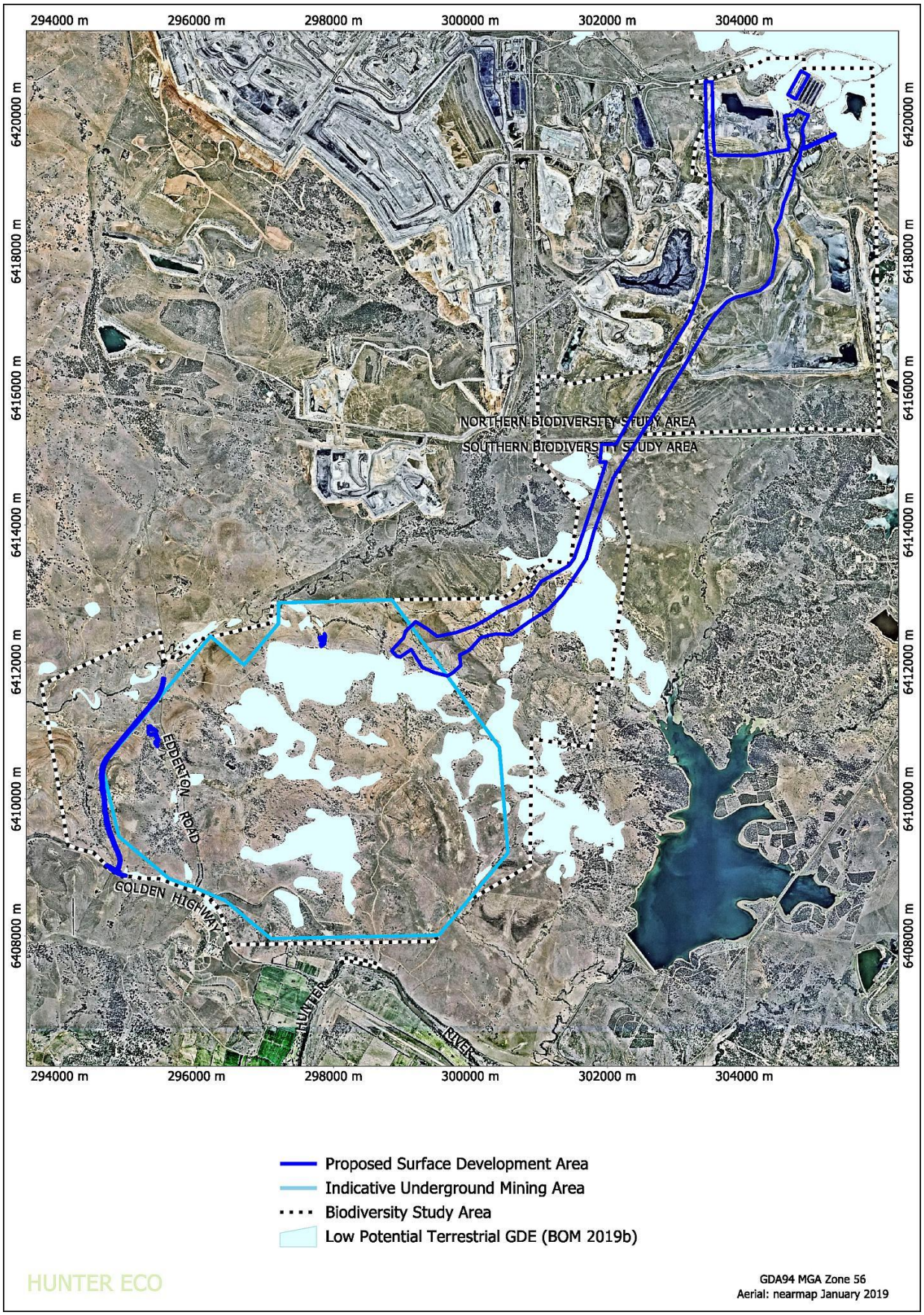


Figure 7: Predicted Areas of Low Potential GDE

7.4 Threatened Ecological Communities

TEC records from within 20 km of the Study Area were extracted from the *BioNet Atlas* (OEH 2019c. TECs listed under the EPBC Act predicted to occur were also extracted using the Commonwealth Protected Matters Search Tool (DEE 2018). Following initial field habitat assessment these communities were evaluated for their likelihood of occurring based on dominant canopy species and habitat conditions. Subsequently after plot data analysis the floristic content of communities was compared with descriptions in the listed community determinations (OEH 2019e and DEE 2019).

Table 6 provides a list of TEC extracted from the *BioNet Atlas* (OEH 2019c). Table 6 also includes TEC from the Commonwealth Protected Matters Search Tool (DEE 2018).

Table 6: TECs Possibly Occurring Within 20 km of the Study Area

Community Name (BC Act)	BC Act Status	EPBC Act Status[1]	Likelihood of Occurring[A]
Blue Gum High Forest in the Sydney Basin Bioregion	CE	-	Out of range, does not occur in the Muswellbrook LGA.
Cumberland Plain Woodland in the Sydney Basin Bioregion	CE	-	Out of range, does not occur in the Muswellbrook LGA.
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	CE	CE[2]	Present (Cumberland Ecology 2015; Hunter Eco this report).
Shale Sandstone Transition Forest in the Sydney Basin Bioregion	CE	-	Out of range, does not occur in the Muswellbrook LGA.
Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion	CE	-	Out of range, does not occur in the Muswellbrook LGA.
Blue Mountains Basalt Forest in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	E	CE[3]	Present (Cumberland Ecology 2015; Hunter Eco this report).
Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	E	CE[3]	Present in the Maxwell Infrastructure area (Hunter Eco this report).
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Out of range, does not occur in the Muswellbrook LGA.
Coastal Upland Swamp in the Sydney Basin Bioregion	E	E[5]	Unsuitable habitat and known to occur from Somersby south to Robertson.
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Out of range, does not occur in the Muswellbrook LGA. Not on a coastal floodplain.
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	E	-	Absent - no Red Gum (*Eucalyptus tereticornis*) in floodplain areas.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	E	-	Present in the Maxwell Infrastructure area (Cumberland Ecology 2015; Hunter Eco this report).
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions	E	-	Absent - no Vine Thicket.
Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Out of range, does not occur in the Muswellbrook LGA. No littoral habitat.
Lower Hunter Spotted Gum-Ironbark Forest in the Sydney Basin Bioregion	E	-	Absent - no Spotted Gum.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E	-	Absent – no lowland rainforest habitat.

Community Name (BC Act)	BC Act Status	EPBC Act Status[1]	Likelihood of Occurring[A]
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South-east Corner, South-eastern Highlands and Australian Alps bioregions	E	-	Out of range, does not occur in the Muswellbrook LGA.
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Out of range, does not occur in the Muswellbrook LGA.
Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Absent - elevation >20 m AHD.
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions	E	-	Unlikely. No swamp habitat. Does not occur in the Muswellbrook LGA.
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	E	-	Unsuitable habitat, does not occur in the Muswellbrook LGA.
Warkworth Sands Woodland in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	E	-	Out of range, does not occur in the Muswellbrook LGA.
White Box Yellow Box Blakely's Red Gum Woodland	E	CE[4]	Present (Cumberland Ecology 2015; Hunter Eco this report).
Blue Mountains Swamps in the Sydney Basin Bioregion	V	-	Out of range, does not occur in the Muswellbrook LGA.
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion	V	-	Out of range, does not occur in the Muswellbrook LGA.
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	CE[3]	Present (Cumberland Ecology 2015; Hunter Eco this report).
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	V	-	Absent - no rainforest.

[A] Likelihood of occurring was assessed against information provided in the OEH (2019e) *NSW Threatened Species Scientific Committee Determinations* and DEE (2019) *Species Profile and Threats Database*.

[1] EPBC TEC names

[2] Hunter Valley Weeping Myall (*Acacia pendula*) Woodland.

[3] Central Hunter eucalypt forest and woodland.

[4] White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[5] Coastal Upland Swamps in the Sydney Basin Bioregion

V = Vulnerable E = Endangered CE = Critically Endangered.

7.5 Endangered Populations

Table 7 shows the endangered populations extracted from the *BioNet Atlas* (OEH 2019c).

Table 7: Endangered Populations Listed as Possibly Occurring in the Study Area

Endangered Population	BC Act Status	EPBC Act Status	Likelihood of Occurrence
Cymbidium canaliculatum population in the Hunter Catchment	Endangered	None	Previously recorded in the Study Area (Cumberland Ecology 2015).
Acacia pendula population in the Hunter Catchment	Endangered	None	Previously recorded in the Study Area (Cumberland Ecology 2015). However, all location of *Acacia pendula* reported by Cumberland Ecology (2015) were re-surveyed and the plants are in fact *Acacia melvillei*.
Diuris tricolor Fitzg., the Pine Donkey Orchid, in the Muswellbrook local government area	Endangered	None	Previously recorded in the Study Area (Cumberland Ecology 2015).
Eucalyptus camaldulensis population in the Hunter Catchment	Endangered	None	Previously recorded along Saddlers Creek approximately 1 km west of the Study Area (Cumberland Ecology 2015).

Targeted surveys for the *Acacia pendula* population in the Hunter Catchment (which is also listed as a threatened ecological community under the EPBC Act and BC Act) were undertaken during floristic surveys to map vegetation within the Study Area. Targeted surveys for the *Eucalyptus camaldulensis* population in the Hunter Catchment were also conducted during vegetation mapping.

The threatened flora species *Cymbidium canaliculatum* and *Diuris tricolor* are components of the endangered populations *Cymbidium canaliculatum* population in the Hunter Catchment and *Diuris tricolor* Fitzg., the Pine Donkey Orchid, in the Muswellbrook local government area, respectively. As such, targeted surveys for these endangered populations were undertaken during the threatened flora surveys as detailed in Section 7.6.

Figure 8 shows the location of flora species representing endangered populations that have previously been recorded in the Study Area. All of these locations were inspected during the current survey to confirm their presence/absence and identity.

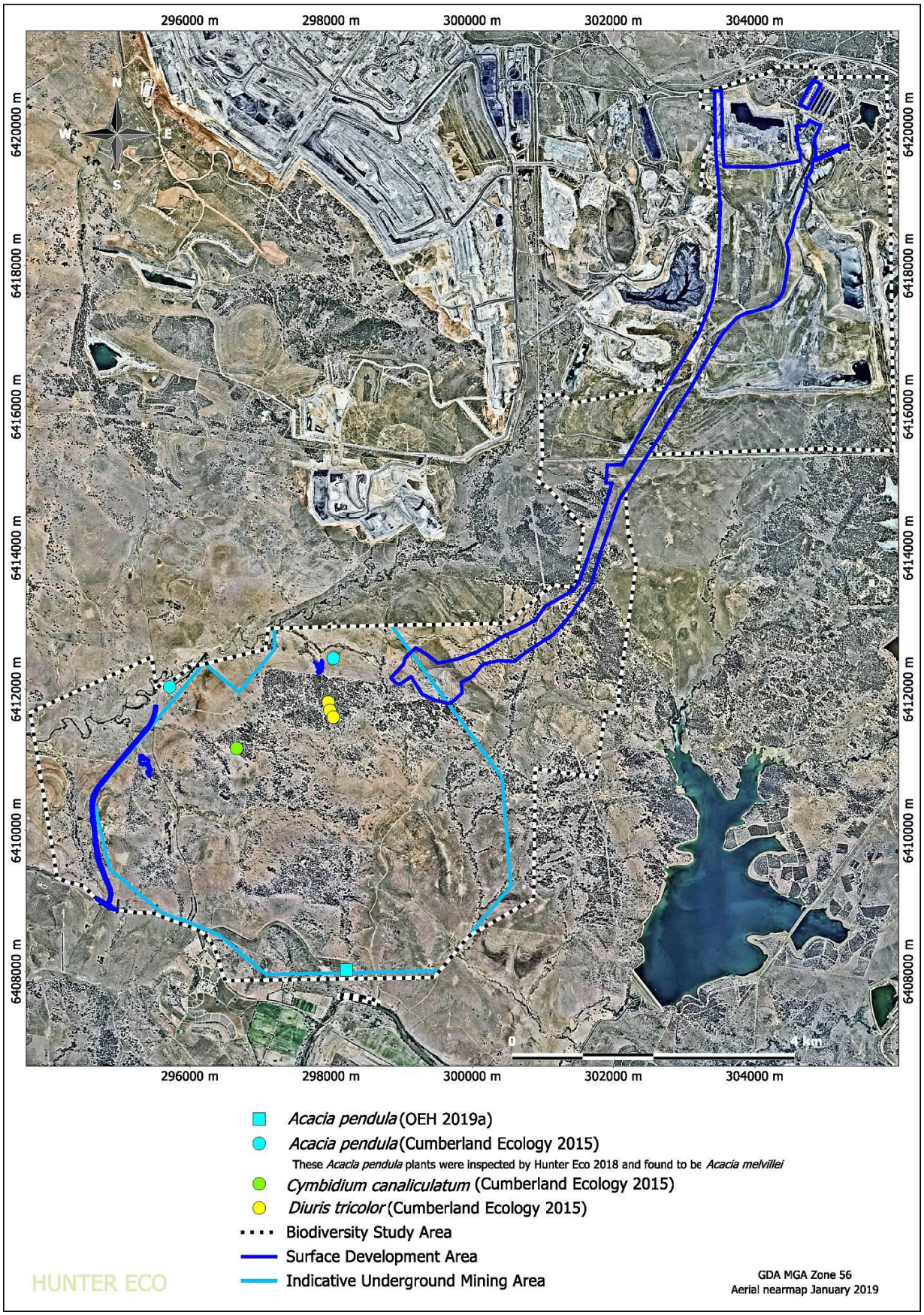


Figure 8: Location of Previously Recorded Flora Species Representative of Endangered Populations

7.6 Threatened Flora Species

To establish a candidate list of threatened species to target (Table 8), a number of sources were reviewed, including:

- threatened flora species records from within a 20 km radius of the Study Area were extracted from the *BioNet Atlas* (OEH 2019c);
- threatened flora species predicted to occur in the Commonwealth Protected Matters Search Tool (DEE 2018) from an area that included the Study Area buffered by one kilometre;
- threatened flora species records from the Study Area (Cumberland Ecology 2015); and
- threatened flora species listed in the *Threatened Biodiversity Data Collection* (OEH 2019b) as associated with the various PCT likely to occur in the Study Area.

Following initial field habitat assessment these species were evaluated for their likelihood of occurring based on known habitat preferences as described in *PlantNET* (RBG 2018) and threatened species profiles (OEH 2019c) (Table 8).

Targeted surveys for threatened orchid species were undertaken in accordance with the *Draft Survey Guidelines for Australia's Threatened Orchids* (DotE 2013). Consistent with these guidelines target orchid species were obtained from the above-listed sources.

Two potentially occurring terrestrial orchid species were Tarengo Leek Orchid (*Prasophyllum petilum)* (Endangered species under the BC Act and EPBC Act) and *Diuris tricolor* (Vulnerable species and Endangered Population under the BC Act). There were no previous records for *Prasophyllum petilum* in the Study Area with the nearest being at Mangoola, 17 km north west (OEH 2019c). There was a small cluster of records of *Diuris tricolor* within the Study Area (Figure 8) and this was a primary target area for survey, where if found at that location during the known flowering period, would lend some confidence to the possibility of the species occurring elsewhere.

Both of these orchids flower during September and October, after which they have no above-ground presence, with *Diuris tricolor* restricted to the last week in September to mid-October. The survey method involved walking transects across a seven-hectare area centred on the previously recorded locations on three occasions, early in the lead up to flowering when emerging leaves could be found, during peak flowering in the last week of September and towards the end of flowering in the middle of October. Further surveys were conducted during peak flowering using meanders in and around the proposed surface development areas, and other selected potential habitat, in order to find any occurrences not previously recorded.

One arboreal orchid species was considered to potentially occur prior to the survey, namely *Cymbidium canaliculatum* (Endangered Population under the BC Act). There was one previous record of this species within the Study Area (Figure 8). This species occurs sporadically throughout the Hunter Catchment in any of several tree species and dead trees, and as such no specific habitat can be targeted. The species was opportunistically targeted during all flora field surveys.

Table 8: Threatened Flora Species Potentially Occurring in the Study Area

Family Name	Scientific Name	Common Name	Status BC Act	Status EPBC Act	BioNet Atlas (OEH, 2019c)	Commonwealth Protected Matters Search Tool (DEE 2018).	Local Records*	Survey Timing (OEH, 2019b)	Associated PCTs (OEH, 2019f)	Likelihood
Apocynaceae	*Cynanchum elegans* [A C]	White-flowered Wax Plant	E	E	-	•	-	All year	1606	Unlikely. Out of range/unsuitable habitat. Occurs at the margin of rainforest and dry forest with no rainforest present in the Study Area. The nearest record is approximately 15 km south west of the Study Area.
Asteraceae	*Olearia cordata* [A]		V	V	-	-	-	All year	-	Distribution does not include the Hunter sub-region.
Asteraceae	*Ozothamnus tesselatus* [A B]		V	V	•	-	-	All year	1655, 1606	Unlikely. Nearest record is at Mangoola approximately 15 km north-west.
Asteraceae	*Rutidosis heterogama* [B]	Heath Wrinklewort	V	V	-	-	-	All year	1655	Unlikely. No records from within 20 km of the Study Area.
Euphorbiaceae	*Monotaxis macrophylla* [B]	Large-leafed Monotaxis	E	-	-	-	-	Jan, Feb, Aug to Dec	1655, 1606, 1607	Possible but only present for a few months after fire and there has been no recent fires in the Study Area. The nearest records are from Wollemi National Park 20 km south east of the Study Area. These were recorded after a severe fire in October 2013 (OEH 2019c).
Fabaceae	*Acacia bynoeana*	Bynoe's Wattle	E	V	-	-	-	Sept, Oct, Nov	1604	Unlikely. Unsuitable habitat (found in woodland with healthy understorey) and nearest record is over 50 km south east of the Study Area.
Lamiaceae	*Prostanthera cineolifera* [B]	Singleton Mint-bush	V	V	-	-	-	All year	1655	Unlikely. Out of range/unsuitable habitat. Grows in open woodlands on exposed sandstone ridges with no records from within 20 km of the Study Area.
Lamiaceae	*Prostanthera cryptandroides* subsp. *cryptandroides* [A B C]	Wollemi Mint-bush	V	V	-	•	-	All year	1655	Unlikely. Out of range/unsuitable habitat. Grows in Narrabeen Sandstone shrubby habitat that does not occur on the Study Area which is primarily of Permian origin. The nearest record is approximately 12 km west of the Study Area.
Malvaceae	*Commersonia rosea* [A]	Sandy Hollow Commersonia	E	E	-	-	-	All year	-	Distribution does not include the Hunter sub-region.

Family Name	Scientific Name	Common Name	Status BC Act	Status EPBC Act	BioNet Atlas (OEH, 2019c)	Commonwealth Protected Matters Search Tool (DEE 2018).	Local Records*	Survey Timing (OEH, 2019b)	Associated PCTs (OEH, 2019f)	Likelihood
Malvaceae	*Lasiopetalum longistamineum* [A]		V	V	-	-	-	All year	-	Distribution does not include the Hunter sub-region.
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V	-	-	-	-	Jan-Mar, Sep-Dec	1604	Unlikely. A moist forest species. Nearest record is 40 km south east of the Study Area.
Myrtaceae	*Eucalyptus parramattensis* subsp. *decadens*	*Eucalyptus parramattensis* subsp. *decadens*	V	V	-	-	-	All year	1604	Unlikely. Found in low sandy woodland. Nearest record is 50 km south east of the Study Area.
Myrtaceae	*Eucalyptus glaucina* [A B C]	Slaty Red Gum	V	V	•	•	-	All year	1691, 1692	Unlikely. Grows in deep moderately fertile well-watered soil that does not occur in the Study Area. There are records in the immediate vicinity of the Study Area.
Myrtaceae	*Eucalyptus nicholii* [A]	Narrow-leaved Black Peppermint	V	V	•	-	-	All year	-	Unlikely. Out of range with no natural records from within 20 km of the Study Area. Commonly used as a street tree of which there are two records within 20 km of the Study Area.
Myrtaceae	*Eucalyptus pumila* [B]	Pokolbin Mallee	V	V	-	-	-	All year	1655	Unlikely. Out of range/unsuitable habitat. Known only from a single population west of Pokolbin and not growing in PCT1655.
Orchidaceae	*Cryptostylis hunteriana* [B]	Leafless Tongue-orchid	V	V	-	-	-	Nov, Dec and Jan	1655, 1606	Unlikely. Out of range/unsuitable habitat with no records within 20 km of the Study Area.
Orchidaceae	*Diuris tricolor*	Pine Donkey Orchid	V, EP	-	•	-	•	Sep and Oct	201, 1604, 1606, 1655	Recorded in the Study Area (Cumberland Ecology 2015).
Orchidaceae	*Prasophyllum petilum* (sp. Wybong) [A B C]	Tarengo Leek Orchid	E	E	-	•	-	Sep to Dec	116, 201	Possible due to potentially suitable Fuzzy Box (PCT201) habitat and that the species is also associated with highly disturbed areas. Somewhat unlikely however due to long-term cattle grazing. The nearest records are from Mangoola approximately 17 km north west of the Study Area.
Orchidaceae	*Pterostylis chaetophora* [B]		V	-	-	-	-	Sep to Nov	1691	Unlikely. No records from within 20 km of the Study Area.
Orchidaceae	*Pterostylis gibbosa* [C]	Illawarra Greenhood	E	E	-	•	-	Sep to Oct	-	Unlikely. No records from within 20 km of the Study Area.

Family Name	Scientific Name	Common Name	Status BC Act	Status EPBC Act	BioNet Atlas (OEH, 2019c)	Commonwealth Protected Matters Search Tool (DEE 2018).	Local Records*	Survey Timing (OEH, 2019b)	Associated PCTs (OEH, 2019f)	Likelihood
Orobanchaceae	*Euphrasia arguta* [C]		CE	CE	-	•	-	Nov to March	-	Unlikely. Grows in grassy areas near rivers and possibly extinct. No records from within 20 km of the Study Area.
Polygonaceae	*Persicaria elatior*	Tall Knotweed	V	V	-	-	-	Dec-May	1731	Unlikely. Nearest record > 80 km south east of the Study Area. A wetland species.
Proteaceae	*Grevillea parviflora* subsp. *parviflora*	Small-flower Grevillea	V	V	-	-	-	All year	1604	Unlikely. Grows in shrubby woodland. Nearest record is >50 km south east of the Study Area.
Rhamnaceae	*Pomaderris bodalla* [A B]	Bodalla Pomaderris	V	-	-	-	-	Sep to Nov	1606	Unlikely. One record in Wollemi National Park approximately 8 km south west of the Study Area.
Rhamnaceae	*Pomaderris queenslandica* [A B]	Scant Pomaderris	E	-	-	-	-	All year	1655, 1606, 1607	Unlikely. The nearest records are approximately 14 km west of the Study Area.
Rhamnaceae	*Pomaderris reperta* [A B]	Denman Pomaderris	CE	CE	-	-	-	All year	1655	Out of range/unsuitable habitat. Only known from near Denman.
Rubiaceae	*Asperula asthenes* [A]	Trailing Woodruff	V	V	-	-	-	Oct to Dec and Jan to March	-	Out of range/unsuitable habitat. The nearest record is approximately 20 km east from the Study Area.
Rutaceae	*Philotheca ericifolia* [A B]		-	V	-	-	-	Sep to Dec	1655	Out of range/unsuitable habitat. The nearest record is approximately 12 km west from the Study Area.
Santalaceae	*Thesium australe* [A B C]	Austral Toadflax	V	V	-	•	-	Nov, Dec, Jan and Feb	-	Unlikely. Generally associated with the grass *Themeda triandra* (Kangaroo Grass) of which there was very little in the Study Area. The nearest record to the Study Area is approximately 12 km north-west.

Targeted surveys were conducted in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016a). However, surveys were also conducted with the possibility in mind of previously unrecorded threatened species being present. All flora species encountered were positively identified so an unexpected occurrence was unlikely to be missed. In other words, all threatened flora species were targeted by default irrespective of habitat suitability or likelihood of occurring.

Discovery of a threatened flora species during the survey would trigger a process of determining the size and extent of the occurrence. The locality of the initial discovery would be searched in an ever-widening pattern to determine the number and extent of the plants. A habitat assessment would be made and areas of similar habitat searched. If the species was restricted to a small area all individuals would be counted and recorded via GPS. If the species were to be widespread, transect searches would be conducted in a way that overall distribution and density could be estimated.

Searches were also conducted during the restricted times that some potentially occurring threatened flora were detectable, in particular *Diuris tricolor* and *Prasophyllum petilum* (*Prasophyllum* sp. 'Wybong') both only flowering in late September to mid-October.

7.7 Koala Potential Habitat

Protection of Koala during the development approval process is controlled by SEPP 44. Schedule 2 of SEPP 44 provides a list of Koala food tree species (Table 9). Initial assessment involves determining whether *potential* Koala habitat is present, defined as *'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component'* in the SEPP 44. Where potential Koala habitat has been identified further investigation in required to determine whether *core* Koala habitat is present, defined as *'an area of land with a resident breeding population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'* in the SEPP 44.

Table 9: SEPP 44 Schedule 2 Koala Feed Trees

Scientific Name	Common Name
Eucalyptus tereticornis	Forest red gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or manna gum
Eucalyptus camaldulensis	River red gum
Eucalyptus haemastoma	Broad-leaved scribbly gum
Eucalyptus signata	Scribbly gum
Eucalyptus albens	White box
Eucalyptus populnea	Bimble box or poplar box
Eucalyptus robusta	Swamp mahogany

The task of this flora assessment is to indicate whether and where potential Koala habitat defined by SEPP 44 might occur across the Study Area. An assessment as to whether or not any potential Koala habitat was core Koala habitat is provided in Future Ecology (2019).

Since SEPP 44 was gazetted in 1995, research has indicated that the Koala has regional preferences for feed trees as well as having other important uses for trees. In keeping with the intent of SEPP 44 of preserving Koala habitat, this more recent data is also included in this habitat assessment.

The NSW Recovery Plan for the Koala (DECC 2008b) subdivides the State into Koala Management Areas and provides a list of feed trees for each area. The Study Area falls within Koala Management Area 1 – North Coast (Table 10).

Table 10: Koala Management Area 1 Feed Trees

Common Name	**Scientific Name**
Primary food tree species	
Tallowwood	*Eucalyptus microcorys*
Parramatta red gum	*Eucalyptus parramattensis*
Forest red gum	*Eucalyptus tereticornis*
Orange gum	*Eucalyptus bancroftii*
Swamp mahogany	*Eucalyptus robusta*
Cabbage gum	*Eucalyptus amplifolia*
Secondary food tree species	
Narrow-leaved red gum	*Eucalyptus seeana*
Craven grey box	*Eucalyptus largeana*
Slaty red gum	*Eucalyptus glaucina*
Grey gum	*Eucalyptus biturbinata*
Small-fruited grey gum	*Eucalyptus propinqua*
Large-fruited grey gum	*Eucalyptus canaliculata*
Red mahogany	*Eucalyptus resinifera*
Steel box	*Eucalyptus rummeryi*
Mountain mahogany	*Eucalyptus notabilis*
Rudder's box	*Eucalyptus rudderi*
Grey box	*Eucalyptus moluccana*
White-topped box	*Eucalyptus quadrangulata*
Yellow box	*Eucalyptus melliodora*
Stringybarks/supplementary species	
Stringybark	*Eucalyptus tindaliae*
Blue-leaved stringybark	*Eucalyptus agglomerata*
Thin-leaved stringybark	*Eucalyptus eugenioides*
Diehard stringybark	*Eucalyptus cameronii*
White stringybark	*Eucalyptus globoidea*

A review of SEPP 44 is being conducted (DP&E 2018) and a revised list of 65 tree species that are responsive to the variation in Koala habitat and behaviour, not restricted to any particular region, is provided (Table 11). It is recognised that Koalas use particular trees both for food and shelter.

Table 11: Koala Important Trees

Scientific Name	**Common Name**
Callitris endlicheri	Black Cypress Pine
Casuarina torulosa	Forest Oak
Eucalyptus agglomerata	Blue-leaved stringybark
Eucalyptus albens	White box
Eucalyptus amplifolia	Cabbage gum
Eucalyptus bancroftii	Orange gum
Eucalyptus baueriana	Blue box
Eucalyptus bicostata	Eurabbie
Eucalyptus biturbinata	Grey gum

Scientific Name	Common Name
Eucalyptus blakelyi	Blakely's red gum
Eucalyptus bosistoana	Coast grey box
Eucalyptus bridgesiana	Apple-topped box
Eucalyptus camaldulensis	River red gum
Eucalyptus camphora	Broad-leaved sally
Eucalyptus canaliculata	Large-fruited grey gum
Eucalyptus chloroclada	Dirty gum
Eucalyptus cinerea	Argyle apple
Eucalyptus conica	Fuzzy box
Eucalyptus consideniana	Yertchuk
Eucalyptus coolabah	Coolabah
Eucalyptus cypellocarpa	Monkey gum
Eucalyptus dalrympleana	Mountain gum
Eucalyptus dealbata	Tumbledown gum
Eucalyptus dwyeri	Dwyer's red gum
Eucalyptus globoidea	White stringybark
Eucalyptus goniocalyx	Bundy
Eucalyptus interstans	-
Eucalyptus largiflorens	Black box
Eucalyptus longifolia	Woollybutt
Eucalyptus macrorhyncha	Red Stringybark
Eucalyptus maidenii	Maiden's gum
Eucalyptus mannifera	Brittle gum
Eucalyptus melliodora	Yellow box
Eucalyptus microcarpa	Western grey box
Eucalyptus microcorys	Tallowwood
Eucalyptus moluccana	Grey box
Eucalyptus nandewarica	Mallee red gum
Eucalyptus nicholii	Narrow-leaved black peppermint
Eucalyptus nobilis	Forest ribbon gum
Eucalyptus nortonii	Large-flowered bundy
Eucalyptus nova-anglica	New England peppermint
Eucalyptus oblonga	Narrow-leaved Stringybark, Sandstone Stringybark
Eucalyptus ovata	Swamp gum
Eucalyptus parramattensis	Parramatta red gum
Eucalyptus pauciflora	Snow gum
Eucalyptus pilligaensis	Pilliga box
Eucalyptus polyanthemos	Red box
Eucalyptus populnea	Bimble box
Eucalyptus prava	Orange gum
Eucalyptus propinqua	Small-fruited grey gum
Eucalyptus pseudoglobulus	Bastard eurabbie
Eucalyptus punctata	Grey gum
Eucalyptus quadrangulata	White-topped Box, Coast White Box

Scientific Name	Common Name
Eucalyptus radiata	Narrow-leaved Peppermint
Eucalyptus robusta	Swamp mahogany
Eucalyptus rossii	Scribbly gum
Eucalyptus rubida	Candlebark
Eucalyptus scias	Large-fruited red mahogany
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum
Eucalyptus sieberi	Silvertop Ash, Black Ash
Eucalyptus tereticornis	Forest red gum
Eucalyptus tereticornis X Eucalyptus robusta	Naturally occurring hybrid
Eucalyptus vicina	-
Eucalyptus viminalis	Ribbon gum
Eucalyptus volcanica	-

Source: (DP&E 2018 Appendix 1)

7.8 Limitations

A limitation to the floristic sampling was the poor condition of ground cover through early to mid-2017 due to the drought conditions and the impact of grazing stock. Woodland sampling produced acceptable results with the expected diversity although there were lower than expected numbers (abundance) of many ground species. The prevailing conditions had a particular impact on terrestrial orchid surveys, these needed to be done during flowering, however the ground cover had only begun to respond to rain and the removal of cattle. Cumberland Ecology (2015) reported surveying for the species across the current Study Area in Spring 2011, in clearly better conditions than those pertaining in 2018, with the species only encountered in the one location, this area was well outside of any proposed disturbance by the Project.

A further limitation was the absence of recent fire that would facilitate the discovery of *Monotaxis macrophylla*. This species is reported as growing on rocky ridges and hillsides (OEH 2019b). Within the Study Area the most likely similar suitable habitat would be on the rocky hill just south of the AGL coal conveyor in PCT 1607 *Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter*. This habitat is outside of any proposed disturbance by the Project.

Sampling of the open grassland was postponed until all stock had been removed and sufficient rainfall had allowed ground species to recover to identifiable condition. Consequently, there was no limitation and all grassland plots yielded high diversity and abundance.

8 RESULTS

Data from the 1,708 RDPs and 109 floristic plots allowed vegetation communities to be tentatively identified across the Study Area, primarily based on the dominant canopy species. Each community was then given a generic descriptive name and code. Figure 9 shows the RDP and plot locations as well as the over 20 km of survey transects.

8.1 Floristic Plot Data Analysis

A preliminary similarity analysis conducted in Primer 7 showed that weeds were distributed randomly across the Study Area and not associated with any PCT; consequently, a secondary similarity analysis was conducted excluding weeds. This weed distribution is to be expected given weeds' capacity for wind and animal dispersal.

Figure 10 shows an nMDS plot for the woodland communities which positions the floristic plots in 2-dimensional space according to their degree of dissimilarity (difference). Conversely this means that the closer plots are together the more similar they are in floristic content. Plots are themed according to the PCT that they are intended to represent. While grouping of individual PCTs lends support to the classification, there is not a great amount of dis-similarity between PCT as indicated by overlapping groups. This overlap can be explained by the fact that there were a large number of ground cover species common to many PCT (see Section 8.4), and many ground cover species were in low abundance. PERMANOVA+ (Anderson, Gorley and Clarke 2008) showed that the PCTs were significantly different (p (perm)=0.001). It is noted that there is considerable dissimilarity between the three areas dominated by *Acacia pendula* where ground cover within the plot at each location was very different even though the canopy was dominated by *Acacia pendula*.

Figure 11 shows the nMDS plot for the grassland areas assigned to their most likely derived PCT. Again, there is some clustering indicating general support for the classification but considerable overlap of clusters is due to many species in common. PERMANOVA+ (Anderson, Gorley and Clarke 2008) showed that these DNG assigned to PCTs were significantly different (p (perm)=0.0001). As expected, the areas of rehabilitated pasture are distinctly different from the natural grassland.

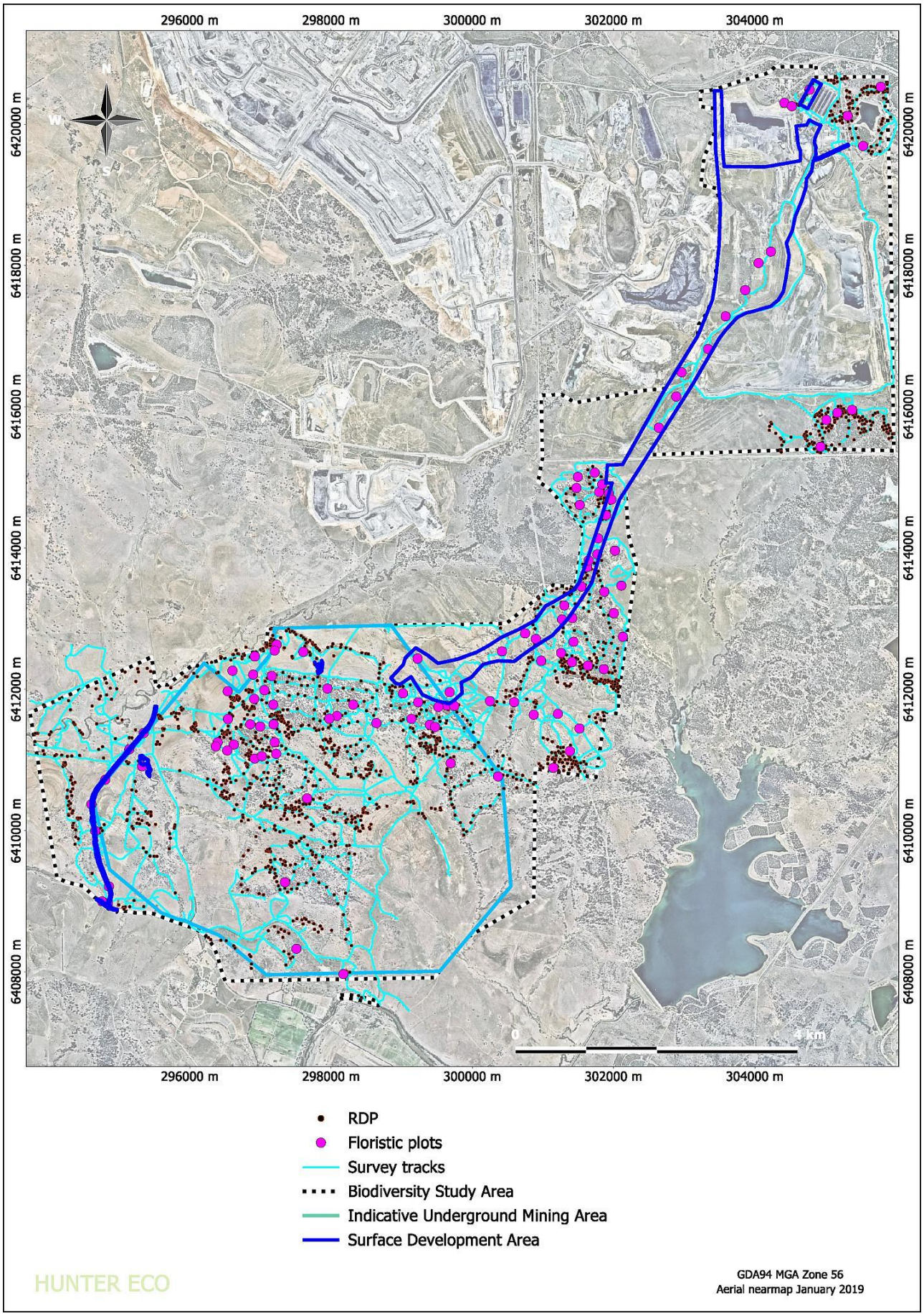
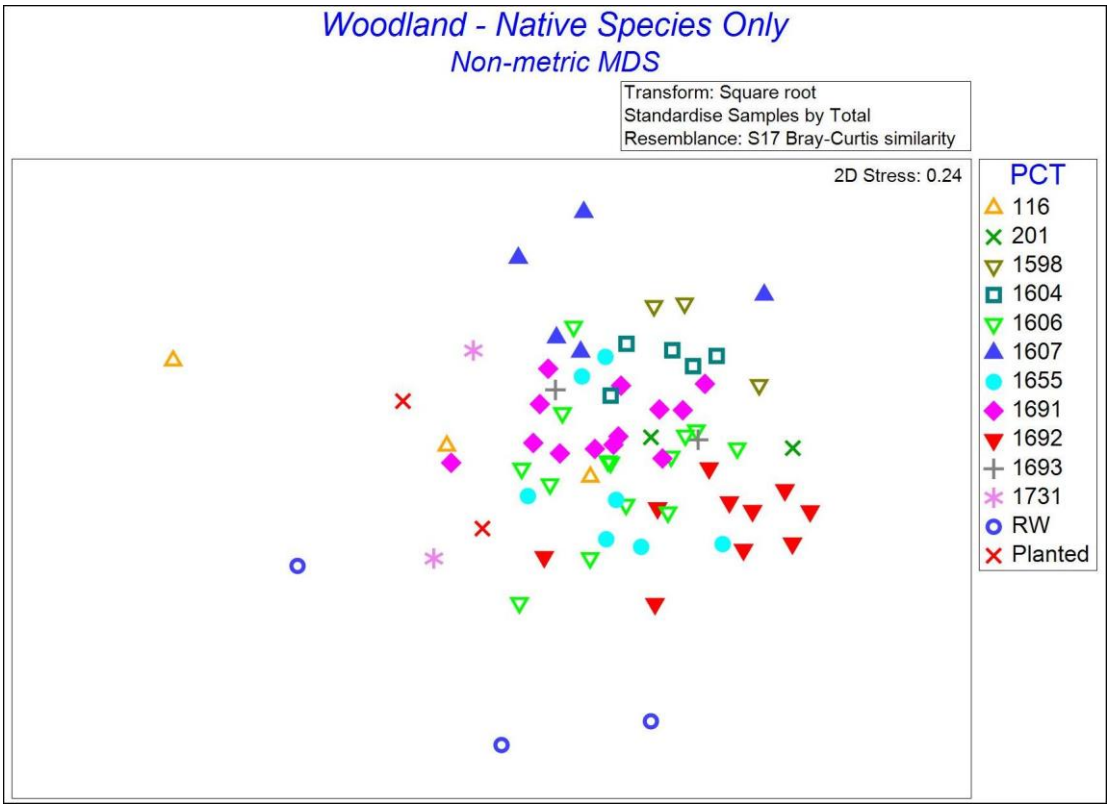
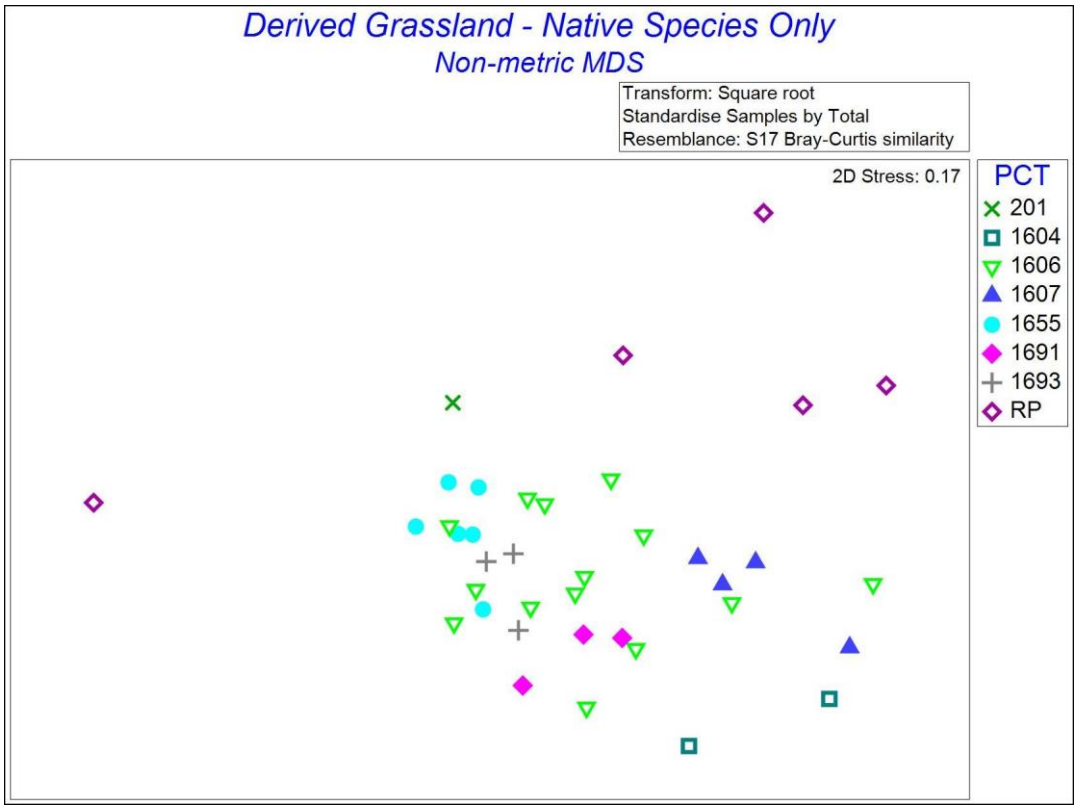


Figure 9: Field Survey Details



RW = Woodland rehabilitation; Planted = planted strip of trees.

Figure 10: nMDS Plot of Woodland PCT



RP =Pasture rehabilitation.

Figure 11: nMDS Plot of Derived Grassland PCT

8.2 PCT Assignment

To assign the generic communities to a PCT, all PCT having the locally characteristic species in the upper stratum were extracted from the *BioNet Vegetation Classification* (OEH 2019a) (downloaded February 2019). These PCT were then filtered by excluding those described as occurring outside of the Sydney Basin Bioregion, or having a low or very low level of classification confidence. The floristic content of the remainder was compared with that recorded in the Study Area plots and the final selection made on the best fit. Table 12 provides a summary of the assignment process for each.

Overall 21 units (PCTs and condition types) were mapped across the Study Area comprising 11 PCTs. Table 13 lists the mapped communities along with the hectares of each occurring in the Study Area. Figures 12 and 13 show the distribution of these communities. Several communities were present in both remnant vegetation form and derived native grassland form where scattered paddock tree species indicated the likely community that was previously cleared.

Detailed profiles of each community are provided in Appendix 4.

8.3 TEC Assignment

Each PCT in the *BioNet Vegetation Classification* (OEH 2019a) is assigned to NSW (BC Act) and/or Commonwealth (EPBC Act) TEC, where community attributes match Scientific Committee threatened community determinations. In some cases, there are multiple options depending on community context in the field. It does appear that TEC assignments in the NSW database require updating as they still reference the former NSW *Threatened Species Conservation Act, 1995*, classify one community as Endangered (E) when it is now listed as Critically Endangered (CE), and do not include a relevant EPBC Act community. Table 14 provides a summary of the assignment process for each TEC, and Figures 14 and 15 show the mapping of the BC Act and EPBC Act communities across the Study Area.

8.4 Vegetation Community Condition

Other than for the rehabilitation areas, condition of the vegetation was classified as woodland in moderate condition and derived native grassland with scattered trees. Within these condition classes the floristic content varied. There was no clear pattern to these variants that facilitated more detailed stratification but it was ensured that floristic sampling was representative of the overall vegetation condition for each community. Detailed information on the vegetation integrity (site condition) data (including plot field data) of each community has been provided to the OEH

8.5 Threatened Ecological Communities Listed under the BC Act

White Box Yellow Box Blakely's Red Gum Woodland

White Box Yellow Box Blakely's Red Gum Woodland is listed as an endangered ecological community under the BC Act. *White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter* (PCT 1606), and *Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains* (PCT 1693) were assessed to be components of the TEC, including their derived native grassland variants. The main identifying characteristics were the presence of *Eucalyptus albens* and *E. albens x moluccana* (White Box x Grey Box) in the canopy of PCT 1606 and *Eucalyptus melliodora* in the canopy of PCT 1693.

White Box Yellow Box Blakely's Red Gum Woodland is predominantly located in the proposed underground mining area, with the community also located to the south (along the proposed transport and services corridor) and southeast of Maxwell Infrastructure (Figure 14).

Table 12: PCT Assignment

PCT	PCT Name	Options	Selection
116	Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley	19 PCT containing Weeping Myall (*Acacia pendula*) in the upper stratum.	Only PCT116 occurs in the Sydney Basin Bioregion.
201	Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	8 PCT containing Fuzzy Box (*Eucalyptus conica*) in the upper stratum.	None of these PCT occur in the Sydney Basin Bioregion despite several records there. PCT201 was selected as being the best fit with high classification confidence. It would appear that Fuzzy Box in the Sydney Basin has not been sampled, or poorly sampled.
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	61 PCT containing Forest Red Gum (*Eucalyptus tereticornis)* in the upper stratum, 39 of which are very low confidence.	PCT1598 was selected as the best match both geographically and floristic content.
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	5 PCT containing Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*Eucalyptus moluccana)* and Spotted Gum (*Corymbia maculata*) in the upper stratum, of which three are very low confidence.	PCT1600 was excluded as it had Red Ironbark (*Eucalyptus fibrosa*) as a component, not present in the Study Area, which left PCT1604 being the best match.
1606	White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	12 PCT containing White Box (*Eucalyptus albens*), Blakely's Red Gum (*Eucalyptus blakelyi*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) in the upper stratum, five of which were of low or very low confidence.	PCT1606 was the best match both floristically and geographically.
1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	17 PCT containing Blakely's Red Gum (*Eucalyptus blakelyi*), Rough-barked Apple (*Angophora floribunda)* and Narrow-leaved Ironbark (*Eucalyptus crebra*), of which nine were of high confidence. Six of those nine were located outside of the Sydney Basin Bioregion, and one was restricted to the Warkworth area.	Of the remaining two PCT1607 was the best floristic match with PCT1696 containing species such as Silver Top Stringbark (*Eucalyptus laevopinea*), more consistent with elevated ridges in the Upper Hunter.
1655	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	5 PCT containing Slaty Box (*Eucalyptus dawsonii*) in the upper stratum all of which occur in the Sydney basin Bioregion. Three are very low confidence and one medium confidence.	PCT1655 was selected because of the inclusion of *Eucalyptus moluccana* which adjoined the Slaty Box vegetation in the Study Area. However, none of the possible PCT clearly matched the composition of the Study Area community, particularly in the shrub layer. It is likely that there is another unsampled Slaty Box lowland community in the Hunter Valley.

PCT	PCT Name	Options	Selection
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	23 PCT having Grey Box (*Eucalyptus moluccana*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) in the upper stratum, nine of which were of high confidence, three of which were located outside of the Sydney Basin Bioregion. Of the remaining six, one was associated with basalt, not occurring in the in the location of this PCT and two contained Spotted Gum as an upper stratum component, none of which were present in this community, which left PCT 1603 or PCT1691.	PCT1691 was selected on the basis of a sparse mid stratum layer and the presence of *Brachychiton populneus*.
1692	Bull Oak grassy woodland of the central Hunter Valley	62 PCT having Bull Oak (*Allocasuarina luehmannii*) in the upper stratum.	Only PCT1692 had *Allocasuarina luehmannii* as the dominant upper stratum species.
1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	71 PCT having Yellow Box (*Eucalyptus melliodora*) and Rough-barked Apple (*Angophora floribunda*) in the upper stratum, 29 of which were of high confidence, and 26 of which were located outside of the Sydney Basin Bioregion.	Of the remaining three, two were associated with basalt soil. This left PCT1693 as the selected community.
1731	Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	23 PCT having Swamp Oak (*Casuarina glauca*) in the upper stratum, of which 14 were of high confidence.	Of these, PCT1731 was the only one not limited to coastal regions.

Table 13: Vegetation Communities Mapped across the Study Area Grouped by Formation

Code	Generic Name	PCT	PCT Name	Class	Area (ha)	Number of Plots
Dry Sclerophyll Forests (Shrub/grass sub-formation)						
1	Red Gum - Ironbark - Apple shrubby woodland	1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	29.9	5
1a	Red Gum - Ironbark - Apple shrubby woodland (DNG)	1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - DNG	North-west Slopes Dry Sclerophyll Woodlands	24.4	4
2	White Box - Ironbark - Red Gum shrubby forest[1]	1606	White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	383.0	14
2a	White Box - Ironbark - Red Gum shrubby forest (DNG)[1]	1606	White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG	North-west Slopes Dry Sclerophyll Woodlands	2161.9	14
Dry Sclerophyll Forests (Shrubby sub-formation)						
3	Slaty Box shrubby woodland[2]	1655	Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin	Western Slopes Dry Sclerophyll Forests	118.7	7
3a	Slaty Box shrubby woodland (DNG)	1655	Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin - DNG	Western Slopes Dry Sclerophyll Forests	389.3	6
Forested Wetlands						
4	Swamp Oak forest	1731	Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley	Coastal Swamp Forests	17.4	2
5	Hunter Lowland Red Gum Forest[3]	1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	Coastal Floodplain Wetlands	12.1	3
Grassy Woodlands						
6	Bull Oak grassy woodland[4]	1692	Bull Oak grassy woodland of the central Hunter Valley	Coastal Valley Grassy Woodlands	99.0	10
7	Yellow Box - Apple grassy woodland[1]	1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Western Slopes Grassy Woodlands	9.5	2
7a	Yellow Box - Apple grassy woodland (DNG)[1]	1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - DNG	Western Slopes Grassy Woodlands	39.7	3
8	Fuzzy Box woodland	201	Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Western Slopes Grassy Woodlands	10.0	2
8a	Fuzzy Box woodland (DNG)	201	Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion - DNG	Western Slopes Grassy Woodlands	141.9	1

Code	Generic Name	PCT	PCT Name	Class	Area (ha)	Number of Plots
9	Ironbark - Grey Box grassy woodland[5]	1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Coastal Valley Grassy Woodlands	180.5	13
9a	Ironbark - Grey Box grassy woodland (DNG)	1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - DNG	Coastal Valley Grassy Woodlands	34.8	3
10	Weeping Myall woodland[6]	116	Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley	Coastal Valley Grassy Woodlands	1.3	3
11	Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland[7]	1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	Coastal Valley Grassy Woodlands	128.0	5
11a	Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland (DNG)	1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter - DNG	Coastal Valley Grassy Woodlands	2.2	2
Other						
-	Planted Trees	0	Planted Trees	None	14.4	2
RP	Pasture Rehabilitation	0	Pasture Rehabilitation	None	347.7	5
RW	Woodland Rehabilitation	0	Woodland Rehabilitation	None	163.4	3
				Total Area (ha)	**4309.1**	**109**

[1] Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box – Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

[2] Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

[3] Listed BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions.

[4] Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland (only the part derived from PCT1655).

[5] Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

[6] Listed BC Act, CE: Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Hunter Valley Weeping Myall (*Acacia pendula*) Woodland.

[7] Listed BC Act, E: Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions; Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

V= Vulnerable E = Endangered CE = Critically Endangered.

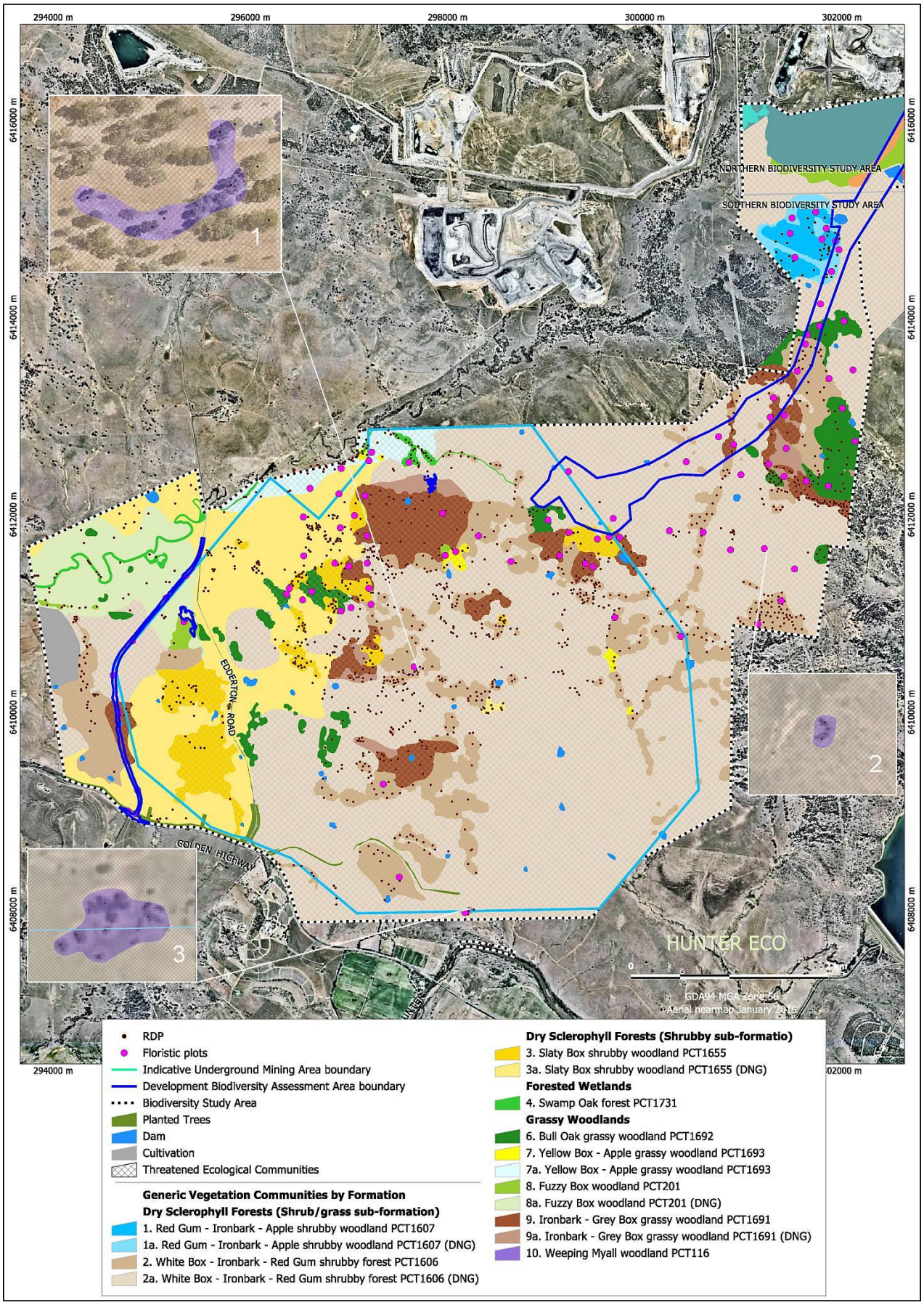


Figure 12: Generic Vegetation Communities Mapped across the Southern Study Area

Figure 13: Generic Vegetation Communities Mapped across Maxwell Infrastructure

Table 14 TEC Assignment

PCT	PCT Common Name	Associated TEC (OEH 2019a)	Assigned TEC	Rationale
116	Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley	Listed BC Act, CE: Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion; Listed EPBC Act, CE: Hunter Valley Weeping Myall Woodland.	BC Act, CE: Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion; EPBC Act, CE: Hunter Valley Weeping Myall (Acacia pendula) Woodland.	The presence of Weeping Myall away from any obvious plantation indicates these TEC.
201	Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Listed BC Act, E: Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions.	None.	The listed TEC is outside of the Sydney Basin Bioregion.
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	Listed BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions; Listed BC Act, E: Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion.	BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions.	The assigned TEC is listed for the Sydney Basin Bioregion, the other is not.
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	Listed BC Act, E: Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions.	BC Act, E: Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions; EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.	The primary canopy content of this PCT is consistent with that of both of these TEC. Note that the EPBC Act TEC was not included in the NSW PCT data.
1606	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.	BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.	The primary canopy content of this PCT is consistent with that of both of these TEC. The derived native grassland variants of this PCT are included in the determination for these TEC.
1607	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	None.	None.	Not a TEC.
1655	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.	BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion; EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.	The primary canopy content of this PCT, in particular Slaty Box, is consistent with that of both of these TEC. Note that the EPBC Act TEC was not included in the NSW PCT data.

PCT	PCT Common Name	Associated TEC (OEH 2019a)	Assigned TEC	Rationale
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions; Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions.	BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions; EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.	The primary canopy content of this PCT, in particular Narrow-leaved Ironbark and Grey Box, is consistent with that of both of these TEC. Note that the EPBC Act TEC was not included in the NSW PCT data. There were no indications of Hunter Lowland Redgum Forest or White Box, Yellow Box Blakely's Red Gum woodland in this PCT in the Study Area.
1692	Bull Oak grassy woodland of the central Hunter Valley	Listed BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions; Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions.	EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland part.	The determination for EPBC Act Central Hunter Valley eucalypt forest and woodland specifically includes *Allocasuarina luehmannii* (Bull Oak) habitat in areas previously dominated by the one or more of the four indicator canopy trees. Slaty Gum (*Eucalyptus dawsonii*) is one of the four and there are patches of PCT1692 in the Study Area that adjoin and are clearly derived from Slaty Box dominated habitat.
1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Woodland.	BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland; EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Woodland.	The primary canopy content of this PCT is consistent with that of both of these TEC. The derived native grassland variants of this PCT are included in the determination for these TEC.
1731	Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Listed BC Act, E: Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.	None.	The determination for Swamp Oak Floodplain Forest states that the TEC generally occurs below 20 m elevation and rarely above 10 m elevation. In the Study Area PCT1731 occurs at a range of 108 - 161 m elevation.

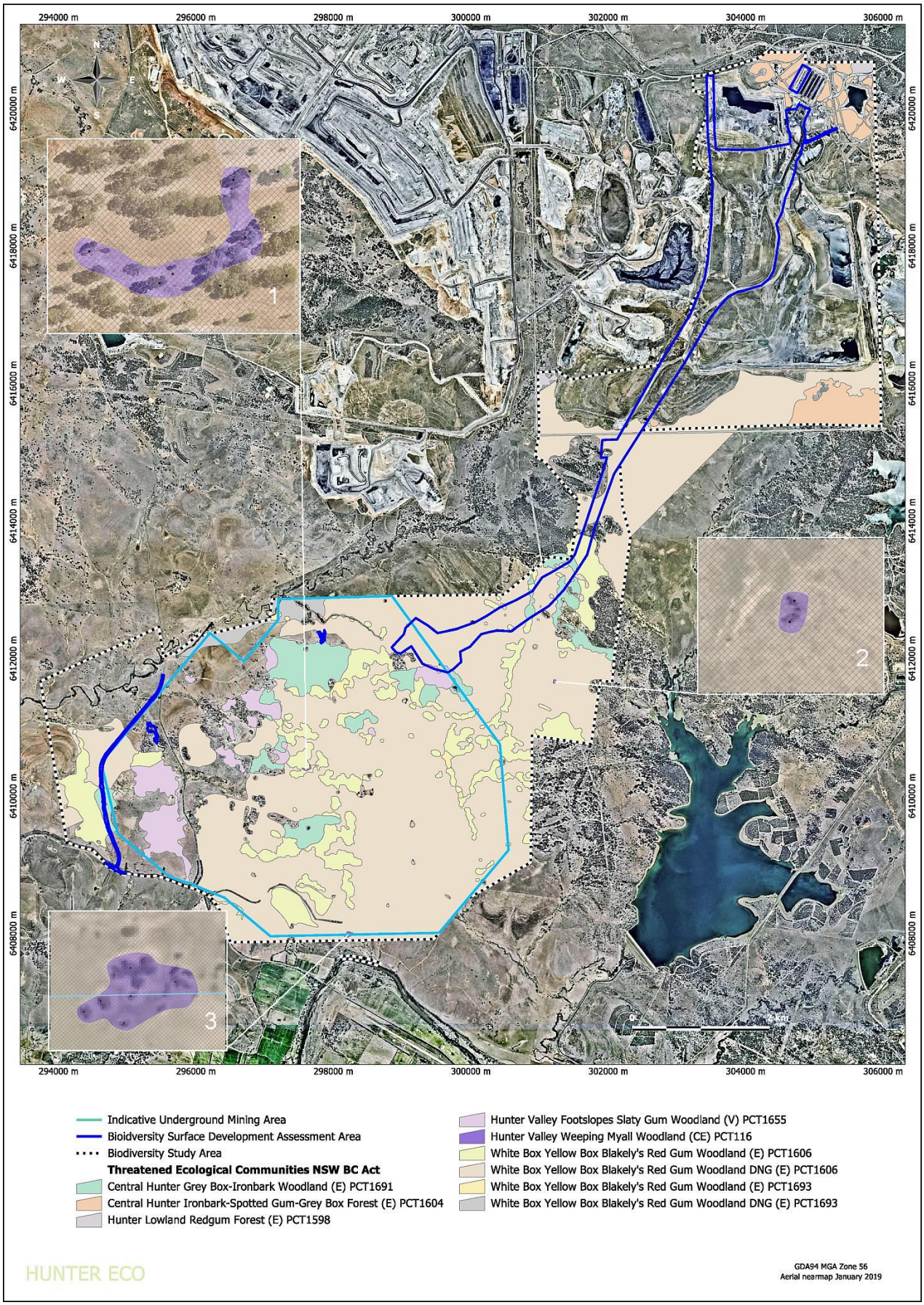


Figure 14: Threatened Ecological Communities NSW BC Act

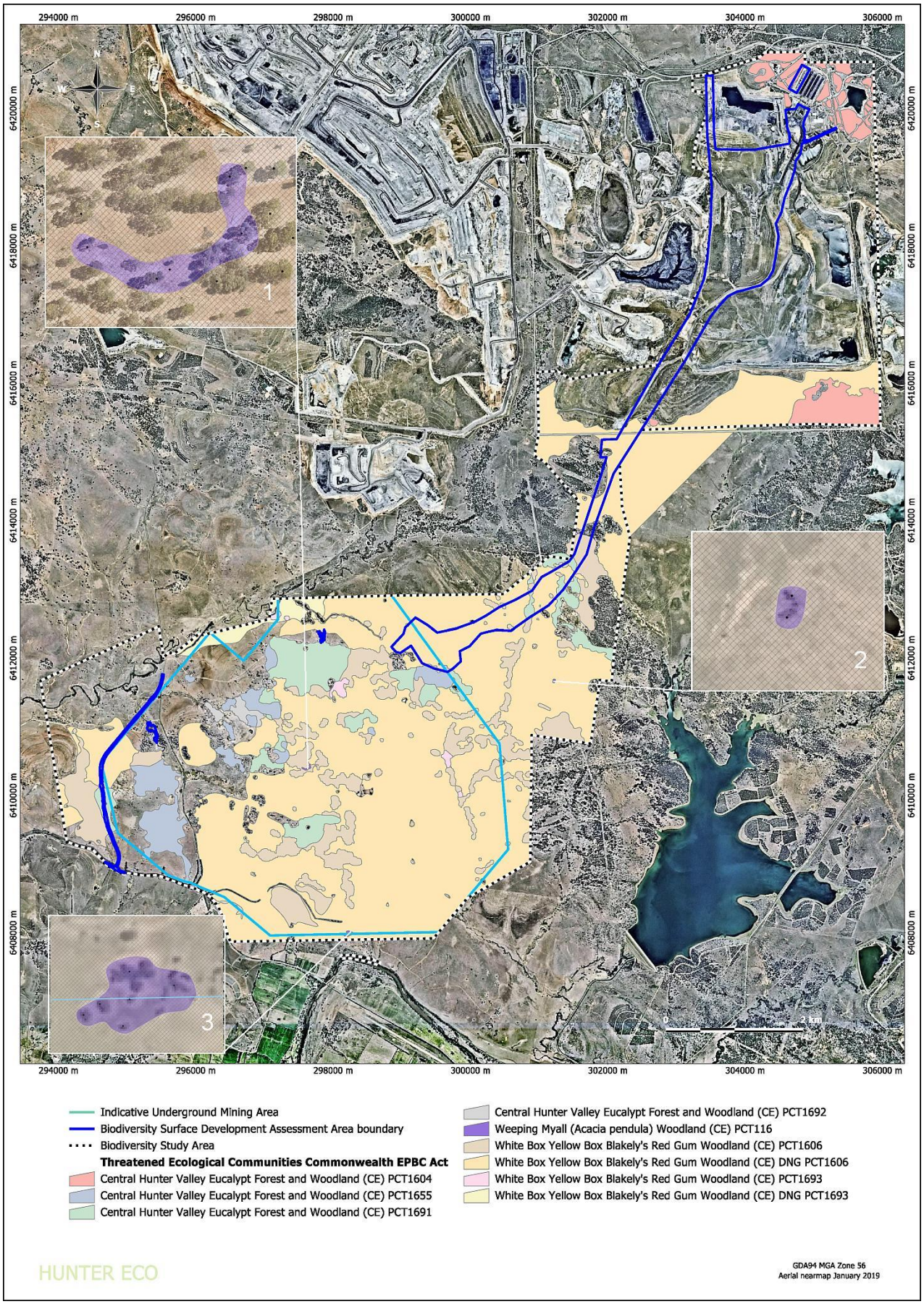


Figure 15: Threatened Ecological Communities Commonwealth EPBC Act

Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion

Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion is listed as a vulnerable ecological community under the BC Act, and is described as a low to mid-high woodland. The determination does not include grasslands derived from this community. *Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin* (PCT 1655) was assessed to be a component of the vulnerable ecological community as the primary canopy content was characterised by the presence of *Eucalyptus dawsonii*, consistent with the TEC.

Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion is scattered across the proposed underground mining area, generally located to the west and northeast (Figure 14).

Hunter Valley Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions

Hunter Valley Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is listed as an endangered ecological community under the BC Act. *Forest Red Gum grassy open forest on floodplains of the lower Hunter* (PCT 1598) was assessed to be a component of the TEC, as the canopy was dominated by *Eucalyptus tereticornis* (Forest Red Gum).

Hunter Valley Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregion is located to the southwest and northeast of Maxwell Infrastructure (Figure 14).

Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is listed as an endangered ecological community under the BC Act. *Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunte*r (PCT 1691) was assessed to be a component of the TEC due to the dominant presence of *Eucalyptus moluccana* in the canopy.

Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is located predominantly in the proposed underground mining area, with a small population of the community near the proposed transport and services corridor (Figure 14).

Central Hunter Ironbark-Spotted Gum-Grey Forest in the NSW North Coast and Sydney Basin Bioregions

Central Hunter Ironbark-Spotted Gum-Grey Forest in the NSW North Coast and Sydney Basin Bioregion is listed as an endangered ecological community under the BC Act. *Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter* (PCT 1604) was assessed to be a component of this threatened community as *Eucalyptus moluccana* (Grey Box) and *Corymbia maculata* (Spotted Gum) were present across the community.

Central Hunter Ironbark-Spotted Gum-Grey Forest in the NSW North Coast and Sydney Basin Bioregion is located to the southeast and northeast of Maxwell Infrastructure (Figure 14).

Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion

Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion is listed as a critically endangered ecological community under the BC Act. *Weeping Myall – Coobah – Scrub Wilga shrubland of the Hunter Valley* (PCT 116) was assessed to be a component of the TEC. The identifying characteristic was the dominant presence of *Acacia pendula*.

Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion is located in three widely separate areas, with two located within the proposed underground mining area and one to the southeast of the proposed transport and services corridor (Figure 14).

8.6 Threatened Ecological Communities Listed under the EPBC Act

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland is listed as a critically endangered ecological community under the EPBC Act. *White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter* (PCT 1606) and *Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains* (PCT 1693) were assessed as components of the TEC, including the derived native grassland variants. The main identifying characteristics were the presence of White Box and White Box x Grey Box in the canopy of PCT 1606 and Yellow Box in the canopy of PCT 1693.

Details provided in Appendices 2 and 4 show that PCT 1606 meets the condition thresholds (DotE 2016a) for this TEC with a predominantly native understorey and over 12 native understorey species in any patch excluding grasses, with all patches >0.1 ha; there were also seven *Important Species* present. Details provided in Appendices 2 and 4 similarly show that PCT 1693 also meets the condition thresholds with a predominantly native understorey and over 12 native understorey species in any patch excluding grasses, with all patches >0.1 ha; there were also 10 *Important Species* present.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland is predominantly located in the proposed underground mining area, with some of the population to the south (along the transport and services corridor) and southeast of Maxwell Infrastructure (Figure 15).

Central Hunter Valley Eucalypt Forest and Woodland

Central Hunter Valley eucalypt forest and woodland is listed as a critically endangered ecological community under the EPBC Act. *Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter* (PCT 1604), *Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin* (PCT 1655), *Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter* (PCT 1691) were assessed as components of the TEC. The primary canopy of each of the local communities was consistent with that of the threatened ecological community given the presence of *Eucalyptus crebra*, Grey Box and Spotted Gum; Slaty Box; Narrow-leaved Ironbark and Grey Box; for PCT 1604, PCT 1655, and PCT 1691, respectively. Areas dominated by *Allocasuarina luehmannii* (Bull Oak), PCT 1692, are specifically excluded from the determination except for sites where any of the key eucalypt canopy species were once dominant. This was the case for areas of PCT 1692 clearly derived from PCT 1655. Elsewhere PCT 1692 was derived from PCT 1606 which includes eucalypt canopy species not part of *Central Hunter Valley Eucalypt Forest and Woodland*.

The determination for *Central Hunter Valley Eucalypt Forest and Woodland* specifically excludes derived grasslands other than for narrow (30 m or less) strips around woodland areas or connection between woodland areas.

Details provided in Appendices 2 and 4 show that PCT 1655 meets the condition thresholds (DotE 2016b) for this TEC with over 50% of the perennial understorey vegetation being native plants and over 12 native understorey species in any patch, with all patches >0.5 ha.

Central Hunter Valley eucalypt forest and woodland is dispersed across the Study Area, predominantly in the proposed underground mining area (PCT 1655, PCT 1691 and part of PCT 1692), with some of the community to the southeast and northeast of the Maxwell Infrastructure (PCT 1604) (Figure 15).

Hunter Valley Weeping Myall (*Acacia pendula*) Woodland

Hunter Valley Weeping Myall (Acacia pendula) Woodland is listed as a critically endangered ecological community under the EPBC Act. *Weeping Myall – Coobah – Scrub Wilga shrubland of the Hunter Valley* (PCT 116) was assessed as a component of the TEC due to the dominating presence of Weeping Myall.

Hunter Valley Weeping Myall (Acacia pendula) Woodland is present in three widely separate areas in the Study Area, with two located within the proposed underground mining area and one to the southeast of the proposed transport and services corridor (Figure 15).

8.7 Flora Species

Appendix 1 lists a total of 348 flora species that were recorded from 74 families and 212 genera, among which were 85 weed species including 14 High Threat Exotic species. The dominant family was Poaceae (Grasses) with 56 native species and 16 weed species including 4 High Threat Exotic species. Asteraceae (Daisies) was represented by 26 native species and 23 weed species including 5 High Threat Exotic species. The High Threat Exotic *Senecio madagascariensis* (Fireweed) was present in all 21 community variants and the native grass *Aristida ramosa* (Purple Wiregrass) was present in 20. Overall, 39 species were present in plot data from 10 or more communities, and 113 species present in five or more communities.

8.8 Threatened Flora Species

Other than the species indicative of Endangered Populations, no threatened flora species were recorded across the Study Area.

8.9 Endangered Populations

All locations of *Acacia pendula* reported by Cumberland Ecology (2015) (Figure 8) were re-surveyed and the plants were found to be *Acacia melvillei* given the deep green non-glaucous foliage and generally erect (not pendulous) form. However Weeping Myall were found in two previously unrecorded locations (Figure 12), as well as several recently planted trees in roadside strips. Also, the *Acacia pendula* record from the BioNET Atlas (OEH 2019c) (Figure 8) was confirmed.

The three widely separated groups of Weeping Myall were typical of the species across the Hunter Valley, being concentrated suckering patches containing numerous plants with no indication of fruiting and germination having occurred (Bell at al 2017). The plants varied from small suckers at the edges of the group to trees approximately three to eight metres tall. The suckers had been kept low by grazing cattle and it is expected that each group would expand with that pressure removed. The areas of the three patches were: Group 1, 0.38 ha; Group 2, 0.19 ha and Group 3, 0.69 ha. Group 1 consisted of three sub-groups each separated by approximately 30 m. Group 2 was in the poorest condition with several dead fallen trees and broken live trees. It is in a very wind-exposed location in a large cleared paddock and aerial imagery (nearmap) shows that the group has approximately halved in size since 2015. Group 3 consisted of six sub-groups separated by 10 to 20 m and spread across approximately 100 m.

On the 17 October 2017, Resource Strategies (2017) inspected the locations of *Diuris tricolor* reported by Cumberland Ecology (2015) and none were found.

The locations of *Diuris tricolor* reported by Cumberland Ecology (2015) were also closely inspected by Hunter Eco, first on 13 September 2018 when plant leaves should have been present, then on 28 September 2018 when flowers should have been present, and again on 23 October 2018 when some flowers might still be present; none were found on any of these occasions. At one of the locations there were several non-threatened *Pterostylis bicolor* terrestrial Greenhood orchids often found growing with *Diuris tricolor*. *Diuris tricolor* is a tuberous plant similar to many terrestrial orchids. Detailed research into four West Australian tuberous orchid species has shown that they do not reliably develop leaves and flowers on an annual basis (Brundrett 2016). In fact, many of the monitored individuals only appeared once in four years with 2 – 3 years dormancy being common. Insufficient rain was a primary factor in maintaining dormancy. Drought conditions prevailed at the time of the orchid survey in the Study Area and it is possible that this suppressed flowering. Just because they were not present in one year does not indicate that they are not dormant or ready to flower in a better season.

The *Cymbidium canaliculatum* reported by Cumberland Ecology (2015) was inspected and appeared dead; this plant was in a large dead tree. A previously unrecorded *Cymbidium canaliculatum* was found (Plate 1) with two healthy plants growing in a living White Box tree (Figure 16).

Plate 1: *Cymbidium canaliculatum* Recorded in the Study Area

8.10 Groundwater Dependent Ecosystems

Across the proposed underground mining area there are several second and third order streams with potential for GDE. The vegetation along these streams (particularly Saddlers Creek) is sporadic consistent with intermittent flow. During surveys conducted in 2018, there was some ponding in the lower extents of these streams which were bordered with Swamp Oak and contained a mix of weedy and native ground cover species generally associated with wet areas. These areas would likely be GDE and were at the outer extent of the underground mining area. Away from the lower streamlines the vegetation consisted of dry sclerophyll forest or woodland which is not groundwater dependent.

To further assess the potential GDE presence along Saddlers and Saltwaters Creeks, a detailed survey of the vegetation associated with the creeks was conducted in July 2019. As already mentioned, Saddlers Creek was dominated by dense patches of Swamp Oak restricted to the stream edge and immediate high bank. The stream bed was choked with Spike Rush (*Juncus acutus*) for much of its length along with scattered *Phragmites australis* and *Typha* sp. The upper reaches of Saddlers Creek also likely contained River Oak (*Casuarina cunninghamiana*) mixed with the dominant Swamp Oak. The dominant scattered large tree at the edges of the Swamp Oak was Rough-barked Apple along with occasional Yellow Box, Fuzzy Box and Blakely's Red Gum. There were no River Red Gum.

BioNet Atlas (OEH 2019c) showed a single River Red Gum paddock tree on the Saddlers Creek floodplain west of the Study Area. This tree was inspected on 3 July 2019 and found to be a Yellow Box, positively identified by the colour of the foliage, and the shape of buds and fruit. In particular the fruit was of a Box type (cup-shaped with recessed disc and enclosed valves) rather than Red Gum type (globose/ovoid with disc raised and exserted valves).

Saltwater Creek vegetation was almost entirely a mix of *Acacia salicina* and Swamp Oak tightly confined to the streamline. *Acacia salicina* is not a GDE species, being found dispersed across the landscape at all elevations.

8.11 Koala Potential Habitat

Of the SEPP 44 preferred feed trees, two occur in the study area, namely Forest Red Gum, which is part of PCT1598 mapped in only a few small locations, and White Box, which is part of PCT 1606. PCT 1598 and PCT 1606 provide 'potential koala habitat' as defined by SEPP 44 because areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The following additional Koala food tree species (recognised by DP&E, 2018) were identified in the study area:

- Grey Box (*Eucalyptus moluccana*) within PCT1604;
- Yellow Box (*E. melliodora*) within PCT1693;
- Blakely's Red Gum (*E. blakelyi*) within PCT1607 and PCT1606; and
- Fuzzy Box (*E. conica*) with PCT201.

The Threatened Biodiversity Data Collection (OEH, 2019a) also recognises PCT1655 could provide potential habitat. However, the occurrence of PCT1655 in the study area only contains Slaty Box which is not a recognised koala food tree.

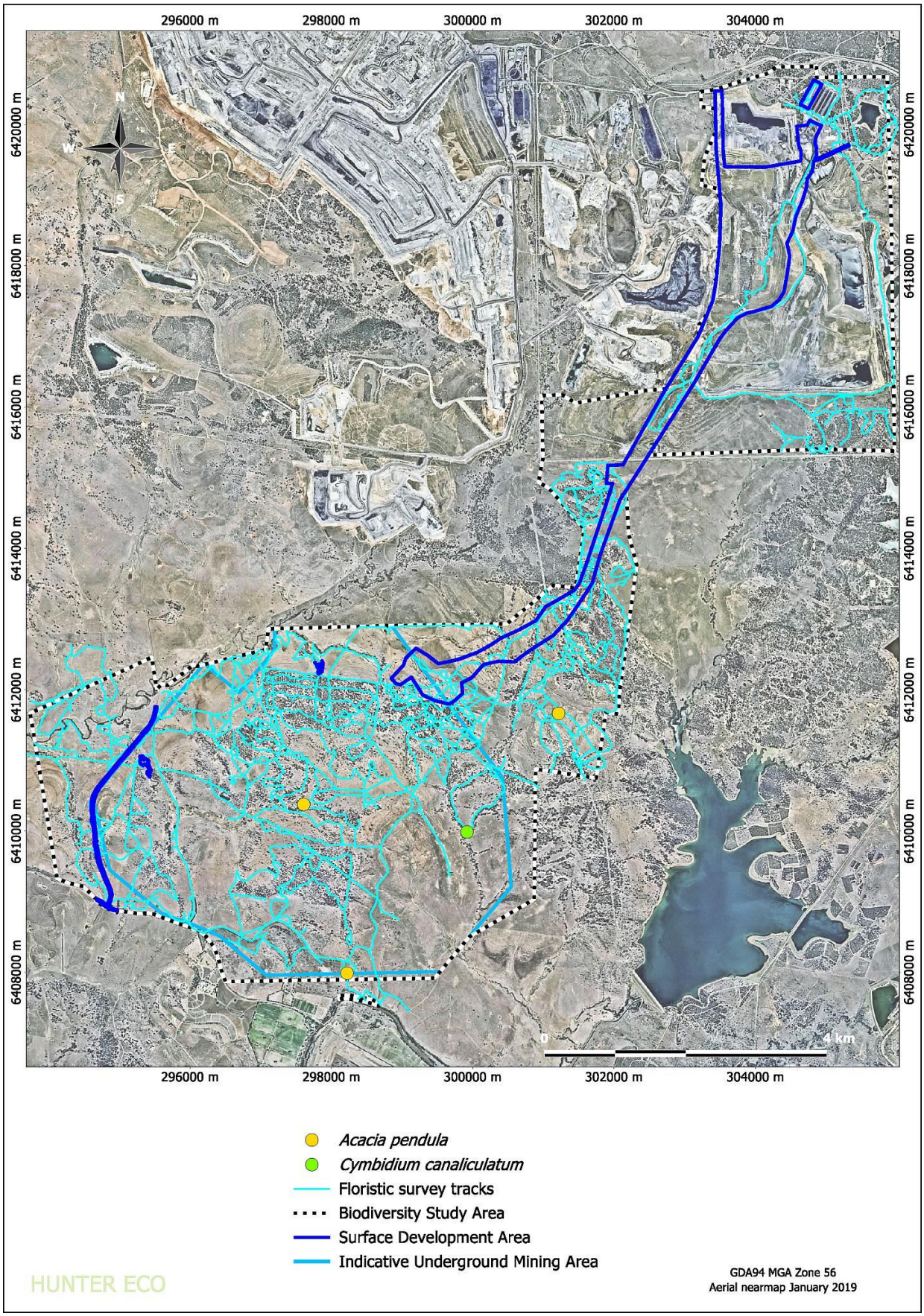


Figure 16: The Location of Individuals from Endangered Populations Recorded by Hunter Eco

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APPENDIX 1 COMBINED FLORISTIC LIST

* = weed ** = High Threat Exotic

Family and Species
Acanthaceae
Brunoniella australis
Rostellularia adscendens
Adiantaceae
Pellaea falcata
Aizoaceae
***Galenia pubescens*
Amaranthaceae
**Gomphrena celosioides*
Alternanthera denticulata
Ptilotus sessilifolius var. *sessilifolius*
Anthericaceae
Arthropodium milleflorum
Arthropodium minus
Arthropodium sp.
Dichopogon fimbriatus
Laxmannia gracilis
Tricoryne elatior
Apiaceae
**Cyclospermum leptophyllum*
Hydrocotyle laxiflora
Apocynaceae
**Gomphocarpus fruticosus*
Marsdenia viridiflora subsp. *viridiflora*
Parsonsia straminea
Asphodelaceae
**Asphodelus fistulosus*
Aspleniaceae
Asplenium flabellifolium
Asteraceae
***Bidens pilosa*
***Carthamus lanatus*
***Senecio madagascariensis*
***Xanthium occidentale*
***Xanthium spinosum*
**Ambrosia tenuifolia*
**Aster subulatus*
**Centaurea melitensis*
**Chondrilla juncea*
**Cirsium vulgare*
**Conyza albida*
**Conyza* sp.
**Facelis retusa*
**Gamochaeta calviceps*
**Hedypnois rhagadioloides*
**Hypochaeris albiflora*
**Hypochaeris glabra*
**Hypochaeris radicata*
**Schkuhria pinnata* var. *abrotanoides*
**Sonchus asper*
**Tagetes minuta*
**Taraxacum officinale*
**Tolpis barbata*
Brachyscome ciliaris var. *subintegrifolia*
Calocephalus citreus
Calotis cuneifolia
Calotis lappulacea
Cassinia quinquefaria
Chrysocephalum semipapposum
Cotula australis
Cotula coronopifolia
Cyanthillium cinereum var. *cinereum*
Cymbonotus lawsonianus
Eclipta platyglossa
Euchiton involucratus
Glossocardia bidens
Leiocarpa leptolepis
Leiocarpa panaetioides
Leiocarpa tomentosa
Leptorhynchos squamatus subsp. *squamatus*
Minuria leptophylla
Olearia elliptica
Ozothamnus diosmifolius
Senecio quadridentatus
Solenogyne bellioides
Vittadinia cervicularis var. *subcervicularis*
Vittadinia muelleri
Vittadinia pterochaeta
Vittadinia sp.
Boraginaceae
Cynoglossum australe
Brassicaceae

Family and Species
**Hirschfeldia incana*
**Lepidium bonariense*
**Rapistrum rugosum*
**Sisymbrium irio*
Lepidium pseudohyssopifolium
Cactaceae
***Opuntia humifusa*
***Opuntia stricta*
Campanulaceae
Wahlenbergia communis
Wahlenbergia gracilis
Wahlenbergia luteola
Wahlenbergia planiflora subsp. *planiflora*
Wahlenbergia sp.
Wahlenbergia stricta
Caryophyllaceae
**Paronychia brasiliana*
**Petrorhagia dubia*
**Petrorhagia nanteuilii*
**Silene gallica* var. *gallica*
**Spergularia marina*
**Spergularia rubra*
**Stellaria media*
Casuarinaceae
Allocasuarina luehmannii
Casuarina glauca
Celastraceae
Denhamia cunninghamii
Chenopodiaceae
Atriplex semibaccata
Dysphania carinata
Dysphania cristata
Dysphania pumilio
Einadia hastata
Einadia nutans
Einadia polygonoides
Einadia trigonos subsp. *stellulata*
Enchylaena tomentosa
Maireana decalvans
Maireana enchylaenoides
Maireana microphylla
Sclerolaena birchii
Sclerolaena muricata var. *villosa*
Clusiaceae
Hypericum gramineum

Family and Species
Commelinaceae
Commelina cyanea
Convolvulaceae
Convolvulus angustissimus
Convolvulus erubescens
Dichondra repens
Dichondra species A
Evolvulus alsinoides
Crassulaceae
Crassula sieberiana
Cyperaceae
Bolboschoenus caldwellii
Carex inversa
Cyperus fulvus
Cyperus gunnii
Fimbristylis dichotoma
Dennstaedtiaceae
Pteridium esculentum
Dilleniaceae
Hibbertia obtusifolia
Ericaceae (Styphelioideae)
Lissanthe strigosa
Euphorbiaceae
Chamaesyce drummondii
Fabaceae (Caesalpinioideae)
Senna barclayana
Fabaceae (Faboideae)
**Lupinus angustifolius*
**Medicago sativa*
**Medicago* sp.
**Melilotus indica*
**Trifolium arvense*
**Vicia villosa*
Cullen tenax
Daviesia ulicifolia
Desmodium brachypodum
Desmodium varians
Glycine clandestina
Glycine stenophita
Glycine tabacina
Hardenbergia violacea
Indigofera australis
Rhynchosia minima
Templetonia stenophylla
Zornia dyctiocarpa

Family and Species
Fabaceae (Mimosoideae)
**Acacia saligna*
Acacia baileyana
Acacia cultriformis
Acacia decora
Acacia falcata
Acacia implexa
Acacia mearnsii
Acacia paradoxa
Acacia pendula
Acacia salicina
Acacia sp.
Neptunia gracilis forma gracilis
Gentianaceae
**Centaurium erythraea*
Geraniaceae
**Erodium cicutarium*
Erodium crinitum
Geranium solanderi
Goodeniaceae
Goodenia bellidifolia subsp. *bellidifolia*
Goodenia fascicularis
Goodenia glauca
Goodenia hederacea subsp. *hederacea*
Goodenia pinnatifida
Goodenia sp.
Scaevola aemula
Juncaceae
***Juncus acutus*
Juncus sarophorus
Juncus subsecundus
Juncus usitatus
Lamiaceae
**Salvia verbenaca*
**Stachys arvensis*
Ajuga australis
Mentha satureioides
Teucrium junceum
Linaceae
**Linum trigynum*
Linum marginale
Lobeliaceae
Isotoma fluviatilis
Lomandraceae
Lomandra bracteata
Lomandra confertifolia subsp. *rubiginosa*
Lomandra filiformis subsp. *coriacea*
Lomandra filiformis subsp. *filiformis*
Lomandra glauca
Lomandra longifolia
Lomandra multiflora
Lomandra sp.
Luzuriagaceae
Geitonoplesium cymosum
Lythraceae
Lythrum hyssopifolia
Malvaceae
**Modiola caroliniana*
**Sida rhombifolia*
Abutilon oxycarpum
Sida corrugata
Sida cunninghamii
Sida hackettiana
Sida trichopoda
Moraceae
Ficus rubiginosa
Myoporaceae
Eremophila debilis
Myoporum montanum
Myrtaceae
**Eucalyptus cladocalyx*
Angophora floribunda
Corymbia maculata
Eucalyptus albens
Eucalyptus beyeriana
Eucalyptus blakelyi
Eucalyptus conica
Eucalyptus crebra
Eucalyptus dawsonii
Eucalyptus melliodora
Eucalyptus moluccana
Eucalyptus sp.
Eucalyptus tereticornis
Nyctaginaceae
Boerhavia dominii
Oleaceae
Jasminum suavissimum
Notelaea microcarpa
Orchidaceae
Cymbidium canaliculatum

Family and Species
Pterostylis bicolor
Oxalidaceae
Oxalis chnoodes
Oxalis exilis
Oxalis perennans
Phormiaceae
Dianella caerulea var. *cinerascens*
Dianella longifolia
Phyllanthaceae
Breynia oblongifolia
Phyllanthus virgatus
Phytolaccaceae
Phytolacca octandra
Pittosporaceae
Bursaria spinosa
Plantaginaceae
**Plantago lanceolata*
**Plantago myosuros* subsp. *myosuros*
Plantago gaudichaudii
Plantago sp.
Plantago turrifera
Plantago varia
Poaceae
***Cenchrus clandestinus*
***Chloris gayana*
***Hyparrhenia hirta*
***Paspalum dilatatum*
**Avena sativa*
**Bromus molliformis*
**Cynodon dactylon*
**Eleusine tristachya*
**Eragrostis pilosa*
**Lolium perenne*
**Melinis repens*
**Panicum bulbosum*
**Panicum miliaceum*
**Setaria pumila*
**Setaria sphacelata*
**Urochloa panicoides*
Anthosachne scabra
Aristida leichhardtiana
Aristida personata
Aristida ramosa
Aristida vagans
Austrostipa nodosa

Family and Species
Austrostipa scabra
Austrostipa scabra subsp. *falcata*
Austrostipa scabra subsp. *scabra*
Austrostipa verticillata
Bothriochloa biloba
Bothriochloa decipiens
Chloris divaricata var. *divaricata*
Chloris truncata
Chloris ventricosa
Cymbopogon refractus
Dichanthium sericeum subsp. *sericeum*
Dichelachne crinita
Dichelachne micrantha
Digitaria brownii
Digitaria coenicola
Digitaria divaricatissima
Digitaria ramularis
Digitaria sp.
Echinochloa colona
Echinopogon intermedius
Enneapogon gracilis
Eragrostis alveiformis
Eragrostis brownii
Eragrostis lacunaria
Eragrostis leptostachya
Eragrostis sororia
Eragrostis sp.
Eriochloa pseudoacrotricha
Eulalia aurea
Microlaena stipoides
Panicum buncei
Panicum decompositum
Panicum effusum
Panicum queenslandicum
Paspalidium distans
Poa affinis
Polypogon monspeliensis
Rytidosperma bipartitum
Rytidosperma caespitosum
Rytidosperma carphoides
Rytidosperma erianthum
Rytidosperma monticola
Rytidosperma pallidum
Rytidosperma racemosum var. *obtusatum*
Rytidosperma setaceum

Family and Species
Rytidosperma sp.
Sporobolus caroli
Sporobolus creber
Themeda triandra
Tripogon loliiformis
Polygonaceae
**Polygonum aviculare*
Persicaria decipiens
Persicaria orientalis
Rumex brownii
Rumex sp.
Portulacaceae
Calandrinia eremaea
Portulaca oleracea
Primulaceae
**Lysimachia arvensis*
Pteridaceae
Cheilanthes sieberi
Ranunculaceae
Clematis glycinoides
Rhamnaceae
Cryptandra amara
Rubiaceae
**Richardia stellaris*
Asperula conferta
Pomax umbellata
Psydrax odorata
Rutaceae
Geijera parviflora
Nematolepis elliptica
Santalaceae
Exocarpos strictus
Santalum lanceolatum
Sapindaceae
Dodonaea viscosa subsp. *angustifolia*
Dodonaea viscosa subsp. *mucronata*
Scrophulariaceae
Veronica plebeia
Solanaceae
***Lycium ferocissimum*
**Cestrum aurantiacum*
**Solanum nigrum*
Solanum campanulatum
Solanum cinereum
Solanum opacum

Family and Species
Solanum parvifolium
Solanum sp.
Stackhousiaceae
Stackhousia viminea
Sterculiaceae
Brachychiton populneus
Thymelaeaceae
Pimelea curviflora var. *sericea*
Pimelea linifolia subsp. *linifolia*
Pimelea neo-anglica
Typhaceae
Typha orientalis
Verbenaceae
**Verbena bonariensis*
**Verbena officinalis*
**Verbena quadrangularis*
**Verbena rigida* var. *rigida*
Clerodendrum tomentosum
Vitaceae
Cayratia clematidea
Clematicissus opaca
Zygophyllaceae
Tribulus micrococcus

APPENDIX 2 FLORA SPECIES RECORDED IN EACH WOODLAND PLANT COMMUNITY TYPE

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Acanthaceae													
Brunoniella australis	.		.	.	.	.	.	.	.	.	.		
Rostellularia adscendens			.		.		.	.		.			
Aizoaceae													
***Galenia pubescens*	.	.		.	.	.	.	.	.	.	.		.
Amaranthaceae													
Ptilotus sessilifolius var. sessilifolius					.		.	.	.		.		
Anthericaceae													
Arthropodium milleflorum			.	.	.	.		.					
Arthropodium minus						.		.					
Arthropodium sp.					.	.	.	.	.				
Dichopogon fimbriatus			.										
Laxmannia gracilis			.						.				
Thysanotus tuberosus			.										
Tricoryne elatior			.					.					
Apiaceae													
**Cyclospermum leptophyllum*			.										
Hydrocotyle laxiflora			.		.								
Apocynaceae													
**Gomphocarpus fruticosus*				.	.	.		.					.
Marsdenia viridiflora					.		.						
Marsdenia viridiflora subsp. viridiflora					.			.					

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Parsonsia straminea						.							
Asphodelaceae													
**Asphodelus fistulosus*													.
Aspleniaceae													
Asplenium flabellifolium						.							
Asteraceae													
***Bidens pilosa*			.	.							.		.
***Carthamus lanatus*	.	.						.		.			
***Senecio madagascariensis*	.	.	.	.	.	.	.	.	.	.	.	.	.
***Xanthium occidentale*						.							
**Ambrosia tenuifolia*			.										
**Aster subulatus*										.			
**Cirsium vulgare*					.								
**Hedypnois rhagadioloides*										.			
**Hypochaeris radicata*					.			.				.	
**Sonchus asper*			.					.			.	.	.
**Taraxacum officinale*								.		.			
**Tolpis barbata*											.		
Brachyscome ciliaris var. subintegrifolia				.	.		.	.		.	.		
Calocephalus citreus				.				.					
Calotis cuneifolia			.	.		.	.	.					
Calotis lappulacea		.	.	.	.	.	.	.	.	.	.		
Cassinia quinquefaria			.						.				
Chrysocephalum semipapposum	.		.	.	.		.	.	.	.		.	
Cotula australis										.	.		

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Cyanthillium cinereum				.								.	
Cyanthillium cinereum var. cinereum			.	.									
Cymbonotus lawsonianus								.		.			
Glossocardia bidens			.	.			.	.					
Leiocarpa leptolepis												.	
Leiocarpa panaetioides											.	.	
Olearia elliptica					.								
Ozothamnus diosmifolius						.							
Solenogyne bellioides		.			.			.	.				
Vittadinia cervicularis var. subcervicularis							.	.		.	.		
Vittadinia muelleri								.					
Vittadinia pterochaeta			.	.				.			.	.	
Vittadinia sp.		.			.		.	.		.			
Boraginaceae													
Cynoglossum australe				.									
Brassicaceae													
**Hirschfeldia incana*													.
**Lepidium bonariense*	.							.		.	.		
**Sisymbrium irio*	.							.					
Lepidium pseudohyssopifolium					.								
Cactaceae													
***Opuntia humifusa*			.	.									
***Opuntia stricta*			.	.	.	.	.	.	.		.		
Campanulaceae													
Wahlenbergia communis				.	.					.	.		

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Wahlenbergia gracilis												.	
Wahlenbergia luteola			.	.	.		.	.					
Wahlenbergia sp.					.		.	.	.	.			
Caryophyllaceae													
**Petrorhagia nanteuilii*			.		.			.		.		.	
**Spergularia rubra*							.	.	.				
Stellaria media						.							
Casuarinaceae													
Allocasuarina luehmannii		.	.	.	.	.	.	.	.	.			
Casuarina glauca											.	.	
Celastraceae													
Denhamia cunninghamii					.		.	.					
Chenopodiaceae													
Atriplex semibaccata				.				.			.	.	.
Dysphania carinata	.												
Dysphania cristata					.			.					
Einadia hastata		.		.	.	.		.	.		.		.
Einadia nutans	.				.	.	.	.	.				
Einadia polygonoides	.				.	.	.	.	.	.	.		
Einadia trigonos subsp. stellulata				.							.		
Enchylaena tomentosa	.			.	.	.	.	.	.	.	.	.	.
Maireana enchylaenoides	.				.		.	.			.		
Maireana microphylla	.				.	.	.	.	.		.		
Sclerolaena muricata var. villosa	.							.					
Clusiaceae													

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Hypericum gramineum			.					.					
Commelinaceae													
Commelina cyanea			.	.		.	.	.		.			
Convolvulaceae													
Convolvulus angustissimus			.					.				.	
Convolvulus erubescens					.			.					
Dichondra repens	.	.	.	.	.	.	.	.	.	.		.	.
Evolvulus alsinoides					.								
Crassulaceae													
Crassula sieberiana								.	.		.		
Cyperaceae													
Carex inversa		.		.	.		.	.	.	.			
Fimbristylis dichotoma									.				
Dilleniaceae													
Hibbertia obtusifolia			.										
Ericaceae (Styphelioideae)													
Lissanthe strigosa				.									
Euphorbiaceae													
Chamaesyce drummondii					.			.		.	.	.	.
Fabaceae (Faboideae)													
**Lupinus angustifolius*													.
**Medicago sativa*													.
**Medicago sp.*					.		.	.		.	.		
**Melilotus indica*													.
**Trifolium arvense*												.	

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Daviesia ulicifolia			.	.									
Desmodium brachypodum		.		.	.	.	.	.		.			
Desmodium varians			.		.		.	.	.	.	.		
Glycine clandestina	.	.	.	.	.	.	.	.	.	.	.	.	
Glycine stenophita			.										
Glycine tabacina											.		
Hardenbergia violacea				.	.		.						.
Indigofera australis					.	.							
Templetonia stenophylla			.	.	.	.	.	.	.		.		
Zornia dyctiocarpa				.				.					
Fabaceae (Mimosoideae)													
**Acacia saligna*													.
Acacia baileyana													.
Acacia decora					.			.	.				.
Acacia falcata			.	.									.
Acacia implexa			.										
Acacia mearnsii													.
Acacia paradoxa					.			.	.				
Acacia pendula	.												
Acacia salicina	.	.			.		.	.	.	.	.	.	.
Acacia sp.													.
Neptunia gracilis forma gracilis												.	.
Geraniaceae													
Erodium crinitum	.							.					
Geranium solanderi		.											

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Goodeniaceae													
Goodenia bellidifolia subsp. bellidifolia			.	.							.		.
Goodenia hederacea subsp. hederacea				.									
Goodenia sp.					.	.	.	.	.				
Scaevola aemula					.								
Juncaceae													
Juncus subsecundus							.						
Lamiaceae													
**Salvia verbenaca*											.		
**Stachys arvensis*			.									.	
Ajuga australis				.	.	.							
Mentha satureioides			.	.									
Teucrium junceum				.	.	.							
Linaceae													
**Linum trigynum*					.								.
Linum marginale				.									
Lobeliaceae													
Isotoma fluviatilis						.							
Lomandraceae													
Lomandra bracteata	.			.				.					
Lomandra confertifolia subsp. rubiginosa						.			.	.			
Lomandra filiformis subsp. coriacea					.								
Lomandra filiformis subsp. filiformis		.	.	.	.	.	.	.	.	.			
Lomandra glauca	.	.			.			.	.	.			
Lomandra multiflora	.	.	.	.	.	.	.	.	.	.			

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Lomandra sp.					.	.			.				
Luzuriagaceae													
Geitonoplesium cymosum						.							
Malvaceae													
**Modiola caroliniana*								.					.
**Sida rhombifolia*	.	.	.	.	.	.	.	.	.	.	.		.
Abutilon oxycarpum					.		.	.	.	.			
Sida corrugata	.	.	.	.	.	.	.	.	.	.	.	.	
Sida cunninghamii							.	.			.		
Sida hackettiana	.		.								.		
Sida trichopoda	.												
Moraceae													
Ficus rubiginosa						.							
Myoporaceae													
Eremophila debilis	.	.	.	.	.	.	.	.	.	.	.		
Myoporum montanum				.	.		.	.					
Myrtaceae													
**Eucalyptus cladocalyx*													.
Angophora floribunda		.				.				.			
Corymbia maculata				.								.	.
Eucalyptus albens	.				.			.		.			.
Eucalyptus beyeriana						.							
Eucalyptus blakelyi				.	.	.					.		
Eucalyptus conica		.											
Eucalyptus crebra		.		.	.			.	.			.	

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Eucalyptus dawsonii							.		.			.	
Eucalyptus melliodora										.			
Eucalyptus moluccana				.		.	.	.	.				
Eucalyptus sp.													.
Eucalyptus tereticornis			.										
Nyctaginaceae													
Boerhavia dominii					.			.					
Oleaceae													
Jasminum suavissimum					.								
Notelaea microcarpa		.	.		.	.	.	.			.		
Oxalidaceae													
Oxalis chnoodes					.								
Oxalis exilis	.		.		.	.		.	.	.	.	.	
Oxalis perennans							.	.	.	.	.	.	
Phormiaceae													
Dianella caerulea var. cinerascens					.	.							
Dianella longifolia					.		.	.	.	.			
Dianella longifolia var. longifolia			.	.									
Phyllanthaceae													
Breynia oblongifolia			.	.	.	.							
Phyllanthus virgatus	.		.				.	.		.	.	.	
Phytolaccaceae													
**Phytolacca octandra*													.
Pittosporaceae													
Bursaria spinosa				.	.			.	.				

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Plantaginaceae													
**Plantago lanceolata*		.	.		.			.		.	.	.	.
Plantago gaudichaudii					.			.		.			
Plantago sp.		.			.	.		.	.				
Plantago turrifera								.					
Plantago varia					.								
Poaceae													
***Cenchrus clandestinus*													.
***Chloris gayana*			.										.
***Hyparrhenia hirta*				.									.
**Bromus molliformis*		.											
**Cynodon dactylon*	.				.	.		.		.	.		.
**Lolium perenne*								.			.		
**Melinis repens*													.
**Panicum bulbosum*													.
**Setaria sphacelata*													.
Anthosachne scabra				.									
Aristida leichhardtiana												.	
Aristida ramosa	.	.	.	.	.	.	.	.	.	.	.		.
Aristida vagans			.	.	.								
Austrostipa nodosa												.	
Austrostipa scabra		.		.	.	.	.	.	.	.			
Austrostipa scabra subsp. falcata			.	.				.					
Austrostipa scabra subsp. scabra	.		.								.		
Austrostipa verticillata	.			.	.	.	.	.	.	.	.		

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Bothriochloa biloba											.	.	
Bothriochloa decipiens								.		.			.
Chloris divaricata							.	.		.			
Chloris divaricata var. divaricata	.			.							.		.
Chloris ventricosa		.			.	.		.		.	.		
Cymbopogon refractus			.	.			.					.	.
Dichanthium sericeum	.							.			.	.	.
Dichanthium sericeum subsp. sericeum								.		.			
Dichelachne crinita			.										
Dichelachne micrantha			.									.	
Digitaria divaricatissima												.	
Digitaria ramularis				.	.		.	.					
Digitaria sp.		.							.				
Eragrostis alveiformis	.		.		.			.					
Eragrostis lacunaria					.			.		.			
Eragrostis leptostachya			.	.	.		.	.		.			
Eragrostis pilosa													.
Eragrostis sp.									.				
Eriochloa pseudoacrotricha								.					.
Microlaena stipoides			.	.	.	.		.			.		
Panicum effusum											.		
Panicum queenslandicum												.	
Paspalidium distans					.		.	.		.	.		
Poa affinis				.									
Rytidosperma bipartitum							.		.				

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Rytidosperma caespitosum			.	.				.			.		.
Rytidosperma erianthum	.								.			.	
Rytidosperma monticola													.
Rytidosperma racemosum var. obtusatum			.										
Rytidosperma sp.	.			.	.	.	.	.	.				
Sporobolus caroli											.		
Sporobolus creber				.	.		.	.		.		.	
Themeda triandra			.		.								
Polygonaceae													
**Polygonum aviculare*	.												
Rumex sp.		.			.			.					
Portulacaceae													
Calandrinia eremaea					.				.				
Portulaca oleracea	.							.					
Primulaceae													
**Lysimachia arvensis*		.	.		.	.	.	.		.	.	.	
Pteridaceae													
Cheilanthes sieberi	.	.	.	.	.	.	.	.	.	.			
Ranunculaceae													
Clematis glycinoides						.							
Rhamnaceae													
Cryptandra amara				.									
Cryptandra amara var. longiflora							.	.					
Rubiaceae													
Asperula conferta	.				.	.	.	.	.			.	

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Pomax umbellata			.										
Psydrax odorata					.	.							
Rutaceae													
Geijera parviflora					.			.					
Nematolepis elliptica								.					
Santalaceae													
Exocarpos strictus			.										
Santalum lanceolatum						.							
Sapindaceae													
Dodonaea viscosa subsp. angustifolia						.							.
Dodonaea viscosa subsp. mucronata						.							.
Scrophulariaceae													
Veronica plebeia		.				.		.	.	.			
Solanaceae													
***Lycium ferocissimum*	.				.	.	.	.		.	.		
**Solanum nigrum*								.					.
Solanum campanulatum					.			.					
Solanum cinereum	.			.								.	
Solanum parvifolium				.									
Solanum sp.		.					.	.	.				
Stackhousiaceae													
Stackhousia viminea			.	.	.		.	.		.			
Sterculiaceae													
Brachychiton populneus			.		.	.	.	.		.	.		
Thymelaeaceae													

Woodland Communities	Plant Community Type												
Family and Species	**116**	**201**	**1598**	**1604**	**1606**	**1607**	**1655**	**1691**	**1692**	**1693**	**1731**	**PL**	**RW**
Pimelea curviflora var. sericea					.				.	.			
Pimelea linifolia							.	.					
Pimelea neo-anglica								.					
Verbenaceae													
**Verbena bonariensis*		.											
**Verbena officinalis*												.	
**Verbena rigida*	.												
Clerodendrum tomentosum						.							
Vitaceae													
Cayratia clematidea						.							
Clematicissus opaca						.							

APPENDIX 3 FLORA SPECIES RECORDED IN EACH GRASSLAND PLANT COMMUNITY TYPE

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Acanthaceae								
Brunoniella australis			.		.	.	.	
Rostellularia adscendens					.			
Aizoaceae								
***Galenia pubescens*	.	.		.	.	.		.
Amaranthaceae								
**Gomphrena celosioides*		.						
Anthericaceae								
Dichopogon fimbriatus						.		
Tricoryne elatior			.			.		
Apiaceae								
**Cyclospermum leptophyllum*	.		.			.		
Apocynaceae								
**Gomphocarpus fruticosus*		.	.	.		.		.
Asphodelaceae								
**Asphodelus fistulosus*								.
Asteraceae								
***Bidens pilosa*								.
***Carthamus lanatus*	.	.	.		.	.	.	
***Senecio madagascariensis*	.	.	.	.	.	.	.	.
**Cirsium vulgare*		.	.					.
**Conyza albida*								.
**Conyza sp.*		.	.			.		.
**Gamochaeta calviceps*					.			
**Hedypnois rhagadioloides*	.				.		.	
**Hypochaeris albiflora*						.		
**Hypochaeris radicata*	.	.			.	.		
**Schkuhria pinnata var. abrotanoides*	.				.		.	
**Sonchus asper*		.			.			.
**Tagetes minuta*		.		.				.
**Taraxacum officinale*			.					
**Tolpis barbata*					.	.		.
Brachyscome ciliaris var. subintegrifolia					.		.	
Calotis lappulacea				.	.	.		
Chrysocephalum semipapposum	.	.	.		.	.	.	
Cymbonotus lawsonianus			.		.			
Eclipta platyglossa			.					
Euchiton involucratus			.			.	.	
Glossocardia bidens			.		.			

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Minuria leptophylla					.		.	.
Senecio quadridentatus				.				.
Solenogyne bellioides							.	
Vittadinia cervicularis var. subcervicularis			.				.	
Vittadinia muelleri			.		.	.	.	.
Vittadinia pterochaeta					.	.	.	.
Brassicaceae								
**Hirschfeldia incana*								.
**Lepidium bonariense*	.		.		.		.	
**Rapistrum rugosum*					.			.
Lepidium pseudohyssopifolium			.	.	.	.		
Cactaceae								
***Opuntia stricta*	.	.						.
Campanulaceae								
Wahlenbergia communis			.	.	.	.		
Wahlenbergia gracilis					.			.
Wahlenbergia luteola		.			.			
Wahlenbergia planiflora subsp. planiflora					.			
Wahlenbergia stricta					.		.	
Wahlenbergia stricta subsp. stricta							.	
Caryophyllaceae								
**Petrorhagia dubia*					.			
**Petrorhagia nanteuilii*	.	.	.		.			
**Silene gallica var. gallica*					.			.
Casuarinaceae								
Allocasuarina luehmannii					.			
Chenopodiaceae								
Atriplex semibaccata						.		
Dysphania carinata				.				
Einadia hastata				.				.
Einadia nutans	.		.	.	.			.
Einadia polygonoides			.	.				
Einadia trigonos subsp. stellulata			.	.				
Enchylaena tomentosa	.				.			
Maireana enchylaenoides					.		.	
Maireana microphylla			.		.		.	
Commelinaceae								
Commelina cyanea		.	.	.				.
Convolvulaceae								
Convolvulus angustissimus			.	.	.	.	.	.
Dichondra repens			.		.	.		.
Dichondra species A	.							

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Crassulaceae								
Crassula sieberiana					.			
Cyperaceae								
Carex inversa			.	.				.
Cyperus fulvus				.				
Cyperus gunnii				.				
Fimbristylis dichotoma			.			.		
Euphorbiaceae								
Chamaesyce drummondii					.		.	.
Fabaceae (Caesalpinioideae)								
Senna barclayana								.
Fabaceae (Faboideae)								
**Medicago sativa*								.
**Medicago sp.*	.				.		.	.
**Trifolium arvense*								.
**Vicia villosa*								.
Desmodium brachypodum				.				
Desmodium varians					.		.	
Glycine clandestina		.	.		.	.	.	
Glycine stenophita					.			
Glycine tabacina					.			
Rhynchosia minima								.
Fabaceae (Mimosoideae)								
Acacia salicina					.			
Neptunia gracilis forma gracilis					.		.	
Gentianaceae								
**Centaurium erythraea*			.			.		.
Geraniaceae								
**Erodium cicutarium*								.
Erodium crinitum			.		.	.	.	.
Goodeniaceae								
Goodenia bellidifolia subsp. bellidifolia					.			
Goodenia glauca					.			
Goodenia sp.					.			
Juncaceae								
Juncus usitatus				.				
Lamiaceae								
**Stachys arvensis*			.		.			
Mentha satureioides		.	.		.	.	.	.
Linaceae								
**Linum trigynum*		.	.		.	.	.	.
Linum marginale		.	.			.		.
Lomandraceae								

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Lomandra bracteata						.	.	
Lomandra confertifolia subsp. rubiginosa					.			
Lomandra filiformis subsp. filiformis		.						
Lomandra longifolia								.
Lomandra multiflora		.						.
Malvaceae								
**Modiola caroliniana*	.		.	.	.			.
**Sida rhombifolia*		.	.	.	.	.	.	.
Sida corrugata		.	.		.	.	.	.
Sida cunninghamii					.		.	
Sida hackettiana		.		.	.	.		
Myoporaceae								
Eremophila debilis			.		.	.		
Myrtaceae								
Eucalyptus blakelyi		.						
Nyctaginaceae								
Boerhavia dominii			.	.			.	
Oxalidaceae								
Oxalis exilis		.	.	.		.		.
Oxalis perennans			.					
Phyllanthaceae								
Phyllanthus virgatus			.		.	.		
Plantaginaceae								
**Plantago lanceolata*	.	.	.		.	.		.
Plantago gaudichaudii			.					
Plantago turrifera					.	.		
Poaceae								
***Cenchrus clandestinus*								.
***Chloris gayana*								.
***Hyparrhenia hirta*		.						.
***Paspalum dilatatum*			.			.		.
**Avena sativa*								.
**Bromus molliformis*			.	.				
**Cynodon dactylon*		.	.	.	.	.		.
**Eleusine tristachya*					.			
**Lolium perenne*	.							
**Melinis repens*								.
**Panicum miliaceum*								.
**Urochloa panicoides*								.
Anthosachne scabra		.	.		.	.		.
Aristida personata					.			
Aristida ramosa	.	.	.	.	.	.	.	.

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Austrostipa nodosa								.
Austrostipa scabra subsp. scabra				.				
Austrostipa verticillata			.	.				
Bothriochloa biloba			.					
Bothriochloa decipiens			.	.	.	.	.	.
Chloris divaricata var. divaricata	.		.	.	.	.	.	
Chloris ventricosa			.	.	.			
Cymbopogon refractus		.	.		.	.	.	.
Dichanthium sericeum	.	.			.		.	.
Dichanthium sericeum subsp. sericeum			.	.		.		
Dichelachne micrantha			.					
Digitaria brownii			.		.			
Digitaria divaricatissima	.				.			
Echinopogon intermedius			.			.		
Enneapogon gracilis					.			
Eragrostis alveiformis	.		.		.		.	
Eragrostis brownii						.		
Eragrostis leptostachya						.		
Eragrostis sororia						.		
Eriochloa pseudoacrotricha			.	.	.	.	.	.
Eulalia aurea			.		.			
Microlaena stipoides		.						
Panicum decompositum			.			.		
Panicum effusum			.		.	.		
Panicum queenslandicum			.			.		
Paspalidium distans			.				.	
Rytidosperma bipartitum							.	
Rytidosperma caespitosum	.		.		.	.	.	.
Rytidosperma erianthum			.		.			
Rytidosperma pallidum			.					
Rytidosperma sp.				.				
Sporobolus caroli			.		.	.		
Sporobolus creber			.	.	.	.	.	
Themeda triandra		.						
Tripogon loliiformis			.					
Polygonaceae								
Rumex brownii			.	.				
Portulacaceae								
Portulaca oleracea	.		.	.				
Primulaceae								
**Lysimachia arvensis*	.	.	.		.	.		.
Pteridaceae								
Cheilanthes sieberi		.	.	.	.	.	.	.

Grassland Communities	Plant Community Type							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Rubiaceae								
**Richardia stellaris*		.	.			.		
Asperula conferta		.		.				.
Solanaceae								
**Solanum nigrum*			.			.		.
Solanum cinereum		.	.	.		.		.
Solanum opacum		.						
Stackhousiaceae								
Stackhousia viminea					.	.		
Thymelaeaceae								
Pimelea linifolia subsp. linifolia					.			
Verbenaceae								
**Verbena officinalis*		.	.					
**Verbena quadrangularis*								.
**Verbena rigida var. rigida*			.		.			
Zygophyllaceae								
Tribulus micrococcus				.				

APPENDIX 4 COMMUNITY PROFILES

The following tables provide details of each vegetation community. The *Key Diagnostic Species* table shows a list of the key species recorded in each community ordered by the BAM Growth Form Group. The total species contribution has been cut off at 95% which results in some discrepancies with the *Species Richness* data which have been determined from the total species list for each community. For example, Community 1 *Key Diagnostic Species* contains 30 species whereas 70 species were recorded in total indicating over 50% of species occurred sporadically.

1. Red Gum - Ironbark - Apple shrubby woodland

Plant Community Type

PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter

Status

Not a TEC.

General Description

This was generally tall open woodland over a rocky hill immediately south of the AGL coal conveyor. The canopy was dominated by *Eucalyptus blakelyi* with occasional patches of *Eucalyptus beyeriana, Eucalyptus moluccana, Angophora floribunda, Brachychiton populneus* or *Ficus rubiginosa*. There was a mid-storey of *Notelaea microcarpa*, and *Clerodendrum tomentosum*. The predominant shrubs were *Teucrium junceum, Enchylaena tomentosa* and *Breynia oblongifolia*. Ground cover consisted of a number of forbs, grasses, fern and twiners. High threat weeds were dominated by *Galenia pubescens* and *Lyceum ferocissimum*.

Species Richness

Native species 60; Weeds 10 including High Threat Weeds 5 Plots: 5 Mean species/plot 28±7.7SD

Key Diagnostic Species

Average similarity: 32.54					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus blakelyi*	12.95	8.4	2.82	25.82
	Notelaea microcarpa	4.72	3.41	3.94	10.47
	Brachychiton populneus	3.24	1.46	1.01	4.47
	Clerodendrum tomentosum	2.56	0.26	0.32	0.79
Shrub	*Teucrium junceum*	2.3	1.19	1.13	3.66
	Enchylaena tomentosa	1.62	0.66	0.62	2.04
	Eremophila debilis	1.27	0.55	0.62	1.71
	Breynia oblongifolia	1.24	0.2	0.32	0.63
	Dodonaea viscosa subsp. angustifolia	0.92	0.2	0.32	0.63
Forb	*Dianella caerulea var. cinerascens*	2.11	1.19	1.13	3.66
	Einadia hastata	1.78	1.19	1.13	3.66
	Dichondra repens	1.62	0.66	0.62	2.04
	Arthropodium sp.	1.75	0.66	0.62	2.04
	Calotis lappulacea	1.27	0.55	0.62	1.71
	Brunoniella australis	1.24	0.2	0.32	0.63
Grass	*Microlaena stipoides*	3.1	0.92	0.54	2.83
	Aristida ramosa	1.94	0.76	0.59	2.33
	Austrostipa verticillata	2.19	0.76	0.55	2.33
	Rytidosperma sp.	1.75	0.66	0.62	2.04
	Austrostipa scabra	2.69	0.51	0.32	1.58
	Lomandra filiformis subsp. filiformis	1.87	0.41	0.32	1.25
Fern	*Cheilanthes sieberi*	1.03	0.26	0.32	0.79
Other	*Clematicissus opaca*	1.43	0.66	0.62	2.04
	Clematis glycinoides	1.27	0.55	0.62	1.71
	Glycine clandestina	0.92	0.2	0.32	0.63
Weed	*Lysimachia arvensis*	1.62	0.66	0.62	2.04
	Cynodon dactylon	2.05	0.26	0.32	0.79
High Threat Exotic	*Galenia pubescens*	2.65	1.48	1.1	4.54
	Lycium ferocissimum	2.14	1.38	1.14	4.25
	Opuntia stricta	1.94	0.76	0.59	2.33

1a. Red Gum - Ironbark - Apple shrubby woodland (DNG)

Plant Community Type

PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter Derived Native Grassland

Status

Not a TEC.

General Description

Open grassland with occasional scattered paddock trees. There were a small number of low shrubs but the dominant groups were forbs, grasses and weeds. High threat weeds were dominated by *Galenia pubescens* and *Senecio madagascariensis*.

Species Richness

Native species 35; Weeds 8 including High Threat Weeds 2 Plots: 4 Mean species/plot 36.25±9.03 SD

Key Diagnostic Species

Average similarity: 40.92					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Shrub	*Solanum cinereum*	2.84	1.69	50.81	4.12
	Maireana microphylla	1.13	0.56	0.58	1.36
Forb	*Commelina cyanea*	2.54	2	4.13	4.9
	Einadia trigonos subsp. stellulata	3.69	1.69	50.81	4.12
	Lepidium pseudohyssopifolium	2.84	1.69	50.81	4.12
	Crassula sieberiana	2.24	0.57	0.58	1.4
	Erodium crinitum	1.13	0.56	0.58	1.36
	Oxalis exilis	1.13	0.56	0.58	1.36
	Boerhavia dominii	1.41	0.56	0.58	1.36
Grass	*Aristida ramosa*	9.67	6.21	2.97	15.17
	Chloris ventricosa	2.54	2	4.13	4.9
	Eriochloa pseudoacrotricha	2.82	1.15	0.58	2.81
	Rytidosperma sp.	1.43	0.57	0.58	1.4
	Bothriochloa decipiens	2.28	0.56	0.58	1.36
	Sporobolus creber	1.13	0.56	0.58	1.36
Weed	*Sida rhombifolia*	5.97	4.52	2.2	11.05
	Petrorhagia nanteuilii	2.54	2	4.13	4.9
	Gomphocarpus fruticosus	1.98	1.69	50.81	4.12
	Verbena quadrangularis	1.43	0.57	0.58	1.4
	Bromus molliformis	1.13	0.56	0.58	1.36
	Modiola caroliniana	1.13	0.56	0.58	1.36
	Plantago lanceolata	1.7	0.56	0.58	1.36
High Threat Exotic	*Galenia pubescens*	7.65	4.52	2.43	11.05
	Senecio madagascariensis	3.41	2.26	2.2	5.52
	Carthamus lanatus	2.28	0.56	0.58	1.36
	Paspalum dilatatum	1.13	0.56	0.58	1.36

2. White Box - Ironbark - Red Gum shrubby forest

Plant Community Type

PCT 1606 White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Status

Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland
Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

General Description

Possibly the most widespread community across the Southern Study Area prior to clearing, but now restricted to numerous patches. The canopy was dominated by *Eucalyptus albens* (White Box) or the hybrid *Eucalyptus albens* x *moluccana* (White Box x Grey Box). Given the difficulties distinguishing between White Box and the hybrid, with both frequently co-occurring, these have all been referred to as White Box. Other common canopy species of varying density across the community were *Allocasuarina luehmannii, Acacia salicina, Eucalyptus blakelyi* and *Eucalyptus crebra*. The few shrubs present were generally small and inconspicuous. Weeds were low in abundance, including high threat weeds.

Species Richness

Native species 94; Weeds 14 including High Threat Weeds 4
Plots: 14
Mean species/plot 24±8.7SD

Key Diagnostic Species

Average similarity: 35.09					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus blakelyi*	3.3	0.45	0.22	1.28
	Notelaea microcarpa	1.74	0.64	0.54	1.82
	Allocasuarina luehmannii	5.08	1.64	0.47	4.68
	Acacia salicina	4.28	1.69	0.73	4.82
	Eucalyptus albens	13.04	9.04	1.68	25.75
Shrub	*Teucrium junceum*	1.11	0.3	0.35	0.84
	Enchylaena tomentosa	1.42	0.35	0.34	0.99
	Eremophila debilis	2.84	1.69	1.13	4.8
Forb	*Arthropodium milleflorum*	0.77	0.16	0.26	0.44
	Calotis lappulacea	0.97	0.26	0.34	0.75
	Templetonia stenophylla	1.23	0.42	0.43	1.19
	Oxalis exilis	1.36	0.43	0.42	1.21
	Chrysocephalum semipapposum	1.34	0.45	0.43	1.29
	Sida corrugata	1.53	0.69	0.64	1.96
	Brunoniella australis	2.42	1.75	1.48	4.99
	Dichondra repens	2.89	1.91	1.54	5.46
Grass	*Chloris ventricosa*				
	Lomandra multiflora subsp. *multiflora*	0.83	0.18	0.26	0.52
	Lomandra filiformis subsp. *filiformis*	1.54	0.55	0.52	1.56
	Austrostipa scabra	1.95	0.55	0.42	1.58
	Austrostipa verticillata	3.03	1.06	0.53	3.01
	Aristida ramosa	4.48	1.31	0.49	3.73
Fern	*Cheilanthes sieberi*	1.13	0.35	0.43	1
Other	*Glycine clandestina*	2.59	1.84	1.44	5.25
Weed	*Lysimachia arvensis*	0.87	0.15	0.25	0.43
	Sida rhombifolia	1.01	0.24	0.34	0.69
	Gomphocarpus fruticosus	0.97	0.25	0.34	0.7
High Threat Exotic	*Opuntia stricta*	1.17	0.38	0.43	1.07
	Senecio madagascariensis	1.65	0.74	0.63	2.12

2a. White Box - Ironbark - Red Gum shrubby forest DNG

Plant Community Type

PCT 1606 White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – Derived Native Grassland

Status

Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland
Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

General Description

Open grassland with occasional scattered paddock trees and high native species richness. There was also a high weed content with the high threat weed *Carthamus lanatus* (Saffron Thistle) having the highest contribution.

Species Richness

Native species 60; Weeds 23 including High Threat Weeds 3
Plots: 14
Mean species/plot 37.7±10.4SD

Key Diagnostic Species

Average similarity: 31.58					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Shrub	*Maireana microphylla*	2.21	0.99	0.71	3.14
	Solanum campanulatum	0.81	0.3	0.46	0.96
	Solanum cinereum	0.82	0.21	0.35	0.66
	Eremophila debilis	0.68	0.19	0.34	0.6
	Enchylaena tomentosa	0.64	0.18	0.35	0.56
Forb	*Chrysocephalum semipapposum*	1.41	0.26	0.29	0.82
	Erodium crinitum	1.82	0.97	0.92	3.08
	Einadia nutans	1.84	0.69	0.57	2.17
	Vittadinia pterochaeta	1.16	0.47	0.6	1.48
	Oxalis exilis	1.31	0.35	0.45	1.12
	Sida corrugata	1.14	0.34	0.45	1.07
	Sida cunninghamii	1.01	0.32	0.46	1.01
	Brunoniella australis	1.02	0.32	0.46	1
	Wahlenbergia communis	0.92	0.31	0.46	0.98
	Crassula sieberiana	0.82	0.31	0.46	0.97
	Asperula conferta	0.81	0.3	0.46	0.96
	Calotis lappulacea	0.81	0.3	0.46	0.94
	Chamaesyce drummondii	0.96	0.3	0.46	0.94
	Vittadinia muelleri	0.77	0.29	0.47	0.91
	Sida hackettiana	1.15	0.21	0.33	0.66
	Goodenia bellidifolia subsp. bellidifolia	0.84	0.19	0.34	0.59
	Plantago turrifera	0.65	0.18	0.34	0.57
	Phyllanthus virgatus	0.52	0.1	0.24	0.32
Grass	*Aristida ramosa*	5.17	2.02	0.78	6.39
	Rytidosperma caespitosum	3.46	1.92	0.89	6.07
	Eragrostis alveiformis	2.47	1.38	1.13	4.36
	Dichanthium sericeum	2.8	1.17	0.6	3.71
	Eriochloa pseudoacrotricha	1.12	0.63	0.77	1.98
	Bothriochloa decipiens	1.76	0.59	0.53	1.86
	Chloris divaricata var. divaricata	1.64	0.5	0.45	1.58
	Chloris divaricata	1.9	0.46	0.34	1.45
	Sporobolus creber	1.29	0.32	0.43	1.02
	Carex inversa	0.81	0.21	0.35	0.65
	Cymbopogon refractus	0.86	0.1	0.24	0.31
Fern	*Cheilanthes sieberi*	1.41	0.26	0.29	0.82
Other	*Glycine clandestina*	1.66	1.4	2.05	4.43
	Convolvulus angustissimus	1.11	0.47	0.6	1.48
	Desmodium varians	0.61	0.17	0.35	0.53
Weed	*Medicago sp.*	1.65	0.89	0.95	2.81

	Lepidium bonariense	1.49	0.86	1	2.71
	Sida rhombifolia	2.01	0.68	0.73	2.14
	Lysimachia arvensis	1.28	0.49	0.59	1.54
	Petrorhagia nanteuilii	1	0.47	0.6	1.47
	Hedypnois rhagadioloides	1.34	0.42	0.44	1.32
	Modiola caroliniana	0.81	0.3	0.46	0.96
	Linum trigynum	1.18	0.3	0.46	0.94
	Stachys arvensis	0.78	0.29	0.47	0.91
	Plantago lanceolata	0.99	0.23	0.34	0.72
	Cynodon dactylon	0.7	0.2	0.35	0.65
	Gomphocarpus fruticosus	0.9	0.09	0.24	0.29
High Threat Exotic	*Carthamus lanatus*	5.4	3.39	1.26	10.73
	Senecio madagascariensis	3.12	1.73	9.55	5.48
	Galenia pubescens	1.16	0.29	0.33	0.93

3. Slaty Box shrubby woodland

Plant Community Type

PCT 1655 Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin

Status

Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

General Description

This community was characterised by the presence of *Eucalyptus dawsonii* (Slaty Box). In areas subject to prior clearing *Allocasuarina luehmannii* and to a lesser extent *Acacia salicina* were co-dominant canopy species. Shrubs were few and inconspicuous while there was good diversity of forbs and grasses. The distribution of Slaty Box paddock trees indicated that the community was once widespread, particularly in the west of the Southern Study Area.

Species Richness

Native species 63; Weeds 8 including High Threat Weeds 4 Plots: 7 Mean species/plot 22±10.1SD

Key Diagnostic Species

Average similarity: 40.87					
Growth Form	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus dawsonii*	23.31	18.32	3.11	44.84
	Allocasuarina luehmannii	5.05	1.69	0.73	4.14
	Acacia salicina	2.98	1.54	0.82	3.78
Shrub	*Eremophila debilis*	3.09	2.02	1.38	4.95
	Enchylaena tomentosa	2.76	1.37	0.85	3.36
Forb	*Einadia nutans*	3.17	1.77	0.88	4.32
	Dichondra repens	2.67	1.37	0.85	3.36
	Templetonia stenophylla	1.87	0.7	0.61	1.72
	Arthropodium sp.	1.98	0.58	0.39	1.41
	Brunoniella australis	1.76	0.44	0.36	1.07
	Oxalis perennans	1.33	0.4	0.4	0.99
	Phyllanthus virgatus	1.11	0.33	0.39	0.81
Grass	*Aristida ramosa*	4.01	2.3	1.27	5.63
	Rytidosperma sp.	2.32	0.88	0.57	2.14
	Austrostipa scabra	2.97	0.77	0.4	1.87
	Lomandra multiflora subsp. multiflora	1.49	0.33	0.39	0.81
	Austrostipa verticillata	2.24	0.24	0.22	0.58
Weed	*Sida rhombifolia*	1.23	0.34	0.39	0.83
High Threat Exotic	*Opuntia stricta*	1.66	0.43	0.39	1.06

3a. Slaty Box shrubby woodland DNG

Plant Community Type

PCT 1655 Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin Derived Native Grassland

Status

Not a TEC.

General Description

Open grassland with occasional scattered paddock trees and moderate native species richness primarily consisting of forbs, grasses and vines. The dominant high threat weed was *Carthamus lanatus*.

Species Richness

Native species 65; Weeds 24 including High Threat Weeds 3
Plots: 6
Mean species/plot 32.7±7.9SD

Key Diagnostic Species

Average similarity: 44.06					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Shrub	*Enchylaena tomentosa*	1.62	1.01	0.93	2.29
Forb	*Vittadinia pterochaeta*	3.35	1.71	1.05	3.88
	Vittadinia muelleri	4.39	1.5	0.55	3.41
	Chamaesyce drummondii	1.67	1.04	0.92	2.37
	Calotis lappulacea	1.55	0.96	0.93	2.17
	Wahlenbergia communis	1.35	0.63	0.61	1.43
	Neptunia gracilis forma gracilis	1.26	0.34	0.4	0.77
	Plantago turrifera	0.99	0.3	0.4	0.69
	Glossocardia bidens	0.98	0.3	0.4	0.68
	Sida cunninghamii	0.91	0.29	0.4	0.65
Grass	*Chloris divaricata var. divaricata*	6.49	5.27	4.21	11.96
	Dichanthium sericeum	6.75	4.54	1.3	10.31
	Rytidosperma caespitosum	3.81	1.96	0.79	4.45
	Sporobolus creber	1.97	1.54	1.52	3.5
	Aristida ramosa	2.23	1.13	0.88	2.57
	Eragrostis alveiformis	1.93	0.97	0.92	2.2
	Eriochloa pseudoacrotricha	1.28	0.58	0.61	1.33
Other	*Glycine clandestina*	2.25	1.6	1.51	3.63
	Convolvulus angustissimus	1.88	1.47	1.53	3.33
	Desmodium varians	1.84	1	0.92	2.26
Weed	*Medicago sp.*	3.97	2.44	2.86	5.55
	Lepidium bonariense	2.55	1.61	1.42	3.66
	Linum trigynum	2.15	1.07	0.87	2.44
	Petrorhagia nanteuilii	1.36	0.64	0.61	1.45
	Lysimachia arvensis	1.32	0.62	0.61	1.41
	Hypochaeris radicata	1.31	0.61	0.61	1.38
	Sida rhombifolia	1.18	0.56	0.62	1.28
	Plantago lanceolata	0.99	0.31	0.4	0.7
High Threat Exotic	*Carthamus lanatus*	4.91	3.08	1.43	6.99
	Galenia pubescens	1.19	0.56	0.62	1.28
	Senecio madagascariensis	1.19	0.56	0.62	1.28

4. Swamp Oak forest

Plant Community Type

PCT1731 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley

Status

Not a TEC.

General Description

This community was located along Saddlers Creek and ephemeral side channels. The clear dominance of *Casuarina glauca* (Swamp Oak) restricts the number of key diagnostic species displayed. Other species present were the tree *Notelaea microcarpa*, grasses *Dichanthium sericeum* and *Microlaena stipoides*, shrubs *Maireana microphylla* and forbs *Brunoniella australis* and *Cotula australis*.

Species Richness

Native species 34; Weeds 14 including High Threat Weeds 5
Plots: 2
Mean species/plot 34±19SD

Key Diagnostic Species

Average similarity: 18.03					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Casuarina glauca*	16.28	9.84	-	54.55
Forb	*Einadia polygonoides*	3.09	1.64	-	9.09
	Oxalis perennans	3.09	1.64	-	9.09
Grass	*Aristida ramosa*	5.37	1.64	-	9.09
	Austrostipa verticillata	3.09	1.64	-	9.09
High Threat Exotic	*Galenia pubescens*	3.09	1.64	-	9.09

5. Hunter Lowland Redgum forest

Plant Community Type

PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter

Status

Listed BC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions.

General Description

This community occurred to the north and south-west of Maxwell Infrastructure and had moderate native species diversity and high weed diversity including five high threat weed species. It was characterised by a dominant canopy of *Eucalyptus tereticornis* (Forest Red Gum). There was a range of shrub, forb and grass species.

Species Richness

Native species 60; Weeds 13 including High Threat Weeds 5 Plots: 3 Mean species/plot36.7±7.9SD

Key Diagnostic Species

Average similarity: 46.81					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus tereticornis*	11.33	9.74	26.13	20.81
	Allocasuarina luehmannii	2.95	0.56	0.58	1.21
Shrub	*Eremophila debilis*	1.89	1.62	26.13	3.47
	Breynia oblongifolia	2.91	0.79	0.58	1.7
	Acacia falcata	1.36	0.56	0.58	1.21
Forb	*Dianella longifolia var. longifolia*	4	2.19	2.56	4.67
	Calotis cuneifolia	1.89	1.62	26.13	3.47
	Chrysocephalum semipapposum	1.89	1.62	26.13	3.47
	Calotis lappulacea	1.62	0.56	0.58	1.21
	Dichondra repens	2.15	0.56	0.58	1.21
	Oxalis exilis	1.62	0.56	0.58	1.21
	Commelina cyanea	1.09	0.53	0.58	1.13
Grass	*Aristida ramosa*	9.97	8.82	14.57	18.85
	Lomandra multiflora	1.89	1.62	26.13	3.47
	Lomandra filiformis subsp. filiformis	2.65	1.06	0.58	2.26
	Cymbopogon refractus	1.62	0.56	0.58	1.21
	Austrostipa scabra subsp. falcata	1.09	0.53	0.58	1.13
Fern	*Cheilanthes sieberi*	5.43	4.76	SD=0!	10.17
Weed	*Lysimachia arvensis*	1.09	0.53	0.58	1.13
	Sida rhombifolia	1.09	0.53	0.58	1.13
High Threat Exotic	*Opuntia humifusa*	4.08	3.17	2.31	6.78
	Bidens pilosa	1.89	1.62	26.13	3.47
	Senecio madagascariensis	1.09	0.53	0.58	1.13

6. Bull Oak grassy woodland

Plant Community Type

PCT 1692 Bull Oak grassy woodland of the central Hunter Valley

Status

Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland (only the part derived from PCT1655).

General Description

This was a community dominated by *Allocasuarina luehmannii* (Bull Oak). This is a community that could best be described as being derived from previous eucalypt-dominated communities as a consequence of clearing. There was a dense litter layer restricting ground cover, and species diversity was over 25% less than the other mapped communities.

Species Richness

Native species 63; Weeds 8 including High Threat Weeds 4 Plots: 10 Mean species/plot 14.5±3.5SD

Key Diagnostic Species

Average similarity: 39.31					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Allocasuarina luehmannii*	26.17	23.63	8.13	60.1
	Acacia salicina	1.58	0.26	0.26	0.66
Shrub	*Eremophila debilis*	1.67	0.53	0.39	1.35
Forb	*Brunoniella australis*	2.66	1.34	0.69	3.4
	Einadia hastata	2.1	0.85	0.53	2.16
	Einadia nutans	2.1	0.85	0.53	2.16
	Pimelea curviflora var. sericea	1.82	0.54	0.38	1.37
	Templetonia stenophylla	1.73	0.51	0.39	1.29
	Crassula sieberiana	1.67	0.5	0.39	1.27
Grass	*Aristida ramosa*	6.92	2.84	0.64	7.23
	Lomandra filiformis subsp. filiformis	3.36	1.39	0.69	3.54
	Austrostipa scabra	1.84	0.56	0.39	1.44
	Lomandra multiflora	1.87	0.55	0.38	1.39
	Lomandra glauca	1.32	0.26	0.26	0.65
Fern	*Cheilanthes sieberi*	2.96	1.41	0.69	3.6
Other	Glycine *clandestina*	2.3	0.92	0.53	2.34
High Threat Exotic	*Galenia pubescens*	2.25	0.36	0.25	0.9
	Opuntia stricta	1.25	0.26	0.26	0.65

7. Yellow Box - Apple grassy woodland

Plant Community Type

PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains

Status

Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

General Description

This community occurred in two locations, in a low drainage basin and along part of Saddlers Creek; the latter was the more disturbed of the two. Other than the characteristic *Eucalyptus melliodora* (Yellow Box), the canopy included *Allocasuarina luehmannii* and *Angophora floribunda*. There was a variety of forbs grasses fern and herbs. While there were four high threat weed species present, they were in low abundance.

Species Richness

Native species 40; 14 Weeds including High Threat Weeds 4 Plots: 2 Mean species/plot 42±14SD

Key Diagnostic Species

Average similarity: 29.25					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus melliodora*	7.17	4.35	-	14.87
	Acacia salicina	3.42	2.5	-	8.55
	Allocasuarina luehmannii	4.15	2.5	-	8.55
Forb	*Dichondra repens*	2.7	2.5	-	8.55
	Brunoniella australis	1.97	1.45	-	4.96
	Chrysocephalum semipapposum	3.22	1.45	-	4.96
	Oxalis exilis	1.97	1.45	-	4.96
	Stackhousia viminea	1.97	1.45	-	4.96
Grass	*Aristida ramosa*	5.72	1.45	-	4.96
	Lomandra glauca	1.97	1.45	-	4.96
	Lomandra multiflora	1.97	1.45	-	4.96
Fern	*Cheilanthes sieberi*	1.97	1.45	-	4.96
Other	*Desmodium varians*	1.97	1.45	-	4.96
	Glycine clandestina	1.97	1.45	-	4.96
Weed	*Sida rhombifolia*	1.97	1.45	-	4.96

7a. Yellow Box - Apple grassy woodland DNG

Plant Community Type

PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains Derived Native Grassland

Status

Listed BC Act, E: White Box Yellow Box Blakely's Red Gum Woodland
Listed EPBC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

General Description

This community was mapped around several isolated Yellow Box paddock trees on the low rise from Saddlers Creek and merging into community 3a Slaty Box shrubby woodland derived native grassland with which it had many features in common. Native species diversity was moderate with low weed diversity.

Species Richness

Native species 30; Weeds 7 including High Threat Weeds 2
Plots: 3
Mean species/plot 30.5±2.5SD

Key Diagnostic Species

Average similarity: 48.87					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Forb	*Chrysocephalum semipapposum*	4.74	4.08	-	8.35
	Vittadinia pterochaeta	3.39	2.7	-	5.53
Grass	*Chloris divaricata var. divaricata*	13.21	10.2	-	20.88
	Eragrostis alveiformis	3.39	2.7	-	5.53
	Rytidosperma bipartitum	3.39	2.7	-	5.53
	Sporobolus creber	3.39	2.7	-	5.53
	Aristida ramosa	2.37	2.04	-	4.18
	Bothriochloa decipiens	2.37	2.04	-	4.18
	Dichanthium sericeum	3.72	2.04	-	4.18
	Eriochloa pseudoacrotricha	2.37	2.04	-	4.18
Other	*Convolvulus angustissimus*	2.37	2.04	-	4.18
	Glycine clandestina	2.37	2.04	-	4.18
Weed	*Lepidium bonariense*	3.39	2.7	-	5.53
	Linum trigynum	2.37	2.04	-	4.18
	Medicago sp.	2.37	2.04	-	4.18
High Threat Exotic	*Carthamus lanatus*	5.43	2.7	-	5.53

8. Fuzzy Box woodland

Plant Community Type

PCT 201 Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion

Status

Not a TEC.

General Description

This community occurred in two locations, in a low drainage basin adjoining community 7 Yellow Box – Apple grassy woodland, and on the western side of Edderton Road; the latter was mostly disturbed remnants. Other than the characteristic tree *Eucalyptus conica* (Fuzzy Box), *Allocasuarina luehmannii* was present at the western location. There was moderate native species diversity and low weed diversity.

Species Richness

Native species 21; Weeds 8 including High Threat Weeds 3
Plots: 2
Mean species/plot 23.5±2.5SD

Key Diagnostic Species

Average similarity: 45.45					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus conica*	14.39	12.12	-	26.67
Forb	*Dichondra repens*	2.9	2.78	-	6.11
	Plantago sp.	2.9	2.78	-	6.11
	Rumex sp.	2.9	2.78	-	6.11
	Sida corrugata	2.9	2.78	-	6.11
Grass	*Aristida ramosa*	14.65	11.11	-	24.44
	Lomandra glauca	2.9	2.78	-	6.11
	Lomandra multiflora	2.9	2.78	-	6.11
Fern	*Cheilanthes sieberi*	4.42	2.78	-	6.11
High Threat Exotic	*Senecio madagascariensis*	2.9	2.78	-	6.11

8a. Fuzzy Box woodland DNG

Plant Community Type

PCT 201 Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion Derived Native Grassland

Status

Not a TEC.

General Description

This community only occurred on the western side of Edderton Road where only one plot was recorded. Diversity of native species was low (42%) and that of weed species was high with four high threat weeds dominated by *Carthamus lanatus*.

Species Richness

Native species 11; Weeds 15 including High Threat Weeds 4
Plots: 1
Mean species/plot N/A

Key Diagnostic Species

No analysis as only one plot was done.

9. Ironbark - Grey Box grassy woodland

Plant Community Type

PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Status

Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions
Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

General Description

This community was generally found in lower areas of the Southern Study Area, with the canopy dominated by Grey Box (*Eucalyptus moluccana*). Occurrences of Narrow-leaved Ironbark (*Eucalyptus crebra*) were infrequent to the extent that the species did not appear in the list of key diagnostic species. In areas subject to prior clearing *Allocasuarina luehmannii* and to a lesser extent *Acacia salicina* were co-dominant canopy species. Shrubs were small and inconspicuous and there were a diverse presence of forbs and grasses.

Species Richness

Native species 96; Weeds 15 including High Threat Weeds 4
Plots: 13
Mean species/plot 29±9.0SD

Key Diagnostic Species

Average similarity: 39.85					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus moluccana*	14.56	11.39	1.97	28.58
	Allocasuarina luehmannii	5.49	2.37	0.68	5.95
	Acacia salicina	1.98	0.9	0.66	2.26
	Notelaea microcarpa	0.99	0.22	0.3	0.56
Shrub	*Eremophila debilis*	3.05	2.43	3.87	6.09
	Enchylaena tomentosa	1.9	1	0.8	2.52
	Maireana microphylla	1.89	0.88	0.67	2.21
Forb	*Brunoniella australis*	2.81	2.38	4.23	5.98
	Dichondra repens	2.86	1.94	1.92	4.87
	Chrysocephalum semipapposum	1.7	0.76	0.63	1.9
	Sida corrugata	1.45	0.66	0.66	1.66
	Templetonia stenophylla	1.44	0.54	0.52	1.36
Grass	*Einadia nutans*	1.33	0.51	0.53	1.28
	Asperula conferta	1.07	0.33	0.41	0.84
	Oxalis perennans	1.2	0.31	0.4	0.78
	Chamaesyce drummondii	1.04	0.3	0.41	0.76
	Calotis lappulacea	1.24	0.26	0.29	0.65
	Glossocardia bidens	1	0.23	0.3	0.57
	Rostellularia adscendens	0.88	0.22	0.31	0.55
	Plantago gaudichaudii	1.07	0.21	0.3	0.52
Fern	*Cheilanthes sieberi*	1.94	0.98	0.8	2.45
Other	*Glycine clandestina*	2.48	1.76	1.36	4.42
	Desmodium varians	1.24	0.5	0.53	1.25
High Threat Exotic	*Opuntia stricta*	1.19	0.37	0.41	0.92
	Senecio madagascariensis	1.14	0.3	0.41	0.76
	Lycium ferocissimum	0.9	0.2	0.31	0.51

9a. Ironbark - Grey Box grassy woodland DNG

Plant Community Type

PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter Derived Native Grassland

Status

Not a TEC.

General Description

Open grassland with occasional scattered trees dominated by the grass *Aristida ramosa* and grasses contributing to over 40% of the floristic content followed by forbs at 25%.

Species Richness

Native species 45; Weeds 18 including High Threat Weeds 4 Plots: 3 Mean species/plot 41±6.9SD

Key Diagnostic Species

Average similarity:					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Shrub	*Eremophila debilis*	0.67	0.66	0.58	1.39
Forb	*Chrysocephalum semipapposum*	2.00	2.52	2.01	5.3
	Brunoniella australis	1.00	1.86	12.58	3.91
	Linum marginale	1.00	1.86	12.58	3.91
	Wahlenbergia communis	1.33	1.86	12.58	3.91
	Mentha satureioides	1.00	0.66	0.58	1.39
	Sida hackettiana	0.67	0.66	0.58	1.39
	Stackhousia viminea	0.67	0.66	0.58	1.39
	Vittadinia muelleri	0.67	0.63	0.58	1.34
	Oxalis exilis	0.67	0.56	0.58	1.19
	Sida corrugata	0.67	0.56	0.58	1.19
Grass	*Aristida ramosa*	5.00	8.00	18.45	16.84
	Cymbopogon refractus	1.67	2.42	2.9	5.1
	Eragrostis leptostachya	1.33	1.86	12.58	3.91
	Bothriochloa decipiens	1.33	1.13	0.58	2.38
	Chloris divaricata var. divaricata	1.33	1.13	0.58	2.38
	Panicum effusum	1.33	1.13	0.58	2.38
	Anthosachne scabra	0.67	0.66	0.58	1.39
	Dichanthium sericeum subsp. sericeum	1.33	0.63	0.58	1.34
	Lomandra bracteata	1.00	0.63	0.58	1.34
	Rytidosperma caespitosum	0.67	0.63	0.58	1.34
	Eriochloa pseudoacrotricha	0.67	0.56	0.58	1.19
	Fimbristylis dichotoma	1.00	0.56	0.58	1.19
Fern	*Cheilanthes sieberi*	1.67	1.13	0.58	2.38
Weed	*Gomphocarpus fruticosus*	1.00	1.86	12.58	3.91
	Cyclospermum leptophyllum	0.67	0.63	0.58	1.34
	Richardia stellaris	0.67	0.63	0.58	1.34
	Linum trigynum	0.67	0.56	0.58	1.19
	Lysimachia arvensis	0.67	0.56	0.58	1.19
	Sida rhombifolia	0.67	0.56	0.58	1.19
High Threat Exotic	*Carthamus lanatus*	1.00	1.86	12.58	3.91
	Senecio madagascariensis	1.33	1.86	12.58	3.91

10. Weeping Myall woodland

Plant Community Type

PCT 116 Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley

Status

Listed BC Act, CE: Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion
Listed EPBC Act, CE: Hunter Valley Weeping Myall (*Acacia pendula*) Woodland.

General Description

This community was present in three widely separate locations and was identifiable by the dominant presence of *Acacia pendula* (Weeping Myall).

Species Richness

Native species 27; Weeds 10 including High Threat Weeds 4
Plots: 3
Mean species/plot 20±9.9SD

Key Diagnostic Species

Average similarity: 23.05					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Acacia pendula*	18.91	11.01	4.56	47.75
Shrub	*Maireana microphylla*	3.5	1.28	0.58	5.56
	Enchylaena tomentosa	3.07	1.15	0.58	4.99
Forb	*Brunoniella australis*	1.79	0.64	0.58	2.78
	Einadia nutans	1.79	0.64	0.58	2.78
Grass	*Aristida ramosa*	3.58	1.28	0.58	5.56
	Austrostipa verticillata	3.58	1.28	0.58	5.56
Weed	*Cynodon dactylon*	13.03	1.92	0.58	8.34
	Sida rhombifolia	1.79	0.64	0.58	2.78
High Threat Exotic	*Galenia pubescens*	4.15	1.92	0.58	8.34
	Senecio madagascariensis	1.79	0.64	0.58	2.78

11. Grey Box – Spotted Gum – Narrow-leaved Ironbark woodland

Plant Community Type

PCT1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Status

Listed BC Act, E: Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions
Listed EPBC Act, CE: Central Hunter Valley eucalypt forest and woodland.

General Description

This community occurs in the Northern Study Area around Maxwell Infrastructure, on the boundary of the Study Area. Narrow-leaved Ironbark, Grey Box and Spotted Gum were all present in varying proportions across the community. There was moderate native species diversity with a number of shrubs, forbs and grasses, and low weed diversity although there were six high threat weed species.

Species Richness

Native species 61; Weeds 8 including High Threat Weeds 6
Plots: 5
Mean species/plot 30.4±6.5SD

Key Diagnostic Species

Average similarity: 37.04					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Eucalyptus moluccana*	5.32	2.38	0.61	6.41
	Corymbia maculata	5.68	1.84	0.53	4.96
	Allocasuarina luehmannii	1.38	0.62	0.62	1.69
Shrub	*Eremophila debilis*	2.54	2.1	8.74	5.67
	Bursaria spinosa	3.57	1.64	0.9	4.43
	Lissanthe strigosa	2.48	1.16	0.62	3.14
	Solanum cinereum	1.69	0.66	0.61	1.77
	Breynia oblongifolia	1.3	0.26	0.32	0.71
Forb	*Brunoniella australis*	2.54	2.1	8.74	5.67
	Dichondra repens	2.41	1.44	1.06	3.88
	Dianella longifolia var. longifolia	2.95	1.37	1.04	3.69
	Templetonia stenophylla	2.02	1.21	1.16	3.27
	Desmodium brachypodum	1.38	0.62	0.62	1.69
	Ajuga australis	1.23	0.23	0.32	0.63
	Arthropodium milleflorum	1.23	0.23	0.32	0.63
	Calotis cuneifolia	1.23	0.23	0.32	0.63
	Cyanthillium cinereum var. cinereum	1.23	0.23	0.32	0.63
	Chrysocephalum semipapposum	0.78	0.2	0.32	0.53
Grass	*Aristida ramosa*	7.06	5.29	2.1	14.27
	Lomandra filiformis subsp. filiformis	4.56	3.48	4.57	9.39
	Lomandra multiflora	2.54	2.1	8.74	5.67
	Rytidosperma caespitosum	2.71	0.78	0.57	2.12
	Microlaena stipoides	2.47	0.47	0.32	1.26
	Austrostipa verticillata	1.31	0.26	0.32	0.71
Fern	*Cheilanthes sieberi*	1.64	0.62	0.62	1.69
Other	*Glycine clandestina*	2.54	2.1	8.74	5.67
High Threat Exotic	*Opuntia humifusa*	1.63	0.62	0.62	1.69
	Senecio madagascariensis	1.31	0.59	0.62	1.59
	Bidens pilosa	0.78	0.2	0.32	0.53

11a. Grey Box – Spotted Gum – Narrow-leaved Ironbark woodland DNG

Plant Community Type

PCT 1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter Derived Native Grassland

Status

Not a TEC.

General Description

This community occurred as one patch in the south-eastern corner of Maxwell Infrastructure. There was low native species diversity and high weed diversity that included five high threat weed species.

Species Richness

Native species 22; Weeds 20 including High Threat Weeds 5
Plots: 2
Mean species/plot 27±1.0SD

Key Diagnostic Species

Average similarity: 38.4					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Shrub	*Solanum cinereum*	2.42	2.27	-	5.92
Forb	*Oxalis exilis*	2.42	2.27	-	5.92
Grass	*Cymbopogon refractus*	7.4	4.55	-	11.84
	Aristida ramosa	8.1	2.56	-	6.68
	Microlaena stipoides	2.42	2.27	-	5.92
Fern	*Cheilanthes sieberi*	2.42	2.27	-	5.92
Weed	*Sida rhombifolia*	3.55	2.56	-	6.68
	Cynodon dactylon	2.42	2.27	-	5.92
	Gomphocarpus fruticosus	3.7	2.27	-	5.92
	Lysimachia arvensis	2.42	2.27	-	5.92
High Threat Exotic	*Senecio madagascariensis*	3.55	2.56	-	6.68

Planted Trees

Plant Community Type

Planted trees

Status

Not a TEC.

General Description

This was a planted strip along the Golden Highway at the point where the proposed Edderton Road re-alignment would intersect. The dominant planted tree was *Eucalyptus dawsonii* (Slaty Box). There were 10 native grass species. Dominant forbs were *Leiocarpa leptolepis* and *Leiocarpa panaetioides*.

Species Richness

Native species 34; Weeds 9 including High Threat Weeds 1 Plots: 1 Mean species/plot N/A

Key Diagnostic Species

No analysis as only one plot was done.

RP Pasture Rehabilitation

Plant Community Type

Pasture rehabilitation

Status

Not a TEC.

General Description

This was open cut mine spoil that had been rehabilitated predominantly with pasture species. There was low native species diversity and high weed diversity including eight high threat weed species; native species were present in low numbers. *Melinis repens* (Red Natal Grass) was the dominant weed species and *Hyparrhenia hirta* (Coolatai Grass) was the dominant high threat weed species.

Species Richness

Native species 32; Weeds 37 including High Threat Weeds 8 Plots: 5 Mean species/plot26±4.6SD

Key Diagnostic Species

Average similarity: 36.48					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Forb	*Erodium crinitum*	1.54	0.68	0.62	1.87
	Commelina cyanea	1.4	0.58	0.62	1.6
Grass	*Dichanthium sericeum*	1.62	0.26	0.32	0.7
Weed	*Melinis repens*	2.95	2.56	5.74	7.02
	Plantago lanceolata	4.57	2.32	1.08	6.35
	Sida rhombifolia	2.29	1.45	1.14	3.99
	Sonchus asper	2.34	1.37	1.11	3.76
	Gomphocarpus fruticosus	2.74	1.28	1.11	3.52
	Lysimachia arvensis	1.98	1.24	1.14	3.39
	Rapistrum rugosum	1.77	0.73	0.61	2
	Centaurium erythraea	1.55	0.63	0.61	1.72
	Medicago sp.	1.46	0.58	0.62	1.6
	Tagetes minuta	1.46	0.3	0.32	0.83
	Conyza sp.	1.27	0.3	0.32	0.83
	Cynodon dactylon	1.35	0.3	0.32	0.83
	Modiola caroliniana	1.12	0.26	0.32	0.7
High Threat Exotic	*Hyparrhenia hirta*	9.64	6.61	1.13	18.13
	Cenchrus clandestinus	8.35	3.38	0.61	9.28
	Chloris gayana	5.23	2.96	1.08	8.12
	Galenia pubescens	4.25	2.08	1.14	5.69
	Paspalum dilatatum	3.88	2.01	0.98	5.52
	Bidens pilosa	3.53	1.83	0.92	5.01

RW Woodland Rehabilitation

Plant Community Type

Woodland rehabilitation

Status

Not a TEC.

General Description

This was open cut waste rock emplacement that has been rehabilitated with a variety of canopy and shrub species. There was low native species diversity and high weed diversity including five high threat weed species; native species were present in low numbers. While sample plots were taken in relatively contiguous patches, overall planting was highly varied. Other native canopy species were *Acacia saligna*, *Eucalyptus cladocalyx* (Sugar Gum) and a variety of Acacia species.

Species Richness

Native species 28; Weeds 25 including High Threat Weeds 5 Plots: 3 Mean species/plot 23±3.6SD

Key Diagnostic Species

Average similarity: 18.22					
BAMC Growth Form Group	**Species**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**
Tree	*Corymbia maculata*	4.85	1.82	0.58	9.98
Shrub	*Acacia decora*	3.44	1.63	0.58	8.92
	Acacia sp.	2.83	0.81	0.58	4.46
	Acacia falcata	1.42	0.61	0.58	3.33
Grass	*Dichanthium sericeum*	1.82	0.81	0.58	4.46
Weed	*Melinis repens*	7.07	3.03	0.58	16.63
	Asphodelus fistulosus	2.83	1.01	0.58	5.54
	Plantago lanceolata	2.03	0.81	0.58	4.46
	Sonchus asper	2.03	0.81	0.58	4.46
	Setaria sphacelata	1.82	0.81	0.58	4.46
	Hirschfeldia incana	3.05	0.61	0.58	3.33
High Threat Exotic	*Senecio madagascariensis*	2.43	2.03	5.65	11.11
	Hyparrhenia hirta	4.85	1.82	0.58	9.98
	Bidens pilosa	2.22	1.01	0.58	5.54

APPENDIX 5 PLOT FIELD DATA

Provided to the OEH.

ATTACHMENT B
MAXWELL PROJECT BASELINE FAUNA SURVEY REPORT

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MAXWELL PROJECT
BASELINE FAUNA SURVEY REPORT

Prepared for Malabar Coal Limited

June 2019

PROJECT NUMBER	2018-01		
PROJECT NAME	Maxwell Project Baseline Fauna Survey Report		
PROJECT ADDRESS	Jerrys Plains NSW		
PREPARED FOR	Malabar Coal Limited		
AUTHOR/S	Garon Staines		
VERSION	**Version**	**Draft/Final**	**Date to client**
	1.0	Draft V1	26/02/2019
		Draft V1B	30/3/2019
		Draft V1C	17/4/2019
		Final V1	25/6/2019

This report should be cited as: '*Future Ecology (2019) Malabar Project Baseline Fauna Survey Report. Prepared for Malabar Coal Limited'*.

Disclaimer

This report has been prepared by Future Ecology for Malabar Coal Limited and may only be used for the purpose agreed between these parties, as described in this report. The opinions, conclusions and recommendations set out in this report are limited to those set out in the scope of works and agreed between these parties. Future Ecology accepts no responsibility or obligation for any third party that may use this information or for conclusions drawn from this report that are not provided in the scope of works or following changes occurring subsequent to the date that the report was prepared.

The recommendations provided in this report are based on the results from currently accepted and naturally limited ecological survey techniques. Every effort is made and reasonable care taken to detect all threatened species that may have potential to occur in the locality.

Any representation, statement, opinion or advice expressed or implied in this report is made in good faith on the basis that Future Ecology Pty Ltd, its agents and employees are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Abbreviations

ABBR./TERM	DESCRIPTION
mm/cm/m/km/ha	millimetres/centimetres/metres/kilometres/hectares
CEEC	Critically Endangered Ecological Community
CHPP	Coal Handling and Preparation Plant
CL	Coal Lease
DA	Development Application
DBH	Diameter at breast height
DEE	Department of the Environment and Energy
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EL	Exploration Licence
EP&A Act	NSW *Environmental Planning and Assessment Act, 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*
IBRA	Interim Biogeographical Regionalisation of Australia
LGA	Local Government Area
masl	metres above sea level
MEA	mine entry area
ML	Mining Lease
NSW	New South Wales
OEH	Office of Environment and Heritage - NSW
BC Act	NSW *Biodiversity Conservation Act, 2016*
*	Denotes exotic species

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Executive Summary

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project). The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook.

This baseline fauna survey report has been prepared by Future Ecology for the Project. This report provides a summary of previous fauna surveys as well as the methods and results of additional fauna surveys undertaken for the Project.

There have been a number of fauna surveys previously undertaken partly within and/or adjacent to the study area since the year 2000. These previous reports provide a good background on the fauna likely to be present in the study area. Additional fauna surveys were completed by Future Ecology in January 2018, June 2018, August 2018, September 2018, November 2018 and December 2018 using a team of up to five ecologists including specialists in birds, reptiles, amphibians and mammals.

A number of sites were surveyed within the study area using a variety of techniques in accordance with relevant NSW and national guidelines. Threatened fauna species listed under the NSW *Biodiversity Conservation Act, 2016* (BC Act) and/or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) which are known or likely to occur in the study area were specifically targeted during the surveys.

Ten broad fauna habitat types were observed within the study area, comprising three natural habitats (Dry Sclerophyll Forest, Grass Woodlands, Forested Wetlands) and seven secondary habitats (Derived Native Grassland, Planted Trees, Cultivation, Waterbody/Dam, Woodland Rehabilitation, Pasture Rehabilitation and Infrastructure/Cleared Land). Most woodland/forest patches showed evidence of historic and ongoing disturbance from grazing. Most woodland/forest patches were small to medium size (< 150 ha), fragmented and lacked structural diversity in terms of subcanopy and understorey layers due to grazing pressure. Connectivity between woodland/forest patches was generally poor across the study area. However, some fauna habitat features such as hollow bearing trees, hollow logs, fallen timber, were present at most survey sites.

A total of 227 fauna species were recorded in the study area during the surveys namely 8 amphibian, 22 reptile, 148 bird, and, 49 mammal species. A total of 25 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in the study area during the surveys completed in 2018.

Four of the threatened fauna species recorded are considered relevant 'species credit species' under the *Threatened Biodiversity Data Collection* in the study area, namely, Pink-tailed Legless Lizard (also known as the Pink-tailed Worm-lizard) (*Aprasia parapulchella*), Striped Legless Lizard (*Delma impar*), Squirrel Glider (*Petaurus norfolcensis*) and Southern Myotis (*Myotis macropus*).

Five of the threatened fauna species recorded are listed under the EPBC Act, namely, the Pink-tailed Legless Lizard, Striped Legless Lizard, Painted Honeyeater (*Grantiella picta*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Large-eared Pied Bat (*Chalinolobus dwyeri*). Two additional threatened fauna species listed under the EPBC Act were recorded during surveys undertaken prior to 2018 in the study area, namely, the Swift Parrot (*Lathamus discolor*) and Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) (south-eastern mainland population). The Corben's Long-eared Bat (*Nyctophilus corbeni*) may also have been recorded in the study area nearly 20 years ago but the record is uncertain as the detection method is not known.

1 Introduction and Project Description

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project). The Project is in the Upper Hunter Valley of New South Wales (NSW), east-southeast of Denman and south-southwest of Muswellbrook (Figure 1).

Underground mining is proposed within Exploration Licence (EL) 5460, which was acquired by Malabar in February 2018. Malabar also acquired existing infrastructure within Coal Lease (CL) 229, Mining Lease (ML) 1531 and CL 395, known as the "Maxwell Infrastructure". The Project would include the use of the substantial existing Maxwell Infrastructure, along with the development of some new infrastructure (Figure 2).

This assessment forms part of an Environmental Impact Statement (EIS) which has been prepared to accompany a Development Application for the Project in accordance with Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act). Malabar also owns EL 7429, an undeveloped EL called the Spur Hill Underground Coking Coal Project in the Upper Hunter.

The Project would involve an underground mining operation that would produce high quality coals over a period of approximately 26 years. At least 75% of coal produced by the Project would be capable of being used in the making of steel (coking coals). The balance would be export thermal coals suitable for the new generation High Efficiency, Low Emissions power generators.

The Project would involve extraction of run-of-mine (ROM) coal from four seams within the Wittingham Coal Measures using the following underground mining methods:

- underground bord and pillar mining with partial pillar extraction in the Whynot Seam; and
- underground longwall extraction in the Woodlands Hill Seam, Arrowfield Seam and Bowfield Seam.

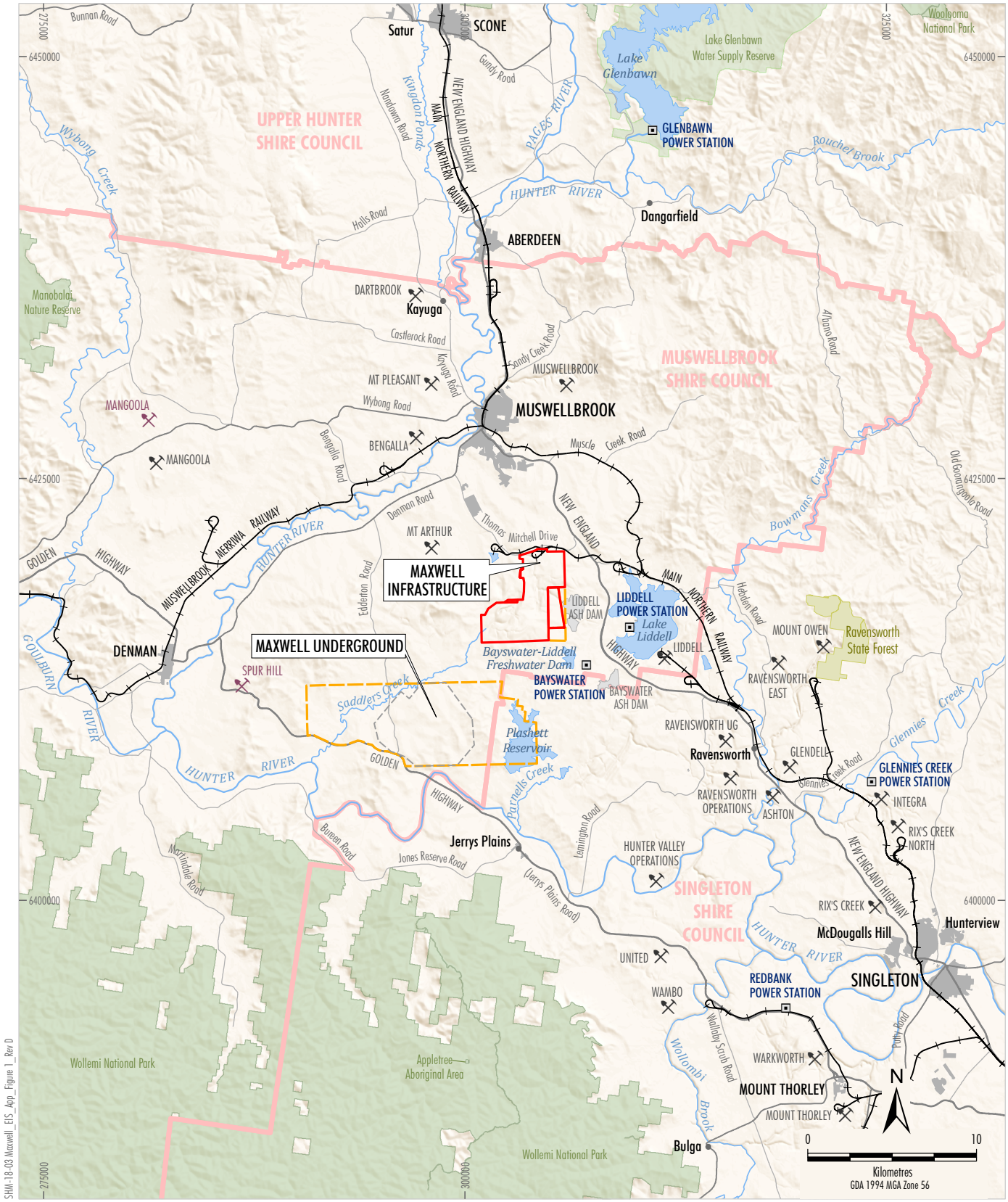
The substantial existing Maxwell Infrastructure would be used for handling, processing and transportation of coal for the life of the Project. The Maxwell Infrastructure includes an existing coal handling and preparation plant (CHPP), train load-out facilities and other infrastructure and services (including water management infrastructure, administration buildings, workshops and services).

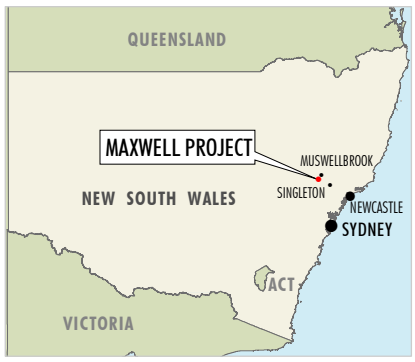
A mine entry area (MEA) would be developed for the Project in a natural valley in the north of EL 5460 to support underground mining and coal handling activities and provide for personnel and materials access.

ROM coal brought to the surface at the MEA would be transported to the Maxwell Infrastructure area. Early ROM coal would be transported via internal roads during the construction and commissioning of a covered overland conveyor system. Subsequently, ROM coal would be transported to the Maxwell Infrastructure area via the covered overland conveyor system.

The existing product coal stockpile area at the Maxwell Infrastructure would be extended to allow for better management of different product coal blends. An additional ROM stockpile would also be developed adjacent to the CHPP to cater for delivery of ROM coal via the covered overland conveyor.

The Project would support continued rehabilitation of previously mined areas and overburden emplacements areas within CL 229, ML 1531 and CL 395. The volume of the East Void would be reduced through the emplacement of reject material generated by Project coal processing activities and would be capped and rehabilitated at the completion of mining.





LEGEND

- Mining Operation
- Proposed Mining Operation
- Railway
- Local Government Boundary
- State Forest
- National Parks and Wildlife Service Estate
- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services and Innovation (2019); Office of Environment and Heritage NSW (2019)

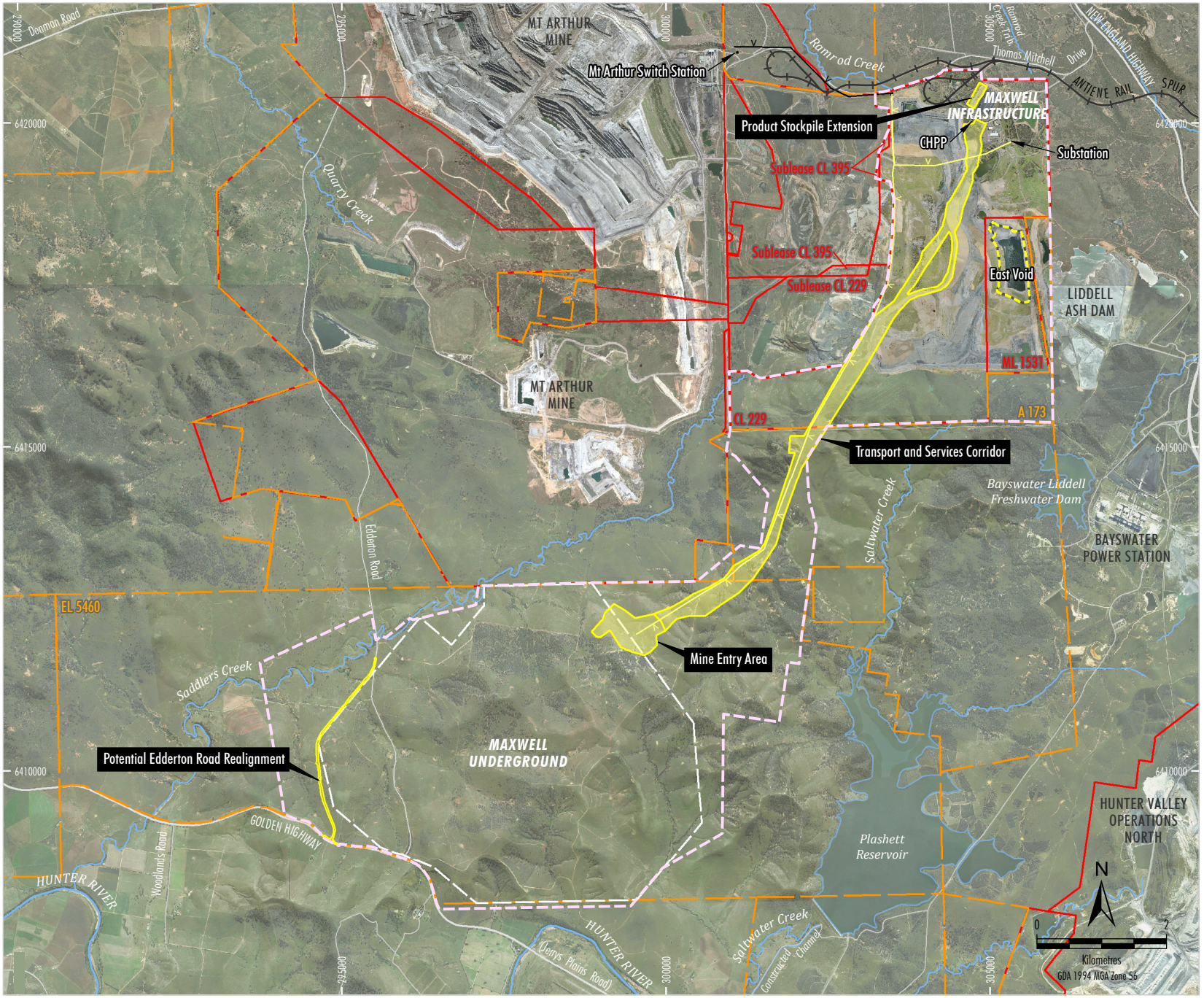
MALABAR COAL

MAXWELL PROJECT

Regional Location

Figure 1

SHA-18-03 Maxwell_EIS_App_Figure 1_Rev D



LEGEND

- Railway
- Exploration Licence Boundary
- Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Indicative Surface Development Area
- CHPP Reject Emplacement Area
- Proposed 66 kV Power Supply
- Proposed Ausgrid 66 kV Power Supply Extension #
- Ecology Study Area

Subject to separate assessment and approval.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Project General Arrangement

Figure 2

SHM-18-03 Maxwell_EIS_App_Fauna_202C

An indicative Project general arrangement is shown on Figure 2. The Project area comprises the following main domains:

- Maxwell Underground – comprising the proposed area of underground mining operations and the MEA within EL 5460.
- Maxwell Infrastructure – the area within existing mining leases comprising the substantial existing infrastructure (including the CHPP) and previous mining areas.
- The transport and services corridor between the Maxwell Underground and Maxwell Infrastructure – this would comprise a site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services.
- A potential realignment of Edderton Road.

A detailed description of the Project is provided in the main document of the EIS.

1.1 Purpose of Report

The purpose of the fauna survey and report is to, within the study area:

- survey and document potentially occurring threatened fauna species listed under the NSW *Biodiversity Conservation Act, 2016* (BC Act) in accordance with the relevant survey guidelines;
- survey and document potentially occurring threatened and protected migratory fauna species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in accordance with the relevant survey guidelines;
- survey and document threatened fauna species according to the *Biodiversity Assessment Methodology* (BAM) (Office of Environment and Heritage [OEH], 2017); and
- document the broad fauna habitats and the habitat for relevant 'species credit species'.

1.2 Site Description

1.2.1 Study Area

The study area is shown on Figure 2 and is approximately 5,000 hectares (ha) in size. The northern area includes the Maxwell Infrastructure and consists primarily of old open cut workings and infrastructure, with some woodland areas. The southern area consists of a mosaic of cleared grazing land and woodland.

1.2.2 Land Use

Agricultural industries in the surrounding area include cattle grazing, cropping, horse breeding and viticulture. Freehold land in the Project area is owned by Malabar, except for a small area in the northern part of the transport corridor and services corridor and a portion of the Maxwell Infrastructure, which are owned by AGL Energy Limited (AGL).

Land within the Project area is primarily cleared, open paddock grazing land, with some areas of remnant forest and open woodland and mainly used for cattle grazing along with minor cropping.

These agricultural activities are supported by farm dams, unsealed tracks, land contouring, cattle yards and fencing. Land to the north of the Maxwell Underground area is associated with active or previous open cut coal mining activities (i.e. the Mt Arthur Mine).

AGL-owned land associated with the Bayswater and Liddell Power Stations is located to the east of the Project. The Plashett Reservoir serves as an off-river water storage for the Bayswater Power Station along with water supply to the Jerrys Plains township.

The Golden Highway is located to the south and Thomas Mitchell Drive is located to the north of the study area. Edderton Road crosses through the western section of the study area.

1.2.3 Regional Setting

The following encompass the study area:

- Hunter Local Land Services Region;
- Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion and Hunter IBRA sub-region; and
- the Muswellbrook Local Government Area (LGA).

1.2.4 Landform and Hydrology

The landform above the underground mining area consists of undulating foothills to moderately-sloping hills over open paddock grazing land, with some areas of remnant forest and open woodland. Surface elevations vary from a low point of approximately 110 metres above Australian Height Datum (mAHD) to a high point of approximately 240 mAHD along a north-east to south-west trending ridgeline.

The Project is located in the Hunter River catchment, with the thalweg of the Hunter River approximately 525 metres (m) south of the underground mining area, at its closest point.

Saddlers Creek, an intermittent stream, is located north of the Maxwell Underground area. Saddlers Creek is a 4th order stream to the north of the underground mining area, and a 5th order stream downstream of Edderton Road. Saddlers Creek is fed by several small ephemeral creeks and drainage lines that traverse the central and northern portions of the Maxwell Underground area. These creeks and drainage lines form complex drainage networks that comprise the central reaches of the Saddlers Creek catchment area. Dry for much of the year, these watercourses commonly only flow after large rain events.

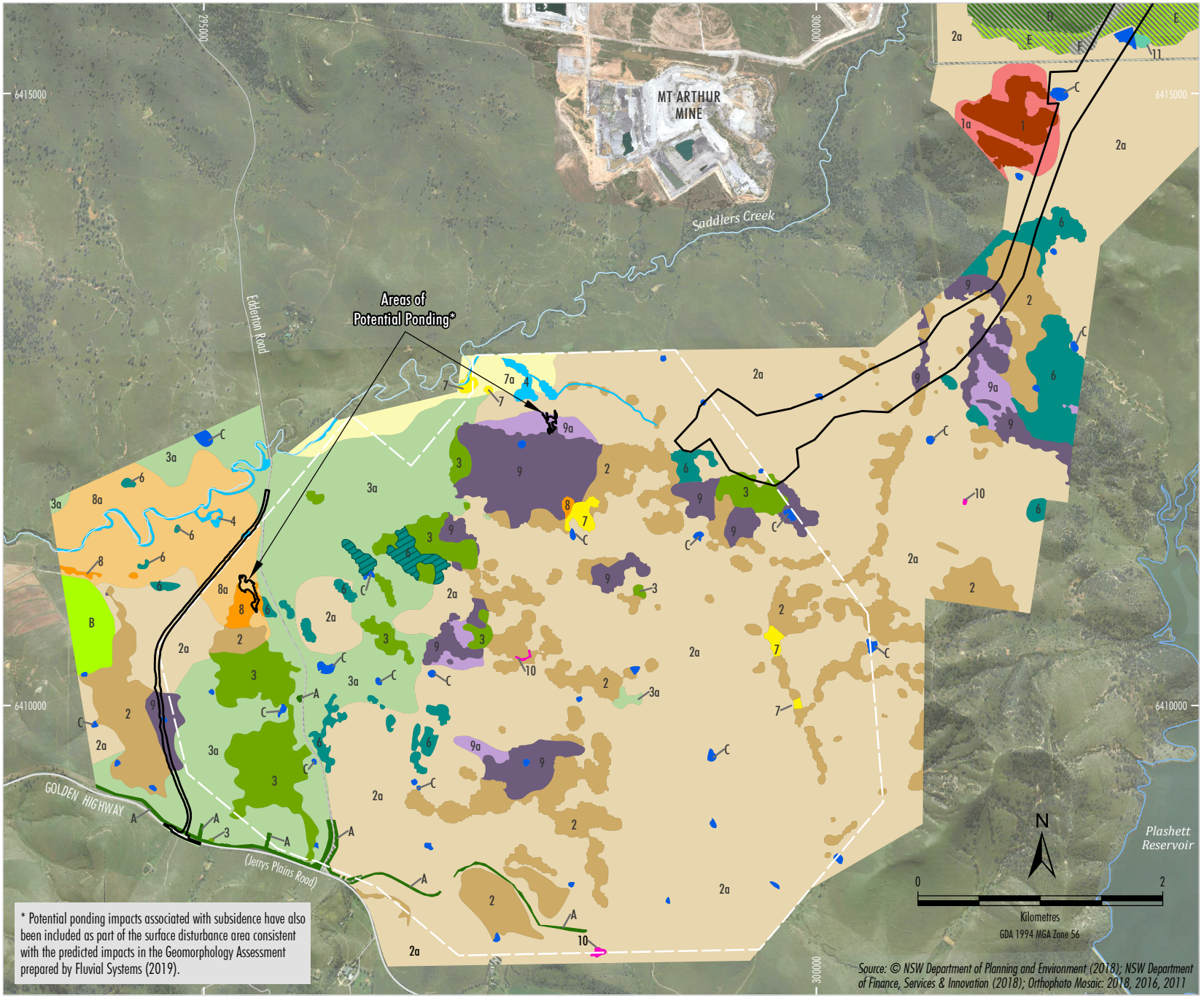
In the eastern portion of the Maxwell Underground area, another series of ephemeral creeks and drainage lines drain moderate to steeply sloping hills before feeding into Saltwater Creek, a 5th order stream immediately upstream of the Hunter River.

1.2.5 Vegetation

Hunter Eco (2019) has undertaken flora surveys across the study area. Eleven native vegetation communities were identified and several of these had corresponding 'Derived Natural Grasslands' (DNG) associated with them (Figures 3a and 3b). The majority of the study area comprises White Box – Ironbark – Red Gum shrubby forest (DNG) (approximately 2,200 ha).

1.2.6 Summary of Previous Threatened Species Recorded in the Study Area

As detailed in Section 2.1, a literature and database review was undertaken to identify threatened fauna species which are known or likely to occur in the study area. Table 1 lists the threatened fauna species that have previous survey or database records in or close to the study area and/or are predicted to occur in the study area.



LEGEND

- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 2a White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3 Slaty Box Shrubby Woodland (PCT1655) [2]
- 3a Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4 Swamp Oak Forest (PCT1731)

Grassy Woodlands

- 6 Bull Oak Grassy Woodland (PCT1692) [3]
- 7 Yellow Box - Apple Grassy Woodland (PCT1693) [1]
- 7a Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693) [1]
- 8 Fuzzy Box Woodland (PCT201)
- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9 Ironbark - Grey Box Grassy Woodland (PCT1691) [4]
- 9a Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 10 Weeping Myall Woodland (PCT116) [5]
- 11 Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]

Other

- A Planted Trees
- B Cultivation
- C Waterbody/Dam
- D Woodland Rehabilitation
- E Pasture Rehabilitation
- F Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland

[2] Listed BC Act, Hunter Valley Footslopes Slaty Gum Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[3] The hatched portions of this PCT is Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[4] Listed BC Act, Central Hunter Grey Box - Ironbark Woodland; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

[5] Listed BC Act, Hunter Valley Weeping Myall Woodland; Listed EPBC Act, Hunter Valley Weeping Myall (Acacia pendula) Woodland

[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland

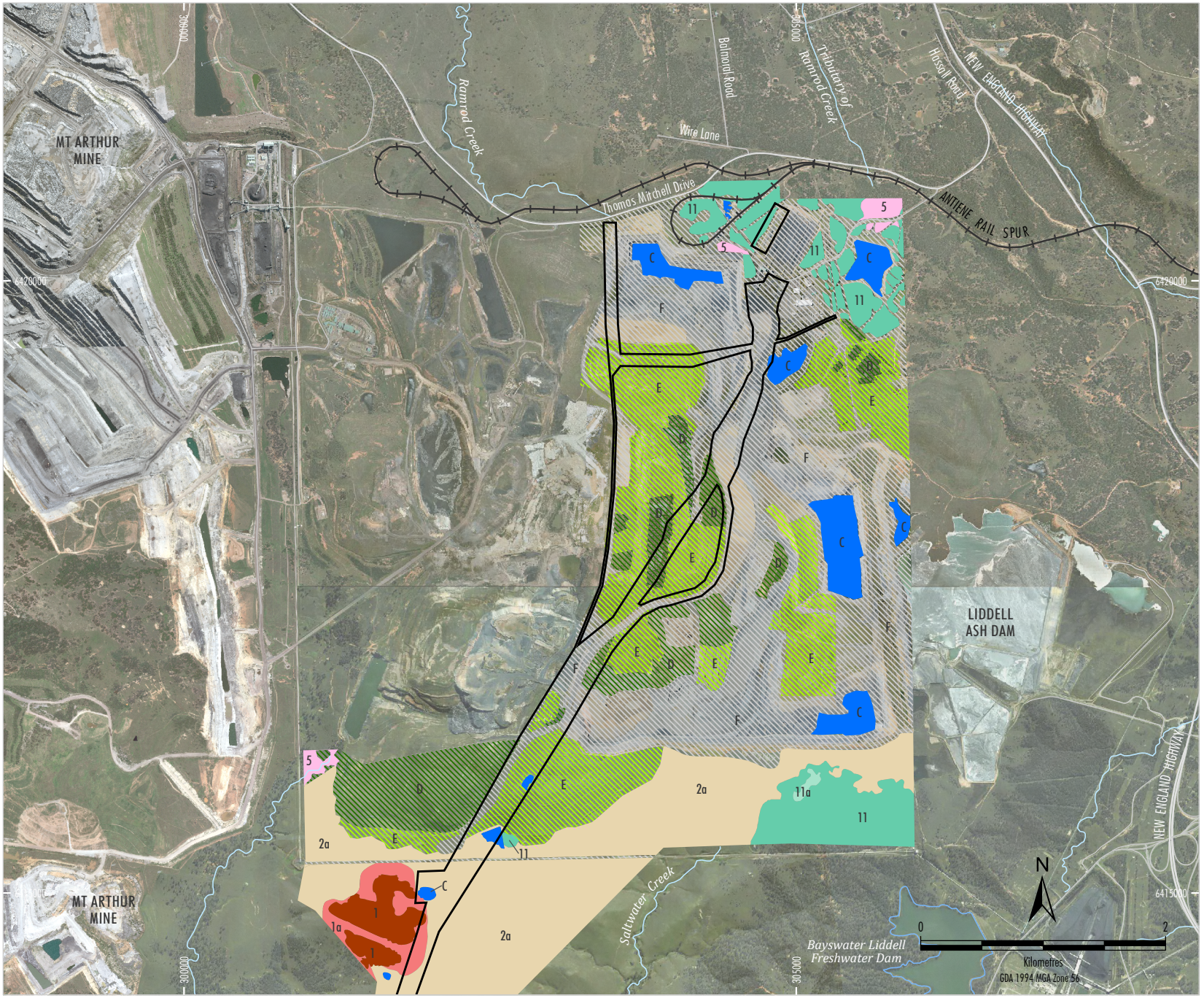
MALABAR COAL

MAXWELL PROJECT

Vegetation Mapping - Maxwell Underground

Figure 3a

SHM-18-03 Maxwell_EIS_App_Fauna_203K



LEGEND

- Biodiversity Assessment Development Footprint

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 — Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a — Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2a — White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606) [1]

Forested Wetlands

- 5 — Hunter Lowland Red Gum Forest (PCT1598) [7]

Grassy Woodlands

- 11 — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604) [6]
- 11a — Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland - Derived Native Grassland (PCT1604)

Other

- C — Waterbody/Dam
- D — Woodland Rehabilitation
- E — Pasture Rehabilitation
- F — Infrastructure/Cleared Land

[1] Listed BC Act, White Box Yellow Box Blakely's Red Gum Woodland; Listed EPBC Act, White Box - Yellow Box - Blakely's Red Gum Woodland
[6] Listed BC Act, Central Hunter Ironbark - Spotted Gum - Grey Box Forest; Listed EPBC Act, Central Hunter Valley Eucalypt Forest and Woodland
[7] Listed BC Act, Hunter Lowland Redgum Forest

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Vegetation Mapping - Maxwell Infrastructure

Figure 3b

SHM-18-03 Maxwell_EIS_App_Fauna_204H

Table 1: Threatened Fauna Species Known or Predicted to occur in the Locality

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Study Area[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Amphibians									
Green and Golden Bell Frog	*Litoria aurea*	V	E	S	Yes	Predicted	Yes	Yes	-
Booroolong Frog	*Litoria booroolongensis*	E	E	S	-	Predicted	-	-	-
Green-thighed Frog	*Litoria brevipalmata*	-	V	S	Yes	-	-	-	-
Reptiles									
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	-	-	-	-	-
Striped Legless Lizard	*Delma impar*	V	V	S	Yes	-	-	-	-
Pale-headed Snake	*Hoplocephalus bitorquatus*	-	V	S	Yes	-	-	-	-
Birds									
Freckled Duck	*Stictonetta naevosa*	-	V	E	-	-	-	Yes	-
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	-	Predicted	-	-	-
Black Falcon	*Falco subniger*	-	V	E	-	-	-	Yes	-
Square-tailed Kite	*Lophoictinia isura*	-	V	S/E	Yes	-	Yes	Yes	-
White-bellied Sea-eagle	*Haliaeetus leucogaster*	Ma	V	S/E	Yes	-	Yes	Yes	-
Spotted Harrier	*Circus assimilis*	-	V	E	Yes	-	Yes	Yes	A
Red Goshawk	*Erythrotriorchis radiatus*	V	CE	S	-	Predicted	-	-	-
Little Eagle	*Hieraaetus morphnoides*	-	V	S/E	Yes	-	Yes	Yes	A, I
Bush Stone-curlew	*Burhinus grallarius*	-	E	S	Yes	-	-	Yes	-
Australian Painted Snipe	*Rostratula australis*	E	E	E	-	Predicted	-	-	-
Eastern Curlew	*Numenius madagascariensis*	CE	-	S/E	-	Predicted	-	-	-
Curlew Sandpiper	*Calidris ferruginea*	CE	E	S/E	-	Predicted	-	-	-
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	-	V	S/E	Yes	-	-	-	-
Gang-gang Cockatoo	*Callocephalon fimbriatum*	-	V	S/E	Yes	-	-	Yes	-
Little Lorikeet	*Glossopsitta pusilla*	-	V	E	Yes	-	Yes	Yes	J
Turquoise Parrot	*Neophema pulchella*	-	V	E	Yes	-	-	Yes	-
Swift Parrot	*Lathamus discolor*	CE	E	S/E	Yes	Predicted	-	-	A
Eastern Grass Owl	*Tyto longimembris*	-	V	E	Yes	-	-	-	-
Masked Owl	*Tyto novaehollandiae*	-	V	S/E	Yes	-	-	-	-
Powerful Owl	*Ninox strenua*	-	V	S/E	Yes	-	Yes	Yes	-

Table 1 (Continued): Threatened Fauna Species Known or Predicted to occur in the Locality

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Study Area[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Barking Owl	*Ninox connivens*	-	V	S/E	Yes	-	Yes	Yes	B
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	-	V	E	Yes	-	Yes	Yes	A
Speckled Warbler	*Chthonicola sagittata*	-	V	E	Yes	-	Yes	Yes	A
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	-	V	E	Yes	-	Yes	-	
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E	Yes	Predicted	-	-	-
Painted Honeyeater	*Grantiella picta*	V	V	E	Yes	Predicted	-	-	-
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	-	V	E	Yes	-	Yes	-	
Flame Robin	*Petroica phoenicea*	-	V	E	Yes	-	-	Yes	-
Scarlet Robin	*Petroica boodang*	-	V	E	Yes	-	Yes	-	A
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	-	V	E	Yes	-	Yes	-	A
Varied Sittella	*Daphoenositta chrysoptera*	-	V	E	Yes	-	Yes	Yes	C
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	-	V	E	Yes	-	Yes	Yes	-
Diamond Firetail	*Stagonopleura guttata*	-	V	E	Yes	-	Yes	Yes	A, B, J
Mammals									
Spotted-tailed Quoll	*Dasyurus maculatus maculatus (south-eastern mainland population)*	E	V	E	Yes	Predicted	Yes	Yes	D, E
Brush-tailed Phascogale	*Phascogale tapoatafa*	-	V	S	Yes	-	Yes	-	-
Common Planigale	*Planigale maculata*	-	V	S	Yes	-	-	-	-
Koala	*Phascolarctos cinereus*	V	V	S/E	Yes	Predicted	Yes	-	-
Eastern Pygmy-possum	*Cercartetus nanus*	-	V	S	Yes	-	-	-	-
Yellow-bellied Glider	*Petaurus australis*	-	V	E	Yes	-	-	-	-
Squirrel Glider	*Petaurus norfolcensis*	-	V	S	Yes	-	Yes	-	A, D, E, F, J
Greater Glider	*Petauroides volans*	V	-	S	-	Predicted	-	-	-
Brush-tailed Rock-wallaby	*Petrogale penicillata*	V	E	S	Yes	Predicted	Yes	-	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	S/E	Yes	Predicted	Yes	-	J

Table 1 (Continued): Threatened Fauna Species Known or Predicted to occur in the Locality

Common Name	Scientific Name	Conservation Status			Database Records				Recorded in Previous Studies[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]	Potentially Associated with PCTs in the Study Area[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	-	V	E	Yes	-	Yes	-	A, J
Eastern Freetail-bat	*Mormopterus norfolkensis*	-	V	E	Yes	-	Yes	-	A, B, C, E, G, J
Northern Freetail-bat	*Mormopterus lumsdenae*	-	V	E	No	-	-	-	G
Little Bentwing-bat	*Miniopterus australis*	-	V	S/E	Yes	-	Yes	-	G
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	-	V	S/E	Yes	-	Yes	-	A, C, D, E, F, G, H, J
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E	Yes	Predicted	Yes	-	B
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S	Yes	Predicted	Yes	-	A, C, G
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	-	V	E	Yes	-	Yes	-	E, F
Southern Myotis	*Myotis macropus*	-	V	S	Yes	-	Yes	-	A, B, G
Greater Broad-nosed Bat	*Scoteanax rueppellii*	-	V	E	Yes	-	Yes	-	B, D, E, J
Eastern Cave Bat	*Vespadelus troughtoni*	-	V	S	Yes	-	Yes	-	A, G, J
New Holland Mouse	*Pseudomys novaehollandiae*	V	-	E	-	Predicted	-	-	-

Highlighted species are species recorded in the study area.

1 Conservation status under the EPBC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered, Ma = Marine.

2 Conservation status under the BC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

3 Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH, 2019a) (current as at March 2019), S = Species, E = Ecosystem.

4 OEH (2019a).

5 Department of the Environment and Energy (2018a).

6 OEH (2019b).

7 Atlas of Living Australia (2018).

8 A – Cumberland Ecology (2009a) and/or Cumberland Ecology (2012)
B – Ecotone (2000).
C – Eco Logical Australia (2015).
D – Eco Logical Australia (2016a).
E – Eco Logical Australia (2016b).
F – Eco Logical Australia (2014).
G– Eco Logical Australia (2017).
H – Umwelt Environmental Consultants (Umwelt) (2006b).
I – Umwelt (2007b).
J – Hansen Bailey (2007).

PCT = Plant Community Type.

2 Methods

2.1 Literature and Database Review

A literature and database review was undertaken prior to undertaking the field surveys (Section 2.3) to identify known or potentially occurring threatened fauna species or their habitats.

The following databases were reviewed:

- *Birdlife Australia Atlas Database* (Birdlife Australia, 2018);
- *BioNet Atlas* (OEH, 2019b);
- *Protected Matters Search Tool* (Department of the Environment and Energy [DEE], 2018a); and
- *Atlas of Living Australia* (Atlas of Living Australia [ALA], 2018).

The following mapping sources were reviewed:

- *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019);
- *SIX Maps* (NSW Spatial Services, 2018); and
- *Google Earth Pro* (Google, 2018).

The following local survey reports were also reviewed:

- *Ecological Assessment – Proposed South Pit Extension Project* (Umwelt, 2006b).
- *Ecological Assessment – Proposed Mt Arthur Underground Project* (Umwelt, 2007b).
- *Drayton Mine Extension Flora and Fauna Impact Assessment* (Hansen Bailey, 2007).
- *Ecological Assessment of Section 75W Modification for Drayton Mine* (Cumberland Ecology, 2009a).
- *Mt Arthur Coal Consolidation Project Ecological Assessment* (Cumberland Ecology, 2009b).
- *Mt Arthur Coal Open Cut Modification – Ecological Assessment* (Hunter Eco, 2013).
- *Mt Arthur Coal – Fauna Survey Report* (Niche Environment and Heritage, 2012).
- *Drayton South Coal Project Ecology Impact Assessment* (Cumberland Ecology, 2012).
- *Drayton South Coal Project Biodiversity Assessment Report* (Cumberland Ecology, 2015a).
- *Drayton South Coal Project Biodiversity Offset Strategy* (Cumberland Ecology, 2015b).
- 2013-2017 Spring Biodiversity Monitoring Reports of the former Drayton Mine (Eco Logical Australia, 2014-2017).

Since 2000, several surveys have been undertaken for surrounding coal projects. Results for each of the surveys are summarised below.

Saddlers Creek Survey

Ecotone (2000 in Cumberland Ecology, 2012) undertook flora and fauna surveys of Saddlers Creek in February 2000. The fauna survey included harp trapping, spotlighting, call playback, hair tube, Anabat and tripline bat surveys and a bird census. During the survey the following threatened species were recorded: the Barking Owl (*Ninox connivens*), Speckled Warbler (*Chthonicola sagittata*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*), Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*), Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), Diamond Firetail (*Stagonopleura guttata*), Koala (*Phascolarctos cinereus*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Corben's Long-eared Bat (*Nyctophilus corbeni*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*) (Table 1). Two additional species which are not listed as threatened in NSW but are listed as nationally protected migratory species under the EPBC Act were also detected, namely the White-throated Needletail (*Hirundapus caudacutus*) and Rainbow Bee-eater (*Merops ornatus*).

Mt Arthur Mine

Umwelt (2006b and 2007b) conducted various fauna monitoring surveys of the Mt Arthur Mine and surrounds between 2004 and 2006. Survey techniques involved hair traps, Elliott traps, cage traps, spotlight and diurnal surveys, Anabat surveys and call playback.

Between 21-25 February 2005, a fauna monitoring survey of the Mt Arthur Mine and the area located to the south-east; near Saddlers Creek and adjacent to the Maxwell Infrastructure, was undertaken. Threatened species recorded during this survey include the Squirrel Glider (*Petaurus norfolcensis*), Eastern Bentwing-bat, Eastern Cave Bat (*Vespadelus troughtoni*) and Southern Myotis (Umwelt, 2006b).

In December 2005, Umwelt (2006a in Hunter Eco, 2013) undertook a monitoring fauna survey of McLeans Hill, Saddlers Creek and Mt Arthur Mine and surrounds. Threatened species recorded include the Speckled Warbler, Grey-crowned Babbler (eastern subspecies), Varied Sittella (*Daphoenositta chrysoptera*), Squirrel Glider, Eastern Freetail-bat, Eastern Bentwing-bat and Southern Myotis.

On 7-11 March and 5-7 December 2005, Umwelt (2007b) conducted surveys for the Mt Arthur Underground Project, in areas located to the south and south-west of the Mt Arthur open cut mining areas, including near Saddlers Creek. Survey techniques included trapping (Elliott traps, cage traps, hair funnels and tubes and harp traps), spotlight surveys, diurnal surveys and Anabat surveys. Threatened species recorded included the Little Eagle (*Hieraaetus morphnoides*), Grey-crowned Babbler (eastern subspecies), Spotted Harrier (*Circus assimilis*), Speckled Warbler, Squirrel Glider, Eastern Bentwing-bat, Eastern Cave Bat, Greater Broad-nosed Bat, Eastern Freetail-bat and Southern Myotis (Umwelt, 2007b). Commonwealth listed migratory species recorded during the survey include the Black-shouldered Kite (*Elanus axillaris*), Wedge-tailed Eagle (*Aquila audax*), Nankeen Kestrel (*Falco cenchroides*), Masked Lapwing (*Vanellus miles*), White-throated Needletail and Rainbow Bee-eater (Umwelt, 2007b).

Umwelt (2007a in Hunter Eco, 2013) undertook a survey in December 2006 of the Mt Arthur Mine and McLeans Hill. Umwelt (2007a in Hunter Eco, 2013) recorded the Speckled Warbler, Eastern Freetail-bat, Large-eared Pied Bat (*Chalinolobus dwyeri*) and Greater Broad-nosed Bat.

The Spotted-tailed Quoll (south-eastern mainland population) (*Dasyurus maculatus maculatus*) was tentatively recorded during the first half of 2006 by a Hunter Valley Energy Coal Pty Ltd (HVEC) staff member on the main access road to the Mt Arthur Mine offices, near the intersection with Thomas Mitchell Drive (Hunter Eco, 2013).

Cumberland Ecology (2010 in Hunter Eco, 2013) conducted flora and fauna surveys of the Mt Arthur Mine surrounds between 20-23 September 2010. During the monitoring survey the Squirrel Glider and Eastern Bentwing-bat were recorded.

In 2012, a Koala was recorded within the Mt Arthur Mine, to the south-west of the Thomas Mitchell Drive Offset Area. The Koala was taken by wildlife carers who relocated him into a rehabilitated area, near where he was originally found (HVEC pers. comm., 2012 in Hunter Eco, 2013).

Niche Environment and Heritage (2012) conducted fauna surveys on 1 May and 7-11 May 2012, for areas associated with expansion of open cut coal mining activities at the Mt Arthur Mine site and adjacent to the Maxwell Infrastructure, but outside the study area.

Survey methods included arboreal Elliott traps, infra-red camera traps, hair tubes, ultrasonic call recording, diurnal bird surveys, spotlight surveys, call playback, stag watching, koala scat searches, herpetological surveys and frog chorus surveys. Two threatened species were recorded during the survey; the Grey-headed Flying-fox and Eastern Freetail-bat (Table 1) (Niche, 2012). The Eastern Bentwing-bat, Eastern Cave Bat and Eastern False Pipistrelle may have been recorded, however call recordings from these species were not of sufficient quality to be certain. The White-bellied Sea-eagle (*Haliaeetus leucogaster*), listed as migratory under the EPBC Act, was recorded near the Mt Arthur Mine during the flora surveys (Hunter Eco, 2013).

Former Drayton South Coal Project

Cumberland Ecology (2012 and 2015a) conducted several fauna surveys within the current study area for the former Drayton South Coal Project. Surveys were undertaken from 30 September-2 October, 26-28 October and 2-3 November in 2009 and from 14-18 March, 2-3 May and 16-24 June in 2011. Survey techniques included hair tubes, Anabat surveys, bird census, spotlight surveys, call playback, Elliott traps, cage traps, infra-red cameras, harp traps, targeted surveys and diurnal surveys.

The following threatened species were recorded during the 2009 and 2011 surveys: Spotted Harrier, Little Eagle, Swift Parrot (*Lathamus discolor*), Brown Treecreeper (eastern subspecies), Speckled Warbler, Grey-crowned Babbler (eastern subspecies), Scarlet Robin (*Petroica boodang*), Diamond Firetail, Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern Freetail-bat, Large-eared Pied Bat, Eastern Bentwing-bat, Southern Myotis (non-definite call identification), and Eastern Cave Bat (non-definite call identification) (Table 1), The Commonwealth listed migratory species, the Rainbow Bee-eater, was also recorded.

Maxwell Infrastructure

Hansen Bailey (2007) conducted fauna surveys of the Maxwell Infrastructure and surrounds for the periods over 14-17 February 2006, 6 September 2006 and 12-16 February 2007. Survey methods included arboreal mammal trapping, arboreal hair tube sampling, spotlighting, call playback, Anabat surveys, avian fauna surveys and opportunistic sightings

Hansen Bailey (2007) recorded the Little Lorikeet (*Glossopsitta pusilla*) (no location given), Diamond Firetail (north of rail loop, north-west of Site 17), Squirrel Glider (between the rail loop and coal stockpiles [equivalent to Site 17]), Grey-headed Flying-fox (flying near the Access Road Dam), Yellow-bellied Sheathtail-bat (non-definite call identification south-west to Site 17), Eastern Freetail-bat (equivalent to Site 17), Eastern Bentwing-bat (equivalent to Site 17), Greater Broad-nosed Bat (non-definite call identification at what is equivalent to Site 16b), and the Eastern Cave Bat (non-definite call identification at equivalent to Sites 16 and 17). The Commonwealth listed migratory species White-throated Needletail and Rainbow Bee-eater were also recorded near the rail loop and south-west of the Access Road Dam, respectively.

Cumberland Ecology (2009a) conducted a site inspection and fauna habitat assessment of the Maxwell Infrastructure in May 2009, During the field surveys call playback surveys were undertaken but no targeted threatened fauna surveys. One threatened species, the Speckled Warbler, was recorded outside the Maxwell Infrastructure, in the Northern Offset.

Eco Logical Australia (2014 to 2017) undertook annual flora and fauna monitoring surveys between 2013 and 2017 of the rehabilitation areas within the Maxwell Infrastructure and surrounds. All surveys were conducted during the spring season, with eight permanent fauna survey plots established and monitored annually for signs of fauna activity. Survey techniques consisted hair tube traps (arboreal and terrestrial) and remote cameras, spotlight surveys, bird census, call playback, herpetological and anabat surveys. Threatened species recorded during the monitoring period included the Squirrel Glider, Varied Sittella, Speckled Warbler, Little Lorikeet, Little Eagle, Grey-crowned Babbler (eastern subspecies), Spotted-tail Quoll (south-eastern mainland population), Brush-tailed Phascogale (*Phascogale tapoatafa*), Eastern Bentwing-bat, Little Bentwing-bat (*Miniopterus australis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Large-eared Pied Bat, Eastern Freetail Bat, Greater Broad-nosed Bat, Yellow-bellied Sheathtail-bat, Eastern Cave Bat, Southern Myotis, and Northern Freetail-bat (*Mormopterus lumsdenae*) (Table 1). The following Commonwealth listed migratory species were also recorded in during the monitoring period: Satin Flycatcher (*Myiagra cyanoleuca*), White-throated Needletail and Rainbow Bee-eater.

2.2 Relevant Survey Guidelines

Relevant guidelines that were followed during fauna surveys are as follows:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation [DEC], 2004a).
- *Hygiene Protocol for The Control of Disease in Frogs.* (Department of Environment and Climate Change [DECC], 2008a).
- *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians* (DECC, 2009).
- '*Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).
- *Survey Guidelines for Australia's Threatened Frogs* (Department of Environment, Water, Heritage and Arts [DEWHA], 2010a).
- *Survey Guidelines for Australia's Threatened Bats* (DEWHA, 2010b).
- *Survey Guidelines for Australia's Threatened Birds* (DEWHA, 2010c).
- *Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC], 2011a).
- *Survey Guidelines for Australia's Threatened Reptiles* (SEWPaC, 2011b).
- *EPBC Act Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (SEWPaC, 2011c).
- *EPBC Act Referral Guidelines for the Vulnerable Koala* (Department of the Environment, 2014).
- SPRAT profiles of relevant Commonwealth listed threatened and/or migratory fauna species (DEE, 2018b).

2.3 Field Survey

2.3.1 Weather, Climate and Astronomical Conditions

Fauna surveys took place over several separate periods:

1. 22 to 28 January 2018;
2. 4 to 7 June 2018;
3. 28 to 30 August 2018;
4. 17 to 20 September 2018;
5. 12 to 16 November 2018;
6. 19 to 23 November 2018;
7. 3 to 7 December 2018; and
8. 17 to 21 December 2018.

Weather records during the surveys were taken from the Maxwell Infrastructure CHPP Automatic Weather Station (AWS), and closest operating Bureau of Meteorology (BoM) AWS at Singleton Sewage Treatment Plant (STP) (station 061397) (BoM, 2018a), approximately 28 kilometres (km) south-east of the study area. Astronomical records were taken from the Geoscience Australia website (2018a, 2018b), the Museum of Applied Arts and Sciences – Sydney Observatory website (2018) and the United States Naval Observatory website (2019).

Since April 2017, there has been serious to severe rainfall deficiencies across large areas of NSW including the study area (BoM, 2018b). Below average rainfall conditions continued into Spring 2018 with only 81% of the average spring rainfall recorded at Singleton STP (BoM, 2018c). Rainfall for 2018 as a whole was exceptionally low over the south eastern quarter of the mainland, with much of the region experiencing totals in the lowest 10% of records. As of January 2019, significant rainfall deficiencies continued to affect large areas of eastern Australia at timescales out to around two years' duration (BoM, 2019a).

In terms of temperature, 2018 was Australia's third-warmest year on record (BoM, 2019b). At Singleton STP the mean maximum temperature for Spring 2018 was 0.3°C below the average and the mean minimum temperature was 2.2°C above the average (BoM, 2018c).

Weather conditions during the January survey period were very hot, with a maximum temperature of 40.8°C recorded and each survey date reaching over 32.5°C. Minimum nightly temperatures were also warm (the minimum recorded temperature being 19.5°C). There was 31.2 millimetres (mm) of rainfall recorded during the survey period from 25 to 28 January 2018.

Weather conditions during the June survey period were cool to mild with temperatures ranging from 9.3°C to 18.2°C. Some very minor rainfall (2 mm) was recorded on each of the last three days of survey, and an additional 4.4 mm of rainfall recorded in the two days prior to the survey period from 2 to 3 June 2018.

The August survey period had very cold frosty mornings and mild days with temperatures ranging from 1.4°C to 18.4°C. Some very minor rainfall (0.2 mm) was recorded on the first day of the survey period, and an additional 11.2 mm of rainfall recorded in the two days prior to the survey period from 26 to 27 August 2018.

Weather conditions during the September survey period were cool mornings and mild to hot days with temperatures ranging from 3.7°C to 27.9°C. No rainfall was recorded during the survey period.

Weather conditions during the November survey periods were warm to hot, with temperatures ranging from 12.5°C to 33.0°C. There was 9.6 mm of rainfall recorded during the last two days of the first survey period, and an additional 17 mm of rainfall recorded four to five days prior to the survey from 7 to 8 November 2018. During the second survey period 1.2 mm of rainfall was recorded on 21 November 2018.

Weather conditions during the December survey periods were warm to hot, with temperatures ranging from 13.6°C to 36.5°C. There was no rainfall recorded in the first survey period, however there was 36.4 mm of rainfall recorded four to six days prior to this survey from 27 to 29 November 2018. During the second survey period 5.2 mm of rainfall was from 17 to 21 December 2018, and an additional 77.2 mm of rainfall recorded in the week prior to the survey from 10 to 16 December 2018.

A summary of these weather records in addition to astronomical records relevant to the survey periods are presented in Table 2.

Table 2: Weather and Astronomical Records during Survey Periods

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Sunrise	Sunset	Moonrise	Moonset	Moonphase
January 2018								
22/01/2018	19.5	40.8	0	0511	1905	0932	2212	Waxing Crescent
23/01/2018	22.5	36.8	0	-	-	-	-	-
24/01/2018	21.2	37.3	0	-	-	-	-	-
25/01/2018	21.0	33.5	0.2	-	-	-	-	First Quarter
26/01/2018	22.2	34.0	0.2	-	-	-	-	-
27/01/2018	22.5	33.7	18.4	-	-	-	-	-
28/01/2018	22.6	32.5	12.4	0517	1902	1543	0130	Waxing Gibbous
June 2018								
4/06/2018	9.3	17.1	0	0651	1658	2148	1056	Waning Gibbous
5/06/2018	10.9	15.4	0.4	-	-	-	-	-
6/06/2018	10.7	12.9	1.4	-	-	-	-	-
7/06/2018	10.2	18.2	0.2	0653	1658	-	1242	Third Quarter
August 2018								
28/08/2018	6.7	16.3	0.2	0619	1737	1910	0720	Full Moon
29/08/2018	2.4	18.4	0	-	-	-	-	-
30/08/2018	1.4	18.1	0	0616	1738	2103	0824	Waning Gibbous
September 2018								
17/09/2018	3.7	19.8	0	0553	1749	1058	0021	First Quarter
18/09/2018	4.5	25.9	0	-	-	-	-	-
19/09/2018	14.4	27.9	0	-	-	-	-	-
20/09/2018	8.6	18.3	0	0549	1751	1325	0249	Waxing Gibbous
November 2018								
12/11/2018	12.5	28.1	0	0549	1931	0915	2338	Waxing Crescent
13/11/2018	14.1	29.8	0	-	-	-	-	-
14/11/2018	16.4	26.3	0	-	-	-	-	-

Table 2 (Continued): Weather and Astronomical Records during Survey Periods

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Sunrise	Sunset	Moonrise	Moonset	Moonphase
15/11/2018	16.1	31.3	8.6	-	-	1151	0105	First Quarter
16/11/2018	14.0	20.3	1	-	-	-	-	-
19/11/2018	13.5	26.8	0	-	-	-	-	-
20/11/2018	13.4	33.0	0	-	-	1630	0356	Waxing Gibbous
21/11/2018	19.3	28.3	1.2	-	-	-	-	-
22/11/2018	18.7	25.6	0	-	-	-	-	-
23/11/2018	14.5	23.3	0	0544	1941	1937	0544	Full Moon
December 2018								
3/12/2018	15.0	31.9	0	0542	1950	0310	1545	Waning Crescent
4/12/2018	16.7	30.4	0	-	-	-	-	-
5/12/2018	17.2	24.5	0	-	-	-	-	-
6/12/2018	15.2	28.5	0	-	-	-	-	-
7/12/2018	13.6	29.9	0	-	-	0537	1943	New Moon
17/12/2018	20.8	33.7	0.2	-	-	1414	0154	Waxing Gibbous
18/12/2018	20.8	30.1	0	-	-	-	-	-
19/12/2018	21.6	31.2	4	-	-	-	-	-
20/12/2018	20.4	36.5	1	-	-	-	-	-
21/12/2018	19.3	26.3	0.2	0546	2003	1821	0417	Waxing Gibbous
(22/12/2018)	-	-	-	-	-	-	-	(Full Moon)

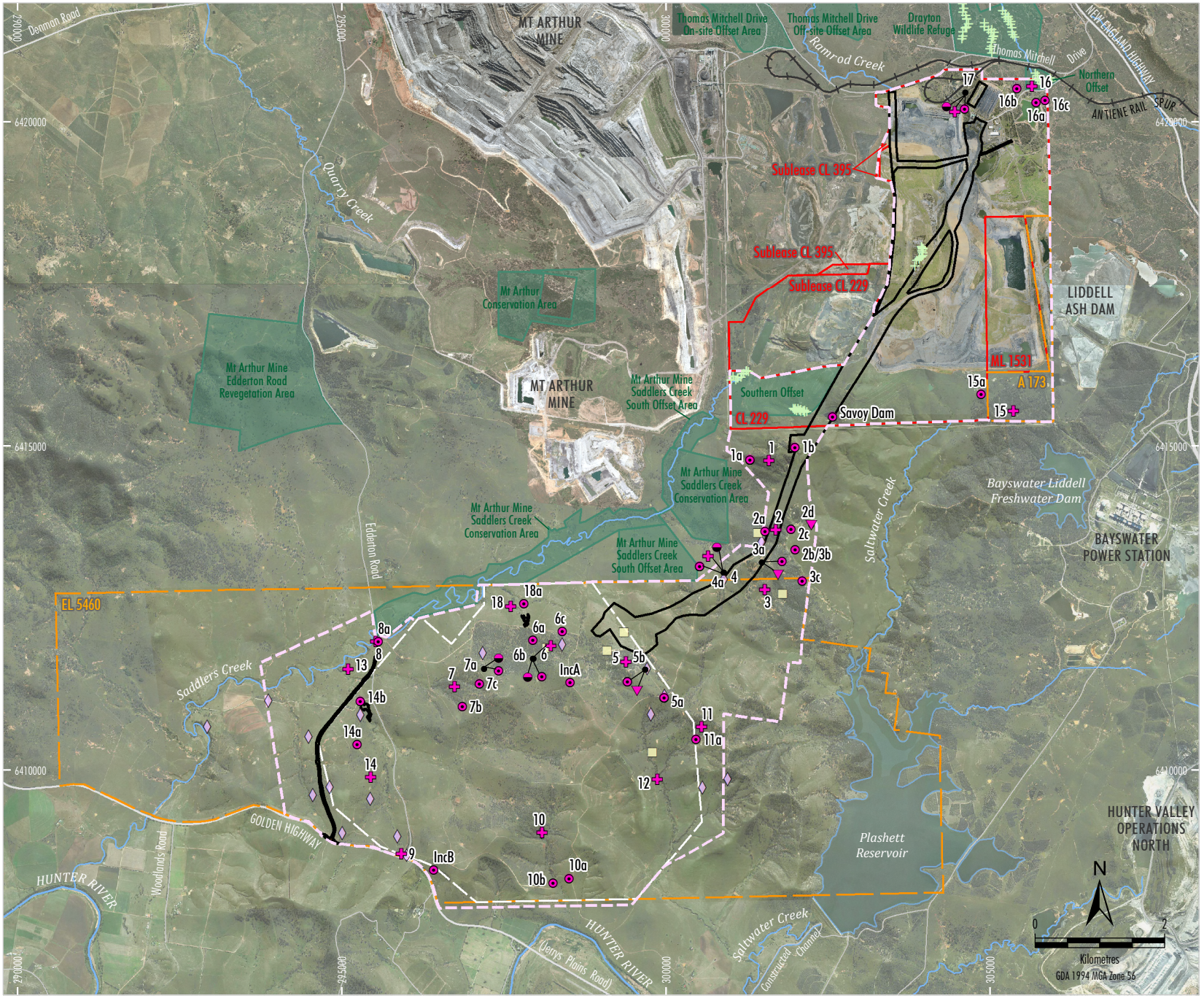
Sources: BOM (2018a), Geoscience Australia (2018a, 2018b), Sydney Observatory (2018), Maxwell Infrastructure CHPP AWS.

2.3.2 Techniques

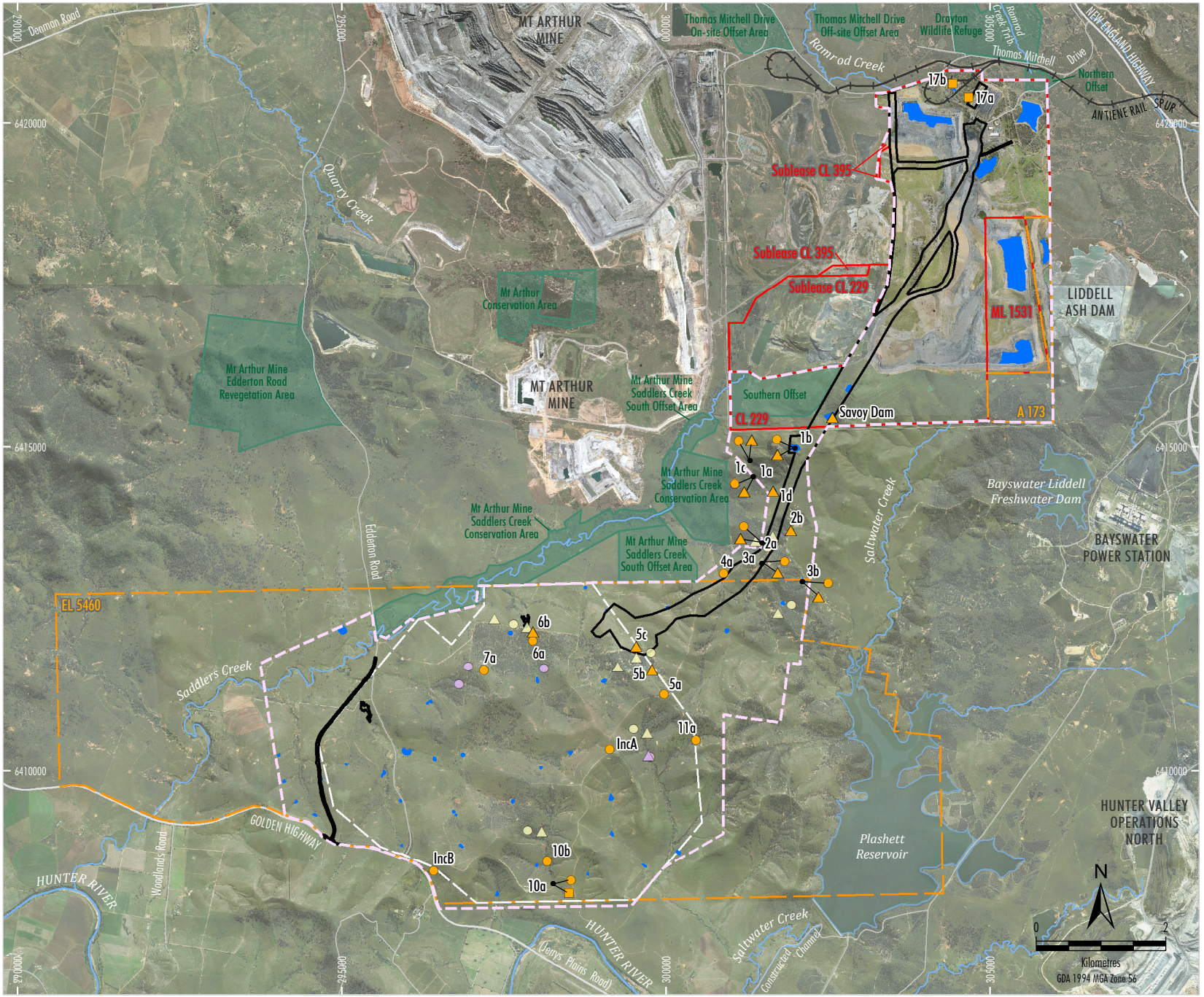
Stratification of the study area and site selection

The study area was initially assessed through interpretation of digital aerial imagery and from literature generated from previous studies. The landscape is mostly cleared agricultural lands and therefore remnant patches of treed vegetation within the study area were used as a basis for the initial stratification. Further stratification considered previous threatened and/or protected migratory fauna records within the study area and the spacing of survey sites.

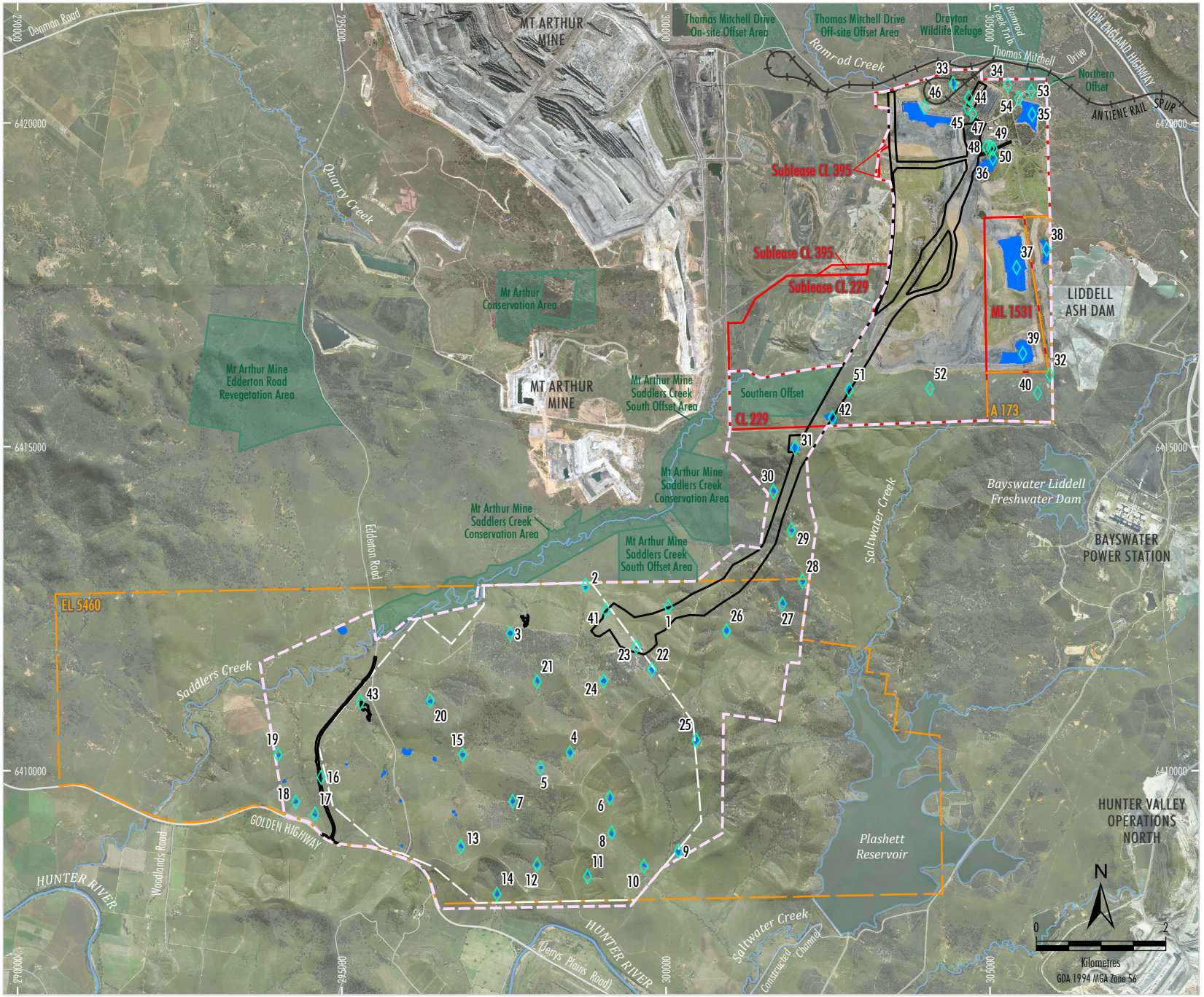
General fauna survey sites are listed in Table 3 and shown on Figure 4. Bat survey sites are shown on Figure 5 and amphibian survey sites are shown on Figure 6. The previous survey sites by Ecotone (2000), Cumberland Ecology in 2011 (2012) and Eco Logical Australia (2017) are also shown on Figures 4 and 5.



SHM-18-03 Maxwell_EIS_App_Fauna_213H



SHM-18-03 Maxwell_EIS_App_Fauna_212D



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area
- Waterbody/Dam
- Amphibian Survey Site

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Amphibian Survey Sites

Figure 6

SHM-18-03 Maxwell_EIS_App_Fauna_211E

Table 3: Fauna Survey Sites for the Study Area

Site	Location (Lat/Long GDA)		Site Type
1	-32.386	150.891	General Fauna Survey Site
1a	-32.386	150.888	Mammal Survey Site
1b	-32.388	150.891	Mammal Survey Site
2	-32.396	150.892	General Fauna Survey Site
2a	-32.396	150.890	Mammal Survey Site
2b/3b^	-32.399	150.895	Mammal Survey Site
2c	-32.396	150.894	Mammal Survey Site
2d	-32.396	150.897	Pitfall Trap
3	-32.404	150.890	General Fauna Survey Site
3a	-32.401	150.889	Mammal Survey Site and Pitfall Trap
3c	-32.403	150.896	Mammal Survey Site
4	-32.402	150.883	General Fauna Survey Site
4a	-32.402	150.883	Mammal Survey Site and Artificial Habitat (Tiles)
5	-32.414	150.867	General Fauna Survey Site
5a	-32.419	150.873	Mammal Survey Site
5b	-32.415	150.870	Mammal Survey Site and Pitfall Trap
6	-32.413	150.852	General Fauna Survey Site
6a	-32.411	150.851	Mammal Survey Site
6b	-32.413	150.851	Mammal Survey Site and Artificial Habitat (Tiles)
6c	-32.410	150.856	Mammal Survey Site
7	-32.417	150.839	General Fauna Survey Site
7a	-32.415	150.843	Mammal Survey Site and Artificial Habitat (Tiles)
7b	-32.420	150.840	Mammal Survey Site
7c	-32.417	150.843	Mammal Survey Site
8	-32.410	150.826	General Fauna Survey Site
8a	-32.410	150.826	Mammal Survey Site
9	-32.440	150.829	General Fauna Survey Site
10	-32.438	150.852	General Fauna Survey Site
10a	-32.444	150.857	Mammal Survey Site
10b	-32.445	150.854	Mammal Survey Site
11	-32.423	150.879	General Fauna Survey Site
11a	-32.425	150.878	Mammal Survey Site
12	-32.430	150.871	General Fauna Survey Site
13	-32.414	150.821	General Fauna Survey Site
14	-32.429	150.824	General Fauna Survey Site
14a	-32.425	150.822	Mammal Survey Site
14b	-32.419	150.823	Mammal Survey Site
15	-32.380	150.931	General Fauna Survey Site
15a	-32.378	150.926	Mammal Survey Site
16	-32.335	150.935	General Fauna Survey Site
16a	-32.337	150.936	Mammal Survey Site
16b	-32.335	150.933	Mammal Survey Site
16c	-32.337	150.937	Mammal Survey Site
17	-32.336	150.924	General Fauna Survey Site, Mammal Survey Site and Artificial Habitat (Tiles)
18	-32.414	150.843	General Fauna Survey Site
18a	-32.406	150.850	Mammal Survey Site

Table 3 (Continued): Fauna Survey Sites for the Study Area

Site	Location (Lat/Long GDA)		Site Type
IncA*	-32.417	150.857	Mammal Survey Site
IncB*	-32.442	150.835	Mammal Survey Site
Savoy Dam	-32.380	150.901	Mammal Survey Site

^ Site 2b/3b was a call-playback survey site located close to the boundary of Sites 2 and 3 and therefore covered both sites.

* Sites IncA and IncB were incidental mammal survey sites.

Eleven survey sites were initially selected for the January 2018 survey period with a further three sites added to the June 2018 survey period to cover additional areas including west of Edderton Road. Some of the survey sites (Sites 2, 3, 4, 5, 6, 7, 9, 10, 11, 12 and 14) had been previously surveyed (or partly surveyed) by Ecotone (2000) and/or Cumberland Ecology (2012). The study area was extended to the north to cover the Maxwell Infrastructure and an additional two sites (Sites 15 and 16) added to this area and initially surveyed in August 2018. The two site locations were selected as they were the largest areas of remaining treed habitat within CL 229. Site 17 was added in October 2018 adjacent to the existing coal stockpile area within CL 229, to cover some additional proposed surface development.

A mine dam (known as Savoy Dam) in the southern part of CL 229 was also added in October 2018. Site 18 was also added at the same time to cover a plant community type (PCT) identified above the Maxwell Underground.

The following survey techniques were undertaken at “General Fauna Survey Sites” listed in Table 3: general diurnal and nocturnal bird, reptile, amphibian and reptile surveys using a variety of standard techniques including observation, listening, spotlighting, call-playback and habitat searches,

The following survey techniques were undertaken at “Mammal Survey Sites” listed in Table 3: live trapping for arboreal and terrestrial mammals using Elliott traps and cages together with the use of hair tubes/funnels, nest boxes and wildlife cameras for longer term monitoring. Insectivorous bats were sampled using harp traps and acoustic devices.

Artificial habitat (second-hand terracotta roofing tiles) were placed at “Artificial Habitat (Tiles) Sites” listed in Table 3. Pitfall traps were placed at the “Pitfall Trap Sites” listed in Table 3.

Field Surveys

It should be noted that some surveys were often done concurrently e.g. spotlighting surveys were carried out at the same time as nocturnal bird and herpetofauna surveys. Given that there was a team of five ecologists in January 2018, two ecologists in June, August and September 2018, and five ecologists in November and December 2018, total survey effort would be in the order of at least two times what is described below for the specialist avifauna and herpetofauna surveys.

The below sub-sections describe the following survey techniques:

- habitat surveys;
- diurnal and nocturnal bird surveys;
- ground Elliott trapping;
- arboreal Elliott trapping;
- cage trapping;
- hair tubes;
- camera trapping;
- nest boxes;
- bat surveys;
- harp trapping;
- ultrasonic bat detection;
- microbat habitat searches;
- nocturnal call playback;
- spotlighting;
- Koala scat searches;
- searches for reptiles and amphibians (active searches, pitfall traps and artificial shelter habitat);
- tadpole surveys; and
- opportunistic observations.

Habitat Surveys

Fauna habitat searches were conducted for potential foraging, roosting, breeding or nesting habitat of nocturnal and diurnal species. This includes inspection for the presence of tree hollows, stags, bird nests, possum dreys, decorticating bark, rock shelters, rock outcrops/crevices, mature/old growth trees, food trees (*Banksia spp*., *Allocasuarina spp*., and winter-flowering eucalypts), culverts, dens, dams, riparian areas and refuge habitats within man-made structures.

The quality of the fauna habitat was assessed and categorised (low, medium or high) by the presence or absence of components of the ecosystems used by different fauna groups, e.g. large hollow-bearing trees for hollow dependent species, presence of understorey and composition of understorey for reptile, mammals and woodland birds.

One or more photos representing the habitat types on each site were taken at the beginning of the first survey of each of the sites. The structure of the canopy, shrub cover and ground cover was recorded for each site along with up to five of the most abundant plant species for each vegetation layer. Fauna habitat types were characterised in the study area in consideration of the vegetation mapping undertaken by Hunter Eco (2019).

Consideration was also given to the occurrence of habitat constraints in the *Threatened Biodiversity Data Collection* (OEH, 2019a) (Table 4).

Table 4: Habitat Constraints Identified in the Threatened Biodiversity Data Collection

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH, 2019a)
Amphibians		
Green and Golden Bell Frog	Species	*Semi-permanent/ephemeral wet areas (within 1km of wet areas).* *Swamps (within 1km of swamp).* *Waterbodies (within 1km of waterbody).*
Green-thighed Frog	Species	*None.*
Reptiles		
Pink-tailed Legless Lizard	Species	*Rocky areas or within 50 m of rocky areas.*
Striped Legless Lizard	Species	*None.*
Pale-headed Snake	Species	*None.*
Birds		
Square-tailed Kite	Species/Ecosystem	*Breeding constraint: Other (Nest trees).* *Foraging constraint: none.*
White-bellied Sea-eagle	Species/Ecosystem	*Breeding constraint: Other (Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines).* *Foraging constraint: Waterbodies (Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines)*
Little Eagle	Species/Ecosystem	*Breeding constraint: Other (Nest trees - live (occasionally dead) large old trees within vegetation.).* *Foraging constraint: none*
Bush Stone-curlew	Species	*Fallen/standing dead timber including logs.*
Glossy Black-cockatoo	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Living or dead tree with hollows greater than 15cm diameter and greater than 5m above ground).* *Foraging constraint: Other (Presence of Allocasuarina and Casuarina species)*
Gang-gang Cockatoo	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Eucalypt tree species with hollows greater than 9 cm diameter)* *Foraging constraint: none*
Swift Parrot	Species/Ecosystem	*Breeding constraint: Other (As per mapped important areas – contact OEH for information).* *Foraging constraint: none.*
Masked Owl	Species/Ecosystem	*Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).* *Foraging constraint: none.*
Powerful Owl	Species/Ecosystem	*Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20cm diameter).* *Foraging constraint: none.*
Barking Owl	Species/Ecosystem	*Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20 cm diameter and greater than 4m above the ground).* *Foraging constraint: none.*
Regent Honeyeater	Species/Ecosystem	*Breeding constraint: Other (As per mapped areas; contact OEH)* *Foraging constraint: none*
Mammals		
Brush-tailed Phascogale	Species	*Hollow-bearing trees*
Common Planigale	Species	*None.*
Koala	Species/Ecosystem	*Breeding constraint: Other (Areas identified via survey as important habitat (see comments)* *Foraging constraint: none.*
Eastern Pygmy-possum	Species	*None*
Squirrel Glider	Species	*None*
Brush-tailed Rock-wallaby	Species	*Other (Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines).*
Grey-headed Flying-fox	Species/Ecosystem	*Breeding constraint: Other (Breeding camps)* *Foraging constraint: none.*

Table 4 (Continued): Habitat Constraints Identified in the Threatened Biodiversity Data Collection

Common Name	Credit Class	Habitat Constraints identified in the *Threatened Biodiversity Data Collection* (OEH, 2019a)
Little Bentwing-bat	Species/Ecosystem	*Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).* *Foraging constraint: none.*
Eastern Bentwing-bat	Species/Ecosystem	*Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).* *Foraging constraint: none.*
Large-eared Pied Bat	Species	*Cliffs (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels).*
Southern Myotis	Species	*Hollow-bearing trees (Within 200 m of riparian zone).* *Other (Bridges, caves or artificial structures within 200 m of riparian zone).*
Eastern Cave Bat	Species	*Caves (Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds).*

Diurnal and Nocturnal Bird Surveys

All ecologists recorded birds as they were encountered during the survey periods however the following information discussed in this section and within Tables 5 to 8 is provided by the dedicated avifauna specialist (Tony Saunders) on the ecological team.

All species that were encountered and identified by sight or call were recorded using the 'Sightings' App. Each significant patch of woodland habitat (a site) was searched using a 500 m radius survey. The time spent on a site was determined by the habitat quality, with the survey effort increased for higher quality sites when compared with lower quality sites. Incidental records of additional or locally significant species were also recorded while travelling around the site and between survey sites.

Specialist bird surveys were conducted in January 2018, June 2018, August 2018, September 2018, November 2018 and December 2018 to cover seasonality and detection requirements of several species.

In January 2018, early morning surveys were conducted between 05:30 and 11:30 hours. Evening surveys were run between 17:30 and 23:30 hours and included listening for calls and spotlighting. No surveys were conducted during the middle of the day in January 2018, as conditions were too hot for bird activity. A total of 42.25 hours was spent surveying 9 sites and an additional 11.25 hours was spent surveying while travelling between sites. The total survey effort over the 6 days from the 22-27 January 2018 was 53.5 hours. Diurnal survey effort was 20.65 hours and nocturnal survey effort was 21.6 hours. The survey effort for each site is summarised below with a break down showing time spent between diurnal and nocturnal surveys.

Table 5: Bird Survey Effort for January 2018 Survey Period

Site	1, 1a, 1b	2, 2a, 2b/3b, 2c, 2d	3, 3a, 3c	4, 4a	5, 5a, 5b	6, 6a, 6b, 6c	7, 7a, 7b, 7c	10, 10a, 10b	11, 11a	Totals
Diurnal (hrs)	3.45	1.70	2.25	1.00	3.00	4.75	1.50	1.00	2.00	**20.65**
Nocturnal (hrs)	5.00	3.30	1.80	3.00	4.25	4.25	Nil	Nil	Nil	**21.6**
Totals (hrs)	**8.45**	**5.00**	**4.05**	**4.00**	**7.25**	**9.00**	**1.50**	**1.00**	**2.00**	**42.25**

Sites 8 and 9 were not surveyed in January 2018 due to poor habitat.

In June 2018 diurnal surveys were conducted between 06:30 and 16:30 hours. Conditions were cool and birds were active throughout the day. Evening surveys were run between 18:30 and 20:30 hours and included listening for calls and spotlighting. Between 20 and 30 live trees and approximately 10 standing dead trees were spotlighted during each nocturnal survey in June 2018. A total of 29.00 hours was spent surveying 13 sites and an additional 6.00 hours was spent surveying while travelling between sites. The total survey effort over the 4 days from the 4-7 June 2018 was 35.00 hours. Diurnal survey effort was 23.75 hours and nocturnal survey effort was 5.25 hours. The survey effort for each site is summarised in the table below with a break down showing time spent between diurnal and nocturnal surveys.

Table 6: Bird Survey Effort for June 2018 Survey Period

Site	1, 1a, 1b	2, 2a, 2b/3b, 2c, 2d	3, 3a, 3c	4, 4a	5, 5a, 5b	6, 6a, 6b, 6c	7, 7a, 7b, 7c	10, 10a, 10b
Diurnal (hrs)	2.00	2.00	2.00	1.00	2.00	2.00	2.25	1.00
Nocturnal (hrs)	-	-	-	-	2.25	-	-	-
Totals (hrs)	**2.00**	**2.00**	**2.00**	**1.00**	**4.25**	**2.00**	**2.25**	**1.00**

Site	11, 11a	12	13	14a, 14b	Totals
Diurnal (hrs)	2.25	1.5	1.75	4.00	**23.75**
Nocturnal (hrs)	1.5	-	-	1.5	**5.25**
Totals (hrs)	**3.75**	**1.5**	**1.75**	**5.5**	**29**

In August 2018, diurnal surveys were conducted between 7:00 and 18:00 hours at Sites 15 and 16 located within the Maxwell Infrastructure area. Conditions were cool and birds were active throughout the day. Evening surveys were run between 18:00 and 19:30 hours and included listening for calls and spotlighting. Two hollow-bearing trees were stag watched on dusk at Site 15 on 28 August 2018. A total of 17.25 hours was spent surveying these two sites. Diurnal survey effort was 14.00 hours and nocturnal survey effort was 3.25 hours. The survey effort for each site is summarised in the table below with a break down showing time spent between diurnal and nocturnal surveys.

Table 7: Bird Survey Effort for August 2018 Survey Period

Site	15, 15a	16, 16a, 16b, 16c	Totals
Diurnal (hrs)	7.5	6.5	**14**
Nocturnal (hrs)	1.5	1.75	**3.25**
Totals (hrs)	**9.0**	**8.25**	**17.25**

In September 2018, diurnal surveys were conducted between 6:30 and 18:00 hours. Evening surveys were run between 18:30 and 20:30 hours and included listening for calls and spotlighting. Between 20 and 30 live trees and approximately 10 standing dead trees were spotlighted during each nocturnal survey. Incidental records of additional or locally significant species were also recorded while travelling around the site and between survey sites. Conditions were cool to warm, sunny and with only very light rain recorded 3 weeks previous to surveys. Heavy grazing pressure combined with the dry conditions had negatively impacted on bird diversity onsite during the survey period. Conditions were cool and calm in the mornings but became windy in the middle of the day and in the early afternoon.

Each significant patch of woodland habitat (a site) was searched using a 500 m radius survey. The time spent on a site was determined by the habitat quality, so that survey effort was increased for higher quality sites compared with lower quality sites.

In addition, several surveys were conducted targeting raptor species such as the Little Eagle and the Square-tailed Kite (*Lophoictinia isura*). For each of these surveys a good vantage point was selected to cover as much of the area under the development footprint as possible. Several vantage points were selected to ensure that the whole site was covered. From each vantage point the horizon was scanned for raptors hunting over the canopy and near the edges of remnant woodland, moving between remnants or circling in thermals.

In September 2018 a total of 21.0 hours was spent surveying eight sites, 7.5 hours was spent on aerial raptor searches and an additional 4.00 hours was spent surveying while travelling between sites. The total survey effort over the 4 days of survey was 32.5 hours. Diurnal survey effort was 16.0 hours and nocturnal survey effort was 5.0 hours. The survey effort for each site is summarised in the table below with a break down showing time spent between diurnal and nocturnal surveys.

Table 8: Bird Survey Effort for September 2018 Survey Period

Site	1, 1a, 1b	2, 2a, 2b/3b, 2c, 2d	3, 3a, 3c	5, 5a, 5b	6, 6a, 6b, 6c	7, 7a, 7b, 7c	8, 8a	11, 11a	Totals
Diurnal (hrs)	4.5	2.5	1.0	2.5	1.5	1.5	0.5	2.0	**16**
Nocturnal (hrs_	1.5	1.5	-	2.0	-	-	-	-	**5**
Totals (hrs)	**6.0**	**4.0**	**1.0**	**4.5**	**1.5**	**1.5**	**0.5**	**2.0**	**21**

In November 2018 surveys were conducted over an eight-day period between 12-23 November 2018 inclusive. Conditions were cool to warm, sunny, dry and sometimes windy. There was evidence of some heavy rain events since the previous surveys and most dams had good levels of water in them. Heavy grazing pressure combined with very dry conditions had negatively impacted on bird diversity onsite during the survey period. There were some signs of recovery, but this was not very advanced at the time of the surveys. Conditions were cool and calm in the mornings and observing conditions were ideal. When conditions became windy surveys were terminated.

Each significant patch of woodland habitat (a site) was searched using a 500 m radius survey. The time spent on a site was determined by the habitat quality, so that survey effort was increased for higher quality sites compared with lower quality sites. Based on the PCTs present, there was an emphasis on sites that contained potential habitat for Regent Honeyeaters (*Anthochaera phrygia*).

In addition, several surveys were conducted targeting raptor species such as the Little Eagle, Square-tailed Kite and Spotted Harrier. For each of these surveys a good vantage point was selected to cover as much of the area under the development footprint as possible. Several vantage points were selected to ensure that the whole site was covered. From each vantage point the horizon was scanned for raptors hunting over the canopy and near the edges of remnant woodland, moving between remnants or circling in thermals. Several potential raptor nests were also recorded within the 'Sightings' App and whether birds were present or not.

Most sites were surveyed by two observers who covered different parts of a site during each visit. Diurnal surveys were conducted between 05:00 and 19:30 hours. Evening surveys were run between 19:30 and 22:30 hours and included listening for calls and spotlighting. A minimum of 30 live trees and 10 standing dead trees (if present) were spotlighted during each nocturnal survey. Incidental records of additional or locally significant species were also recorded while travelling around the site and between survey sites.

In November 2018 a total of 124.25 hours was spent surveying 11 sites. An additional 24 hours were spent on aerial raptor searches and incidental surveying while travelling between sites. Diurnal survey effort was 136.25 hours and nocturnal survey effort was 12.0 hours. Total survey effort was 148.25 hours. The survey effort for each site is summarised in the table below with a break down showing time spent between diurnal and nocturnal surveys.

Table 9: Bird Survey Effort for November 2018 Survey Period

Site	1, 1a, 1b	2, 2a, 2b/3b, 2c, 2d	3, 3a, 3c	4, 4a	5, 5a, 5b	6, 6a, 6b, 6c	7, 7a, 7b, 7c	9	10, 10a, 10b	17	18, 18a	Raptors / Incidental	Totals
Diurnal (hrs)	4.5	23	8	6	36	8	7.5	1	1.75	12	4.5	24	**136.25**
Nocturnal (hrs)	-	5	-	-	4	-	-	-	-	-	3	**-**	**12**
Totals (hrs)	**4.5**	**28**	**8**	**6**	**40**	**8**	**7.5**	**1**	**1.75**	**12**	**7.5**	**24**	**148.25**

In December 2018 surveys were conducted over a six and a half-day period between 3-19 December 2018 inclusive. Conditions were warm, sunny, dry and sometimes windy to hot and humid with storms building. There was evidence of some heavy rain events since the previous surveys and most dams had good levels of water in them. Heavy grazing pressure combined with very dry conditions negatively impacted on bird diversity onsite during the surveys. The recovery was more advanced at the time of the final surveys undertaken in December 2018 as the effects of the rain storms and the removal of cattle from the property was evident. Conditions were cool and calm in the mornings and observing conditions were ideal.

Each significant patch of woodland habitat (a site) was searched using a 500 m radius survey. The time spent on a site was determined by the habitat quality, so that survey effort was increased for higher quality sites compared with lower quality sites. There was an emphasis on sites that contained potential habitat for Regent Honeyeaters.

All sites containing PCTs that were possible habitat for the Regent Honeyeater were surveyed for a minimum of 20 hours each. These include sites 2, 3, 4, 5, 6, 7 and 17.

Additional potential raptor nests were also recorded including whether birds were present or not in the 'Sightings' App.

Most sites were surveyed by two observers who covered different parts of a site during each visit. Diurnal surveys were conducted between 5:00 and 20:30 hours. Evening surveys were run between 20:30 and 22:30 hours and included listening for calls and spotlighting. A minimum of 30 live trees and 10 standing dead trees (if present) were spot-lighted during each nocturnal survey. Incidental records of additional or locally significant species were also recorded while travelling around the site and between survey sites.

In December 2018 a total of 67.75 hours was spent surveying 10 sites. An additional 12.5 hours were spent on aerial raptor searches and incidental surveying while travelling between sites. Diurnal survey effort was 80.25 hours and nocturnal survey effort was 11.75 hours. The total survey effort was 91 hours. The survey effort for each site is summarised in the table below with a break down showing time spent between diurnal and nocturnal surveys.

Table 10: Bird Survey Effort for December 2018 Survey Period

Site	1, 1a, 1b	3, 3a, 3c	4, 4a	6, 6a, 6b, 6c	7, 7a, 7b, 7c	11, 11a	14a, 14b	17	18, 18a	Savoy Dam	Raptors / Incidental	Totals
Diurnal (hrs)	11.0	12.75	14.25	0.75	1.75	10.0	-	8.0	3.25	6.0	12.5	**80.25**
Nocturnal (hrs)	4.0	-	-	-	-	-	3.0	3.75	-	-1.0	-	**11.75**
Totals (hrs)	**15.0**	**12.75**	**14.25**	**0.75**	**1.75**	**10.0**	**3.0**	**11.75**	**3.25**	**7.0**	**12.5**	**91**

During all survey periods signs of owl use were searched for under and on some hollow-bearing trees with hollows large enough to accommodate large forest owl species (i.e. owl pellets, remains of meals, faecal whitewash, feathers).

Ground Elliott Trapping

Elliott traps targeting small to medium sized ground-dwelling mammals were set out for four consecutive nights from 23-27 January 2018 (Sites 1a, 2a and 3b), and 19-23 November 2018 (Site 7b). A total of 25 “A” Elliott traps (measuring 33 centimetres (cm) x 10 cm x 9 cm) were deployed at each of the relevant sites.

Figure 4 shows the location of the mammal trapping sites, which included ground Elliott traps.

Trap lines typically traversed areas of diverse vegetation or habitat features as identified from the habitat search as likely areas to support the target mammal. Each trap was baited with a bait mix of peanut butter, honey, molasses, rolled oats, vanilla essence, almond essence and fish sauce.

Dry bedding material (leaves or coconut husk) was placed in each Elliott trap and the traps were covered in plastic bags if wet weather threatened. Traps were checked early each morning for captures, with any captured animals identified and immediately released. Traps were left closed for the day and re-opened on dusk.

Arboreal Elliott Trapping

Elliott traps targeting arboreal species identified from the literature review, namely the Squirrel Glider, were placed in habitat with large trees (some with hollows) and vegetated ground cover, for four consecutive nights from 23-27 January 2018 (Sites 1a, 2a and 3a) and 19-23 November 2018 (Sites 5d, 6b, 7b, 18a).

Figure 4 shows the location of the trapping sites.

Ten “B” Elliott traps (15 cm x 15 cm x 56 cm) were deployed at each of the relevant sites. The traps were placed greater than two meters off the ground on a platform fixed to the trunk of the tree at approximately 30-50 m spacing.

Each trap was baited with a bait mix of peanut butter, honey, molasses, rolled oats, vanilla essence, almond essence and fish sauce.

Dry bedding material (leaves or coconut husk) was placed in each Elliott trap and the traps were covered in plastic bags if wet weather threatened. Traps were checked early each morning for captures, with any captured animals identified and immediately released. Traps were left closed for the day and re-opened on dusk.

Cage Trapping

Cage traps targeting medium mammals were deployed at Sites 1a, 2a and 3b, for four consecutive nights from 23-27 January 2018, as part of the terrestrial and arboreal Elliott trapping grids. An additional cage was deployed at Site 3. Figure 4 shows the location of the trapping sites.

Three cages were Mascot Wire Works steel traps measuring 20 cm x 20 cm x 56 cm with a 12.5 x 50 mm mesh (i.e. 'bandicoot' sized traps). The fourth cage was a larger 'dog' sized trap also from Mascot Wire Works and this was deployed at Site 2a.

Cages were baited with sardines and covered in hessian bags. Traps were checked early each morning for captures, with any captured animals identified and immediately released. Traps were left closed for the day and re-opened on dusk.

Between 27 January and 6 June 2018, a single bandicoot sized cage at Site 3 was closed, baited with fresh sardines and a jar of molasses and left onsite as part of bait stations for longer term camera trapping (130 nights).

Hair Tubes

Hair tube surveys, targeting small to medium-sized arboreal and terrestrial mammals, were deployed for at least four-five consecutive evenings as follows:

- Site 1a – 21 tubes over five nights (22-27 January 2018).
- Site 2a – 22 tubes over four nights (23-27 January 2018).
- Site 3a – 20 tubes over four nights (23-27 January 2018).
- Site 5a – two tubes over four nights (23-27 January 2018).
- Site 6a – two tubes over four nights (23-27 January 2018).
- Site 16a – five tubes over 76 nights from (29 August 29 – 13 November 2018).
- Site 16b – five tubes over 76 nights from (29 August 29 – 13 November 2018).
- Site 18a – 20 tubes over 18 nights (16 November – 4 December 2018).

Figure 4 shows the location of the trapping sites.

All hair tubes were single sided and five sizes of were used, 90 mm diameter (large), 50 mm diameter (medium), 40 mm diameter (small), 30 mm diameter (extra small) and Faunatech funnels. Double-sided tape was placed at the entrance on the upper side of the tube to collect hairs of animals attracted to the bait. All tubes were baited with peanut butter, honey, molasses, rolled oats, vanilla essence, almond essence and fish sauce. Tubes at Sites 15 and 16 were baited with a mix of flour, sardines, and tuna oil.

Hair tubes were set on the ground, in shrub/tree bases and in trees at a height approximately 1-1.5 m above the ground.

Between 27 January and 6 June 2018, a number of fresh hair tubes were deployed as part of bait stations for longer term camera trapping as follows:

- Site 1a – two tubes over 130 nights.
- Site 2a – four tubes over 130 nights.
- Site 3a – four tubes over 130 nights.

Any hairs collected were sent to an expert in hair analysis (Barbara Triggs, Genoa Victoria) for analysis.

Camera Trapping

Wildlife cameras were deployed as part of live trapping and/or hair tube transects at Sites 1, 2, 3, 5, 6, 7 and 17 in areas of suitable habitat. Several types of cameras were used including Scout Guard SG562C White Flash, Scout Guard SG550V, Reconyx PC900, Reconyx PC90 and Moultrie D80.

All cameras were set to take still photos only.

Cameras were deployed as follows:

- Site 1a – two cameras each placed for five nights (22-27January 2018).
- Site 2b – two cameras each placed for four nights (23-27January 2018).
- Site 3c – two cameras each placed for four nights (23-27January 2018).
- Site 5a – one camera placed for four nights (23-27January 2018).
- Site 6a – one camera placed for four nights (23-27January 2018).
- Site 6b – one camera placed for 21 nights (13 November – 4 December 2018).
- Site 7c – one camera placed for 20 nights (14 November – 4 December 2018).
- Site 17a – two cameras each placed for 15 nights (4 December – 20 December 2018).
- Location IncA – two cameras each placed for 3 nights (26 December – 29 December 2018).

Figure 4 shows the location of the trapping sites.

Cameras were pointed at bait stations or closed cages baited with a lure of sardines, and/or hair tubes baited with peanut butter, honey, molasses, rolled oats, vanilla essence, almond essence and fish sauce.

Between 27 January and 6 June 2018, cameras were deployed as part of bait stations for longer term camera trapping as follows:

- Site 1a – one camera over 130 nights.
- Site 2a – one camera over 130 nights.
- Site 3a – one camera over 130 nights.

In addition, two cameras were deployed facing a fresh cattle carcass at a location between Sites 5 and 6 and also left for 130 nights as above.

The use of camera traps is an additional survey technique to those described in DEC (2004a) but is discussed in SEWPaC (2011a) in regard to threatened mammals.

Nest boxes

15 nest boxes (five at each of Sites 1a, 2a and 3a – Figure 4) were deployed for 132-133 nights (24/25 January – June 6 2018). Nest boxes were made from natural recycled hollows and were generally of dimensions and entrance diameters suitable for use by small to medium sized arboreal mammals such as Squirrel Glider, Eastern Pygmy-possum (*Cercartetus nanus*) and microbats.

Bat Surveys

Bats were surveys in accordance with the *'Species Credit' Threatened Bats and their Habitat: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

Surveys were undertaken by appropriately experienced bat surveyors, Adam Greenhalgh B.App.Sc., Garon Staines B.App.Sc., and Nick Everitt B.Env.Sc., and bat call identification was undertaken by Amanda Lo Cascio B.Sc.,M.Env (2018; 2019). These surveyors each have over 10 years of experience surveying and identifying bats in NSW.

All bat species in Table 1 were targeted during the surveys, however species in Table 11 were specifically targeted in accordance with the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018). The survey requirements and survey details are provided in Table 11.

The bat surveys were undertaken in January 2018, November 2018 and December 2018 (Table 11) in suitable weather conditions (Section 2.3.1).

The bat surveys for the Grey-headed Flying-fox, Corben's Long eared Bat and Large-eared Pied Bat were also undertaken in consideration of the *Survey Guidelines for Australia's Threatened Bats* (DEWHA, 2010b).

The following sections provide the dates of each survey, details of the methods (harp trapping, ultrasonic bat detection and microbat habitat searches) and total survey effort for bats.

Harp Trapping

Harp trapping for insectivorous bats was carried out at Sites 1, 2, 3, 5, 6 and a mine dam (known as Savoy Dam) as follows:

- Site 1a – one harp trap placed for two nights (22-23 January 2018).
- Site 1d – Dam 30 - one harp trap placed for one night (26 January 2018).
- Site 1b – Quarry Pond - two harp traps placed for four nights (3-7 December 2018).
- Site 1c – Power Easement - four harp traps placed for three nights (17, 18 and 20 December 2018).
- Site 2a – one harp trap placed for two nights (23-24 January 2018).
- Site 2b – Dam 29 - two harp traps place for three nights (12-15 November 2018).
- Site 3a – one harp trap placed for two nights (24-25 January 2018).
- Site 3b – Dam 28 - two harp traps placed for three nights (12-15 November 2018).
- Site 5b – Dam 22 - two harp traps placed for four nights (15, 19, 21and 22 November 2018).
- Site 5c – Dam 23 - two harp traps placed for four nights (15, 19, 21 and 22 November 2018).
- Site 6b – one harp trap placed for two nights (25-26 January 2018).
- Savoy Dam – two harp traps placed for four nights (3-7 December 2018).

Harp traps were set at the above sites within potential flyways wherever possible and/or adjacent to waterbodies.

Harp traps were inspected for captures usually once at night and then again before dawn and then disarmed for the day. Any captures were identified to species level and then released prior to sunrise the same day or were held during the day in cotton bags back at the accommodation and then released at dusk.

Figure 5 shows the bat survey sites.

Table 11: '*Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment* Method (OEH, 2018)

Species	Credit Type[1]	Potential Habitat[#]	Survey Method	Survey Period	Required Survey Effort[#]	Required Minimum Number of Days[#]	Actual Survey Details
Grey-headed Flying-fox *Pteropus poliocephalus*	Species Credit for Breeding Habitat	*The initial search for camps should encompass any recorded camps and roosting habitat likely to occur on the subject land. If a camp is located the survey only needs to take place in the camp (that is the area occupied by the target species) to identify breeding females*	Daytime camp survey	Oct – Dec	6 hrs (two hours/day)	3 (one per month)	No camps are known to occur in the study area (DEE, 2019). Numerous daytime searches were conducted throughout the study area. No camps were found and therefore the survey effort is not applicable.
Little Bentwing-bat *Miniopterus australis*	Species Credit for Breeding Habitat	*Caves, tunnels, mines or other structures known or suspected to be used by M.australis including species records in the NSW BioNet Atlas with microhabitat code 'IC –in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.*	Harp trap	Dec – Feb	8	4	There are no *BioNet Atlas* (OEH, 2019b) records of these two species in the study area with *'microhabitat code 'IC –in cave'; observation type code 'E nest-roost'; with numbers of individuals >500'.* No caves, tunnels or disused underground mines occur in the study area. The study area does not appear to provide the deep (often limestone) cave habitat required by these species for maternity roosts. Sub-optimal potential habitat was only detected at Site 1 (old quarry and a nearby rocky hill) and a small rocky escarpment near the corner of Edderton Road and Golden Highway. Harp trapping was carried out at Site 1 in early December 2018 using two harp traps over four nights and repeated two weeks later in December 2018 using four harp traps over three nights (i.e. a total effort of 20 trap-nights over 7 nights). Rocky crevices at Site 1 and along a small escarpment near corner of Edderton Road and Golden Highway were inspected for bat roosts. Acoustic recording devices at Site 1 for 16 detector nights in total in January and December 2018 and at small escarpment Edderton Road/Golden Highway for two detector nights in November 2018.
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*	Species Credit for Breeding Habitat	*Caves, tunnels, mines or other structures known or suspected to be used by M.schreibersii oceanensis including species records in the NSW BioNet Atlas with microhabitat code 'IC –in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature*	Harp trap	Dec – Feb	8	4	
Large-eared Pied Bat *Chalinolobus dwyeri*	Species Credit	*The PCTs associated with the species (as per the Threatened Biodiversity Data Collection) within 100m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings. Traps should be set in woodlands, valley floors, riparian areas and relatively fertile parts of the subject land where possible.*	Harp trap or mist net	Mid Nov – end Jan	16	4	No caves, cliffs, escarpments, tunnels, disused underground mines or derelict buildings occur in the study area. The study area does not appear to provide the deep sandstone overhang with domed roof habitat required by these species for maternity roosts. Sub-optimal potential habitat was only detected at Site 1 (old quarry and a nearby rocky hill) and a small rocky escarpment near the corner of Edderton Road and Golden Highway. Harp trapping was carried out at Site 1 in early December 2018 using two harp traps over four nights and repeated two weeks later in late December 2018 using four harp traps over three nights (i.e. a total effort of 20 trap-nights over 7 nights). Rocky crevices at Site 1 and along a small escarpment near corner of Edderton Road and Golden Highway were inspected for bat roosts. Acoustic recording devices at Site 1 for 16 detector nights in total in January and December 2018 and at the small escarpment near Edderton Road/Golden Highway for two detector nights in November 2018. 65 harp trap nights were carried out across the study area in January, November and December 2018. Acoustic recording (34 trap nights) were conducted in January, November and December 2018 at a number of sites across the study area. Culverts were inspected at Sites 10 and 17.
			Acoustic detection	Mid Nov – end Jan	16	4	

Table 11 (Continued): '*Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018)

Species	Credit Type[1]	Potential Habitat[#]	Survey Method	Survey Period	Required Survey Effort[#]	Required Minimum Number of Days[#]	Actual Survey Details
Southern Myotis *Myotis macropus*	Species Credit	*The range of PCTs associated with the species (as per the Threatened Biodiversity Data Collection) within 200 meters of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3m or wider)*	Harp trap or mist net	Oct – Mar	16	4	No medium to large permanent creeks, rivers or lakes occur in the study area. The study area does contain a number of farm and mine water dams. Some of these dams are within 200 m of relevant PCTs associated with this species in the study area. Harp trapping was carried out next to dam/ponds at Sites 1, 2, 3, 5 and a mine dam (known as Savoy Dam) in November and December 2018. 65 harp trap nights were carried out across the study area in January, November and December 2018. Acoustic recording (34 trap nights) were conducted in January, November and December 2018 at a number of sites across the study area. Culverts were inspected at Sites 10 and 17.
			Roost search	Oct – Mar	1 per structure	30 min per feature	
			Acoustic detection	Oct – Mar	16	4	
Eastern Cave Bat *Vespadelus troughtoni*	Species Credit	*The PCTs associated with the species (as per the Threatened Biodiversity Data Collection) within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat. Traps should be set in woodlands, valley floors, riparian areas and relatively fertile parts of the subject land where possible.*	Harp trap or mist net	Nov – end Jan	16	4	No caves, cliffs, escarpments, tunnels, disused underground mines or derelict buildings occur in the study area. Sub-optimal potential habitat was only detected at Site 1 (old quarry and a nearby rocky hill) and a small rocky escarpment near corner of Edderton Road and Golden Highway. Harp trapping was carried out at Site 1 in early December 2018 using two harp traps over four nights and repeated two weeks later in December 2018 using four harp traps over three nights (i.e. a total effort of 20 trap-nights over 7 nights). Rocky crevices at Site 1 and along a small escarpment near corner of Edderton Road and Golden Highway were inspected for bat roosts. Acoustic recording devices at Site 1 for 16 detector nights in total in January and December 2018 and at small escarpment Edderton Road/Golden Highway for two detector nights in November 2018. 65 harp trap nights were carried out across the study area in January, November and December 2018. Acoustic recording (34 trap nights) were conducted in January, November and December 2018 at a number of sites across the study area.
			Roost search	Nov – end Jan	1 per structure	30 min per feature	
			Acoustic detection	Nov – end Jan	16	4	

1 Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH, 2019a) (current as at March 2019).

'*Species Credit'Tthreatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

Ultrasonic Bat Detection - Anabat

Electronic detectors were used to collect ultrasonic calls of microbat species. Detectors used included: Anabat SD1 and Express detectors (Titley Scientific, Brisbane QLD), and an SMBAT2+ Songmeter and Echo Meter Touch 2 PRO (Wildlife Acoustics, Maynard, MA, USA).

Detectors were used both statically (i.e. set and left in one location overnight) and actively (carried around) when undertaking nocturnal searches.

Static recording detectors were placed in an area of habitat, left for a minimum of two nights, placed at ground level or off the ground aiming along potential microbat flyways that microbats could use to forage and navigate their way through woodland areas. For active recording, Anabats were carried when spotlighting surveys were undertaken recording as the surveyor passes through habitat.

Electronic bat call recording units were deployed during the January 2018 survey period as follows:

- Site 1a – one unit placed for two nights (22-23 January 2018).
- Site 2a – one unit placed for two nights (23-24 January 2018).
- Site 3a – one unit placed for two nights (24-25 January 2018).
- Site 4a – one unit placed for two nights (25-26 January 2018).
- Site 5a – one unit placed for two nights (23-24 January 2018).
- Site 6a – one unit placed for two nights (23-24 January 2018).
- Site 7a – one unit placed for two nights (23-24 January 2018).
- Site 10a:
    - One unit placed for two nights at culvert (25-26 January 2018).
    - One unit placed at dam for 0.25 hours (6 June 2018).
- Site 11a – one unit placed for one night (26 January 2018).
- Two units were placed at an observed bat roost tree between Sites 5 and 10 (Site IncA) at dusk on 27 January 2018 for approximately 0.5 hour as several bats emerged from the tree.
- A mobile unit was carried across several sites over several nights during nocturnal work including Site 1 (22 January 2018 for 0.25 hour), Site 2 (23 January 2018 for 1 hour) and Site 5 (24 January 2018 for 0.25 hour).
- Site 1b Quarry Pond – one detector placed for four nights, one detector placed for three nights (3-7 December 2018).
- Site 1c Power Easement – one detector placed for four nights, one detector placed for three nights (17-21 December 2018).
- Rocky escarpment near corner of Golden Highway and Edderton Road (Site IncB) – one detector placed for two nights (5-7 December 2018).

During the June 2018 survey period a bat detector unit was deployed for approximately 0.25 hour to assist the identification of two bats observed foraging over a farm dam at Site 10.

Figure 5 shows the bat survey sites.

Microbat Habitat Searches

Culverts were visually inspected during the day for roosting bats as follows:

- Sites 1a and 1b various dates in November and December 2018.
- Site 10a – Site 10 culvert – 26 January 2018.
- Site 17a – Site 17 culvert – 12 November and 20 December 2018.
- Site 17b – Rail Loop Dam culvert – 20 December 2018.
- Site IncB – various dates November and December 2018.

Figure 5 shows the bat survey sites.

Nocturnal Call Playback

The playback of pre-recorded calls of threatened nocturnal species was carried out at dusk or after dark using digital MP3 players coupled to loudhailers or portable speakers.

After an initial listening period of ten minutes, each call was played for a total of five minutes, followed by a five-minute listening period, with the last listening period followed by at least ten minutes of spotlighting.

Species targeted (in order of call-playback) were the Koala, Squirrel Glider, Yellow-bellied Glider (*Petaurus australis*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Barking Owl, Sooty Owl (*Tyto tenebricosa*) and Bush Stone-curlew (*Burhinus grallarius*). During the November/December 2018 surveys, calls of Green and Golden Bell Frog (*Litoria aurea*) were also broadcast at sites with potential habitat (dams, ponds, drainage lines with sedges and reeds). Any fauna responding were identified either by characteristic call or direct observation using spotlights.

Figure 4 shows the mammal survey sites which includes call-playback.

Call playback was carried out as follows:

- Site 1:
  - Site 1a – Power Easement – 22 January 2018.
  - Site 1a – Power Easement – 27 January 2018.
  - Site 1a – Power Easement – 17 September 2018.
  - Site 1b – Quarry Pond – 3 December 2018.
  - Site 1b – Quarry Pond – 5 December 2018.
  - Site 1b – Quarry Pond – 6 December 2018.
  - Site 1a – Power Easement – 17 December 2018.
  - Site 1a – Power Easement – 18 December 2018.
  - Site 1a – Power Easement – 21 December 2018.
- Site 2:
  - Site 2a – 23 January 2018.
  - Site 2a – 26 January 2018.
  - Site 2b/3b – 18 September 2018 in paddock on eastern side (note that the call playback survey at this location also covered both Sites 2 and 3, due to the volume at which the calls were played).
  - Site 2c – 12 November 2018.

- Site 2c – 12 November 2018.
- Site 2c – Dam 29 – 14 November 2018.

- Site 3:
  - Site 3a – 23 January 2018 (note that the call playback survey at this location also covered Sites 2 and 3, located within 500 m, due to the volume at which the calls were played).
  - Site 3a – 26 January 2018 (note that the call playback survey at this location also covered Site 2, located downslope within 500 m, due to the volume at the which the calls were played).
  - Site 2b/3b – 18 September 2018 in paddock on eastern side (note that this location covered both Sites 2 and 3).
  - Site 3c – 12 November 2018.
  - Site 3c – 14 November 2018.
- Site 4:
  - Site 4a – 26 January 2018.
  - Site 4a – 4 December 2018.
  - Site 4a – 6 December 2018.
- Site 5:
  - Site 5a – 24 January 2018.
  - Site 5a – 5 June 2018.
  - Site 5b – 19 September 2018.
  - Site 5a – 12 November 2018.
  - Site 5a – 13 November 2018
  - Site 5b – 15 November 2018.
  - Site 5b – 20 November 2018.
- Site 6:
  - Site 6a – 13 November 2018.
  - Site 6c – 15 November 2018 (note that the call playback survey at this location also covered Site 18, located within 500 m downslope, due to the volume at which the calls were played).
  - Site 6b – 5 December 2018 (note that the call playback survey at this location also covered Site 7 located within 800 m upslope, and Site 18, approximately 800 m downslope, due to the volume at which the calls were played).
- Site 7:
  - Site 7a – 25 January 2018 (note that the call playback survey at this location also covered Site 6, located downslope within 500 m, due to the volume at which the calls were played).
  - Site 7a – 14 November 2018 (note that the call playback survey at this location also covered Sites 6, 8, 13, 14 and 18, located downslope within 0.5-2 km, as the survey was on a very still night and domestic dogs from ‘Edderton’ property 2 km away to north-west were heard responding to calls).
  - Site 7b – 21 November 2018.
  - Site 7b – 22 November 2018.

- Site 8:
  - Site 8a – 4 December 2018 (note that the call playback survey at this location also covered Site 13, located approximately 600 m downstream, due to the volume at which the calls were played).
- Site 10:
  - Site 10a – 6 June 2018.
  - Site 10b – 19 December 2018.
- Site 11:
  - January, June, November, December 2018 sessions covered by nearby Site 5a call-playback sessions (see above).
- Site 13:
  - Covered by call-playback surveys conducted at Sites 7a, 8a and 14b within 600m of this site.
- Site 14:
  - Site 14a – 4 June 2018.
  - Site 14b – 5 December 2018 (note that the call playback survey at this location also covered Site 13, located approximately 500 m downslope, due to the volume at which the calls were played).
  - Site 14b – 19 December 2018 (note that the call playback survey at this location also covered Site 13, located approximately 500 m downslope, due to the volume at which the calls were played).
- Site 15a – 28 August 2018.
- Site 16a – 29 August 2018.
- Site 17:
  - Site 17a – 4 December 2018.
  - Site 17a – 6 December 2018.
- Site 18:
  - Site 18a – 4 December 2018.
  - Site 18a – 6 December 2018.
- a mine dam (known as Savoy Dam):
  - Savoy – 3 December 2018.
  - Savoy – 6 December 2018.

Spotlighting

Spotlighting was conducted on foot by using powerful LED hand-held torches and/or headlamps. It was undertaken in conjunction with call-playback and nocturnal searches for fauna at several sites over several nights and survey periods as follows:

- Site 1:
  - Site 1a – Power Easement – 22 January 2018 (five observers for 1.25 hours each).
  - Site 1a – Power Easement – 27 January 2018 (five observers for 1.25 hours each).
  - Site 1a – Power Easement – 17 September 2018 (two observers for 1.25 hours each).

- Site 1c – Quarry Pond – 3 December 2018 (two observers for 1.5 hours each).
- Site 1c – Quarry Pond – 5 December 2018 (two observers for 0.25 hours each).
- Site 1c – Quarry Pond – 6 December 2018 (two observers for 0.25 hours each).
- Site 1a – Power Easement – 17 December 2018 (two observers for 1 hour each).
- Site 1a – Power Easement – 18 December 2018 (two observers for 1 hour each).
- Site 1a – Power Easement – 20 December 2018 (two observers for 0.25 hours each).
- Site 1a – Power Easement – 21 December 2018 (two observers for 0.5 hour each).

- Site 2:
  - Site 2a – 23 January 2018 (two observers for 1 hour each).
  - Site 2a – 26 January 2018 (three observers for 1 hour each).
  - Site 2a – 27 January 2018 (four observers for 1 hour each).
  - Site 2b/3b – 18 September 2018 (two observers for 0.625 hours each).
  - Site 2c – 12 November 2018 (two observers for 1 hour each).
  - Site 2c – 13 November 2018 (two observers for 1.25 hours each).
  - Site 2c – 14 November 2018 (three observers for 0.75 hours each).
- Site 3:
  - Site 3a – 23 January 2018 (three observers for 1 hour each).
  - Site 3a – 26 January 2018 (two observers for 1 hour each).
  - Site 3a – 27 January 2018 (one observer for 0.5 hour).
  - Site 2b/3b – 18 September 2018 (two observers for 0.625 hours each).
  - Site 3c – 12 November 2018 (two observers for 1.75 hours each).
  - Site 3c – 14 November 2018 (three observers for 1.25 hours each).
- Site 4:
  - Site 4a – 26 January 2018 (five observers for 0.75 hours each).
  - Site 4a – 4 December 2018 (two observers for 0.75 hours each).
  - Site 4a – 6 December 2018 (two observers for 1 hours each).
  - Site 4a – 6 December 2018 (two observers for 0.25 hours each).
- Site 5:
  - Site 5a – 24 January 2018 (three observers for 1.25 hours each).
  - Site 5a – 5 June 2018 (two observers for 2 hours each).
  - Site 5b – 19 September 2018 (two observers for 1.25 hours each).
  - Site 5a – 12 November 2018 (two observers for 1.5 hours each).
  - Site 5a – 13 November 2018 (two observers for 0.5 hours each).
  - Site 5b – 15 November 2018 (three observers for 1.25 hours each).
  - Site 5b – 20 November 2018 (two observers for 1.25 hours each).
  - Site 5b – 20 December 2018 (two observers for 0.25 hours each).

- Site 6:
  - Site 6a –25 January 2018 (three observers for 1.5 hours each).
  - Site 6a – 13 November 2018 (two observers for 1 hour each).
  - Site 6b – 14 November 2018 (one observer for 1.25 hours).
  - Site 6c – 15 November 2018 (three observers for 1.25 hours each).
  - Site 6b – 5 December 2018 (three observers for 1.25 hours each).
- Site 7:
  - Site 7a – 25 January 2018 (two observers for 2 hours each, three observers for 1 hour).
  - Site 7a – 14 November 2018 (two observers for 1.25 hours each).
  - Site 7b – 21 November 2018 (three observers for 1.25 hours each).
  - Site 7b – 22 November 2018 (three observers for 1.25 hours each).
- Site 8a – 4 December 2018 (two observers for 0.25 hours each).
- Site 10:
  - Site 10a – 6 June 2018 (two observers for 1.25 hours each).
  - Site 10b – 19 December 2018 (two observers for 1.25 hours each).
- Site 11:
  - Site 11a – 24 January 2018 (two observers for 1.25 hours each).
  - Site 11a – 13 November 2018 (two observers for 1.25 hours each).
  - Site 11a – 20 December 2018 (two observers for 0.25 hours each).
- Site 14:
  - Site 14a – 4 June 2018 (two observers for 1.5 hours each).
  - Site 14b – 5 December 2018 (three observers for 0.5 hours each).
  - Site 14b – 19 December 2018 (two observers for 2 hours each).
- Site 15a – 28 August 2018 (two observers for 1.5 hours each).
- Site 16a – 29 August 2018 (two observers for 1.75 hours each).
- Site 17:
  - Site 17a – 4 December 2018 (two observers for 1.5 hours each).
  - Site 17a – 6 December 2018 (one observer for 0.75 hours).
- Site 18:
  - Site 18a – 15 November 2018 (two observers for 1.5 hours each).
  - Site 18a – 4 December 2018 (two observers for 0.75 hours each).
  - Site 18a – 6 December 2018 (two observers for 0.75 hours each).
- a mine dam (known as Savoy Dam):
  - Savoy – 3 December 2018 (two observers for 1 hour each).
  - Savoy – 6 December 2018 (two observers for 0.5 hours each).

Figure 4 shows the mammal survey sites which includes spotlighting.

Koala Scat Searches

One preferred food species listed in NSW *State Environmental Planning Policy No. 44 – Koala Habitat Protection* (SEPP 44) Schedule 2 Koala feed trees was observed in the study area during fauna surveys, namely White Box (*Eucalyptus albens*).

Additional Koala food species to that scheduled in SEPP 44 are listed in the *NSW State Recovery Plan for the Koala* (DECC, 2008b). The study area is located within the Central Coast Koala Management Area where the following listed secondary food tree species were observed: Fuzzy box (*Eucalyptus conica*), Yellow Box (*E. melliodora*) and Grey Box (*E. moluccana*) (Hunter Eco, 2019).

General Koala scat searches were undertaken at several sites as part of diurnal and nocturnal fauna searches and are included in those times. Any potential Koala scats detected were firstly examined to see if they were composed of finely chewed Eucalyptus leaves and to help differentiate from Brush-tailed Possum (*Trichosurus vulpecula*) scats (which can be superficially similar). Where such scats were detected then they were sent to expert Barbara Triggs for further identification and targeted surveys using the *Spot Assessment Technique for determining localised levels of habitat use by Koalas* (Phillips and Callaghan, 2011), were carried out.

Searches for Reptiles and Amphibians – Active Searches, Pitfall Traps and Artificial Shelter Habitat

Active searches were conducted at selected/preferred sites located at representative habitat components across the study area. This included potential shelter, refuge, foraging, over-wintering and breeding habitat for the range of species detected and searched for. Inspected habitat features included ground logs/timber, surface rock, cow pats, rock shelters, rock outcrops/crevices, decorticating bark, mature/old growth trees and stags with accessible crevices/fissures/hollows, culverts, dams, riparian zones (ponded sections of creeks and creek banks), soaks and man-made refuge habitats, where present, at each survey site and across the study area.

Further opportunistic searches including searches of other suitable microhabitat features encountered whilst traversing between survey plots – this approach targeted species known to have specific habitat/micro-habitat preferences not apparent within the survey plots chosen. Similarly, during road/track traverses (diurnal and nocturnal) scans were made for species that were active or more active at certain times of the day.

Surveys for amphibians were undertaken in accordance with the OEH *Hygiene Protocol for the Control of Disease in Frogs* (DECC, 2008a).

Initial habitat surveys were carried out for the threatened Green and Golden Bell Frog at 54 dams/ponds/drainage lines within the study area (Figure 6), searching for habitat features known to be favoured by this species (still water with some growth of Cumbungi (*Typha* sp) and/or other sedges such as *Phragmites australis*, *Juncus acutus*).

Targeted surveys were then carried out at 11 locations which contained at least some habitat features for this species. Surveys consisted of diurnal and/or nocturnal active searches for frogs and tadpoles, call-playback and listening (Figure 6) as follows:

- Location 31 – Quarry Pond: 16 November 2018 and 3-6 December 2018.
- Location 29 – Dam: 12-14 November 2018.
- Location 28 – Dam: 12-14 November 2018.
- Location 43 – Drainage Line: 5-6 and 19 December 2018.
- Location 32 – Pond Complex: 20 December 2018.
- Location 34 – Dam: 13 November 2018 and 20 December 2018.

- Location 48 – Concrete Pond #1: 12 November 2018, 3 and 20 December 2018.
- Location 50 – Concrete Pond #2: 20 December 2018.
- Location 44 – Drainage Line with Ponds: 12 November 2018, 3 and 20 December 2018.
- Location 33 – Railway Loop Dams: 20 December 2018.
- Location 51 – Workshop Dam 1: 20 December 2018.
- Location 52 – Workshop Dam 2: 20 December 2018.

All ecologists recorded herpetofauna as they were encountered during the survey periods however the following information is in relation to the dedicated herpetofauna specialists (Henry Cook, Ross Wellington and Alex Dudley) on the ecological team.

Diurnal surveys were generally conducted between dawn and midday or until conditions became too hot. Evening surveys were generally run between dusk and 22:00-23:00 hours. The time spent on a site was determined by the habitat quality and the species to be targeted, so that survey effort was increased for higher quality sites compared with lower quality sites.

Specific targeted surveys were conducted for Striped Legless Lizard (*Delma impar*), Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Pale-headed Snake (*Hoplocephalus bitorquatus*).

In January 2018 the total survey effort over the 6 days from the 22-27 January 2018 was 48.25 hours. Diurnal survey effort was 12.75 hours and nocturnal survey effort was 35.5 hours. The survey effort for each site in January 2018 is summarised below with a break down showing time spent between diurnal and nocturnal surveys.

Table 12: Herpetofauna Survey Effort for January 2018 Survey Period

Site	1	2	3	4	5	6	7	10	11	Totals
Diurnal (hrs)	3.75	1.50	2.25	1.50	1.00	0.50	0.50	1.00	0.75	**12.75**
Nocturnal (hrs)	20.00	7.50	1.00	1.00	Nil	2.00	2.00	Nil	2.00	**35.5**
Totals (hrs)	**23.75**	**9.00**	**3.25**	**2.5**	**1.00**	**2.5**	**2.5**	**1.00**	**2.75**	**48.25**

No habitat searches for reptiles and amphibians were carried out during the cooler June, August and September 2018 survey periods but if any species were incidentally encountered, they were recorded.

In November 2018 diurnal survey effort was a least 136.25 hours and nocturnal survey effort was at least 19 hours. The survey effort for each site in November 2018 is summarised below with a break down showing time spent between diurnal and nocturnal surveys.

Table 13: Herpetofauna Survey Effort for November 2018 Survey Period

Site	1	2	3	4	5	6	7	9	10	17	18	Incidental	Totals
Diurnal (hrs)	4.5	23	8	6	36	8	7.5	1	1.75	12	4.5	24	**136.25**
Nocturnal (hrs)	-	5.75	1.25	-	5.25	1.25	2.5	-	-	-	3	**-**	**19.00**
Totals (hrs)	**4.5**	**28.75**	**9.25**	**6**	**41.25**	**9.25**	**10**	**1**	**1.75**	**12**	**7.5**	**24**	**155.25**

In December 2018 diurnal survey effort was at least 84.25 hours and nocturnal survey effort was at least 16 hours. The survey effort for each site in December 2018 is summarised below with a break down showing time spent between diurnal and nocturnal surveys.

Table 14: Herpetofauna Survey Effort for December 2018 Survey Period

Site	1	3	4	6	7	10	11	13	14	16	17	18
Diurnal (hrs)	11.0	12.75	14.25	0.75	1.75	-	10.0	1.5	1.5	1	8.0	3.25
Nocturnal (hrs)	5	-	-	1.25	-	1.25	0.25	-	3.5	-	3.75	-
Totals (hrs)	**16**	**12.75**	**14.25**	**2.0**	**1.75**	**1.25**	**10.25**	**1.5**	**5.0**	**1**	**11.75**	**3.25**

Site	Savoy Dam	Incidental	Totals
Diurnal (hrs)	6.0	12.5	**84.25**
Nocturnal (hrs)	1.0	-	**16.00**
Totals (hrs)	**7.0**	**12.5**	**100.25**

During the November/December 2018 survey periods two additional reptile survey techniques were employed being Pitfall Traps and Artificial Shelter Habitat (see Figure 4 for locations).

Pitfall trap grids

Pitfall trap grids consisting of six 150 mm diameter, 600 mm deep end capped PVC pipes with 300 mm high drift fencing were deployed at Sites 2d, 3a and 5b for four days/nights from 19-23 November 2018 (Figure 4). Pits were deployed and placed 5 m apart in a straight line with a continuous run of drift fence placed along the pitfalls and extending for a few metres beyond the end pitfalls as per DEC (2004a). A piece of polystyrene foam together with leaf litter was placed in the bottom of each pit. In the event of inclement weather or when not in use, the top end of the pits was capped. In addition, at least two reptile net funnel traps were placed on each pitfall drift fence line. Pitfalls and funnels were typically checked at dawn, in the afternoon and after sunset and any animals identified and released.

Artificial shelter habitat

Artificial shelter habitat consisting of grids of second-hand terracotta roofing tiles (approximately 40 cm x 30 cm) were deployed at Sites 4a, 6, 7a and 17 to specifically target Striped Legless Lizard as per SEWPaC (2011c) (Figure 4). Arrays at Sites 6b, 7a and 17 consisted of 50 tiles, at 5 metre spacing between tiles, arranged in a grid of 10 tiles by five. 70 tiles were deployed at Site 4a. At each relevant site, tiles were placed in DNG adjacent to grassy woodland / open forest where grass cover was not too sparse. Wherever possible a northerly aspect was chosen. Artificial shelter habitat was deployed from 13 November to 23 December 2018 (39 days/nights) and checked one to two times a week during survey periods when ambient temperatures were not too high.

Targeted habitat surveys

Based on advice from the OEH, targeted habitat surveys for the Pink-tailed Legless Lizard were carried out by two researchers over two days from 30 April 2019 to 1 May 2019 to map rocky areas that provide potential habitat. As such, surveys specifically targeted areas of lightly imbedded surface rock within PCT 1606 and 1606 DNG (where the Pink-tailed Legless Lizard was recorded during the 2018 surveys) within the proposed underground mining area and associated surface disturbance areas (including within the vicinity of the proposed Edderton Road realignment). In order to create the species polygon, a 50 m zone was applied around the rocky areas, as request by OEH.

Areas of lightly imbedded surface rock were mapped within the target vegetation community type either on foot or via 4WD using a GPSKit device with an accuracy of +/- 5-10 m.

Opportunistic Observations

All fauna observed or heard opportunistically during the field surveys (including travelling between sites in the broader area) were recorded. Characteristic signs, tracks, trails and other indirect evidence of fauna species from all fauna groups were also recorded. Any observed predator scats and/or owl pellets containing bone and fur material were collected and sent for analysis to expert Barbara Triggs (Genoa, Victoria).

2.3.3 Survey Effort

Table 15 provides a summary of the survey techniques and effort employed at each of the survey sites.

2.3.4 Limitations

Despite below average rainfall conditions (Section 2.3.1), a number of fauna surveys have been carried in the study area since the early 2000s and therefore it is likely that the fauna and habitats present (or potentially present) are well understood.

2.3.5 Nomenclature

Primary sources of literature accessed for nomenclature includes:

- *CSIRO list of Australian Vertebrates* (Clayton et al, 2006);
- Birds - *Systematics and Taxonomy of Australian Birds* (Christidis and Boles, 2008);
- Mammals - *The Mammals of Australia, Third Edition*, (Van Dyck and Strahan, 2008);
- Bats - *Australian Bats, Second Edition*, (Churchill, 2009) and *A current taxonomic list of Australian Chiropteran* (Reardon, Armstrong, and Jackson, 2015); and
- Amphibians/Reptiles - *Reptiles and Amphibians of Australia, Seventh Edition*, (Cogger, 2018).

Table 15: Summary of Survey Techniques and Effort Used at Each Site within the Study Area

Site (Figure 4)	Habitat Survey (hrs)	Diurnal Bird Survey (hrs)	Nocturnal Bird Surveys (hrs)	Ground "A" Elliott Trapping (small) (trap nights)	Arboreal "B" Elliott Trapping (trap nights)	Cage Trapping (trap nights)	Hair Tubes (trap nights)	Camera Trapping (trap nights)	Nest boxes (trap nights)	Harp Trapping (trap nights)	Ultrasonic Bat Detection – Anabat (detector nights)	Habitat searches for cave roosting bats (hrs)	Nocturnal Call Playback (sessions)	Spotlighting (hrs)	Diurnal Searches for Reptiles and Amphibians (hrs)	Nocturnal Searches for Reptiles and Amphibians (hrs)(nights)	Pitfall Trapping (trap nights)	Artificial Shelters (trap nights)
1, 1a and 1b	2	25.45	10.5 (14.5*)	100	40	4	365	140	660	23	16.25	6	9	24.5	19.25	25 (>2 nights)	-	-
2, 2a, 2b/3b, 2c and 2d	2	29.2	9.8 (7.45*)	100	40	4	608	138	530	16	3	-	6	17	24.5	13.25 (4.00*) (>2 nights)	24	-
3, 3a, 2b/3b and 3c	2	26	1.8 (11.2*)	100	40	8	600	138	665		2	-	5	14	23	2.25 (10.75*) (>2 nights)	24	-
4 and 4a	2	22.25	3 (4.75*)	-	-	-	-	-	-	-	2	-	3	7.75	21.75	1 (6.75*) (>2 nights)	-	2730
5, 5a and 5b	2	43.5	12.5		40	-	8	4	-	16	2	-	7	21	37	5.25 (16.75*) (>2 nights)	24	-
6, 6a, 6b and 6c	2	17	4.25 (11*)	-	40	-	8	25	-	2	2	-	5	15.25	9.25	4.5 (10.75*) (>2 nights)	-	1950
7, 7a, 7b and 7c	2	14.5	17*	100	40	-	-	20	-	-	2	-	5	17	9.75	4.5 (12.5*) (>2 nights)	-	1950
8 and 8a	2	0.5	-	-	-	-	-	-	-	-	-	-	2	0.5	-	1.5* (1 night)	-	
9	2	1.00	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
10, 10a and 10b	2	3.75	5*	-	-	-	-	-	-	-	2.5	1	2	5	2.75	1.25 (3.75*) (2 nights)	-	
11 and 11a	2	16.25	1.5 (4*)	-	-	-	-	-	-	-	1	-	4	5.5	10.75	2.25 (3.25*) (>2 nights)	-	
12	2	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
13	2	1.75	-	-	-	-	-	-	-	-	-	-	4	-	1.5	-	-	
14a and 14b	2	4.00	4.5 (4*)	-	-	-	-	-	-	-	-	-	4	8.5	1.5	3.5 (5.00*) (>2 nights)	-	-
15 and 15a	2	7.50	1.5 (1.5*)	-	-	-	-	-	-	-	-	-	1	3	-	3* (1 night)	-	-
16, 16a, 16b and 16c	2	6.50	1.7 (1.55*)	-	-	-	760	-	-	-	-	-	1	3.5	1	3.25* (1 night)	-	-
17	2	20	3.75	-	-	-	-	30	-	-	-	3	2	3.75	20	3.75 (2 nights)	-	1950
18 and 18a	2	7.75	3 (3*)	-	40	-	360	-	-	-	-	-	5	6	7.75	3 (3*) (> 2 nights)	-	-
A mine dam (known as Savoy Dam)	2	6	1 (2*)	-	-	-	-	-	-	8	-	-	2	3	6	1 (2*) (2 nights)	-	-
Rocky Escarpment near corner Edderton Road and Golden Highway (IncB)	-	-	-	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
Incidental (including IncA)	-	36.5	-	-	-	-	-	266	-	-	1	-	-	-	36.5	-	-	-
Totals	38	290.90	145.75	400	280	16	2,709	623	1,855	65	35.75	16	67	155.25	233.25	156.75	72	8,580

* Additional hours undertaken during activities other than the dedicated nocturnal bird surveys by Tony Saunders or dedicated herpetofauna nocturnal surveys by Henry Cook, Ross Wellington and Alex Dudley.

2.3.6 Targeted Searches for Threatened Fauna

Threatened fauna species listed under the BC Act and/or EPBC Act which are known or likely to occur in the study area were specifically targeted during the surveys (Table 16). Threatened fauna species were targeted in accordance with the survey timing, techniques and effort described within the relevant survey guidelines listed in Section 2.2.

Table 1 provides a list of threatened fauna species-specifically targeted during the surveys (although the surveys were designed to obtain an inventory of all native and introduced fauna species present not only the threatened species listed).

The following species listed in Table 1 did not have any potential habitat in the study area and are therefore not included in Table 16: Booroolong Frog (*Litoria booroolongensis*) and Green-thighed Frog (*Litoria brevipalmata*).

2.3.7 Species Credit Species Habitat Polygon Mapping

Species credit species habitat polygon maps have been produced in accordance with the BAM (OEH, 2017) and the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

Where a survey confirms the species is present or likely to use the habitat in the study area, a 'species polygon' is produced that shows the area of suitable fauna species habitat for a species credit species. Species polygons were prepared for the Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis based on the results of the survey.

The 'species polygons' were mapped using a best available ortho-rectified aerial image and contain the suitable habitat features or habitat components associated with that species on the subject land. A GPS was used to confirm the location of the species polygon.

Hunter Eco (2019) undertook a paddock tree assessment for Squirrel Glider connectivity from woodland patches, conducted using maximum separation between canopies of 50 m potential gliding distance. To achieve this paddock trees were digitally extracted from enhanced high-resolution aerial imagery into a vector drawing. A Distance Network with maximum distance 50 m was applied to the extracted canopies and those trees were grouped that were within 50 m or less from each other, and similarly connected to woodland patches. Hunter Eco (2019) notes that a limitation of this approach was that all paddock trees were extracted irrespective of height. This then would include regrowth trees that were likely to be too short for a glider to attain maximum gliding distance from.

Table 16: Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Amphibians							
Green and Golden Bell Frog	*Litoria aurea*	V	E	S	NSW (DECC, 2009): Combination of tadpole surveys, call surveys (this species has a distinctive call) and active searching both during the day and night. Small areas of habitat (less than 0.3 ha) should be surveyed for a minimum of one hour on three separate occasions during the species' activity period. Larger areas, which may include whole wetlands and lagoon margins, are more difficult to survey and require a minimum of three separate four-hourly searches during the species' activity period. Commonwealth guidelines (DEWHA, 2010a) similar to NSW but require 4 separate visits from September to March.	January to March, November and December	**The survey guideline requirements and timing were met.** Approximately 42 dams/ponds have been identified in the study area as occurring within or adjacent to PCTs 1598, 1604, 1606, 1691, 1692 and 1731 (Hunter Eco, 2019) (Figure 6). All were inspected in November/December 2018 and most were found to not provide suitable habitat for this species due to lack of fringing and aquatic vegetation. Four dams/ponds/drainage lines which did provide some potential habitat were intensively surveyed at least three times for at least one person hour on each occasion in accordance with DECC (2009) guidelines. This includes locations 28, 29, 31 and 43. Survey techniques included diurnal and nocturnal active searches and call-playback. Less intensive surveys involving 1-2 diurnal call-playback sessions were also carried out at locations 32, 33, 34, 44, 45, 48, and 49.
Reptiles							
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	Diurnal habitat searches (which includes overturning of rocks) in spring and early summer (SEWPaC, 2011b).	September to November	**The survey guideline requirements and timing were met.** Diurnal habitat searches (which included the overturning of rocks) were undertaken at several sites in November 2018 (Table 13). In addition to the above, pitfall trapping and placement of artificial shelter habitat in November 2018 could have also detected this species. Further, although outside the survey timing by OEH (2019a), diurnal habitat searches (which included the overturning of rocks) was also undertaken in January 2018 and December 2018 (Tables 12 and 14).

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Striped Legless Lizard	*Delma impar*	V	V	S	NSW guidelines (DEC, 2004a): Pitfall trapping over 24 trap nights, preferably using six traps for a minimum of four consecutive nights per stratification unit up to 100 ha. Commonwealth Guidelines and Referral Guidelines (SEWPaC 2011a:b): Either artificial shelter sites or pitfall trapping as primary technique but artificial sites are preferred where there is surface rock. Habitat searches are secondary. Artificial shelter: up to 10 grids of 50 tiles on north facing slopes in habitat areas >30 ha as a minimum at least 50 pitfall configurations should be used for sites greater than 25 ha, using 2-5 pitfalls, 5m fence per configuration. Survey timing: September to May (SEWPaC, 2011b)	September to December	**The survey guideline requirements and timing were met.** This species was survey via multiple methods, namely pitfall trapping, artificial shelter sites and active searching. Pitfall trapping was undertaken over 24 trap nights, using six traps for four consecutive nights, at Sites 2d, 3a and 5b in November 2018 (Figure 4). In addition, four grids of 50 artificial shelter sites (total of 200) were installed at Sites 6a, 7a and 17, with 70 tiles deployed at Site 4a, in November 2018 and checked several times through December 2018 (Figure 4). As a secondary measure, diurnal and nocturnal active searches were carried out in November/December 2018 at several sites with suitable habitat including the above sites. Further, diurnal habitat searches were also undertaken in January 2018, within the survey timing recommended by SEWPaC (2011b).
Pale-headed Snake	*Hoplocephalus bitorquatus*	-	V	S	No species-specific requirement defined. General survey guidelines (DEC, 2004a) for nocturnally active snakes such as this species require thirty-minute searches on two separate nights per stratification unit.	January, February, March, November and December	**The survey guideline requirements and timing were met.** Diurnal and nocturnal habitat searches for reptiles (which targeted woodland habitat in close proximity to watercourses) were undertaken within general fauna survey sites 1, 2, 3, 4, 5, 6, 7, 10 and 11 and for at least 30 minutes on at least one day/night (some sites surveyed for two day/nights) in January 2018 (Table 12 and Figure 4). Additional nocturnal reptile searches for the Pale-headed Snake were undertaken at several sites with suitable habitat (hollow trees) within PCTs 1604, 1655, 1606, 1691 and 1692 and particularly focused on Sites 3 and 5 were conducted on at least two separate nights in November/December 2018. Total survey effort for most sites during warm seasons exceeded two nights of survey and 30 mins per session. Rain fell in January, November and December 2018 (Table 2).

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Birds							
Freckled Duck	*Stictonetta naevosa*	-	V	E	No species-specific requirement defined. Diurnal bird surveys as per DEC (2004a) would be appropriate for these species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Diurnal bird surveys were undertaken in areas of suitable habitat i.e. dams.
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	NSW (DEC, 2004a): No species-specific requirement defined. Diurnal and nocturnal surveys would be appropriate for this species. Federal (DEWHA, 2010c): Observation of targeted foraging habitat within wetlands in the early morning or early evening. Detection by sightings and unsolicited calls. Area searches in suitable habitat for sightings, nests, indicative footprints and feathers.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Quality wetland habitat is not present in study area. Diurnal and nocturnal surveys undertaken in dams in study area would have detected this species if it were to occur.
Black Falcon	*Falco subniger*	-	V	E	No species-specific requirement defined (DEC, 2004a), except for Red Goshawk where searches for its distinctive nest and area searches (80 hours over 10 days) is recommended (DEWHA, 2010c). Diurnal bird surveys would be appropriate for these species. Some species have seasonal survey requirements under BAM.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Diurnal bird surveys were undertaken, particularly in woodland habitat in close proximity to watercourses. The diurnal bird surveys exceeded 80 hours over 10 days. Raptor surveys from high points in study area would have detected these species, if present. Particular attention was given to searches for and inspection of raptor nests to determine use and what species were using them were undertaken. In accordance with BAM seasonal surveys for Square-tailed Kite were undertaken in January, September, November and December 2018, White-bellied Sea-eagle in August, September, November and December 2018, and Little Eagle in August and September 2018.
Square-tailed Kite	*Lophoictinia isura*	-	V	S/E		January, September, October, November and December	
White-bellied Sea-eagle	*Haliaeetus leucogaster*	Ma	V	S/E		July, August, September, October, November and December	
Spotted Harrier	*Circus assimilis*	-	V	E		None	
Red Goshawk	*Erythrotriorchis radiatus*	V	CE	S		All year	
Little Eagle	*Hieraaetus morphnoides*	-	V	S/E		August, September and October	

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Bush Stone-curlew	*Burhinus grallarius*	-	E	S	No species-specific requirement defined. Nocturnal bird surveys incorporating call-playback and spotlighting would be appropriate for this species.	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous nocturnal bird surveys incorporating call-playback and spotlighting were carried out at various sites at various times of the year for this species.
Australian Painted Snipe	*Rostratula australis*	E	E	E	Area searches or transects; targeted stationary observations at dawn and dusk of suitable foraging locations within wetlands (DEWHA, 2010c).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Quality wetland habitat not present in study area. Diurnal and nocturnal surveys undertaken in dams in study area would have covered this species. Targeted stationary observations were generally not undertaken as no habitat for this species (e.g. wetlands, lakes, swamps and clay pans) is present within the study area.
Eastern Curlew	*Numenius madagascariensis*	CE	-	S/E	No species-specific requirement defined. Diurnal bird surveys would be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Suitable habitat (intertidal estuarine mudflats and saltmarsh) is not present in study area. Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018.
Curlew Sandpiper	*Calidris ferruginea*	CE	E	S/E	No species-specific requirement defined. Diurnal bird surveys would be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018 but suitable habitat (intertidal estuarine mudflats, saltmarsh) is not present in study area.
Glossy Black-cockatoo	*Calyptorhynchus lathami*	-	V	S/E	No species-specific requirement defined (DEC, 2004a). DEWHA (2010c) has some recommended survey techniques for Glossy Black Cockatoo (which is listed as nationally endangered in South Australia) and these techniques are also relevant to this species wherever it occurs. Diurnal surveys for all species would be appropriate together with searches for chewed Casuarina cones under trees for signs of Glossy Black Cockatoo (DEWHA, 2010c).	March, April, May, June, July and August	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018 including within the required seasonal survey periods for Glossy Black Cockatoo and Gang-gang Cockatoo. Chewed cones (Glossy Black Cockatoo) were searched for under casuarina trees whenever encountered. Wherever hollows suitable for nesting by Glossy Black Cockatoo or Gang-gang Cockatoo were detected they were searched (from the ground) for signs of nesting, feathers etc.
Gang-gang Cockatoo	*Callocephalon fimbriatum*	-	V	S/E		January, October, November and December	
Little Lorikeet	*Glossopsitta pusilla*	-	V	E		None	
Turquoise Parrot	*Neophema pulchella*	-	V	E		None	

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Swift Parrot	*Lathamus discolor*	CE	E	S/E	DEWHA (2010c) recommends area searches or transect surveys of suitable habitat (20 hours over 8 days), preferably in the early morning and afternoon when birds are most active and vocal. Detection by sighting or call. Slow-moving vehicle transects also effective in expansive areas, detecting loud, distinctive 'clinking' call that can be heard over noise of engine. Targeted surveys of patches of heavily flowering eucalypts may be useful. Timing: surveys on the mainland should be conducted between March and July (DEWHA, 2010c).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Specific diurnal surveys for this species were carried out in June and August 2018 targeting patches of flowering box trees at that time. In June 23.75 hours were spent on diurnal surveys over 4 days in August 14 hours was spent over 3 days (i.e. a total of 36.75 hours over 7 days).
Eastern Grass Owl	*Tyto longimembris*	-	V	E	DEC (2004a) requires nocturnal surveys for all species incorporating quiet listening, spotlighting and call-playback. A minimum of five visits per site is suggested for Powerful Owl and Barking Owl and eight visits for Masked Owl. DEC (2004a) states that the surveys can occur any time of year.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** At least five nocturnal surveys per relevant site were carried out during the survey timing (OEH, 2019a), with additional sessions conducted outside of the OEH (2019a) survey period (May to August) but within the DEC (2004a) survey period (any time of year). A total of 69 call playback sessions were undertaken (Table 15). Wherever hollows suitable for nesting were detected they were searched (from the ground) for signs of nesting, feathers, pellets, remains of prey etc.
Masked Owl	*Tyto novaehollandiae*	-	V	S/E		May, June, July and August	
Powerful Owl	*Ninox strenua*	-	V	S/E		May, June, July and August	
Barking Owl	*Ninox connivens*	-	V	S/E		May, June, July, August, September, October, November and December	
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	-	V	E	No species-specific requirement defined. Diurnal bird surveys would be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018.
Speckled Warbler	*Chthonicola sagittata*	-	V	E		None	

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	-	V	E	No species-specific requirement defined. Diurnal bird surveys would be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018.
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E	Diurnal bird surveys undertaken for 20 hours over 10 days in areas of less than 50 ha (DEWHA, 2010c). The species is most conspicuous in the breeding season (primarily between September and November) (DEWHA, 2010c). Targeted searches of woodland patches with heavily flowering trees may be useful as well as call playback (DEWHA, 2010c).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** At least 20 hours per site of diurnal surveys for this species were carried out at several sites in September, November and December 2018 (an excess of 10 days). Numerous diurnal bird surveys were also completed outside of the required survey timing period.
Painted Honeyeater	*Grantiella picta*	V	V	E	No species-specific requirement defined. Diurnal bird surveys would be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous diurnal bird surveys were carried out throughout the study area from January to December 2018.
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	-	V	E		None	
Flame Robin	*Petroica phoenicea*	-	V	E		None	
Scarlet Robin	*Petroica boodang*	-	V	E		None	
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	-	V	E		None	
Varied Sittella	*Daphoenositta chrysoptera*	-	V	E		None	
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	-	V	E		None	
Diamond Firetail	*Stagonopleura guttata*	-	V	E		None	

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Mammals							
Spotted-tailed Quoll	*Dasyurus maculatus maculatus (south-eastern mainland population)*	E	V	E	Habitat surveys (for potentially suitable habitat resources and signs of activity, scats and latrines), hair tubes and camera trapping (SEWPaC, 2011a). May to August is the optimal survey period for this species (SEWPaC, 2011a). 40 hair tubes (funnels) per 100 ha sampling units spread 100m apart from May to August (SEWPaC, 2011a).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** A total of 5,004 hair tube trap nights and 623 camera trap nights were completed over the study area from January to June and November to December 2018. A total of 16 cage and 280 arboreal Elliott B trap nights were carried out in January and November 2018. A total of 1,855 nest box nights were carried out from January to June 2018. Numerous nocturnal spotlighting surveys were carried out throughout the study area. Predator scats were collected and analysed whenever detected.
Brush-tailed Phascogale	*Phascogale tapoatafa*	-	V	S	No species-specific requirement defined. Nocturnal spotlighting surveys, wildlife cameras, nest boxes, hair tubes and arboreal Elliott trapping would all be appropriate for this species.	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tail Quoll would also have covered this species.
Common Planigale	*Planigale maculata*	-	V	S	No species-specific requirement defined. Pitfall trapping, artificial shelter habitat, nocturnal spotlighting surveys, wildlife cameras, hair tubes and Elliott trapping would all be appropriate for this species.	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tail Quoll would also have covered this species. In addition, a total of 24 nights of pitfall trapping took place at each of 3 sites in the study area (total of 72 trap nights). Also, a total of 400 Elliott A terrestrial trap nights were carried out. This species may also have been potentially detected via the artificial shelter habitats (roofing tiles).
Koala	*Phascolarctos cinereus*	V	V	S/E	Federal guidelines (Commonwealth of Australia, 2014) discuss direct and indirect methods depending on density of animals and purpose of study. For low density populations indirect methods (signs) are recommended including searches for scratchings, scats etc. For higher density populations call-playback, spotlighting, wildlife cameras and other methods are recommended. Direct observation surveys should be undertaken between August and January (Commonwealth of Australia, 2014).	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous spotlighting and call-playback sessions were undertaken across the study area from January to December 2018 including during the recommended target period between August and January. A total of 623 camera trap nights were completed over the study area from January to December 2018. Searches for scratchings on tree trunks and scats were undertaken as part of general ecological surveys on a daily basis.

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Eastern Pygmy-possum	*Cercartetus nanus*	-	V	S	No species-specific requirement defined. Pitfall trapping, hair tubes, nest boxes, nocturnal spotlighting surveys, wildlife cameras, and Elliott trapping would all be appropriate for this species.	January, February, March, October, November and December	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tail Quoll would also have covered this species. In addition, a total of 24 nights of pitfall trapping took place at each of 3 sites in the study area (total of 72 trap nights). Also, a total of 400 Elliott A terrestrial trap nights were carried out.
Yellow-bellied Glider	*Petaurus australis*	-	V	E	No species-specific requirement defined. Hair tubes, nest boxes, nocturnal spotlighting and call-playback surveys, wildlife cameras, and Elliott trapping would all be appropriate for these species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tail Quoll would also have covered these species. In addition, numerous call-playback surveys were conducted across the study area over the survey period.
Squirrel Glider	*Petaurus norfolcensis*	-	V	S		All year	
Greater Glider	*Petauroides volans*	V	-	S		All year	
Brush-tailed Rock-wallaby	*Petrogale penicillata*	V	E	S	Thorough daytime searches for signs and habitat resources are considered an adequate form of survey method for detecting the brush-tailed rock wallaby, as long as all suitable rocky habitat including mid-level ledges and holes are inspected for signs of activity (SEWPaC, 2011a). Camera traps are also considered to be suitable (SEWPaC, 2011a).	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The rocky hill at Site 1 and the small escarpment near the main entrance off Edderton Road / The Golden Highway provide the only potential (but sub-optimal) habitat for this species in the study area. They were thoroughly searched for signs of this species on a number of occasions. Camera traps were also used.
Grey-headed Flying-fox, Little Bentwing-bat, Eastern Bentwing-bat, Large-eared Pied Bat, Southern Myotis, Eastern Cave Bat	-	-	-	-	Refer to Table 11.	-	Refer to Table 11.

Table 16 (Continued): Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status			Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
		EPBC Act[1]	BC Act[2]	Credit Class[3]			
Yellow-bellied Sheathtail bat, Eastern Freetail-bat, Northern Freetail-bat, Corben's Long-eared Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat	Various	-	-	E	Harp trapping and ultrasonic bat detection (Anabat) (DEC, 2004a; DEWHA, 2010b)	Oct to March	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** A total of 69 harp trap nights and 34 Anabat detection nights were undertaken (Table 15).
New Holland Mouse	*Pseudomys novaehollandiae*	V	-	E	No species-specific requirement defined. Pitfall trapping, artificial shelter habitat, nocturnal spotlighting surveys, wildlife cameras, hair tubes and Elliott trapping would all be appropriate for this species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tail Quoll would also have covered this species. In addition, a total of 24 nights of pitfall trapping took place at each of 3 sites in the study area (total of 72 trap nights). Also, a total of 400 Elliott A terrestrial trap nights were carried out. This species may also have been potentially detected via the artificial shelter habitats (roofing tiles).

[1] Threatened species status under the EPBC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

[2] Threatened species status under the BC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

[3] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH, 2019a) (current as at March 2019), E = Ecosystem, S = Species.

3 Survey Results

3.1 Fauna Habitat Types

Vegetation within the study area was described and mapped by Hunter Eco (2019). Broad fauna habitat types in the study area have been described and mapped on Figures 7a and 7b based on the vegetation mapping by Hunter Eco (2019) and include:

- Dry Sclerophyll Forest.
- Grassy Woodlands.
- Forested Wetlands.
- Derived Native Grassland (DNG).
- Planted Trees.
- Cultivation.
- Waterbody/Dam.
- Woodland Rehabilitation.
- Pasture Rehabilitation.
- Infrastructure/Cleared Land.

The broad fauna habitat types are described below while a summary of habitat features, habitat types and dominant flora species observed at each survey site is presented in **Appendix B**.

Livestock grazing has effectively removed the shrub layer from parts of the study area and suppressed the ground-cover layer. The growth and flowering of groundcover species observed in November and December 2018 surveys following sporadic rainfall and removal of cattle was very noticeable.

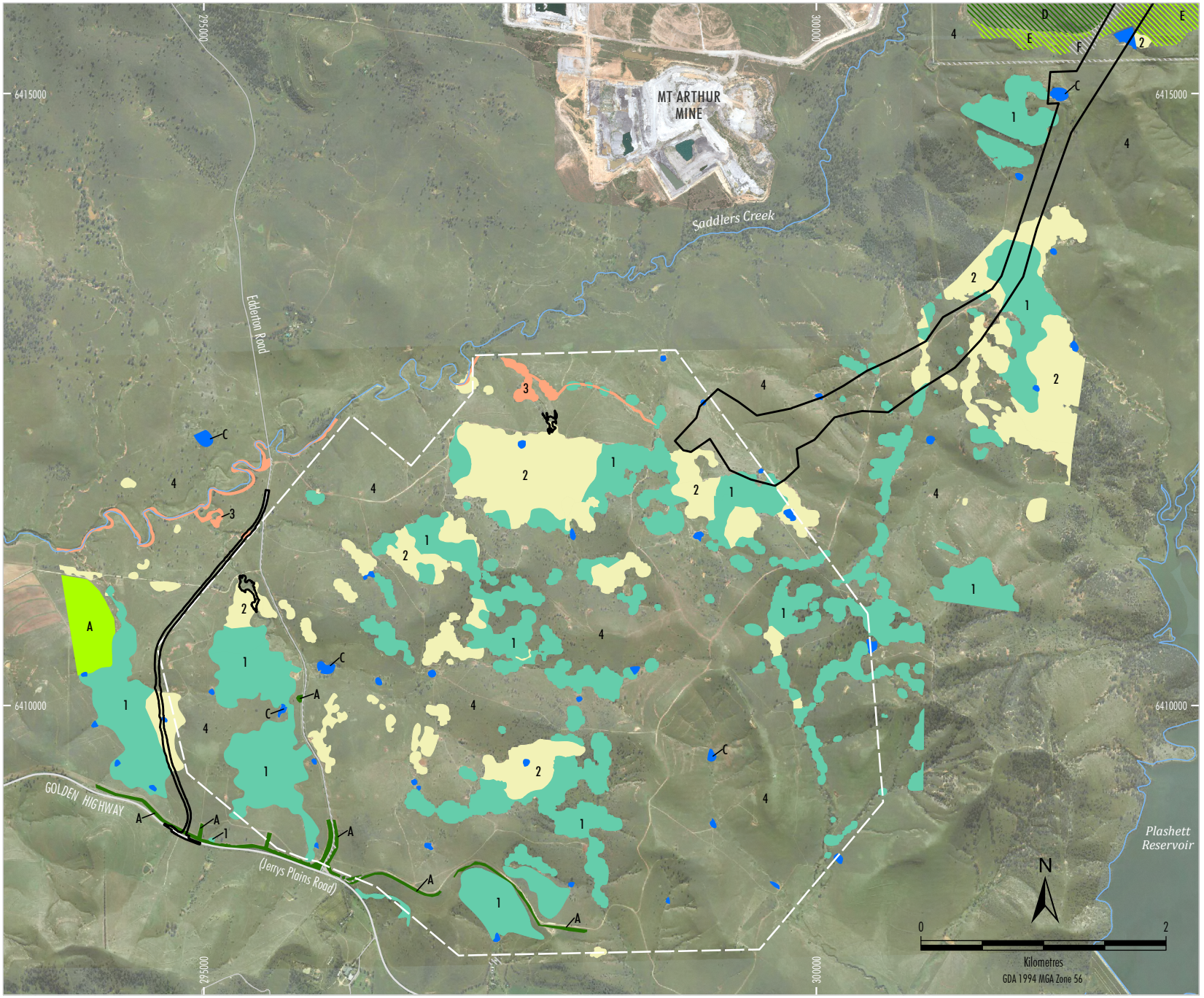
Some relatively small areas of scattered surface rock were observed throughout the study area including at most survey sites. Observed surface rock was generally small (<50 cm diameter) and rocks were mostly located directly on soil rather than rock on rock. The exception to this was at Sites 1 and IncB (Figure 4). A rocky rise and associated escarpment were located at Site 1 with a smaller escarpment located at Site IncB. An old quarry was located at Site 1b with some exposed vertical rock faces, quarried rock and spoil.

Dry Sclerophyll Forest

The dry sclerophyll forest in the study area comprises Red Gum - Ironbark - Apple shrubby woodland (PCT 1607), White Box - Ironbark - Red Gum shrubby forest (PCT 1606) and Slaty Box shrubby woodland (PCT 1655) (Hunter Eco, 2019).

This habitat type consisted of remnant patches of native dominated vegetation containing a Eucalypt dominated canopy (Figure 7a).

The common canopy species included White Box (*Eucalyptus albens*), Blakely's Red Gum (*E. blakelyi*), Bulloak (*Allocasuarina luehmannii*) and Slaty Gum (*E. dawsonii*). If a sub-canopy was present it was generally patchy and dominated by Bulloak (*Allocasuarina luehmannii*) and/or Kurrajong (*Brachychiton populneus*).



LEGEND

- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- 1 Dry Sclerophyll Forest
- 2 Grassy Woodland
- 3 Forested Wetland
- 4 Derived Native Grassland
- A Planted Trees
- B Cultivation
- C Waterbody/Dam
- D Woodland Rehabilitation
- E Pasture Rehabilitation
- F Infrastructure/Cleared Land

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Orthophoto Mosaic: 2018, 2016, 2011

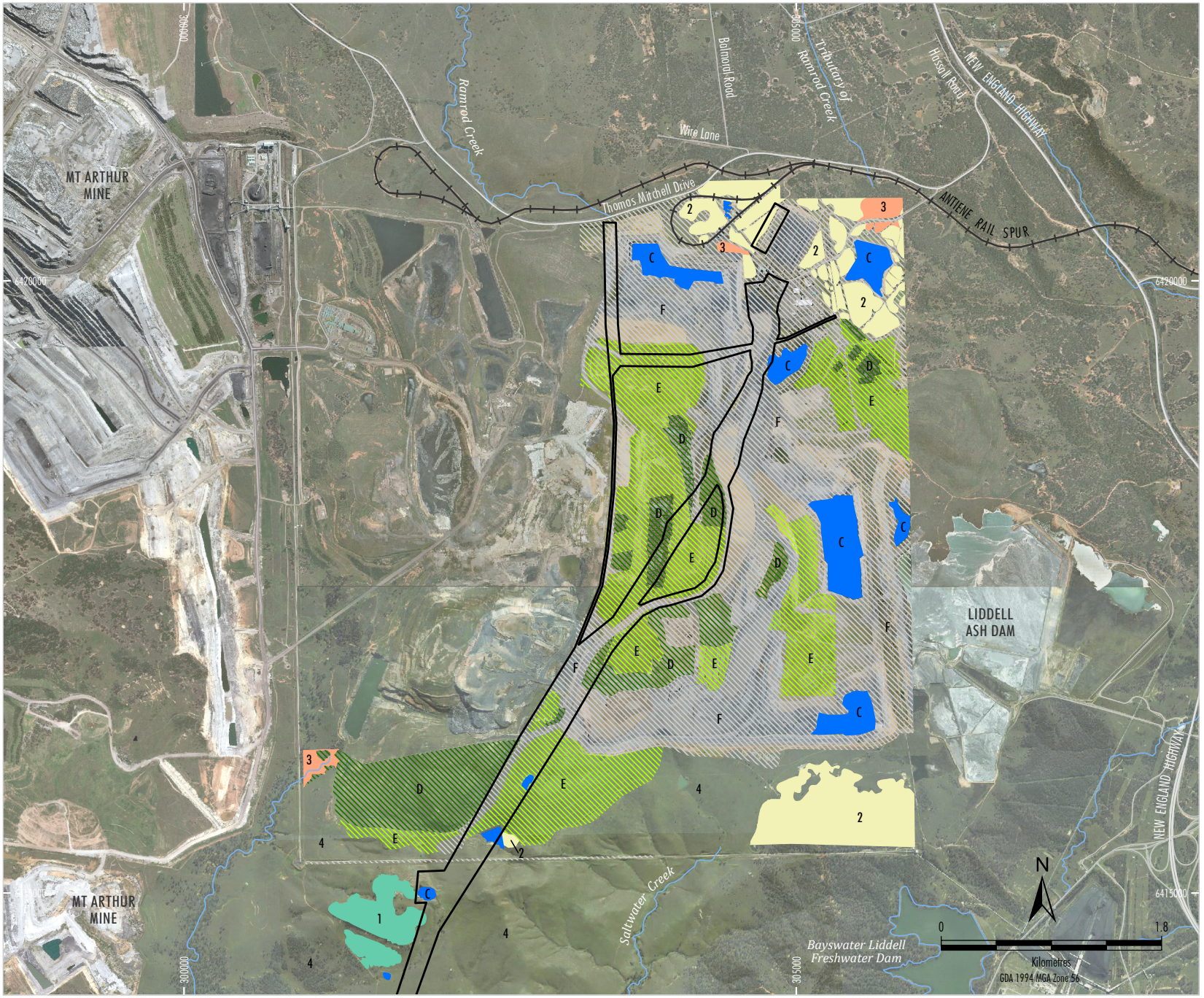
MALABAR COAL

MAXWELL PROJECT

Broad Fauna Habitat Types - Maxwell Underground

Figure 7a

SHM-18-03 Maxwell_EIS_App_Fauna_205E



LEGEND

- Biodiversity Assessment Development Footprint
- 1 Dry Sclerophyll Forest
- 2 Grassy Woodland
- 3 Forested Wetland
- 4 Derived Native Grassland
- C Waterbody/Dam
- D Woodland Rehabilitation
- E Pasture Rehabilitation
- F Infrastructure/Cleared Land

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Broad Fauna Habitat Types - Maxwell Infrastructure

Figure 7b

SHM-18-03 Maxwell_EIS_App_Fauna_206E

Where a shrub layer was present it was generally very sparse with common species being Cooba (*Acacia salicina*), Mock Olive (*Notelaea spp.)*, Blackthorn (*Bursaria spinosa*) and the weed species African Boxthorn (*Lycium ferocissimum*).

The groundcover layer was typically sparse. It was typically co-dominated by a variety of grass and forb species depending on the site. Common species included Slender Bamboo Grass (*Austrostipa verticillata*), Purple Wire-grass (*Aristida ramosa*), and Small-leaf Bluebush (*Maireana microphylla*).

Generally, this habitat type contained areas of more complex vegetation and a greater number of fauna habitat features such as leaf litter, fallen timber, hollow logs, hollow-bearing trees and dead trees.

Dead trees (stags) and hollow-bearing trees were present at most sites but generally in low relative abundance.

All sites within this habitat type exhibited some degree of disturbance as a result of agricultural activities; including grazing, clearing, removal of fallen timber, removal or thinning of shrub and sub-canopy layers. Generally, the connectivity for this habitat type was low to moderate across the study area due to historical clearing to support agriculture.

Grassy Woodlands

The grassy woodlands in the study area comprises Bull Oak grassy woodland (PCT 1692), Yellow Box - Apple grassy woodland (PCT 1693), Fuzzy Box woodland (PCT 201), Ironbark - Grey Box grassy woodland (PCT 1691), Weeping Myall woodland (PCT 116), and Grey Box - Spotted Gum - Narrow-leaved Ironbark woodland (PCT 1604) (Hunter Eco, 2019).

This habitat type consisted of remnant patches of native dominated vegetation which contained a more spread out Eucalypt dominated canopy and a grass/forb dominated understorey with fewer shrubs.

The common canopy species included Narrow-leaved Ironbark (*Eucalyptus crebra*), Grey Box (*E. moluccana*), Bulloak, Yellow Box (*E. melliodora*), Spotted Gum (*Corymbia maculata*) and Fuzzy Box (*E. conica*).

The groundcover layer is typically sparse. It is typically co-dominated by a variety of grass and forb species depending on the site. Common species include Slender Bamboo Grass (*Austrostipa verticillata*), Purple Wire-grass (*Aristida ramosa*), and Small-leaf Bluebush (*Maireana microphylla*).

Generally, this habitat type contained a greater number of fauna habitat features such as leaf litter, fallen timber, hollow logs, hollow-bearing trees, dead trees, and areas of more complex vegetation.

Dead trees (stags) and hollow-bearing trees were present at most sites but generally in low relative abundance.

All sites within this habitat type showed some degree of disturbance including grazing, clearing, removal of fallen timber, removal or thinning of shrub and sub-canopy layers. Generally, the connectivity for this habitat type was low to moderate across the study area which has been heavily cleared for agricultural.

Derived Native Grassland

This habitat type consists of open grassy areas between patches of Dry Sclerophyll Forest and Grassy Woodlands. Cover was sparse to moderately dense. Typical species included Slender Bamboo Grass, Purple Wire-grass, and Small-leaf Bluebush.

Fauna habitat features were generally poor within this habitat type as it only provided open areas for some species. Generally fallen timber, hollow logs etc. were absent.

This habitat type was probably formed by and subject to ongoing disturbance from grazing and other agricultural practices.

Connectivity in this habitat type was generally moderate to high as it formed large connected areas across the study area landscape.

Scattered or remnant trees (paddock trees) were occasionally present in this broad fauna habitat type.

It was found adjacent to or interspersed with most sites and was the most abundant habitat type within the study area.

Forested Wetlands

The forested wetland comprises Swamp Oak forest (PCT 1731) and Hunter Lowland Red Gum Forest (PCT 1598) (Hunter Eco, 2019). This habitat type was associated with parts of the Saddlers Creek drainage line and consisted of a mixture of riparian remnant old growth trees and Swamp Oak (*Casaurina glauca*) regeneration (Figure 7a).

The common canopy species included Swamp Oak (*Casuarina glauca*), Bulloak (*Allocasuarina luehmannii*), Rough-barked Apple (*Angophora floribunda*) and Yellow Box (*Eucalyptus melliodora*). If a sub-canopy was present it was dominated by Swamp Oak, Bulloak and/or Cooba (*Acacia salicina*). If a shrub layer was present it typically included Silver Cassia (*Senna artemisioides)*, Small-leaf Bluebush (*Maireana microphylla*) and the weeds African Boxthorn (*Lycium Ferocissimum*) and Common Prickly Pear (*Opuntia stricta).*

The groundcover layer was mostly sparse. It was typically co-dominated by a variety of grass and forb species depending on the site. Common species included *Aristida ramosa, Austrostipa verticillata, Cynodon dactylon* and *Phalaris aquatica.*

It was in poor condition due to sparse cover, grazing pressure, erosion and dry conditions.

It provided few tree hollows, fallen logs and dead standing trees.

It was poorly connected except along watercourse where the riparian zone varies in thickness and quality and with some open sections with little woody cover.

Planted Trees

This occurred as a narrow 20 m wide strip of planted trees along the frontage of the study area with the Golden Highway near the Edderton Road intersection (Figure 7a). The dominant planted tree was *Eucalyptus dawsonii* (Slaty Gum) (Hunter Eco, 2019).

Habitat value is low due to narrow area of planting, young age of planted trees and lack of features such as tree hollows, dead standing tree and fallen logs.

Cultivation

There was an area of cultivated land west of Edderton Road (Figure 7a). It contained no native tree or shrub species and has little habitat value.

Waterbody/Dam

There were 52 waterbodies/dams within the study area with most being relatively small farm dams associated with grazing activity (Figures 7a and 7b). There were several larger waterbodies associated with old mining pits and dams associated with the previous Drayton open cut coal mine.

Saddlers Creek and Saltwater Creek and their tributaries were located in the southern part of the study area. They appeared to have no permanently flowing water and only a few small ponds observed at some locations during the survey periods.

Most waterbodies/dams lacked aquatic vegetation and/or dense fringing vegetation and provided lower quality habitat for most species. Grazing has degraded most of the dams and suppressed growth of aquatic plants and fringing sedges.

Woodland Rehabilitation

The location of woodland rehabilitation of previous open cut mining areas at the Maxwell Infrastructure is shown on Figure 7b.

Hunter Eco (2019) describes the woodland rehabilitation as comprising a low native species diversity and high weed diversity including five high threat weed species; native species were present in low numbers. Native canopy species were *Acacia saligna*, *Eucalyptus cladocalyx* (Sugar Gum) and a variety of Acacia species.

The woodland rehabilitation provides lower quality fauna habitat compared to intact woodland sites (Malabar, 2018), except perhaps movement and foraging habitat for more mobile species.

Pasture Rehabilitation

The location of pasture rehabilitation of previous open cut mining areas at the Maxwell Infrastructure is shown on Figure 7b.

Hunter Eco (2019) describes the pasture rehabilitation as comprising of a low native flora species diversity and high weed diversity including eight high threat weed species; native species were present in low numbers. *Melinis repens* (Red Natal Grass) was the dominant weed species and *Hyparrhenia hirta* (Coolatai Grass) was the dominant high threat weed species.

The pasture rehabilitation provides lower quality fauna habitat compared to intact woodland sites (Malabar, 2018), except perhaps movement and foraging habitat for more mobile species.

Infrastructure/Cleared Land

Cleared land and infrastructure areas associated with the Maxwell Infrastructure are shown on Figures 7a and 7b.

3.2 Fauna Species

A total of 227 fauna species were recorded in the study area during the 2018 surveys including 8 amphibian, 22 reptile, 148 bird, and 49 mammal species. 12 of the recorded species were exotics.

Appendix A contains the full list of fauna species recorded during the survey periods.

3.3 Threatened Fauna Species Listed under the BC Act

3.3.1 Threatened Fauna Species Recorded During the Surveys

A total of 25 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in the study area during the current surveys, as well as the Square-tailed Kite which was observed during vegetation surveys (Colin Driscoll, Hunter Eco, pers. obs.) (Table 17). Five of the species recorded by Future Ecology are listed under the EPBC Act (all listed as vulnerable) (Table 17).

Table 17: Threatened Fauna Species Recorded During this Study

Common Name	Scientific Name	Conservation Status		Credit Class[3]
		BC Act	EPBC Act[2]	
Reptiles				
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S
Striped Legless Lizard	*Delma impar*	V	V	S
Birds				
Square-tailed Kite	*Lophoictinia isura*	V	-	E*
White-bellied Sea-eagle	*Haliaeetus leucogaster*	V	-	E*
Spotted Harrier	*Circus assimilis*	V	-	E
Little Eagle	*Hieraaetus morphnoides*	V	-	E*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	E*
Little Lorikeet	*Glossopsitta pusilla*	V	-	E
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	E
Speckled Warbler	*Chthonicola sagittata*	V	-	E
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	-	E
Painted Honeyeater	*Grantiella picta*	V	V	E
Flame Robin	*Petroica phoenicea*	V	-	E
Scarlet Robin	*Petroica boodang*	V	-	E
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V	-	E
Varied Sittella	*Daphoenositta chrysoptera*	V	-	E
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	E
Mammals				
Squirrel Glider	*Petaurus norfolcensis*	V	-	S
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	E*
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	E
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	-	E
Little Bentwing-bat	*Miniopterus australis*	V	-	E*
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V	-	E*
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S^
Southern Myotis	*Myotis macropus*	V	-	S

[1] Conservation status under the BC Act (current as at March 2019). V = Vulnerable.

[2] Conservation status under the EPBC Act (current as at March 2019). V = Vulnerable.

[3] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (OEH, 2019a) (current as at March 2019). E = Ecosystem, S = Species

* This species is a duel credit species, however, no breeding habitat was recorded and therefore it is considered an ecosystem credit species in the study area.

^ This species is a species credit species, however, no breeding habitat was recorded and therefore no species credits would be generated from the study area.

Figures 8 to 11 show the locations of threatened fauna species records.

Four of the species in Table 17 are considered 'species credit species' in the study area (Figure 12), namely:

- Pink-tailed Legless Lizard;
- Striped Legless Lizard;
- Squirrel Glider; and
- Southern Myotis.

Figure 13 shows the locations of threatened fauna species listed under the EPBC Act.

All of the species in Table 17 are discussed below.

Pink-tailed Legless Lizard (*Aprasia parapulchella*)

This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This small, distinctive legless lizard lives beneath lightly embedded rocks on sloping, generally well-drained soils in derived grasslands and grassy woodlands (Wong et al., 2011; OEH, 2019c). It has a specialised diet and lives in the burrows of small ants; the eggs and larvae of which it relies on for food (Wong et al., 2011). It currently has a patch-work distribution along the foothills of the western slopes of the Great Dividing Range between Bendigo in Victoria and Gunnedah in NSW with populations mostly fragmented and isolated from one another (Wong et al., 2011). The population density is low except in the most favourable habitats (Wong et al., 2011), with the most abundant populations known from the Australian Capital Territory (ACT) and in NSW between Yass and Cooma (ACT Government, 2017a).

This species has not been previously recorded in the study area (Table 1). A single adult specimen of Pink-tailed Legless Lizard was found beneath a rock in grassland at Site 5 in November 2018 (Figure 8; Plate 1). In addition, a single slough (shed skin) of the same species was also found beneath a rock in the same area. It was not recorded in any pitfall traps or artificial shelter habitat.

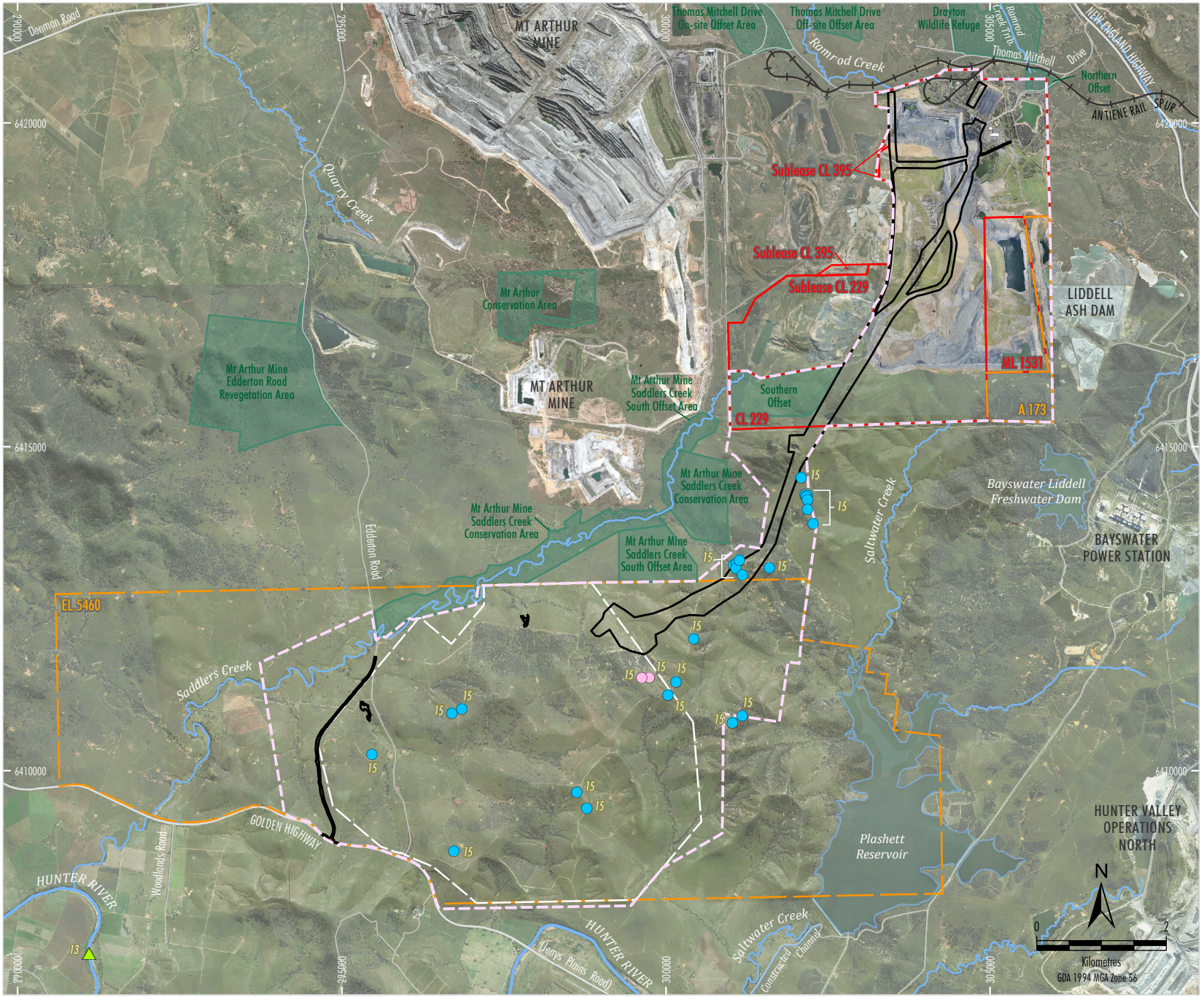
This represents the first record of this species in the Muswellbrook LGA and represents an eastern range extension of its current known distribution with the closest record being from Goulburn River National Park about 80 km to the west of the study area and dated 2000 (OEH, 2019b).

The vegetation where this species was found on site is White Box - Ironbark - Red Gum shrubby forest PCT1606 - Derived Native Grassland (Hunter Eco, 2019).

There are no PCTs published in the *Threatened Biodiversity Data Collection* (OEH, 2019a) as being associated with this species within the Sydney Basin – Hunter IBRA sub-region. The *Threatened Biodiversity Data Collection* (OEH, 2019a) describes a habitat constraint for this species as rocky areas or within 50 m of rocky areas (Table 4).

Throughout its range this species generally occupies sites with a grassy ground layer with little or no leaf litter, and relatively low tree and shrub cover (Wong et al., 2011).

This species can be hard to detect and may only occur in low numbers across the study area. It is most likely to occur in similar grassy habitat to that found at Site 5 at locations with a good cover of native grasses and forbs as well as lightly-embedded rocks. It is unlikely to be found at any locations where the ground layer vegetation has been subject to pasture improvement and/or heavy stock concentrations (Wong et al., 2011).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Green and Golden Bell Frog
- Pink-tailed Legless Lizard
- Striped Legless Lizard

Reference:
13. OEH (2019)
15. Future Ecology (2019)
Note: There are no references 1 - 12 and 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

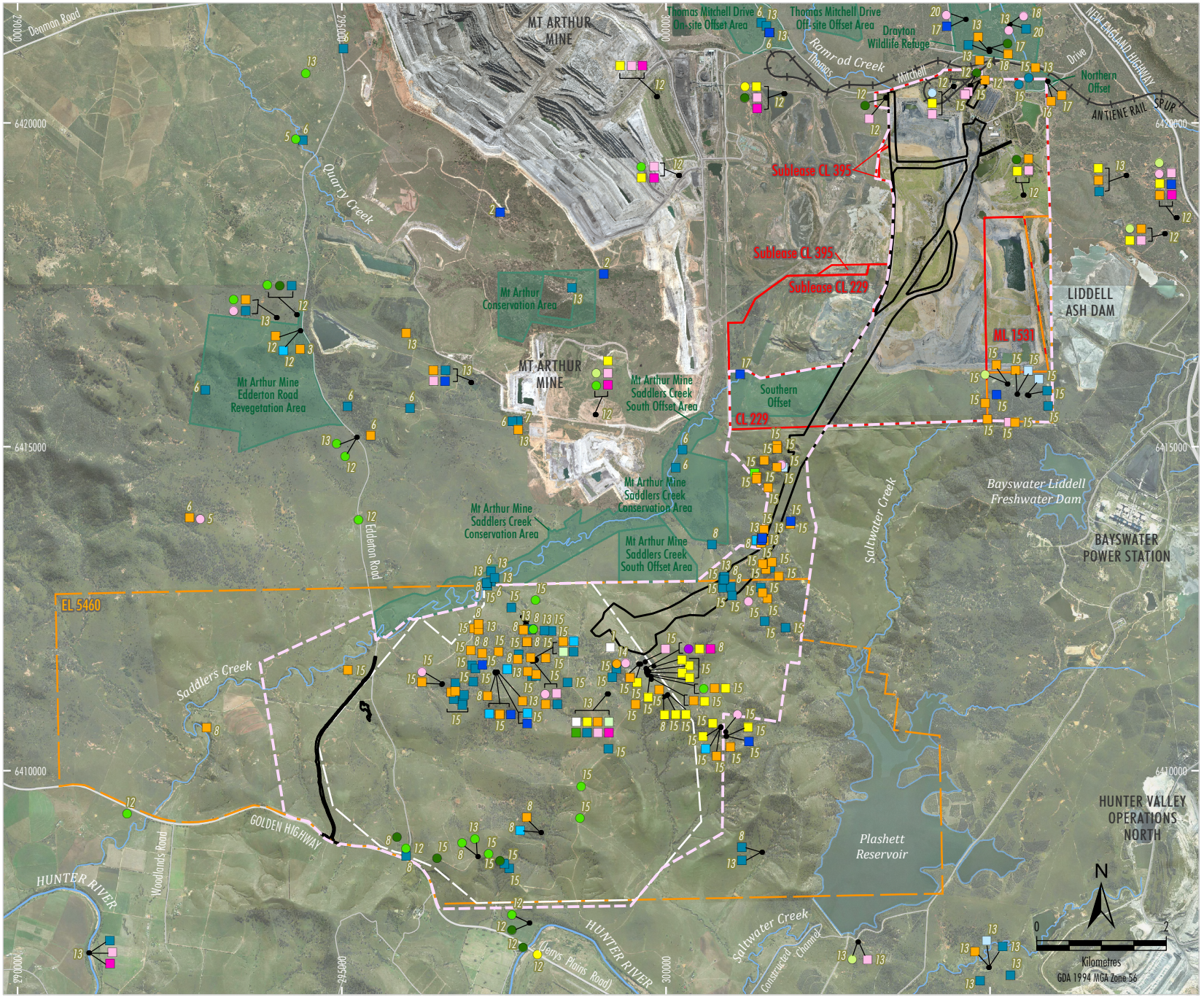
MALABAR COAL

MAXWELL PROJECT

Threatened Reptiles and Amphibians

Figure 8

SHM-18-03 Maxwell_EIS_App_Fauna_222D



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Black Falcon
- Square-tailed Kite
- White-bellied Sea-Eagle
- Spotted Harrier
- Little Eagle
- Bush Stone-curlew
- Glossy Black-Cockatoo
- Little Lorikeet
- Swift Parrot
- Barking Owl
- Brown Treecreeper (eastern subspecies)
- Speckled Warbler
- Black-chinned Honeyeater (eastern subspecies)
- Painted Honeyeater
- Hooded Robin (south-eastern form)
- Flame Robin
- Scarlet Robin
- Grey-crowned Babbler (eastern subspecies)
- Varied Sittella
- Dusky Woodswallow
- Diamond Firetail

Reference:

1. *Ecotone (2000)*
2. *Umwelt (2005)*
3. *Umwelt (2006b)*
5. *Umwelt (2007b)*
6. *Cumberland Ecology (2009a)*
7. *Cumberland Ecology (2010)*
8. *Cumberland Ecology (2012)*
12. *Birdlife Australia (2017)*
13. *OEH (2019)*
14. *Hunter Eco (pers. comm. (2019))*
15. *Future Ecology (2019)*
16. *Eco Logical Australia (2014)*
17. *Eco Logical Australia (2015)*
18. *Eco Logical Australia (2016a)*
20. *Eco Logical Australia (2016b)*

Note: There are no references 4, 9 - 11 and 19 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019); MSEC (2019)
Orthophoto Mosaic: 2018, 2016, 2011

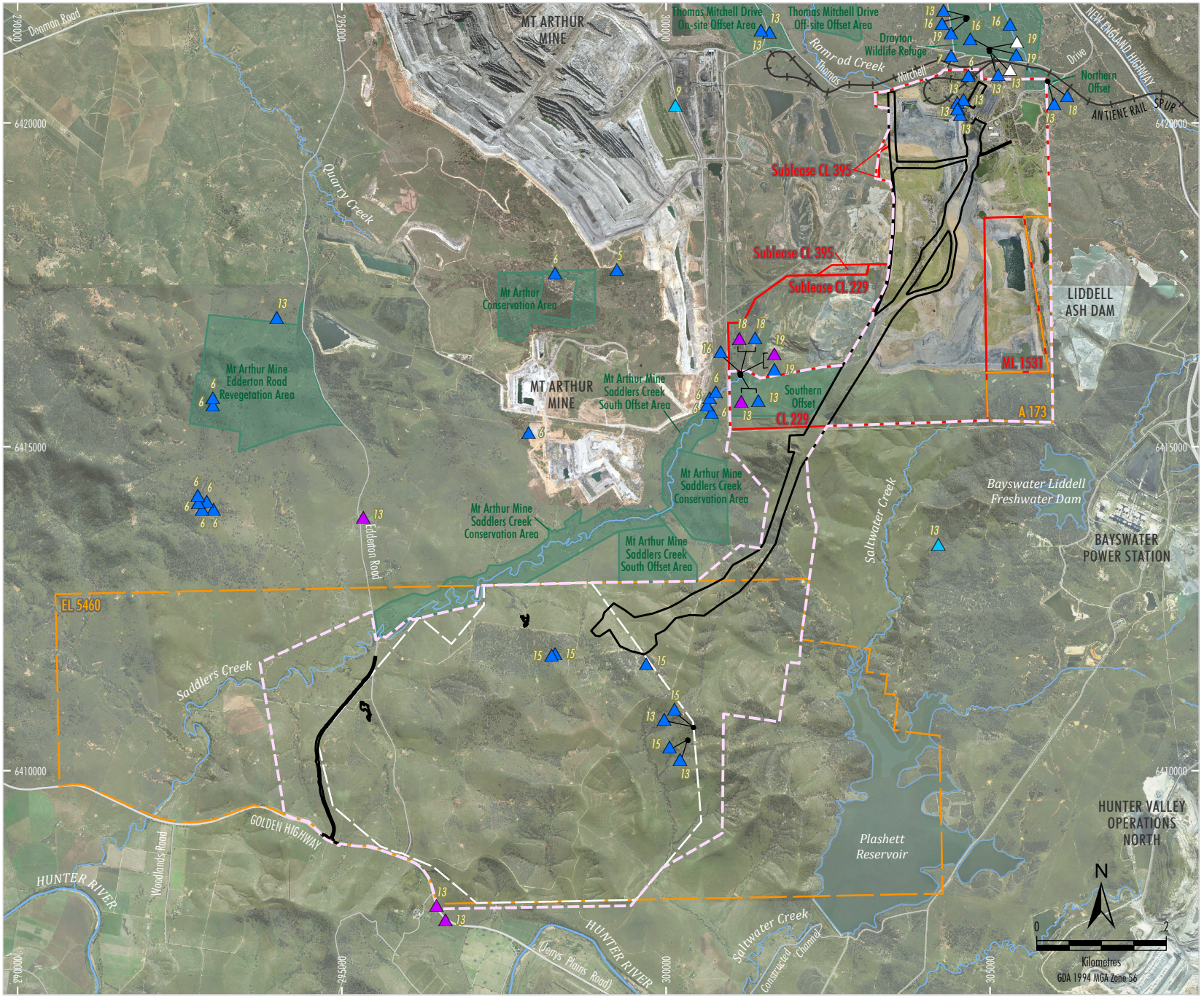
MALABAR COAL

MAXWELL PROJECT

Threatened Birds

Figure 9

SHM-18-03 Maxwell_EIS_App_Fauna_208F



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Spotted-tailed Quoll
- Brush-tailed Phascogale
- Koala
- Squirrel Glider

Reference:

5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
9. HVEC (pers. Comm. (2012))
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)

Note: There are no references 1 - 4, 8, 10 - 12, 14 and 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

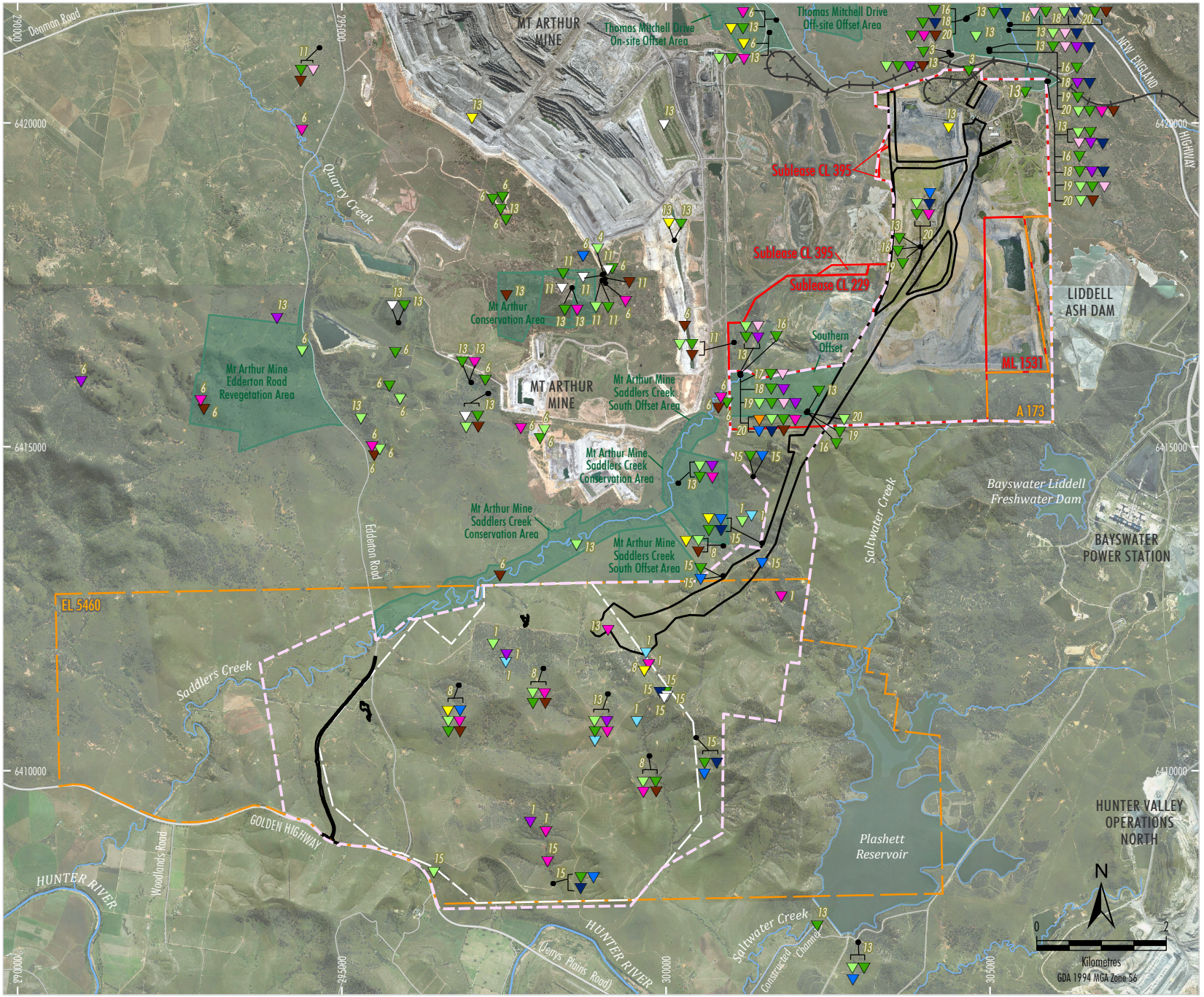
MALABAR COAL

MAXWELL PROJECT

Threatened Mammals

Figure 10

SHM-18-03 Maxwell_EIS_App_Fauna_223E



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Grey-headed Flying-fox
- Yellow-bellied Sheathtail-bat
- Northern Freetail Bat
- Eastern Freetail-bat
- Eastern Bentwing-bat
- Corben's Long-eared Bat
- Large-eared Pied Bat
- Little Bentwing-bat
- Eastern False Pipistrelle
- Southern Myotis
- Greater Broad-nosed Bat
- Eastern Cave Bat

Reference:

1. Ecotone (2000)
3. Umwelt (2006b)
4. Umwelt (2007a)
6. Cumberland Ecology (2009a)
8. Cumberland Ecology (2012)
11. Niche (2012)
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
17. Eco Logical Australia (2015)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)
20. Eco Logical Australia (2017)

Note: There are no references 2, 5, 7, 9, 10, 12 and 14 on this figure. (Some records by Niche (2012) were possible/probable records).

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)

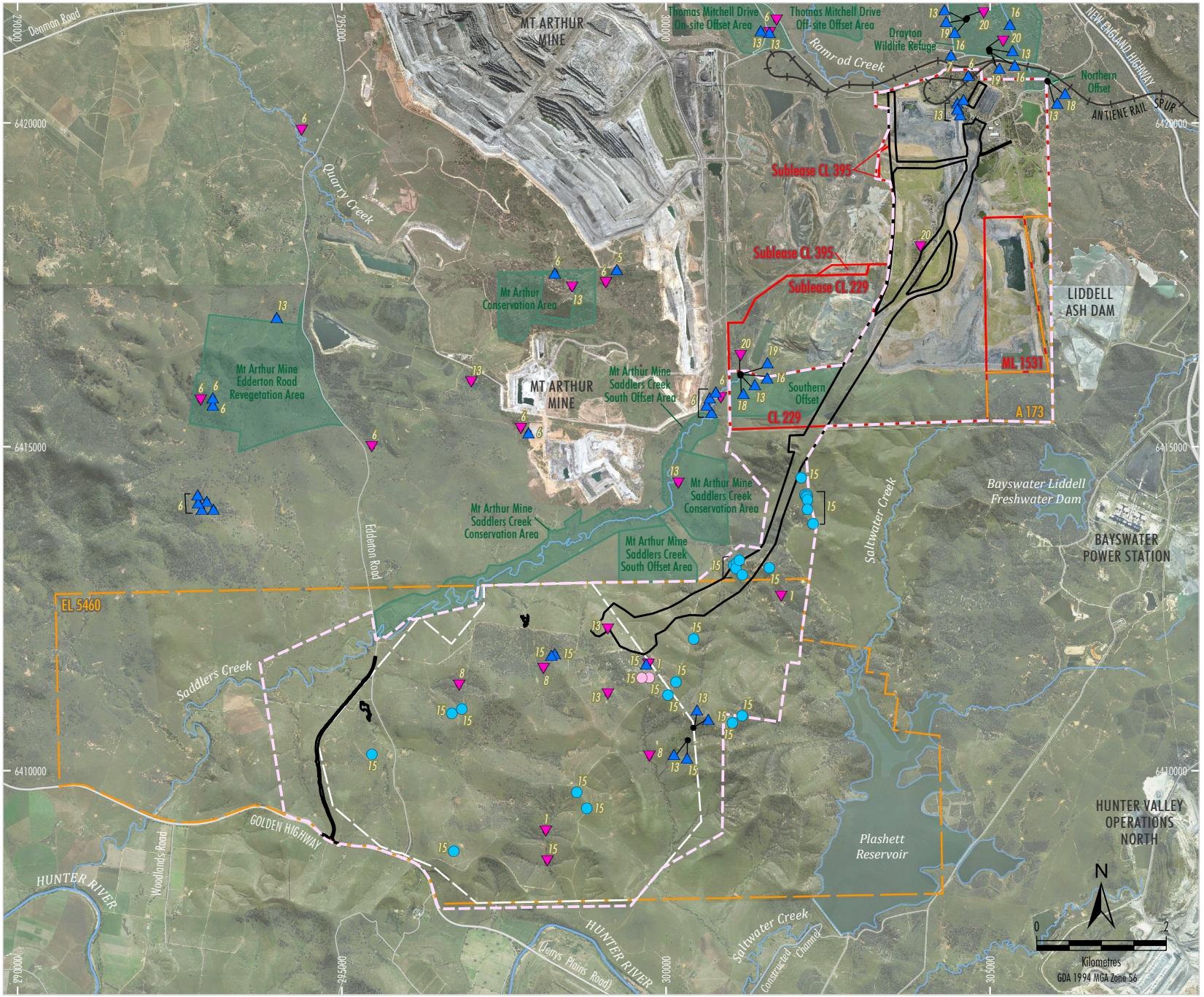
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Bats

Figure 11



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Pink-tailed Legless Lizard
- Striped Legless Lizard
- Squirrel Glider
- Southern Myotis

Reference:

1. *Ecotone (2000)*
5. *Umwelt (2007b)*
6. *Cumberland Ecology (2009a)*
7. *Cumberland Ecology (2010)*
8. *Cumberland Ecology (2012)*
13. *OEH (2019)*
15. *Future Ecology (2019)*
16. *Eco Logical Australia (2014)*
18. *Eco Logical Australia (2016a)*
19. *Eco Logical Australia (2016b)*
20. *Eco Logical Australia (2017)*

Note: There are no references 2 - 4, 9 - 12, 14 and 17 on this figure.

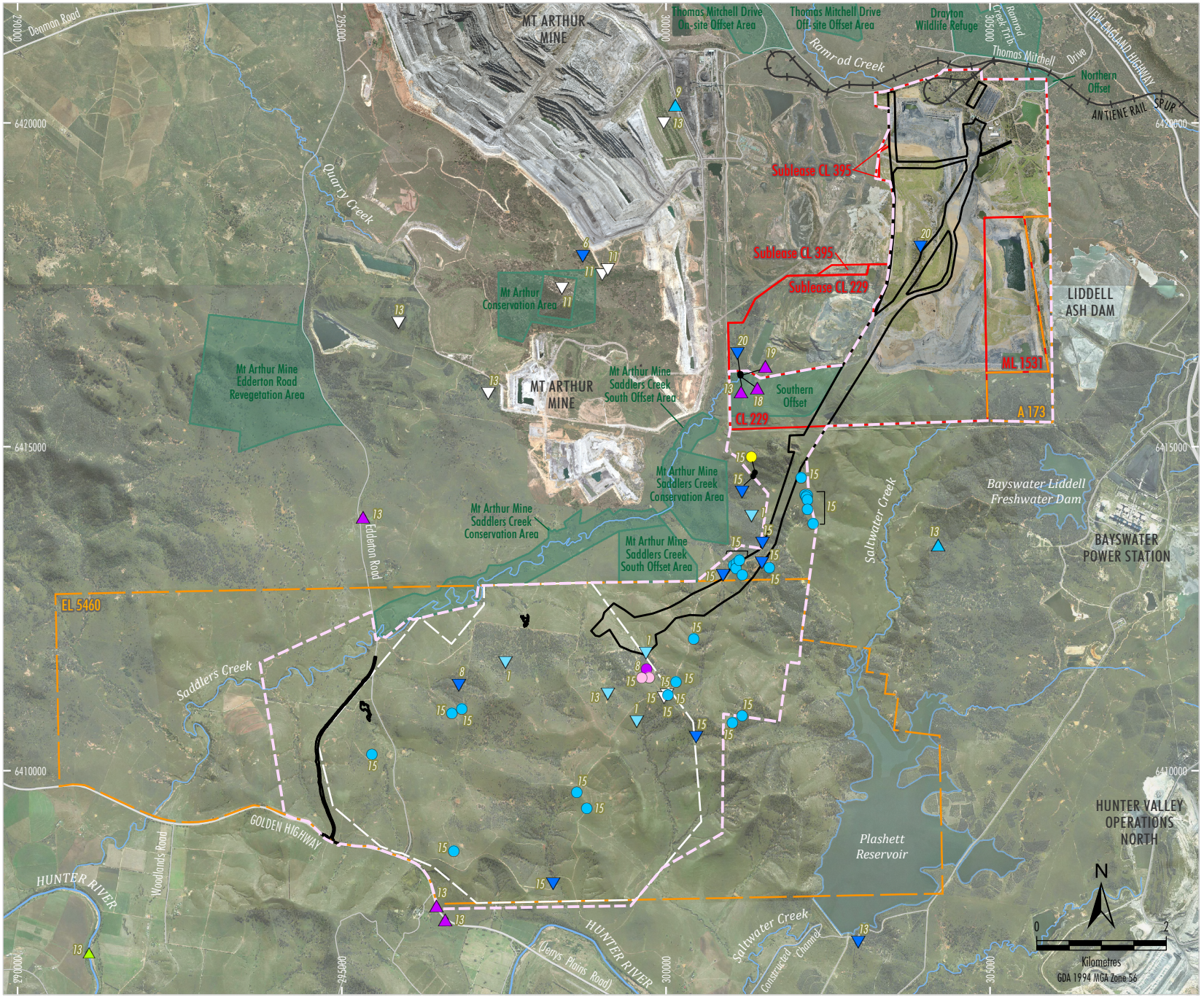
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Species Credit Species Relevant to the Study Area

Figure 12



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Green and Golden Bell Frog
- Pink-tailed Legless Lizard
- Striped Legless Lizard
- Swift Parrot
- Painted Honeyeater
- Spotted-tailed Quoll
- Koala
- Grey-headed Flying-fox
- Large-eared Pied Bat
- Corben's Long-eared Bat

Reference:

5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)
20. Eco Logical Australia (2017)

Note: There are no references 1 - 4, 8 - 12, 14 and 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Threatened Species Listed under the EPBC Act

Figure 13

SHM-18-03 Maxwell_EIS_App_Fauna_207E

To further refine the potential habitat within the study area, in accordance with advice from the OEH, rocky areas were identified in PCT 1606 and 1606 DNG (where the Pink-tailed Legless Lizard was previously recorded during the 2018 surveys) (Section 2.3.3). In order to create the species polygon, a 50 m zone was applied around the rocky areas, as requested by OEH.

Figure 14 shows the species polygon (extent of habitat) for the Pink-tailed Legless Lizard in study area.

Plate 1: Pink-tailed Legless Lizard at Site 5, November 2018 (Henry Cook).

Striped Legless Lizard (*Delma impar*)

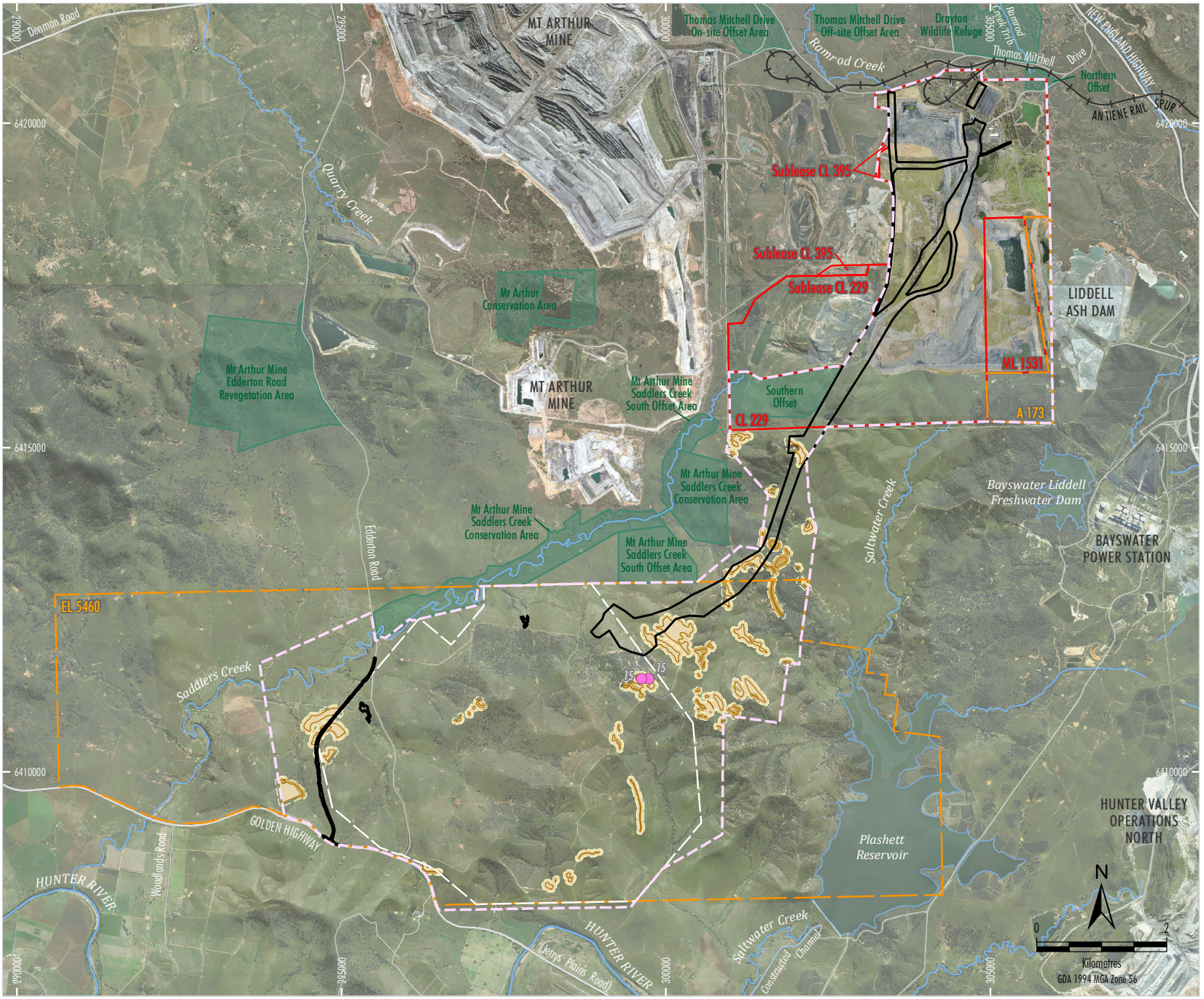
This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

In NSW, the Striped Legless Lizard mostly occurs in the Southern Tablelands and the South West Slopes regions. It also occurs in the ACT, Victoria and south-eastern South Australia (OEH, 2019c).

Striped Legless Lizards are easily distinguished from other members of the genus *Delma* by the combination of two supranasal scales (rather than four), the first upper labial scale being partially fused to the nasal scale, the third upper labial scale being below the eye and the possession of a linear pattern (Smith and Robertson, 1999; Wilson and Swan, 2017; Cogger, 2018).

It is mainly found in Natural Temperate Grassland dominated by perennial, tussock-forming grasses such as Kangaroo Grass *Themeda australis*, spear-grasses *Austrostipa* spp. and poa tussocks *Poa* spp., and occasionally wallaby grasses *Austrodanthonia* spp., but has also been observed in grasslands that have a high exotic component and occasionally in open Box-Gum Woodland provided the tree cover is low (ACT Government, 2017b; OEH, 2019c). It is sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter (OEH, 2019c).

This species has not been previously recorded in the study area (Table 1). 26 observations of Striped Legless Lizard as either living specimens (16 individuals) or sloughs (shed skins) (10 sloughs) were made at several locations within the study area in November and December 2018 (Figure 8; Plate 2). The majority of the observations were made under cow pats (dung) in open grassy areas with a good cover of native grasses and herbs. There was one observation within a pitfall trap at Site 3 and one slough and an individual animal observed beneath artificial shelter habitat at Site 6.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Pink-tailed Legless Lizard

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Other

- Rocky Area
- Rocky Area 50 m Zone

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Pink-tailed Legless Lizard Species Polygon

Figure 14

SHM-18-03 Maxwell_EIS_App_Fauna_215C

There are only five previous records of this species from the Upper Hunter area, all from near Muswellbrook Common and dated from the year 2013. This is approximately 15 km north-east of the study area. The Upper Hunter population appears to be disjunct from other recorded populations which occur greater than 200 km to the south.

Prior to commencement of surveys Muswellbrook Common was inspected by two ecologists from Future Ecology and was found to be composed of a thick cover of largely exotic grasses and forbs together with some rocks and dumped materials. The vegetation where this species was found in the study area is mapped as the following PCTs (Hunter Eco, 2019):

- PCT 1606 (3 observations).
- PCT 1606 - DNG (18 observations).
- PCT 1655 (1 observation).
- PCT 1655 DNG (2 observations).
- PCT 1692 (1 observation).
- An unmapped location just outside of study area with adjacent mapped vegetation being PCT 1606 and PCT 1606 DNG (1 observation).

The following PCTs are published in the *Threatened Biodiversity Data Collection* (OEH, 2019a) as being associated with this species within the Sydney Basin – Hunter IBRA sub-region:

- PCT 1655.
- PCT 1604.
- PCT 1691.
- PCT 1692.
- PCT 1693.

The density of native grass and forbs across the study area would fluctuate due to rainfall and grazing pressure. It was noted that the property was de-stocked around August-September 2018. During surveys in November-December 2018 a number of previously unseen forb species were conspicuous due to flowering and grass cover seemed to be subjectively denser than previous surveys. Given that most observations were made under cow pats then cattle may form an important role in microhabitat creation for this species in the study area but conversely intense grazing pressure, pasture improvement and ploughing are known to be deleterious to Striped Legless Lizard (ACT Government, 2017b).

Given the paucity of previous records of this species in the Upper Hunter and the lack of research on locally preferred vegetation, it is possible that all of the published associated PCTs together with the non-associated PCTs in which it was observed to occur in the study area would form potential habitat for this species across the study area, namely:

- PCT 1655.
- PCT 1655 DNG.
- PCT 1604.
- PCT 1606.
- PCT 1606 DNG.
- PCT 1691.
- PCT 1691 DNG.

- PCT 1692.
- PCT 1693.
- PCT 1693 DNG.

Figure 15 shows the species polygon (extent of habitat) for the Striped Legless Lizard in study area.

Plate 2: Striped Legless Lizard, November-December 2018 (Alex Dudley).

Square-tailed Kite (*Lophoictinia isura*)

This species is listed as 'vulnerable' in NSW and it is not nationally listed. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

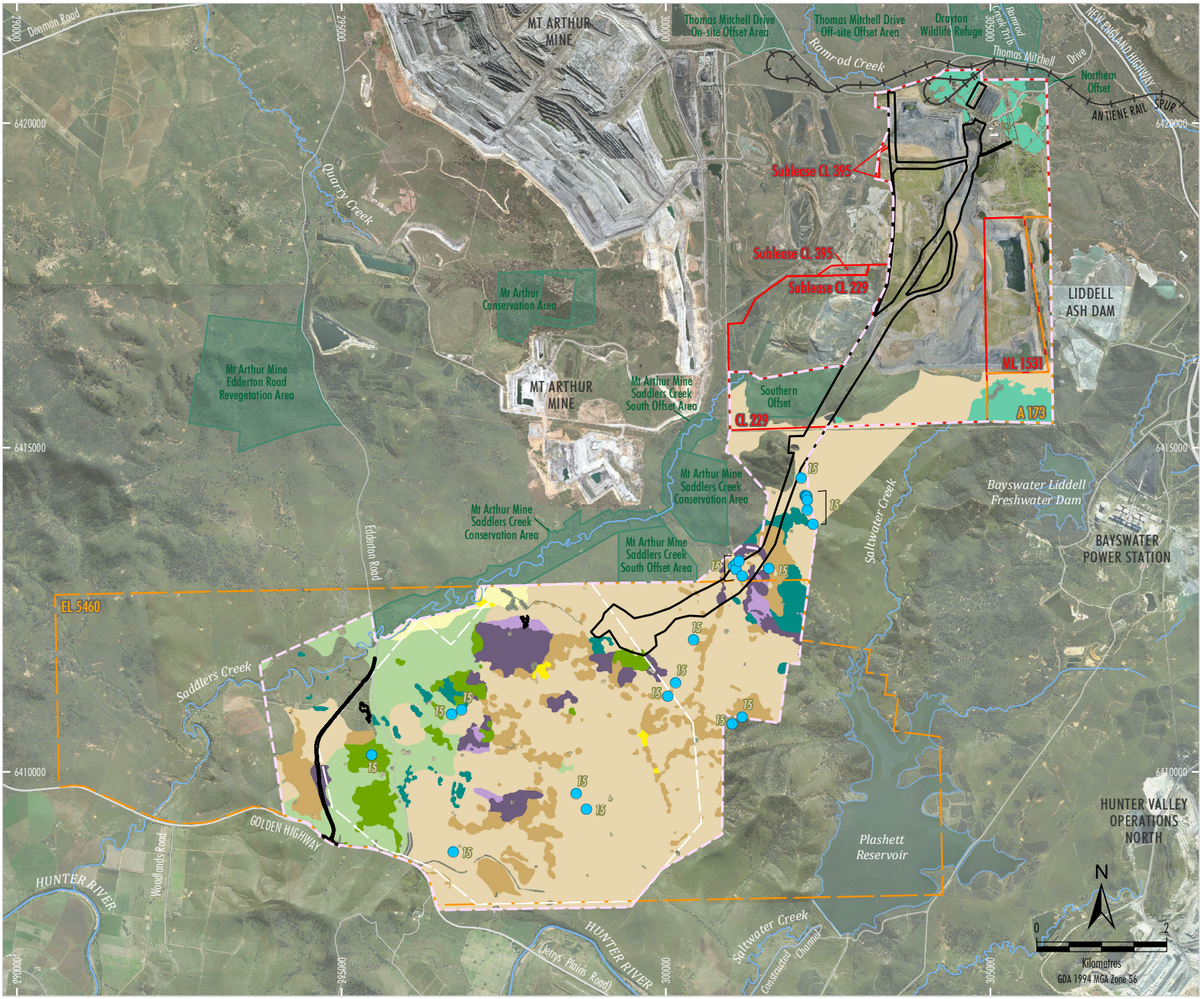
This species has not been previously recorded in the study area (Table 1). A single individual of this species was observed at Site 5 (within PCT 1655) in September 2018 during vegetation surveys (Colin Driscoll Hunter Eco, pers. obs.). (Figure 9). It was not observed during any other survey period.

A raptor nest located within 200 m of this observation was checked several times during September, November and December 2018 by Future Ecology and while it appeared to be in use in September due to fresh prey remains and whitewash below the nest no raptor species was ever observed in or near the nest. During the November-December surveys the nest appeared to be unoccupied.

Several additional raptor nests were detected across the study area during current surveys and if occupied the only occupants observed were Wedge-tailed Eagles.

There are additional records of this species outside the study area (ALA, 2018) where it appears to have been observed in cleared agricultural land and disturbed native vegetation.

No evidence of breeding habitat for this species was recorded and therefore this species is regarded as an Ecosystem Credit Species within the study area. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which occur in the study area would provide potential habitat (Appendix C).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Striped Legless Lizard

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)
- 3a. Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 7a. Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 9a. Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Striped Legless Lizard Species Polygon

Figure 15

SHM-18-03 Maxwell_EIS_App_Fauna_210F

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

This species is listed as 'vulnerable' in NSW and is nationally listed as a Marine species. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species has not been previously recorded in the study area (Table 1). Two individuals were observed gliding across Site 15 (over PCT 1604) during the August 2018 surveys (Figure 9). They were not observed to land or to perch.

There are additional records of this species outside the study area (Birdlife Australia, 2018; ALA, 2018; OEH, 2019b) where it appears to have been observed over water (Lake Liddell), cleared agricultural land and native vegetation as well as near the Mt Arthur Mine.

A large raptor nest was detected at Site 15 during the August 2018 survey but it was observed to be occupied by a Wedge-tailed Eagle. Several additional raptor nests were detected across the study area during current surveys and if occupied the only occupants observed were Wedge-tailed Eagles.

No evidence of breeding habitat for this species was recorded and therefore this species is regarded as an Ecosystem Credit Species within the study area. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which occur in the study area would provide potential habitat (Appendix C) together with the non-associated PCT 1604.

Spotted Harrier (*Circus assimilis*)

This species is listed as 'vulnerable' in NSW but it is not nationally listed. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species was observed as single individuals at several locations in the study area including Sites 5 and 18 during the November-December 2018 survey period mostly foraging over open grassland (Figure 9; Plate 3). It is indeterminant whether the same or several individuals were observed over the survey period.

The mapped PCTs in which it was observed during November 2018 were PCT1606 DNG and PCT1691.

Several raptor nests were detected across the study area during current surveys and if occupied the only occupants observed were Wedge-tailed Eagles.

The PCTs in the *Threatened Biodiversity Data Collection* (OEH, 2019a) associated with this highly mobile species which have been mapped in the study area would provide potential habitat (Appendix C) (i.e.PCT 1731) together with two additional non-associated PCTs in which it was observed, namely PCT 1606 DNG and PCT 1691.

Plate 3: Spotted Harrier, November 2018 (Alex Dudley).

Little Eagle (*Hieraaetus morphnoides*)

This species is listed as 'vulnerable' in NSW and it is not nationally listed. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species was observed as single individuals at two locations during the November 2018 survey (Figure 9).

Two different individuals may have been observed based on morphology – one individual appeared to be a light morph and the other a dark morph.

The mapped PCT in which it was observed during November 2018 was PCT 1606 and 1606 DNG. Mapped PCTs at previous observations of this species by others within the study area include PCT 1655 DNG (Cumberland Ecology, 2012). It was also recorded by Umwelt (2007b) within the study area but it is not clear in what PCT (note this record is not shown on Figure 9 as the location was not reported).

There are additional records of this species outside the study area where it appears to have been observed in both cleared agricultural land, rural residential land and disturbed native vegetation.

Several raptor nests were detected across the study area during current surveys and if occupied the only occupants observed were Wedge-tailed Eagles.

No evidence of breeding habitat for this species was recorded and therefore this species is regarded as an Ecosystem Credit Species within the study area. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which occur in the study area would provide potential habitat (Appendix C).

Glossy Black Cockatoo (*Calyptorhynchus lathami)*

This species is listed as 'vulnerable' in NSW and it is not nationally listed. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species has not been previously recorded in the study area (Table 1). It was detected indirectly at Site 16 in August 2018 (Figure 9), via the observation of chewed cones of a she-oak species *Allocasuarina gymnanthera*, a known food species for Glossy Black Cockatoo (DEC, 2004b). Chewed cones were observed under several trees at two nearby locations within Site 16. The second location was about 20 m north of the actual northern boundary of the study area and Site 16. The actual birds were never observed and no nesting activity was observed despite the presence of suitable large tree hollows at several locations within the study area.

The mapped PCT in which it was observed within the study area was PCT 1604.

The vegetation at the second location just outside the northern boundary of the study area and within 20 m of Site 16 is not mapped but the adjacent vegetation includes:

- PCT 1598.
- PCT 1604.

There are no previous observations of this species by others within the study area.

No evidence of breeding habitat for this species was recorded and therefore this species is regarded as an Ecosystem Credit Species within the study area. The published PCTs for this species which occur in the study area would provide potential habitat (Appendix C).

Little Lorikeet (*Glossopsitta pusilla)*

This species is listed as 'vulnerable' in NSW and it is not nationally listed. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species has been previously recorded in the study area by Hanson Bailey (2007) within PCT 1604 Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland (Table 1). This species was recorded in January 2018 and June 2018 (most observations during flowering of Grey Box/White Box). It was observed at Site 1 (six individuals), 3 (two individuals), 5 (six individuals), 6 (no. of individuals not recorded), 7 (one individual) and immediately adjacent to Site 11 (four individuals) but about 40 m outside of study area (Figure 9).

The mapped PCTs in which it was observed include:

- PCT 201.
- PCT 1655.
- PCT 1606 (just outside of study area).
- PCT 1607.
- PCT 1691.

The PCTs in the *Threatened Biodiversity Data Collection* (OEH, 2019a) associated with this highly mobile species which have been mapped in the study area would provide potential habitat (Appendix C).

Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at Sites 5 and 11 during the 2018 survey periods (Figure 9):

- Site 5 (one to six individuals) in January, June, September and November 2018.
- Site 11 (one to two individuals) in June 2018.

The mapped PCTs in which it was observed include:

- PCT 1655.
- PCT 1606 and PCT 1606 DNG.
- PCT 1691.

Mapped PCTs at previous observations of this species by others within the study area (Figure 9) include:

- PCT 1606 DNG (OEH, 2019b).
- PCT 1691.
- PCT 1655 (Cumberland Ecology, 2012).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Speckled Warbler (*Chthonicola sagittata*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period as follows (Figure 9):

- Site 1 (one to three individuals) in January, June, September and November 2018.
- Site 2 (one to four individuals) in January, June and November 2018.
- Site 3 (two to three individuals) in January, June and November 2018.
- Site 5 (one to four individuals) in January, June and November 2018.
- Site 6 (one to five individuals) in January, June and November 2018.
- Site 7 (one to five individuals) in June and November 2018.
- Site 11 (two individuals) in June and November 2018.
- Site 13 (one individual) in June 2018.
- Site 15 (two to three individuals) in August 2018.

The mapped PCTs in which it was observed include:

- PCT 201 and 201 DNG;
- PCT 1655 DNG;
- PCT 1604;
- PCT 1606 and 1606 DNG;
- PCT 1607 and 1607 DNG;
- PCT 1691; and
- PCT 1692.

It has been previously observed within the study area by others including Cumberland Ecology (2012) with records from what are now Sites 2, 6, 10 and about 20 m from Site 16 just outside the study area (Eco Logical Australia, 2015) (Figure 9).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1606 (Cumberland Ecology, 2012);
- PCT 1691 (Cumberland Ecology, 2012; OEH, 2019b); and
- PCT 1598 (Eco Logical Australia, 2015) – just outside of Site 16 and study area.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

Two individuals of this species were observed mating at Site 6 in June 2018, within PCT 1691 (Figure 9).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Painted Honeyeater (*Grantiella picta*)

This species is listed as' vulnerable' in NSW and is nationally listed as vulnerable. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species has not been previously recorded in the study area (Table 1). A single individual was detected at Site 1a in January 2018, within PCT 1607 (Figure 9).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) (Figure 16).

Flame Robin (*Petroica phoenicea*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

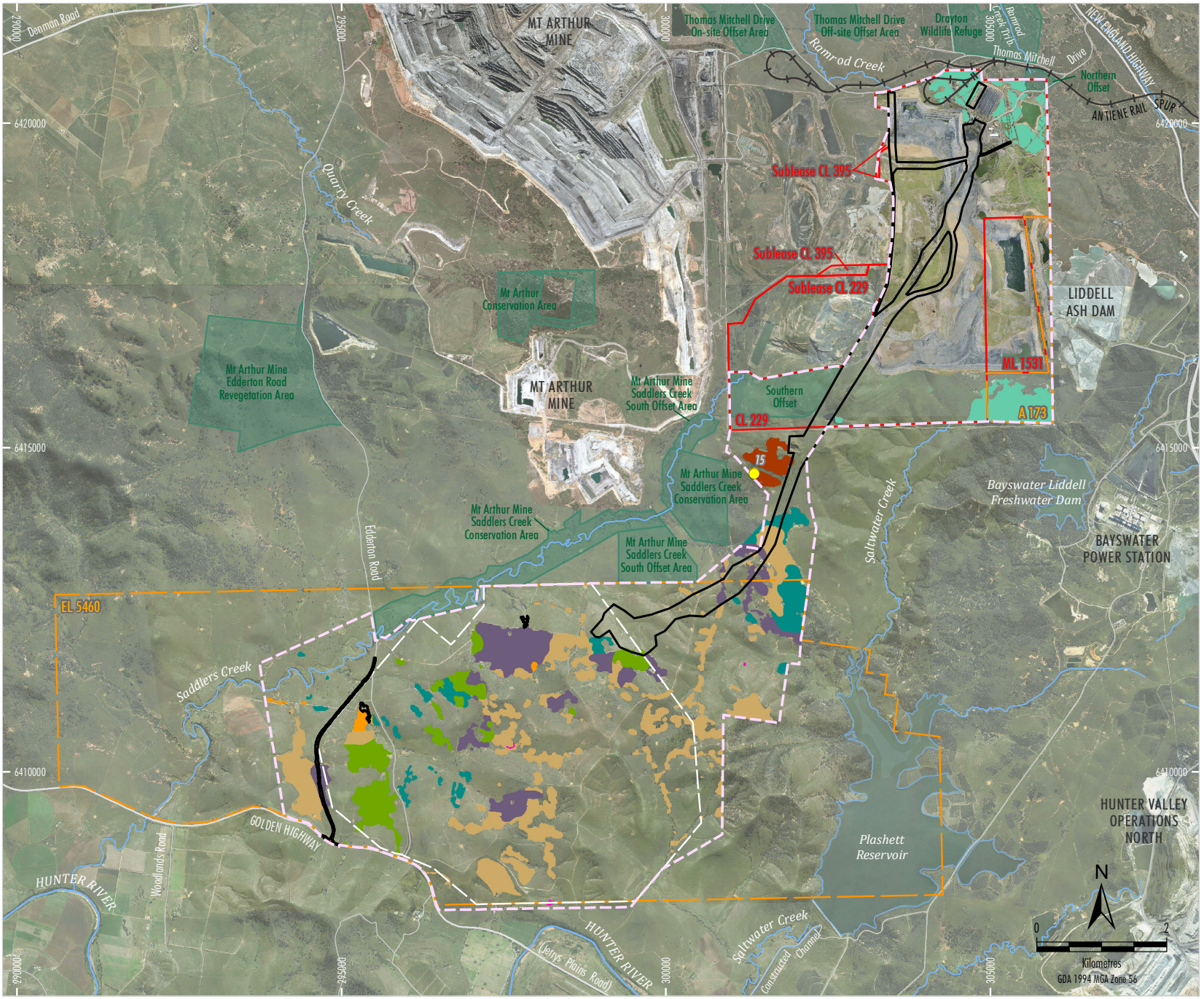
This species has not been previously recorded in the study area (Table 1). It was detected during the 2018 survey period as follows (Figure 9):

- Site 1 (one individual) in June 2018; and
- Site 15 (one individual on two dates) in August 2018.

The mapped PCTs in which it was observed were:

- PCT 1604; and
- PCT 1607.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Painted Honeyeater

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 10. Weeping Myall Woodland (PCT116)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
15. Future Ecology (2019)
Note: There are no references 1 - 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Painted Honeyeater Potential Habitat

Figure 16

Scarlet Robin (*Petroica boodang*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected during the 2018 survey period as follows (Figure 9):

- Site 6 (one individual) in June 2018;
- Site 7 (one individual on two separate days) in June 2018; and
- Site 11 (one individual) in June 2018.

The mapped PCTs in which it was observed were:

- PCT 1606;
- PCT 1655 DNG; and
- PCT 1691.

It has been previously observed within the study area by others including Cumberland Ecology (2012) with records from what are now Sites 2, 6 and 10 (Figure 9). Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1606 (Cumberland Ecology, 2012); and
- PCT 1691 (Cumberland Ecology, 2012; OEH, 2019b).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period as follows (Figure 9):

- Site 3 (3 to 13 individuals) in January and December 2018.
- Site 4 (3 to 9 individuals) in January, November and December 2018.
- Site 5 (3 to 7 individuals) in January and November 2018.
- Site 6 (2 to 5 individuals) in January, June, September and November 2018.
- Site 7 (2 to 9 individuals) in January, June, September, November and December 2018.
- Site 15 (3 to 6 individuals) in August 2018.
- Site 18 (five individuals) in November 2018.
- Incidental (5 to 8 individuals) in January 2018.

The mapped PCTs in which it was observed include:

- PCT 201;
- PCT 1655 and PCT 1655 DNG;
- PCT 1604;

- PCT 1606 and PCT 1606 DNG;
- PCT 1691;
- PCT 1692;
- PCT 1693; and
- PCT 1731.

It has been previously observed within the study area by others with records from what are now Site 4, just south of Site 5, near Site 9, just north of what is now Site 18 (OEH, 2019b; Cumberland Ecology, 2012:2015) (Figure 9).

Mapped PCTs at previous observations of this species by others within the study area include:

- No PCT – Planted Trees (Cumberland Ecology, 2012).
- PCT 1691 (Cumberland Ecology, 2012).
- PCT 1693 and PCT 1731 (Cumberland Ecology, 2012) – just outside of Site 18 and study area.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCT 1693 and PCT 1731.

Varied Sittella (*Daphoenositta chrysoptera*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period as follows (Figure 9):

- Site 2 (3 to 12 individuals) in January and November 2018.
- Site 7 (1 to 3 individuals) in June and November 2018.
- 50 m outside Site 11 and study area (five individuals) in June 2018.
- Site 15 (three individuals) in August 2018.

The mapped PCTs in which it was observed include:

- PCT 1604;
- PCT 1606 and 1606 DNG;
- PCT 1655 and 1655 DNG;
- PCT 1691; and
- PCT 1692.

It has been previously observed within the study area by others with a record from around 1 km north of Site 1 within the Maxwell Infrastructure area (Eco Logical Australia, 2015) (Figure 9).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1598 (Eco Logical Australia, 2015).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCT 1598 and PCT 1692.

Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

This species has not been previously recorded in the study area (Table 1). It was detected at several locations within the study area during the 2018 survey period as follows (Figure 9):

- Site 5 (no. of individuals not recorded) in January 2018.
- Site 6 (no. of individuals not recorded) in January 2018.
- Site 15 (13 individuals) in August 2018.
- Site 17 (1 to 3 individuals) in November and December 2018.

The mapped PCTs in which it was observed include:

- PCT 201;
- PCT 1606 DNG;
- PCT 1655; and
- PCT 1604.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCT 1604 and PCT 1606 DNG.

Squirrel Glider (*Petaurus norfolcensis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period as follows (Figure 10):

- Site 11 (two individuals recorded on same occasion via spotlight) in January 2018.
- Site 5 (one individual recorded via spotlight on two occasions) in November 2018.
- Site 6 (two individuals recorded on same occasion via spotlight) in November 2018.

The mapped PCTs in which it was observed include:

- PCT 1655; and
- PCT 1606.

It has been previously observed within the study area by others with records from just north of what is now Site 17, at Site 17, and around 750 m north-west of what is now Site 1 all within the Maxwell Infrastructure area (Cumberland Ecology, 2009a; Eco Logical Australia, 2015, 2016a, 2016b; OEH, 2019b) (Figure 10).

It is not clear as to how many individual Squirrel Gliders have been previously recorded by others within the study area but Cumberland Ecology (2009a) states that five Squirrel Gliders were recorded via trapping in February 2007 in what is now Site 17. Eco Logical Australia (2016b) do not state how many individual Squirrel Gliders were recorded only the areas in which they were recorded.

There are additional records of this species outside the study area (Umwelt, 2006b, 2007b; Cumberland Ecology, 2009a, 2010; OEH, 2019b) where it appears to have been recorded in cleared agricultural land, native vegetation, disturbed native vegetation, and the edge of disturbed mining lands (note that some of these records are not shown on Figure 10 as the locations were not reported). Some of the records are from within 250 m of the north-west corner of the study area between the Maxwell Infrastructure and the Mt Arthur Mine and around 750 m north-west of what is now Site 1 (Cumberland Ecology, 2009a). Adjacent mapped vegetation in the study area is PCT 1598 and PCT 1606 DNG and woodland rehabilitation. There is an additional record from about 15 m east of the study area and what is now Site 16 (OEH, 2019b). The adjacent mapped vegetation is PCT 1598 and PCT 1604.

This species is likely to occur in low numbers throughout the study area in associated PCTs (201, 1655, 1606). It was also recorded in the study area in the non-associated PCTs 1598 and 1604. It does not require large vegetation remnants to occur as it has a relatively small mean home range of 3-9 ha in coastal habitats and 3-4 ha in productive inland habitat fragments (NSW Scientific Committee, 2008). It is more likely to occur in vegetation patches with suitable microhabitat components (Smith, 2002; Smith and Murray, 2003; NSW Scientific Committee, 2008; Beyer et al., 2008; Crane et al., 2013). including:

- large healthy eucalypt trees close to drainage lines with a preference for Yellow Box (*E. melliodora*) when eucalypts are not flowering and large healthy eucalypts on ridges and upper slopes when eucalypts are in flower;
- abundant tree hollows with small openings (<=5 cm) for denning in living or dead trees; and
- a variety of food resources including nectar, pollen, sap and invertebrates and most importantly a reliable supply of winter nectar and pollen in either the canopy or understorey plant species.

Figure 17 shows the species polygon (extent of habitat) for the Squirrel Glider in the study area.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

This species is listed as ‘vulnerable’ under the BC Act and EPBC Act. It is classified as a ‘Species/Ecosystem Credit Species’ in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

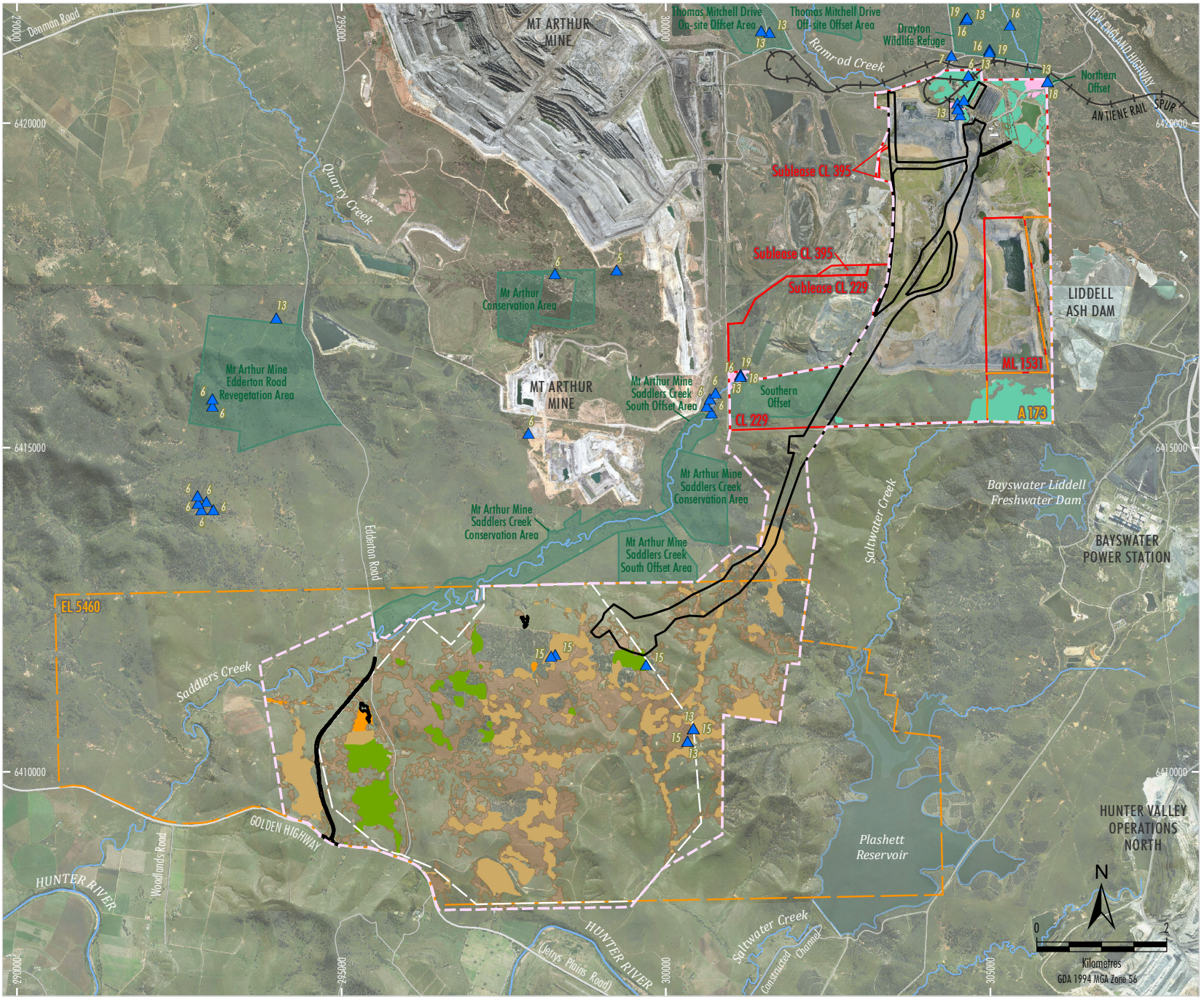
This species has been previously recorded in the study area by Hansen Bailey (2007) (Table 1). It was detected foraging in flowering White Box (*Eucalyptus albens*) trees within the study area during the 2018 survey period as follows (Figure 11):

- Site 5 (two individuals recorded) in June 2018.
- Site 11 (one individual recorded) in June 2018.

The mapped PCTs in which it was observed were PCT 1606 and PCT 1606 DNG.

It has not been previously observed within the study area by others except for a single individual observed flying over the woodland adjacent to the Maxwell Infrastructure office building (Hansen Bailey, 2007). The vegetation here has been mapped as PCT 1604.

There are some additional records of this species outside the study area including records from the adjacent Mt Arthur Mine (Niche, 2012; OEH, 2019b) where vegetation was previously listed as or currently appears to be rehabilitation grassland, rehabilitation woodland, remnant woodland, and disturbed native vegetation.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Squirrel Glider

SPECIES POLYGON MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Forested Wetlands

- 5. Hunter Lowland Red Gum Forest (PCT1598)

Grassy Woodlands

- 8. Fuzzy Box Woodland (PCT201)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Other

- Paddock Trees that may provide Potential Habitat

Reference:

5. Umwelt (2007b)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
13. OEH (2019)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)

Note: There are no references 1 - 4, 8 - 12, 14 and 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)

Orthophoto Mosaic: 2018, 2016, 2011

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Squirrel Glider Species Polygon

Figure 17

SHM-18-03 Maxwell_EIS_App_Fauna_216G

No camps of this species were recorded within the study area during current surveys. Hansen Bailey (2007) state that no camps were observed in the study area during their field surveys over 10 years ago.

The closest mapped camp of this species to the study area are from Muswellbrook township (DEE, 2019), approximately 8 km north of the study area.

Given that no camps of this species occur within the study area it will be considered as an Ecosystem Credit Species under the BAM. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) (Figure 18).

Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at one location within the study area during the 2018 survey period with a definite confidence level, namely Site 2 (via acoustic recording) in January 2018. (Figure 11).

The mapped PCT in which it was recorded was PCT1606.It has been previously observed within the study area by others (Cumberland Ecology, 2011; OEH, 2018), with records from what is now Site 5, 7 as well as within old mine workings within the Maxwell Infrastructure area. Currently mapped vegetation at these observations include PCT1176 and PCT1606 (DNG).

There are a few additional records of this species outside the study area from the adjacent Mt Arthur Mine area (Cumberland Ecology, 2009a, 2012; OEH, 2019b) where it appears to have been recorded in disturbed native vegetation and what is now disturbed mining lands.

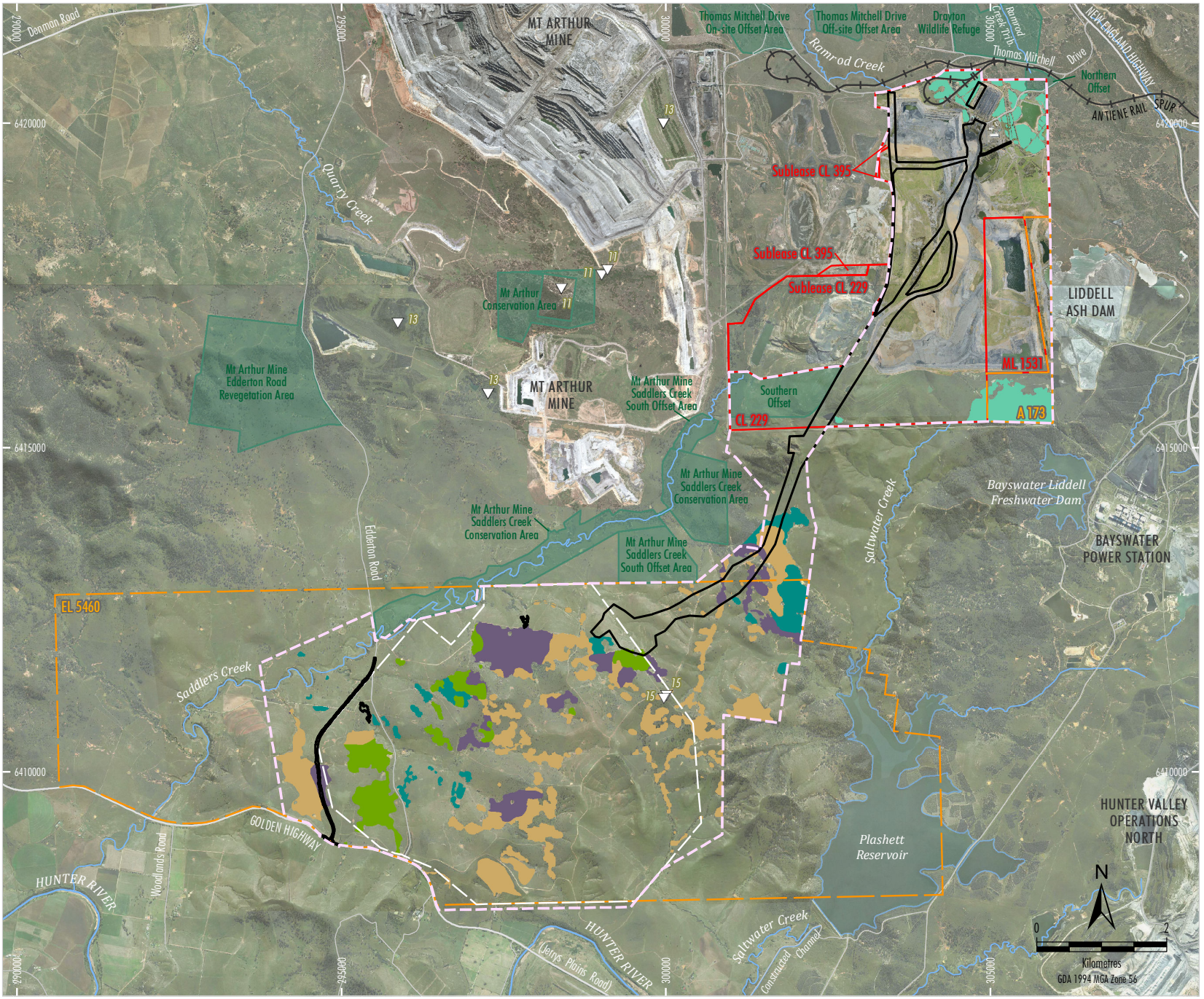
The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Eastern Freetail-bat (*Mormopterus norfolkensis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at one location within the study area during the 2018 survey period with a definite confidence level at a small rocky escarpment near the main entrance off Golden Highway/Edderton Road (via acoustic recording) in December 2018 (Figure 11). The mapped PCT in which it was recorded was PCT 1606.

It has been previously observed within the study area by others with records from the south-west corner of the Maxwell Infrastructure (Eco Logical Australia, 2017; OEH, 2019b), within 20m of the north-east corner of the study area adjacent to what is now Site 16, just south of what is now Site 5 (OEH, 2019b), southern and central western parts of the Maxwell Infrastructure area (Eco Logical Australia, 2017), Site 6 (Ecotone, 2000), Sites 6, 7 and 12 (Cumberland Ecology, 2012) (Figure 11).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Grey-headed Flying-fox

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
11. Niche (2012)
13. OEH (2019)
15. Future Ecology (2019)
Note: There are no references 1 - 10, 12 and 14 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Grey-headed Flying-fox Potential Habitat

Figure 18

SHM-18-03 Maxwell_EIS_App_Fauna_220E

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT1598 (Eco Logical Australia, 2017);
- PCT1655 (Cumberland Ecology, 2012);
- PCT1606 (Cumberland Ecology, 2012);
- PCT1691 (Ecotone, 2000); and
- PCT1693 (Cumberland Ecology, 2012).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCTs 1598, 1606, 1693.

Little Bentwing-bat (*Miniopterus australis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period via acoustic recording with a definite confidence level as follows (Figure 11):

- Site 2 in January 2018.
- Site 5 in January 2018.
- Site 10 in January 2018.
- Site 11 in January 2018.

The mapped PCT in which it was recorded was PCT 1606 and 1606 DNG.

It has been previously observed within the study area by others with records from the south-west corner of the Maxwell Infrastructure area (Eco Logical Australia, 2017; OEH, 2019b), within 20 m of the north-east corner of the study area adjacent to what is now Site 16, and central western part of the Maxwell Infrastructure area (Eco Logical Australia, 2017) (Figure 11).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1598 (Eco Logical Australia, 2017; OEH, 2019b).

Only five nursery sites /maternity colonies are known in Australia, most typically limestone caves and in NSW they share maternity roosts with the Eastern Bentwing-bat (Churchill, 2009; OEH, 2019c).

The study area provides little in the way of potential maternity roost habitat defined as caves, underground mines or tunnels by the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018). In addition, there no records of this species within or adjacent to the study area indicating that records were obtained within caves, roosts or where observed numbers exceeded 500 individuals.

The study area has a few minor sandstone overhangs and crevices at Site 1 and a small rocky escarpment near the entrance to the Plashett property at the corner of Golden Highway and Edderton Road. There were also some crevices associated with the old volcanic rock quarry at Site 1. There was no sign of any maternity roosts at any of these sites (including actual bats entering/exiting overhangs and crevices, guano, staining, meal remains, capture of lactating females, high numbers of calls recorded on acoustic devices) despite roost searches, harp-trapping and acoustic monitoring taking place during the summer breeding period for this species.

Due to the absence of breeding habitat, this species is considered an ecosystem credit species in the study area. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCTs 1598 and 1606.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period via acoustic recording with a definite confidence level as follows (Figure 11):

- Site 1 in January 2018.
- Site 2 in January 2018.
- Site 4 in January 2018.
- Site 5 in January 2018.
- Site 10 in January 2018.
- Site 11 in January 2018.

The mapped PCT in which it was recorded were:

- PCT 1606 and 1606 DNG; and
- PCT 1607 DNG.

It has been previously observed within the study area by others with records from just south of Site 5 (OEH, 2019b), at Sites 6, 7 and 12 (Cumberland Ecology, 2012), the north-east sections of the Maxwell Infrastructure area (OEH, 2019b), within 20m of the north-east corner of the study area adjacent to what is now Site 16 (Eco Logical Australia, 2015-2017; OEH, 2019b), in rail loop area north of Site 17 (Umwelt, 2006b), and south-western and south central parts of the Maxwell Infrastructure area (Eco Logical Australia, 2014-2017; OEH, 2019b) (Figure 11).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT1598 (Eco Logical, 2014-2017);
- PCT1655 (Cumberland Ecology, 2012);
- PCT1604 (Umwelt, 2006b);
- PCT1606 (Cumberland Ecology, 2012); and
- PCT1693 (Cumberland Ecology, 2012).

There are additional records of this species outside the study area (Umwelt, 2006b; Cumberland Ecology, 2009a; Niche, 2012; OEH, 2019b) where it appears to have been recorded in agricultural land, native vegetation, rehabilitation woodland, disturbed native vegetation and active mining disturbance areas with several records associated with the Mt Arthur Mine (note that some of these records are not shown on Figure 11 as the locations were not recorded).

It is known from at least three complex limestone cave (Karst) systems in NSW including Abercrombie, Jenolan and Wombeyan Karst Conservation Reserves and in NSW they share maternity roosts with the Eastern Bentwing-bat (National Parks and Wildlife Service, 2019).

The study area provides little in the way of potential maternity roost habitat defined as caves, underground mines or tunnels by the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method'* (OEH, 2018). In addition, there no records of this species within or adjacent to the study area indicating that records were obtained within caves, roosts or where observed numbers exceeded 500 individuals.

The study area has a few minor sandstone overhangs and crevices at Site 1 and a small rocky escarpment near the entrance to the Plashett property at the corner of Golden Highway and Edderton Road. There were also some crevices associated with the old volcanic rock quarry at Site 1. There was no sign of any maternity roosts at any of these sites (including actual bats entering/exiting overhangs and crevices, guano, staining, meal remains, capture of lactating females, high numbers of calls recorded on acoustic devices) despite roost searches, harp-trapping and acoustic monitoring taking place during the summer breeding period for this species.

Due to the absence of breeding habitat, this species is considered an ecosystem credit species in the study area. The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCTs 1598, 1607 and 1693.

Large-eared Pied Bat (*Chalinobolus dwyeri*)

This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was detected at several locations within the study area during the 2018 survey period via acoustic recording with a definite confidence level as follows (Figure 11):

- Site 1 in January 2018 and December 2018.
- Site 2 in January 2018.
- Site 3 in January 2018.
- Site 4 in January 2018.
- Site 10 in January 2018.
- Site 11 in January 2018.

The mapped PCT in which it was recorded were:

- PCT 1606 and 1606 DNG; and
- PCT 1607 and 1607 DNG.

It has been previously observed within the study area by others with records from Site 7 (Cumberland Ecology, 2012), the south-west corner of the Maxwell Infrastructure area (Eco Logical Australia, 2017) and central western part of the Maxwell Infrastructure area (Eco Logical Australia, 2017) (Figure 11).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT1655 (Cumberland Ecology, 2012); and
- PCT1598 (Eco Logical Australia, 2017).

There are additional records of this species outside the study area (Cumberland Ecology, 2012; OEH, 2019b) where it appears to have been recorded in disturbed native vegetation. There is an additional record from Eco Logical Australia (2015) although it is not stated where (note this record is not shown on Figure 11 as the location was not reported).

Potential breeding habitat for this species is defined as: "The PCTs associated with the species (as per the TBDC) within 100 m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old underground mines, tunnels, culverts, derelict concrete buildings" by the *'Species Credit' Tthreatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

The study area has a few minor sandstone overhangs and crevices at Site 1 and a small rocky escarpment near the entrance to the Plashett property at the corner of Golden Highway and Edderton Road. There were also some crevices and Fairy Martin (*Petrochelidon ariel*) nests (Churchill, 2009) associated with the old volcanic rock quarry at Site 1. None of the overhangs at Site 1 appeared to be deep enough to provide the 'twilight area', and high domed ceiling with indentations in which this species prefers to roost (Churchill, 2009; QLD Department of Environment and Resource Management, 2011).

The largest overhang observed was at the small rocky escarpment near the Golden Highway and this had a depth of around 3-4 m with a crevice running through the ceiling. There was no sign of any maternity roosts at any of these sites (including actual bats entering/exiting overhangs and crevices, guano, staining, meal remains, capture of lactating females, high numbers of calls recorded on acoustic devices) despite roost searches, harp-trapping and acoustic monitoring taking place during the summer breeding period for this species (November to end of January). No bats of this species were captured in harp traps during the survey including those placed at the Site 1 Quarry (November 2018) and the Site 1 Powerline Easement (December 2018) just below a rocky escarpment. There was calls recorded from this species at the Site 1 Powerline Easement site but none at the Site 1 Quarry.

In addition, there are no records of this species within or adjacent to the study area indicating that records were obtained within caves, roosts etc.

Therefore, in accordance with '*Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018) breeding habitat is not considered present on the subject land because no breeding individuals of the target species were observed. In addition, the proposed impact is not a potential 'serious and irreversible impact' (SAII) (OEH, 2018).

Southern Myotis (*Myotis macropus*)

This species is listed as 'vulnerable' under the BC Act but is not listed under the EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

Two individuals were observed foraging over a dam at Site 10 within the study area in June 2018 (Figure 11). The pair were observed for nearly 30 minutes as they foraged within 20 cm of the dam surface occasionally raking its surface. An acoustic recorder was also used to supplement the visual observation. At least some of the calls had the typical characteristics for this species.

The mapped PCT around this dam at Site 10 was PCT 1606 and 1606 DNG.

It was not recorded with a definite confidence level anywhere else in the study area during the current survey period, was not caught in harp traps placed around dams at Site 1, 2, 3 and 5 and a mine dam (known as Savoy Dam) in November/December 2018 and was not observed foraging over any dam (apart from Site 10).

It has been previously observed within the study area by others with records from south of Site 5 (OEH, 2019b), Sites 3, 5 and 10 (Ecotone, 2000), Sites 6, 7 and 12 (Cumberland Ecology, 2012), the south-west corner and western central areas of the Maxwell Infrastructure area (Eco Logical Australia, 2017).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1655 (Ecotone, 2000; Cumberland Ecology, 2012);
- PCT 1606 (Ecotone, 2000; Cumberland Ecology 2012);
- PCT 1606 DNG (OEH, 2019b);
- PCT 1693 (Cumberland Ecology, 2012); and
- PCT 1598 (Eco Logical Australia, 2017).

There are additional records of this species outside the study area (Cumberland Ecology, 2012; Eco Logical Australia, 2017; OEH, 2019b) where it appears to have been recorded in native vegetation, disturbed native vegetation, current disturbed mine workings, a dam and cleared agricultural land (note some of these records are not shown on Figure 11 as the location was not reported).

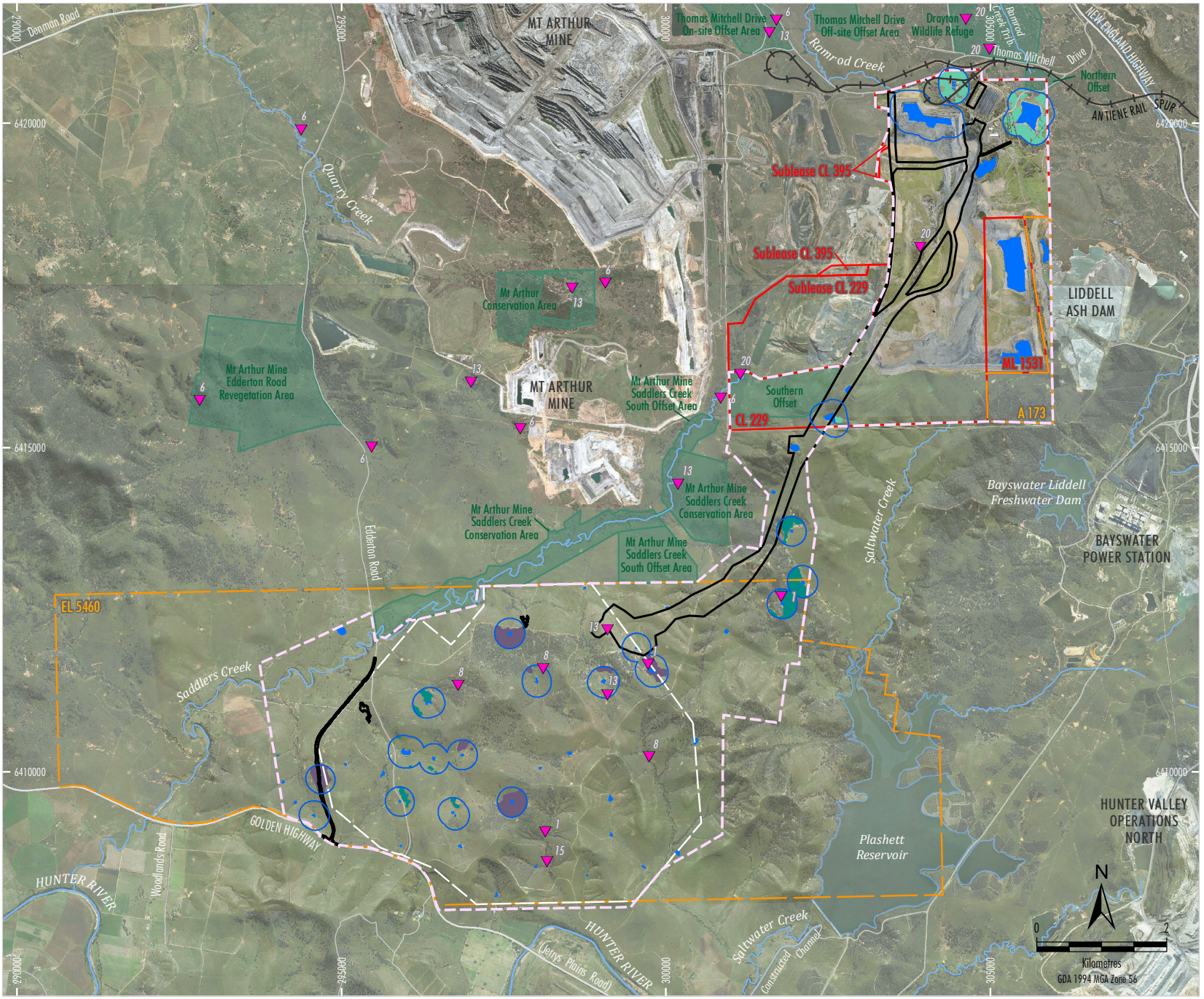
Potential breeding habitat for this species is defined as: ”The range of PCTs associated with the species (as per the TBDC) within 200 meters of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3m or wider)” by the *‘Species Credit’ Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

The study area has many farm dams but no permanently flowing creeks. No Southern Myotis was caught via harp trapping around the pond in the Old Quarry at Site 1 and at dams at Sites 2, 3, and 5. The study area lacks old wooden bridges typically favoured by this species. Culverts at Sites 10 and 17 and another at the Railway Loop dam were checked visually for roosting bats during the day but no bats, staining or guano was observed. The only potential breeding habitat would be the numerous old hollow-bearing trees which occur near some dams. Little Forest Bat (*Vespadelus vulturnus*) was observed to be possibly roosting in a hollow-bearing tree adjacent to a dam at Site 5 but Southern Myotis was not detected.

In addition, there no records of this species within or adjacent to the study area indicating that records were obtained within roosts etc.

Therefore, in accordance *‘Species Credit’ Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018) habitat is considered present in the study area in dams and ponds which occur in associated PCTs mapped for the study area, namely 1691, 1604, 1692.

Figure 19 shows the species polygon (extent of habitat) for the Southern Myotis in study area.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Southern Myotis

SPECIES POLYGON MAPPING

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Other

- Waterbody/Dam
- Waterbody/Dam 200 m Buffer

Reference:
1. Ecotone (2000)
6. Cumberland Ecology (2009a)
8. Cumberland Ecology (2012)
13. OEH (2019)
15. Future Ecology (2019)
20. Eco Logical Australia (2017)
Note: There are no references 2 - 5, 7, 9 - 12, 14 and 16 - 19 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Southern Myotis Species Polygon

Figure 19

SHM-18-03 Maxwell_EIS_App_Fauna_225F

3.3.2 Other Threatened Fauna Species Previously Recorded within the Study Area

Some additional threatened species which were not detected by Future Ecology during current surveys have been previously detected within the study area by others (Ecotone, 2000; Cumberland Ecology, 2009a:2012; Eco Logical Australia, 2017; OEH, 2018) and are listed in Table 18.

Figures 8 to 11 show the locations of threatened fauna species records (based on the surveys detailed in this report, previous surveys and database records) within the study area and surrounds. Unconfirmed records (those which are possible or probable) are not shown on the figures or the table below.

Table 18: Threatened Species Recorded by Others in the Study Area but not Future Ecology

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Previous Studies[8]
		BC Act[1]	EPBC Act[2]		
Birds					
Swift Parrot	*Lathamus discolor*	E	CE	E*	A
Barking Owl	*Ninox connivens*	V	-	E>	B
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	-	E	B
Diamond Firetail	*Stagonopleura guttata*	V	-	E	A, B, G
Mammals					
Spotted-tailed Quoll	*Dasyurus maculatus maculatus (south-eastern mainland population)*	V	E	E	C, D
Northern Freetail-bat	*Mormopterus lumsdenae*	V	-	E	F
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E	B
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	E	D, E
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	E	B, C, D, G
Eastern Cave Bat	*Vespadelus troughtoni*	V	-	S^	A, F, G

[1] Conservation status under the BC Act (current as at March 2019). V = Vulnerable, E = Endangered.

[2] Conservation status under the EPBC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

[3] Biodiversity credit class under the Threatened Biodiversity Data Collection (OEH, 2019a) (current as at March 2019). E = Ecosystem, S = Species.

* This species is classed an ecosystem credit species in the study area based on no important habitat mapping within the study area by OEH.

> This species is a duel credit species, however, no breeding habitat was recorded and therefore it is considered an Ecosystem credit species in the study area.

^ This species is a species credit species, however, no breeding habitat was recorded.

[8] Study area previous survey references:

A – Cumberland Ecology (2009a) and/or Cumberland Ecology (2012).

B – Ecotone (2000).

C – Eco Logical Australia (2016a).

D – Eco Logical Australia (2016b).

E – Eco Logical Australia (2015).

F – Eco Logical Australia (2017).

G – Hansen Bailey (2007).

Swift Parrot (*Lathamus discolor*)

This species is listed as 'endangered' in NSW and 'critically endangered' nationally. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a). Swift Parrot in the study area are classed as ecosystem credit species based on no important habitat mapping within the study area by OEH.

It was not recorded by Future Ecology during surveys in 2018 including surveys in June 2018 during some flowering of White Box/Grey Box (*Eucalyptus albens/moluccana*) in the study area but has been previously recorded in 2011 on what is now Site 5 (Cumberland Ecology, 2012) (Figure 9). Two individuals were detected; one observed foraging on mistletoe and Grey Box and the second individual was heard calling (Cumberland Ecology, 2012). The sightings were in PCT 1691.

There were few if any records of this species from the Upper Hunter during the winter months of 2018 but approximately 200 Swift Parrots were recorded in the Lower Hunter in May 2018 (Mick Roderick and Alex Berryman pers. obs. 29/5 in #234487 of Birdline NSW, 2019).

The PCTs in the *Threatened Biodiversity Data Collection* (OEH, 2019a) associated with this highly mobile species which have been mapped in the study area would provide potential habitat (Appendix C) (Figure 20).

Barking Owl (*Ninox connivens*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as a 'Species/Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected during current 2018 surveys within the study area despite numerous nocturnal call-playback and spotlighting sessions throughout the year, but has been previously detected in 2000 (Ecotone, 2000) at what is now Site 5 (Figure 9). There is little information about this observation other than this species was 'tentatively recorded' in 2000 within the study area (Cumberland Ecology, 2012).

There are also two additional records of this species from the study area within 1 km of the Ecotone observation (Figure 9). The *Bionet Atlas* record (OEH, 2019b) is also from the year 2000 and this species was listed as observed (rather than heard). There is not much detail of the third record other than its coordinates (ALA, 2018). Given that all three records from the study area are within 1 km of each other and two are from the year 2000 they could represent the same observation/record or at least the same survey as Ecotone (2000).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1606 DNG (Ecotone, 2000; ALA, 2018; OEH, 2019b).

There are no other records of this species from within the immediate vicinity of the study area.

Given that this species has not been recorded within the study area (or immediate vicinity) since 2000 and there was no indication of nesting/breeding, this species is regarded as an Ecosystem Credit Species within the study area. The published PCTs for this species which occur in the study area would provide potential habitat (Appendix C).

Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the Threatened Biodiversity Data Collection (OEH, 2019a).

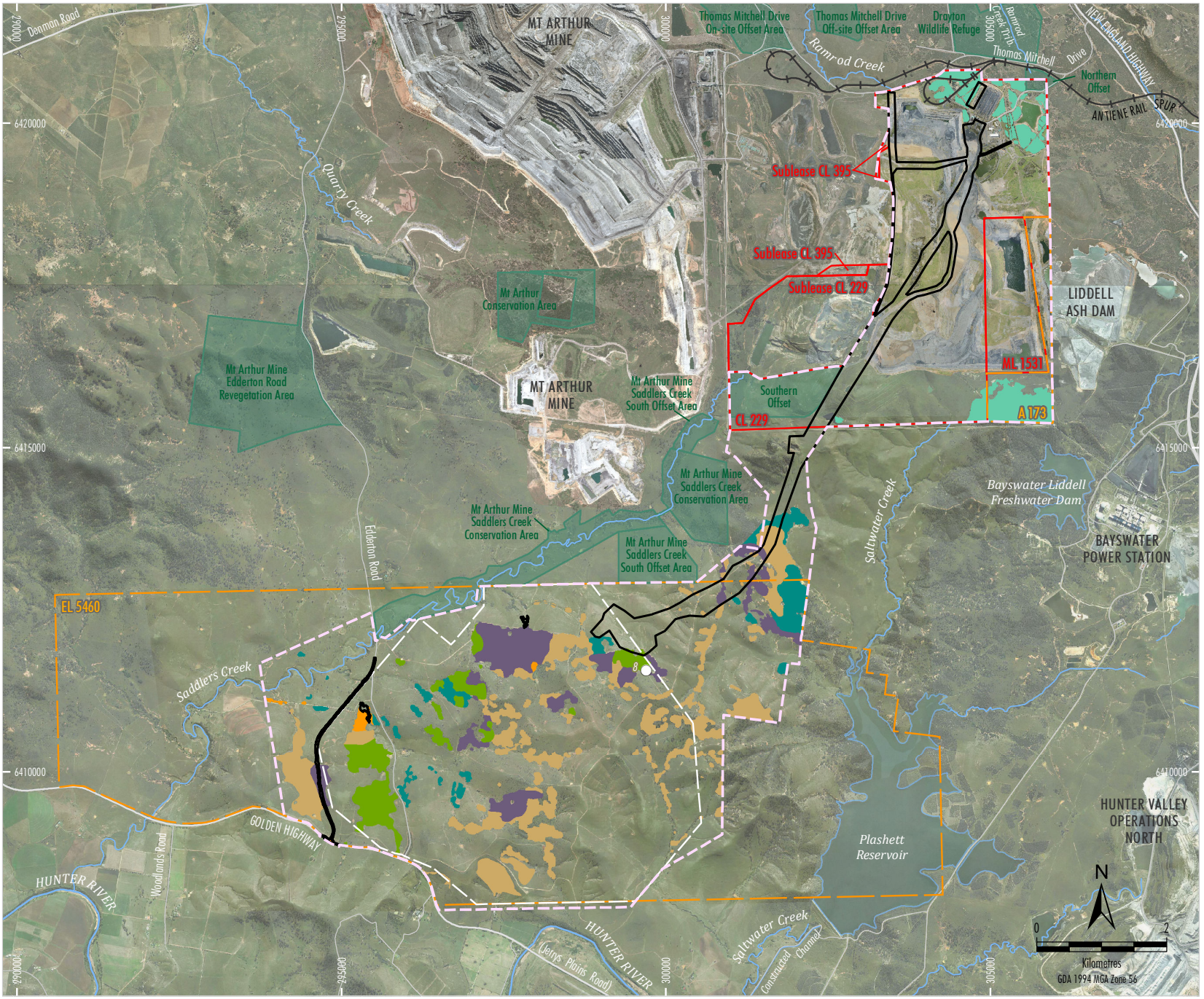
It was not detected during Future Ecology surveys in 2018. It has been previously recorded by others within the study area just south of what is now Site 5 (OEH, 2019b) (Figure 9).

The Bionet Atlas record (OEH, 2019b) lists four individuals as detected on 4/02/2000 and appears to be the same record from Ecotone (2000) discussed in Cumberland Ecology (2012).

The mapped PCT in which it was observed was PCT1606 DNG.

There are no additional records of this species within or nearby the study area.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Swift Parrot

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 8. Fuzzy Box Woodland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
8. Cumberland Ecology (2012)
Note: There are no references 1 - 7 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

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Swift Parrot Potential Habitat

Figure 20

SHM-18-03 Maxwell_EIS_App_Fauna_217F

Diamond Firetail (*Stagonopleura guttata*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected during Future Ecology surveys in 2018. It has been previously recorded by others within the study area as follows (Figure 9):

- At what is now Site 5 (Cumberland Ecology, 2012) – two individuals weredetected.
- At the Rail Loop Dam, west of what is now Site 17 (Hansen Bailey, 2007) – three individuals were detected.
- South of what is now Site 5 (OEH, 2019b).
- An unknown location within the study area (Ecotone, 2000) (note this record is not shown on Figure 9 as the location was not reported).

The mapped PCTs in which it was observed was:

- PCT 1604 (Hansen Bailey, 2007).
- PCT 1655 (Cumberland Ecology, 2012).
- PCT 1606 DNG (OEH, 2019b).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with additional non-associated PCTs in which it was also observed to occur within the study area, namely: PCT 1691.

Spotted-tail Quoll (*Dasyurus maculatus*) (south-eastern mainland population)

This species is listed as 'vulnerable' in NSW and is listed as 'endangered' nationally. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected during Future Ecology surveys in 2018.

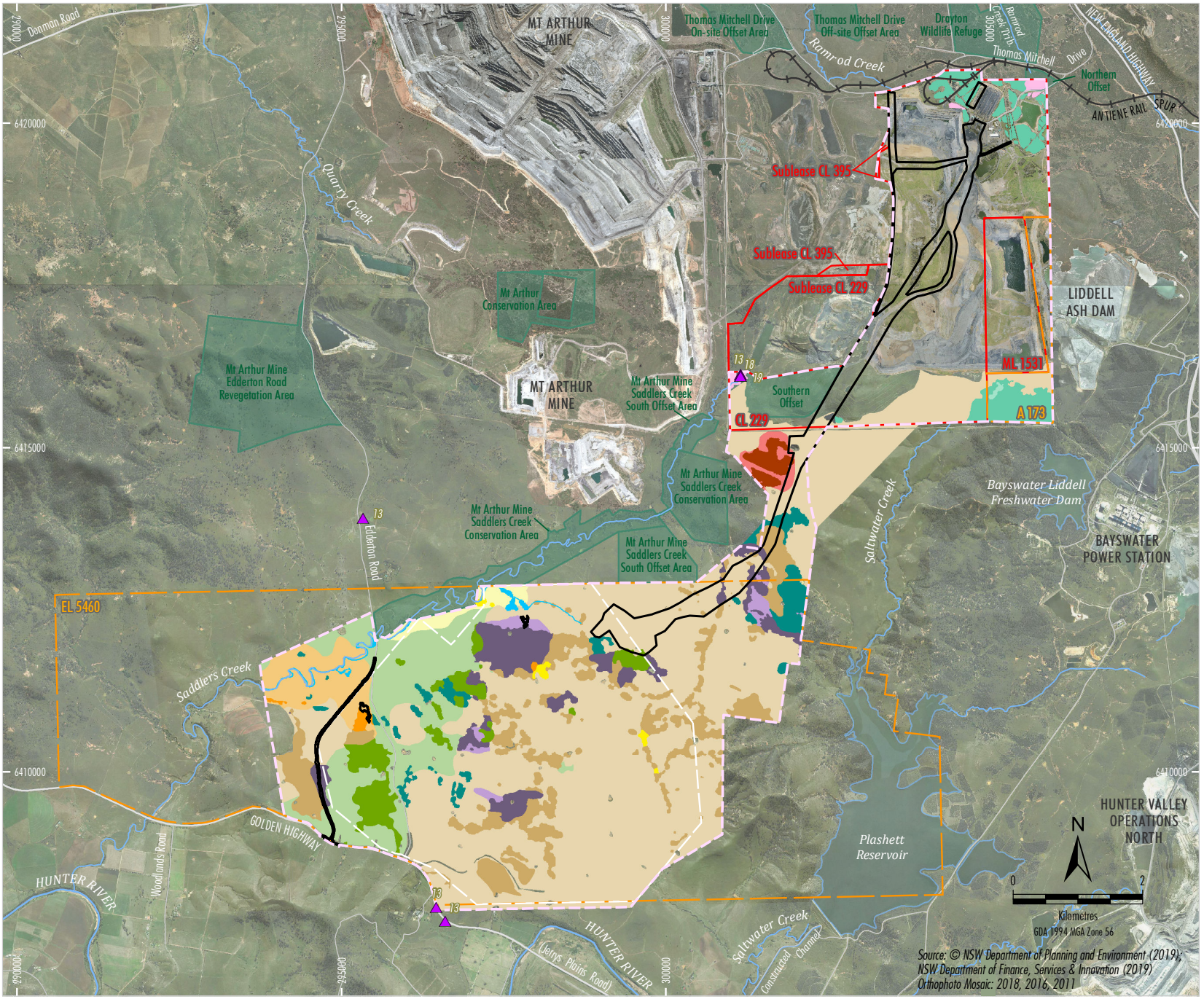
It has been previously observed within the study area by others with a record from around 1 km north of Site 1 within the Maxwell Infrastructure area (Eco Logical Australia, 2016a:2016b; OEH 2019b) (Figure 10).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1598 (Eco Logical Australia, 2016a:2016b), one individual was observed via wildlife camera.

There are additional records of this species outside the study area (ALA, 2018; OEH, 2019b) where it appears to have been recorded in cleared agricultural land, disturbed native vegetation, residential land (Jerrys Plains village), and on a road (New England Highway). The Spotted-tail Quoll was also tentatively recorded during the first half of 2016 by a HVEC staff member on the main access road to the Mt Arthur Mine offices (Hunter Eco, 2013).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

Figure 21 shows the potential habitat for the Spotted-tail Quoll in the study area.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Spotted-tailed Quoll

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 1a. Red Gum - Ironbark - Apple Shrubby Woodland - Derived Native Grassland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)
- 2a. White Box - Ironbark - Red Gum Shrubby Forest - Derived Native Grassland (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)
- 3a. Slaty Box Shrubby Woodland - Derived Native Grassland (PCT1655)

Forested Wetlands

- 4. Swamp Oak Forest (PCT1731)
- 5. Hunter Lowland Red Gum Forest (PCT1598)

Grassy Woodlands

- 6. Bull Oak Grassy Woodland (PCT1692)
- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 7a. Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693)
- 8. Fuzzy Box Woodland (PCT201)
- 8a. Fuzzy Box Woodland - Derived Native Grassland (PCT201)
- 9. Ironbark - Grey Box Grassy Woodland (PCT1691)
- 9a. Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)
- 11a. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland - Derived Native Grassland (PCT1604)

Reference:
13. OEH (2019)
18. Eco Logical Australia (2016a)
19. Eco Logical Australia (2016b)
Note: There are no references 1 - 13 and 15 - 17 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019) Orthophoto Mosaic: 2018, 2016, 2011

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Spotted-tailed Quoll Potential Habitat

Figure 21

SHM-18-03 Maxwell_EIS_App_Fauna_214D

Northern Freetail-bat (*Mormopterus lumsdenae*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected during the 2018 survey period by Future Ecology.

It has been previously observed within the study area by others with a single record from the south-west corner of the Maxwell Infrastructure area (Eco Logical Australia, 2017) (Figure 11). There are no details supplied as to how this species was detected but it is assumed that it was recorded on an acoustic device as part of the annual monitoring of the Maxwell Infrastructure area by Eco Logical Australia as such devices were used on the previous monitoring sessions (Eco Logical, 2014-2016).

The location where this species was recorded is mapped as PCT 1598 (Eco Logical Australia, 2017).

There are no additional records of this species outside the study area or within the Muswellbrook LGA (OEH, 2019b).

Given its current published distributional range of this species it is unlikely that this species occurs in the study area; positive identification would need to be made from a caught individual to confirm its occurrence locally.

Given that it does not occur in the region then, are no PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

Corben's Long-eared Bat (*Nyctophilus corbeni*)

This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected with a definite confidence level during the 2018 survey period by Future Ecology.

It has been previously observed within the study area by others with records south-west of Site 5 (OEH, 2019b), and south of Site 5, including Sites 5 and Site 6 (Ecotone, 2000) (Figure 11). There is no information available as to if this species was identified by live trapping or by call recording. A record in the *Bionet Atlas* (OEH, 2019b) dated the year 2000 from Saddlers Creek is probably an Ecotone (2000) record and states the detection method as 'M' or miscellaneous.

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1655 (Ecotone, 2000).
- PCT 1606 DNG (OEH, 2019b; Ecotone, 2000).
- PCT 1691 (Ecotone, 2000).

There is one additional record of this species outside the study area (where it occurs about 190m west of Site 2 (Ecotone, 2000) in disturbed native vegetation. Nearby mapped native vegetation includes PCT1606 DNG and PCT1692.

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat together with an additional non-associated PCT in which it was also observed to occur within the study area, namely: PCT 1691.

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected within the study area during the 2018 survey period with a definite confidence level.

It has been previously observed within the study area by others with records from the south-west corner of the Maxwell Infrastructure area and within 20m of the north-east corner of the study area adjacent to what is now Site 16 (Eco Logical Australia, 2015:2016b; OEH, 2019b) (Figure 11).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1598 (Eco Logical Australia, 2015:2016b; OEH, 2019b).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with an additional non-associated PCT in which it was also observed to occur within the study area, namely: PCT 1598.

Greater Broad-nosed Bat (*Scoteanax rueppellii*)

This species is listed as 'vulnerable' under the BC Act and is not listed under the EPBC Act. It is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected within the study area during the 2018 survey period with a definite confidence level.

It has been previously observed within the study area by others with records from just south-west of Site 5 (OEH, 2019b), Site 6, 10 (Ecotone, 2000), the south-west corner of the Maxwell Infrastructure area and within 20m of the north-east corner of the study area adjacent to what is now Site 16 (Eco Logical Australia, 2016a:2016b; OEH, 2019b) (Figure 11).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1598 (Eco Logical Australia, 2016a:2016b).
- PCT 1606 (Ecotone, 2000).
- PCT 1691 (Ecotone, 2000).

The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C) together with an additional non-associated PCT in which it was also observed to occur within the study area, namely: PCT 1598.

Eastern Cave Bat (*Vespadelus troughtoni*)

This species is listed as 'vulnerable' under the BC Act but is not listed under the EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

It was not detected within the study area during the 2018 survey period.

It has been previously observed within the study area by others with records from Sites 6, 7 and 12 (Cumberland Ecology, 2012), the south-west corner of the Maxwell Infrastructure area (Eco Logical Australia, 2017) (Figure 11), north-east corner of the Maxwell Infrastructure area and at what is now Site 17 (Hansen Bailey, 2007).

Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 1655 (Cumberland Ecology, 2012).
- PCT 1606 (Cumberland Ecology, 2012).
- PCT 1693 (Cumberland Ecology, 2012).

- PCT 1598 (Eco Logical Australia, 2017).
- PCT 1604 (Hansen Bailey, 2007).

There are additional records of this species outside the study area (Cumberland Ecology, 2009a; Niche, 2012; OEH, 2019b) where it appears to have been recorded in disturbed native vegetation, current disturbed mine workings and cleared agricultural land.

Potential breeding habitat for this species is defined as: "The PCTs associated with the species (as per the TBDC) within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old underground mines or tunnels, old buildings and sheds within the potential habitat" by the *'Species credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

The study area has a few minor sandstone overhangs and crevices at Site 1 and a small rocky escarpment near the entrance to the Plashett property at the corner of Golden Highway and Edderton Road. There were also some crevices and Fairy Martin (*Petrochelidon ariel*) nests (Churchill, 2009) associated with the old volcanic rock quarry at Site 1. None of the overhangs observed had domed ceiling with indentations in which this species prefers to roost (Churchill, 2009). The largest overhang observed was at the small rocky escarpment near the Golden Highway and this had a depth of around 3-4 m with a crevice running through the ceiling. There was no sign of any maternity roosts at any of these sites (including actual bats entering/exiting overhangs and crevices, guano, staining, meal remains, capture of lactating females, high numbers of calls recorded on acoustic devices) despite roost searches, harp-trapping and acoustic monitoring taking place during the summer breeding period for this species (November to end of January). No bats of this species were captured in harp traps during the survey including those placed at the Site 1 Quarry (November 2018) and the Site 1 Powerline Easement (December 2018) just below a rocky escarpment. There were no calls of this species recorded with a definite confidence level.

In addition, there no records of this species within or adjacent to the study area indicating that records were obtained within caves, roosts etc.

Therefore, in accordance with *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018) breeding habitat is not considered present on the subject land because despite there being potential breeding habitat no breeding individuals of the target species were observed. In addition, the proposed impact is not a potential 'serious and irreversible impact' (SAII) (OEH, 2018).

3.3.3 Other Threatened Fauna Species Not Recorded in the Study Area

A number of threatened fauna not recorded in the study area during past or present surveys are discussed in Table 19.

Table 19: Other Threatened Fauna Species Not Recorded in the Study Area

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Amphibians					
Green and Golden Bell Frog	*Litoria aurea*	E	V	S	Not recorded, despite targeted surveys.
Booroolong Frog	*Litoria booroolongensis*	E	E	S	No potential habitat as preferred habitat of permanent western flowing rocky streams (OEH, 2019a) are not present within the study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Green-thighed Frog	*Litoria brevipalmata*	V	-	S	No potential habitat as preferred habitat of rainforest and moist eucalypt forest (OEH, 2019a) not present in study area.
Reptiles					
Pale-headed Snake	*Hoplocephalus bitorquatus*	V	-	S	Not recorded, despite targeted surveys.
Birds					
Freckled Duck	*Stictonetta naevosa*	V	-	E	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	Some marginal habitat present (e.g. farm and mine dams) but large permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.) (OEH, 2019a) are absent. Not recorded despite several surveys over several years since year 2000. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Black Falcon	*Falco subniger*	V	-	E	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Red Goshawk	*Erythrotriorchis radiatus*	CE	V	S	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Bush Stone-curlew	*Burhinus grallarius*	E	-	S	Not recorded, despite targeted surveys.
Australian Painted Snipe	*Rostratula australis*	E	E	E	Some marginal habitat present in the form of ephemeral shallow, freshwater terrestrial wetlands (Birdlife Australia, 2018) but not recorded despite several surveys over several years since year 2000. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Eastern Curlew	*Numenius madagascariensis*	-	CE	S/E	No potential habitat, as preferred estuarine intertidal mudflat habitat (OEH, 2019a) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Curlew Sandpiper	*Calidris ferruginea*	E	CE	S/E	No potential habitat, as preferred estuarine intertidal mudflat habitat (OEH, 2019a) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	-	E^	Not recorded, despite targeted surveys.
Turquoise Parrot	*Neophema pulchella*	V	-	E	Not recorded, despite targeted surveys.
Eastern Grass Owl	*Tyto longimembris*	V	-	E	Not recorded, despite targeted surveys.
Masked Owl	*Tyto novaehollandiae*	V	-	E^	Not recorded, despite targeted surveys.
Powerful Owl	*Ninox strenua*	V	-	E^	Not recorded, despite targeted surveys.

Table 19 (Continued): Other Threatened Fauna Species Not Recorded in the Study Area

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	E*	Not recorded, despite targeted surveys. Regent Honeyeater in the study area are classed as ecosystem credit species based on no important habitat mapping within the study area by OEH.
Mammals					
Brush-tailed Phascogale	*Phascogale tapoatafa*	V	-	S	Not recorded, despite targeted surveys.
Common Planigale	*Planigale maculata*	V	-	S	Not recorded, despite targeted surveys.
Koala	*Phascolarctos cinereus*	V	V	E^	Not recorded, despite targeted surveys.
Eastern Pygmy-possum	*Cercartetus nanus*	V	-	S	Not recorded, despite targeted surveys.
Yellow-bellied Glider	*Petaurus australis*	V	-	E	Not recorded, despite targeted surveys.
Greater Glider	*Petauroides volans*	-	V	S	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E	V	S	No potential habitat as preferred rocky escarpment habitat with complex structures such as fissures, caves and ledges absent from study area. The two minor and relatively simple rocky escarpment habitats present in the study area were the subject of targeted surveys and this species was not recorded.
New Holland Mouse	*Pseudomys novaehollandiae*	-	V	E	Not recorded, despite targeted surveys.

1 Conservation status under the BC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered

2 Conservation status under the EPBC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered

3 Biodiversity credit class under the Threatened Biodiversity Data Collection (OEH, 2019a) (current as at March 2019). E = Ecosystem, S = Species.

* This species is classed an ecosystem credit species in the study area based on no important habitat mapping within the study area by OEH.

^ This species is a duel credit species, however, no core habitat is present therefore it is considered an ecosystem credit species in the study area.

3.4 Potential Koala Habitat – SEPP 44

There are two relevant definitions that apply when considering Koala habitat under SEPP 44:

- 'potential koala habitat' means areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component; and
- 'core koala habitat' means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings and historical records of a population.

Koala preferred feed tree species listed in SEPP 44 are:

- Grey Gum (*Eucalyptus punctata*);
- Forest Red Gum (*E. tereticornis*);
- Swamp Mahogany (*E. robusta*);
- Tallowwood (*E. microcorys*);
- Ribbon or Manna Gum (*E. viminalis*);
- River Red Gum (*E. camaldulensis*);
- Broad-leaved Scribbly Gum (*E. haemastoma*);
- Scribbly Gum (*E. signata*);
- White Box (*E. albens*); and
- Bimble Box or Poplar Box (*E. populnea*).

Koala Potential Habitat

Hunter Eco (2019) undertook a survey of potential koala food trees in the study area. Of the SEPP 44 preferred feed trees, two occur in the study area, namely Forest Red Gum, which is part of PCT 1598 mapped in only a few small locations, and White Box, which is part of PCT 1606 (Figure 22). PCT 1598 and PCT 1606 provide 'potential koala habitat' as defined by SEPP 44 because areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The following additional Koala food tree species (recognised by Department of Planning and Environment, 2018) were identified in the study area (Hunter Eco, 2019):

- Grey Box (*E. moluccana*) within PCT 1604;
- Yellow Box (*E. melliodora*) within PCT 1693;
- Blakely's Red Gum (*E. blakelyi*) within PCT 1607 and PCT 1606; and
- Fuzzy Box (*E. conica*) with PCT 201.

The *Threatened Biodiversity Data Collection* (OEH, 2019a) also recognises PCT 1655 could provide potential habitat. However, the occurrence of PCT1655 in the study area only contains Slaty Box (*E. dawsonii*) which is not a recognised koala food tree.

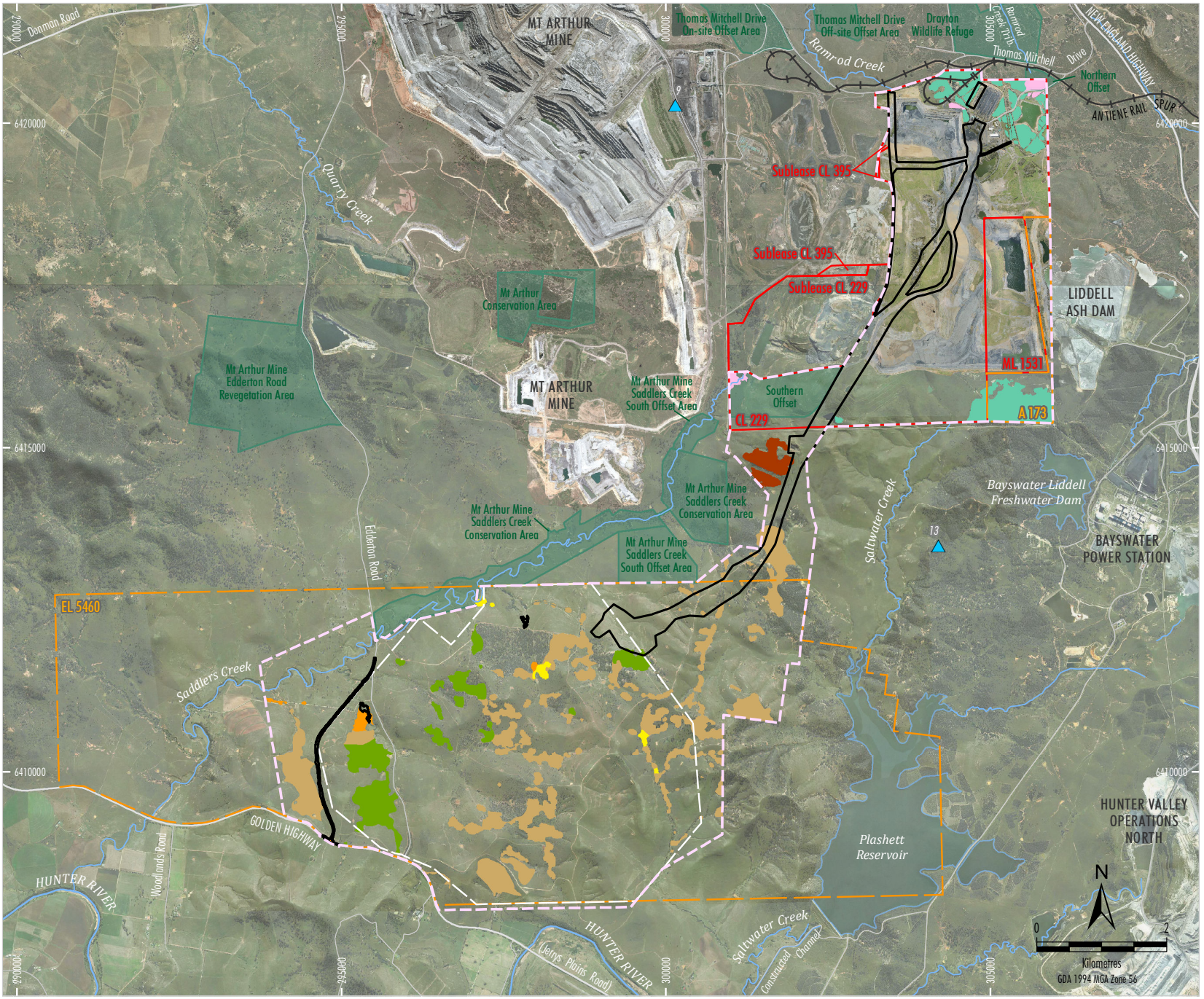
Potential koala habitat is mapped on Figure 22.

Koala Presence

No 'core koala habitat' occurs in the study area. The Koala was not detected during the 2018 survey period by Future Ecology and it has not been previously recorded within the study area during past studies. There are a few additional records of this species outside the study area including from:

- disturbed mining land at the Mt Arthur Mine about 3 km west of the study area (HVEC Personnel pers. Comms., 2012 in Hunter Eco, 2013);
- disturbed native vegetation about 2.2 km north-east of study area dated 2006 and with an accuracy of 10 km (OEH, 2019b); and
- disturbed native vegetation / cleared powerline easement about 1.9 km east of study area dated from 1954 (OEH, 2019b).

There are 24 records of this species within the Muswellbrook LGA (OEH, 2019b). If this species does occur in the locality it is likely to be in very low numbers and/or only occurs occasionally.



LEGEND

- Maxwell Project Exploration Licence Boundary
- Maxwell Project Mining and Coal Lease Boundary
- Indicative Extent of Underground Development
- Biodiversity Assessment Development Footprint
- Ecology Study Area
- Existing Conservation/Offset Area

Threatened Species

- Koala

POTENTIAL HABITAT MAPPING

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1. Red Gum - Ironbark - Apple Shrubby Woodland (PCT1607)
- 2. White Box - Ironbark - Red Gum Shrubby Forest (PCT1606)

Dry Sclerophyll Forests (Shrubby sub-formation)

- 3. Slaty Box Shrubby Woodland (PCT1655)

Forested Wetlands

- 5. Hunter Lowland Red Gum Forest (PCT1598)

Grassy Woodlands

- 7. Yellow Box - Apple Grassy Woodland (PCT1693)
- 8. Fuzzy Box Woodland (PCT201)
- 11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)

Reference:
9. HVEC (pers. Comm. (2012)
13. OEH (2019)
Note: There are no references 1 - 8 and 10 - 12 on this figure.

Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services & Innovation (2019)
Orthophoto Mosaic: 2018, 2016, 2011

MALABAR COAL

MAXWELL PROJECT

Koala
Potential Habitat

Figure 22

SHM-18-03 Maxwell_EIS_App_Fauna_226C

3.5 Threatened Fauna Species Listed under the EPBC Act

Records of threatened fauna species listed under the EPBC Act are shown on Figure 13. Five threatened fauna species listed under the EPBC Act were recorded during the surveys, namely, the Pink-tailed Legless Lizard, Striped Legless Lizard, Painted Honeyeater, Grey-headed Flying-fox and Large-eared Pied Bat. Two additional threatened fauna species listed under the EPBC Act were previously recorded in the study area during other surveys, namely, the Swift Parrot and Spotted-tailed Quoll (south-eastern mainland population).

The Corben's Long-eared Bat may also have been recorded in the study area nearly 20 years ago but the record is uncertain as the detection method is not known. This species was not recorded with certainty during the present survey (Section 3.3.2).

The potentially relevant threatened species under the EPBC Act are listed in Table 20.

Table 20: Threatened Fauna Species Listed under the EPBC Act

Common Name	Scientific Name	Conservation Status		Survey Result
		BC Act[1]	EPBC Act[2]	
Amphibians				
Green and Golden Bell Frog	*Litoria aurea*	E	V	Not recorded, despite targeted during past and present surveys.
Booroolong Frog	*Litoria booroolongensis*	E	E	No potential habitat, as preferred habitat of permanent western flowing rocky streams (OEH, 2019a) are not present within the study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Reptiles				
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	Recorded during this survey (Section 3.3.1; Figure 14).
Striped Legless Lizard	*Delma impar*	V	V	Recorded during this survey (Section 3.3.1; Figure 15).
Birds				
Australasian Bittern	*Botaurus poiciloptilus*	E	E	Some marginal habitat present (e.g. farm and mine dams) but large permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.) (OEH, 2019a) are absent. Not recorded despite several surveys over several years since year 2000. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Red Goshawk	*Erythrotriorchis radiatus*	CE	V	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Australian Painted Snipe	*Rostratula australis*	E	E	Some marginal habitat present in the form of ephemeral shallow, freshwater terrestrial wetlands (Birdlife Australia, 2018) but not recorded despite several surveys over several years since year 2000. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Eastern Curlew	*Numenius madagascariensis*	-	CE	No potential habitat, as preferred estuarine intertidal mudflat habitat (OEH, 2019a) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Curlew Sandpiper	*Calidris ferruginea*	E	CE	No potential habitat, as preferred estuarine intertidal mudflat habitat (OEH, 2019a) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

Table 20 (Continued): Threatened Fauna Species Listed under the EPBC Act

Common Name	Scientific Name	Conservation Status		Survey Result
		BC Act[1]	EPBC Act[2]	
Swift Parrot	*Lathamus discolor*	E	CE	Previously recorded in 2011 on what is now Site 5 (Cumberland Ecology, 2012) (Figure 20). Two individuals were detected; one observed foraging on mistletoe and Grey Box and the second individual was heard calling (Cumberland Ecology, 2012). The sightings were in PCT 1691. Swift Parrot is classed as ecosystem credit species in the study area based on no important habitat mapping within the study area by OEH.
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	Not recorded, despite targeted surveys. Regent Honeyeater are classed as ecosystem credit species in the study area based on no important habitat mapping within the study area by OEH.
Painted Honeyeater	*Grantiella picta*	V	V	Recorded during this survey (Section 3.3.1; Figure 16).
Mammals				
Spotted-tailed Quoll	*Dasyurus maculatus maculatus (south-eastern mainland population)*	V	E	It has been previously observed within the study area by others with a record from around 1 km north of Site 1 within the Maxwell Infrastructure area (Eco Logical Australia, 2016a:2016b; OEH 2019b) (Figure 21).
Koala	*Phascolarctos cinereus*	V	V	Not recorded, despite targeted surveys (Section 3.4; Figure 22).
Greater Glider	*Petauroides volans*	-	V	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a).
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E	V	No potential habitat, as preferred rocky escarpment habitat with complex structures such as fissures, caves and ledges is absent from study area. The two minor and relatively simple rocky escarpment habitats present in the study area were the subject of targeted surveys and this species was not recorded.
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Recorded during this survey (Section 3.3.1; Figure 18).
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	It has been previously observed within the study area by others with records near Sites 5 and 6 (Ecotone, 2000) (Figure 11). There is no information available as to if this species was identified by live trapping or by call recording.
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Recorded during this survey (Section 3.3.1). No known roosting sites.
New Holland Mouse	*Pseudomys novaehollandiae*	-	V	Not recorded, despite targeted surveys.

[1] Threatened species status under the BC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

[2] Threatened species status under the EPBC Act (current as at March 2019). V = Vulnerable, E = Endangered, CE = Critically Endangered.

4 Conclusion

Future Ecology has reviewed a number of fauna surveys previously undertaken partly within and/or adjacent to the study area since the year 2000, and then undertaken additional fauna surveys in 2018.

Ten broad fauna habitat types were observed within the study area, comprising three natural habitats (Dry Sclerophyll Forest, Grassy Woodlands, Forested Wetlands) and seven secondary habitats (Derived Native Grassland, Planted Trees, Cultivation, Waterbody/Dam, Woodland Rehabilitation, Pasture Rehabilitation and Infrastructure/Cleared Land). The majority of survey sites were located within the Woodland or Open Forest broad fauna habitat types. Most woodland/forest patches showed evidence of historic and ongoing disturbance from grazing. Most woodland/forest patches were small to medium size (<150 ha), fragmented and lacked structural diversity in terms of subcanopy and understorey layers due to grazing pressure. Connectivity between remnant Woodland/Open Forest habitats was generally poor across the study area. However, some fauna habitat features such as hollow bearing trees, hollow logs, fallen timber, were present at most survey sites.

A total of 227 fauna species were recorded in the study area during the 2018 surveys including 8 amphibian, 22 reptile, 148 bird and 49 mammal species. A total of 25 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in the study area during the current surveys.

Four of the threatened fauna species recorded are considered relevant ‘species credit species’ in the study area, namely, Pink-tailed Legless Lizard, Striped Legless Lizard, Squirrel Glider and Southern Myotis.

Five threatened fauna species listed under the EPBC Act were recorded during the surveys, namely, the Pink-tailed Legless Lizard, Striped Legless Lizard, Painted Honeyeater, Grey-headed Flying-fox and Large-eared Pied Bat. Two additional threatened fauna species listed under the EPBC Act were previously recorded in the study area during other surveys, namely, the Swift Parrot and Spotted-tailed Quoll (south-eastern mainland population). The Corben’s Long-eared Bat may also have been recorded in the study area nearly 20 years ago but the record is uncertain as the detection method is not known.

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Appendix A Fauna Species Detected

Sites 1 to 7

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 1	Observation Type	Confidence Level	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 5	Observation Type	Confidence Level	Site 6	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level
Amphibians	Common Eastern Froglet	*Crinia signifera*							X	W																
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*							X	OW								X	OW		X	W				
Amphibians	Dusky Toadlet	*Uperoleia fusca*																								
Amphibians	Smooth Toadlet	*Uperoleia laevigata*							X	OW																
Amphibians	Green Tree Frog	*Litoria caerulea*							X	O		X	O		X	O		X	O							
Amphibians	Eastern Dwarf Tree Frog	*Litoria fallax*							X	OW																
Amphibians	Broad-palmed Frog	*Litoria latopalmata*				X	O		X	OW		X	OW					X	O		X	W				
Amphibians	Peron's Tree Frog	*Litoria peronii*				X	O,W	PR	X	OW		X	OW					X	OW		X	W		X	W	
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*				X	K		X	O		X	O					X	O		X	O				
Reptiles	Macquarie Turtle	*Emydura macquarii*																								
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*				X	O		X	O		X	O		X	O		X	O		X	O, T		X	O	
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*				X	O		X	O		X	O		X	O		X	O					X	O	
Reptiles	Thick-tailed Gecko	*Underwoodisaurus milii*				X	O														X	O		X	O	
Reptiles	**Pink-tailed Legless Lizard**	***Aprasia parapulchella***		**V**	**V**													**X**	**O**							
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**				**X**	**O, H**		**X**	**T**		**X**	**H**								**X**	**H**	
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*										X	T													
Reptiles	Southern Rainbow-skink	*Carlia tetradactyla*							X	O		X	O		X	O		X	O, T							
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*										X	O					X	O					X	O	
Reptiles	Robust Ctenotus	*Ctenotus robustus*				X	O		X	O		X	O, T		X	O, T		X	O, T		X	O		X	O	
Reptiles	Tree Skink	*Egernia striolata*				X	O		X	O		X	O		X	O		X	O		X	O				
Reptiles	Barred-sided Skink	*Concinnia tenuis*													X	O										
Reptiles	Eastern Ranges Rock-skink	*Liopholis modesta*				X	O		X	O					X	O								X	O	
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*																X	O							
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*																								
Reptiles	Eastern Water Dragon	*Intellagama lesueurii*																								
Reptiles	Eastern Bearded Dragon	*Pogona barbata*							X	O					X	O		X	O		X	O				
Reptiles	Sand Goanna	*Varanus gouldii*							X	FB, O																
Reptiles	Lace Monitor	*Varanus varius*				X	Q		X	Q		X	O		X	O		X	O		X	Q, O				
Reptiles	Brown-snouted Blind Snake	*Anilios wiedii*				X	O								X	O										
Reptiles	Spotted Black Snake	*Pseudechis guttatus*							X	O		X	O								X	O		X	O	
Birds	Stubble Quail	*Coturnix pectoralis*				X	O		X	O																
Birds	Brown Quail	*Coturnix ypsilophora*							X	O								X	O		X	O				
Birds	Plumed Whistling Duck	*Dendrocygna eytoni*																								
Birds	Black Swan	*Cygnus atratus*																								
Birds	Pink-eared Duck	*Malacorhynchus membranaceus*																								
Birds	Australian Wood Duck	*Chenonetta jubata*				X	O		X	O								X	O		X	O		X	O	
Birds	Pacific Black Duck	*Anas superciliosa*				X	O		X	O								X	O		X	O				
Birds	Australasian Shoveler	*Anas rhynchotis*																								
Birds	Grey Teal	*Anas gracilis*				X	O		X	O								X	O		X	O		X	O	
Birds	Chestnut Teal	*Anas castanea*							X	O		X	O													
Birds	Hardhead Duck	*Aythya australis*				X	O											X	O		X	O				

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Birds	Musk Duck	*Biziura lobata*																								
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*				X	O					X	O					X	O		X	O				
Birds	Hoary-headed Grebe	*Poliocephalus poliocephalus*																								
Birds	Straw-necked Ibis	*Threskiornis spinicollis*																								
Birds	Nankeen Night Heron	*Nycticorax caledonicus*																X	O							
Birds	**Cattle Egret**	***Ardea ibis***			**M**																					
Birds	White-necked Heron	*Ardea pacifica*																								
Birds	White-faced Heron	*Egretta novaehollandiae*				X	O		X	O		X	O					X	O		X	O				
Birds	Little Pied Cormorant	*Microcarbo melanoleucos*										X	O													
Birds	Pied Cormorant	*Phalacrocorax varius*																								
Birds	Australasian Darter	*Anhinga novaehollandiae*																								
Birds	Nankeen Kestrel	*Falco cenchroides*				X	OW											X	O					X	O	
Birds	Brown Falcon	*Falco berigora*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Black-shouldered Kite	*Elanus axillaris*																								
Birds	Black Kite	*Milvus migrans*																								
Birds	**Square-tailed Kite**	***Lophoictinia isura***		**V**														**X**	**O**							
Birds	**White-bellied Sea Eagle**	***Haliaeetus leucogaster***		**V**	**M**																					
Birds	**Spotted Harrier**	***Circus assimilis***		**V**														**X**	**O**							
Birds	Brown Goshawk	*Accipiter fasciatus*				X	O											X	O		X	O				
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*				X	O																			
Birds	Wedge-tailed Eagle	*Aquila audax*				X	O		X	O, E		X	O		X	O		X	O		X	O		X	O, E	
Birds	**Little Eagle**	***Hieraaetus morphnoides***		**V**																						
Birds	Purple Swamphen	*Porphyrio porphyrio*																								
Birds	Eurasian Coot	*Fulica atra*																								
Birds	Black-winged Stilt	*Himantopus himantopus*																								
Birds	Red-necked Avocet	*Recurvirostra novaehollandiae*																								
Birds	Banded Lapwing	*Vanellus tricolor*																								
Birds	Masked Lapwing	*Vanellus miles*				X	O		X	O		X	O		X	O		X	O					X	O	
Birds	Black-fronted Dotterel	*Elseyornis melanops*																X	O							
Birds	Common Bronzewing	*Phaps chalcoptera*				X	O					X	O		X	O		X	O		X	O		X	O	
Birds	Crested Pigeon	*Ocyphaps lophotes*										X	O		X	O		X	O		X	O		X	O	
Birds	Bar-shouldered Dove	*Geopelia humeralis*							X	O, W		X	W													
Birds	**Glossy Black-Cockatoo**	***Calyptorhynchus lathami***		**V**																						
Birds	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*																								
Birds	Galah	*Eolophus roseicapillas*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Little Corella	*Cacatua sanguinea*																X	W							
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*				X	O		X	O											X	O		X	O	
Birds	Rainbow Lorikeet	*Trichoglossus haematodus*																								
Birds	Musk Lorikeet	*Glossopsitta concinna*							X	O		X	O		X	O		X	O		X	O		X	O	
Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**		**X**	**O**		**X**	**O**		**X**	**O**					**X**	**O**		**X**	**O**		**X**	**O**	
Birds	Crimson Rosella	*Platycercus elegans*																								
Birds	Eastern Rosella	*Platycercus eximius*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Australian King-Parrot	*Alisterus scapularis*				X	O		X	O								X	O							
Birds	Pallid Cuckoo	*Cuculus pallidus*													X	O		X	O							
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*				X	O											X	O							
Birds	Black-eared Cuckoo	*Chalcites osculans*																X	O		X	O				

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Birds	Horsfield's Bronze-Cuckoo	*Chalcites basalis*				X	O					X	O					X	O		X	O		X	O	
Birds	Shining Bronze Cuckoo	*Chrysococcyx lucidus*							X	O		X	O													
Birds	Eastern Koel	*Eudynamys orientalis*													X	O		X	OW							
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*				X	OW		X	O		X	OW		X	O		X	O		X	O				
Birds	Eastern Barn Owl	*Tyto javanica*				X	O		X	OW					X	W					X	O				
Birds	Southern Boobook	*Ninox novaeseelandiae*																								
Birds	Tawny Frogmouth	*Podargus strigoides*				X	O		X	O		X	OW					X	O		X	O		X	O	
Birds	White-throated Nightjar	*Eurostopodus mystacalis*																								
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*				X	O, W		X	O, W		X	OW		X	OW		X	OW		X	O		X	O	
Birds	Laughing Kookaburra	*Dacelo novaeguineae*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Sacred Kingfisher	*Todiramphus sanctus*										X	O											X	W	
Birds	**Rainbow Bee-eater**	***Merops ornatus***			**M**													**X**	**O**							
Birds	**Brown Treecreeper (eastern subspecies)**	***Climacteris picumnus victoriae***		**V**														**X**	**O**							
Birds	Variegated Fairy-wren	*Malurus lamberti*							X	O																
Birds	Superb Fairy-wren	*Malurus cyaneus*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Spotted Pardalote	*Pardalotus punctatus*				X	O		X	W		X	O								X	O		X	O	
Birds	Striated Pardalote	*Pardalotus striatus*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**		**X**	**O**		**X**	**O**		**X**	**O**					**X**	**O**		**X**	**O**		**X**	**O**	
Birds	Weebill	*Smicrornis brevirostris*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Western Gerygone	*Gerygone fusca*							X	O		X	OW		X	OW		X	O		X	O		X	O	
Birds	White-throated Gerygone	*Gerygone olivacea*										X	W					X	O							
Birds	Brown Thornbill	*Acanthiza pusilla*																								
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*				X	O		X	O		X	O								X	O		X	O	
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Yellow Thornbill	*Acanthiza nana*				X	O		X	O		X	OW					X	O		X	O		X	O	
Birds	Striated Thornbill	*Acanthiza lineata*																								
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Singing Honeyeater	*Lichenostomus virescens*																								
Birds	White-eared Honeyeater	*Nesoptilotis leucotis*																								
Birds	Fuscous Honeyeater	*Lichenostomus fuscus*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	White-plumed Honeyeater	*Lichenostomus penicillatus*				X	O					X	O		X	O		X	O		X	O				
Birds	Noisy Miner	*Manorina melanocephala*							X	O		X	OW		X	O		X	O		X	O		X	O	
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*																								
Birds	**Black-chinned Honeyeater (eastern subspecies)**	***Melithreptus gularis gularis***		**V**																	**X**	**O**				
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	White-naped Honeyeater	*Melithreptus lunatus*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Noisy Friarbird	*Philemon corniculatus*				X	O		X	O		X	OW		X	O		X	O		X	O		X	O	
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*				X	W		X	OW		X	O		X	O		X	O		X	O		X	O	
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*							X	O		X	O					X	OW		X	O				
Birds	Red Wattlebird	*Anthochaera carunculata*				X	O		X	O																
Birds	**Painted Honeyeater**	***Grantiella picta***		**V**	**V**	**X**	**W**																			
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*																						X	O	
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*							X	W		X	W													
Birds	Eastern Yellow Robin	*Eopsaltria australis*				X	O		X	O														X	O	
Birds	Jacky Winter	*Microeca fascinans*																X	O		X	O		X	O	
Birds	Rose Robin	*Petroica rosea*				X	O																			

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Birds	**Flame Robin**	***Petroica phoenicea***		**V**		**X**	**W**																			
Birds	**Scarlet Robin**	***Petroica boodang***		**V**																	**X**	**O**		**X**	**O**	
Birds	Red-capped Robin	*Petroica goodenovii*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	**Grey-crowned Babbler (eastern subspecies)**	***Pomatostomus temporalis ssp temporalis***		**V**								**X**	**OW**		**X**	**O**		**X**	**O**		**X**	**O**		**X**	**O**	
Birds	**Varied Sittella**	***Daphoenositta chrysoptera***		**V**					**X**	**O**														**X**	**O**	
Birds	Golden Whistler	*Pachycephala pectoralis*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Rufous Whistler	*Pachycephala rufiventris*				X	O		X	OW		X	OW		X	O		X	O		X	O		X	O	
Birds	Grey Shrike-thrush	*Colluricincla harmonica*																								
Birds	Grey Fantail	*Rhipidura albiscapa*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	Willie Wagtail	*Rhipidura leucophrys*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Magpie-lark	*Grallina cyanoleuca*				X	O		X	O		X	O					X	O		X	O		X	O	
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M**	**X**	**O**											**X**	**O**							
Birds	Grey Butcherbird	*Cracticus torquatus*				X	O		X	O		X	W					X	O		X	O		X	O	
Birds	Pied Butcherbird	*Cracticus nigrogularis*				X	O		X	O		X	W		X	O		X	O		X	O		X	O	
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	O		X	O,Q		X	O		X	O		X	O		X	O	
Birds	Pied Currawong	*Strepera graculina*				X	O		X	OW		X	O		X	O		X	O		X	O		X	O	
Birds	Masked Woodswallow	*Artamus personatus*																X	O		X	O				
Birds	White-browed Woodswallow	*Artamus superciliosus*							X	O								X	O		X	O		X	O	
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**														**X**	**O**		**X**	**O**				
Birds	Cicadabird	*Coracina tenuirostris*										X	O													
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Ground Cuckoo-shrike	*Coracina maxima*																								
Birds	White-winged Triller	*Lalage sueurii*				X	O					X	O					X	O		X	O		X	O	
Birds	Olive-backed Oriole	*Oriolus sagittatus*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Little Raven	*Corvus mellori*																								
Birds	Australian Raven	*Corvus coronoides*				X	O		X	OW		X	O		X	O		X	O		X	O		X	O	
Birds	White-winged Chough	*Corcorax melanorhamphos*				X	O		X	O		X	Q, O		X	OW		X	O		X	O		X	O	
Birds	Common Starling	*Sturnus vulgaris*	X			X	O																			
Birds	Common Myna	*Sturnus tristis*	X																							
Birds	White-backed Swallow	*Cheramoeca leucosterna*																								
Birds	Welcome Swallow	*Hirundo neoxena*				X	O											X	O							
Birds	Fairy Martin	*Petrochelidon ariel*				X	O											X	O							
Birds	Tree Martin	*Petrochelidon nigricans*				X	O											X	O							
Birds	Silvereye	*Zosterops lateralis*				X	O																	X	O	
Birds	Australian Reed Warbler	*Acrocephalus australis*				X	OW		X	W																
Birds	Tawny Grassbird	*Megalurus timoriensis*										X	O													
Birds	Rufous Songlark	*Cincloramphus mathewsi*				X	O		X	O								X	O							
Birds	Brown Songlark	*Cincloramphus cruralis*							X	O								X	O							
Birds	Golden-headed Cisticola	*Cisticola exilis*																								
Birds	Horsfield's Bushlark	*Mirafra javanica*							X	O																
Birds	Mistletoebird	*Dicaeum hirundinaceum*				X	O		X	W		X	O		X	W		X	O		X	OW		X	O	
Birds	Richard's Pipit	*Anthus novaeseelandiae*																								
Birds	Red-browed Finch	*Neochmia temporalis*				X	O																			
Birds	Zebra Finch	*Taeniopygia guttata*																								
Birds	Double-barred Finch	*Taeniopygia bichenovii*				X	O		X	O		X	O					X	O		X	O		X	O	
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*				X	P, O		X	P, O		X	F,P					X	O		X	O				

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 1	Observation Type	Confidence Level	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 5	Observation Type	Confidence Level	Site 6	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level
Mammals	Yellow-footed Antechinus	*Antechinus flavipes*							X	O		X	T													
Mammals	Common Dunnart	*Sminthopsis murina*				X	O														X	O		X	O	
Mammals	Common Wombat	*Vombatus ursinus*																								
Mammals	Sugar Glider	*Petaurus breviceps*																X	F	PO						
Mammals	**Squirrel Glider**	***Petaurus norfolcensis***		**V**														**X**	**O**		**X**	**O**				
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*																								
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*				X	Q,O,X,H	D	X	O, Q		X	O		X	O		X	O		X	O		X	O	
Mammals	brushtail possum	*Trichosurus sp.*				X	H, P	PR																		
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*				X	O, Y, P, X		X	O		X	O		X	O		X	O		X	O		X	O	
Mammals	Eastern Wallaroo	*Macropus robustus*				X	O																			
Mammals	Red-necked Wallaby	*Macropus rufogriseus*				X	O		X	Q, O		X	O		X	O		X	Q		X	O		X	O	
Mammals	Swamp Wallaby	*Wallabia bicolor*				X	X,Y																			
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**													**X**	**O**							
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**					**X**	**U**	**D**															
Mammals	**Eastern Freetail-bat**	***Mormopterus norfolkensis***		**V**																				**X**	**U**	**PO**
Mammals	Little Mastiff-bat	*Mormopterus planiceps*				X	U	D	X	U	D	X	U	D	X	U	D	X	U	D	X	U	D	X	U	D
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*				X	U	D	X	U	D				X	U	PO									
Mammals	White-striped Freetail-bat	*Austronomus australis*				X	W, U	D	X	W, U	D	X	U	D	X	W,U	D	X	U	D	X	W		X	U	D
Mammals	**Little Bentwing-bat**	***Miniopterus australis***		**V**					**X**	**U**	**D**	**X**	**U**	**PO**				**X**	**U**	**D**	**X**	**U**	**PO**	**X**	**U**	**PO**
Mammals	**Eastern Bentwing-bat**	***Miniopterus schreibersii oceanensis***		**V**		**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**PO**	**X**	**U**	**PO**
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*							X	T																
Mammals	Long-eared Bat	*Nyctophilus sp.*				X	U	PO	X	U	PO	X	U	PO	X	U	PO							X	U	PO
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**	**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**D**	**X**	**U**	**D**							**X**	**U**	**PR**
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*				X	U	D	X	T, U	D	X	U	D	X	U	D	X	U	D	X	T		X	U	D
Mammals	Chocolate Wattled Bat	*Chalinolobus morio*				X	U	D	X	T, U	D	X	U	D	X	U	D	X	U	D	X	U	PO	X	U	D
Mammals	**Eastern False Pipistrelle**	***Falsistrellus tasmaniensis***		**V**		**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**
Mammals	**Southern Myotis**	***Myotis macropus***		**V**		**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**							**X**	**U**	**PO**
Mammals	**Greater Broad-nosed Bat**	***Scoteanax rueppellii***		**V**		**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**
Mammals	Inland Broad-nosed Bat	*Scotorepens balstoni*				X	U	D	X	U	D	X	U	D	X	U	D	X	U	D	X	U	PO	X	U	D
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*				X	U, T	D	X	U	D	X	U	D	X	U	D	X	U	D	X	U	D	X	U	D
Mammals	A Broad-nosed Bat	*Scotorepens sp.*				X	O																			
Mammals	Large Forest Bat	*Vespadelus darlingtoni*																								
Mammals	Eastern Forest Bat	*Vespadelus pumilus*				X	U	PO	X	U	PO	X	U	PO	X	U	PO	X	U	PO	X	U	PO	X	U	PO
Mammals	Southern Forest Bat	*Vespadelus regulus*				X	U	D	X	U	D	X	U	D	X	U	D	X	U	PO	X	U	PO	X	U	PO
Mammals	**Eastern Cave Bat**	***Vespadelus troughtoni***		**V**		**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**	**X**	**U**	**PO**
Mammals	Little Forest Bat	*Vespadelus vulturnus*				X	T		X	T	D	X	T		X	U	PR	X	U	PO	X	T		X	U	PO
Mammals	House Mouse	*Mus musculus*	X						X	T														X	O	
Mammals	a rodent	*Family Muridae*				X	H	PR																		
Mammals	Dingo	*Canis lupus dingo*				X	O								X	O										
Mammals	Dog	*Canis lupus familiaris*	X			X	P					X	P	D	X	P								X	X	D
Mammals	Hybrid Dog	*Canis lupus/familiaris*	X									X	W		X	P										
Mammals	Fox	*Vulpes vulpes*	X			X	Q, O, H, P	D	X	P	PO	X	P	PO	X	P		X	O					X	P	PO
Mammals	Cat	*Felis catus*	X			X	O		X	H	PR	X	H	PR				X	H	D						
Mammals	Brown Hare	*Lepus capensis*	X									X	Q, O		X	O		X	O		X	O				
Mammals	Rabbit	*Oryctolagus cuniculus*	X			X	O		X	O		X	O, X	D	X	O		X	O		X	O		X	O	
Mammals	Horse	*Equus caballus*	X																							

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Mammals	Pig	*Sus scrofa*	X			X	O																			
Mammals	European Cattle	*Bos taurus*	X			X	O		X	Q		X	Q		X	O		X	O		X	O		X	O	

Sites 8-13

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 8	Observation Type	Confidence Level	Site 9	Observation Type	Confidence Level	Site 10	Observation Type	Confidence Level	Site 11	Observation Type	Confidence Level	Bat Roost Tree	Observation Type	Confidence Level	Site 12	Observation Type	Confidence Level	Site 13	Observation Type	Confidence Type
Amphibians	Common Eastern Froglet	*Crinia signifera*																								
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*										X	W													
Amphibians	Dusky Toadlet	*Uperoleia fusca*																								
Amphibians	Smooth Toadlet	*Uperoleia laevigata*																								
Amphibians	Green Tree Frog	*Litoria caerulea*										X	O		X	O										
Amphibians	Eastern Dwarf Tree Frog	*Litoria fallax*																								
Amphibians	Broad-palmed Frog	*Litoria latopalmata*										X	OW		X	O										
Amphibians	Peron's Tree Frog	*Litoria peronii*										X	O		X	W										
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*										X	O		X	O										
Reptiles	Macquarie Turtle	*Emydura macquarii*																								
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*																								
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*													X	O										
Reptiles	Thick-tailed Gecko	*Underwoodisaurus milii*													X	O										
Reptiles	**Pink-tailed Legless Lizard**	***Aprasia parapulchella***		**V**	**V**																					
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**										**X**	**O, H**										
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*																								
Reptiles	Southern Rainbow-skink	*Carlia tetradactyla*										X	O		X	O										
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*																								
Reptiles	Robust Ctenotus	*Ctenotus robustus*				X	O					X	O		X	O										
Reptiles	Tree Skink	*Egernia striolata*										X	O		X	O										
Reptiles	Barred-sided Skink	*Concinnia tenuis*																								
Reptiles	Eastern Ranges Rock-skink	*Liopholis modesta*													X	O										
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*																								
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*				X	O																			
Reptiles	Eastern Water Dragon	*Intellagama lesueurii*																								
Reptiles	Eastern Bearded Dragon	*Pogona barbata*																								
Reptiles	Sand Goanna	*Varanus gouldii*																								
Reptiles	Lace Monitor	*Varanus varius*													X	O										
Reptiles	Brown-snouted Blind Snake	*Anilios wiedii*																								
Reptiles	Spotted Black Snake	*Pseudechis guttatus*																								
Birds	Stubble Quail	*Coturnix pectoralis*																								
Birds	Brown Quail	*Coturnix ypsilophora*																								
Birds	Plumed Whistling Duck	*Dendrocygna eytoni*										X	OW													
Birds	Black Swan	*Cygnus atratus*																								

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Birds	Pink-eared Duck	*Malacorhynchus membranaceus*													X	O										
Birds	Australian Wood Duck	*Chenonetta jubata*										X	O		X	O										
Birds	Pacific Black Duck	*Anas superciliosa*										X	O		X	O										
Birds	Australasian Shoveler	*Anas rhynchotis*													X	O										
Birds	Grey Teal	*Anas gracilis*										X	O		X	O										
Birds	Chestnut Teal	*Anas castanea*																								
Birds	Hardhead Duck	*Aythya australis*																								
Birds	Musk Duck	*Biziura lobata*																								
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*										X	O		X	O	X									
Birds	Hoary-headed Grebe	*Poliocephalus poliocephalus*																								
Birds	Straw-necked Ibis	*Threskiornis spinicollis*																								
Birds	Nankeen Night Heron	*Nycticorax caledonicus*																								
Birds	**Cattle Egret**	***Ardea ibis***			**M**																			X	O	
Birds	White-necked Heron	*Ardea pacifica*																								
Birds	White-faced Heron	*Egretta novaehollandiae*							X	O											X	O		X	O	
Birds	Little Pied Cormorant	*Microcarbo melanoleucos*																								
Birds	Pied Cormorant	*Phalacrocorax varius*																								
Birds	Australasian Darter	*Anhinga novaehollandiae*																								
Birds	Nankeen Kestrel	*Falco cenchroides*				X	O					X	O		X	O					X	O				
Birds	Brown Falcon	*Falco berigora*																						X	O	
Birds	Black-shouldered Kite	*Elanus axillaris*																								
Birds	Black Kite	*Milvus migrans*																								
Birds	**Square-tailed Kite**	***Lophoictinia isura***		**V**																						
Birds	**White-bellied Sea Eagle**	***Haliaeetus leucogaster***		**V**	**M**																					
Birds	**Spotted Harrier**	***Circus assimilis***		**V**																						
Birds	Brown Goshawk	*Accipiter fasciatus*																								
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*													X	O										
Birds	Wedge-tailed Eagle	*Aquila audax*										X	O		X	O					X	O				
Birds	**Little Eagle**	***Hieraaetus morphnoides***		**V**								**X**	**O**													
Birds	Purple Swamphen	*Porphyrio porphyrio*																								
Birds	Eurasian Coot	*Fulica atra*																								
Birds	Black-winged Stilt	*Himantopus himantopus*																								
Birds	Red-necked Avocet	*Recurvirostra novaehollandiae*																								
Birds	Banded Lapwing	*Vanellus tricolor*																								
Birds	Masked Lapwing	*Vanellus miles*																								
Birds	Black-fronted Dotterel	*Elseyornis melanops*																								
Birds	Common Bronzewing	*Phaps chalcoptera*													X	O										
Birds	Crested Pigeon	*Ocyphaps lophotes*							X	W		X	O											X	O	
Birds	Bar-shouldered Dove	*Geopelia humeralis*																								
Birds	**Glossy Black-Cockatoo**	***Calyptorhynchus lathami***		**V**																						
Birds	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*																								
Birds	Galah	*Eolophus roseicapillus*				X	O		X	O		X	O		X	O					X	O		X	O	
Birds	Little Corella	*Cacatua sanguinea*																								
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*																						X	O	
Birds	Rainbow Lorikeet	*Trichoglossus haematodus*																								
Birds	Musk Lorikeet	*Glossopsitta concinna*													X	O										

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Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**											**X**	**O**										
Birds	Crimson Rosella	*Platycercus elegans*																								
Birds	Eastern Rosella	*Platycercus eximius*							X	O		X	O		X	O					X	O		X	O	
Birds	Australian King-Parrot	*Alisterus scapularis*																								
Birds	Pallid Cuckoo	*Cuculus pallidus*																								
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*													X	O										
Birds	Black-eared Cuckoo	*Chalcites osculans*																								
Birds	Horsfield's Bronze-Cuckoo	*Chalcites basalis*																								
Birds	Shining Bronze Cuckoo	*Chrysococcyx lucidus*																								
Birds	Eastern Koel	*Eudynamys orientalis*										X	O		X	O										
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*													X	O										
Birds	Eastern Barn Owl	*Tyto javanica*																								
Birds	Southern Boobook	*Ninox novaeseelandiae*													X	O										
Birds	Tawny Frogmouth	*Podargus strigoides*													X	O										
Birds	White-throated Nightjar	*Eurostopodus mystacalis*																								
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*													X	O										
Birds	Laughing Kookaburra	*Dacelo novaeguineae*													X	OW										
Birds	Sacred Kingfisher	*Todiramphus sanctus*																								
Birds	**Rainbow Bee-eater**	***Merops ornatus***			**M**										**X**	**O**										
Birds	**Brown Treecreeper (eastern subspecies)**	***Climacteris picumnus victoriae***		**V**											**X**	**O**										
Birds	Variegated Fairy-wren	*Malurus lamberti*																								
Birds	Superb Fairy-wren	*Malurus cyaneus*				X	O		X	O					X	O								X	O	
Birds	Spotted Pardalote	*Pardalotus punctatus*													X	O										
Birds	Striated Pardalote	*Pardalotus striatus*							X	O					X	O					X	O		X	O	
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**											**X**	**O**								X	O	
Birds	Weebill	*Smicrornis brevirostris*													X	O										
Birds	Western Gerygone	*Gerygone fusca*										X	O		X	O										
Birds	White-throated Gerygone	*Gerygone olivacea*													X	O										
Birds	Brown Thornbill	*Acanthiza pusilla*																								
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*										X	O		X	O										
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				X	O					X	O		X	O								X	O	
Birds	Yellow Thornbill	*Acanthiza nana*													X	O								X	O	
Birds	Striated Thornbill	*Acanthiza lineata*													X	O										
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*													X	O										
Birds	Singing Honeyeater	*Lichenostomus virescens*																								
Birds	White-eared Honeyeater	*Nesoptilotis leucotis*																								
Birds	Fuscous Honeyeater	*Lichenostomus fuscus*													X	O										
Birds	White-plumed Honeyeater	*Lichenostomus penicillatus*													X	O								X	O	
Birds	Noisy Miner	*Manorina melanocephala*							X	O		X	O		X	O					X	O				
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*							X	O																
Birds	**Black-chinned Honeyeater (eastern subspecies)**	***Melithreptus gularis gularis***		**V**																						
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*													X	O										
Birds	White-naped Honeyeater	*Melithreptus lunatus*													X	O										
Birds	Noisy Friarbird	*Philemon corniculatus*													X	O					X	O				
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*										X	O		X	O										
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*							X	O																

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Birds	Red Wattlebird	*Anthochaera carunculata*																								
Birds	**Painted Honeyeater**	***Grantiella picta***		**V**	**V**																					
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*																								
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*																								
Birds	Eastern Yellow Robin	*Eopsaltria australis*																								
Birds	Jacky Winter	*Microeca fascinans*													X	O										
Birds	Rose Robin	*Petroica rosea*																								
Birds	**Flame Robin**	***Petroica phoenicea***		**V**																						
Birds	**Scarlet Robin**	***Petroica boodang***		**V**											**X**	**O**										
Birds	Red-capped Robin	*Petroica goodenovii*													X	O										
Birds	**Grey-crowned Babbler (eastern subspecies)**	***Pomatostomus temporalis ssp temporalis***		**V**																						
Birds	**Varied Sittella**	***Daphoenositta chrysoptera***		**V**											**X**	**O**										
Birds	Golden Whistler	*Pachycephala pectoralis*							X	O					X	O								X	O	
Birds	Rufous Whistler	*Pachycephala rufiventris*							X	O					X	O								X	O	
Birds	Grey Shrike-thrush	*Colluricincla harmonica*																						X	O	
Birds	Grey Fantail	*Rhipidura albiscapa*										X	W		X	O										
Birds	Willie Wagtail	*Rhipidura leucophrys*				X	O		X	O					X	O								X	O	
Birds	Magpie-lark	*Grallina cyanoleuca*										X	O		X	O										
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M**																					
Birds	Grey Butcherbird	*Cracticus torquatus*							X	O		X	O		X	O										
Birds	Pied Butcherbird	*Cracticus nigrogularis*							X	W		X	O		X	O								X	O	
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	O		X	O		X	O								X	O	
Birds	Pied Currawong	*Strepera graculina*													X	O								X	O	
Birds	Masked Woodswallow	*Artamus personatus*																								
Birds	White-browed Woodswallow	*Artamus superciliosus*				X	O																			
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**																						
Birds	Cicadabird	*Coracina tenuirostris*																								
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*										X	O		X	O										
Birds	Ground Cuckoo-shrike	*Coracina maxima*										X	O													
Birds	White-winged Triller	*Lalage sueurii*																								
Birds	Olive-backed Oriole	*Oriolus sagittatus*																								
Birds	Little Raven	*Corvus mellori*																								
Birds	Australian Raven	*Corvus coronoides*				X	O		X	O		X	OW		X	O								X	O	
Birds	White-winged Chough	*Corcorax melanorhamphos*										X	O		X	O										
Birds	Common Starling	*Sturnus vulgaris*	X						X	O																
Birds	Common Myna	*Sturnus tristis*	X						X	O																
Birds	White-backed Swallow	*Cheramoeca leucosterna*																								
Birds	Welcome Swallow	*Hirundo neoxena*				X	O																			
Birds	Fairy Martin	*Petrochelidon ariel*							X	E																
Birds	Tree Martin	*Petrochelidon nigricans*																								
Birds	Silvereye	*Zosterops lateralis*													X	O										
Birds	Australian Reed Warbler	*Acrocephalus australis*																								
Birds	Tawny Grassbird	*Megalurus timoriensis*																								
Birds	Rufous Songlark	*Cincloramphus mathewsi*																								
Birds	Brown Songlark	*Cincloramphus cruralis*																								
Birds	Golden-headed Cisticola	*Cisticola exilis*																								

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Birds	Horsfield's Bushlark	*Mirafra javanica*																								
Birds	Mistletoebird	*Dicaeum hirundinaceum*							X	O		X	O		X	O										
Birds	Richard's Pipit	*Anthus novaeseelandiae*				X	O																			
Birds	Red-browed Finch	*Neochmia temporalis*																								
Birds	Zebra Finch	*Taeniopygia guttata*										X	O													
Birds	Double-barred Finch	*Taeniopygia bichenovii*																						X	O	
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*										X	P		X	O										
Mammals	Yellow-footed Antechinus	*Antechinus flavipes*																								
Mammals	Common Dunnart	*Sminthopsis murina*																								
Mammals	Common Wombat	*Vombatus ursinus*																						X	FB	PO
Mammals	Sugar Glider	*Petaurus breviceps*										X	W													
Mammals	**Squirrel Glider**	***Petaurus norfolcensis***		**V**											**X**	**O**					X	M	PO			
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*																								
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*										X	O		X	O								X	X	PR
Mammals	brushtail possum	*Trichosurus sp.*																								
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*				X	O					X	O		X	O					X	O		X	O	
Mammals	Eastern Wallaroo	*Macropus robustus*																			X	O				
Mammals	Red-necked Wallaby	*Macropus rufogriseus*													X	O										
Mammals	Swamp Wallaby	*Wallabia bicolor*																								
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**										**X**	**W**										
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**																						
Mammals	**Eastern Freetail-bat**	***Mormopterus norfolkensis***		**V**								**X**	**U**	**PR**												
Mammals	Little Mastiff-bat	*Mormopterus planiceps*										X	U	D	X	U	D	X	U	D						
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*													X	U	PO									
Mammals	White-striped Freetail-bat	*Austronomus australis*										X	U	D	X	U	D									
Mammals	**Little Bentwing-bat**	***Miniopterus australis***		**V**								**X**	**U**	**D**	**X**	**U**	**D**									
Mammals	**Eastern Bentwing-bat**	***Miniopterus schreibersii oceanensis***		**V**								**X**	**U**	**D**	**X**	**U**	**D**									
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*																								
Mammals	Long-eared Bat	*Nyctophilus sp.*										X	U	PO	X	U	PO									
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**							**X**	**U**	**D**	**X**	**U**	**D**									
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*										X	U	PO	X	U	D	X	U	PO						
Mammals	Chocolate Wattled Bat	*Chalinolobus morio*										X	U	D	X	U	D									
Mammals	**Eastern False Pipistrelle**	***Falsistrellus tasmaniensis***		**V**								**X**	**U**	**PO**												
Mammals	**Southern Myotis**	***Myotis macropus***		**V**								**X**	**U/O**	**PO/D**	**X**	**U**	**PO**									
Mammals	**Greater Broad-nosed Bat**	***Scoteanax rueppellii***		**V**								**X**	**U**	**PO**	**X**	**U**	**PO**									
Mammals	Inland Broad-nosed Bat	*Scotorepens balstoni*										X	U	PR	X	U	D	X	U	D						
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*										X	U	PO	X	U	PO									
Mammals	A Broad-nosed Bat	*Scotorepens sp.*																								
Mammals	Large Forest Bat	*Vespadelus darlingtoni*													X	U	PO									
Mammals	Eastern Forest Bat	*Vespadelus pumilus*										X	U	PO	X	U	D									
Mammals	Southern Forest Bat	*Vespadelus regulus*										X	U	PO	X	U	D									
Mammals	**Eastern Cave Bat**	***Vespadelus troughtoni***		**V**								**X**	**U**	**PO**	**X**	**U**	**PO**									
Mammals	Little Forest Bat	*Vespadelus vulturnus*										X	U	PO	X	U	PO									
Mammals	House Mouse	*Mus musculus*	X																							
Mammals	a rodent	*Family Muridae*																								
Mammals	Dingo	*Canis lupus dingo*																								

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Mammals	Dog	*Canis lupus familiaris*	X												X	P					X	P				
Mammals	Hybrid Dog	*Canis lupus/familiaris*	X												X	P										
Mammals	Fox	*Vulpes vulpes*	X												X	O, P	D				X	O		X	P	
Mammals	Cat	*Felis catus*	X									X	O		X	O										
Mammals	Brown Hare	*Lepus capensis*	X																							
Mammals	Rabbit	*Oryctolagus cuniculus*	X									X	O		X	O, X	D				X	P,X,Y	D	X	FB	
Mammals	Horse	*Equus caballus*	X																		X	O				
Mammals	Pig	*Sus scrofa*	X												X	O										
Mammals	European Cattle	*Bos taurus*	X												X	X	D				X	O		X	O	

Sites 14 - Incidental

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	Site 16	Observation Type	Confidence Type	Site 17	Observation Type	Confidence Type	Site 18	Observation Type	Confidence Type	Small rock escarpment Main Entrance	Observation Type	Confidence Type	Savoy Dam	Observation Type	Confidence Type	Incidental	Observation Type
Amphibians	Common Eastern Froglet	*Crinia signifera*							X	W		X	W		X	W											X	W
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*													X	OW		X	OW								X	O
Amphibians	Dusky Toadlet	*Uperoleia fusca*							X	W																		
Amphibians	Smooth Toadlet	*Uperoleia laevigata*																										
Amphibians	Green Tree Frog	*Litoria caerulea*				X	O											X	O								X	OW
Amphibians	Eastern Dwarf Tree Frog	*Litoria fallax*													X	OW												
Amphibians	Broad-palmed Frog	*Litoria latopalmata*				X	O					X	O		X	W		X	W								X	O
Amphibians	Peron's Tree Frog	*Litoria peronii*													X	W		X	O									
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*				X	O																				X	O
Reptiles	Macquarie Turtle	*Emydura macquarii*																									X	O
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*													X	O		X	O									
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*																			X	O					X	O
Reptiles	Thick-tailed Gecko	*Underwoodisaurus milii*																										
Reptiles	**Pink-tailed Legless Lizard**	***Aprasia parapulchella***		**V**	**V**																							
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**	**X**	**O**																				**X**	**O**
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*																										
Reptiles	Southern Rainbow-skink	*Carlia tetradactyla*							X	O								X	O		X	O					X	O
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*													X	O												
Reptiles	Robust Ctenotus	*Ctenotus robustus*				X	O		X	O		X	O		X	O		X	O								X	O
Reptiles	Tree Skink	*Egernia striolata*													X	O		X	O		X	O					X	O
Reptiles	Barred-sided Skink	*Concinnia tenuis*																										
Reptiles	Eastern Ranges Rock-skink	*Liopholis modesta*																			X	O					X	O
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*																										
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*																										
Reptiles	Eastern Water Dragon	*Intellagama lesueurii*							X	O																		
Reptiles	Eastern Bearded Dragon	*Pogona barbata*							X	O																	X	O
Reptiles	Sand Goanna	*Varanus gouldii*																										

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Reptiles	Lace Monitor	*Varanus varius*													X	O											X	O, Q
Reptiles	Brown-snouted Blind Snake	*Anilios wiedii*																										
Reptiles	Spotted Black Snake	*Pseudechis guttatus*				X	O					X	O															
Birds	Stubble Quail	*Coturnix pectoralis*																						X	O		X	O
Birds	Brown Quail	*Coturnix ypsilophora*				X	O																					
Birds	Plumed Whistling Duck	*Dendrocygna eytoni*																										
Birds	Black Swan	*Cygnus atratus*										X	O															
Birds	Pink-eared Duck	*Malacorhynchus membranaceus*																										
Birds	Australian Wood Duck	*Chenonetta jubata*				X	O					X	OW					X	O					X	O		X	O
Birds	Pacific Black Duck	*Anas superciliosa*				X	O		X	O														X	O		X	O
Birds	Australasian Shoveler	*Anas rhynchotis*										X	O															
Birds	Grey Teal	*Anas gracilis*							X	O		X	O											X	O		X	O
Birds	Chestnut Teal	*Anas castanea*																										
Birds	Hardhead Duck	*Aythya australis*										X	O														X	O
Birds	Musk Duck	*Biziura lobata*										X	O														X	O
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*							X	O														X	O		X	O
Birds	Hoary-headed Grebe	*Poliocephalus poliocephalus*							X	O		X	O														X	O
Birds	Straw-necked Ibis	*Threskiornis spinicollis*																									X	O
Birds	Nankeen Night Heron	*Nycticorax caledonicus*																										
Birds	**Cattle Egret**	***Ardea ibis***			**M**																							
Birds	White-necked Heron	*Ardea pacifica*																						X	O		X	O
Birds	White-faced Heron	*Egretta novaehollandiae*							X	O		X	O					X	O					X	O		X	O
Birds	Little Pied Cormorant	*Microcarbo melanoleucos*										X	O															
Birds	Pied Cormorant	*Phalacrocorax varius*							X	O																		
Birds	Australasian Darter	*Anhinga novaehollandiae*													X	O												
Birds	Nankeen Kestrel	*Falco cenchroides*				X	O		X	O					X	O												
Birds	Brown Falcon	*Falco berigora*				X	O											X	O					X	O		X	O
Birds	Black-shouldered Kite	*Elanus axillaris*																									X	O
Birds	Black Kite	*Milvus migrans*																									X	O
Birds	**Square-tailed Kite**	***Lophoictinia isura***		**V**																								
Birds	**White-bellied Sea Eagle**	***Haliaeetus leucogaster***		**V**	**M**				**X**	**O**																		
Birds	**Spotted Harrier**	***Circus assimilis***		**V**														**X**	**O**								**X**	**O**
Birds	Brown Goshawk	*Accipiter fasciatus*																									X	O
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*																										
Birds	Wedge-tailed Eagle	*Aquila audax*							X	O		X	O					X	O					X	O		X	O
Birds	**Little Eagle**	***Hieraaetus morphnoides***		**V**																							**X**	**O**
Birds	Purple Swamphen	*Porphyrio porphyrio*							X	O																		
Birds	Eurasian Coot	*Fulica atra*							X	O		X	O											X	O		X	O
Birds	Black-winged Stilt	*Himantopus himantopus*										X	O															
Birds	Red-necked Avocet	*Recurvirostra novaehollandiae*										X	O															
Birds	Banded Lapwing	*Vanellus tricolor*																									X	O
Birds	Masked Lapwing	*Vanellus miles*										X	OW		X	O		X	O					X	O		X	O
Birds	Black-fronted Dotterel	*Elseyornis melanops*							X	O		X	O															
Birds	Common Bronzewing	*Phaps chalcoptera*																										
Birds	Crested Pigeon	*Ocyphaps lophotes*				X	O		X	O								X	O									
Birds	Bar-shouldered Dove	*Geopelia humeralis*																										

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Birds	**Glossy Black-Cockatoo**	***Calyptorhynchus lathami***		**V**								**X**	**G**															
Birds	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*													X	O												
Birds	Galah	*Eolophus roseicapillas*				X	O		X	O					X	O		X	O					X	O		X	O
Birds	Little Corella	*Cacatua sanguinea*																										
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*							X	O		X	OW		X	O		X	O									
Birds	Rainbow Lorikeet	*Trichoglossus haematodus*										X	OW															
Birds	Musk Lorikeet	*Glossopsitta concinna*				X	O		X	OW																		
Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**																								
Birds	Crimson Rosella	*Platycercus elegans*										X	O															
Birds	Eastern Rosella	*Platycercus eximius*				X	O		X	O		X	O		X	O		X	O					X	O		X	O
Birds	Australian King-Parrot	*Alisterus scapularis*				X	O					X	O														X	W
Birds	Pallid Cuckoo	*Cuculus pallidus*																									X	O
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*							X	O																		
Birds	Black-eared Cuckoo	*Chalcites osculans*																										
Birds	Horsfield's Bronze-Cuckoo	*Chalcites basalis*													X	O											X	O
Birds	Shining Bronze Cuckoo	*Chrysococcyx lucidus*																										
Birds	Eastern Koel	*Eudynamys orientalis*																X	O									
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*													X	O		X	O									
Birds	Eastern Barn Owl	*Tyto javanica*							X	O																		
Birds	Southern Boobook	*Ninox novaeseelandiae*																										
Birds	Tawny Frogmouth	*Podargus strigoides*																X	O								X	O
Birds	White-throated Nightjar	*Eurostopodus mystacalis*																									X	OW
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*				X	O					X	W														X	O
Birds	Laughing Kookaburra	*Dacelo novaeguineae*				X	O								X	OW		X	O									
Birds	Sacred Kingfisher	*Todiramphus sanctus*																X	W									
Birds	**Rainbow Bee-eater**	***Merops ornatus***			**M**										**X**	**O**												
Birds	**Brown Treecreeper (eastern subspecies)**	***Climacteris picumnus victoriae***		**V**																								
Birds	Variegated Fairy-wren	*Malurus lamberti*																										
Birds	Superb Fairy-wren	*Malurus cyaneus*				X	O		X	O		X	O		X	O		X	O								X	O
Birds	Spotted Pardalote	*Pardalotus punctatus*							X	OW		X	OW		X	O												
Birds	Striated Pardalote	*Pardalotus striatus*							X	OW		X	OW		X	O		X	W									
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**					X	O																		
Birds	Weebill	*Smicrornis brevirostris*							X	OW		X	OW					X	O								X	W
Birds	Western Gerygone	*Gerygone fusca*							X	OW																		
Birds	White-throated Gerygone	*Gerygone olivacea*																										
Birds	Brown Thornbill	*Acanthiza pusilla*							X	OW																		
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*							X	OW																		
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				X	O		X	O								X	O								X	O
Birds	Yellow Thornbill	*Acanthiza nana*				X	O		X	O		X	O					X	O									
Birds	Striated Thornbill	*Acanthiza lineata*																										
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*							X	OW		X	OW															
Birds	Singing Honeyeater	*Lichenostomus virescens*							X	O																		
Birds	White-eared Honeyeater	*Nesoptilotis leucotis*										X	OW															
Birds	Fuscous Honeyeater	*Lichenostomus fuscus*										X	OW															
Birds	White-plumed Honeyeater	*Lichenostomus penicillatus*													X	OW												
Birds	Noisy Miner	*Manorina melanocephala*							X	OW		X	OW		X	O		X	O									

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	Site 16	Observation Type	Confidence Type	Site 17	Observation Type	Confidence Type	Site 18	Observation Type	Confidence Type	Small rock escarpment Main Entrance	Observation Type	Confidence Type	Savoy Dam	Observation Type	Confidence Type	Incidental	Observation Type
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*																										
Birds	**Black-chinned Honeyeater (eastern subspecies)**	***Melithreptus gularis gularis***		**V**																								
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*							X	OW		X	OW															
Birds	White-naped Honeyeater	*Melithreptus lunatus*							X	OW		X	OW															
Birds	Noisy Friarbird	*Philemon corniculatus*				X	O		X	OW		X	OW		X	O		X	O									
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*				X	O											X	O									
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*				X	O		X	O					X	O		X	O									
Birds	Red Wattlebird	*Anthochaera carunculata*							X	O		X	OW															
Birds	**Painted Honeyeater**	***Grantiella picta***		**V**	**V**																							
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*										X	OW															
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*																										
Birds	Eastern Yellow Robin	*Eopsaltria australis*																										
Birds	Jacky Winter	*Microeca fascinans*																										
Birds	Rose Robin	*Petroica rosea*							X	O		X	O															
Birds	**Flame Robin**	***Petroica phoenicea***		**V**					X	O																		
Birds	**Scarlet Robin**	***Petroica boodang***		**V**																								
Birds	Red-capped Robin	*Petroica goodenovii*				X	O											X	O									
Birds	**Grey-crowned Babbler (eastern subspecies)**	***Pomatostomus temporalis ssp temporalis***		**V**					X	O								**X**	**OW**								**X**	**O**
Birds	**Varied Sittella**	***Daphoenositta chrysoptera***		**V**					X	O																		
Birds	Golden Whistler	*Pachycephala pectoralis*							X	OW		X	OW					X	O									
Birds	Rufous Whistler	*Pachycephala rufiventris*				X	O		X	O					X	O		X	OW		X	O						
Birds	Grey Shrike-thrush	*Colluricincla harmonica*				X	O											X	O									
Birds	Grey Fantail	*Rhipidura albiscapa*				X	O		X	O		X	O															
Birds	Willie Wagtail	*Rhipidura leucophrys*							X	O					X	O		X	O								X	O
Birds	Magpie-lark	*Grallina cyanoleuca*				X	O											X	O								X	E
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M**																							
Birds	Grey Butcherbird	*Cracticus torquatus*				X	O		X	OW		X	OW		X	O		X	O									
Birds	Pied Butcherbird	*Cracticus nigrogularis*				X	O		X	OW		X	OW		X	O		X	O								X	W
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	OW		X	OW		X	O		X	O									
Birds	Pied Currawong	*Strepera graculina*				X	O		X	O		X	OW		X	OW		X	O									
Birds	Masked Woodswallow	*Artamus personatus*																										
Birds	White-browed Woodswallow	*Artamus superciliosus*																X	O								X	O
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**					X	O					**X**	**O**												
Birds	Cicadabird	*Coracina tenuirostris*																									X	W
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				X	O		X	O					X	O												
Birds	Ground Cuckoo-shrike	*Coracina maxima*																										
Birds	White-winged Triller	*Lalage sueurii*													X	O		X	O									
Birds	Olive-backed Oriole	*Oriolus sagittatus*							X	O					X	O												
Birds	Little Raven	*Corvus mellori*													X	O												
Birds	Australian Raven	*Corvus coronoides*				X	O		X	OW		X	OW		X	O		X	OW								X	Q
Birds	White-winged Chough	*Corcorax melanorhamphos*				X	O		X	OW																		
Birds	Common Starling	*Sturnus vulgaris*	X			X	O																				X	O
Birds	Common Myna	*Sturnus tristis*	X																								X	O
Birds	White-backed Swallow	*Cheramoeca leucosterna*																									X	O
Birds	Welcome Swallow	*Hirundo neoxena*				X	O		X	O		X	O		X	O												
Birds	Fairy Martin	*Petrochelidon ariel*																										

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	Site 16	Observation Type	Confidence Type	Site 17	Observation Type	Confidence Type	Site 18	Observation Type	Confidence Type	Small rock escarpment Main Entrance	Observation Type	Confidence Type	Savoy Dam	Observation Type	Confidence Type	Incidental	Observation Type
Birds	Tree Martin	*Petrochelidon nigricans*				X	O					X	O					X	O								X	O
Birds	Silvereye	*Zosterops lateralis*							X	O		X	O															
Birds	Australian Reed Warbler	*Acrocephalus australis*																									X	OW
Birds	Tawny Grassbird	*Megalurus timoriensis*																										
Birds	Rufous Songlark	*Cincloramphus mathewsi*				X	O								X	O		X	O									
Birds	Brown Songlark	*Cincloramphus cruralis*																									X	OW
Birds	Golden-headed Cisticola	*Cisticola exilis*																						X	O		X	O
Birds	Horsfield's Bushlark	*Mirafra javanica*																									X	O
Birds	Mistletoebird	*Dicaeum hirundinaceum*							X	OW					X	OW												
Birds	Richard's Pipit	*Anthus novaeseelandiae*				X	O																				X	O
Birds	Red-browed Finch	*Neochmia temporalis*													X	O												
Birds	Zebra Finch	*Taeniopygia guttata*																										
Birds	Double-barred Finch	*Taeniopygia bichenovii*				X	O											X	O									
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*																			X	P		X	O			
Mammals	Yellow-footed Antechinus	*Antechinus flavipes*																										
Mammals	Common Dunnart	*Sminthopsis murina*																										
Mammals	Common Wombat	*Vombatus ursinus*																									X	P
Mammals	Sugar Glider	*Petaurus breviceps*																										
Mammals	**Squirrel Glider**	***Petaurus norfolcensis***		**V**																								
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*							X	E																		
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*							X	O		X	O, H					X	O									
Mammals	brushtail possum	*Trichosurus sp.*																										
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*				X	O		X	O		X	O		X	O		X	O					X	O			
Mammals	Eastern Wallaroo	*Macropus robustus*							X	O																		
Mammals	Red-necked Wallaby	*Macropus rufogriseus*							X	O		X	O		X	O												
Mammals	Swamp Wallaby	*Wallabia bicolor*							X	P	PR																X	X
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**																							
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**																								
Mammals	**Eastern Freetail-bat**	***Mormopterus norfolkensis***		**V**																	**X**	**U**	**D**					
Mammals	Little Mastiff-bat	*Mormopterus planiceps*																			X	U	D					
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*																										
Mammals	White-striped Freetail-bat	*Austronomus australis*																										
Mammals	**Little Bentwing-bat**	***Miniopterus australis***		**V**																								
Mammals	**Eastern Bentwing-bat**	***Miniopterus schreibersii oceanensis***		**V**																	**X**	**U**	**D**					
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*																										
Mammals	Long-eared Bat	*Nyctophilus sp.*																										
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**																							
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*																			X	U	D					
Mammals	Chocolate Wattled Bat	*Chalinolobus morio*																										
Mammals	**Eastern False Pipistrelle**	***Falsistrellus tasmaniensis***		**V**																								
Mammals	**Southern Myotis**	***Myotis macropus***		**V**																								
Mammals	**Greater Broad-nosed Bat**	***Scoteanax rueppellii***		**V**																								
Mammals	Inland Broad-nosed Bat	*Scotorepens balstoni*																			X	U	D					
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*																										
Mammals	A Broad-nosed Bat	*Scotorepens sp.*																										
Mammals	Large Forest Bat	*Vespadelus darlingtoni*																										

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	Site 16	Observation Type	Confidence Type	Site 17	Observation Type	Confidence Type	Site 18	Observation Type	Confidence Type	Small rock escarpment Main Entrance	Observation Type	Confidence Type	Savoy Dam	Observation Type	Confidence Type	Incidental	Observation Type
Mammals	Eastern Forest Bat	*Vespadelus pumilus*																										
Mammals	Southern Forest Bat	*Vespadelus regulus*																										
Mammals	**Eastern Cave Bat**	***Vespadelus troughtoni***		**V**																								
Mammals	Little Forest Bat	*Vespadelus vulturnus*																										
Mammals	House Mouse	*Mus musculus*	X																									
Mammals	a rodent	*Family Muridae*																										
Mammals	Dingo	*Canis lupus dingo*																									X	O
Mammals	Dog	*Canis lupus familiaris*	X						X	P, F	D							X	P	D							X	P
Mammals	Hybrid Dog	*Canis lupus/familiaris*	X																									
Mammals	Fox	*Vulpes vulpes*	X						X	P	PO	X	P	PO							X	F					X	Q, O
Mammals	Cat	*Felis catus*	X																								X	O
Mammals	Brown Hare	*Lepus capensis*	X			X	O											X	O								X	O
Mammals	Rabbit	*Oryctolagus cuniculus*	X			X	O		X	O					X	O		X	O		X	H	D	X	O, Y	D	X	O
Mammals	Horse	*Equus caballus*	X																									
Mammals	Pig	*Sus scrofa*	X																									
Mammals	European Cattle	*Bos taurus*	X			X	O					X	X	D				X	H	D							X	O, Q

Key

X: detected
O: observed
W: heard
U: ultrasonic call recorded (microbats)
H: hair sample
Q: captured on camera
T: trapped
XX: in a scat

D: Definite detection (for identification via hair or ultrasonic call)
Pr: Probable detection (for identification via hair or ultrasonic call)
Po: Possible detection (for identification via hair or ultrasonic call)
Bold type: listed threatened and/or protected migratory species
V: listed as vulnerable under the BC and/or EPBC Act
E: listed as endangered under the BC and/or EPBC Act
CE: listed as critically endangered under the BC and/or EPBC Act
M: listed as a migratory and/or marine species under the EPBC Act

Appendix B Fauna Survey Site Descriptions

Site Number: 1

Site Description: Open eucalypt forest with a sparse shrub layer and mainly rocks and leaf litter for ground cover.

Habitat Condition: Evidence of heavy grazing and very dry conditions have left site in poor condition.

Site Disturbance Level and Type: Highly disturbed due to cattle grazing.

Connectivity: Connected to areas of woodland to the south through a narrow and broken corridor.

Site Location: -32.38643, 150.89076

Patch Size: 40 hectares

Topography, Slope and Aspect: Rocky hill with a moderately steep slope to the south-west.

Soil Type: Shallow, stoney brown clay loam.

Canopy Height: 10-15 m

DBH Canopy Trees: 0.4 to 1.2 m **DBH Sub-canopy Trees:** 0.1 to 0.3 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter (PCT 1607).
- Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter – DNG (PCT 1607).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).
- Dam.

Site Number: 2

Site Description: Dry open Box Gum woodland, with patches of dense regrowth of Bulloak and dense cover of leaf litter.

Habitat Condition: Poor very dry conditions with shrub layer with sparse foliage. The intermittent watercourse consists of an eroded gully.

Site Disturbance Level and Type: Some evidence of low disturbance through grazing.

Connectivity: Connected to the south and to the west, with cleared areas to the north and east.

Site Location: -32.39606, 150.89162

Patch Size: 55 hectares

Topography, Slope and Aspect: Gently sloping hillside to the east along drainage line.

Soil Type: Red-brown deep clay.

Canopy Height: 12-15 m

DBH Canopy Trees: 0.4 to 0.8 m **DBH Sub-canopy Trees:** 0.1 to 0.2 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).

Site Number: 3

Site Description: Sparse open box woodland with sparse shrub layer and ground cover on ridge top with Bulloak regeneration on slope and scattered Grey Box on lower slopes near creek lines and gullies.

Habitat Condition: Generally poor with evidence of grazing creating sparse ground cover with no regeneration of eucalypts.

Site Disturbance Level and Type: Heavily disturbed through cattle grazing.

Connectivity: Connected to the south to a much larger remnant offsite.

Site Location: -32.40436, 150.88962

Patch Size: 20 hectares

Topography, Slope and Aspect: Ridge top running north-west to south-east with a slope to a valley floor to the south-west.

Soil Type: Deep red-brown clay loam.

Canopy Height: 12 to 18 m

DBH Canopy Trees: 0.7 to 1.2 m **DBH Sub-canopy Trees:** 0.2 to 0.5 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** moderate

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter – DNG (PCT 1691).
- Bull Oak grassy woodland of the central and upper Hunter (PCT 1692).

Site Number: 4

Site Description: Narrow band of mature White Box forming a very open woodland along a ridge top with very sparse shrub and ground cover.

Habitat Condition: Very open habitat mostly cleared and heavily grazed by cattle.

Site Disturbance Level and Type: Heavily disturbed through clearing and cattle grazing.

Connectivity: Connected to a large remnant to the north and to the rest of the narrow band to the south, which eventually reaches another large remnant in about 2 kilometres.

Site Location: -32.40188, 150.88299

Patch Size: 5 hectares

Topography, Slope and Aspect: Ridge top running north-south.

Soil Type: Shallow red-brown clay loam with some stones.

Canopy Height: 12-15 m

DBH Canopy Trees: 0.5 to 1.3 m **DBH Sub-canopy Trees:** 0.2 to 0.3 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).

Site Number: 5

Site Description: Mature White Box/Grey Box open forest with areas of Bulloak regrowth and 2 dams (dry at the time of the survey). Shrub layer and ground cover very sparse.

Habitat Condition: Generally poor with evidence of heavy grazing.

Site Disturbance Level and Type: Very disturbed due to cattle grazing.

Connectivity: Partial tenuous connection with woodland remnants to the west and surrounded by open pasture on all other sides.

Site Location: -32.41405, 150.86669

Patch Size: 35 hectares

Topography, Slope and Aspect: Gentle slope to the north with a drainage line running to the north through the middle of the slope.

Soil Type: Deep red-brown clay loam.

Canopy Height: 15 to 18 m

DBH Canopy Trees: 0.4 to 1.3 m **DBH Sub-canopy Trees:** 0.2 to 0.4 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin (PCT 1655).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).
- Dam.

Site Number: 6

Site Description: Open White Box/Grey Box/Yellow Box forest with scattered patches of regenerating Bulloak and Cooba with sparse shrub layer and groundcover. Contains 2 dams with water at time of survey.

Habitat Condition: Poor due heavy grazing with much bare earth around dams.

Site Disturbance Level and Type: Heavily disturbed due to cattle grazing with little eucalypt regeneration.

Connectivity: Some weak connectivity to smaller remnants to the east and to the west.

Site Location: -32.41378, 150.84975

Patch Size: 80 hectares

Topography, Slope and Aspect: Low area with gentle slope to the north.

Soil Type: Deep red-brown clay loam.

Canopy Height: 12 to 15 m

DBH Canopy Trees: 0.3 to 0.7 m **DBH Sub-canopy Trees:** 0.1 to 0.3 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** moderate

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant grass cover species present.

Vegetation Community (Hunter Eco, 2019):

- Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion (PCT 201).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).
- Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains (PCT 1693).
- Dam.

Site Number: 7

Site Description: Open White Box/Grey Box forest with patches of Bulloak and sparse shrub layer and mainly leaf litter as groundcover.

Habitat Condition: Evidence of grazing pressure and in generally poor condition with little eucalypt regeneration.

Site Disturbance Level and Type: Moderately disturbed with cattle grazing.

Connectivity: Continuous with very open woodland to the south-east and to a denser woodland patch to the north-east.

Site Location: -32.41698, 150.83850

Patch Size: 25 hectares

Topography, Slope and Aspect: Low ridge top that slopes gently to the west along 2 gullies.

Soil Type: Deep red-brown clay loam.

Canopy Height: 10 to 15 m

DBH Canopy Trees: 0.4 to 0.7 m **DBH Sub-canopy Trees:** 0.2 to 0.3 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin (PCT 1655).
- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin - DNG (PCT 1655).
- White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (PCT 1691).
- Bull Oak grassy woodland of the central Hunter Valley (PCT 1692).

Site Number: 8

Site Description: Dense narrow corridor of Swamp Oak regrowth along a creek-line.

Habitat Condition: Evidence of recent grazing and with thin cover of grass and much bare ground, condition poor.

Site Disturbance Level and Type: Recent grazing and mostly cleared around patch.

Connectivity: Connectivity poor with small isolated patches of regrowth along creek-line and with cleared grazing land around patch.

Site Location: -32.41063, 150.82563

Patch Size: 3 hectares

Topography, Slope and Aspect: Low area with gentle slopes along creek-line which drains towards the west.

Soil Type: Deep red-brown clay loam.

Canopy Height: 8-10 m

DBH Canopy Trees: 0.1 to 0.3 m **DBH Sub-canopy Trees:** 0.03 to 0.1 m

Tree Hollow Density: nil **Fallen Log Density:** low

Standing Dead Tree Density: nil **Mistletoe Density**: nil

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (PCT 1731).
- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin - DNG (PCT 1655).

Site Number: 9

Site Description: Areas along roads at the intersection have been planted with trees in three rows within fenced areas about 20 m wide along roadsides. The area of planting runs for about 100 to 200 m along three sections and for about 1 kilometre along the other road edge.

Habitat Condition: Trees are tall and thin because of close planting but there is some recruitment of local native shrub and grass species. Habitat value is low due to narrow area of planting.

Site Disturbance Level and Type: Very low level of disturbance after original planting as good fencing has excluded livestock.

Connectivity: Poor connectivity to the north with some patchy regenerating woodland along creek-line.

Site Location: -32.44012, 150.82915

Patch Size: 3 hectares

Topography, Slope and Aspect: Gently slopes from west to east along main planting area and to road junction for other 3 areas.

Soil Type: Red-brown deep clay-loam.

Canopy Height:10-15 m

DBH Canopy Trees: 0.3 to 0.7 **DBH Sub-canopy Trees:** 0.1 to 0.2

Tree Hollow Density: nil **Fallen Log Density:** nil

Standing Dead Tree Density: nil **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Planted trees.

Site Number: 10

Site Description: Sparse open box woodland along a gully with patches of Bulloak with sparse shrub layer and poor cover of grasses and forbes. A dam (dry at the time of the survey) is also in this site.

Habitat Condition: Very poor open woodland with little regeneration of eucalypts.

Site Disturbance Level and Type: Highly disturbed by grazing cattle.

Connectivity: Some connectivity to the north of the site to areas of regeneration Bulloak and scattered eucalypts.

Site Location: -32.43750, 150.85237

Patch Size: 10 hectares

Topography, Slope and Aspect: Moderately steep slope to the south along a gully.

Soil Type: Red-brown clays.

Canopy Height: 8-12 m

DBH Canopy Trees: 0.4 to 0.8 m **DBH Sub-canopy Trees:** 0.1 to 0.2 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).

Site Number: 11

Site Description: Mature stand of White Box in an open forest on a moderately steep slope with a sparse understorey and shrub layer and moderate grass cover. There is a large dam with water at the bottom of the slope.

Habitat Condition: Fair condition although there is little regeneration of eucalypts.

Site Disturbance Level and Type: Moderate with cattle grazing.

Connectivity: Connects to very open woodland to the west and to a larger remnant to the east.

Site Location: -32.42325, 150.87886

Patch Size: 10 hectares

Topography, Slope and Aspect: Moderately steep slope to the west from a ridge top.

Soil Type: Red-brown clay loam.

Canopy Height: 12 to 16 m

DBH Canopy Trees: 0.7 to 1.3 m **DBH Sub-canopy Trees:** 0.5 to 0.7 m

Tree Hollow Density: moderate **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Dam.

Site Number: 12

Site Description: A long remnant of riparian woodland in mostly cleared area of pastureland with scattered Grey Box and Bulloak with some dense areas of Bulloak and Cooba regeneration.

Habitat Condition: Evidence of heavy grazing and very dry conditions have left site in poor condition.

Site Disturbance Level and Type: Highly disturbed due to cattle grazing.

Connectivity: Connected to larger patch of vegetation to the north at the head of the creek valley.

Site Location: -32.459599, 150.856216

Patch Size: 15 hectares

Topography, Slope and Aspect: Creek valley sloping to the south.

Soil Type: Shallow, stoney brown clay loam.

Canopy Height: 10-18 m

DBH Canopy Trees: 0.3 to 1.3 m **DBH Sub-canopy Trees:** 0.2 to 0.4 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter (PCT 1606).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).
- Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains (PCT 1693).

Site Number: 13

Site Description: A small remnant of riparian woodland along Saddlers Creek in mostly cleared area of pastureland with scattered Fuzzy Box and Swamp Oak with some dense areas of Swamp Oak regeneration.

Habitat Condition: Evidence of heavy grazing and very dry conditions have left site in poor condition.

Site Disturbance Level and Type: Highly disturbed due to cattle grazing.

Connectivity: Poorly connected via sparse cover of riparian vegetation along creeks passing through the site.

Site Location: -32.414284, 150.821075

Patch Size: 10 hectares

Topography, Slope and Aspect: Mainly level area along the banks of the creek.

Soil Type: Shallow, stoney brown clay loam.

Canopy Height: 10-12 m

DBH Canopy Trees: 0.3 to 0.6 m

DBH Sub-canopy Trees: 0.1 to 0.3 m

Tree Hollow Density: low

Fallen Log Density: low

Standing Dead Tree Density: low

Mistletoe Density: Very low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion – DNG (PCT 201).
- Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (PCT 1731).

Site Number: 14

Site Description: Mostly cleared area of pastureland with scattered remnant of eucalypts and Bulloak with some dense areas of Bulloak regeneration.

Habitat Condition: Evidence of heavy grazing and very dry conditions have left site in poor condition.

Site Disturbance Level and Type: Highly disturbed due to cattle grazing.

Connectivity: Poorly connected via sparse cover of riparian vegetation along creeks passing through the site.

Site Location: -32.429379, 150.824432

Patch Size: 50 hectares

Topography, Slope and Aspect: Gently undulating with a slight slope to the north along the drainage lines passing through the site.

Soil Type: Shallow, stoney brown clay loam.

Canopy Height: 15-20 m

DBH Canopy Trees: 0.4 to 1.2 m **DBH Sub-canopy Trees:** 0.2 to 0.4 m

Tree Hollow Density: High density of hollows in each tree but only moderate density over the whole site due to tree spacing.

Fallen Log Density: Moderate

Standing Dead Tree Density: Moderate **Mistletoe Density:** Very low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion (PCT 201).
- Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion – DNG (PCT 201).
- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin (PCT 1655)
- Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter and Sydney Basin – DNG (PCT 1655).

Site Number: 15

Site Description: Open eucalypt forest with a patchy shrub layer and some dense areas of sapling regrowth with a mixture of sparse grass cover and leaf litter for ground cover.

Habitat Condition: No evidence of recent grazing and much regeneration. Habitat in fair condition despite very dry conditions.

Site Disturbance Level and Type: Partial clearing for grazing in the past but little recent disturbance.

Connectivity: Connected to a much larger area of woodland to the south, broken only by a road and conveyer belt.

Site Location: -32.380155, 150.931008

Patch Size: 70 hectares

Topography, Slope and Aspect: Ridge top at western edge and slope to the east with several small gullies passing through site and joining at eastern edge.

Soil Type: Shallow, red-brown clay loam with some exposed rock.

Canopy Height: 15-20 m

DBH Canopy Trees: 0.2 to 0.9 m **DBH Sub-canopy Trees:** 0.1 to 0.2 m

Tree Hollow Density: low **Fallen Log Density:** moderate

Standing Dead Tree Density: moderate **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter (PCT 1604).
- White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG (PCT 1606).

Site Number: 16

Site Description: Tall dense regrowth Spotted Gum forest with some dry open Box Gum woodland and small patches of shrubby cover.

Habitat Condition: Regrowth areas are structurally very simple with only tall trees and leaf litter. Patches of Box Gum woodland structurally more complex and in fair condition.

Site Disturbance Level and Type: Much of the site has been previously cleared for grazing but is now covered with regrowth forest with no recent evidence of disturbance.

Connectivity: Connected to the north-west through to the north-east to a very large area of woodland.

Site Location: -32.335047, 150.935035

Patch Size: 80 hectares

Topography, Slope and Aspect: Gently slopes towards large dam at the centre of the site.

Soil Type: Red-brown shallow stoney clay-loam.

Canopy Height: 15-20 m

DBH Canopy Trees: 0.2 to 0.6 m

DBH Sub-canopy Trees: 0.1 to 0.2 m

Tree Hollow Density: low

Fallen Log Density: low

Standing Dead Tree Density: low

Mistletoe Density: low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter (PCT 1604).
- Forest Red Gum grassy open forest on floodplains of the lower Hunter (PCT 1598).
- Dam.
- Infrastructure and old workings.

Site Number: 17

Site Description: Open eucalypt forest regeneration with a few old growth trees, with a patchy and mostly sparse shrub layer and some dense areas of sapling regrowth with a mixture of sparse grass cover and leaf litter for ground cover.

Habitat Condition: No evidence of recent grazing and much regeneration. Habitat in poor condition due to sparse cover and very dry conditions.

Site Disturbance Level and Type: Previously mostly cleared but little recent disturbance.

Connectivity: Connected to a much larger area of remnant woodland to the north and the west. Mine infrastructure to the east and south.

Site Location: -32.336447, 150.924972

Patch Size: 10 hectares

Topography, Slope and Aspect: Gentle slopes to the west on undulating land with some small flood water courses running from the southern edge to the north-west.

Soil Type: Shallow, stoney red-brown clay loam.

Canopy Height: 12-17 m

DBH Canopy Trees: 0.2 to 1.3 m **DBH Sub-canopy Trees:** 0.1 to 0.2 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: low **Mistletoe Density:** low

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter (PCT 1604).
- Infrastructure and old workings.

Site Number: 18

Site Description: Mixture of riparian remnant old growth trees and Swamp Oak and Bulloak regeneration along a creek running east to west through mostly cleared grazing area that has only been released from grazing for a few months.

Habitat Condition: Evidence of recent grazing and much regeneration. Habitat in poor condition due to sparse cover and very dry conditions.

Site Disturbance Level and Type: Previously mostly cleared with evidence of grazing pressure under very dry conditions.

Connectivity: Poorly connected except along watercourse where the riparian zone varies in thickness and quality and with some open sections with little woody cover.

Site Location: -32.405822, 150.847956

Patch Size: 3 hectares

Topography, Slope and Aspect: Gentle slopes to the west on mostly flat land with watercourse running to the west through the site.

Soil Type: Deep red-brown clay loam.

Canopy Height: 8-18 m

DBH Canopy Trees: 0.1 to 0.9 m **DBH Sub-canopy Trees:** 0.1 to 0.2 m

Tree Hollow Density: low **Fallen Log Density:** low

Standing Dead Tree Density: moderate **Mistletoe Density:** nil

Dominant Canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Maxwell Project Baseline Flora Report* (Hunter Eco, 2019) for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2019):

- Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley (PCT 1731).
- Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains – DNG (PCT 1693).
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606).

Appendix C Threatened Biodiversity Data Collection Species PCT Associations Sydney Basin – Hunter IBRA Sub-region

Table C-1
Threatened Biodiversity Data Collection Species PCT Associations Sydney Basin – Hunter IBRA Sub-region

Scientific Name	Common Name	PCT	Notes
Litoria aurea	Green and Golden Bell Frog	1598	Species not present.
Litoria aurea	Green and Golden Bell Frog	1604	
Litoria aurea	Green and Golden Bell Frog	1606	
Litoria aurea	Green and Golden Bell Frog	1691	
Litoria aurea	Green and Golden Bell Frog	1692	
Litoria aurea	Green and Golden Bell Frog	1731	
Litoria brevipalmata	Green-thighed Frog	1598	No potential habitat in the study area. Species not present.
Litoria brevipalmata	Green-thighed Frog	1604	
Aprasia parapulchella	Pink-tailed Legless Lizard	None	Recorded in PCT 1606. Potential habitat within rocky areas mapped in PCT 1606 and 1606 DNG.
Delma impar	Striped Legless Lizard	1604	Recorded in PCT 1655 and 1655 DNG, PCT 1692, PCT 1693 DNG, PCT 1691 DNG, PCT1606 and PCT1606 DNG so these are also considered habitat.
Delma impar	Striped Legless Lizard	1655	
Delma impar	Striped Legless Lizard	1691	
Delma impar	Striped Legless Lizard	1692	
Delma impar	Striped Legless Lizard	1693	
Hoplocephalus bitorquatus	Pale-headed Snake	1604	Species not present.
Hoplocephalus bitorquatus	Pale-headed Snake	1606	
Hoplocephalus bitorquatus	Pale-headed Snake	1655	
Hoplocephalus bitorquatus	Pale-headed Snake	1691	
Hoplocephalus bitorquatus	Pale-headed Snake	1692	
Lophoictinia isura	Square-tailed Kite	201	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Lophoictinia isura	Square-tailed Kite	1604	
Lophoictinia isura	Square-tailed Kite	1606	
Lophoictinia isura	Square-tailed Kite	1607	
Lophoictinia isura	Square-tailed Kite	1655	
Lophoictinia isura	Square-tailed Kite	1691	
Lophoictinia isura	Square-tailed Kite	1692	
Lophoictinia isura	Square-tailed Kite	1693	
Haliaeetus leucogaster	White-bellied Sea-Eagle	201	These PCTs are considered appropriate potential foraging habitat and PCT 1604 (recorded in). No breeding habitat is present.
Haliaeetus leucogaster	White-bellied Sea-Eagle	1598	
Haliaeetus leucogaster	White-bellied Sea-Eagle	1607	
Haliaeetus leucogaster	White-bellied Sea-Eagle	1691	
Haliaeetus leucogaster	White-bellied Sea-Eagle	1692	
Haliaeetus leucogaster	White-bellied Sea-Eagle	1731	
Circus assimilis	Spotted Harrier	1731	PCT 1606 DNG and 1691 are also considered potential habitat.
Hieraaetus morphnoides	Little Eagle	116	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Hieraaetus morphnoides	Little Eagle	201	
Hieraaetus morphnoides	Little Eagle	1604	
Hieraaetus morphnoides	Little Eagle	1606	
Hieraaetus morphnoides	Little Eagle	1655	
Hieraaetus morphnoides	Little Eagle	1691	
Hieraaetus morphnoides	Little Eagle	1692	
Hieraaetus morphnoides	Little Eagle	1731	
Burhinus grallarius	Bush Stone-curlew	201	Species not present.
Burhinus grallarius	Bush Stone-curlew	1604	
Burhinus grallarius	Bush Stone-curlew	1606	
Burhinus grallarius	Bush Stone-curlew	1655	
Burhinus grallarius	Bush Stone-curlew	1691	
Burhinus grallarius	Bush Stone-curlew	1692	

Scientific Name	Common Name	PCT	Notes
Calyptorhynchus lathami	Glossy Black-Cockatoo	201	These PCTs are considered appropriate foraging habitat. No breeding habitat is present.
Calyptorhynchus lathami	Glossy Black-Cockatoo	1604	
Calyptorhynchus lathami	Glossy Black-Cockatoo	1606	
Calyptorhynchus lathami	Glossy Black-Cockatoo	1655	
Calyptorhynchus lathami	Glossy Black-Cockatoo	1691	
Calyptorhynchus lathami	Glossy Black-Cockatoo	1692	
Callocephalon fimbriatum	Gang-gang Cockatoo	201	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Callocephalon fimbriatum	Gang-gang Cockatoo	1604	
Callocephalon fimbriatum	Gang-gang Cockatoo	1606	
Callocephalon fimbriatum	Gang-gang Cockatoo	1655	
Callocephalon fimbriatum	Gang-gang Cockatoo	1691	
Callocephalon fimbriatum	Gang-gang Cockatoo	1692	
Callocephalon fimbriatum	Gang-gang Cockatoo	1731	
Glossopsitta pusilla	Little Lorikeet	201	These PCTs are considered appropriate.
Glossopsitta pusilla	Little Lorikeet	1598	
Glossopsitta pusilla	Little Lorikeet	1604	
Glossopsitta pusilla	Little Lorikeet	1606	
Glossopsitta pusilla	Little Lorikeet	1607	
Glossopsitta pusilla	Little Lorikeet	1655	
Glossopsitta pusilla	Little Lorikeet	1691	
Glossopsitta pusilla	Little Lorikeet	1692	
Glossopsitta pusilla	Little Lorikeet	1693	
Neophema pulchella	Turquoise Parrot	201	These PCTs are considered appropriate.
Neophema pulchella	Turquoise Parrot	1604	
Neophema pulchella	Turquoise Parrot	1606	
Neophema pulchella	Turquoise Parrot	1607	
Neophema pulchella	Turquoise Parrot	1655	
Neophema pulchella	Turquoise Parrot	1691	
Neophema pulchella	Turquoise Parrot	1692	
Neophema pulchella	Turquoise Parrot	1693	
Lathamus discolor	Swift Parrot	201	These PCTs are considered appropriate potential foraging habitat. No important habitat (as defined by OEH) is present.
Lathamus discolor	Swift Parrot	1604	
Lathamus discolor	Swift Parrot	1606	
Lathamus discolor	Swift Parrot	1655	
Lathamus discolor	Swift Parrot	1691	
Lathamus discolor	Swift Parrot	1692	
Tyto longimembris	Eastern Grass Owl	1731	This species is considered unlikely to use habitat in the study area. Species not present.
Tyto novaehollandiae	Masked Owl	201	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Tyto novaehollandiae	Masked Owl	1604	
Tyto novaehollandiae	Masked Owl	1606	
Tyto novaehollandiae	Masked Owl	1655	
Tyto novaehollandiae	Masked Owl	1691	
Tyto novaehollandiae	Masked Owl	1692	
Ninox strenua	Powerful Owl	1604	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Ninox strenua	Powerful Owl	1606	
Ninox strenua	Powerful Owl	1655	
Ninox strenua	Powerful Owl	1691	
Ninox strenua	Powerful Owl	1692	
Ninox connivens	Barking Owl	201	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Ninox connivens	Barking Owl	1598	
Ninox connivens	Barking Owl	1604	
Ninox connivens	Barking Owl	1606	
Ninox connivens	Barking Owl	1607	
Ninox connivens	Barking Owl	1655	
Ninox connivens	Barking Owl	1691	
Ninox connivens	Barking Owl	1692	
Ninox connivens	Barking Owl	1693	
Ninox connivens	Barking Owl	1731	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	201	These PCTs are considered appropriate.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1598	

Scientific Name	Common Name	PCT	Notes
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1604	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1606	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1607	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1655	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1691	
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1693	
Chthonicola sagittata	Speckled Warbler	201	These PCTs are considered appropriate.
Chthonicola sagittata	Speckled Warbler	1598	
Chthonicola sagittata	Speckled Warbler	1604	
Chthonicola sagittata	Speckled Warbler	1606	
Chthonicola sagittata	Speckled Warbler	1607	
Chthonicola sagittata	Speckled Warbler	1655	
Chthonicola sagittata	Speckled Warbler	1691	
Chthonicola sagittata	Speckled Warbler	1692	
Chthonicola sagittata	Speckled Warbler	1693	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	201	These PCTs are considered appropriate.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1604	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1606	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1655	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1691	
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1692	
Anthochaera phrygia	Regent Honeyeater	201	These PCTs are considered appropriate potential foraging habitat. No important habitat (as defined by OEH) is present.
Anthochaera phrygia	Regent Honeyeater	1604	
Anthochaera phrygia	Regent Honeyeater	1606	
Anthochaera phrygia	Regent Honeyeater	1607	
Anthochaera phrygia	Regent Honeyeater	1655	
Anthochaera phrygia	Regent Honeyeater	1691	
Anthochaera phrygia	Regent Honeyeater	1693	
Grantiella picta	Painted Honeyeater	116	These PCTs are considered appropriate.
Grantiella picta	Painted Honeyeater	201	
Grantiella picta	Painted Honeyeater	1604	
Grantiella picta	Painted Honeyeater	1606	
Grantiella picta	Painted Honeyeater	1607	
Grantiella picta	Painted Honeyeater	1655	
Grantiella picta	Painted Honeyeater	1691	
Grantiella picta	Painted Honeyeater	1692	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	201	These PCTs are considered appropriate.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1598	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1604	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1606	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1607	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1655	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1691	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1692	
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1693	
Petroica phoenicea	Flame Robin	116	These PCTs are considered appropriate.
Petroica phoenicea	Flame Robin	1604	
Petroica phoenicea	Flame Robin	1606	
Petroica phoenicea	Flame Robin	1607	
Petroica phoenicea	Flame Robin	1655	
Petroica phoenicea	Flame Robin	1691	
Petroica phoenicea	Flame Robin	1692	
Petroica boodang	Scarlet Robin	116	These PCTs are considered appropriate.
Petroica boodang	Scarlet Robin	201	
Petroica boodang	Scarlet Robin	1598	

Scientific Name	Common Name	PCT	Notes
Petroica boodang	Scarlet Robin	1604	
Petroica boodang	Scarlet Robin	1606	
Petroica boodang	Scarlet Robin	1607	
Petroica boodang	Scarlet Robin	1655	
Petroica boodang	Scarlet Robin	1691	
Petroica boodang	Scarlet Robin	1692	
Petroica boodang	Scarlet Robin	1693	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	201	PCT 1693 and PCT 1731 are also considered potential habitat.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1604	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1606	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1655	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1691	
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1692	
Daphoenositta chrysoptera	Varied Sittella	116	PCT 1692 and PCT 1598 are also considered potential habitat.
Daphoenositta chrysoptera	Varied Sittella	201	
Daphoenositta chrysoptera	Varied Sittella	1598	
Daphoenositta chrysoptera	Varied Sittella	1604	
Daphoenositta chrysoptera	Varied Sittella	1606	
Daphoenositta chrysoptera	Varied Sittella	1607	
Daphoenositta chrysoptera	Varied Sittella	1655	
Daphoenositta chrysoptera	Varied Sittella	1691	
Daphoenositta chrysoptera	Varied Sittella	1693	
Daphoenositta chrysoptera	Varied Sittella	1731	
Artamus cyanopterus cyanopterus	Dusky Woodswallow	201	PCT 1604 and PCT 1606 DNG are also considered potential habitat.
Stagonopleura guttata	Diamond Firetail	201	PCT 1691 is also considered potential habitat.
Stagonopleura guttata	Diamond Firetail	1604	
Stagonopleura guttata	Diamond Firetail	1606	
Stagonopleura guttata	Diamond Firetail	1655	
Dasyurus maculatus	Spotted-tailed Quoll	201	These PCTs are considered appropriate (in woodland and DNG form).
Dasyurus maculatus	Spotted-tailed Quoll	1598	
Dasyurus maculatus	Spotted-tailed Quoll	1604	
Dasyurus maculatus	Spotted-tailed Quoll	1606	
Dasyurus maculatus	Spotted-tailed Quoll	1607	
Dasyurus maculatus	Spotted-tailed Quoll	1655	
Dasyurus maculatus	Spotted-tailed Quoll	1691	
Dasyurus maculatus	Spotted-tailed Quoll	1692	
Dasyurus maculatus	Spotted-tailed Quoll	1693	
Dasyurus maculatus	Spotted-tailed Quoll	1731	
Phascogale tapoatafa	Brush-tailed Phascogale	201	These PCTs are considered appropriate.
Phascogale tapoatafa	Brush-tailed Phascogale	1604	
Phascogale tapoatafa	Brush-tailed Phascogale	1606	
Phascogale tapoatafa	Brush-tailed Phascogale	1691	
Phascogale tapoatafa	Brush-tailed Phascogale	1692	
Phascogale tapoatafa	Brush-tailed Phascogale	1731	
Planigale maculata	Common Planigale	1604	This species is considered unlikely to use habitat in the study area. Species not present.
Planigale maculata	Common Planigale	1606	
Planigale maculata	Common Planigale	1655	
Planigale maculata	Common Planigale	1691	
Planigale maculata	Common Planigale	1692	
Phascolarctos cinereus	Koala	201	These PCTs are considered appropriate.
Phascolarctos cinereus	Koala	1598	
Phascolarctos cinereus	Koala	1604	
Phascolarctos cinereus	Koala	1606	
Phascolarctos cinereus	Koala	1607	
Phascolarctos cinereus	Koala	1655	
Phascolarctos cinereus	Koala	1693	
Cercartetus nanus	Eastern Pygmy-possum	1604	This species is considered unlikely to use habitat in the study area. Species not present.
Cercartetus nanus	Eastern Pygmy-possum	1606	
Cercartetus nanus	Eastern Pygmy-possum	1655	

Scientific Name	Common Name	PCT	Notes
Cercartetus nanus	Eastern Pygmy-possum	1691	
Cercartetus nanus	Eastern Pygmy-possum	1692	
Petaurus australis	Yellow-bellied Glider	1604	This species is considered unlikely to use habitat in the study area. Species not present.
Petaurus australis	Yellow-bellied Glider	1606	
Petaurus norfolcensis	Squirrel Glider	201	PCT 1598 and 1604 are also considered potential habitat.
Petaurus norfolcensis	Squirrel Glider	1606	
Petaurus norfolcensis	Squirrel Glider	1655	
Petrogale penicillata	Brush-tailed Rock-wallaby	201	This species is considered unlikely to use habitat in the study area. Species not present.
Petrogale penicillata	Brush-tailed Rock-wallaby	1604	
Petrogale penicillata	Brush-tailed Rock-wallaby	1655	
Petrogale penicillata	Brush-tailed Rock-wallaby	1691	
Petrogale penicillata	Brush-tailed Rock-wallaby	1692	
Pteropus poliocephalus	Grey-headed Flying-fox	1604	These PCTs are considered appropriate.
Pteropus poliocephalus	Grey-headed Flying-fox	1606	
Pteropus poliocephalus	Grey-headed Flying-fox	1655	
Pteropus poliocephalus	Grey-headed Flying-fox	1691	
Pteropus poliocephalus	Grey-headed Flying-fox	1692	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	201	These PCTs are considered appropriate.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1604	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1606	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1655	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1691	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1692	
Mormopterus norfolkensis	Eastern Freetail-bat	1604	PCT 1598, 1606 and 1693 are also considered potential habitat.
Mormopterus norfolkensis	Eastern Freetail-bat	1691	
Mormopterus norfolkensis	Eastern Freetail-bat	1692	
Miniopterus australis	Little Bentwing-bat	1604	PCT 1598 and 1606 are also considered potential habitat.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	201	PCT 1598, 1607 and 1693 are also considered potential habitat.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	1604	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	1606	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	1655	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	1691	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	1692	
Nyctophilus corbeni	Corben's Long-eared Bat	201	PCT 1691 is also considered potential habitat.
Nyctophilus corbeni	Corben's Long-eared Bat	1606	
Nyctophilus corbeni	Corben's Long-eared Bat	1655	
Chalinolobus dwyeri	Large-eared Pied Bat	201	Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).
Chalinolobus dwyeri	Large-eared Pied Bat	1604	
Chalinolobus dwyeri	Large-eared Pied Bat	1606	
Chalinolobus dwyeri	Large-eared Pied Bat	1655	
Chalinolobus dwyeri	Large-eared Pied Bat	1691	
Chalinolobus dwyeri	Large-eared Pied Bat	1692	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1604	PCT 1598 is also considered potential habitat.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1606	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1655	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1691	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1692	
Myotis macropus	Southern Myotis	1604	Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).
Myotis macropus	Southern Myotis	1691	
Myotis macropus	Southern Myotis	1692	
Scoteanax rueppellii	Greater Broad-nosed Bat	1604	PCT 1598 is also considered potential habitat.
Scoteanax rueppellii	Greater Broad-nosed Bat	1606	
Scoteanax rueppellii	Greater Broad-nosed Bat	1655	
Scoteanax rueppellii	Greater Broad-nosed Bat	1691	
Scoteanax rueppellii	Greater Broad-nosed Bat	1692	
Vespadelus troughtoni	Eastern Cave Bat	1604	Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method'*(OEH, 2018).
Vespadelus troughtoni	Eastern Cave Bat	1606	
Vespadelus troughtoni	Eastern Cave Bat	1655	

ATTACHMENT C
BAM BIODIVERSITY CREDIT REPORT - STAGE 1 BIODIVERSITY ASSESSMENT
DEVELOPMENT FOOTPRINT

BAM Credit Summary Report

Proposal Details

Assessment Id
00014113/BAAS17004/19/00014114

Proposal Name
Maxwell Underground NSW Stage 1

BAM data last updated *
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Assessor Name
Colin Driscoll

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* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

BAM Credit Summary Report

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone	Vegetation	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk	Potential SAII	Ecosystem credits
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter								
6	1607_Derived_nati	27.6	4.9	0.25	High Sensitivity to Potential Gain	1.75		59
7	1607_Moderate	50.5	0.4	0.25	High Sensitivity to Potential Gain	1.75		9
							Subtotal	**68**
Bull Oak grassy woodland of the central Hunter Valley								
8	1692_Moderate	36.9	2.8	0.25	High Sensitivity to Potential Gain	1.75		45
							Subtotal	**45**
Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion								
1	201_Moderate	47.5	0.5	0.25	High Sensitivity to Potential Gain	2.50		15
9	201_Derived_nativ	23.1	1.0	0.25	High Sensitivity to Potential Gain	2.50		14
							Subtotal	**29**
Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin								
2	1655_Moderate	46.5	1.2	0.25	High Sensitivity to Potential Gain	1.50		21
							Subtotal	**21**
Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter								
3	1604_Moderate	68.4	1.3	0.25	High Sensitivity to Potential Gain	2.00		44
10	1604_Low_RW	28.1	15.2	0.25	High Sensitivity to Potential Gain	2.00		214
13	1604_Low_RP	3.8	49.3	0.25	High Sensitivity to Potential Gain	2.00		0
							Subtotal	**258**
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter								

11	1691_Moderate	48.3	7.6	0.25	High Sensitivity to Potential Gain	2.00		184
12	1691_Derived_nati	40.7	0.3	0.25	High Sensitivity to Potential Gain	2.00		6
							Subtotal	**190**
White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter								
4	1606_Derived_nati	15.8	122.7	0.25	High Sensitivity to Potential Gain	2.00	TRUE	971
5	1606_Moderate	45.4	9.5	0.25	High Sensitivity to Potential Gain	2.00	TRUE	216
							Subtotal	**1187**
							Total	**1798**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAII	Species credits
Aprasia parapulchella / Pink-tailed Legless Lizard (Fauna)						
1606_Derived_native_gra	15.8	29.5	0.25	2	False	233
1606_Moderate	45.4	3.4	0.25	2	False	77
1607_Derived_native_gra	27.6	0.4	0.25	2	False	6
1607_Moderate	50.5	0.1	0.25	2	False	3
1691_Moderate	48.3	2.6	0.25	2	False	63
					Subtotal	**382**
Delma impar / Striped Legless Lizard (Fauna)						
1655_Moderate	46.5	1.2	0.25	1.5	False	21
1604_Moderate	68.4	1.3	0.25	1.5	False	33
1606_Derived_native_gra	15.8	122.7	0.25	1.5	False	728

1606_Moderate	45.4	9.5	0.25	1.5	False	162
1692_Moderate	36.9	2.8	0.25	1.5	False	39
1691_Moderate	48.3	7.6	0.25	1.5	False	138
1691_Derived_native_gra	40.7	0.3	0.25	1.5	False	5
					Subtotal	**1126**
Myotis macropus / Southern Myotis (Fauna)						
1692_Moderate	36.9	0.5	0.25	2	False	9
					Subtotal	**9**
Petaurus norfolcensis / Squirrel Glider (Fauna)						
201_Moderate	47.5	0.5	0.25	2	False	12
1604_Moderate	68.4	1.3	0.25	2	False	44
1606_Derived_native_gra	15.8	28	0.25	2	False	222
1606_Moderate	45.4	9.5	0.25	2	False	216
1655_Moderate	46.5	1.2	0.25	2	False	28
201_Derived_native_gras	23.1	0.2	0.25	2	False	2
					Subtotal	**524**

ATTACHMENT D
BAM BIODIVERSITY CREDIT REPORT - STAGE 2 BIODIVERSITY ASSESSMENT
DEVELOPMENT FOOTPRINT

BAM Credit Summary Report

Proposal Details

Assessment Id

00014113/BAAS17004/19/00014117

Proposal Name

Maxwell Underground NSW-COM Stage 2

BAM data last updated *

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Assessment Type

Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

BAM Credit Summary Report

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone	Vegetation	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk	Potential SAII	Ecosystem credits
Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion								
1	201_Derived_nativ	23.1	1.8	0.25	High Sensitivity to Potential Gain	2.50		26
							Subtotal	**26**
Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin								
2	1655_Derived_nati	26.5	2.4	0.25	High Sensitivity to Potential Gain	1.50		24
3	1655_Low	31.2	0.2	0.25	High Sensitivity to Potential Gain	1.50		2
							Subtotal	**26**
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter								
6	1691_Moderate	51.4	2.0	0.25	High Sensitivity to Potential Gain	2.00		51
							Subtotal	**51**
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley								
7	1731_Moderate	41.2	0.2	0.25	High Sensitivity to Potential Gain	1.75		4
							Subtotal	**4**
White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter								
4	1606_Derived_nati	31.0	2.9	0.25	High Sensitivity to Potential Gain	2.00	TRUE	45
5	1606_Moderate	46.6	0.1	0.25	High Sensitivity to Potential Gain	2.00	TRUE	2
							Subtotal	**47**
							Total	**154**

BAM Credit Summary Report

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAII	Species credits
Aprasia parapulchella / Pink-tailed Legless Lizard (Fauna)						
201_Derived_native_gras	23.1	0.2	0.25	2	False	2
1606_Derived_native_gra	31.0	2.5	0.25	2	False	39
					Subtotal	**41**
Delma impar / Striped Legless Lizard (Fauna)						
1655_Derived_native_gra	26.5	2.4	0.25	1.5	False	24
1606_Derived_native_gra	31.0	2.9	0.25	1.5	False	34
1606_Moderate	46.6	0.1	0.25	1.5	False	2
1691_Moderate	51.4	2	0.25	1.5	False	39
					Subtotal	**99**
Myotis macropus / Southern Myotis (Fauna)						
1691_Moderate	51.4	1.4	0.25	2	False	36
					Subtotal	**36**
Petaurus norfolcensis / Squirrel Glider (Fauna)						
1606_Moderate	46.6	0.1	0.25	2	False	2
1606_Derived_native_gra	31.0	0.9	0.25	2	False	14
1655_Derived_native_gra	26.5	0.8	0.25	2	False	11
201_Derived_native_gras	23.1	0.5	0.25	2	False	6
					Subtotal	**33**

ATTACHMENT E
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - STAGE 1

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00014113/BAAS17004/19/00014114

Proposal Name
Maxwell Underground NSW Stage 1

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Proponent Names

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Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

Predicted Threatened Species Not On Site

No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.5	29.00
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Not a TEC	1.2	21.00
1604-Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	65.8	258.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely’s Red Gum Woodland	132.2	1187.00
1607-Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Not a TEC	5.3	68.00
1692-Bull Oak grassy woodland of the central Hunter Valley	Not a TEC	2.8	45.00

1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	7.9	190.00

201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion

Like-for-like credit retirement options

Class	Trading group	HBT	IBRA region
Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands - ≥ 90% cleared group (including Tier 2 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1604-Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Like-for-like credit retirement options

Name of offset trading group	Trading group	HBT	IBRA region

	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1600, 1601, 1604	-	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1607-Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	North-west Slopes Dry Sclerophyll Woodlands This includes PCT's: 228, 429, 435, 517, 527, 529, 564, 588, 594, 595, 597, 598, 856, 1165, 1306, 1308, 1317, 1387, 1586, 1607	North-west Slopes Dry Sclerophyll Woodlands - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Western Slopes Dry Sclerophyll Forests This includes PCT's: 54, 110, 179, 217, 243, 255, 270, 273, 287, 291, 309, 321, 322, 323, 324, 325, 327, 330, 331, 333, 341, 343, 346, 348, 354, 358, 379, 387, 396, 398, 399, 401, 402, 403, 404, 405, 406, 407, 408, 409, 414, 415, 417, 419, 420, 423, 425, 430, 431, 440, 443, 449, 455, 456, 457, 459, 462, 463, 467, 468, 469, 470, 471, 472, 473, 476, 477, 478, 479, 480, 482, 515, 531, 532, 576, 577, 581, 592, 610, 617, 671, 673, 676, 712, 713, 714, 746, 863, 889, 940, 956, 1133, 1176, 1277, 1278, 1279, 1307, 1313, 1314, 1316, 1381, 1398, 1610, 1629, 1654, 1655, 1656, 1657, 1660, 1661, 1663, 1668, 1669, 1671, 1672, 1674, 1676, 1677, 1678, 1679, 1680, 1709, 1711, 1770, 1771	Western Slopes Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1603, 1605, 1691, 1692	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1692-Bull Oak grassy woodland of the central Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	Coastal Valley Grassy Woodlands This includes PCT's: 116, 618, 622, 623, 760, 761, 762, 829, 830, 834, 837, 838, 849, 850, 1326, 1395, 1603, 1604, 1691, 1692	Coastal Valley Grassy Woodlands - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Area	Credits
Aprasia parapulchella / Pink-tailed Legless Lizard	36.0	382.00
Delma impar / Striped Legless Lizard	145.4	1126.00
Myotis macropus / Southern Myotis	0.5	9.00
Petaurus norfolcensis / Squirrel Glider	40.7	524.00

Aprasia parapulchella/ Pink-tailed Legless Lizard	1606_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
	1606_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
	1607_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region

		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
	1607_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
	1691_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
Delma impar/ Striped Legless Lizard	1604_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW

Delma impar/ Striped Legless Lizard	1604_Moderate		
	1606_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1606_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1655_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW

Delma impar/ Striped Legless Lizard	1691_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1691_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1692_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
Myotis macropus/ Southern Myotis	1692_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region

		Myotis macropus/Southern Myotis	Any in NSW
Petaurus norfolcensis/ Squirrel Glider	1604_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW
	1606_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW
	1606_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW

Petaurus norfolcensis/ Squirrel Glider	1606_Moderate	
	1655_Moderate	**Like-for-like credit retirement options**
		Spp / IBRA region
		Petaurus norfolcensis/Squirrel Glider / Any in NSW
	201_Derived_native_grass	**Like-for-like credit retirement options**
		Spp / IBRA region
		Petaurus norfolcensis/Squirrel Glider / Any in NSW
	201_Moderate	**Like-for-like credit retirement options**
		Spp / IBRA region
		Petaurus norfolcensis/Squirrel Glider / Any in NSW

ATTACHMENT F
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - STAGE 2

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00014113/BAAS17004/19/00014117

Proposal Name
Maxwell Underground NSW-COM Stage 2

BAM data last updated *
04/07/2019

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
12

Proponent Names

Report Created
02/08/2019

BAM Case Status
Open

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

Predicted Threatened Species Not On Site

Name
Petaurus australis / Yellow-bellied Glider

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.8	26.00
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Not a TEC	2.6	26.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	3.0	47.00
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	2.0	51.00
1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Not a TEC	0.2	4.00

201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands - ≥ 90% cleared group (including Tier 2 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Western Slopes Dry Sclerophyll Forests This includes PCT's: 54, 110, 179, 217, 243, 255, 270, 273, 287, 291, 309, 321, 322, 323, 324, 325, 327, 330, 331, 333, 341, 343, 346, 348, 354, 358, 379, 387, 396, 398, 399, 401, 402, 403, 404, 405, 406, 407, 408, 409, 414, 415, 417, 419, 420, 423, 425, 430, 431, 440, 443, 449, 455, 456, 457, 459, 462, 463, 467, 468, 469, 470, 471, 472, 473, 476, 477, 478, 479, 480, 482, 515, 531, 532, 576, 577, 581, 592, 610, 617, 671, 673, 676, 712, 713, 714, 746, 863, 889, 940, 956, 1133, 1176, 1277, 1278, 1279, 1307, 1313, 1314, 1316, 1381, 1398, 1610, 1629, 1654, 1655, 1656, 1657, 1660, 1661, 1663, 1668, 1669, 1671, 1672, 1674, 1676, 1677, 1678, 1679, 1680, 1709, 1711, 1770, 1771	Western Slopes Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1603, 1605, 1691, 1692	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	Coastal Swamp Forests This includes PCT's: 839, 1064, 1227, 1230, 1231, 1232, 1716, 1717, 1718, 1719, 1723, 1730, 1731, 1795, 1798	Coastal Swamp Forests - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Area	Credits
Aprasia parapulchella / Pink-tailed Legless Lizard	2.7	41.00
Delma impar / Striped Legless Lizard	7.4	99.00
Myotis macropus / Southern Myotis	1.4	36.00
Petaurus norfolcensis / Squirrel Glider	2.3	33.00

Aprasia parapulchella/ Pink-tailed Legless Lizard	1606_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
	201_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW
Delma impar/ Striped Legless Lizard	1606_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region

		Delma impar/Striped Legless Lizard	Any in NSW
	1606_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1655_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW
	1691_Moderate	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Delma impar/Striped Legless Lizard	Any in NSW

Myotis macropus/ Southern Myotis	1691_Moderate	**Like-for-like credit retirement options**
		Spp / IBRA region
		Myotis macropus/Southern Myotis / Any in NSW
Petaurus norfolcensis/ Squirrel Glider	1606_Derived_native_grass	**Like-for-like credit retirement options**
		Spp / IBRA region
		Petaurus norfolcensis/Squirrel Glider / Any in NSW
	1606_Moderate	**Like-for-like credit retirement options**
		Spp / IBRA region
		Petaurus norfolcensis/Squirrel Glider / Any in NSW

Petaurus norfolcensis/ Squirrel Glider	1655_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW
	201_Derived_native_grass	**Like-for-like credit retirement options**	
		Spp	IBRA region
		Petaurus norfolcensis/Squirrel Glider	Any in NSW

ATTACHMENT G
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - STAGE 1

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00014113/BAAS17004/19/00014114	Maxwell Underground NSW Stage 1	04/07/2019
Assessor Name	Assessor Number	BAM Data version *
Colin Driscoll	BAAS17004	12
Proponent Name(s)	Report Created	BAM Case Status
	02/08/2019	Open
Assessment Revision	Assessment Type	Date Finalised
1	Major Projects	To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Variations)

Predicted Threatened Species Not On Site

No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.5	29.00
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Not a TEC	1.2	21.00
1604-Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	65.8	258.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	132.2	1187.00
1607-Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Not a TEC	5.3	68.00
1692-Bull Oak grassy woodland of the central Hunter Valley	Not a TEC	2.8	45.00
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	7.9	190.00

201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands - ≥ 90% cleared group (including Tier 2 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 2 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1604-Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1600, 1601, 1604	-	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 3 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	Yes	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher	Yes (including artificial)	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1607-Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	North-west Slopes Dry Sclerophyll Woodlands This includes PCT's: 228, 429, 435, 517, 527, 529, 564, 588, 594, 595, 597, 598, 856, 1165, 1306, 1308, 1317, 1387, 1586, 1607	North-west Slopes Dry Sclerophyll Woodlands - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 6 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Western Slopes Dry Sclerophyll Forests This includes PCT's: 54, 110, 179, 217, 243, 255, 270, 273, 287, 291, 309, 321, 322, 323, 324, 325, 327, 330, 331, 333, 341, 343, 346, 348, 354, 358, 379, 387, 396, 398, 399, 401, 402, 403, 404, 405, 406, 407, 408, 409, 414, 415, 417, 419, 420, 423, 425, 430, 431, 440, 443, 449, 455, 456, 457, 459, 462, 463, 467, 468, 469, 470, 471, 472, 473, 476, 477, 478, 479, 480, 482, 515, 531, 532, 576, 577, 581, 592, 610, 617, 671, 673, 676, 712, 713, 714, 746, 863, 889, 940, 956, 1133, 1176, 1277, 1278, 1279, 1307, 1313, 1314, 1316, 1381, 1398, 1610, 1629, 1654, 1655, 1656, 1657, 1660, 1661, 1663, 1668, 1669, 1671, 1672, 1674, 1676, 1677, 1678, 1679, 1680, 1709, 1711, 1770, 1771	Western Slopes Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	Yes	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 7 or higher	Yes (including artificial)	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region
	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1603, 1605, 1691, 1692	-	Yes	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 3 or higher	Yes (including artificial)	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1692-Bull Oak grassy woodland of the central Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Coastal Valley Grassy Woodlands This includes PCT's: 116, 618, 622, 623, 760, 761, 762, 829, 830, 834, 837, 838, 849, 850, 1326, 1395, 1603, 1604, 1691, 1692	Coastal Valley Grassy Woodlands - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 6 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Area	Credits
Aprasia parapulchella / Pink-tailed Legless Lizard	36.0	382.00
Delma impar / Striped Legless Lizard	145.4	1126.00
Myotis macropus / Southern Myotis	0.5	9.00
Petaurus norfolcensis / Squirrel Glider	40.7	524.00

Aprasia parapulchella/ Pink-tailed Legless Lizard	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act	IBRA region

			shown below	
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1607_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1607_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	1691_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Delma impar/ Striped Legless Lizard	1604_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act	IBRA region

			shown below	
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	1655_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1691_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act	IBRA region

			shown below	
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1691_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1692_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Myotis macropus/ Southern Myotis	1692_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Myotis macropus/Southern Myotis	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	1604_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing	IBRA region

			under Part 4 of the BC Act shown below	
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	1655_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	201_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act	IBRA region

			shown below	
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	201_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT H
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - STAGE 2

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00014113/BAAS17004/19/00014117	Maxwell Underground NSW-COM Stage 2	04/07/2019
Assessor Name	Assessor Number	BAM Data version *
Colin Driscoll	BAAS17004	12
Proponent Name(s)	Report Created	BAM Case Status
	02/08/2019	Open
Assessment Revision	Assessment Type	Date Finalised
1	Major Projects	To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Variations)

Predicted Threatened Species Not On Site

Name
Petaurus australis / Yellow-bellied Glider

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.8	26.00
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Not a TEC	2.6	26.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	3.0	47.00
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	2.0	51.00
1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	Not a TEC	0.2	4.00

201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region

	Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands - ≥ 90% cleared group (including Tier 2 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 2 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin

Like-for-like credit retirement options

Class	Trading group	HBT	IBRA region
Western Slopes Dry Sclerophyll Forests This includes PCT's: 54, 110, 179, 217, 243, 255, 270, 273, 287, 291, 309, 321, 322, 323, 324, 325, 327, 330, 331, 333, 341, 343, 346, 348, 354, 358, 379, 387, 396, 398, 399, 401, 402, 403, 404, 405, 406, 407, 408, 409, 414, 415, 417, 419, 420, 423, 425, 430, 431, 440, 443, 449, 455, 456, 457, 459, 462, 463, 467, 468, 469, 470, 471, 472, 473, 476, 477, 478, 479, 480, 482, 515, 531, 532, 576, 577, 581, 592, 610, 617, 671, 673, 676, 712, 713, 714, 746, 863, 889, 940, 956, 1133, 1176, 1277, 1278, 1279, 1307, 1313, 1314, 1316, 1381, 1398, 1610, 1629, 1654, 1655, 1656, 1657, 1660, 1661, 1663, 1668, 1669, 1671, 1672, 1674, 1676, 1677, 1678, 1679, 1680, 1709, 1711, 1770, 1771	Western Slopes Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	HBT	IBRA region

	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 7 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1691-Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	**Like-for-like credit retirement options**			
	Name of offset trading group	Trading group	HBT	IBRA region
	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions This includes PCT's: 1603, 1605, 1691, 1692	-	Yes	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Grassy Woodlands	Tier 3 or higher	Yes (including artificial)	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1731-Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	**Like-for-like credit retirement options**			
	Class	Trading group	HBT	IBRA region
	Coastal Swamp Forests This includes PCT's: 839, 1064, 1227, 1230, 1231, 1232, 1716, 1717, 1718, 1719, 1723, 1730, 1731, 1795, 1798	Coastal Swamp Forests - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Forested Wetlands	Tier 6 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Area	Credits
Aprasia parapulchella / Pink-tailed Legless Lizard	2.7	41.00
Delma impar / Striped Legless Lizard	7.4	99.00
Myotis macropus / Southern Myotis	1.4	36.00

Petaurus norfolcensis / Squirrel Glider	2.3	33.00

Aprasia parapulchella/ Pink-tailed Legless Lizard	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	201_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Aprasia parapulchella/Pink-tailed Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or	IBRA region

			higher category of listing under Part 4 of the BC Act shown below	
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Delma impar/ Striped Legless Lizard	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1606_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	1655_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1691_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Delma impar/Striped Legless Lizard	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing	IBRA region

			under Part 4 of the BC Act shown below	
		Fauna		Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Myotis macropus/ Southern Myotis	1691_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Myotis macropus/Southern Myotis	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	1606_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Petaurus norfolcensis/ Squirrel Glider	1606_Moderate	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1655_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act	IBRA region

			shown below	
		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	201_Derived_native_grass	**Like-for-like options**		
		Spp	IBRA region	
		Petaurus norfolcensis/Squirrel Glider	Any in NSW	
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

		Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT I
BIODIVERSITY PAYMENT SUMMARY REPORT - STAGE 1

Biodiversity payment summary report

Assessment Id	Payment data version	Assessment Revision	Report created
00014113/BAAS17004/19/00014114	61	1	02/08/2019

Assessor Name	Assessor Number	Proposal Name	BAM Case Status
Colin Driscoll	BAAS17004	Maxwell Underground NSW Stage 1	Open

Assessment Type	Date Finalised
Major Projects	To be finalised

PCT list

Include	PCT common name	Credits
Yes	**201 -** Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	29
Yes	**1604 -** Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	258
Yes	**1606 -** White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	1187
Yes	**1607 -** Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	68
Yes	**1692 -** Bull Oak grassy woodland of the central Hunter Valley	45
Yes	**1691 -** Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	190
Yes	**1655 -** Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	21

Species list

Include	Species	Credits
Yes	***Aprasia parapulchella*** (Pink-tailed Legless Lizard)	382

Yes	***Delma impar*** (Striped Legless Lizard)	1126
Yes	***Myotis macropus*** (Southern Myotis)	9
Yes	***Petaurus norfolcensis*** (Squirrel Glider)	524

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

IBRA sub region	PCT common name	Baseline price	Dynamic coefficient	Market coefficient	Risk premium	Administrative cost	Methodology adjustment factor	Price per credit	No. of ecosystem credits	Final credits price
Hunter	**201 -** Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	29	$78,976.78
Hunter	**1604 -** Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	258	$702,621.00
Hunter	**1606 -** White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	1187	$ 3,232,601.26

Hunter	**1607 -** Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	68	$185,186.93
Hunter	**1692 -** Bull Oak grassy woodland of the central Hunter Valley **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	45	$122,550.17
Hunter	**1691 -** Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	190	$517,434.07
Hunter	**1655 -** Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	21	$57,190.08

Subtotal (excl. GST)	**$4,896,560.29**
GST	**$489,656.03**
Total ecosystem credits (incl. GST)	**$5,386,216.32**

Species credits for threatened species

Biodiversity payment summary report

Species profile ID	Species	Threat status	Price per credit	Risk premium	Administrative cost	No. of species credits	Final credits price
10061	***Aprasia parapulchella*** (Pink-tailed Legless Lizard)	Vulnerable	$506.66	19.9900%	$20.00	382	$239,873.59
10211	***Delma impar*** (Striped Legless Lizard)	Vulnerable	$434.47	19.9900%	$20.00	1126	$609,526.94
10549	***Myotis macropus*** (Southern Myotis)	Vulnerable	$725.00	19.9900%	$20.00	9	$8,009.35
10604	***Petaurus norfolcensis*** (Squirrel Glider)	Vulnerable	$434.47	19.9900%	$20.00	524	$283,651.97
						Subtotal (excl. GST)	**$1,141,061.85**
						GST	**$114,106.18**
					Total species credits (incl. GST)		**$1,255,168.04**
						Grand total	**$6,641,384.36**

ATTACHMENT J
BIODIVERSITY PAYMENT SUMMARY REPORT - STAGE 2

Biodiversity payment summary report

Assessment Id	Payment data version	Assessment Revision	Report created
00014113/BAAS17004/19/00014117	61	1	02/08/2019

Assessor Name	Assessor Number	Proposal Name	BAM Case Status
Colin Driscoll	BAAS17004	Maxwell Underground NSW-COM Stage 2	Open

Assessment Type	Date Finalised
Major Projects	To be finalised

PCT list

Include	PCT common name	Credits
Yes	**201 -** Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	26
Yes	**1606 -** White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	47
Yes	**1691 -** Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	51
Yes	**1731 -** Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	4
Yes	**1655 -** Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	26

Species list

Include	Species	Credits
Yes	***Aprasia parapulchella*** (Pink-tailed Legless Lizard)	41
Yes	***Delma impar*** (Striped Legless Lizard)	99
Yes	***Myotis macropus*** (Southern Myotis)	36

Yes	***Petaurus norfolcensis*** (Squirrel Glider)	33

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

IBRA sub region	PCT common name	Baseline price	Dynamic coefficient	Market coefficient	Risk premium	Administrative cost	Methodology adjustment factor	Price per credit	No. of ecosystem credits	Final credits price
Hunter	**201 -** Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	26	$70,806.77
Hunter	**1606 -** White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	47	$127,996.85
Hunter	**1691 -** Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	51	$138,890.20
Hunter	**1731 -** Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	4	$10,893.35

Hunter	**1655 -** Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin **Warning: This PCT has NO trades recorded**	$2,252.97	0.71782200	2.17841491	19.99%	$20.00	1.0000	$2,723.34	26	$70,806.77

Subtotal (excl. GST)	**$419,393.94**
GST	**$41,939.39**
Total ecosystem credits (incl. GST)	**$461,333.33**

Species credits for threatened species

Species profile ID	Species	Threat status	Price per credit	Risk premium	Administrative cost	No. of species credits	Final credits price
10061	***Aprasia parapulchella*** (Pink-tailed Legless Lizard)	Vulnerable	$506.66	19.9900%	$20.00	41	$25,745.59
10211	***Delma impar*** (Striped Legless Lizard)	Vulnerable	$434.47	19.9900%	$20.00	99	$53,590.73
10549	***Myotis macropus*** (Southern Myotis)	Vulnerable	$725.00	19.9900%	$20.00	36	$32,037.39
10604	***Petaurus norfolcensis*** (Squirrel Glider)	Vulnerable	$434.47	19.9900%	$20.00	33	$17,863.58

Subtotal (excl. GST)	**$129,237.29**

	GST	**$12,923.73**
Total species credits (incl. GST)		**$142,161.02**
	Grand total	**$603,494.35**