MALABAR

MAXWELL UNDERGROUND MINE PROJECT

APPENDIX D

Biodiversity Development Assessment Report

Certification under clause 6.15 Biodiversity Conservation Act 2016

I certify that this report has been prepared based on the requirements of, and information provided under, the Biodiversity Assessment Method and clause 6.15 of the *Biodiversity Conservation Act 2016* (BC Act).

Signature: Colin Driscoll

Date: 30 June 2022

BAM Assessor Accreditation no: BAAS17004

This BDAR has been prepared to meet the requirements of BAM 2020. Appendix A provides an assessment of compliance with the minimum information requirements outlined in BAM Appendix K.

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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: *the 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 PCT. 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, no high-frequency burning, and evidence of recruitment of native species.*

Biodiversity Assessment Method Calculator: *the online computer program that provides decision support to assessors and proponents by applying the BAM and referred to as the BAM-C. The BAM-C contains biodiversity data from the BioNet Vegetation Classification and the Threatened Biodiversity Data Collection that the assessor is required to use in a BAM assessment. The BAM-C applies the equations used in the BAM, including those to determine the number and class of biodiversity credits required to offset the impacts of a development, or created at a biodiversity stewardship site. It is published by the Department.*

Biodiversity credit report: *the report produced by the BAM-C 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. For biodiversity stewardship sites, the biodiversity credit report sets out the number and class of biodiversity credits that are created at that 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: *the gain in biodiversity values achieved from the implementation of management actions on areas of land, 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.*

Class of biodiversity credit: *biodiversity credits that share the same attributes (refer to Subsection 10.2 of the BAM 2020).*

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. The term development footprint is also taken to include clearing footprint, except where the reference is to a small area development or a major project development.*

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, activity, clearing or biodiversity certification 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 weed cover: *plant cover composed of vascular plants that, if not controlled, will invade and outcompete native plant species. Also referred to as high threat weeds or high threat exotic vegetation. Plants considered to be high threat weeds are listed on the high threat weeds list published in the BAM-C*

Mapped Important Areas: *For a small number of species for which we have extensive, long-term datasets that indicate the importance of parts of the landscape, the species credit components of their habitat will be mapped as 'important areas'. Mapping these areas seeks to address the criticism that survey rarely detects these highly mobile species, resulting in the ongoing loss of core habitat. Mapping means that if impacted by development, these important areas required for the species to persist in the wild will be offset within a mapped important area.*

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. Native vegetation cover includes regrowth, derived native grasslands and plantations that are comprised of plants native to New South Wales*

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

Retirement of Credits: *the action taken whereby biodiversity credits created for a biobanking agreement or a biodiversity stewardship agreement are used to offset the impacts of development, clearing or biodiversity certification.*

Sensitivity to Loss: *a component of the biodiversity risk weighting for an entity that considers the increased threat posed to an entity from offsetting the loss of habitat or population.*

Serious and irreversible impact: *impacts likely to contribute significantly to the risk of a threatened species or ecological community becoming extinct in accordance with the principles set out in clause 6.7(2) of the BC regulation*

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

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

Species Credit Species: *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 subject to a development, activity, clearing, biodiversity certification or a biodiversity stewardship proposal. It excludes the assessment area which surrounds the subject land (i.e. the area of land in the 1500 m buffer zone around the subject land or 500 m buffer zone for linear proposals). In the case of a biodiversity certification proposal, subject land includes the biodiversity certification assessment area.*

Vegetation Class: *a level of classification of vegetation communities, as defined in Keith (2004).*

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 quantitative measure of vegetation condition calculated in accordance with Equation 23 or Equation 24.*

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 Resources Limited (Malabar), is seeking to modify Development Consent SSD 9526 (the Modification) for the approved Maxwell Underground Mine Project (the Project). The Project is east-southeast of Denman and south-southwest of Muswellbrook in New South Wales (NSW).

A Biodiversity Development Assessment Report (BDAR) was prepared by Hunter Eco for the Project in July 2019 and Development Consent SSD 9526 was granted in December 2020. Malabar previously sought to modify Development Consent SSD 9526 under section 4.55(1A) of the *Environmental Planning and Assessment Act 1979* for a minor extension to the mine entry area (MEA) (Modification 1) (Malabar, 2021). A BDAR was prepared by Hunter Eco for Modification 1 in August 2021 and Modification 1 was subsequently approved on 19 November 2021. EPBC 2018/8287 was varied on 14 December 2021.

This BDAR was prepared by Dr Colin Driscoll (Hunter Eco) to assess the likely biodiversity impacts from an additional Modification to the Project. The proposed Modification is located wholly within the approved Development Application Area and would comprise the following components:

- re-orientation of the longwall panels in the Woodlands Hill, Arrowfield and Bowfield Seams resulting in a minor increase in the approved underground mining extent;
- reduction in width of some of the longwall panels in the Woodlands Hill Seam, which facilitates earlier commencement of longwall mining;
- repositioning of the upcast ventilation shaft site and associated infrastructure; and
- other minor works and ancillary infrastructure components (e.g. access road and ancillary water management infrastructure for the repositioned ventilation shaft site).

Landscape Features

The Modification area is located within a broader area (the Development Application Area) which includes the Maxwell Underground and areas of potential subsidence impacts.

The majority of this area (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 small, unnamed watercourses. The extant woodland/forest vegetation habitat is fragmented due to past land clearance.

Native Vegetation

This BDAR assesses the relatively minor modifications to the approved Project layout, using the extensive information from the previous BDARs plus supplementary sampling. The additional native vegetation to be disturbed as a result of the Modification is approximately 13.3 hectares (ha). The Development Footprint associated with the Modification includes the proposed ventilation shaft surface development area and several small areas of additional potential subsidence ponding.

The native vegetation in the proposed ventilation shaft location consists mostly of derived native grassland of box-gum or narrow-leaved ironbark shrubby open forest or grassy woodland dominated communities. The additional ponding areas also consist mostly of native grassland derived from Slaty Box woodland or Fuzzy Box woodland.

Despite the degraded nature of the vegetation present compared to the woodland/forest vegetation that were once present, 3.9 ha of Plant Community Type (PCT) 1606 (2.6 ha in derived native grassland form and 1.3 ha in woodland form) and 2.5 ha of PCT 1693 (in derived native grassland form) in the Development Footprint meet the criteria for the *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South*

Western Slopes, South East Corner and Riverina Bioregions listed as a threatened ecological community (TEC) under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* listed as a TEC under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Additionally, the 0.5 ha of PCT 1655 woodland present meets the criteria for *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* listed as a vulnerable TEC under the BC Act, and 1.2 ha of PCT 1691 woodland meets the criteria for *Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* listed as a TEC under the BC Act.

Threatened Species

Targeted surveys for threatened flora were conducted for the Project by Hunter Eco in 2017, 2018 and 2019 and fauna surveys were conducted by Future Ecology in 2017 and 2018. Targeted flora surveys for Modification 1 were conducted by Hunter Eco in June 2021. Additional targeted flora surveys for this Modification were conducted by Hunter Eco in September, October and November 2021, and May and June 2022.

Three ‘species credit species’ (as defined by the *Threatened Biodiversity Data Collection*) are relevant to the Modification as they are known to be present in habitat adjoining the Development Footprint, namely the:

- Striped Legless Lizard (*Delma impar*);
- Squirrel Glider (*Petaurus norfolcensis*); and
- Southern Myotis (*Myotis macropus*).

Additionally, four threatened flora species were assumed to be present in areas where targeted surveys could not be completed within the appropriate survey timing, namely the:

- Leafless Tongue Orchid (*Cryptostylis hunteriana*);
- Pine Donkey Orchid (*Diuris tricolor*);
- Tarengo Leek Orchid (*Prasophyllum petilum*); and
- Austral Toadflax (*Thesium australe*).

Measures to Avoid, Minimise, Mitigate and Manage Impacts

The proposed ventilation shaft surface development areas associated with the Modification have been positioned so as to avoid potential impacts on threatened flora recorded in the area and to minimise the disturbance of woodland, where possible.

This BDAR provides the measures that would be employed to mitigate and manage potential impacts, such as a vegetation clearance protocol and a commitment to remediate surface cracks associated with subsidence.

Conclusion

The credit calculation has determined the offset requirement for impacts to native vegetation (ecosystem credit requirement) and impacts to known or potential habitat for the Leafless Tongue Orchid, Pine Donkey Orchid, Tarengo Leek Orchid, Austral Toadflax, Striped Legless Lizard, Southern Myotis and Squirrel Glider (species credit requirements). The Modification requires a total of 247 ecosystem credits (Table ES-1) and 297 species credits (Table ES-2).

Table ES-1
Impacts that Require an Offset – Ecosystem Credits

Vegetation Zone	PCT	Threatened Ecological Community Listed under the BC Act	Impact area (ha)	Number of Ecosystem Credits Required
2	1606	White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	1.3	56
2a	1606		2.6	36
3	1655	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	0.5	4
3a	1655	Not a TEC	1.7	0
6	1692	Not a TEC	0.6	15
7a	1693	White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	2.5	45
8	201	Not a TEC	0.2	9
8a	201	Not a TEC	1	18
9	1691	Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	1.2	35
9a	1691	Not a TEC	1.7	29
		Total Woodland/Forest	**3.8**	**119**
		Total Derived Native Grassland	**9.5**	**128**
		Total	**13.3**	**247**

Table ES-2
Impacts that Require an Offset – Species Credits

Common Name	Scientific Name	Loss of Habitat (ha)	Number of Species Credits Required
Leafless Tongue Orchid	*Cryptostylis hunteriana*	2.2	11
Pine Donkey Orchid	*Diuris tricolor*	1.2	17
Tarengo Leek Orchid	*Prasophyllum* petilum	1.2	21
Austral Toadflax	*Thesium australe*	1.8	8
Striped Legless Lizard	*Delma impar*	12.1	156
Squirrel Glider	*Petaurus norfolcensis*	3.8	75
Southern Myotis	*Myotis macropus*	0.3	9
		Total	**297**

1 INTRODUCTION

Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Resources Limited (Malabar), is seeking to modify Development Consent State Significant Development (SSD) 9526 (the Modification) for the approved Maxwell Underground Mine Project (the Project). The Project is located in the Upper Hunter Valley of New South Wales (NSW), with the Mine Entry Area (MEA) located approximately 15 kilometres (km) south-southwest of Muswellbrook (Figure 1).

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).

1.1 PROJECT OVERVIEW

Development Consent SSD 9526 for the Project was granted by the Independent Planning Commission (IPC) on 22 December 2020. The Project was subsequently approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 10 March 2021 (EPBC 2018/8287).

The Project is an underground mining operation that is approved to operate for 26 years (until 2047). It involves the 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 is approved 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).

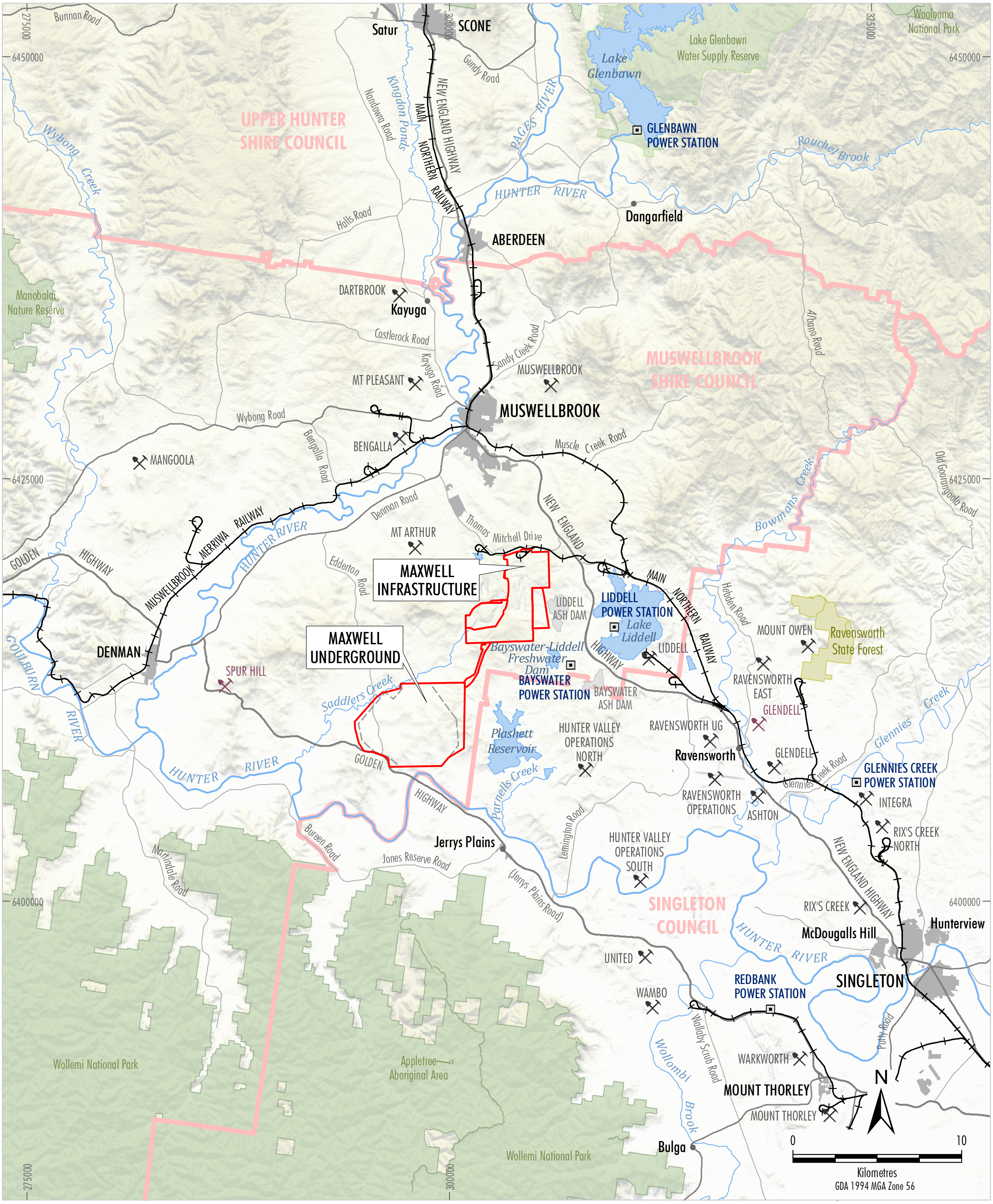
The Project area comprises the following main domains:

- Maxwell Underground – comprising the approved area of underground mining operations and the MEA within Mining Lease ML1822.
- Maxwell Infrastructure – the area within Coal Lease (CL) 229, ML 1531 and CL 395 comprising the substantial existing infrastructure (including the CHPP) and previous mining areas.
- The transport and services corridor between the Maxwell Underground and Maxwell Infrastructure – the area within CL 229, ML1820 comprising the proposed site access road, a covered, overland conveyor, power supply and other ancillary infrastructure and services.
- The realignment of Edderton Road.

A detailed description of the Project is provided in the main document of the EIS. The approved Project general arrangement is shown on Figure 2.

Malabar previously sought to modify Development Consent SSD 9526 under section 4.55(1A) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for a minor extension to the MEA (Modification 1) (Malabar, 2021). Modification 1 was subsequently approved on 19 November 2021 and EPBC 2018/8287 was varied on 14 December 2021.

Malabar is now seeking to modify SSD 9526 under section 4.55(2) of EP&A Act.



Source: NSW Spatial Services (2022)

LEGEND

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

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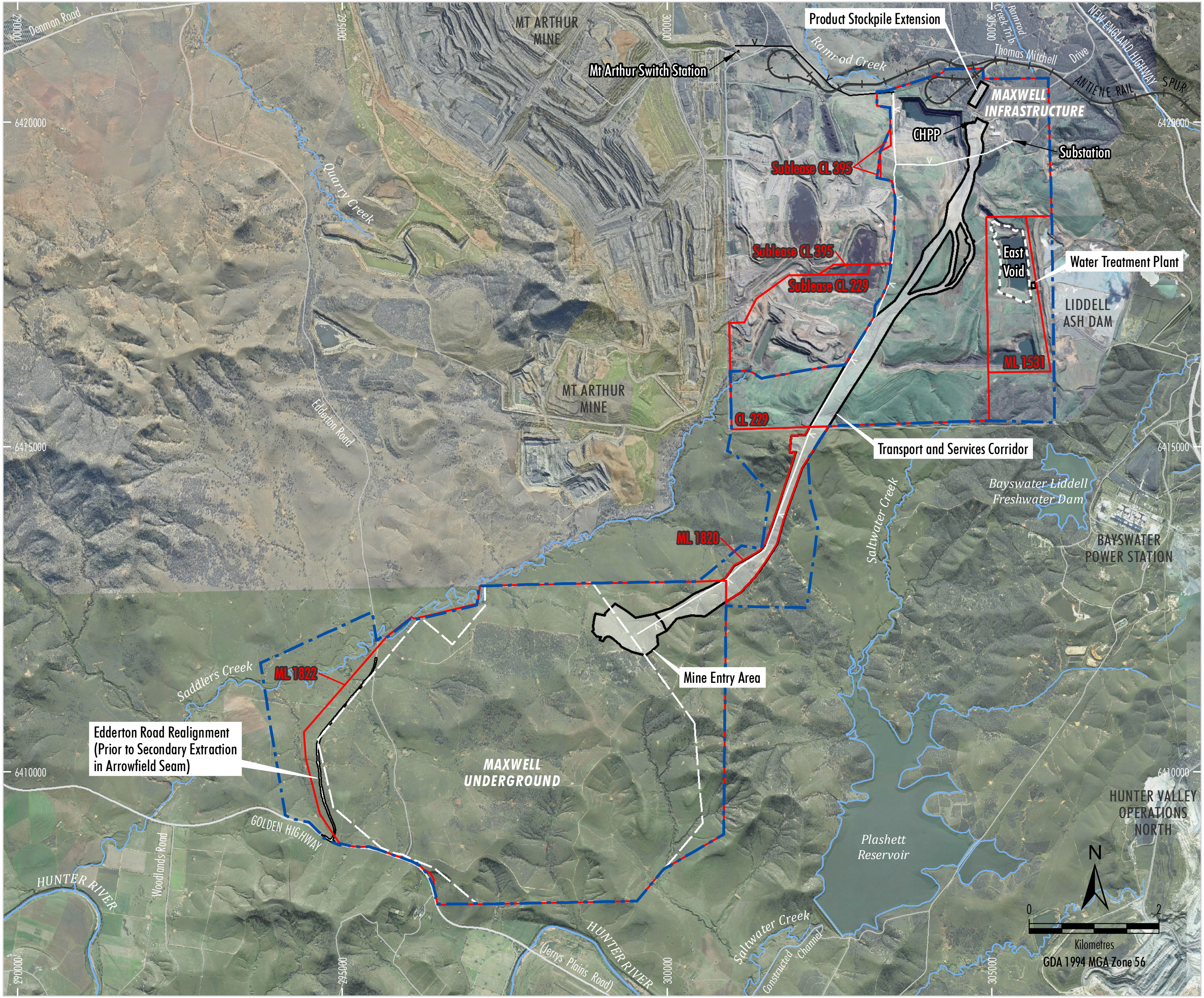
MAXWELL UNDERGROUND MINE PROJECT

Regional Location

Figure 1



LEGEND

- Mining and Coal Lease Boundary
- Proposed Ausgrid 66 kV Power Supply Extension #

Approved Maxwell Underground Mine

- Development Application Area
- Indicative Extent of Underground Development
- Indicative Surface Development Area
- CHPP Reject Emplacement Area
- 66 kV Power Supply

Subject to separate assessment and approval.

Source: NSW Spatial Services (2022); MSEC (2021); Orthophoto Mosaic: 2020, 2019

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MAXWELL UNDERGROUND MINE PROJECT

Approved General Arrangement

Figure 2

SHM-20-04 MOD LW_BDAR_203B

1.2 MODIFICATION DESCRIPTION

The Modification is located wholly within the approved Development Application Area and would comprise the following components:

- re-orientation of the longwall panels in the Woodlands Hill, Arrowfield and Bowfield Seams resulting in a minor increase in the approved underground mining extent;
- reduction in the width of some of the longwall panels in the Woodlands Hill Seam, which facilitates earlier commencement of longwall mining;
- repositioning of the upcast ventilation shaft site and associated infrastructure; and
- other minor works and ancillary infrastructure components (e.g. access road and ancillary water management infrastructure for the repositioned ventilation shaft site).

The Modification does not change the total resource extraction and maximum annual production but would result in some minor changes to the timing of run-of-mine (ROM) coal extraction from the Maxwell Underground. No change to any coal handling and processing infrastructure is proposed as part of the Modification. Figure 3 shows the proposed general arrangement for the Modification with the repositioned ventilation shaft and associated infrastructure. The ancillary water management infrastructure will be located entirely within the Development Footprint associated with the Modification.

1.3 GENERAL DESCRIPTION OF THE SUBJECT LAND

The Subject Land associated with the Modification (including operational and construction footprints) is approximately 13.3 hectares (ha) in size (Figure 4). This total area comprises approximately 9.5 ha for the proposed ventilation shaft surface development area, and approximately 3.8 ha for the additional areas of potential ponding impacts associated with subsidence (Figure 4) consistent with the predicted impacts in the *Subsidence Predictions and Impact Assessments for the Modification to the Maxwell Underground Mine Project* prepared by Mine Subsidence Engineering Consultants (MSEC 2022). The Subject land is herein referred to as the Development Footprint.

The inclusion of the areas of potential ponding in the Development Footprint is consistent with the *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b).

1.4 BIODIVERSITY OFFSETS SCHEME ENTRY

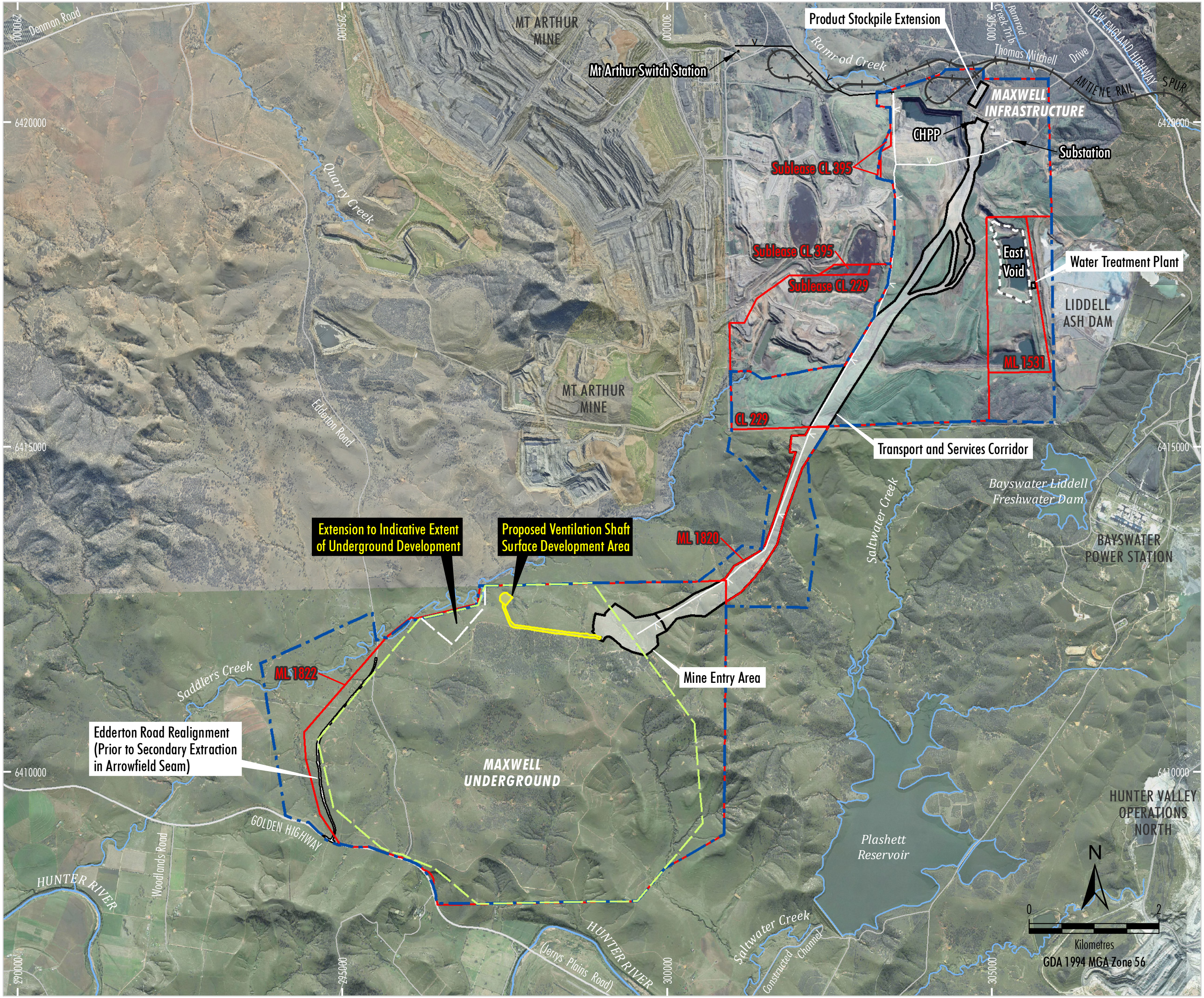
This BDAR has been prepared for a modification to an SSD and therefore the Biodiversity Offset Scheme applies.

1.5 EXCLUDED IMPACTS

No land clearing of native vegetation (category 1-exempt land) occurs in the Development Footprint.

1.6 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The Project was approved under the EPBC Act in March 2021 (EPBC 2018/8287). The controlling provisions for the Project were "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). This BDAR assesses the relatively minor modifications to the approved Project layout.



LEGEND

Mining and Coal Lease Boundary

Proposed Ausgrid 66 kV Power Supply Extension #

Approved Maxwell Underground Mine

Development Application Area

Indicative Extent of Underground Development

Indicative Surface Development Area

CHPP Reject Emplacement Area

66 kV Power Supply

Proposed Modification

Modified Indicative Extent of Underground Development

Indicative Modification Surface Development Area

Subject to separate assessment and approval.

Source: NSW Spatial Services (2022); MSEC (2021); Orthophoto Mosaic: 2020, 2019

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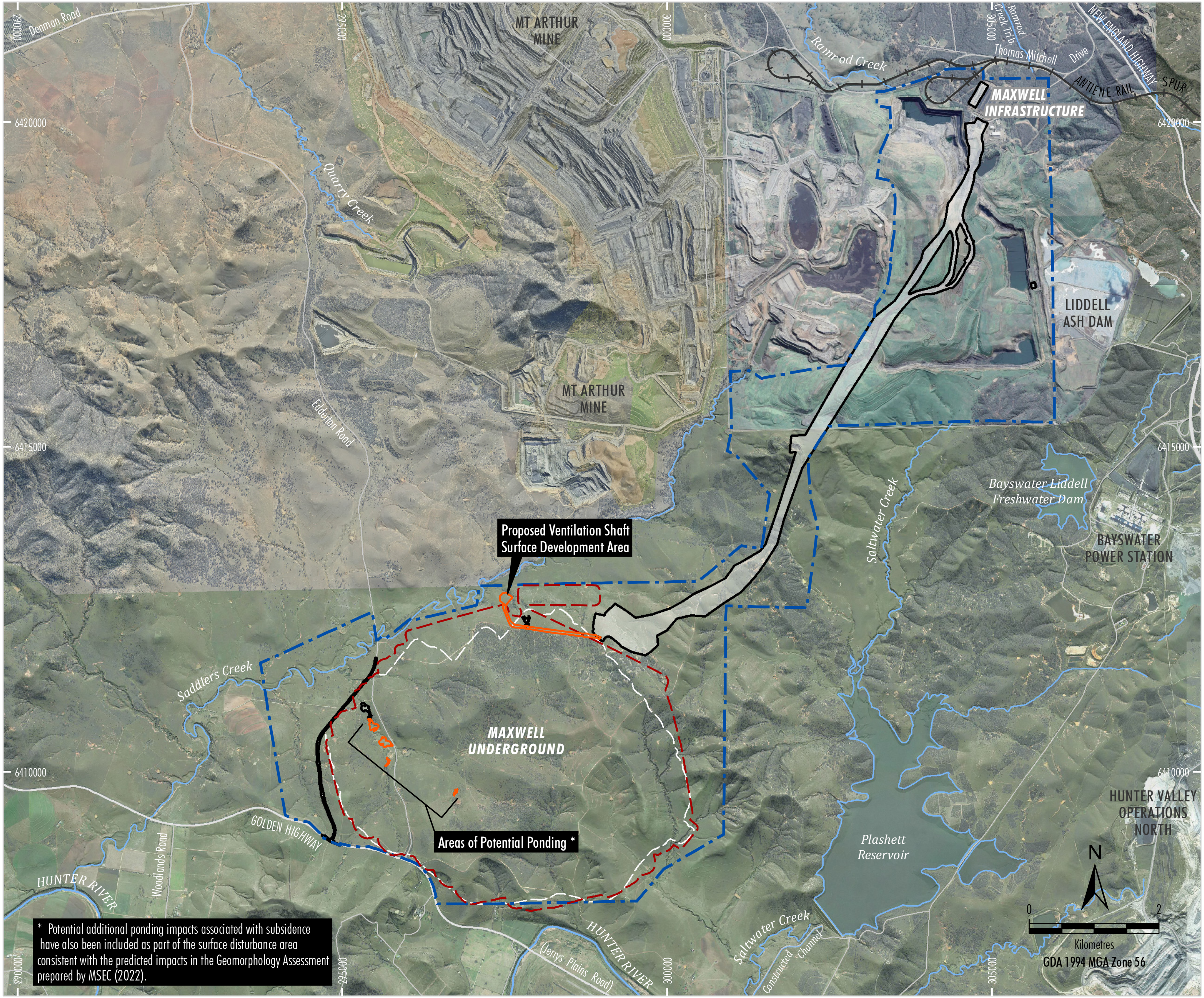
Proposed General Arrangement

Figure 3

SHM-20-04 MOD LW_BDAR_204C



LEGEND
- Development Application Area
- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2020, 2019

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Development Footprint

Figure 4

SHM-20-04 MOD LW_BDAR_225D

1.7 INFORMATION SOURCES USED IN THIS ASSESSMENT

Flora surveys encompassing the general locality around the approved surface development areas and underground mining area were conducted by Hunter Eco in 2017, 2018, 2019 (Hunter Eco 2019a) and 2021 (Hunter Eco 2021). Comprehensive fauna surveys over the same area were conducted by Future Ecology in 2017 and 2018 (Future Ecology 2019) (Attachment A). The Development Footprint for this BDAR is a subset of the previous flora and fauna study areas. In order to collect detailed specific information on the flora species and conditions of the vegetation in the Development Footprint, supplementary flora surveys were undertaken by Hunter Eco in September, October and November 2021, as well as May and June 2022.

Published databases used in this assessment include:

- *Threatened Biodiversity Data Collection* (TBDC) (DPE 2022a)[1];
- *BioNet Vegetation Classification* (DPE 2022b);
- *BioNet Atlas* (DPE 2021c)[2]; 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 11.

It was not necessary to use local data or deviate from the DPE databases (DPE 2022a, 2022b).

The Biodiversity Assessment Method (BAM) Credit Calculator (BAM-C) (App last updated: 09/12/2021 11:00 [Version: 1.4.0.00] BAM data last updated: 16/06/2022 [Version: 54]) was used in this assessment.

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[1] This website is titled 'Profiles'.

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

2 LANDSCAPE FEATURES

This section provides a description of the landscape features relevant to the Development Footprint in accordance with the BAM (DPIE 2020).

2.1 ASSESSMENT AREA

A site-based assessment method was applied to the Modification whereby a 1,500 m buffer is placed around the Development Footprint.

2.2 IBRA BIOREGIONS AND SUB-REGIONS

In accordance with the BAM (DPIE 2020), the Site Map is shown on Figure 5 and the Location Map for the Development Footprint is shown on Figure 6.

The Modification area lies within the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion, Hunter IBRA sub-region. The IBRA regional boundaries (Department of the Environment [DotE] 2012) do not occur near the Development Footprint and hence are not shown on Figures 5 and 6.

2.3 RIVERS, STREAMS, ESTUARIES AND WETLANDS

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 is downstream of the Modification. The upper reaches of Saddlers Creek are immediately north of the underground mining area with the creek continuing south-west to the Hunter River. The proposed access road crosses two unnamed drainage lines in the north of the Maxwell Underground area. The additional ponding areas are along unnamed drainage lines in the west and south (Figure 6).

There are no important or local wetlands on or, adjacent to the Development Footprint (after the Department of Agriculture, Water and the Environment [DAWE] 2022). The closest important wetland is too far away (over 50 km) to be shown on Figure 6.

2.4 HABITAT CONNECTIVITY

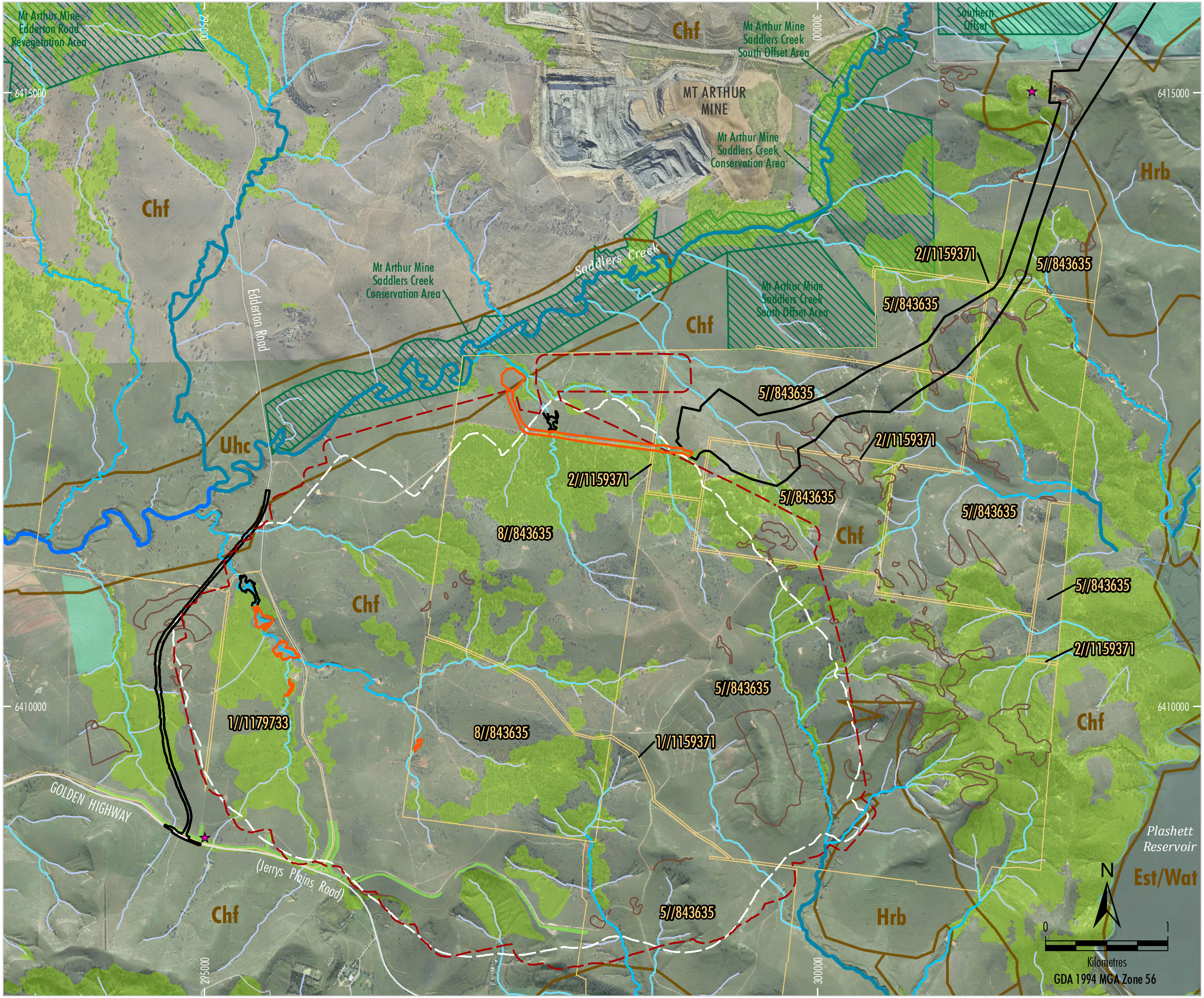
Native vegetation extent and habitat connectivity were determined by site survey and current aerial photography. Connectivity of woodland/forest habitat was assessed where gaps between discrete patches were 100 metres (m) or less and native grassland habitat where gaps were 30 m or less. The woodland/forest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

2.5 KARST, CAVES, CREVICES, CLIFFS, ROCKS AND OTHER GEOLOGICAL FEATURES

There are no karst, caves, cliffs or other areas of geological significance on, or in the vicinity of, the Modification.

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 Modification.



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- 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)

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

* Note the Subject Land cadastral boundaries have not been surveyed and are based on the NSW Spatial Services Spatial Database, 2021.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

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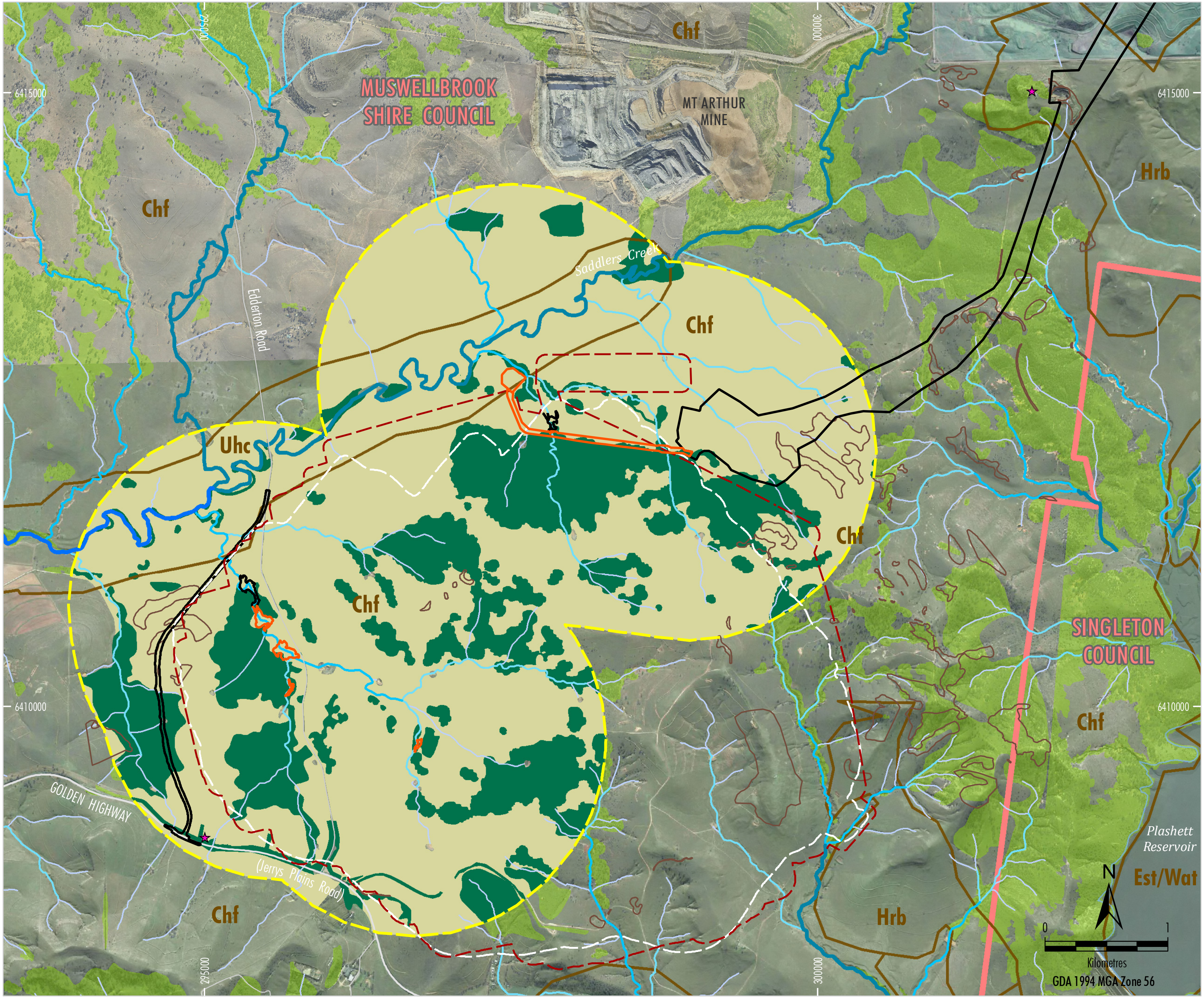
Site Map

Figure 5

SHM-20-04 MOD LW_BDAR_206C



LEGEND

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

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 Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

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Location Map

Figure 6

SHM-20-04 MOD LW_BDAR_205D

2.7 NSW MITCHELL LANDSCAPE

The Development Footprint is mostly within the Central Hunter Foothills Mitchell landscape, but the repositioned vent shaft is located in the Upper Hunter Channels and Floodplain (Mitchell 2002) (Figure 5).

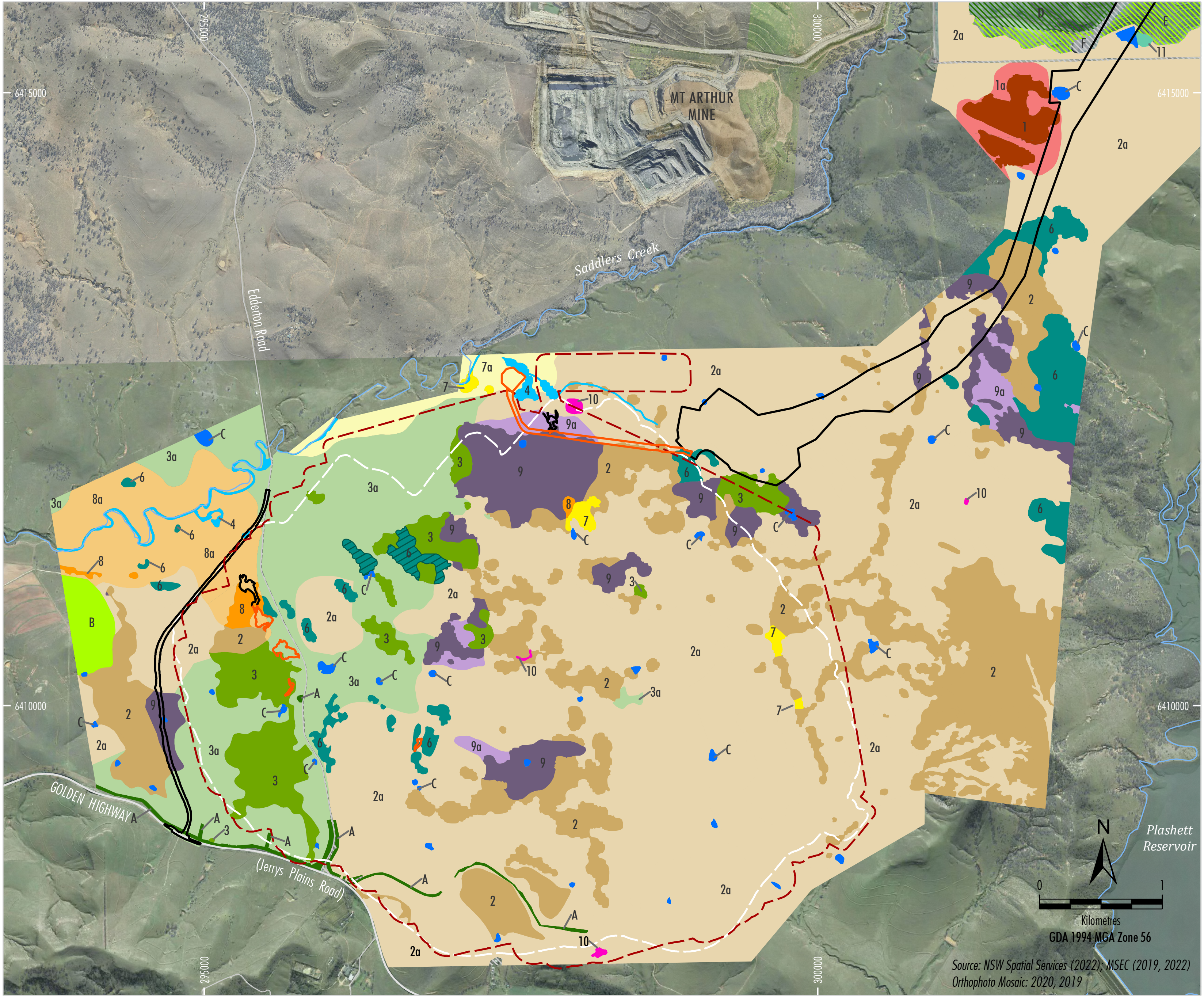
2.8 NATIVE VEGETATION COVER

The Development Footprint consists entirely of native vegetation, comprising 3.8 ha of woodland and 9.5 ha of derived native grassland, totalling 13.3 ha (Figure 7). The extent of native vegetation cover within the buffer area and patch size has been assessed (Table 1).

Table 1
Native Vegetation Extent in the Buffer Area

Component	Native Vegetation Extent in the Buffer Area (%)	Patch Size (ha)
Development Footprint	98.2	>100

Areas not shown as native vegetation on the Location Map (Figure 5) are cleared of native vegetation. There were no notable differences between mapped vegetation extent and aerial imagery.



LEGEND

Approved Surface Development Area

Approved Extent of Conventional Subsidence (20 mm subsidence contour)

Modified Extent of Conventional Subsidence (20 mm subsidence contour)

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

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Vegetation Mapping

Figure 7

SHM-20-04 MOD LW_BDAR_201F

3 NATIVE VEGETATION

This section provides a description of the native vegetation relevant to the Development Footprint.

3.1 EXISTING INFORMATION ON NATIVE VEGETATION

This BDAR has built upon the extensive flora and vegetation survey and assessment works completed for the *Maxwell Project Baseline Flora Report* (Hunter Eco 2019a), *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b), and *Maxwell Underground Mine Project Mine Entry Area Modification Biodiversity Development Assessment Report* (Hunter Eco 2021). A desktop assessment of the Modification disturbance areas was conducted to determine what information was already available and if any extra data was needed to be collected by field survey.

3.2 SUPPLEMENTRY SURVEYS

Supplementary flora surveys were undertaken by Dr Colin Driscoll (Hunter Eco) on 24 September, 27-28 September, 5 October and 1 November 2021 as well as 24 May, 27 May and 10 June 2022. The purpose of the supplementary flora surveys was to collect additional Vegetation Integrity (VI) plots and conduct additional targeted surveys for threatened flora species.

A total of seven VI plots were sampled from within the Development Footprint (Figures 8a and 8b). Section 3.5.3 describes the VI plots used in the BAM-C. A description of the surveys undertaken for threatened flora species is provided in Section 4.4.

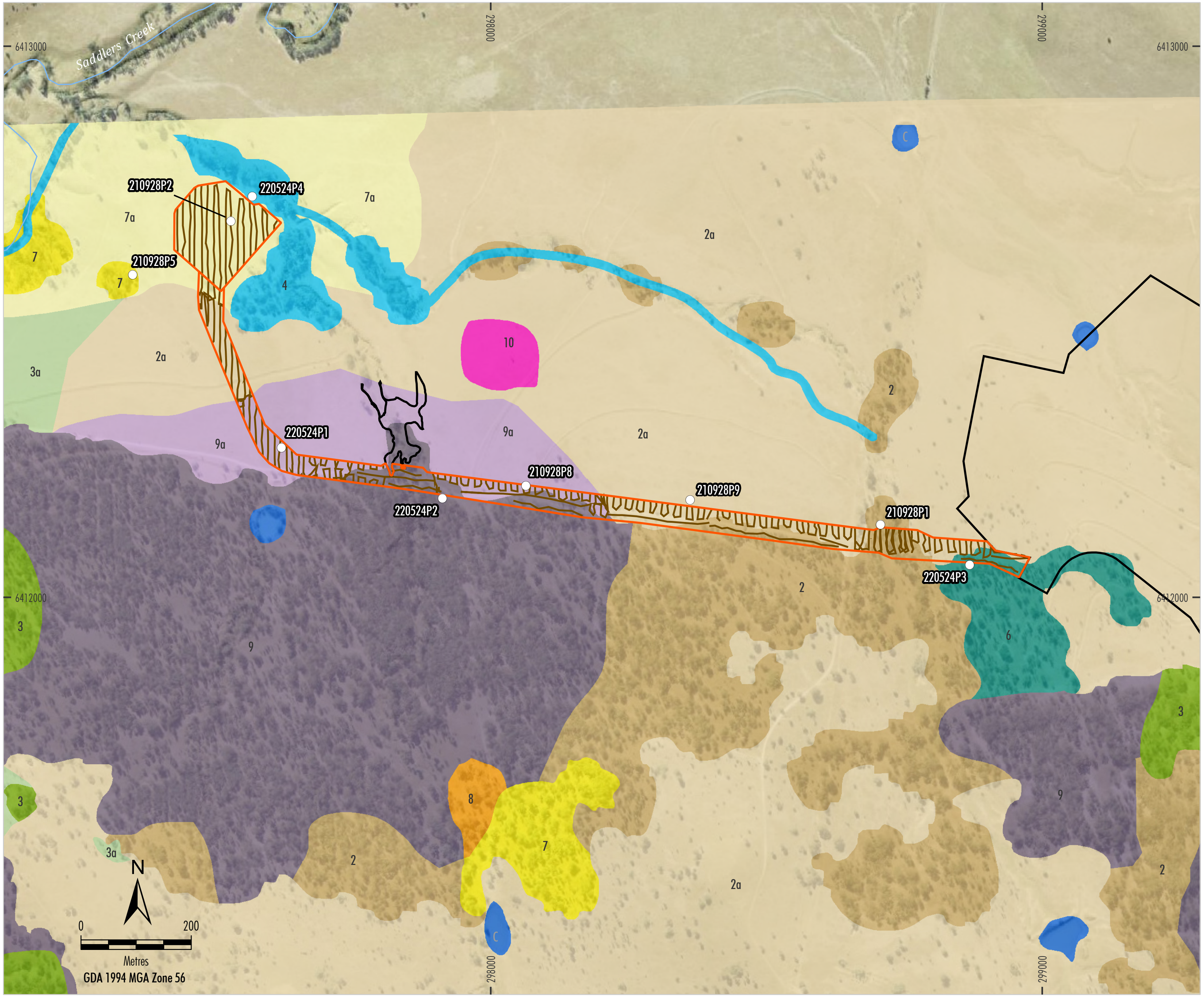
3.3 NATIVE VEGETATION EXTENT

The Development Footprint consists entirely of native vegetation, comprising 3.8 ha of woodland and 9.5 ha of derived native grassland, totalling 13.3 ha. The Development Footprint is made up of the repositioned vent shaft and associated infrastructure (involving the clearance of 9.5 ha of native vegetation comprising 2.8 ha of woodland and 6.7 ha of derived native grassland) and the additional ponding areas (covering 1 ha of woodland and 2.8 ha of derived native grassland).

3.4 PLANT COMMUNITY TYPES

3.4.1 Plant Community Types and Classes

Plant Community Types (PCTs) within the Development Footprint and surrounding area have been identified in accordance with the BAM (DPIE 2020) and *BioNet Vegetation Classification* (DPE 2022b) (Figure 7) (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* (DPE 2022b) and the Vegetation Integrity Scores (Section 3.6.2).



LEGEND
Approved Surface Development Area
Development Footprint
Survey Transect
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)
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)
7 Yellow Box - Apple Grassy Woodland (PCT1693) [1]
7a Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693) [1]
8 Fuzzy Box Woodland (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]

Other
C Waterbody/Dam

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

Source: NSW Spatial Services (2022)
Orthophoto Mosaic: NSW Spatial Services (2020)

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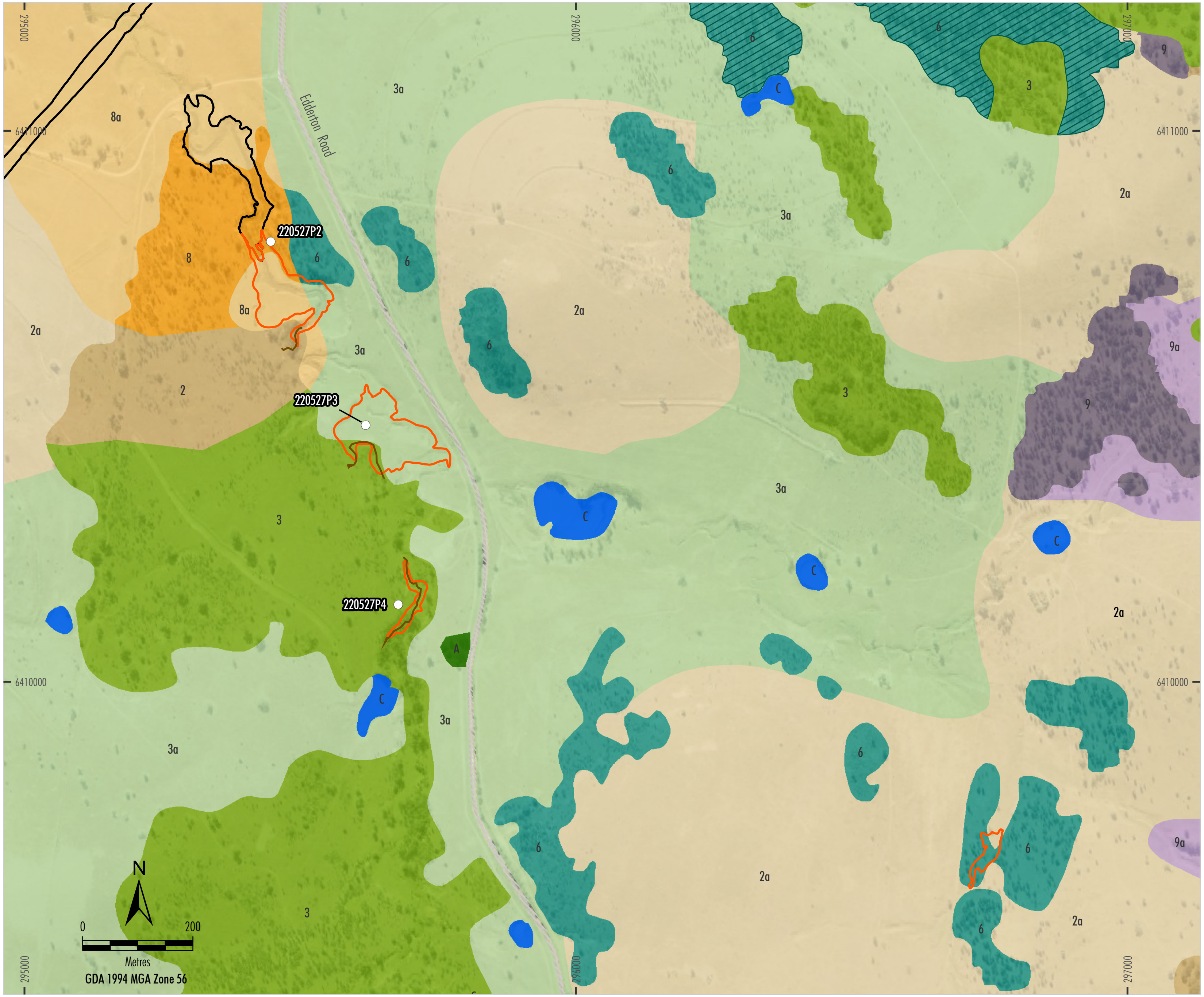
Vegetation Integrity Plot and Survey Transect Locations - Proposed Ventilation Shaft Surface Development Area

Figure 8a

SHM-20-04 MOD LW_BDAR_202H



LEGEND

- Approved Surface Development Area
- Development Footprint
- Survey Transect
- Vegetation Integrity Plot Location

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 1 White Box - Ironbark - Red Gum Shrubby Forest (PCT1606) [1]
- 1a 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)

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)

Other

- A Planted Trees
- D Waterbody/Dam
- E 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

Source: NSW Spatial Services (2022)
Orthophoto Mosaic: NSW Spatial Services (2020)

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MAXWELL UNDERGROUND MINE PROJECT

Vegetation Integrity Plot and Survey Transect Locations - Areas of Potential Ponding

Figure 8b

SHM-20-04 MOD LW_BDAR_224C

Table 2
Plant Community Type Data

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)								
2	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	1.3[A]	29%	High	69.4
2a	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)	2.6[B]	29%	High	22.2
3	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	0.5[C]	36%	High	19.5
3a	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)	1.7[D]	36%	High	11.5
Grassy Woodlands								
6	1692	Bull Oak grassy woodland of the Central Hunter Valley*	Coastal Valley Grassy Woodlands	6. Bull Oak Grassy Woodland	0.6[E]	53%	High	58.7
7a	1693	Yellow Box – Rough-barked Apple gassy woodland of the upper Hunter and Liverpool Plains – DNG	Western Slopes Grassy Woodlands	7a. Yellow Box - Apple Grassy Woodland (DNG)	2.5	64%	High	29
8	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	0.2[F]	94%	High	74.8
8a	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[G]	94%	High	28.4

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	1.2	77%	High	59
9a	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)	1.7	77%	High	34
				Total Woodland/Forest	3.8	-	-	-
				Total Derived Native Grassland	9.5	-	-	-
				Total	13.3	-	-	-

[1] Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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.

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

^ DPE (2022b).

~ BAM Credit Calculator.

[A] Approximately 0.1 ha of PCT1606 is associated with potential subsidence ponding impacts (Figure 8b).

[B] Approximately 0.1 ha of PCT1606 DNG is associated with potential subsidence ponding impacts (Figure 8b).

[C] Approximately 0.5 ha of PCT1655 is associated with potential subsidence ponding impacts (Figure 8b).

[D] Approximately 1.7 ha of PCT1655 DNG is associated with potential subsidence ponding impacts (Figure 8b).

[E] Approximately 0.2 ha of PCT1692 is associated with potential subsidence ponding impacts (Figure 8b).

[F] Approximately 0.2 ha of PCT201 is associated with potential subsidence ponding impacts (Figure 8b).

[G] Approximately 1 ha of PCT201 DNG is associated with potential subsidence ponding impacts (Figure 8b).

3.4.2 Justification of PCT Selection

The Development Footprint is a subset of much larger area that was classified and mapped by Hunter Eco (2019). Hunter Eco (2019a) justifies the PCT and vegetation zone mapping (including the species relied upon for identification of PCTs). No changes have been made to this original classification and mapping. Table 3 provides an extract from Hunter Eco (2019a) for the six PCTs relevant to the Modification.

Table 3
Justification for PCT Selection

PCT	PCT Name	Options	Selection
201	Fuzzy Box woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	8 PCTs containing Fuzzy Box (*Eucalyptus conica*) in the upper stratum.	None of these PCT occur in the Sydney Basin Bioregion despite several records there. PCT 201 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.
1606	White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	12 PCTs 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.	PCT 1606 was the best match both floristically and geographically.
1655	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	5 PCTs 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.	PCT 1655 was selected because of the inclusion of *Eucalyptus moluccana* which adjoined the Slaty Box vegetation in the Development Footprint. However, none of the possible PCT clearly matched the composition of the Development Footprint community, particularly in the shrub layer. It is likely that there is another unsampled Slaty Box lowland community in the Hunter Valley.
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	23 PCTs 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.	PCT 1691 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 PCTs having Bull Oak (*Allocasuarina luehmannii*) in the upper stratum.	Only PCT 1692 had *Allocasuarina luehmannii* as the dominant upper stratum species.

PCT	PCT Name	Options	Selection
1693	Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	71 PCTs 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 PCT 1693 as the selected community.

Source: Hunter Eco (2019a)

3.4.3 Plant Community Types Percent Cleared Value

The BAM (DPIE 2020) 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 (DPE 2022b). Percent cleared values for each PCT are shown in Table 2.

3.4.4 Threatened Ecological Communities

Threatened ecological communities (TECs) and associated PCTs within the Development Footprint are listed in Table 4. TECs listed under the BC Act and TECs listed under the EPBC Act are shown on Figures 9a and 9b, respectively.

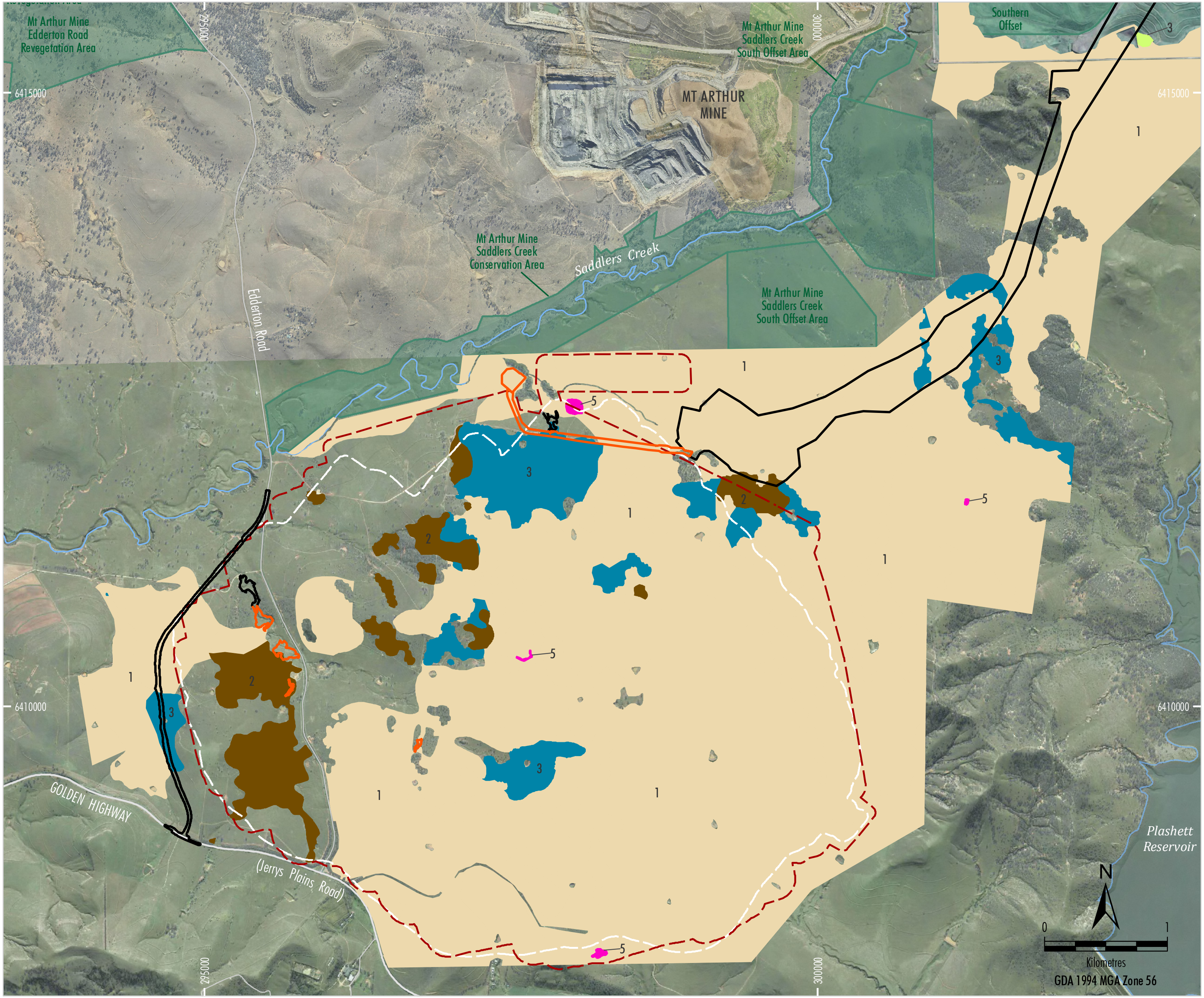
Table 4
Threatened Ecological Communities

Threatened Ecological Community	Conservation Status*	Associated vegetation zones within the Development Footprint	Area within Development Footprint (ha)
Threatened Ecological Communities listed under the BC Act			
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	CE	1606[A], 1693	6.4 (comprising 1.3 ha of woodland and 5.1 ha of DNG)
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion listed under the BC Act	V	1655[B]	0.5 (woodland)
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions listed under the BC Act	E	1691	1.2 (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[A], 1693	6.4 (comprising 1.3 ha of woodland and 5.1 ha of DNG)
Central Hunter Valley Eucalypt Forest and Woodland	CE	1691, 1655[B]	1.7 (woodland)

* Threatened ecological community status under the BC Act and EPBC Act (current as at June 2022).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

[A] Approximately 0.1 ha of PCT1606 woodland and 0.1 ha of PCT1606 DNG is associated with potential subsidence ponding impacts (Figure 8b).

[B] Approximately 0.5 ha of PCT1655 is associated with potential subsidence ponding impacts (Figure 8b).



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
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 Valley Weeping Myall Woodland

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

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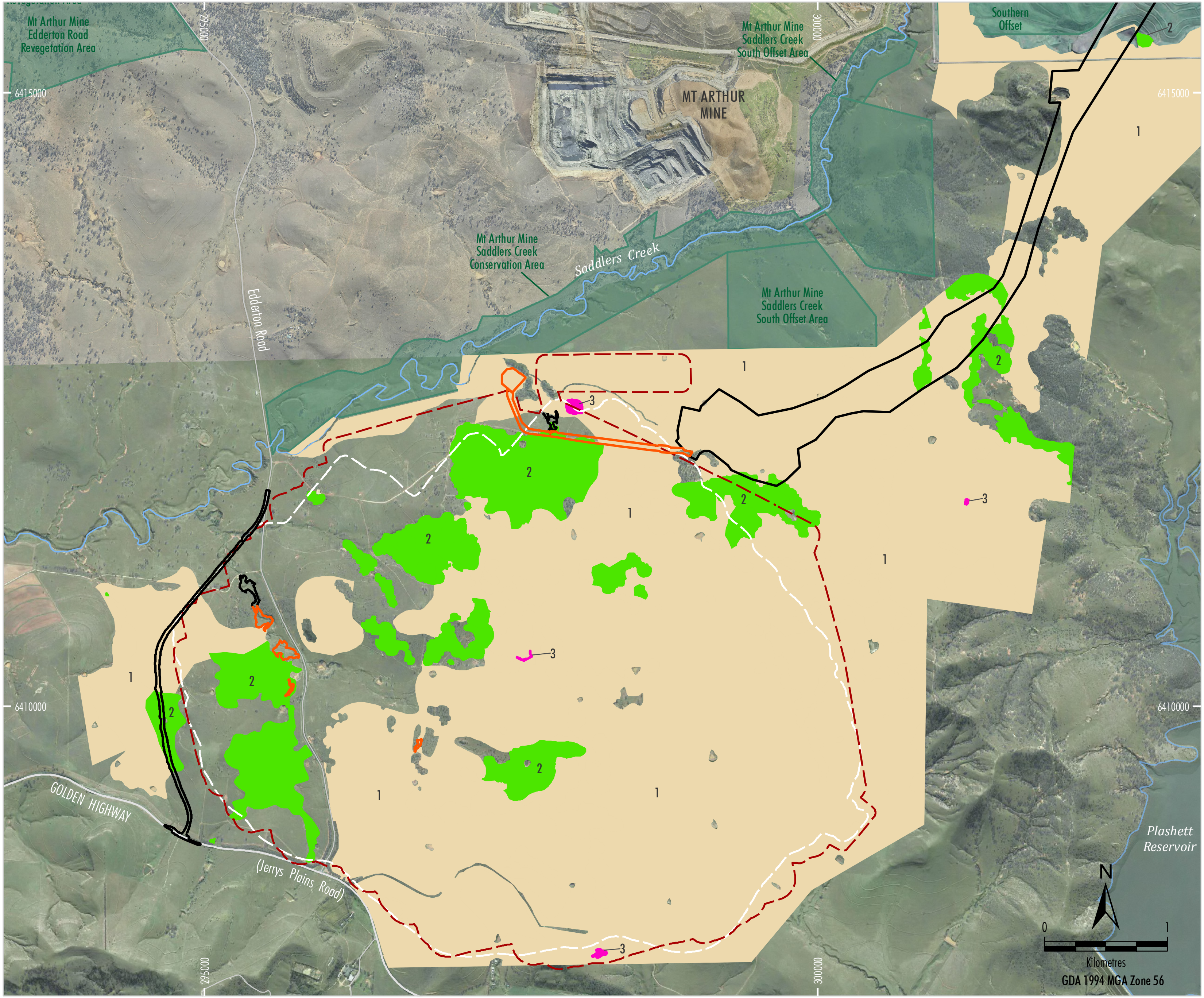
Threatened Ecological Communities Listed under the BC Act

Figure 9a

SHM-20-04 MOD LW_BDAR_227B



LEGEND
- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- 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. Hunter Valley Weeping Myall (*Acacia pendula*) Woodland

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

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Threatened Ecological Communities Listed under the EPBC Act

Figure 9b

SHM-20-04 MOD LW_BDAR_229D

3.4.5 Evidence to Support Threatened Ecological Communities

Each PCT in the *BioNet Vegetation Classification* (DPE 2022b) 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. Table 5 provides a summary of the assignment process for each TEC, and Figures 9a and 9b show the mapping of the BC Act and EPBC Act communities.

Table 5
Justification for TEC Assignment

PCT	PCT Common Name	Associated TEC (DPE 2022a)	Assigned TEC in this BDAR	Rationale
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
1606	White Box - Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter	Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland	BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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
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
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina	BC Act, E: Central Hunter Grey Box; 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

PCT	PCT Common Name	Associated TEC (DPE 2022a)	Assigned TEC in this BDAR	Rationale
		Bioregions; 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		Blakely's Red Gum woodland.
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	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 Development Footprint 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, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; Listed EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland	BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; EPBC Act, CE: White Box Yellow Box Blakely's Red Gum Woodland	The primary canopy content of this PCT is consistent with that of both of these TECs. The derived native grassland variants of this PCT are included in the determination for these TECs.

3.5 VEGETATION ZONES

Eleven vegetation zones (i.e. areas of native vegetation that are the same PCT and similar broad condition states) are mapped across the Development Footprint (Table 2). The vegetation has been recognised as being in woodland or derived native grassland condition states.

3.6 VEGETATION INTEGRITY (VEGETATION CONDITION)

3.6.1 Vegetation Integrity Plots

The baseline flora surveys involved the collection of data from 109 plots located to sample the vegetation zones present, with the number of plots meeting the requirements per area for each zone (Attachment B). For the Modification, seven additional plots were collected from within or in the immediate vicinity of the Development Footprint. The location of vegetation integrity (site condition) plots used in the BAM-C for the Development Footprint are shown on Figures 8a and 8b.

Patch size for the vegetation zones is >100 ha.

3.6.2 Vegetation Integrity Score

The BAM-C was used to determine the VI Scores for each vegetation zone (Table 6). According to the BAM-C, all of the vegetation zones have a VI Score requiring an offset, except Vegetation Zone 3a (Table 6). Vegetation Zone 3a is a derived native grassland in low condition.

Table 6
Vegetation Integrity Score Detail

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?
2	1606[1]	Woodland	74.8	61.3	72.7	2	69.4	≥15	Yes
2a	1606[1]	DNG	28.3	25.6	15.0	0	22.2	≥15	Yes
3	1655[2]	Woodland	38.4	15.6	12.3	0	19.5	≥17	Yes
3a	1655	DNG	23.4	15.2	4.3	0	11.5	≥17	No
6	1692*	Woodland	75.6	56.7	47.3	0	58.7	≥17	Yes
7a	1693[1]	DNG	26.8	60.7	15.0	0	29.0	≥15	Yes
8	201	Woodland	66.3	75.9	83.2	0	74.8	≥17	Yes
8a	201	DNG	26.6	57.2	15.0	0	28.4	≥17	Yes
9	1691[3]	Woodland	60.3	76.5	44.5	0	59.0	≥15	Yes
9a	1691	DNG	62.7	41.7	15.0	0	34.0	≥17	Yes

1 Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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.

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

4 HABITAT SUITABILITY FOR THREATENED SPECIES

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are predetermined by DPE in the BAM-C and TBDC (DPE 2022a). The BAM (DPIE 2020) states:

'Ecosystem credit species' are threatened species whose occurrence can generally be predicted by vegetation surrogates and/or landscape features, or that have a low probability of detection using targeted surveys. The TBDC identifies the threatened species assessed for ecosystem credits. A targeted survey is not required to identify or confirm the presence of ecosystem credit species.

'Species credit species' are threatened species for which vegetation surrogates and/or landscape features cannot reliably predict the likelihood of their occurrence or components of their habitat. These species are identified in the TBDC. A targeted survey or an expert report is required to confirm the presence of these species on the Development Footprint. Alternatively, for a development, activity, clearing or biodiversity certification proposal only, the proponent may elect to assume the species is present (this option must not be applied to proposed biodiversity stewardship sites).

In some circumstances the TBDC may identify a threatened species that requires assessment for ecosystem credits and species credits (referred to as dual credit species).

For dual credit species, part of the habitat is assessed as a species credit (e.g. breeding habitat or land mapped on an important habitat map for a species). The remaining habitat components for the species are assessed as an ecosystem credit (e.g. foraging habitat).

Dual credit species are generally:

a. highly mobile species that rely on particular habitat components for breeding, such as maternity caves for bats, tree hollows for some large forest owls or cockatoos, or

b. species for which particular areas in the landscape are important for their survival, such as selected beaches for migratory shorebirds.

4.1 ECOSYSTEM CREDIT SPECIES - HABITAT SUITABILITY ASSESSMENT

In accordance with the BAM (DPIE 2020), assessing habitat suitability for an ecosystem credit species involves the following steps:

Step 1: Identify threatened species for assessment; and
Step 2: Assess the habitat constraints and vagrant species on the Development Footprint.

These steps are applied below.

4.1.1 Identify Ecosystem Species for Assessment

A total of 34 ecosystem credit species for assessment are listed in Table 7 from the BAM-C.

Table 7
Ecosystem Species from the BAM-C

Scientific Name	Common Name	Conservation Status[1] BC Act	Conservation Status[1] EPBC Act	Class of Credit[2]	Sensitivity to Gain Class
Birds					
Falco subniger	Black Falcon	V	-	E	Moderate
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Moderate
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	High
Hieraaetus morphnoides	Little Eagle	V	-	S/E	Moderate
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	High
Callocephalon fimbriatum	Gang-gang Cockatoo	V	E	S/E	Breeding: High Foraging: Moderate
Glossopsitta pusilla	Little Lorikeet	V	-	E	High
Neophema pulchella	Turquoise Parrot	V	-	E	High
Lathamus discolor	Swift Parrot	E	CE	S/E	Moderate
Tyto novaehollandiae	Masked Owl	V	-	S/E	High
Ninox strenua	Powerful Owl	V	-	S/E	High
Ninox connivens	Barking Owl	V	-	S/E	High
Hirundapus caudacutus	White-throated Needletail	-	V	E	High
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	E	High
Chthonicola sagittata	Speckled Warbler	V	-	E	High
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	E	Moderate
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	High
Grantiella picta	Painted Honeyeater	V	V	E	Moderate
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	E	Moderate
Petroica phoenicea	Flame Robin	V	-	E	Moderate
Petroica boodang	Scarlet Robin	V	-	E	Moderate
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	E	Moderate
Daphoenositta chrysoptera	Varied Sittella	V	-	E	Moderate
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	E	Moderate
Stagonopleura guttata	Diamond Firetail	V	-	E	Moderate
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	High
Petaurus australis	Yellow-bellied Glider	V	-	E	High
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	High
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	E	High
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	E	High

Scientific Name	Common Name	Conservation Status[1] BC Act	EPBC Act	Class of Credit[2]	Sensitivity to Gain Class
Miniopterus orianae oceanensis	Large Bentwing-bat	V	-	S/E	Breeding: Very High Foraging: High
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E	High
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	E	High
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	E	High

1 Threatened fauna species status under the BC Act and/or EPBC Act (current as at June 2022).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

2 Biodiversity credit class under the TBDC (DPE 2022a) (current as at June 2022). E = Ecosystem; S = Species.

4.1.2 Exclusion of Ecosystem Species

No ecosystem species were removed from the BAM-C.

4.1.3 Addition of Ecosystem Species

No ecosystem species were added to the BAM-C.

4.2 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 Development Footprint.

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 Habitat (Species Polygon) for species assessed by area.

4.2.1 Species Credit Species from the BAM-C

A total of 45 species credit species from the BAM-C are listed in Table 8 for assessment.

Table 8
Species Credit Species for Assessment

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Associated Vegetation Zone/s (DPE 2020a)
		BC Act	EPBC Act		
Flora					
Acacia pendula – endangered population	Weeping Myall population in the Hunter catchment	E	-	S	1606, 1655, 1692, 1691
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	1606, 1655, 1655 DNG
Cymbidium canaliculatum – endangered population	Tiger Orchid population in the Hunter Catchment	E	-	S	1606, 1655, 1692, 1691
Cynanchum elegans	White-flowered Wax Plant	E	E	S	1606
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	V/EP	-	S	1606, 1606 DNG, 1655, 1655 DNG, 1691, 1691 DNG, 1693 DNG, 201, 201 DNG
Eucalyptus glaucina	Slaty Red Gum	V	V	S	1692, 1691
Eucalyptus pumilla	Pokolbin Mallee	V	V	S	1655
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S	1606
Ozothamnus tesselatus	Ozothamnus tesselatus	V	V	S	1606, 1655
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	1606
Pomaderris queenslandica	Scant Pomaderris	E	-	S	1606, 1655
Pomaderris reperta	Denman Pomaderris	CE	CE	S	1655
Prasophyllum petilum	Tarengo Leek Orchid	E	E	S	1691, 1691 DNG, 201, 201 DNG
Prasophyllum sp. Wybong[3]	Tarengo Leek Orchid (syn.)	-	CE	S	201, 201 DNG
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	1655
Prostanthera cryptandroides subsp. cryptandroides	Wollemi Mint-bush	V	V	S	1655
Pterostylis chaetophora	Rusty Greenhood	V	-	S	1691, 1691 DNG
Thesium australe	Austral Toadflax	V	V	S	1606, 1606 DNG, 1655, 1655 DNG
Amphibians					
Litoria aurea	Green and Golden Bell Frog	E	V	S	1606, 1692, 1691
Reptiles					
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	1606, 1606 DNG 1655, 1655 DNG 1692, 1693 DNG, 1691, 1691 DNG

[3] Bell (2020) considered *Prasophyllum* sp. Wybong as a synonym of the Tarengo Leek Orchid (*Prasophyllum petilum*) in his expert report (Attachment C), following the Australian Plant Name Index. While it is no longer listed under the BC Act, *Prasophyllum* sp. Wybong is still listed under the EPBC Act because the synonym is yet to be accepted by the Australian Plant Census. Therefore, *Prasophyllum* sp. Wybong has still been considered for assessment under the Commonwealth EPBC Act (Section 7.6).

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Associated Vegetation Zone/s (DPE 2020a)
		BC Act	EPBC Act		
Delma impar	Striped Legless Lizard	V	V	S	1606, 1606 DNG, 1655, 1655 DNG, 1692, 1693 DNG, 1691, 1691 DNG
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	1606, 1655, 1692, 1691
Birds					
Lophoictinia isura	Square-tailed Kite	V	-	S/E	1606, 1655, 1692, 1693 DNG, 201, 1691
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	1692, 201, 1691
Hieraaetus morphnoides	Little Eagle	V	-	S/E	1606, 1655, 1692, 201, 1691
Burhinus grallarius	Bush Stone-curlew	E	-	S	1606, 1655, 1692, 201, 1691
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	1606, 1655, 1692, 201, 1691
Callocephalon fimbriatum	Gang-gang Cockatoo	V	E	S/E	1606, 1655, 1692, 201, 1691
Lathamus discolour	Swift Parrot	E	CE	S/E	1606, 1655, 1692, 201, 1691
Tyto novaehollandiae	Masked Owl	V	-	S/E	1606, 1655, 1692, 201, 1691
Ninox strenua	Powerful Owl	V	-	S/E	1606, 1655, 1692, 1691
Ninox connivens	Barking Owl	V	-	S/E	1606, 1655, 1692, 1693, 201, 1691
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	1606, 1655, 1693, 201, 1691
Mammals					
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	1606, 1692, 201, 1691
Planigale maculata	Common Planigale	V	-	S	1606, 1655, 1692, 1691
Phascolarctos cinereus	Koala	E	E	S	1606, 1655, 1691, 1692, 1693, 201
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	1606, 1655, 1692, 1691
Petauroides volans	Greater Glider	-	V	S	1606, 1655, 1691
Petaurus norfolcensis	Squirrel Glider	V	-	S	1606, 1655, 201, paddock trees in 1606 DNG, 1655 DNG and 201 DNG
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S	1655, 1692, 201, 1691
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	1606, 1655, 1692, 1691

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Associated Vegetation Zone/s (DPE 2020a)
		BC Act	EPBC Act		
Miniopterus orianae oceanensis	Large Bentwing-bat	V	-	S/E	1606, 1655, 1692, 201, 1691
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	1606, 1655, 1692, 201, 1691
Myotis macropus	Southern Myotis	V	-	S	1692, 1691
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	1606, 1655

1 Threatened flora species status under the BC Act and/or EPBC Act (current as at June 2022).
V = Vulnerable; E = Endangered; CE = Critically Endangered; EP = Endangered Population.
2 Biodiversity credit class under the TBDC (DPE 2022a) (current as at June 2022).
E = Ecosystem; S = Species.

4.2.2 Exclusion of Species Credit Species

4.2.2.1 Geographical Constraints

Geographic constraints are identified in the TBDC (DPE 2022a) for some species credit species (Table 9). None of the geographic constraints are relevant to the Development Footprint.

4.2.2.2 Habitat Constraints and Vagrancy

Habitat constraints are identified in the TBDC (DPE 2022a) for some species credit species, and the absence of identified habitat precludes the species from further assessment (Table 10).

4.2.2.3 Degraded Habitat

A candidate species credit species is considered unlikely to occur on the Development Footprint (or specific vegetation zones) if after carrying out a field assessment of the habitat constraints or microhabitats on the Development Footprint, the assessor determines that the habitat is substantially degraded to the point that the species is unlikely to utilise the Development Footprint (or specific vegetation zones) (DPIE 2020).

No habitat within the Development Footprint was considered to be degraded.

4.2.2.4 Review of Databases

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

- Birdlife Australia Atlas Database (Birdlife Australia 2018);
- *BioNet Atlas* (DPE 2022c);
- Protected Matters Search Tool (DAWE 2022a); and
- *Atlas of Living Australia* (Atlas of Living Australia [ALA] 2021).

Attachment E provides a summary of the threatened species records in the locality from survey records or database records (threatened species shaded in Attachment E are species with records in the Project study area). Threatened species records are shown on Figures 10 to 14.

Table 9
Species Credit Species – Geographic Constraints

Scientific Name	Common Name	Geographic Constraint within the Hunter Sub-zone in the BAM Calculator	Assessment
Acacia pendula – endangered population	Weeping Myall population in the Hunter catchment	Within Hunter River catchment	Not a relevant constraint.
Cymbidium canaliculatum – endangered population	Tiger Orchid population in the Hunter Catchment	Must be within Hunter catchment as defined by Australia's River Basins (Geoscience Australia 1997)	Not a relevant constraint.
Diuris tricolor – endangered population	Pine Donkey Orchid population in the Muswellbrook local government area	Muswellbrook local government area	Not a relevant constraint.

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

Table 10
Species Credit Species - Habitat Constraints

Common Name	Credit Class	Habitat Constraints identified in the TBDC (DPE 2022a)	Assessment Prior to the Surveys
Flora			
Weeping Myall population in the Hunter catchment	Species	*None.*	-
Leafless Tongue Orchid	Species	*None.*	-
Tiger Orchid population in the Hunter Catchment	Species	*Epiphytic in a range of eucalypts, Acacia and Angophora; Cut stumps or logs on ground.*	Habitat constraint present.
White-flowered Wax Plant	Species	*None.*	-
Pine Donkey Orchid	Species	*None.*	-
Pine Donkey Orchid population in the Muswellbrook local government area	Species	*None.*	-
Slaty Red Gum	Species	*None.*	-
Pokolbin Mallee	Species	*None.*	-

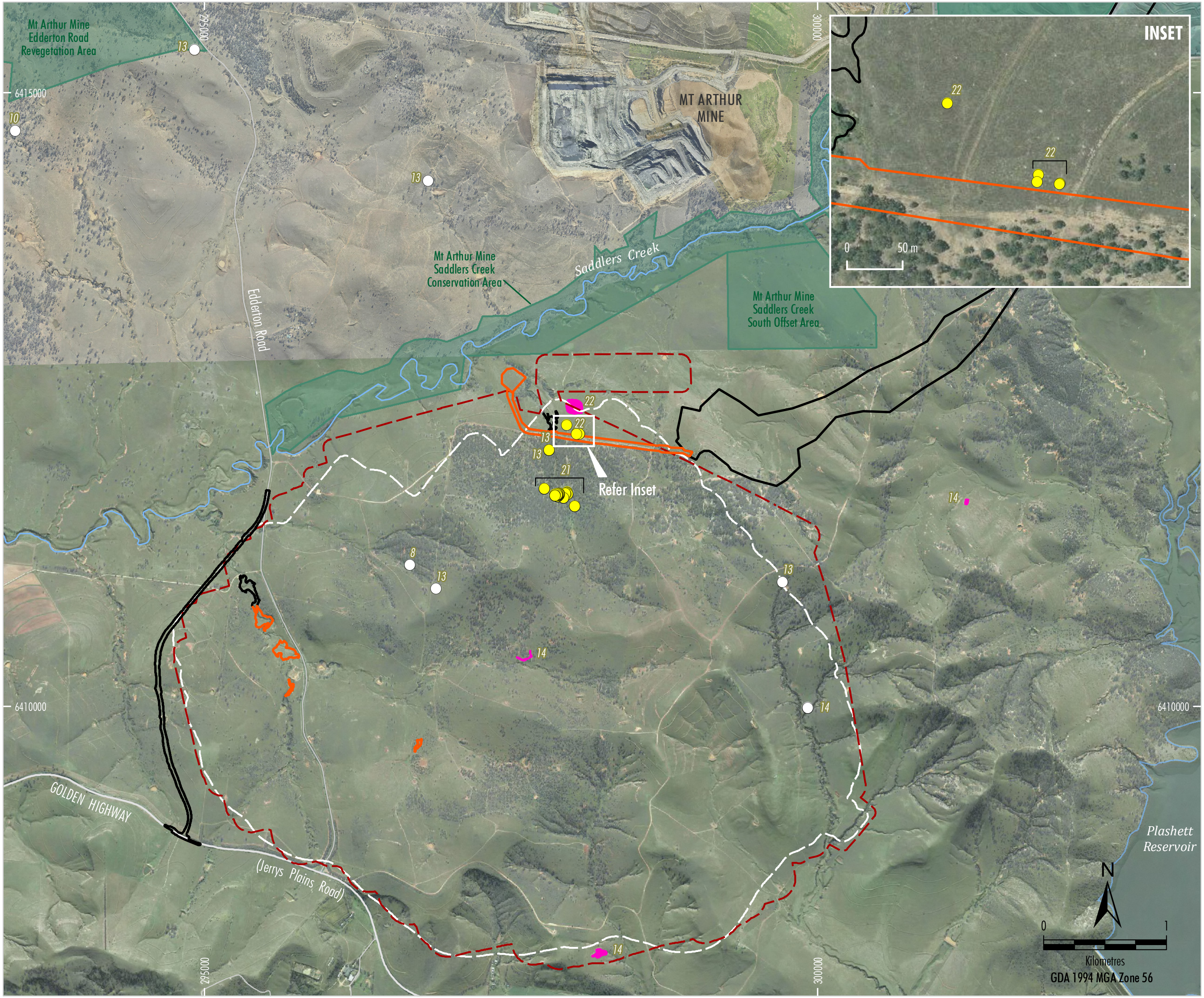
Common Name	Credit Class	Habitat Constraints identified in the TBDC (DPE 2022a)	Assessment Prior to the Surveys
Large-leafed Monotaxis	Species	*Species is a short-lived annual, and will not be present unless a recent disturbance/fire event has occurred and triggered germination.*	Habitat constraint absent.
Ozothamnus tesselatus	Species	*None.*	-
Bodalla Pomaderris	Species	*None.*	-
Scant Pomaderris	Species	*None.*	-
Denman Pomaderris	Species	*None.*	-
Tarengo Leek Orchid	Species	*None.*	-
Singleton Mint Bush	Species	*None.*	-
Wollemi Mint-bush	Species	*None.*	-
Rusty Greenhood	Species	*None.*	-
Austral Toadflax	Species	*None.*	-
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).*	Habitat constraint present.
Reptiles			
Pink-tailed Legless Lizard	Species	*Rocky areas or within 50 m of rocky areas.*	Habitat constraint absent.
Striped Legless Lizard	Species	*None.*	-
Pale-headed Snake	Species	*None.*	-
Birds			
Square-tailed Kite	Species/Ecosystem	*Breeding constraint: Other (Nest trees).*	Habitat constraint absent.
White-bellied Sea-Eagle	Species/Ecosystem	*Breeding constraint: Other (Living or dead mature trees within suitable vegetation within 1 km of a rivers, lakes, large dams or creeks, wetlands and coastlines).*	Habitat constraint absent.
Little Eagle	Species/Ecosystem	*Breeding constraint: Other (Nest trees - live (occasionally dead) large old trees within vegetation).*	Habitat constraint absent.
Bush Stone-curlew	Species	*Fallen/standing dead timber including logs.*	Habitat constraint present.
Glossy Black-Cockatoo	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Living or dead tree with hollows greater than 15 cm diameter and greater than 5 m above ground).*	Habitat constraint absent.

Common Name	Credit Class	Habitat Constraints identified in the TBDC (DPE 2022a)	Assessment Prior to the Surveys
Gang-gang Cockatoo	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Eucalypt tree species with hollows greater than 9 cm diameter).*	Habitat constraint present only in PCT 1606 woodland.
Swift Parrot	Species/Ecosystem	*Breeding constraint: Other (As per mapped important areas).*	Habitat constraint absent. Not a mapped important area.
Masked Owl	Species/Ecosystem	*Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20 cm diameter).*	Habitat constraint absent.
Powerful Owl	Species/Ecosystem	*Breeding constraint: Hollow-bearing tree (Living or dead trees with hollows greater than 20 cm diameter).*	Habitat constraint absent.
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).*	Habitat constraint absent
Regent Honeyeater	Species/Ecosystem	*Breeding constraint: Other (As per mapped areas).*	Habitat constraint absent. Not a mapped important area.
Mammals			
Brush-tailed Phascogale	Species	*Hollow-bearing trees.*	Habitat constraint present only in PCT 1606 woodland.
Common Planigale	Species	*None.*	-
Koala	Species	*Presence of koala use trees. Refer to the Koala (Phascolarctos cinereus): Biodiversity Assessment Method Survey Guide for information on targeted survey requirements and mapping species polygons.*	Habitat constraint present in PCTs 1606 and 1691 (woodland).
Eastern Pygmy-possum	Species	*None.*	-
Greater Glider	Species	*Hollow dependent species that will have large trees with hollows within its home range. Home range is < 5 ha and typically 1 to 3 ha.*	Habitat constraint present only in PCT 1606 woodland.
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 constraint absent.
Grey-headed Flying-fox	Species/Ecosystem	*Breeding constraint: Other (Breeding camps).*	Habitat constraint absent.
Large Bentwing-bat	Species/Ecosystem	*Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding).*	Habitat constraint absent.
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 constraint absent.
Southern Myotis	Species	*Hollow-bearing trees (Within 200 m of riparian zone).*	Habitat constraint absent.

Common Name	Credit Class	Habitat Constraints identified in the TBDC (DPE 2022a)	Assessment Prior to the Surveys
		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).*	Habitat constraint absent.

Shaded species are species that have habitat constraints as identified in the TBDC (DPE 2022a) such that these species are not likely to occur and are therefore excluded from further assessment.

* Habitat Constraints not in the BAM-C.



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence
(20 mm subsidence contour)
Modified Extent of Conventional Subsidence
(20 mm subsidence contour)
Development Footprint
Existing Conservation/Offset Area
Endangered Populations
Tiger Orchid (*Cymbidium canaliculatum* population
in the Hunter Catchment)
Weeping Myall (*Acacia pendula* population
in the Hunter Catchment) #
Pine Donkey Orchid population
in the Muswellbrook Local Government Area

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

Note: DPIE (2020) 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.

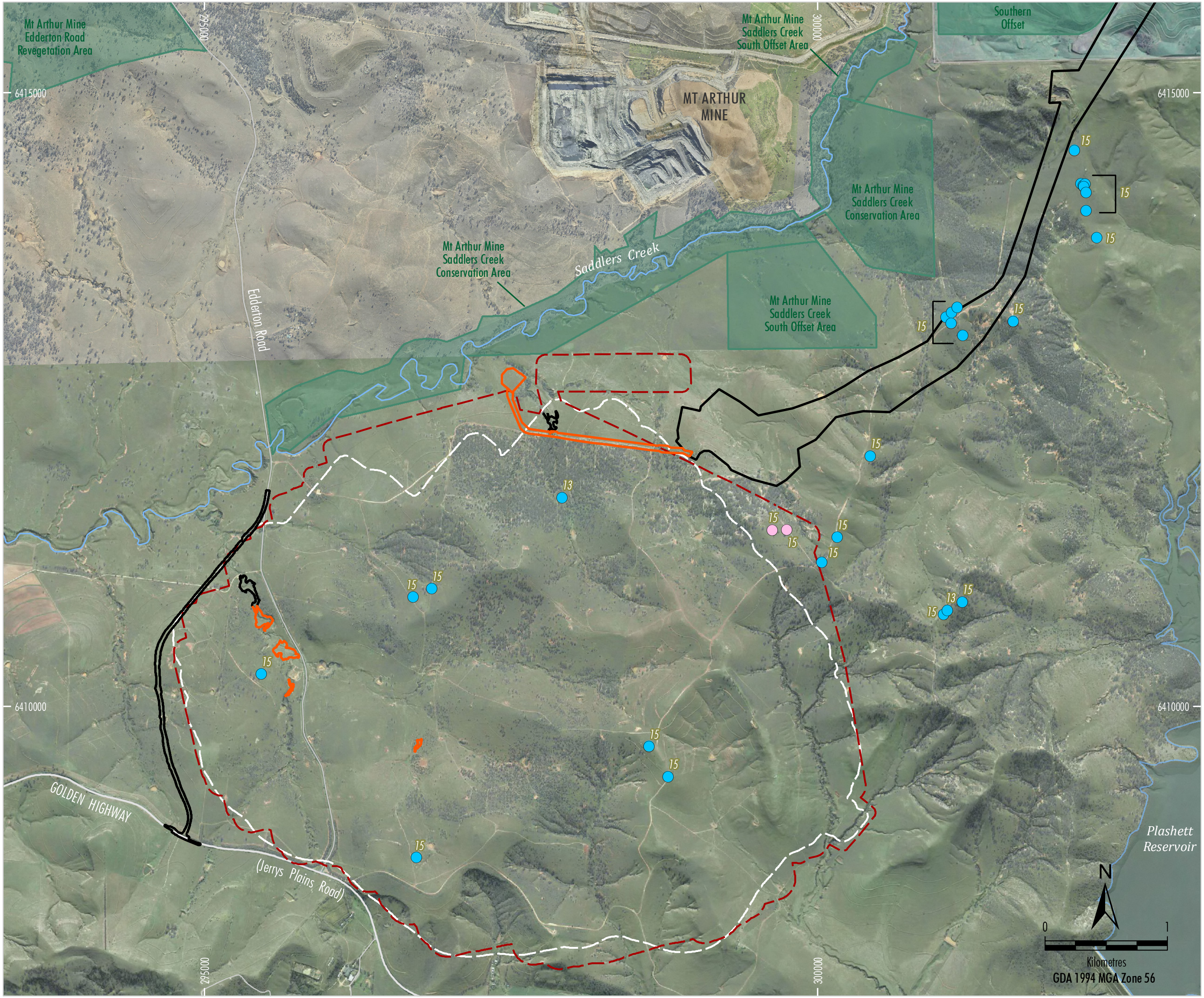
Reference:
8. Cumberland Ecology (2015)
10. Hunter Eco (2012)
13. DPE (2022)
14. Hunter Eco (2019)
21. Hunter Eco (2020)
22. Hunter Eco (2022)
Note: There are no references 1 - 7, 9, 11, 12 and 15 - 20 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR
MAXWELL UNDERGROUND MINE PROJECT
Threatened Flora Species/ Endangered Populations

Figure 10

SHM-20-04 MOD LW_BDAR_207F



LEGEND
- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- Existing Conservation/Offset Area

Threatened Species
- Pink-tailed Legless Lizard
- Striped Legless Lizard

Reference:
13. DPE (2022)
15. Future Ecology (2019)
Note: There are no references 1 - 12 and 14 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

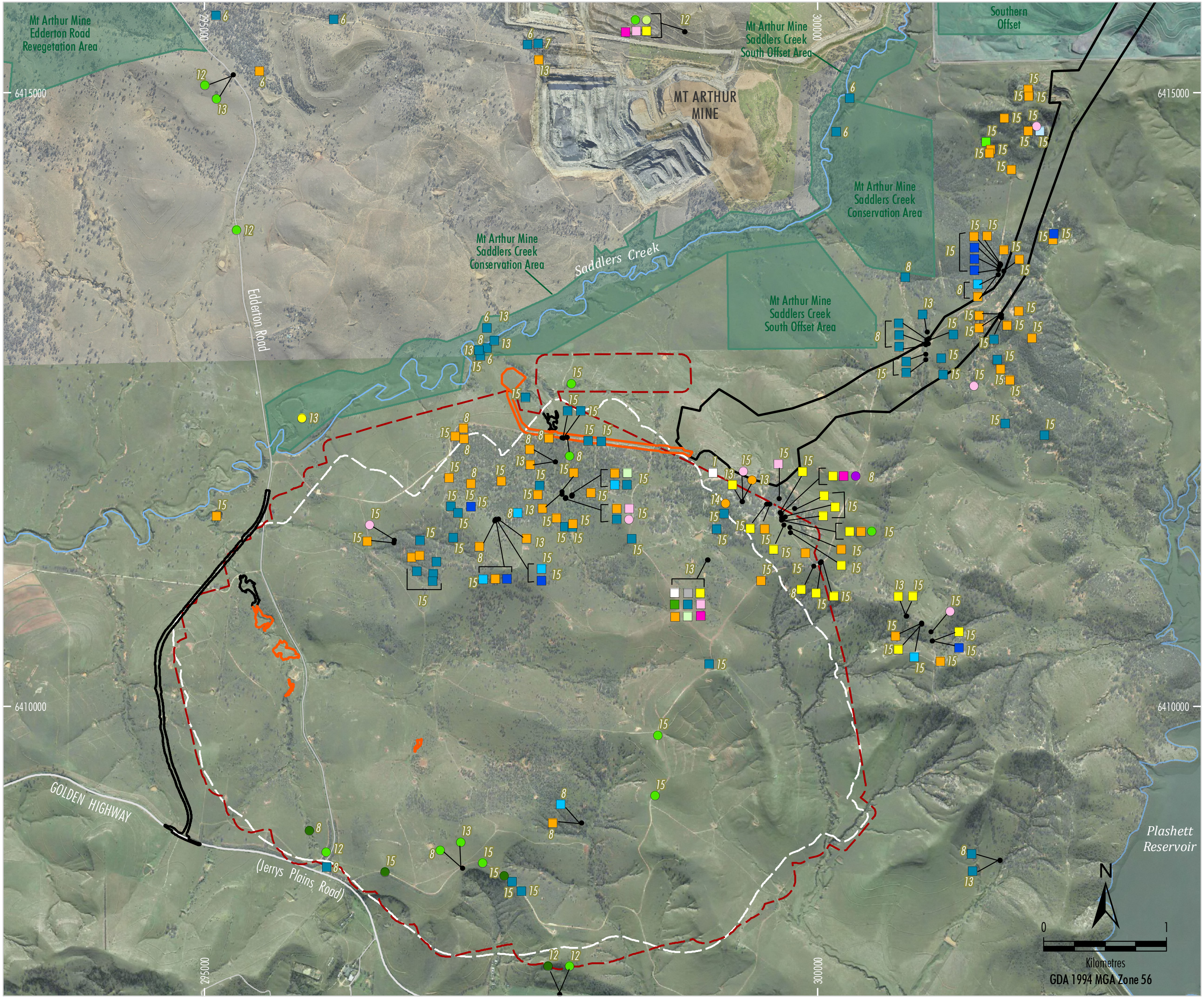
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Threatened Reptiles and Amphibians

Figure 11

SHM-20-04 MOD LW_BDAR_208C



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- Existing Conservation/Offset Area

Threatened Species

- Black Falcon
- Square-tailed Kite
- White-bellied Sea-Eagle
- Spotted Harrier
- Little Eagle
- Little Lorikeet
- Swift Parrot
- Barking Owl
- White-throated Needletail
- 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)
6. Cumberland Ecology (2009a)
7. Cumberland Ecology (2010)
8. Cumberland Ecology (2015)
12. Birdlife Australia (2018)
13. DPE (2022)
14. Hunter Eco (pers. comm. (2019))
15. Future Ecology (2019)

Note: There are no references 2 - 5 and 9 - 11 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

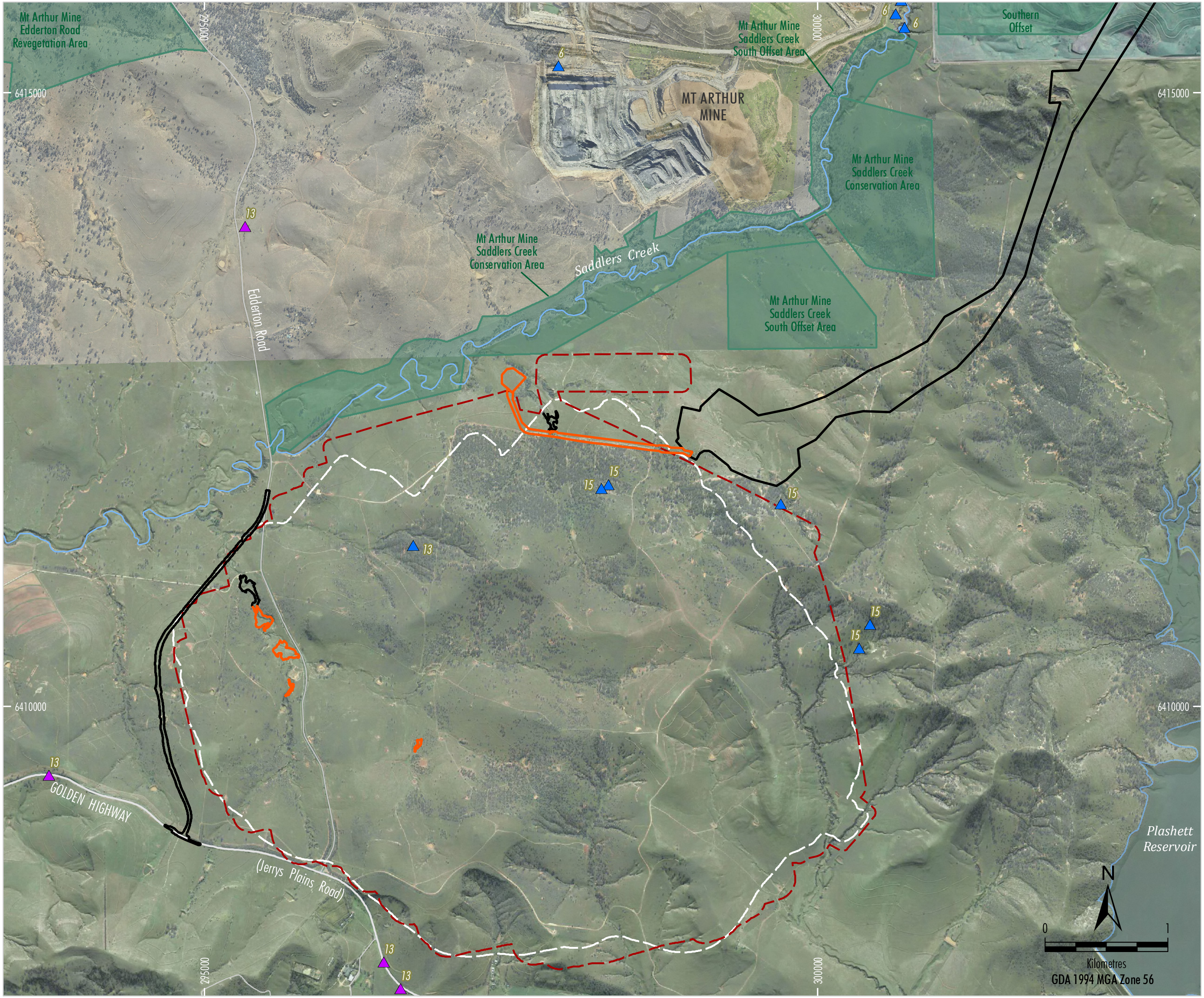
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Threatened Birds

Figure 12

SHM-20-04 MOD LW_BDAR_209D



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
Existing Conservation/Offset Area
Threatened Species
Spotted-tailed Quoll
Squirrel Glider

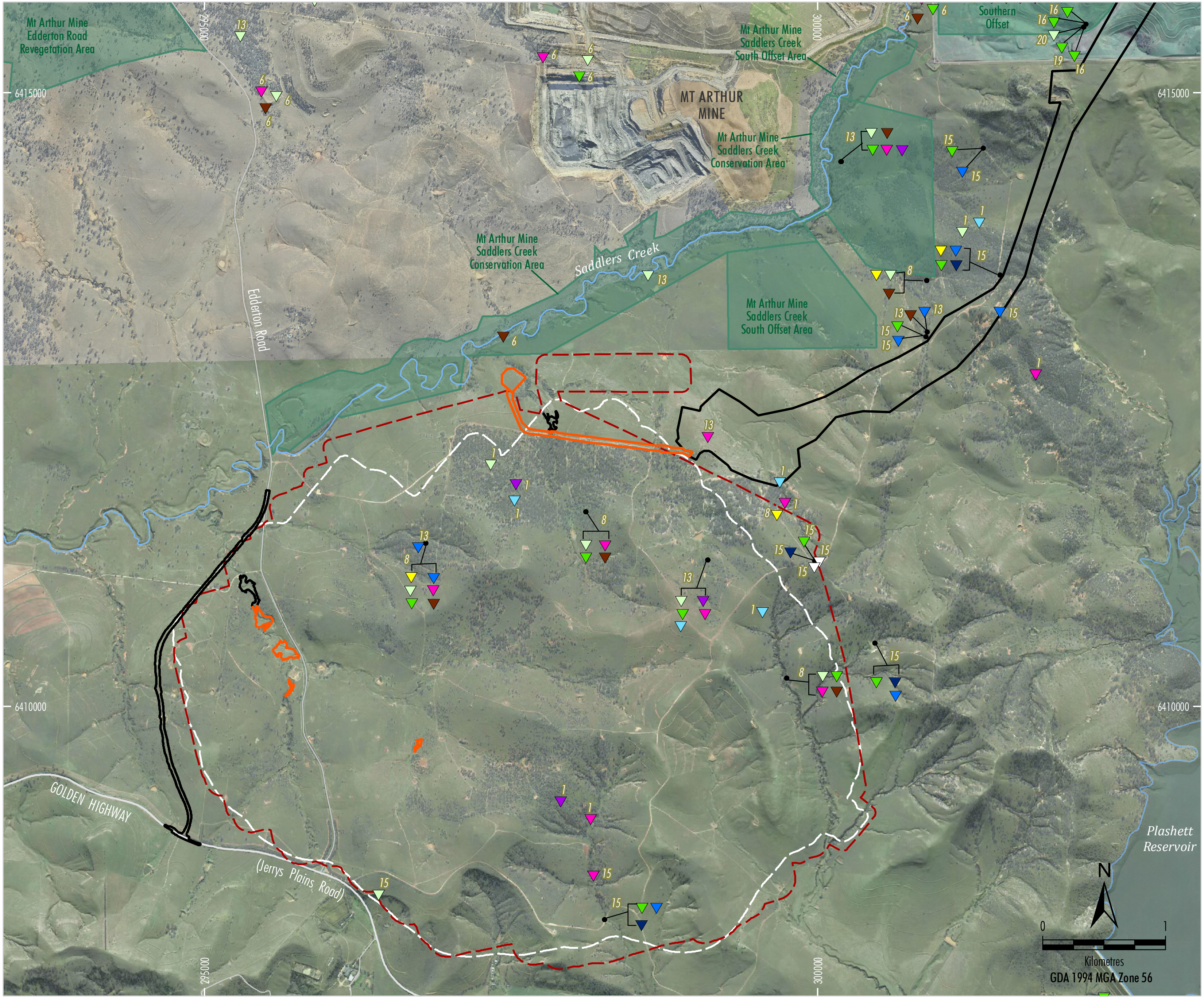
Reference:
6. Cumberland Ecology (2009a)
13. DPE (2022)
15. Future Ecology (2019)
Note: There are no references 1 - 5, 7 - 12 and 14 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR
MAXWELL UNDERGROUND MINE PROJECT
Threatened Mammals

Figure 13

SHM-20-04 MOD LW_BDAR_210D



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- Existing Conservation/Offset Area

Threatened Species

- Grey-headed Flying-fox
- Yellow-bellied Sheathtail-bat
- Eastern Coastal Free-tailed Bat
- Large Bent-winged Bat
- Corben's Long-eared Bat
- Large-eared Pied Bat
- Little Bent-winged Bat
- Eastern False Pipistrelle
- Southern Myotis
- Greater Broad-nosed Bat
- Eastern Cave Bat

Reference:

1. Ecotone (2000)
6. Cumberland Ecology (2009a)
8. Cumberland Ecology (2015)
13. DPE (2022)
15. Future Ecology (2019)
16. Eco Logical Australia (2014)
19. Eco Logical Australia (2016b)
20. Eco Logical Australia (2017)
Note: There are no references 2 - 5, 7, 9 - 12, 14, 17 - 18 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Threatened Bats

Figure 14

SHM-20-04 MOD LW_BDAR_211C

4.3 SPECIES CREDIT SPECIES – ASSESSMENT METHOD

4.3.1 Species Important Habitat Mapping

No DPE Important Habitat Mapping is relevant to the Development Footprint.

4.3.2 Expert Reports

Dr Stephen Bell of Eastcoast Flora Survey prepared an expert report (Bell 2020) (Attachment C) for the Maxwell Underground assessing the likelihood of three orchid species, (Pine Donkey Orchid (*Diuris tricolor*), Tarengo Leek Orchid (*Prasophyllum petilum* and syn. *Prasophyllum* sp. Wybong[4]) and Rusty Greenhood (*Pterostylis chaetophora*), occurring in PCTs associated with Development Footprint. Of the vegetation zones present in the Development Footprint, Bell (2020) concluded that only PCT 1691 derived grassland may provide habitat for the Pine Donkey Orchid (*Diuris tricolor*) and Tarengo Leek Orchid, and that the Rusty Greenhood (*Pterostylis chaetophora*) was unlikely to occur in any PCT.

The Modification Development Footprint contains two PCTs (1693 and 201) not included in the analysis in the expert report (Bell 2020). The TBDC indicates that Pine Donkey Orchid (*Diuris tricolor*) may be associated with PCT 1693, and Tarengo Leek Orchid (*Prasophyllum petilum*) may be associated with PCT 201 (albeit that this association relates to PCT 201 as it occurs in the NSW South Western Slopes Bioregion [Table 3]).

On the basis of the analysis by Dr Stephen Bell (Bell 2020) (Attachment C), the information in the TBDC (DPE 2022a) and site observations, Rusty Greenhood (*Pterostylis chaetophora*) is not considered to be relevant to the Modification and has been excluded from targeted survey.

Targeted surveys for the Pine Donkey Orchid (*Diuris tricolor*) are warranted within PCT 1691 derived grassland, PCT 1693 and PCT 201. Targeted surveys for the Tarengo Leek Orchid (*Prasophyllum petilum*) are warranted within PCT 1691 and PCT 201. Targeted surveys within PCT 1691 and 1693 were conducted on 27 September 2021 and 5 October 2021. Targeted surveys for Pine Donkey Orchid (*Diuris tricolor*) and Tarengo Leek Orchid (*Prasophyllum petilum*) were not able to be undertaken in PCT 201 (potential ponding area) during the appropriate survey months. These species are discussed in Section 4.3.3.

4.3.3 Species Assumed to be Present

Austral Toadflax

The potential ponding areas were modelled subsequent to the targeted surveys for Austral Toadflax conducted in November 2021. As a result, Austral Toadflax was not able to be targeted in the potential ponding area during November to February. In June 2022, PCT 1606 (woodland) and PCT 1655 (woodland) were searched for the host plant Kangaroo Grass (*Themeda triandra*) and no host plant was found. There are two vegetation zones in the potential ponding areas that are associated with Austral Toadflax and were not able to be surveyed:

- approximately 0.1 ha of PCT1606 DNG; and
- approximately 1.7 ha of PCT1655 DNG.

[4] Bell (2020) considered *Prasophyllum* sp. Wybong as a synonym of the Tarengo Leek Orchid (*Prasophyllum petilum*) in his expert report (Attachment C), following the Australian Plant Name Index. While it is no longer listed under the BC Act, *Prasophyllum* sp. Wybong is still listed under the EPBC Act because the synonym is yet to be accepted by the Australian Plant Census. Therefore, *Prasophyllum* sp. Wybong has still been considered for assessment under the Commonwealth EPBC Act (Section 7.6).

In accordance with the BAM (DPIE 2020), Austral Toadflax has been assumed present in these derived native grassland areas that were not able to be surveyed. However, given the absence of Austral Toadflax or its host grass species during other surveys, it is considered unlikely for the species to be present.

Leafless Tongue Orchid

The potential ponding areas were modelled subsequent to the targeted surveys for Leafless Tongue Orchid (*Cryptostylis hunteriana*) conducted in November 2021. As a result, targeted surveys for Leafless Tongue Orchid (*Cryptostylis hunteriana*) were not able to be undertaken in PCT 1655 woodland and DNG at the potential ponding area. In accordance with the BAM (DPIE 2020), the Leafless Tongue Orchid (*Cryptostylis hunteriana*) has been assumed present in the areas that were not able to be surveyed.

Pine Donkey Orchid and Tarengo Leek Orchid

The potential ponding area was identified after the targeted surveys for Pine Donkey Orchid (*Diuris tricolor*) and Tarengo Leek Orchid (*Prasophyllum petilum*) in September/October 2021. As a result, targeted surveys for Pine Donkey Orchid (*Diuris tricolor*) and Tarengo Leek Orchid (*Prasophyllum petilum*) were not able to be undertaken in PCT 201 woodland and DNG at the potential ponding areas. In accordance with the BAM (DPIE 2020), the Pine Donkey Orchid (*Diuris tricolor*) and Tarengo Leek Orchid (*Prasophyllum petilum*) have been assumed present in the areas that were not able to be surveyed.

4.3.4 Species for Survey

A total of 16 threatened flora species required surveying for this BDAR (Table 11).

4.4 SPECIES CREDIT SPECIES – SURVEY

Threatened Flora

Dr Colin Driscoll undertook targeted surveys for threatened flora species for the Project (Hunter Eco 2019) and for Modification 1 (Hunter Eco 2021). The following three threatened flora species/populations were identified (Figure 10):

- Tiger Orchid (*Cymbidium canaliculatum* – endangered population);
- Pine Donkey Orchid (*Diuris tricolor*); and
- *Acacia pendula* population in the Hunter catchment (*Acacia pendula* – endangered population).

None of these previously identified threatened flora species occur in the Development Footprint associated with the Modification. Supplementary flora surveys for this Modification were undertaken by Dr Colin Driscoll on 24, 27 and 28 September, 5 October and 1 November 2021 as well as 24 May and 10 June 2022 (Table 11). The supplementary surveys involved parallel transects in September and October 2021 (PCTs 1606 [woodland], 1693 [DNG], and 1691 [woodland and DNG]), November 2021 (PCTs 1606 [woodland and DNG] and 1692 [woodland]), May 2022 (PCTs 1731 woodland, 1606 woodland, 1692 woodland and 1691 woodland), and June 2022 (PCTs 1606 woodland and 1655 woodland). Months in which targeted surveys were undertaken are shaded in Table 11.

Surveys were conducted according to the requirements in the Department of Planning, Industry & Environment (DPIE) (2020) *Surveying Threatened Plants and Their Habitats: NSW Survey Guide for the Biodiversity Assessment Method*. As noted in Section 4.3.3, Austral Toadflax, Leafless Tongue Orchid, Pine Donkey Orchid and Tarengo Leak Orchid were not able to be targeted in the potential ponding area during appropriate survey months. In accordance with the BAM (DPIE 2020), these species have been assumed present.

Threatened Fauna

Future Ecology (2019) (Attachment A) undertook targeted surveys for candidate fauna species credit species for the Project. Months in which targeted surveys were undertaken are shaded in Table 11. Details of the surveys are described for each species in Table 12.

Table 11
Species Credit Species Requiring Survey and Timing

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Relevant Associated PCT (DPE 2020a)	Survey Months for Each Species											
		BC Act	EPBC Act			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flora																	
Acacia pendula – endangered population	*Acacia pendula* population in the Hunter catchment	E	-	S	1606, 1655, 1692, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	1606, 1655, 1655 DNG	Yes	Yes	-	-	-	-	-	-	-	-	Yes	Yes
Cymbidium canaliculatum – endangered population	Tiger Orchid	E	-	S	1606, 1655, 1692, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Cynanchum elegans	White-flowered Wax Plant	E	E	S	1606	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diuris tricolor	Pine Donkey Orchid	V/E P	-	S	1655, 1655 DNG	-	-	-	-	-	-	-	-	Yes	Yes	-	-
Eucalyptus glaucina	Slaty Red Gum	V	V	S	1692, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus pumila	Pokolbin Mallee	V	V	S	1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ozothamnus tesselatus	-	V	V	S	1606, 1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	1606	-	-	-	-	-	-	-	-	Yes	Yes	Yes	-
Pomaderris queenslandica	Scant Pomaderris	E	-	S	1606, 1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris reperta	Denman Pomaderris	CE	CE	S	1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prasophyllum petilum	Tarengo Leek Orchid	E	E	S	1691, 1691 DNG, 201, 201 DNG	-	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Relevant Associated PCT (DPE 2020a)	Survey Months for Each Species											
		BC Act	EPBC Act			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prostanthera cryptandroides subsp. *Cryptandroides*	Wollemi Mint-bush	V	V	S	1655	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thesium australe	Austral Toadflax	V	V	S	1606, 1606 DNG, 1655, 1655 DNG	Yes	Yes	-	-	-	-	-	-	-	-	Yes	Yes
Amphibians																	
Litoria aurea	Green and Golden Bell Frog	E	V	S	1606, 1731, 1692, 1691	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Reptiles																	
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	1606, 1655, 1692, 1691	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes	Yes
Delma impar	Striped Legless Lizard	V	V	S	1606, 1655, 1692, 1693 DNG, 1691	-	-	-	-	-	-	-	-	Yes	Yes	Yes	Yes
Birds																	
Burhinus grallarius	Bush Stone-curlew	E	-	S	1606, 1655, 1692, 201, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	1606	Yes	-	-	-	-	-	-	-	-	Yes	Yes	Yes
Mammals																	
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	1606	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Planigale maculata	Common Planigale	V	-	S	1606, 1655, 1692, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phascolarctos cinereus	Koala	E	E	S	1606, 1655, 1691, 1692, 1693, 201	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	1606, 1655, 1692, 1691	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Relevant Associated PCT (DPE 2020a)	Survey Months for Each Species											
		BC Act	EPBC Act			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Petauroides volans	Greater Glider	-	V	S	1606	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Petaurus norfolcensis	Squirrel Glider	V	-	S	1606, 1655, 201, paddock trees in 1606 DNG, 1655 DNG and 201 DNG	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Myotis macropus	Southern Myotis	V	-	S	1691	Yes	Yes	Yes	-	-	-	-	-	-	Yes	Yes	Yes

Note: Months in which surveys for the species are to be conducted in accordance with the *Threatened Biodiversity Data Collection* (DPE 2022a) 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 June 2022). V = Vulnerable; E = Endangered; CE = Critically Endangered.

[2] Biodiversity credit class under the *Threatened Biodiversity Data Collection* (DPE 2022a) (current as at June 2022). E = Ecosystem; S = Species.

Table 12
Details of Targeted Surveys for Threatened Fauna

Common Name	Conservation Status[1]		Class of Credit[2]	Survey Details	Outcome of Survey
	BC Act	EPBC Act			
Amphibians					
Green and Golden Bell Frog	E	V	S	All dams/ponds identified in the EIS study area (encompassing the Modification area) were inspected and targeted searches were conducted at sites identified as potential habitat by Future Ecology (2019).	Species not present.
Reptiles					
Pale-headed Snake	V	-	S	Future Ecology (2019) conducted diurnal and nocturnal habitat searches as well as searches of suitable habitat (hollow trees) across the EIS study area (encompassing the Modification area).	Species not present.
Striped Legless Lizard	V	V	S	Future Ecology (2019) recorded one specimen 1 km southeast of the Maxwell Mine Entry Area and there have been 26 observations within the EIS study area (encompassing the Modification area).	Species present in the EIS study area. Potential habitat may be present within the Development Footprint.
Birds					
Bush Stone-curlew	E	-	S	Numerous nocturnal bird surveys incorporating call-playback and spotlighting were carried out by Future Ecology (2019) at various sites at various times of the year for this species.	Species not present.
Gang-gang Cockatoo	V	-	S/E	Future Ecology carried out numerous diurnal bird surveys throughout the EIS study area (encompassing the Modification area) from January to December 2018 including within the required seasonal survey periods for Gang-gang Cockatoo. Wherever suitable nesting hollows were detected, they were inspected for signs of nesting, feathers, etc.	Species not present.
Mammals					
Brush-tailed Phascogale	V	-	S	Future Ecology (2019) completed a total of 5,004 hair tube trap nights and 501 camera trap nights over the EIS study area (encompassing the Modification 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.	Species not present.

Common Name	Conservation Status[1]		Class of Credit[2]	Survey Details	Outcome of Survey
	BC Act	EPBC Act			
Common Planigale	V	-	S	As per Brush-tailed Phascogale. In addition, Future Ecology (2019) also completed a total of 400 Elliott A terrestrial trap nights.	Species not present.
Koala	E	E	S	Future Ecology (2019) completed numerous spotlighting and call-playback sessions across the EIS study area (encompassing the Modification area) from January to December 2018 including during the recommended target period between August and January. A total of 501 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. The methods are consistent with the *Koala (Phascolarctos cinereus): Biodiversity Assessment Method Survey Guide* (DPE, 2022f).	Species not present.
Eastern Pygmy-possum	V	-	S	As per Brush-tailed Phascogale. 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 (Future Ecology 2019).	Species not present.
Greater Glider	-	V	S	As per Brush-tailed Phascogale. In addition, Future Ecology (2019) also completed numerous call-playback surveys across the EIS study area (encompassing the Modification area) over the survey period.	Species not present.
Squirrel Glider	V	-	S	As per Brush-tailed Phascogale. In addition, Future Ecology (2019) also completed numerous call-playback surveys across the EIS study area (encompassing the Modification area) over the survey period. The Squirrel Glider was observed by Future Ecology (2019) (Attachment A) 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 modified Mine Entry Area (Figure 17). Numerous other records of the species also exist (Umwelt 2006, 2007; Cumberland Ecology 2009a, 2010; DPE 2022b).	Species present in the EIS study area. Potential habitat may be present within the Development Footprint.
Southern Myotis	V	-	S	Future Ecology (2019) completed harp trapping and acoustic recording next to dam/ponds at various sites across the EIS study area (encompassing the Modification area) and a mine dam (known as Savoy Dam). Culverts were inspected at two study sites (Future Ecology 2019). The Southern Myotis was observed by Future Ecology (2019) at a dam surrounded by PCT 1606 (both woodland and DNG forms present). It has been previously observed within the EIS study area (encompassing the Modification area) by others (DPE 2022a; Ecotone 2000; Cumberland Ecology 2012; Eco Logical Australia 2017).	Species present in the EIS study area. Potential habitat may be present within the Development Footprint.

Shaded species are not relevant to the Development Footprint.

4.4.1 Survey Results

Threatened Flora

Two threatened flora populations, *Acacia pendula* population in the Hunter Catchment and *Diuris tricolor* population in the Muswellbrook Local Government Area (LGA), were recorded in the vicinity of the proposed ventilation shaft surface development area (Figures 10 and 15), however the footprint of the Modification was altered to avoid potential impacts on these two species.

Diuris tricolor individuals were recorded directly adjacent to the proposed ventilation shaft access road (Figure 10). However, targeted surveys within the Development Footprint found that the species was absent in all areas of potential habitat, so a species polygon was not required.

Species polygons for the four threatened flora species that were assumed present are shown on Figure 16.

Threatened Fauna

The Pink-tailed Legless Lizard was previously identified as being relevant to the Project, however it was not recorded in the Development Footprint and no rocky habitat was present (Figure 17).

The following species credit fauna species were relevant to the Modification (Figures 18 to 20):

- 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 Development Footprint contains potential habitat for the Squirrel Glider, Striped Legless Lizard, and Southern Myotis. The Squirrel Glider has a biodiversity risk weighting of '2', the Striped Legless Lizard has a biodiversity risk weighting of '1.5', and the Southern Myotis has a biodiversity risk weighting of '2'. None of these species are Potential SAII Entities.

Striped Legless Lizard

One specimen of Striped Legless Lizard was recorded by Future Ecology (2019) (Attachment A) approximately 1 km south east of the MEA (Figure 18). A total of 26 observations of Striped Legless Lizard were recorded within the Project study area, 16 of which were live specimens and 10 were sloughs (shed skin). 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.

Squirrel Glider

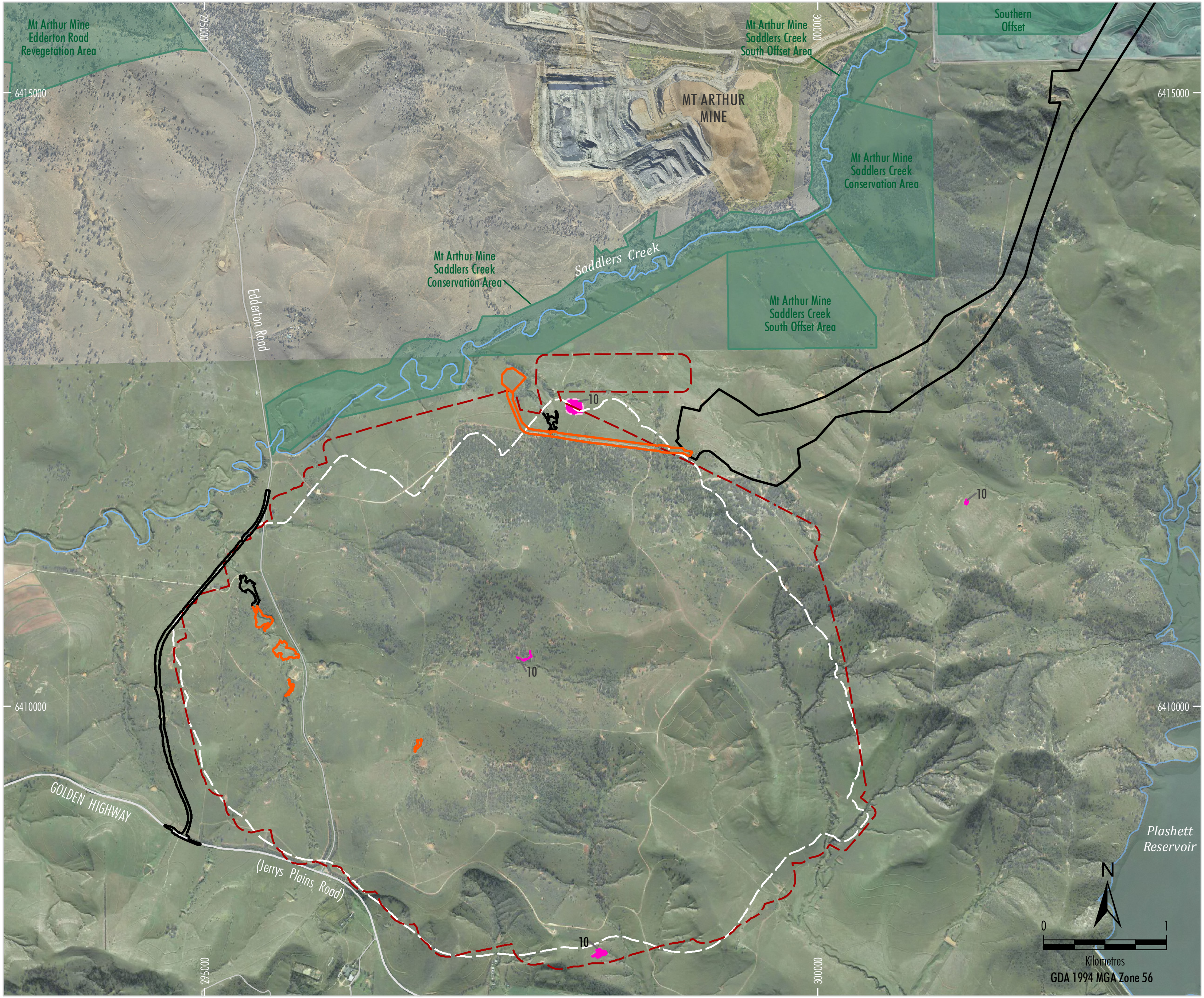
The Squirrel Glider was observed by Future Ecology (2019) (Attachment A) twice just outside of the Maxwell Underground to the east, twice in the north of the Maxwell Underground and twice (of one individual) just south of the MEA (as modified) (Figure 19). It is not clear how many other Squirrel Gliders have been recorded by other groups in the past, however this number is expected to be relatively high (Umwelt 2006, 2007; Cumberland Ecology 2009a, 2010; DPE 2022b). There have also been several observations of this species outside of the Project study area by other groups.

Southern Myotis

The Southern Myotis was observed by Future Ecology (2019) at a dam surrounded by PCT 1606 (both woodland and DNG forms present) (Figure 20). It has been previously observed within the Project study area by others (DPE 2022c; Ecotone 2000; Cumberland Ecology 2012; Eco Logical Australia 2017).

4.4.2 Species Polygons

Species Polygons were prepared by Future Ecology (2019) (Attachment A) as shown on Figures 15 to 20. The area of habitat in the Development Footprint is quantified in Table 13.



LEGEND

Approved Surface Development Area

Approved Extent of Conventional Subsidence (20 mm subsidence contour)

Modified Extent of Conventional Subsidence (20 mm subsidence contour)

Development Footprint

Existing Conservation/Offset Area

SPECIES POLYGON MAPPING

Grassy Woodlands

10 Weeping Myall Woodland (PCT116)

Acacia pendula Species Polygon

Reference:
Hunter Eco (2019, 2022)

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

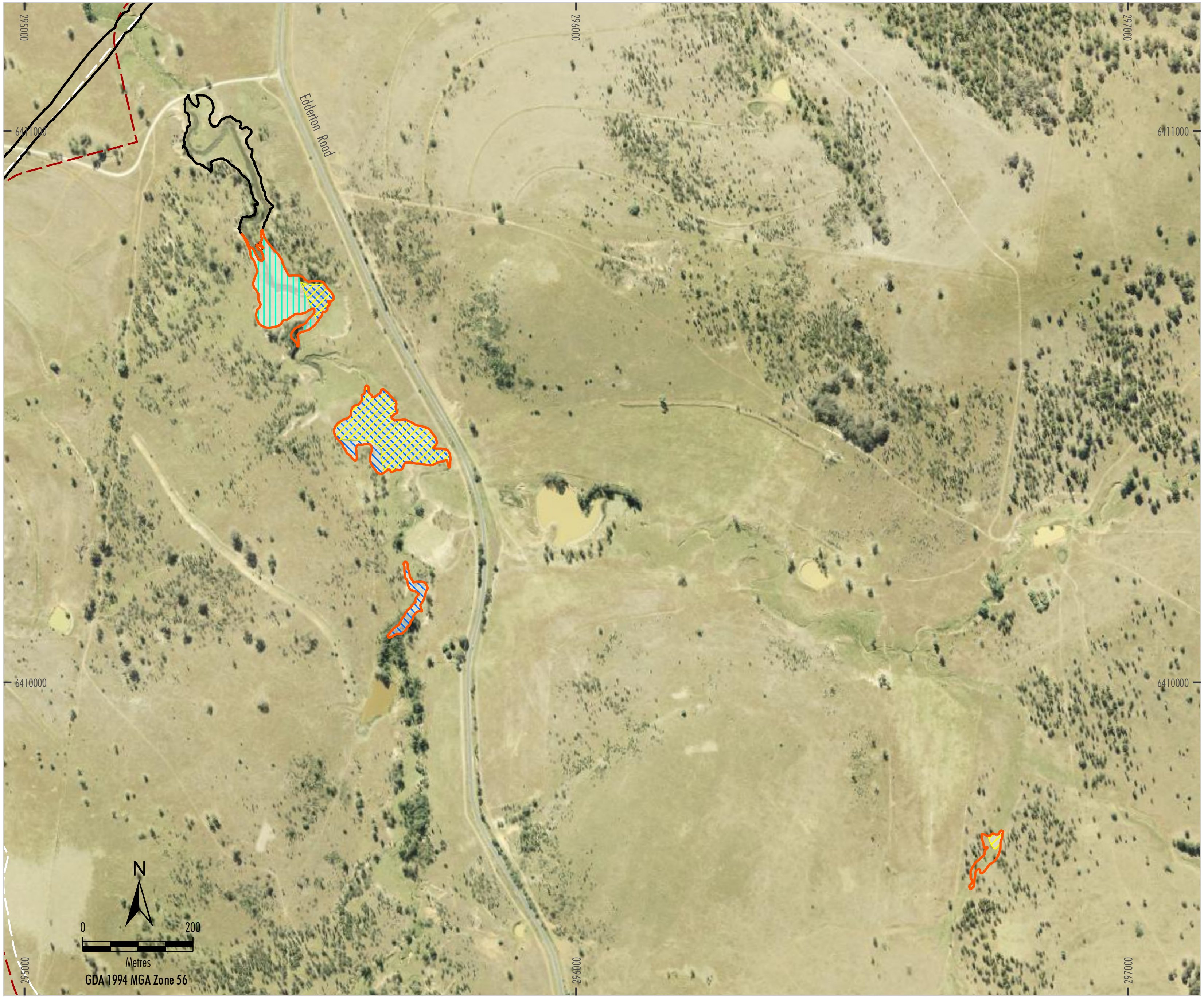
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Weeping Myall (*Acacia pendula* Population in the Hunter Catchment) Species Polygon

Figure 15

SHM-20-04 MOD LW_BDAR_212E



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
SPECIES POLYGON MAPPING
Thesium australe
Cryptostylis hunteriana
Pine Donkey Orchid and *Prasophyllum* sp. Wybong

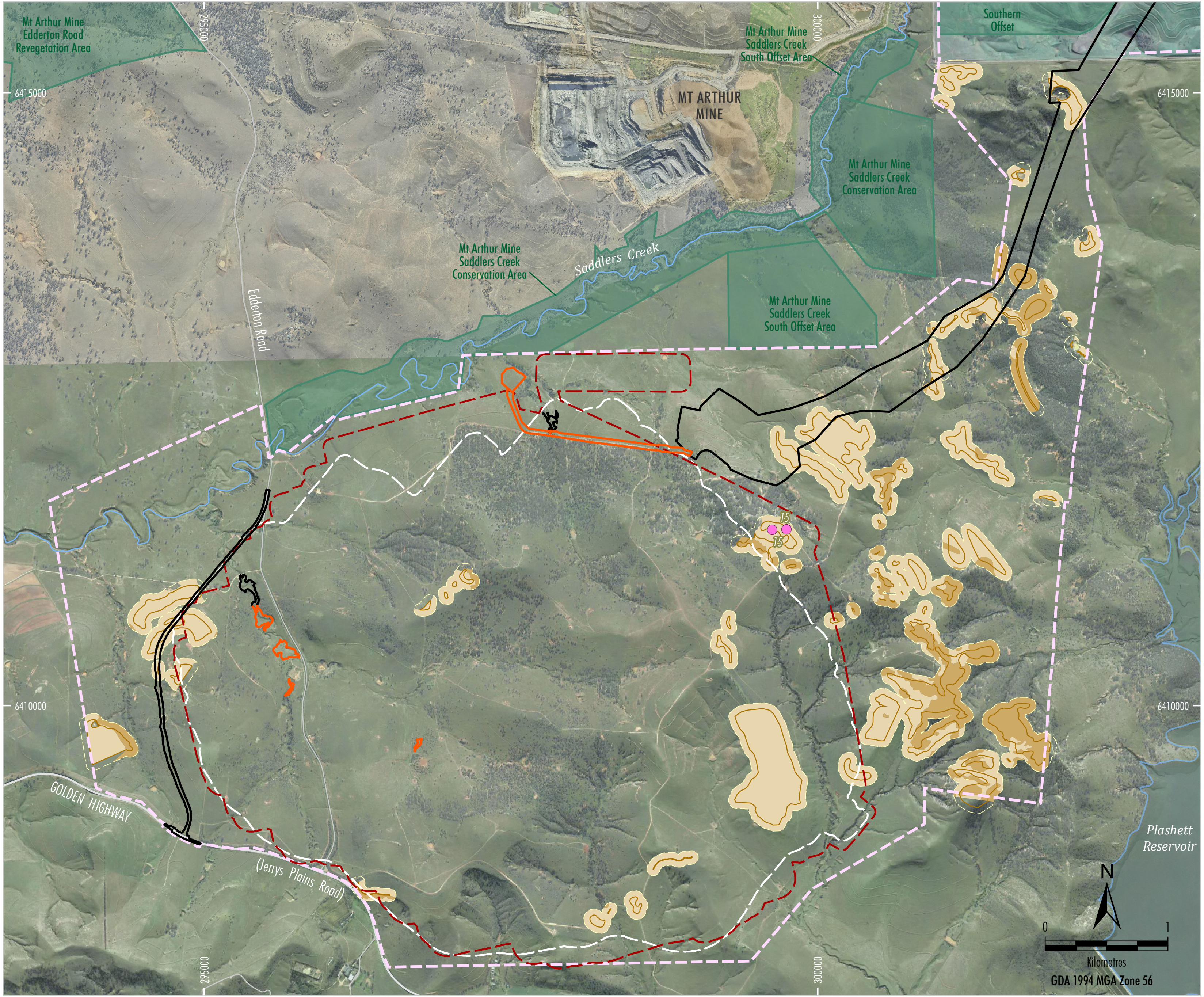
Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2020, 2019

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Flora Species Assumed Present
Species Polygons

Figure 16



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- Existing Conservation/Offset Area
- Ecology Study 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 Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

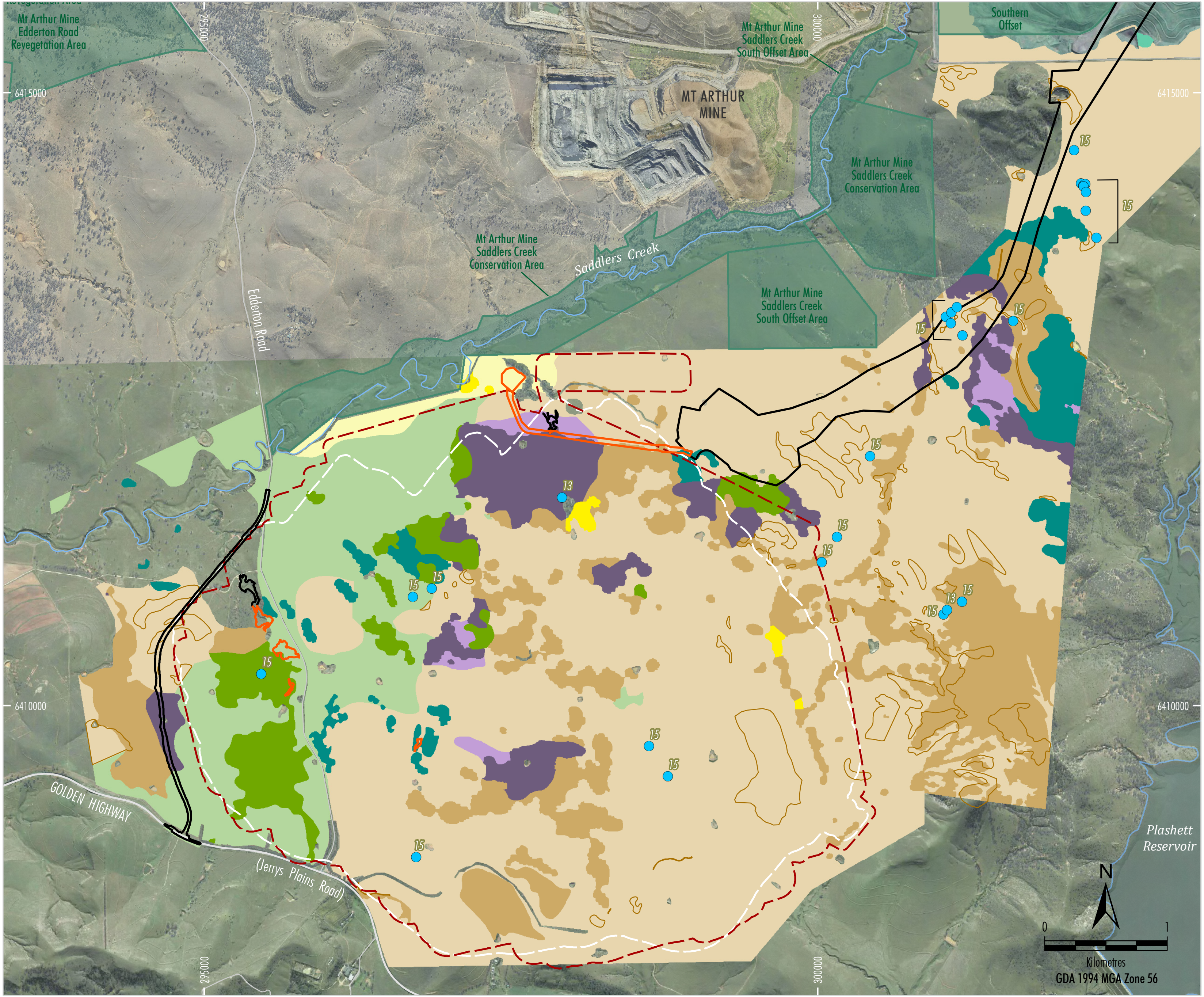
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Pink-tailed Legless Lizard
Species Polygon

Figure 17

SHM-20-04 MOD LW_BDAR_214D



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
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)

Other
Rocky Area

Reference:
13. DPE (2022)
15. Future Ecology (2019)
Note: There are no references 1 - 12 and 14 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

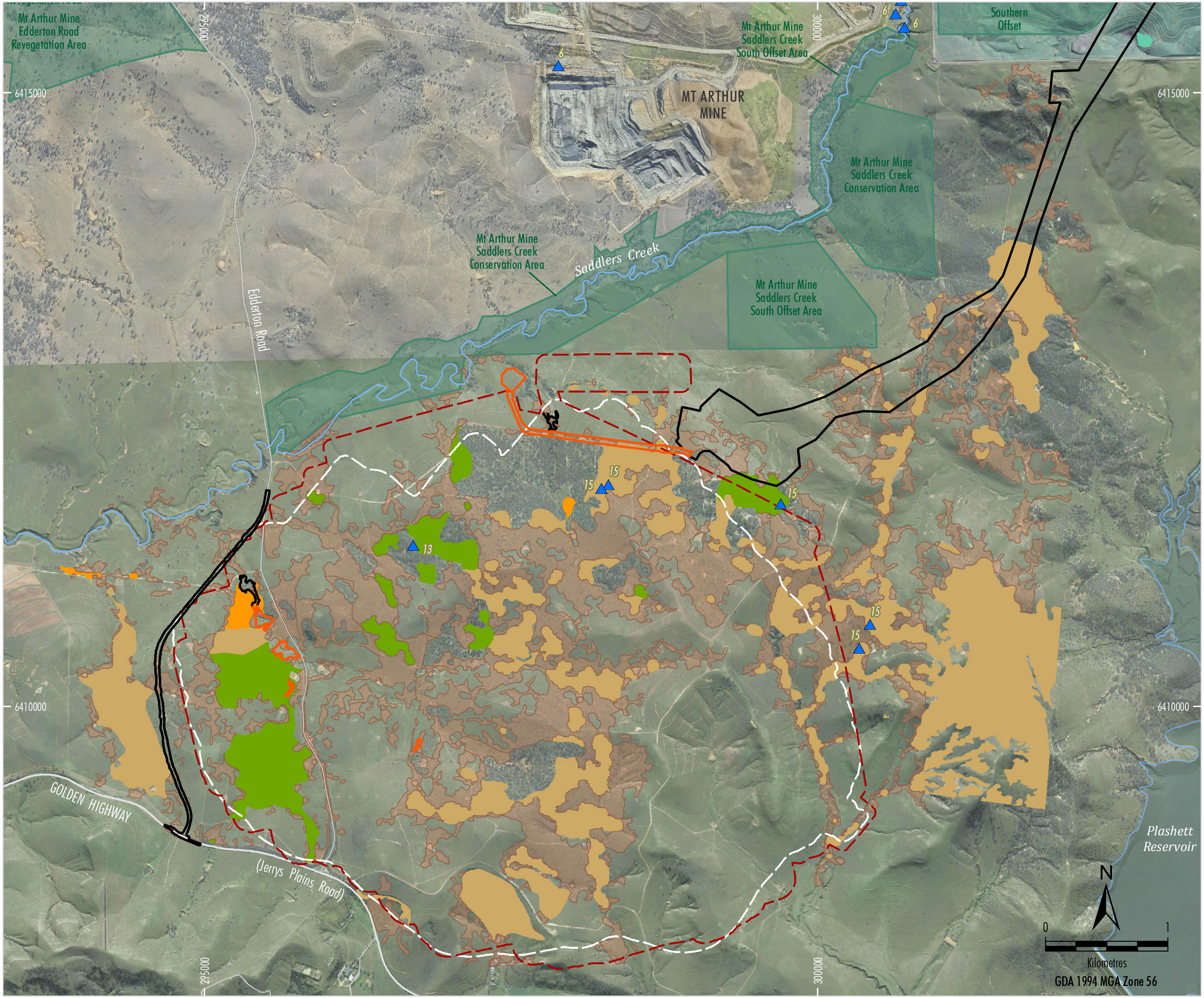
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Striped Legless Lizard Species Polygon

Figure 18

SHM-20-04 MOD LW_BDAR_215C



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
Existing Conservation/Offset Area
Threatened Species
Squirrel Glider
SPECIES POLYGON
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)
11. Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1604)
Other
Paddock Trees that may provide Potential Habitat

Reference:
6. Cumberland Ecology (2009a)
13. DPE (2022)
15. Future Ecology (2019)
Note: There are no references 1 - 5, 7 - 12 and 14 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

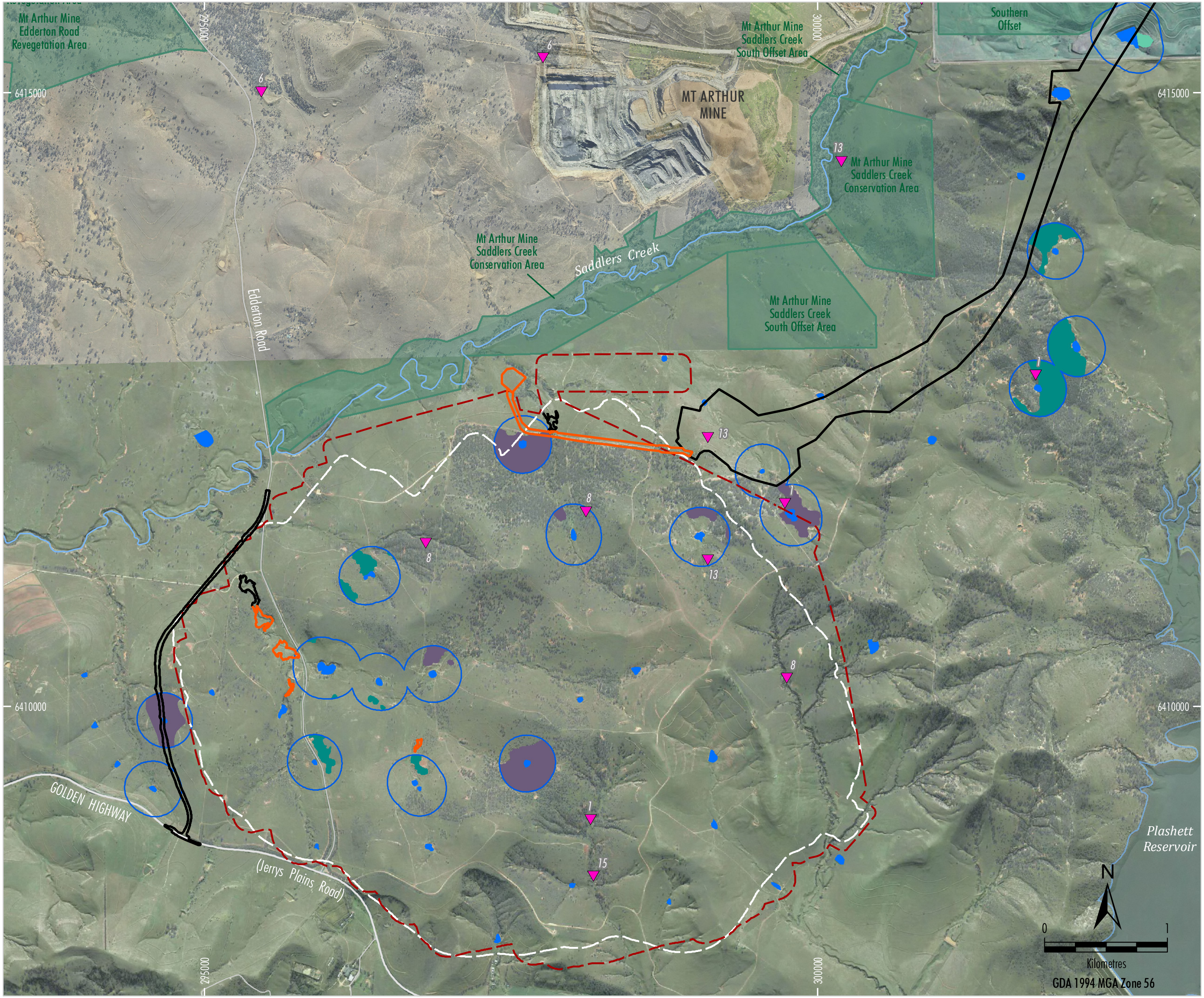
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Squirrel Glider Species Polygon

Figure 19

SHM-20-04 MOD LW_BDAR_216C



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- 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 (2015)
13. DPE (2022)
15. Future Ecology (2019)
Note: There are no references 2 - 5, 7, 9 - 12 and 14 on this figure.

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Southern Myotis Species Polygon

Figure 20

SHM-20-04 MOD LW_BDAR_217C

Table 13
Species Credit Species Area of Habitat

Generic Name	PCT	VI Score~	Area of Habitat (ha)							
			Pink-tailed Legless Lizard	Striped Legless Lizard	Squirrel Glider	Southern Myotis	Leafless Tongue Orchid (Assumed Present)	Pine Donkey Orchid (Assumed Present)	Tarengo Leek Orchid (Assumed Present)	Austral Toadflax (Assumed Present)
2. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606	1606	69.4	0	1.3[A]	1.3[A]	-	0	0	-	0
2a. White Box - Ironbark - Red Gum Shrubby Forest PCT 1606 (DNG)	1606	22.2	0	2.6[B]	1.1*[B]	-	0	0	-	0.1[B]
3. Slaty Box Shrubby Woodland PCT 1655	1655	19.5	0	0.5[C]	0.5[C]	-	0.5[C]	0	-	0
3a. Slaty Box Shrubby Woodland (DNG)	1655	11.5	0	1.7[D]	0.4*[D]	-	1.7[D]	0	-	1.7[D]
6. Bull Oak Grassy Woodland PCT 1692	1692	58.7	0	0.6[E]	-	-	-	-	-	-
7a. Yellow Box - Apple Grassy Woodland (DNG)	1693	29	0	2.5	-	-	-	0	0	-
8. Fuzzy Box Woodland PCT 201	201	74.8	0	-	0.2[F]	-	-	0.2[F]	0.2[F]	-
8a. Fuzzy Box Woodland PCT 201 (DNG)	201	28.4	0	-	0.3*[G]	-	-	1[G]	1[G]	-
9. Ironbark - Grey Box Grassy Woodland PCT 1691	1691	59	0	1.2	-	0.3[#]	-	0	0	-
9a. Ironbark - Grey Box Grassy Woodland PCT 1691 (DNG)	1691	34	0	1.7	-	-	-	0	0	-
		Total	**0**	**12.1**	**3.8**	**0.3[#]**	**2.2**	**1.2**	**1.2**	**1.8**

~ Vegetation Integrity Score – refer to Table 6.
* Area covered by paddock trees.
[A] Approximately 0.1 ha of PCT1606 is associated with potential subsidence ponding impacts (Figure 8b).
[B] Approximately 0.1 ha of PCT1606 DNG is associated with potential subsidence ponding impacts (Figure 8b).
[C] PCT1655 is associated with potential subsidence ponding impacts (Figure 8b).
[D] PCT1655 DNG is associated with potential subsidence ponding impacts (Figure 8b).
[E] Approximately 0.2 ha of PCT1692 is associated with potential subsidence ponding impacts (Figure 8b).
[F] PCT201 is associated with potential subsidence ponding impacts (Figure 8b).
[G] PCT201 DNG is associated with potential subsidence ponding impacts (Figure 8b).

5 PRESCRIBED BIODIVERSITY IMPACT ENTITIES

Prescribed biodiversity impact entities are discussed below.

5.1 KARSTS, CAVES, CREVICES, CLIFFS, ROCKS AND OTHER GEOLOGICAL FEATURES

There are no karsts, caves, crevices or cliffs that provide habitat for threatened species in the Development Footprint.

5.2 HUMAN MADE STRUCTURES AND NON-NATIVE VEGETATION

There are no human made structures that provide habitat for threatened species in the Development Footprint. There are no areas of non-native vegetation that provide habitat for threatened species in the Development Footprint.

5.3 HABITAT CORRIDORS OR LINKAGES

No defined habitat corridors or linkages would be impacted. It is recognised that the derived native grassland may provide habitat linkages for some species (e.g. Striped Legless Lizard) (Section 7.3.4).

5.4 WATERBODIES OR HYDROLOGICAL PROCESSES THAT SUSTAIN THREATENED SPECIES

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

A Groundwater Review has been prepared by SLR (2022) to assess and update groundwater modelling and predictions based on the modified longwalls in the Woodlands Hill, Arrowfield and Bowfield Seams. The Project groundwater assessment (HydroSimulations 2019) showed 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 hundreds 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). Groundwater model predictions by SLR (2022) concluded that the Modification is not expected to cause a material increase in drawdown in the Saddlers Creek and Saltwater Creek Alluvium, while it would result in a lesser impact on deeper strata beneath the Hunter River relative to the approved Project (SLR 2022). Consistent with HydroSimulations (2019) assessment for the approved Project, SLR (2022) also found that stream baseflow would not be affected by this drawdown in the alluvium. In other words, the groundwater drawdown associated with the proposed Modified Project would not materially impact surface water flow in either creek.

As described in Section 7.2.19, it is unlikely that the Project predicted drawdown would adversely impact the Swamp Oak along either Saddlers or Saltwater Creeks.

Consistent with the approved Project, the modified longwall layout has been located and designed to minimise subsidence impacts and to avoid or minimise impacts on water resources.

5.5 THREATENED SPECIES AT RISK FROM VEHICLE STRIKE

The Modification involves repositioning of the upcast ventilation shaft site and associated infrastructure (including an access road and services corridor approximately 1.7 km in length and an average width of 40 m). The risk on threatened species from vehicle strike is discussed in Section 7.3.8.

6 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 ML 1822. 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 as described in the *Maxwell Project – Biodiversity Development Assessment Report* (Hunter Eco, 2019).

The extension to the MEA, the clean water diversion bank and the water treatment facility associated with Modification 1 involved some additional disturbance of derived native grassland (Box-Gum TEC) but avoided woodland/forest vegetation communities.

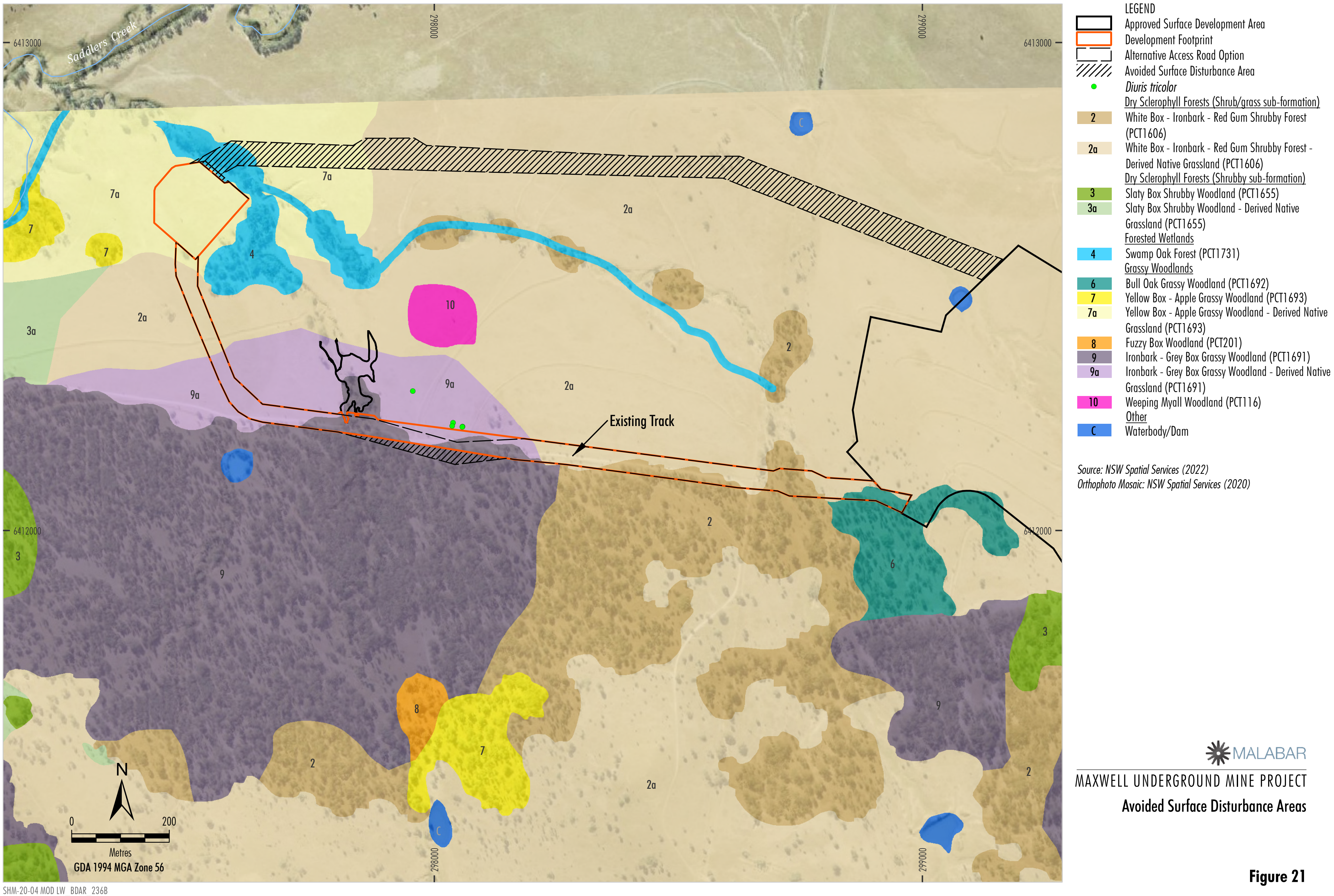
The upcast ventilation shaft site was originally proposed to be located in the MEA. As shown on Figure 21, the location of the repositioned ventilation shaft and associated infrastructure has been selected to:

- Make use of an existing access track for the access road corridor;
- Avoid a known population of Weeping Myall (*Acacia pendula*) recorded in the derived native grassland habitat north of the proposed access road;
- Avoid known locations of Pine Donkey Orchid (*Diuris tricolor*) individuals recorded in the derived native grassland habitat adjacent to the proposed access road;
- Avoid the clearance of woodland areas represented by PCTs 1693 and 1731; and
- Minimise the clearance of woodland areas represented by PCTs 1606 and 1691 which cannot be completely avoided due to the location of the existing access track.

Malabar considered two alternative access road alignments (Figure 21) but these were discounted on the basis that they would involve clearance of additional woodland vegetation (including riparian vegetation associated with a tributary of Saddlers Creek).

The clearance of Box-Gum TEC for the Modification is unavoidable, as it covers a large area surrounding the Project surface facilities such that the Modification could not be moved in a way that would avoid or reduce the amount lost. However, the proposed ventilation shaft surface development area is predominantly located in derived grassland, and minimises the need to clear woodland and natural drainage lines.

There are no alternative modes or technologies relevant to the Modification.


Saddlers Creek
6413000
298000
299000
6412000
7a
7
4
2a
3a
9a
10
2
3
9
6
8
C
Existing Track
N
0
200
Metres
GDA 1994 MGA Zone 56
LEGEND
Approved Surface Development Area
Development Footprint
Alternative Access Road Option
Avoided Surface Disturbance Area
Diuris tricolor
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)
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)
9 Ironbark - Grey Box Grassy Woodland (PCT1691)
9a Ironbark - Grey Box Grassy Woodland - Derived Native Grassland (PCT1691)
10 Weeping Myall Woodland (PCT116)
Other
C Waterbody/Dam
Source: NSW Spatial Services (2022)
Orthophoto Mosaic: NSW Spatial Services (2020)
MALABAR
MAXWELL UNDERGROUND MINE PROJECT
Avoided Surface Disturbance Areas
Figure 21
SHM-20-04 MOD LW_BDAR_236B

7 EVALUATION OF POTENTIAL IMPACTS

7.1 DIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

7.1.1 Clearance of Native Vegetation

After applying the measures to avoid and/or minimise impacts on biodiversity values (Section 6), the Modification would result in the direct clearance of approximately 9.5 ha of native vegetation within the Development Footprint (Table 14). When the additional ponding impact area (3.8 ha) is also included, the total amount of native vegetation to be disturbed for the Modification is 13.3 ha, in addition to the native vegetation approved to be disturbed by the Project (i.e. 166 ha). Ponding impacts are further described in Section 7.2.1.

Threatened species associated with the Development Footprint are discussed in Section 4.

The clearance areas associated with the 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 (Figure 22). 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.

Table 14 presents the total native vegetation to be cleared for the Modification. Representative photos of each vegetation zone are shown on Plates 1 to 6.

7.1.2 Clearance of Threatened Ecological Communities

Table 15 summarises the amount of clearance associated with TECs.

7.1.3 Clearance of Threatened Species Habitat

Table 13 (above) provides details of the species credit species habitat to be cleared by the Project.

7.1.4 Cumulative Impacts

As described in the *Maxwell Underground Mine Project – Mine Entry Area Modification - Biodiversity Development Assessment Report* (Hunter Eco 2021), the surface development for the Project would involve direct disturbance of approximately 26.2 ha of fragmented native woodland/forest and 139.8 ha of derived native grassland, including areas that would be impacted from ponding within the Maxwell Underground area. The total amount of native vegetation to be disturbed for the Project (prior to this Modification) is approximately 166 ha.

The Modification is assessed under the BAM (DPIE 2020) and would require a biodiversity offset resulting in no net loss in biodiversity, the same as was required for the approved Project and Modification 1. The biodiversity offset is required to be a greater area of land, multiple times the size of the Development Footprint, which will be conserved and managed to achieve a gain in biodiversity values.

Table 14
Native Vegetation Clearance Summary

Vegetation Zone	PCT	Generic Name (Attachment A)	Area (ha)#	Percent Cleared ^	Before development				After development				Change
					Composition	Structure	Function	VI score	Composition	Structure	Function	VI score	Change in VI score
2	1606	2. White Box – Ironbark – Red Gum Shrubby Forest	1.2[1]	29%	74.8	61.3	72.7	69.4	0	0	0	0	69.4
2a	1606	2a. White Box – Ironbark – Red Gum Shrubby Forest (DNG)	2.5[1]	29%	28.3	25.6	15	22.2	0	0	0	0	22.2
6	1692	6. Bull Oak Grassy Woodland	0.4*	53%	75.6	56.7	47.3	58.7	0	0	0	0	58.7
7a	1693	7a. Yellow Box – Apple Grassy Woodland (DNG)	2.5[1]	64%	26.8	60.7	15	29	0	0	0	0	29
9	1691	9. Ironbark – Grey Box Grassy Woodland	1.2[2]	77%	60.3	76.5	44.5	59	0	0	0	0	59
9a	1691	9a. Ironbark – Grey Box Grassy Woodland (DNG)	1.7	77%	62.7	41.7	15	34	0	0	0	0	34
		Total Woodland/Forest	2.8	-	-	-	-	-	-	-	-	-	-
		Total Derived Native Grassland	6.7	-	-	-	-	-	-	-	-	-	-
		Total	9.5	-	-	-	-	-	-	-	-	-	-

Area associated with direct clearance for the Modification.

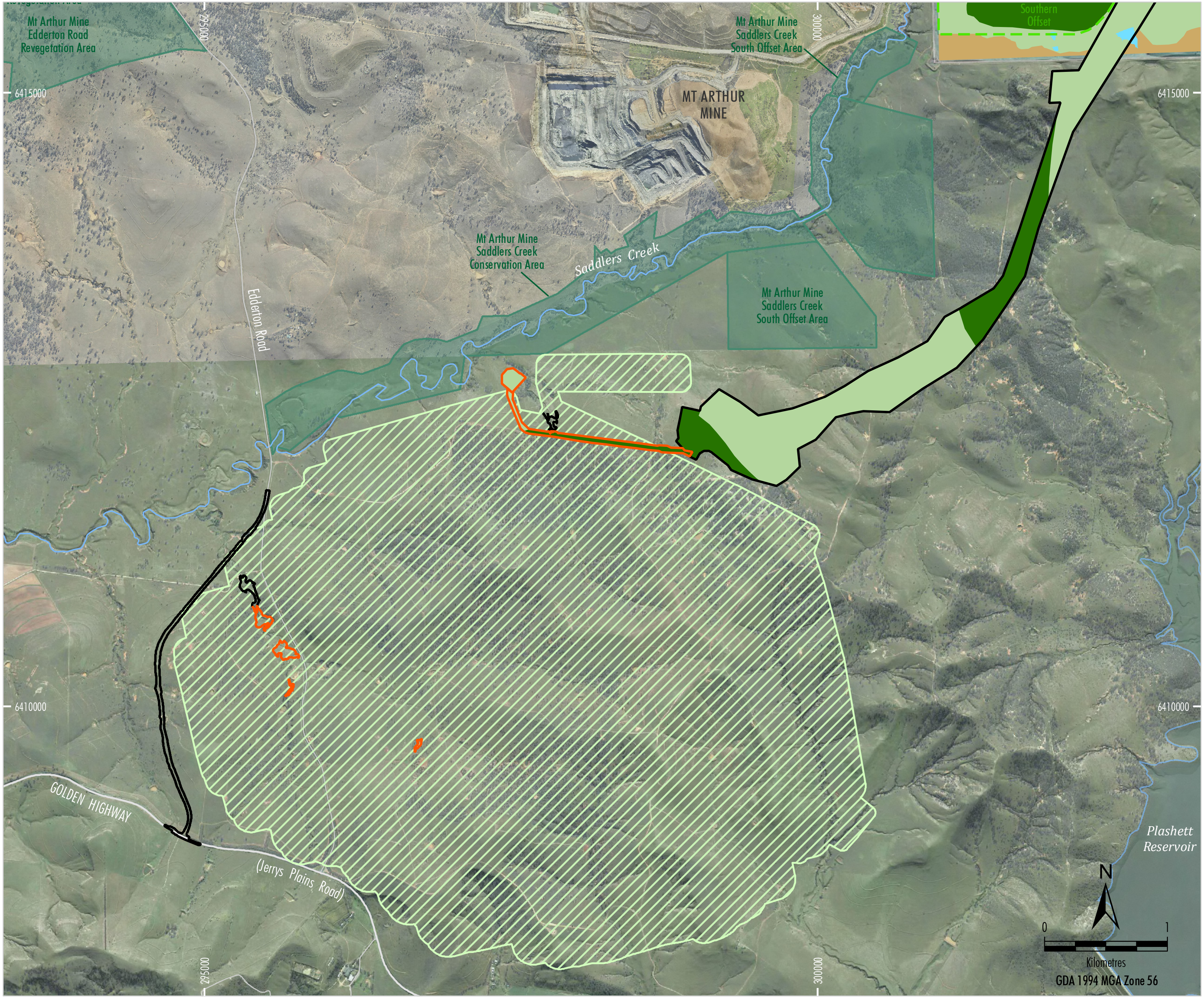
1 Listed BC Act, CE: White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; Listed 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.

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

~ BAM Credit Calculator.

^ DPE (2022b)



LEGEND

- Approved Surface Development Area
- 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

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

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Rehabilitation Domains

Figure 22

SHM-20-04 MOD LW_BDAR_235B

Plate 1 Vegetation Community 2. White Box - Ironbark - Red Gum Shrubby Forest

Plate 2 Vegetation Community 2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)

Plate 3 Vegetation Community 6. Bull Oak Grassy Woodland

Plate 4 Vegetation Community 7a. Yellow Box - Apple Grassy Woodland (DNG)

Plate 5 Vegetation Community 9. Ironbark - Grey Box Grassy Woodland

Plate 6 Vegetation Community 9a. Ironbark - Grey Box Grassy Woodland (DNG)

Table 15
Threatened Ecological Community Clearance Summary

Threatened Ecological Community	Conservation Status*	Associated PCT	Clearance Area	Ponding Impacts	Total Impact
Threatened Ecological Communities listed under the BC Act					
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	CE	1606, 1693	6.2	0.2	6.4 (comprising 1.3 ha of woodland and 5.1 ha of DNG)
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion listed under the BC Act	V	1655	-	0.5 (woodland)	0.5 (woodland)
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions listed under the BC Act	E	1691	1.2 (woodland)	-	1.2 (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, 1693	6.2	0.2	6.4 (comprising 1.3 ha of woodland and 5.1 ha of DNG)
Central Hunter Valley eucalypt forest and woodland	CE	1691, 1655	1.2 (woodland)	0.5 (woodland)	1.7 (woodland)

* Threatened ecological community status under the BC Act and EPBC Act (current as at June 2022).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

7.2 INDIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

Native vegetation adjacent to the Development Footprint is shown on Figure 7 and threatened fauna records adjacent to the Development Footprint are shown on Figure 10. Potential indirect impacts on habitat and vegetation listed in the BAM (DPIE 2020) are assessed below in relation to the Modification.

7.2.1 Potential Subsidence Impacts

The approved extent of predicted conventional subsidence relative to native vegetation is shown on Figure 7 and is based on the predicted 20 millimetres (mm) subsidence contour in MSEC (2019). Figure 7 also shows the extent of predicted conventional subsidence from the Modification (MSEC 2022). The native vegetation within the approved and modified subsidence area is quantified in Table 16. An additional 185.5 ha of native vegetation is within the additional subsidence area.

Table 16
Native Vegetation within the Subsidence Area

PCT	Generic Name	Subsidence Area (ha)		
		Original Approved Project	Proposed Modified Project	Difference
Dry Sclerophyll Forests (Shrub/grass sub-formation)				
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	207.1	218.3	+11.2
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	1,025	1,107.6	+82.6
Dry Sclerophyll Forests (Shrubby sub-formation)				
1655	3. Slaty Box Shrubby Woodland[2]	103.8	111.8	+8
1655	3a. Slaty Box Shrubby Woodland (DNG)	247.3	299.8	+52.5
Grassy Woodlands				
1692	6. Bull Oak Grassy Woodland[3]	35	34.9	-0.1
1693	7. Yellow Box – Apple Grassy Woodland[1]	7.4	7.4	0
1693	7a. Yellow Box – Apple Grassy Woodland (DNG)[1]	-	9.2	+9.2
201	8. Fuzzy Box Woodland	7.7	8.3	+0.6
201	8a. Fuzzy Box Woodland (DNG)	17.9	17.2	-0.7
1691	9. Ironbark - Grey Box Grassy Woodland[4]	115.8	128.9	+13.1
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	17.3	22.1	+4.8
116	10. Weeping Myall Woodland[5]	0.4	1.8	+1.4
Forested Wetlands				
1731	4. Swamp Oak Forest	<0.1	2.3	+2.3
Other				
N/A	Planted Trees	7.3	7.9	+0.6
	Total Native Vegetation	**1,784.7**	**1,969.6**	**+184.9**
	Total Other	**7.3**	**7.9**	**+0.6**
	Total Subsidence Area	**1,792**	**1,977.5**	**+185.5**

Note: The area of waterbodies (e.g. dams), infrastructure and cleared land is not included in the total subsidence area.

1 Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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 (2022) using the Incremental Profile Method (IPM), which is consistent with the method applied in MSEC (2019) for the approved Project. The IPM was calibrated for local single-seam and multi-seam mining (including bord and pillar mining), along with the geological conditions for the Project, as discussed in the EIS Subsidence Assessment (MSEC, 2019). In relation to the subsidence prediction methodology, the subsidence peer reviewer for the EIS, Professor Bruce Hebblewhite, noted:

> *"It is noted that much of the Study Area is agricultural land with relatively few sensitive features that could be adversely impacted by the subsidence effects discussed. To this extent, the application of the MSEC IPM prediction methodology is considered to provide reasonable levels of confidence for subsidence prediction and impact assessment, given that "worst-case" scenarios have been adopted in the cases where greatest uncertainty exists."*

The maximum predicted total vertical subsidence, based on the modified underground mining layout, is greater than the maximum predicted value based on the approved Project. However, the potential for impacts does not result from absolute vertical subsidence but rather from the differential movements (i.e. tilt, curvature and strain) (MSEC 2022). The surface area located within the limit of predicted vertical subsidence is 1,989 ha based on the modified underground mining layout and 1,805 ha based on the approved Project. The surface area within the limit of vertical subsidence therefore increases by 184 ha due to the Modification; however, this represents a change of only approximately 10% (MSEC 2022).

Consistent with the approved Project, subsidence movements for the modified underground mining layout 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 (2022) 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 (as modified) can be reasonably estimated and assessed based on experience and monitoring results from similar underground mining operations elsewhere in the Hunter Valley.

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 (as modified) 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 *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b).

Overall, consistent with the approved Project, subsidence from the modified underground mining layout 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.

Potential Subsidence Ponding Impacts

Approximately 2 ha of the approved extent of predicted conventional subsidence was included as 'clearance' in the *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) to account for potential subsidence ponding impacts. Due to the Modification, an additional 3.8 ha of vegetation is associated with potential subsidence ponding impacts within the extent of predicted conventional subsidence (Section 1.3 and Figure 4). The vegetation within the potential ponding areas is shown on Figure 8b and quantified in Table 17.

Table 17
Native Vegetation Within Potential Ponding Areas

PCT	Generic Name	Potential Ponding Area (ha)		
		Original Approved Project	Proposed Modified Project	Difference
Dry Sclerophyll Forests (Shrub/grass sub-formation)				
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	0	0.1	+0.1
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	<0.1	<0.2	+0.1
Dry Sclerophyll Forests (Shrubby sub-formation)				
1655	3. Slaty Box Shrubby Woodland[2]	0	0.5	+0.5
1655	3a. Slaty Box Shrubby Woodland (DNG)	0	1.7	+1.7
Grassy Woodlands				
1692	6. Bull Oak Grassy Woodland[3]	0	0.2	+0.2
201	8. Fuzzy Box Woodland	0.5	0.7	+0.2
201	8a. Fuzzy Box Woodland (DNG)	1	2	+1
1691	9. Ironbark - Grey Box Grassy Woodland[4]	<0.3	<0.3	+0
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	<0.3	<0.3	+0
	Total Woodland	**0.7**	**1.7**	**+1**
	Total DNG	**1.3**	**4.1**	**+2.8**
	Total	**2**	**5.8**	**+3.8**

1 Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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 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.

Threatened Ecological Communities

Threatened ecological communities within the subsidence area are quantified in Table 18. As described above, subsidence is unlikely to materially impact native vegetation, including these TECs.

Table 18
Threatened Ecological Communities within the Subsidence Area

Threatened Ecological Community	Conservation Status	Subsidence Area (ha)		
		Original Approved Project	Proposed Modified Project	Difference
Listed under the BC Act				
White Box Yellow Box Blakely's Red Gum Woodland	E	1,239.5 (comprising 214.5 ha of woodland and 1,025 ha of DNG)	1,342.5 (comprising 225.7 ha of woodland and 1,116.8 ha of DNG)	+103 (+11.2 ha of woodland and +91.8 ha of DNG)
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	103.8 (woodland)	111.8 (woodland)	+8
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	115.8 (woodland)	182.6 (comprising 160.5 ha of woodland and 22.1 ha of DNG)	+66.8 (+44.7 ha of woodland and +22.1 ha of DNG)
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	CE	0.4 (woodland)	1.8 (woodland)	+1.4 (woodland)
	Subtotal	**1,459.5**	**1,638.7**	**+179.2**
Listed under the EPBC Act				
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	1,239.5 (comprising 214.5 ha of woodland and 1,025 ha of DNG)	1,342.5 (comprising 225.7 ha of woodland and 1,116.8 ha of DNG)	+103 (+11.2 ha of woodland and +91.8 ha of DNG)
Central Hunter Valley Eucalypt Forest and Woodland	CE	231.6[#] (woodland)	240.7 (woodland)	+9.1 (woodland)
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	CE	0.4 (woodland)	1.8 (woodland)	+1.4 (woodland)
	Subtotal	**1,471.5**	**1,585**	**+113.5**

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

Threatened Flora Species and Populations

The following three threatened flora species/populations were identified within the approved extent of predicted conventional subsidence (Figure 10):

- Tiger Orchid (*Cymbidium canaliculatum* – endangered population);
- Pine Donkey Orchid (*Diuris tricolor*);
- Acacia pendula population in the Hunter catchment (*Acacia pendula* – endangered population)

None of these threatened flora species/populations occur within an area modelled to experience ponding and it is unlikely that subsidence would affect the viability of these plants.

The Project is likely to have a positive impact on *Acacia pendula and Diuris tricolor* because Malabar has erected a livestock proof fence around a 20 m buffer from the previously recorded occurrences in the approved extent of predicted conventional subsidence. A livestock proof fence would also be established around the *Diuris tricolor* records newly recorded by Hunter Eco. The area would be signed 'Environmental Protection Area'.

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.

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 are warranted (e.g. without machinery). The review would consider, among other factors, mapped rocky areas that may provide habitat for threatened lizards.

7.2.2 Inadvertent Impacts on Adjacent Habitat or Vegetation

As described in the *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b), a vegetation clearance protocol would be adopted (Section 8) to minimise the risk of inadvertent impacts on adjacent habitat or native vegetation in the short-term during construction or operation of the Project (and Modification).

7.2.3 Impacts on Adjacent Habitat or Vegetation from a Change in Land Use Pattern (Increased Human Activity)

No adverse impacts are likely on habitat and vegetation adjacent to the Development Footprint as the Modification would not increase human activity in the locality.

7.2.4 Reduced Viability of Adjacent Habitat Due to Edge Effects

There would be no material edge effects from the proposed ventilation shaft relocation. There would be a slight increase in the native vegetation that would be adjacent to the proposed Modified Project (compared to the approved surface development area). However, the viability of the adjacent habitat is unlikely to be reduced due to edge effects because the adjacent habitat is either derived native grassland or fragmented woodland.

7.2.5 Reduced Viability of Adjacent Habitat Due to Noise, Dust or Light Spill

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that 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 generated as a result of the Project. 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.

The Modification would not significantly increase night-lighting in relation to the approved Project. Modelling by Todoroski Air Sciences (2022) and RWDI (2022) confirms that the scale of dust and noise-generating activities would not materially increase compared to the activities assessed for the Project. For example, the site access road would be sealed, and dust suppression would occur along the site access road, prior to it being sealed.

7.2.6 Transport of Weeds and Pathogens from the Site to Adjacent Vegetation

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that weeds are relatively evenly distributed across the wider area which means that it is unlikely that there would be any dispersal of weeds from the Project 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. The Modification is unlikely to increase the risk of weeds or pathogens transporting from the site to adjacent vegetation.

7.2.7 Increased Risk of Fauna Starvation, Exposure and Loss of Shade or Shelter

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that sufficient connectivity would remain around the Development Footprint such that no fauna are likely to become isolated as a result of the Project. The Modification would not increase the risk of fauna becoming isolated and subject to starvation, exposure and loss of shade or shelter.

7.2.8 Loss of Breeding Habitats

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that the Project is not likely to indirectly impact fauna breeding habitat resources (such as trees with hollows and bush rock). Similarly, the Modification is unlikely to indirectly impact fauna breeding habitat resources.

7.2.9 Trampling of Threatened Flora Species

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that no threatened flora species have been located in areas at risk of trampling during construction or operation of the Project. A number of Pine Donkey Orchid individuals have been recorded in close proximity to the proposed ventilation shaft access road (Figure 15), however the plants have been flagged and the road would be located so as to avoid impacts on any individuals. A livestock proof fence would also be established around the Diuris tricolor records newly recorded by Hunter Eco. The area would be signed 'Environmental Protection Area'.

7.2.10 Inhibition of Nitrogen Fixation and Increased Soil Salinity

The Project (and proposed Modified Project) would not inhibit nitrogen fixation or increase soil salinity.

7.2.11 Fertiliser Drift

The Project (and proposed Modified 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 fertiliser) would continue on Malabar-owned properties irrespective of the Project (and proposed Modified Project).

7.2.12 Rubbish Dumping

The Project (and proposed Modified Project) would not involve rubbish dumping. Rubbish generated by the Project (and proposed Modified Project) would be disposed of appropriately in designated areas.

7.2.13 Wood Collection

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

7.2.14 Bush Rock Removal and Disturbance

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

7.2.15 Increase in Predatory Species Populations

The Project (and proposed Modified Project) is unlikely to increase predatory species populations (such as Cat and Red Fox). Agricultural activities would continue to occur in the vicinity of the Project area (and proposed Modified Project), including control of pest animal populations.

7.2.16 Increase in Pest Animal Populations

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) describes that the Project is unlikely to increase pest animal populations. The Project (and proposed Modified Project) would continue pest management activities (e.g. wild dogs and rabbits).

7.2.17 Increased Risk of Fire

The Project (and proposed Modified Project) is 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.

7.2.18 Disturbance to Specialist Breeding and Foraging Habitat

The BAM (DPIE 2020) 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 Development Footprint.

7.2.19 Groundwater Dependent Vegetation

A Groundwater Review has been prepared by SLR (2022) to assess and update groundwater modelling and predictions based on the modified longwalls in the Woodlands Hill, Arrowfield and Bowfield Seams. The Project groundwater assessment (HydroSimulations 2019) showed that the alluvium under Saddlers and Saltwater Creeks receives water from the pressurised underlying coal seam, and that mining of the coal was 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 model predictions by SLR (2022) concluded that the Modification would not cause a material increase in drawdown in the Saddlers Creek and Saltwater Creek Alluvium.

Vegetation within the extent of predicted alluvial drawdown is shown on Figure 23 for the approved Project and Figure 24 for the proposed Modified Project.

Consistent with HydroSimulations (2019) assessment for the approved Project, SLR (2022) also found that stream baseflow (and surface water flow) would not be affected by the predicted groundwater drawdown in the alluvium associated with the Modification. Consequently, it is unlikely that the Modification would adversely impact the Swamp Oak along either Saddlers or Saltwater Creeks.

7.3 PRESCRIBED BIODIVERSITY IMPACTS

7.3.1 Karsts, Caves, Crevices, Cliffs, Rocks and Other Geological Features

As described in Section 2.7, there are no karsts, caves, cliffs or other areas of geological significance on, or in the vicinity of, the Development Footprint.

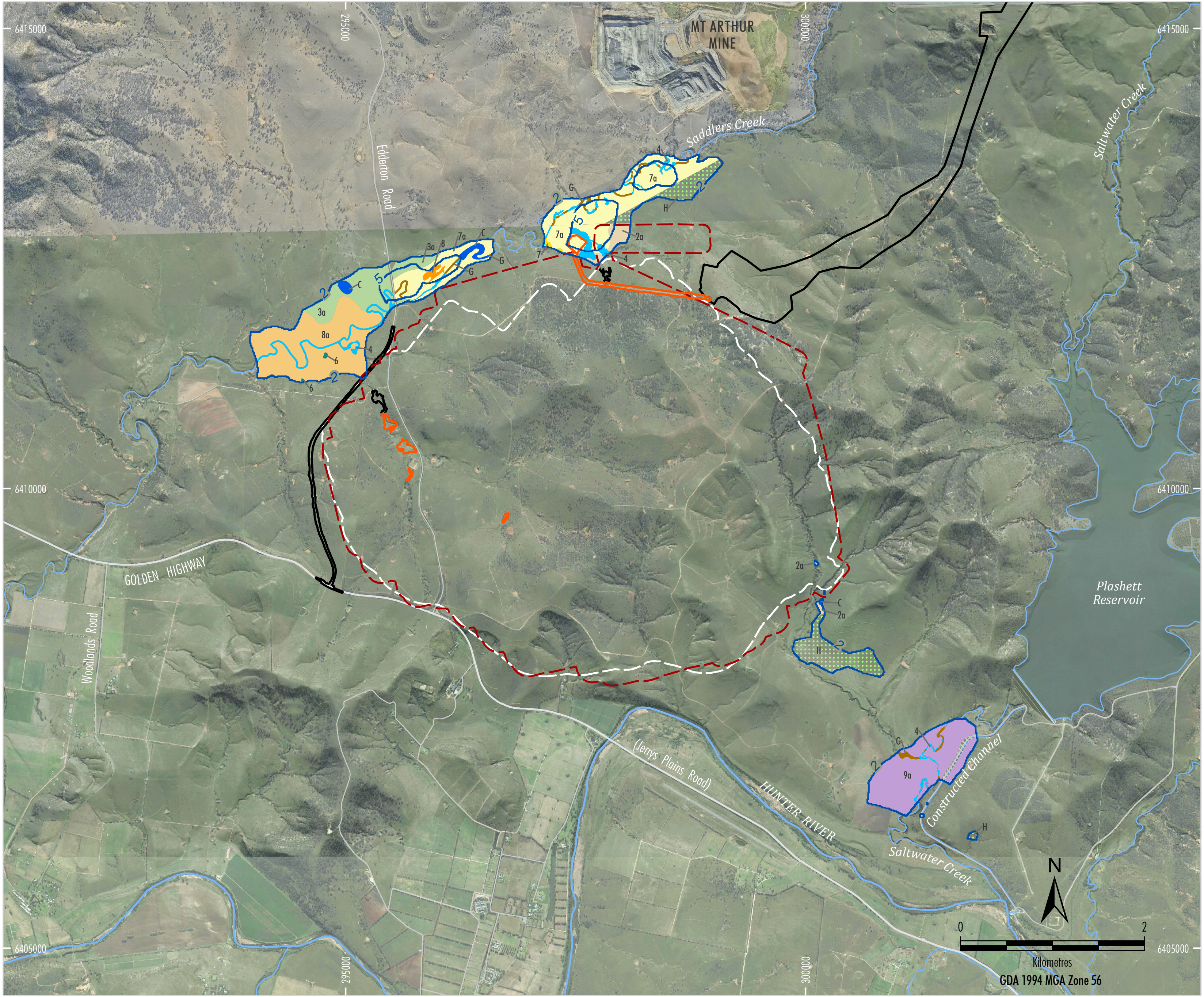
The Modification area does not contain any rocky areas that provide potential habitat for the Pink-tailed Legless Lizard (or any other threatened species) as shown on Figure 17.

7.3.2 Human Made Structures

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

7.3.3 Non-Native Vegetation

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



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- 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
- F Infrastructure/Cleared Land
- G Bare Soil
- H Derived Native Grassland - Not Surveyed

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
HydroSimulations (2019)
Orthophoto Mosaic: 2019, 2020

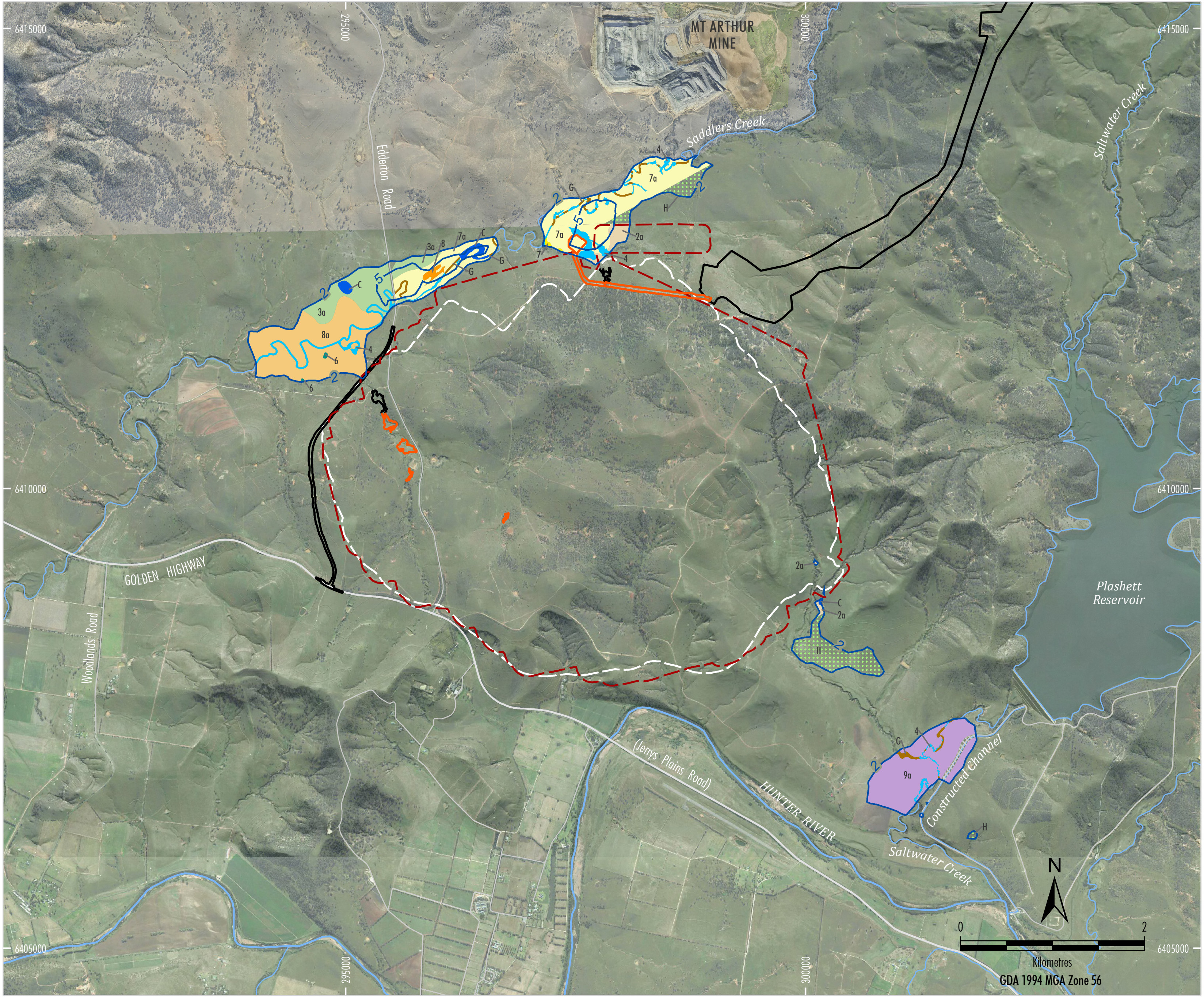
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Vegetation Mapping - Approved Extent of Predicted Alluvial Drawdown

Figure 23

SHM-20-04 MOD LW_BDAR_237A



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- 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
- F Infrastructure/Cleared Land
- G Bare Soil
- H Derived Native Grassland - Not Surveyed

Source: NSW Spatial Services (2022); MSEC (2019, 2022) SLR (2022) Orthophoto Mosaic: 2019, 2020

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Vegetation Mapping - Proposed Modification Extent of Predicted Alluvial Drawdown

Figure 24

SHM-20-04 MOD LW_BDAR_218A

7.3.4 Habitat Connectivity

The BAM (DPIE 2020) states the following assessment requirements for habitat connectivity:

> *Assessment of the impacts of the proposal on connectivity of habitat of threatened entities must:*
>
> *(a) describe the nature, extent and duration of short-term and long-term impacts*
> *(b) predict the consequences of impacts for the persistence of the threatened entities identified in Subsection 6.1.3, taking into consideration mobility, abundance, range and other relevant life history factors*
> *(c) justify predictions of impacts with relevant literature and other published sources of information.*

Habitat connectivity areas are shown on Figure 5 and woodland areas within the assessment buffer areas are shown on Figure 6. There are no defined woodland corridors in the Development Footprint, however, it is possible that the woodland areas facilitate the movement of species in the landscape. It is recognised that the derived native grassland may provide habitat linkages for some species (e.g. Striped Legless Lizard) (Section 7.3.4).

All threatened species and communities known to occur in the Development Footprint 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]).

Fragmentation as a result of the Modification would be negligible because the proposed ventilation shaft surface disturbance area is small (combined approximately 9.6 ha) and adjoins the approved Project disturbance area. Sufficient connectivity would remain around the Development Footprint such that no threatened species are likely to become isolated as a result of the Modification.

The surface disturbance areas associated with the 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 Figure 22. Revegetation would aim to increase the continuity of woodland vegetation by establishing links between woodland vegetation.

7.3.5 Fauna Movement

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

The proposed ventilation shaft and access road are located along the edge of woodland habitat and will not prevent movement of species between patches of woodland or riparian habitat.

As described in Section 7.3.4, all threatened species and communities known to occur in the Development Footprint are likely to benefit from the current level of connectivity. However, despite the impact to habitat connectivity, sufficient connectivity would remain around the Development Footprint (Figure 7) such that no threatened species are likely to become isolated as a result of the Modification.

7.3.6 Water Quality, Water Bodies and Hydrological Processes that Sustain Threatened Species and Threatened Ecological Communities

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

As a consequence of the Modification, there would be small increases in catchment runoff and direct rainfall and evaporation relative to the approved Project (as modified). The Modification would result in two minor interactions between the Saddlers Creek probable maximum flood extent and the Project (as modified), namely at the northern unnamed tributary (within the ventilation shaft pad footprint) and at the southern tributary, with backwater flow overlapping a very small section of the subsidence zone.

The Modification increases the catchment excised by 2.4 ha. The total predevelopment catchment area of Saddlers Creek is 9,714 ha and, therefore, the Modification would increase the loss of catchment by approximately 0.02%. The impact of the Modification on catchment excision (and subsequent loss of flows) in Saddlers Creek would be negligible and would not be measured (WRM 2022).

7.3.7 Wind Turbines

No wind turbines are planned for the Project (or proposed Modified Project).

7.3.8 Vehicle Strike

The BAM (DPIE 2020) states the following assessment requirements for vehicle strike on threatened species of animals or on animals that are part of a TEC:

Assessment of the impacts of vehicle strikes on threatened fauna or fauna that are part of a TEC as identified in Subsection 6.1.6 must:

- *a) predict the likelihood of vehicle strike to each relevant species, considering mobility, abundance, range and other relevant life cycle factors*
- *b) estimate vehicle strike rates with supporting data or literature, where available*
- *c) predict the consequences of the impacts for the persistence of the relevant species*
- *d) justify predictions of impacts with relevant literature and other published sources of information.*

The Modification would include a proposed access road that is located adjacent to the following TECs listed under the BC Act (Figure 9a):

- White Box Yellow Box Blakely's Red Gum Woodland; 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 14. There is little likelihood of the legless lizards becoming roadkill 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 risk of vehicle strike was addressed in the original BDAR for the Project for the approved transport and services corridor. The approved transport and services corridor is approximately 10.3 km in length and comprises the site access road, a covered overland conveyor, power supply and other ancillary infrastructure and services. It was concluded that vehicle strike was possible, however, it is not expected to be of a magnitude that would threaten the local persistence of any species.

In comparison, the proposed ventilation shaft access road is approximately 1.7 km in length and an average of 40 m wide, has mostly been positioned along an existing access track, and would comprise a road and electricity transmission line. Vehicle strike of animals along the proposed access road is possible, however, vehicle use along the access road would be irregular and existing measures to mitigate the impact would continue to be implemented (i.e. fencing along the length of the access road to exclude kangaroos (and cattle) and imposing speed limits on internal roads). The risk of vehicle strike is not expected to be of a magnitude that would threaten the local persistence of any species.

7.4 IMPACTS ON THREATENED SPECIES AND COMMUNITIES UNDER THE NSW FISHERIES MANAGEMENT ACT 1994

An aquatic ecology assessment was prepared for the Project by Eco Logical (2019) in consideration of the requirements under the *Fisheries Management Act 1994* (FM Act) and the *Threatened Species Assessment Guidelines: the Assessment of Significance* (DPI, 2008).

Two species, the Purple-spotted Gudgeon (listed as an endangered species under the FM Act) and Darling River Hardyhead in the Hunter Catchment (listed as an endangered population under the FM Act), have modelled distributions along the Hunter River, adjacent to the Project. However, neither of these species were found during the 2018 field surveys by Eco Logical (2019). Eco Logical (2019) concluded that it is unlikely that the Project would directly or indirectly impact these species, or the habitats that support them, as the Project would have a negligible impact on the flow frequency in the Hunter River and habitat features would not be impacted. Further, no TECs listed under the FM Act potentially occur in the Project area and surrounds.

The proposed Modified Project would not directly impact these species, or their habitats. It is also considered that the proposed Modified Project is unlikely to indirectly impact these species, or the habitats because the impact of the Modification on catchment excision (and loss of flows) in Saddlers Creek would be negligible and would not be measurable (WRM 2022) (Section 7.3.6).

7.5 STATE ENVIRONMENTAL PLANNING POLICY (BIODIVERSITY CONSERVATION)

The *State Environmental Planning Policy (Biodiversity and Conservation) 2021* (Biodiversity and Conservation SEPP) began on 1 March 2022 and consolidates, transfers and repeals provisions of various SEPPs in NSW including the Koala Habitat Protection SEPP (2020 and 2021). The provisions within the repealed SEPPs have been transferred to the new SEPP.

The land associated with the Development Footprint is zoned RU1 Rural. Chapter 3 of the Biodiversity and Conservation SEPP (Koala Habitat Protection 2020) applies for all RU1, RU2 and RU3 zoned land outside of the Sydney Metropolitan Area and some LGAs of the Central Coast. The Muswellbrook LGA is included in the Central Coast Koala Management Area (KMA).

Schedule 3 of the Biodiversity and Conservation SEPP lists Koala use tree species for each KMA. For the Central Coast KMA, the following tree species are listed that occur in woodland within the Development Footprint:

- White Box (*Eucalyptus albens*) in PCT 1606; and
- Grey Box (*Eucalyptus moluccana*) in PCT 1691.

The areas involved are small, PCT 1606 comprises only 1.3 ha and PCT 1691 only 1.2 ha, and adjoin large patches of these PCTs, viz. 30 ha of PCT 1606 and 67 ha of PCT 1691. As described in Section 4.4, the Koala has not been recorded in this location, despite targeted surveys.

7.6 COMMONWEALTH *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999*

7.6.1 Background

The Project was approved under the EPBC Act in March 2021 (EPBC 2018/8287). The controlling provisions for the Project were "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).

This BDAR assesses some relatively minor modifications to the approved Project layout. The proposed Modified Project would be located wholly within the approved Development Application Area, as shown in Annexure 1 of EPBC Approval 2018/8287.

The total amount of native vegetation to be disturbed for the Modification is approximately 13.3 ha. Table 19 provides a summary of the approved and additional proposed habitat disturbance for each of the threatened species and communities relevant to the EPBC Act Approval (EPBC 2018/8287). The PCTs that represent habitat for each species are listed in Table 20.

Table 19
Threatened Species and Communities listed under the EPBC Act - Summary of Habitat Disturbance

Scientific Name	Common Name	Conservation Status[1]		Class of Credit[2]	Approved Habitat Disturbance (ha)	Additional Proposed Habitat Disturbance (ha)	Total
		BC Act	EPBC Act				
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	38.7	0	38.7
Delma impar	Striped Legless Lizard	V	V	S	157.1	12.1[A] (7.7%)	169.2
Lathamus discolour	Swift Parrot	E	CE	S/E	25	3.8[B] (15.2%)	28.8
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	22.5	3.2[C] (14.2%)	25.7
Central Hunter Valley Eucalypt Forest and Woodland Ecological Community		-	CE	-	12.1	1.7[D] (14%)	13.8
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Ecological Community		-	CE	-	139	6.4[E] (4.6%)	145.4

1 Threatened species status under the BC Act and/or EPBC Act (current as at June 2022). V = Vulnerable; E = Endangered; CE = Critically Endangered.
2 Biodiversity credit class under the TBDC (DPE 2022a) (current as at June 2022). E = Ecosystem; S = Species.
A Approximately 2.6 ha is associated with additional potential subsidence ponding impacts (Figure 8b).
B Approximately 1 ha is associated with additional potential subsidence ponding impacts (Figure 8b).
C Approximately 0.8 ha is associated with additional potential subsidence ponding impacts (Figure 8b).
D Approximately 0.5 ha is associated with additional potential subsidence ponding impacts (Figure 8b).
E Approximately 0.2 ha is associated with additional potential subsidence ponding impacts (Figure 8b).

Table 20 provides a summary of the composition of the potential habitat for each threatened species relevant to the EPBC Act Approval (EPBC 2018/8287).

Table 20
Threatened Fauna listed under the EPBC Act – Composition of Additional Proposed Habitat Disturbance

PCT	Generic Name	Pink-tailed Legless Lizard	Striped Legless Lizard	Swift Parrot	Regent Honeyeater
1606	2. White Box - Ironbark - Red Gum Shrubby Forest[1]	0	1.3[A]	1.3[A]	1.3[A]
1606	2a. White Box - Ironbark - Red Gum Shrubby Forest (DNG)[1]	0	2.6[B]	-	-
1655	3. Slaty Box Shrubby Woodland[2]	-	0.5[C]	0.5[C]	0.5[C]
1655	3a. Slaty Box Shrubby Woodland (DNG)	0	1.7[D]	-	-
1692	6. Bull Oak Grassy Woodland	-	0.6[E]	0.6[E]	-
1693	7a. Yellow Box - Apple Grassy Woodland	0	2.5	-	-
201	8. Fuzzy Box Woodland	-	-	0.2[F]	0.2[F]
201	8a. Fuzzy Box Woodland (DNG)	-	-	-	-
1691	9. Ironbark - Grey Box Grassy Woodland[3]	0	1.2	1.2	1.2
1691	9a. Ironbark - Grey Box Grassy Woodland (DNG)	-	1.7	-	-
	Total	**0**	**12.1**	**3.8**	**3.2**

1 Listed BC Act, CE: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions; 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.
A Approximately 0.1 ha of PCT1606 is associated with potential subsidence ponding impacts (Figure 8b).
B Approximately 0.1 ha of PCT1606 DNG is associated with potential subsidence ponding impacts (Figure 8b).
C Approximately 0.5 ha of PCT1655 is associated with potential subsidence ponding impacts (Figure 8b).
D Approximately 1.7 ha of PCT1655 DNG is associated with potential subsidence ponding impacts (Figure 8b).
E Approximately 0.2 ha of PCT1692 is associated with potential subsidence ponding impacts (Figure 8b).
F Approximately 0.2 ha of PCT201 is associated with potential subsidence ponding impacts (Figure 8b).
G Approximately 1 ha of PCT201 DNG is associated with potential subsidence ponding impacts (Figure 8b).

This section provides a detailed analysis of the nature and extent of the impacts relevant to the following species and communities:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Ecological Community;
- Central Hunter Valley Eucalypt Forest and Woodland Ecological Community;
- Striped Legless Lizard;
- Swift Parrot; and
- Regent Honeyeater.

The assessments below are in accordance with relevant Commonwealth guidelines and policy statements (DAWE 2022b).

7.6.2 White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

The Modification would result in the direct clearance of approximately 6.2 ha of *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Box-Gum TEC) comprising predominantly derived grassland (approximately 5 ha – PCTs 1606 DNG and 1693 DNG) and some woodland form of this community (totalling approximately 1.2 ha – PCT 1606) (Figure 9b) (Table 15). The Modification avoids clearance of the woodland form of PCT 1693.

An additional 0.2 ha of Box-Gum TEC represented by PCT 1606 (0.1 ha in woodland form and 0.1 ha in derived native grassland form) are within the additional potential ponding areas associated with the Modification (Figure 9b).

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

e) reduce the extent of an ecological community

The EPBC Act Box-Gum listing (DEH 2021) advice notes: *The Box – Gum Grassy Woodland and Derived Grassland ecological community occurs in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria.* The distribution is also noted to include the Sydney Basin Bioregion in which the Modification is located. There is approximately 1,343.2 ha of Box-Gum woodland within the area subject to subsidence associated with the proposed Modified Project (Table 18) of which approximately 1,117.5 ha is the DNG form. Compared to the approved Project, this is an additional 11.2 ha of woodland form and 92.5 ha of derived native grassland form of the Box-Gum TEC subject to subsidence.

The Modification would result in the disturbance of approximately 6.4 ha of Box-Gum TEC represented by PCTs 1606 and 1693 (1.3 ha in woodland form and 5.1 ha in derived native grassland form). As described in Section 6, the clearance of Box-Gum TEC for the Modification is unavoidable, as it covers a large area surrounding the Project surface facilities such that the Modification could not be moved in a way that would avoid or reduce the amount lost. However, the proposed ventilation shaft surface development area has been positioned predominantly within an area of derived native grassland so as to avoid unnecessary impacts on woodland (Figure 9b).

In the long-term, the surface disturbance areas associated with the 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 action would not reduce the extent of Box-Gum woodland or derived native grassland either locally or nationally.

f) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Fragmentation of Box-Gum TEC as a result of the Modification would be negligible because the disturbance areas are small (combined approximately 6.4 ha) and there would be no direct or indirect isolation of important areas of Box-Gum TEC as it would remain connected around the Development Footprint of both the Modification and the approved Project (Figure 9b).

g) adversely affect habitat critical to the survival of an ecological community

The derived native grassland and woodland in the Development Footprint is not *habitat critical to the survival* of the Box-Gum TEC. The Box-Gum TEC in and adjacent to the Development Footprint (Figure 9b) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, grazing, habitat fragmentation, weed invasion and lack of fire (TSSC 2006; Rawlings et al. 2010; DECCW 2010).

h) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

The woodland and derived native grassland (conforming to the Box-Gum TEC) in the Development Footprint would be cleared. The Modification would not modify or destroy abiotic factors necessary for the survival of the Box-Gum TEC in the surrounds. The proposed ventilation shaft surface development would not alter water availability (primarily from direct rainfall) or change soil nutrients in the areas surrounding the clearance area.

Other than for the additional 0.2 ha of PCT 1606 subject to potential subsidence ponding impacts as a result of the Modification, 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).

i) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

The woodland and derived native grassland (conforming to the Box-Gum TEC) in the Development Footprint would be cleared. The Modification would not cause a change in the species composition in the occurrence of the Box-Gum TEC in the surrounds. As described earlier, the occurrence of the ecological community in and adjacent to the proposed ventilation shaft surface development area is primarily in a derived native grassland landscape (of average quality as indicated by a VI score of 22.2 for PCT 1606 DNG and 29 for PCT 1693 DNG [Table 6]) and is subject to a number of existing threats.

j) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

i. assisting invasive species, that are harmful to the listed ecological community, to become established, or

ii. causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The Modification is unlikely to cause a reduction in the quality or integrity of the occurrence of the Box-Gum TEC in the surrounds. Mitigation measures for the ecological community are outlined in Section 8 and include the following:

- implementation of a vegetation clearance protocol;
- weed management; and
- bushfire management.

k) interfere with the recovery of an ecological community

The Modification would not interfere with any of the objectives or actions outlined in the *National Recovery Plan for White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECCW 2010). As such, the Modification is unlikely to interfere with the recovery of the Box-Gum TEC*.*

Conclusion

The loss of approximately 6.4 ha of the Box-Gum TEC is not considered significant in consideration of the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013).

The impacts on the Box-Gum TEC would be offset in accordance with the NSW Biodiversity Offsets Scheme and would result in the retirement of the required number and class of like-for-like ecosystem credits (Section 9.4).

7.6.3 Central Hunter Valley Eucalypt Forest and Woodland

A total of 1.7 ha of *Central Hunter Valley Eucalypt Forest and Woodland* in woodland form is present within the Development Footprint for the Modification. The Modification would result in the direct clearance of approximately 1.2 ha of *Central Hunter Valley Eucalypt Forest and Woodland* represented by PCT 1691, as well as potential subsidence ponding impacts on 0.5 ha represented by PCT 1655 (Figure 9b) (Table 15).

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

a) reduce the extent of an ecological community

The listing advice for this TEC (DotE 2015a) notes that the community occurs in both the Hunter and Kerrabee IBRA sub-regions of the Sydney Basin and NSW North Coast IBRA regions respectively. The Modification would result in the disturbance of approximately 1.7 ha of *Central Hunter Valley Eucalypt Forest and Woodland* represented by PCTs 1691 and 1655. The listing advice notes that the TEC is also represented by PCTs 1603, 1604, 1692 and 1748. The TEC in the Development Footprint is not located at the edge of its potential distribution. Therefore, the action would not reduce the extent of the community. As described in Section 6, disturbance to this TEC has been avoided where possible to minimise the amount lost. However, the Modification could not be positioned in a way that would completely avoid impacts on this TEC. In the long-term, the surface disturbance areas associated with the 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.*

b) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Fragmentation of *Central Hunter Valley Eucalypt Forest and Woodland* as a result of the Modification would be negligible because the disturbance areas are small (combined approximately 1.7 ha) and there would be no direct or indirect isolation of important areas of the TEC as it would remain connected around the Development Footprint of both the Modification and the approved Project (Figure 9b).

c) *adversely affect habitat critical to the survival of an ecological community*

The woodland in the Development Footprint is not *habitat critical to the survival of the Central Hunter Valley Eucalypt Forest and Woodland*. The *Central Hunter Valley Eucalypt Forest and Woodland* in and adjacent to the Development Footprint (Figure 9b) is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, grazing, habitat fragmentation, weed invasion and lack of fire (DotE 2015a; DEE 2016a).

d) *modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns*

Approximately 1.2 ha of woodland conforming to *Central Hunter Valley Eucalypt Forest and Woodland* would be cleared at the proposed ventilation shaft surface development area and an additional 0.5 ha would be subject to potential ponding. The Modification would not modify or destroy abiotic factors necessary for the survival of the community in the surrounds. The proposed ventilation shaft surface development would not alter water availability (primarily from direct rainfall) or change soil nutrients in the areas surrounding the area of immediate loss.

There is approximately 240.7 ha of *Central Hunter Valley Eucalypt Forest and Woodland* within the area subject to subsidence associated with the proposed Modified Project (Table 18), which is an additional 9.1 ha compared to the original approved Project. Other than for additional areas of potential subsidence ponding containing 0.5 ha of *Central Hunter Valley Eucalypt Forest and Woodland* (PCT 1655), 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).

e) *cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting*

The Modification would not cause a change in the species composition in the occurrence of *Central Hunter Valley Eucalypt Forest and Woodland* in the surrounds. As described above, the occurrence of the ecological community in and adjacent to the proposed ventilation shaft surface development area is subject to a number of existing threats.

f) *cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:*

iii. *assisting invasive species, that are harmful to the listed ecological community, to become established, or*

iv. *causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or*

The Modification is unlikely to cause a reduction in the quality or integrity of the occurrence of the *Central Hunter Valley Eucalypt Forest and Woodland* in the surrounds as potential indirect impacts (and edge effects) from environmental weeds, dust, erosion and sediment would be managed. Mitigation measures for the ecological community are outlined in Section 8 and include the following:

- implementation of a vegetation clearance protocol;
- weed management; and
- bushfire management.

g) interfere with the recovery of an ecological community

The Modification would not interfere with any of the objectives or actions outlined in the *Approved Conservation Advice (including listing advice) for the Central Hunter Valley Eucalypt Forest and Woodland Ecological Community* (DotE 2015a). As such, the Modification is unlikely to interfere with the recovery of the Box-Gum TEC.

Conclusion

The loss of approximately 1.7 ha of the *Central Hunter Valley Eucalypt Forest and Woodland* is not considered significant in consideration of the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013). 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).

7.6.4 Striped Legless Lizard

The Striped Legless Lizard is the only species credit species listed under the EPBC Act that is relevant to the Development Footprint (Section 4.4.1).

This species was not recorded within the Development Footprint associated with the Modification during targeted surveys undertaken in 2018 by Future Ecology (2019) (Attachment A), however four individuals were recorded within approximately 1 km of the approved Mine Entry Area Extensions (Figure 18). A total of 26 observations of Striped Legless Lizard were recorded in the broader Project study area, including live specimens (16 individuals) and sloughs (10). Most records were associated with the Maxwell Underground and along or near the transport and services corridor between the Maxwell Underground and Maxwell Infrastructure. The majority of observations were made under dried cow manure in open grassy areas with a good cover of native grasses and herbs, though the species was also recorded with pitfall traps and artificial shelter habitat, and associated with rocks and dumped material.

The Modification would result in the clearance of approximately 12.1 ha of potential habitat for the Striped Legless Lizard within the Development Footprint (Figure 18) (Table 20). The clearance would be required for the proposed ventilation shaft and associated infrastructure (including the access road). The Development Footprint also includes minor areas (approximately 2.6 ha) of potential subsidence ponding (Figure 18).

An assessment of the significant impact criteria (DotE 2013) for the Striped Legless Lizard is provided below.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of an important population of a species

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) recognised that the local population of the Striped Legless Lizard could be considered an important population (as defined by DSEWPaC 2011). However, the Modification is not likely to lead to a long-term decrease in the size of the population of the Striped Legless Lizard because the area of potential habitat to be disturbed for the Modification (12.1 ha) is small compared to the wider occurrence of known and potential habitat (Figure 18). The potential habitat comprises of open agricultural grazing land with dried cow manure that may provide shelter, but no rocky habitat is present.

In the long-term, the surface disturbance areas associated with the Development Footprint would be rehabilitated and revegetated when 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. (Section 8). The 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 Development Footprint (Figure 18).

b) reduce the area of occupancy of an important population

The Striped Legless Lizard was not recorded within the Development Footprint. Given its presence in the surrounds, it is possible that the Striped Legless Lizard utilises potential habitat within the Development Footprint. Utilising occurrence records from BioNet (DPE 2022c), the area of occupancy of the Striped Legless Lizard important population in the Muswellbrook region is 19 square kilometres (km^2) determined from one km square grid cells. The Development Footprint lies across two cells that have existing records which would not be affected. Thus, the Modification would not reduce the area of occupancy of an important population.

c) fragment an existing important population into two or more populations

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) (DAWE 2021b). The creation of barriers to lizard movements can cause populations to become fragmented (DAWE 2021b). The Modification could potentially limit movement of the Striped Legless Lizard; however, this species was not recorded within the Development Footprint or close to the access road at the proposed ventilation shaft location, and the Modification is unlikely to impact movement patterns for this species (Section 7.3.5; Figure 18). Therefore, based on available data, the population is unlikely to be significantly fragmented.

d) adversely affect habitat critical to the survival of a species

The *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) recognised that potential habitat for the species in the Project area may form part of 'habitat critical to the survival of the species' according to the Threatened Species Scientific Committee (TSSC) (2016) 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 (DPE, 2022c). The Muswellbrook Common population appears to be disjunct from other recorded populations which occur greater than approximately 200 km to the south (DPE, 2022c). The removal of the habitat for the Modification is not likely to be material to the survival of the species given the area of potential habitat to be disturbed is small (12.1 ha) and comprised of open agricultural grazing land with dried cow manure that may provide shelter, but no rocky habitat.

It is possible that subsidence could impact this species as 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, so long-term impacts from subsidence are not expected.

e) disrupt the breeding cycle of an important population

Breeding habitat for the Striped Legless Lizard is determined by the presence of two or more adult individuals or juveniles and a habitat assessment of available resources such as tussocks with high biomass, surface rocks or invertebrate burrows (TSSC 2016a). While it is possible that the species could breed in the Development Footprint, the area of potential habitat to be disturbed is small (12.1 ha) and better habitat (rocky areas) occur outside of the Development Footprint (Figure 18).

f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

In the long-term, the surface disturbance areas associated with the Development Footprint would be rehabilitated and revegetated when surface facilities are no longer required (Section 8) 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 population of this species would persist in the surrounding locality due to the amount of known habitat and occurrence of the species outside the Development Footprint (Figure 18).

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

h) introduce disease that may cause the species to decline, or

The Modification is unlikely to indirectly impact the Striped Legless Lizard adjacent to the Development Footprint as the Modification would include measures to manage environmental weeds spreading from the Development Footprint, considering that the Striped Legless Lizard is a grassland specialist (DAWE 2021b).

Best practice mitigation measures as outlined in the *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable striped legless lizard,* Delma impar (DSEWPaC 2011) have been considered, and would include (Section 8):

- 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.

i) interfere substantially with the recovery of the species

The Modification would not interfere with any of the objectives, criteria and actions outlined in the *National Recovery Plan for the Striped Legless Lizard* (Delma impar) *1999-2003* (Smith and Robertson 1999). As such, the Modification is unlikely to interfere substantially with the recovery of the Striped Legless Lizard.

Conclusion

In the *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b), it was conservatively considered that the Project was 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 was made considering that the local population of the Striped Legless Lizard in the Development Footprint 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 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.

Though it contributes to a minor reduction in the area of occupancy and potential habitat available for the Striped Legless Lizard, the loss of approximately 12.1 ha of potential habitat for the Striped Legless Lizard associated with the Modification is not considered significant in consideration of the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013).

The Modification 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 Offsets Scheme and would result in the retirement of the required number and class of like-for-like species credits (Section 9.4).

7.6.5 Swift Parrot

The Swift Parrot has not been recorded within the Development Footprint.

The Modification would result in the direct clearance of approximately 3.8 ha of potential foraging habitat for the Swift Parrot (Figure 7) (Table 20). The clearance would be required for the proposed ventilation shaft and associated infrastructure (including the access road). The clearance area also includes a minor area (approximately 1 ha) of potential subsidence ponding (Figure 7). An assessment of the significant impact criteria (DotE 2013) for the Swift Parrot is provided below.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of a population

The removal of 3.8 ha of potential foraging habitat in the Development Footprint is likely to be of little consequence to the Swift Parrot given the occurrence of similar potential foraging habitat in the surrounding landscape and considering that no breeding habitat or mapped important habitat is present in the Development Footprint or surrounds (DPE 2022d).
In the long-term, the surface disturbance areas associated with the 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*.

b) reduce the area of occupancy of the species

Swift Parrot has not been recorded in the Development Footprint, no breeding habitat for this species is present (as it breeds in Tasmania), and there is an absence of important habitat (DPE 2022d). Therefore, the removal of 3.8 ha of potential foraging habitat in the Development Footprint is not likely to reduce the area of occupancy of the Swift Parrot given the occurrence of similar potential habitat in the surrounding landscape.

c) fragment an existing population into two or more populations

Swift Parrot has not been recorded in the Development Footprint and the removal of 3.8 ha of potential foraging habitat for the Modification is unlikely to fragment an existing population of Swift Parrot or create any barriers to movement for this species.

d) adversely affect habitat critical to the survival of a species

There is no mapped important habitat for the Swift Parrot in the Development Footprint (DPE 2022d), and no breeding habitat for this species is present (as it breeds in Tasmania), therefore the Modification will not impact habitat critical to the survival of the species.

e) disrupt the breeding cycle of a population

There is no breeding habitat for Swift Parrot present as it breeds only in Tasmania.

f) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Swift Parrot has not been recorded in the Development Footprint, no breeding habitat for this species is present (as it breeds in Tasmania), and there is an absence of important habitat (DPE 2022d). Therefore, the removal of 3.8 ha of potential foraging habitat in the Development Footprint is likely to be of little consequence to the Swift Parrot given the occurrence of similar potential habitat in the surrounding landscape.

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).

g) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

h) introduce disease that may cause the species to decline, or

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 8).

Mitigation measures for the species are outlined in Section 7.6.8 and include the following:

- implementation of a vegetation clearance protocol; and
- surface disturbance areas associated with the 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).

i) interfere with the recovery of the species.

The Modification would not interfere with any of the objectives, criteria and actions outlined in the *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Birds Australia 2011). As such, the Modification is unlikely to interfere substantially with the recovery of the Swift Parrot.

Conclusion

The Modification may not have a material adverse impact on the Swift Parrot as this species has not been recorded in the Development Footprint, no breeding habitat for this species is present (as it breeds in Tasmania), and absence of important habitat (DPE 2022d).

The impacts on the Swift Parrot would be offset in accordance with the NSW Biodiversity Offset Scheme. This species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (DPE 2022a) given absence of important habitat (DPE 2022d) (Table 10).

7.6.6 Regent Honeyeater

The Regent Honeyeater has not been recorded in the Development Footprint. The Modification would result in the direct clearance of approximately 3.2 ha of potential foraging habitat for the Regent Honeyeater (Figure 7) (Table 20). The clearance areas also include a minor area (approximately 0.8 ha) of potential subsidence ponding (Figure 7). An assessment of the significant impact criteria (DotE 2013) for the Swift Parrot is provided below.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

a) lead to a long-term decrease in the size of a population

No important habitat or potential breeding habitat for the Regent Honeyeater is present within the Development Footprint (DPE 2022d) and it is unlikely that the removal of 3.2 ha of potential foraging habitat would impact the Regent Honeyeater given the occurrence of similar potential foraging habitat in the surrounding landscape.

In the long-term, the surface disturbance areas associated with the 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.

b) reduce the area of occupancy of the species

If the potential foraging habitat in the 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.

c) fragment an existing population into two or more populations

The Regent Honeyeater has not been recorded during targeted surveys and no breeding habitat or important habitat areas are present within the Development Footprint (DPE 2022d), so the Modification is unlikely to fragment an existing population.

d) adversely affect habitat critical to the survival of a species

No important habitat or potential breeding habitat for the Regent Honeyeater is present within the Development Footprint or surrounds (DPE 2022d). Regent Honeyeater potential foraging habitat adjacent to the Development Footprint (Figure 7) 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 2016).

e) disrupt the breeding cycle of a population

No potential breeding habitat for the Regent Honeyeater is present within the Development Footprint or surrounds.

f) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Modification would not impact important habitat or potential breeding habitat for the Regent Honeyeater. The removal of 3.2 ha of potential foraging habitat is likely to have little consequence for the species given the occurrence of similar potential habitat in the surrounding landscape.

Subsidence is unlikely to materially impact the potential foraging 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).

g) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

h) introduce disease that may cause the species to decline, or

The Modification is unlikely to indirectly impact the Regent Honeyeater (were it to use the woodland potential habitat adjacent to the Development Footprint) as potential indirect impacts would be managed (Section 8). Mitigation measures for the species are outlined in Section 7.6.8 and include the following:

- implementation of a vegetation clearance protocol; and
- surface disturbance areas associated with the 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).

i) interfere with the recovery of the species.

The Modification would not interfere with any of the objectives, criteria and actions outlined in the *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (Commonwealth of Australia 2016). As such, the Modification is unlikely to interfere substantially with the recovery of the Regent Honeyeater.

Conclusion

The Modification may not have a material adverse impact on the Regent Honeyeater as this species has not been recorded in the Development Footprint, no breeding habitat for this species is present, and due to the absence of important habitat (DPE 2022d).

The impacts on Regent Honeyeater would be offset in accordance with the NSW Biodiversity Offset Scheme. This species is classified as an 'Ecosystem Credit Species' in the *Threatened Biodiversity Data Collection* (DPE 2022a) given the absence of important habitat (DPE 2022d) (Table 10).

7.6.7 Other Species

In addition to those species assessed in the BAM-C, the Painted Honeyeater, White-throated Needletail, Spotted-tailed Quoll, Corben's Long-eared Bat and Grey-headed Flying-fox are listed as 'known to occur' within the locality of the Development Footprint in the EPBC Act Protected Matters Search (DAWE 2022a). These five species have been assessed as 'ecosystem species' and included in the BAM-C for the generation of ecosystem credits.

Four flora species have been assumed present in associated PCTs within the potential subsidence ponding areas associated with the Modification. An assessment of the significant impact criteria (DotE 2013) was not undertaken for these species because it is considered that these species are unlikely to be impacted by the Modification, as outlined below. Additionally, targeted surveys for these species are to be undertaken in suitable conditions in the future.

Austral Toadflax

In accordance with the BAM (DPIE 2020), Austral Toadflax has been assumed present in these derived native grassland areas of the associated PCTs 1606 and 1655 that were not able to be surveyed in the required months. However, given the absence of the common host Kangaroo Grass (*Themeda triandra*) during other surveys it is considered unlikely for the species to be present.

Leafless Tongue Orchid

In accordance with the BAM (DPIE 2020), the Leafless Tongue Orchid (*Cryptostylis hunteriana*) has been assumed present in the areas that were not able to be surveyed in the required months. The approved conservation advice (DotE 2008) for the species states that it is generally found in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland and lowland forest. Soil types include moist sands or moist to dry clay loam. None of these conditions apply to the Development Footprint and likely explain why the nearest record of the species is >85 km to the east. Thus it is considered unlikely for the species to be present.

Pine Donkey Orchid

In accordance with the BAM (DPIE 2020), the Pine Donkey Orchid (*Diuris tricolor*) has been assumed present in the areas that were not able to be surveyed in the required months.

Tarengo Leek Orchid

In accordance with the BAM (DPIE 2020), the Tarengo Leek Orchid (*Prasophyllum petilum*) has been assumed present in the areas that were not able to be surveyed in the required months. As previously noted, *Prasophyllum* sp. Wybong is a recognised synonym of the Tarengo Leek Orchid (*Prasophyllum petilum*) but is considered for assessment here because it is still listed under the EPBC Act (as at June 2022). However, given the absence of *Prasophyllum* sp. Wybong during adjacent surveys it is considered unlikely for the species to be present.

7.6.8 Mitigation Measures Relevant to MNES

Conservation advice, recovery plans and threat abatement plans for relevant EPBC Act-listed species and communities are considered in Table 21. A reconciliation table of all conservation advice, recovery plans and threat abatement plans for relevant EPBC listed species is provided in Table 22.

7.6.9 Conclusion

The impacts of the Modification on biodiversity on a local scale would be minimal. Any impacts on protected matters listed under the EPBC Act would be localised and negligible on a regional, state and national scale. It is concluded that there is unlikely to be significant residual impact on any threatened species and communities listed under the EPBC Act as a result of the Modification.

Table 21
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.
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).

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/ Effectiveness	Basis for the Mitigation Measures
	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.	
	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.		
			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	Surface disturbance areas associated with the	Effective when applied.	TSSC (2016b) and Saunders

Matter	Impact	Mitigation Measure	Techniques	Impact Mitigation Measures/ Effectiveness	Basis for the Mitigation Measures
		and Revegetation	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.		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).
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 2016).
	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 2016).
	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 2016).

Table 22
Summary of Conservation Advice, Recovery Plans or Threat Abatement Plans for EPBC Listed Species in the Project Area

Matter	Conservation Advice, Recovery Plans and Threat Abatement Plans (EPBC Species Profile and Threats Database)
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	• No approved Conservation Advice. • *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (NSW DECCW 2010). • *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads* (DSEWPAC 2011a). • *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (Sus scrofa) (2017) (DEE 2017). • *Threat abatement plan for disease in natural ecosystems caused by* Phytophthora cinnamomic (DEE 2018b).
Central Hunter Valley Eucalypt Forest and Woodland	• *Approved Conservation Advice (including listing advice) for the Central Hunter Valley eucalypt forest and woodland ecological community* (DotE 2015a) • No adopted or made Recovery Plan. • No Threat Abatement Plan.
Striped Legless Lizard	• *Conservation Advice* Delma impar *striped legless lizard* (TSSC 2016a). • *National Recovery Plan for the Striped Legless Lizard* (Delma impar) *1999-2003* (Smith, W.J.S. & P. Robertson 1999). • *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (DSEWPAC 2011b). • *Threat abatement plan for predation by feral cats* (DotE 2015c). • *Threat abatement plan for competition and land degradation by rabbits* (DEE 2016b). • *Threat abatement plan for predation by the European red fox* (DEWHA 2008).
Swift Parrot	• *Conservation Advice* Lathamus discolor *swift parrot* (TSSC 2016b). • *National Recovery Plan for the Swift Parrot* (Lathamus discolor) (Saunders, D.L. & C.L. Tzaros 2011). • *Threat abatement plan for predation by feral cats* (DotE 2015c).
Regent Honeyeater	• *Conservation Advice* Anthochaera phrygia *regent honeyeater* (DotE 2015b). • *National Recovery Plan for the Regent Honeyeater* (Anthochaera phrygia) (DotE 2016). • *Threat abatement plan for competition and land degradation by rabbits* (DEE 2016b).

8 MEASURES TO MITIGATE AND MANAGE IMPACTS

The measures to mitigate and manage impacts from the Project as described in the *Maxwell Project Biodiversity Development Assessment Report* (Hunter Eco 2019b) (Table 23) would continue to be applied to the proposed Modified Project.

Table 23
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 14 (no reduction in vegetation disturbance area 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 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.

9 IMPACT SUMMARY

9.1 SERIOUS AND IRREVERSIBLE IMPACTS

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-C.

Two species, the Regent Honeyeater and Swift Parrot, have been assessed as 'ecosystem credit species' due to the absence of potential breeding habitat or important habitat areas within the Development Footprint and surrounds. The TBDC (DPE 2022a) considers that these species are not likely to have potential serious and irreversible impacts within ecosystem credit areas, despite being listed as threatened entities (DPE 2022e).

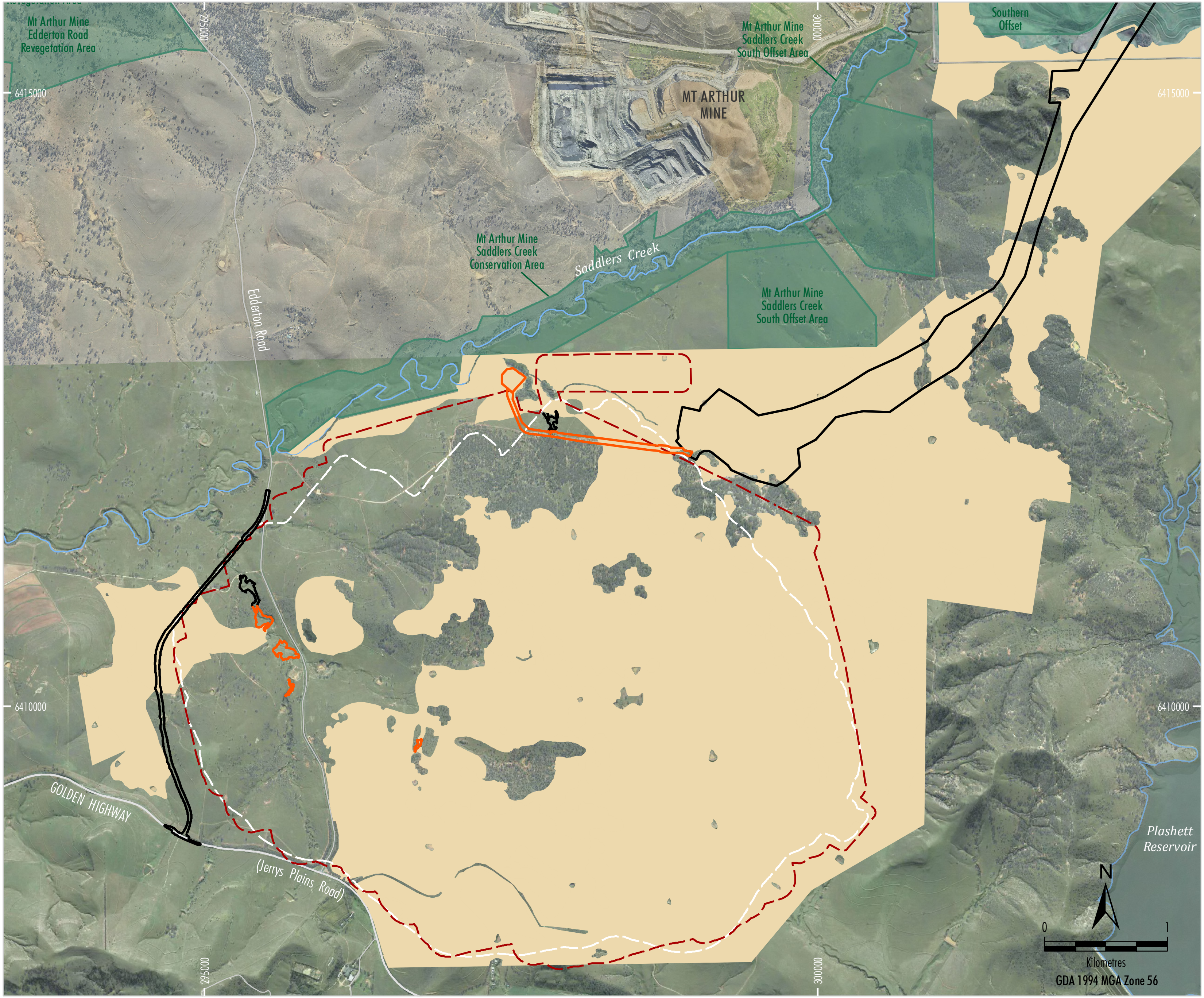
There is one 'potential SAII entity' relevant to the Modification, namely the Box-Gum TEC (Figure 25).

9.1.1 BAM Requirement

The BAM (DPIE 2020) requires the following information to be provided:

9.1.1 Additional impact assessment provisions for threatened ecological communities at risk of an SAII

1. *The assessor is required to provide further information in the BDAR or BCAR regarding the impacts on each TEC at risk of an SAII. This must include the action and measures taken to avoid the direct and indirect impact on the TEC at risk of an SAII. Where these have been addressed elsewhere the assessor can refer to the relevant sections of the BDAR and BCAR.*
2. *The assessor must consult the TBDC and/or other sources to report on the current status of the TEC including:*
    a. *evidence of reduction in geographic distribution (Principle 1, clause 6.7(2)(a) BC Regulation) as the current total geographic extent of the TEC in NSW AND the estimated reduction in geographic extent of the TEC since 1970 (not including impacts of the proposal)*
    b. *extent of reduction in ecological function for the TEC using evidence that describes the degree of environmental degradation or disruption to biotic processes (Principle 2, clause 6.7(2)(b) BC Regulation) indicated by:*
        i. *change in community structure*
        ii. *change in species composition*
        iii. *disruption of ecological processes*
        iv. *invasion and establishment of exotic species*
        v. *degradation of habitat, and*
        vi. *fragmentation of habitat*
    c. *evidence of restricted geographic distribution (Principle 3, clause 6.7(2)(c) BC Regulation), based on the TEC's geographic range in NSW according to the:*
        i. *extent of occurrence*
        ii. *area of occupancy, and*
        iii. *number of threat-defined locations*
    d. *evidence that the TEC is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation).*
3. *Where the TBDC indicates data is 'unknown' or 'data deficient' for a TEC for a criterion listed in Subsection 9.1.1(2.), the assessor must record this in the BDAR or BCAR.*
4. *In relation to the impacts from the proposal on the TEC at risk of an SAII, the assessor must include data and information on:*
    a. *the impact on the geographic extent of the TEC (Principles 1 and 3) by estimating the total area of the TEC to be impacted by the proposal:*
        i. *in hectares, and*
        ii. *as a percentage of the current geographic extent of the TEC in NSW.*



LEGEND
Approved Surface Development Area
Approved Extent of Conventional Subsidence (20 mm subsidence contour)
Modified Extent of Conventional Subsidence (20 mm subsidence contour)
Development Footprint
Existing Conservation/Offset Area
Threatened Ecological Communities
White Box - Yellow Box - Blakely's Red Gum Woodland

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Serious and Irreversible Impact Entities

Figure 25

SHM-20-04 MOD LW_BDAR_230C

Data and information should include direct impacts (i.e. from clearing) and indirect impacts where partial loss of the TEC is likely as a result of the proposal. The assessor should consider for example, changes to fire regime (frequency, severity), hydrology, pollutants, species interactions (increased competition, changes to pollinators or dispersal), fragmentation, increased edge effects and disease, pathogens and parasites, which are likely to contribute to the loss of flora and/or fauna species characteristic of the TEC

b. the extent that the proposed impacts are likely to contribute to further environmental degradation or the disruption of biotic processes (Principle 2) of the TEC by:

i. estimating the size of any remaining, but now isolated, areas of the TEC;

including areas of the TEC within 500 m of the development footprint or equivalent area for other types of proposals

ii. describing the impacts on connectivity and fragmentation of the remaining areas of TEC measured by:

- *distance between isolated areas of the TEC, presented as the average distance if the remnant is retained AND the average distance if the remnant is removed as proposed, and*
- *estimated maximum dispersal distance for native flora species characteristic of the TEC, and*
- *other information relevant to describing the impact on connectivity and fragmentation, such as the area to perimeter ratio for remaining areas of the TEC as a result of the development*

iii. describing the condition of the TEC according to the vegetation integrity score for the relevant vegetation zone(s) (Section 4.3). The assessor must also include the relevant composition, structure and function condition scores for each vegetation zone.

5. The assessor may also provide new information that demonstrates that the principle identifying that the TEC is at risk of an SAII is not accurate.

The Box-Gum TEC is a 'potential SAII entity' due to Principle 1 and 2 in the DPIE (2019) *Guidance and Criteria to Assist a Decision Maker to Determine a Serious and Irreversible Impact*.

These are addressed below.

1. The assessor is required to provide further information in the BDAR or BCAR regarding the impacts on each TEC at risk of an SAII.

Approximately 6.4 ha of Box-Gum TEC would be cleared, represented by PCT 1606 (1.3 ha in woodland form and 2.6 ha in derived native grassland form) and PCT 1693 (2.5 ha in derived native grassland form), of which the relatively low condition grassland is currently used for grazing livestock (Vegetation Zone 2a with a VI Score of 22.2 and Vegetation Zone 7a with a VI score of 29) (Table 6).

The clearance of Box-Gum TEC for the Modification is unavoidable, as it covers a large area surrounding the Project surface facilities such that the Modification could not be moved in a way that would avoid or reduce the amount lost.

2. The assessor must consult the TBDC and/or other sources to report on the current status of the TEC

Principle 1, clause 6.7(2)(a) of the BC Regulation states that:

(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

Considering historical, recent and contemporary clearing in combination, the TSSC estimates that the Box-Gum TEC has experienced a distribution reduction exceeding 90% across its entire range.

The current total geographic extent of the TEC in NSW is estimated to be 70,280,000 ha (TSSC 2020).

Principle 2, clause 6.7(2)(b) of the BC Regulation further defines a serious and irreversible impact as contributing to the decline of a TEC because:

> *(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*

Box-Gum TEC has experienced a high degree of reduction in ecological function as a result of environmental degradation and disruption to biotic processes. It is estimated that less than 10% of the original distribution of the community has avoided the long-term impacts of pastoralism, and compositional changes associated with grazing and management practices continue to impact remnant areas of Box-Gum TEC. The TSSC (2020) states that the community is subject to a number of threatening processes that have caused severe declines in biotic processes and interactions, including grazing, pasture improvement, dryland salinity, elevated soil nitrogen and prolonged absence of fire. These threats have been associated with the invasion and establishment of exotic species, *Eucalyptus* spp. dieback, habitat fragmentation, and changes in community structure and species composition (TSSC, 2020).

3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a TEC for a criterion listed in Subsection 9.1.1(2.), the assessor must record this in the BDAR or BCAR.

The TBDC (DPE 2022a) does not indicate data is 'unknown' or 'data deficient' for the Box-Gum TEC.

4. In relation to the impacts from the proposal on the TEC at risk of an SAII, the assessor must include data and information on:

a. the impact on the geographic extent of the TEC (Principles 1 and 3) by estimating the total area of the TEC to be impacted by the proposal:

b. the extent that the proposed impacts are likely to contribute to further environmental degradation or the disruption of biotic processes (Principle 2) of the TEC by:

Approximately 6.4 ha of Box-Gum TEC would be cleared, represented by PCT 1606 (1.3 ha in woodland form and 2.6 ha in derived native grassland form) and PCT 1693 (2.5 ha in derived native grassland form) (Table 4). This is a small area considering the current total geographic extent of the TEC in NSW is estimated to be 70,280,000 ha (<0.00000001%) (TSSC, 2020).

Clearance of native vegetation and the construction of the proposed ventilation shaft infrastructure and access road is unlikely to cause any change to fire regimes, pollutants, or disease, pathogens and parasites. Potential impacts of clearing of the Box-Gum TEC by the Modification 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.

Fragmentation of Box-Gum TEC as a result of the Modification would be minimal because the Modification areas are small (combined 13.3 ha) and adjoin the approved Project disturbance area. The Modification does create a separation between two large areas of Box-Gum TEC along the 1.7 km-long proposed ventilation shaft access road (with a maximum width <55 m), although the TEC does remain connected around the boundary of the approved Project (Figure 25).

The condition of the Box-Gum TEC remaining outside of the Development Footprint would be at least retained as it is currently. For example, there would be no intrusion by firewood collectors or bush rock collectors. Potential 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. As such, the Modification is unlikely to contribute to loss of flora or fauna species characteristic of the Box-Gum TEC.

5. The assessor may also provide new information that demonstrates that the principle identifying that the TEC is at risk of an SAII is not accurate.

Not applicable.

9.1.2 BC Regulation Requirements

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 DPIE (2019) *Guidance and Criteria to Assist a Decision Maker to Determine a Serious and Irreversible Impact*.

Will the Modification 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 derived grassland that conforms to the Box-Gum TEC (Section 9.4).

Will the Modification 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 described in Section 9.1.1(*4*), 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 having a State-wide distribution.

Will the Modification 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 derived grassland that conforms to the Box-Gum TEC in the Development Footprint 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).

The Modification is unlikely to have a serious and irreversible impact on the Box-Gum TEC given the small areas of woodland and derived grassland that conforms to the Box-Gum TEC in the Development Footprint (combined 6.4 ha) relative to the wider occurrence of the Box-Gum TEC (Figure 25). 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 9.4).

9.2 IMPACTS REQUIRING/NOT REQUIRING AN OFFSET

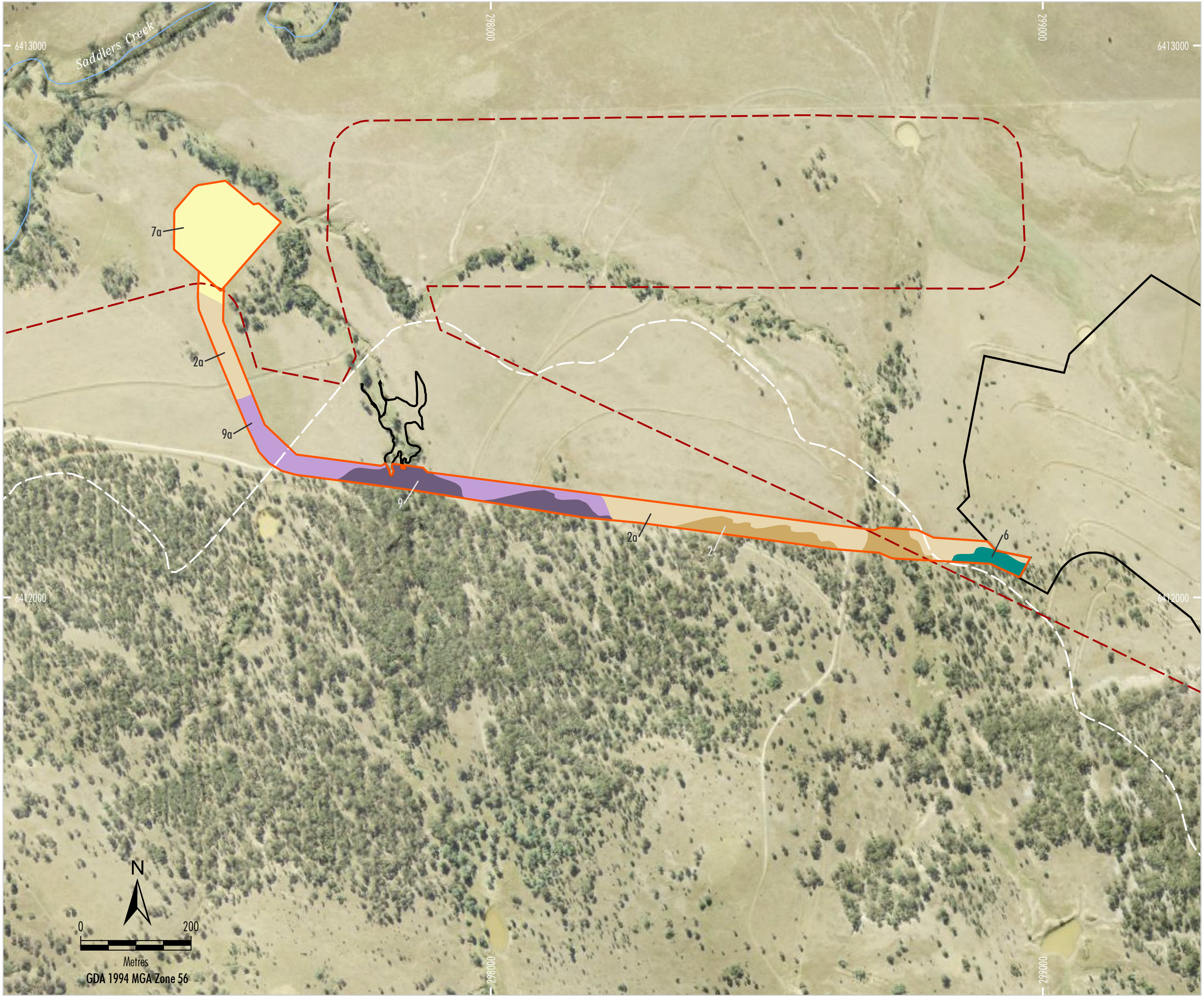
The VI Scores for all but one vegetation zone (3a) is sufficiently high that all remaining vegetation zones require an offset (Figures 26a and 26b). Vegetation Zone 3a (PCT 1655 DNG) is not representative of a TEC, is associated with threatened species habitat, has a VI score of 11.5 (Table 6) and is therefore below the threshold for requiring an offset (Figure 27).

9.3 AREAS NOT REQUIRING ASSESSMENT

No parts of the Development Footprint are devoid of native vegetation, so all areas require assessment.

9.4 BIODIVERSITY CREDITS

Table 24 provides a summary of the ecosystem credits required for the Modification. The change in VI Score is provided in Table 14 and the future score is assumed to be ‘zero’. Table 25 provides a summary of the species credits required for the Modification.



LEGEND

Approved Surface Development Area

Approved Extent of Conventional Subsidence (20 mm subsidence contour)

Modified Extent of Conventional Subsidence (20 mm subsidence contour)

Development Footprint

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]

Grassy Woodlands

6 Bull Oak Grassy Woodland (PCT1692)

7a Yellow Box - Apple Grassy Woodland - Derived Native Grassland (PCT1693) [1]

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

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

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: NSW Spatial Services (2020)

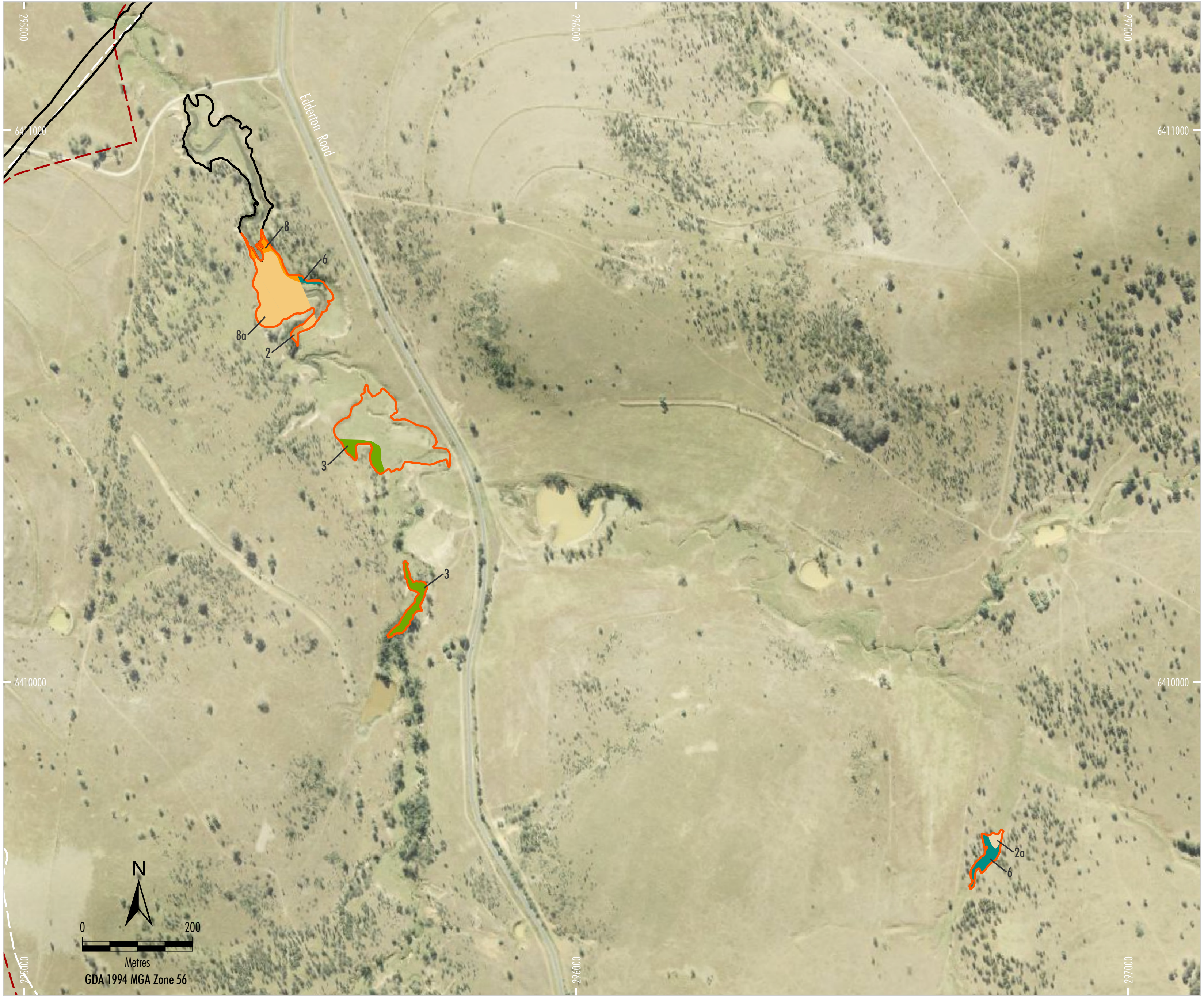
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Areas Requiring Offset - Proposed Ventilation Shaft Surface Development Area

Figure 26a

SHM-20-04 MOD LW_BDAR_232B



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint

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)

- 3 Slaty Box Shrubby Woodland (PCT1655) [2]

Grassy Woodlands

- 6 Bull Oak Grassy Woodland (PCT1692)
- 8 Fuzzy Box Woodland (PCT201)
- 8a Fuzzy Box Woodland - Derived Native Grassland (PCT201)

[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

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: NSW Spatial Services (2020)

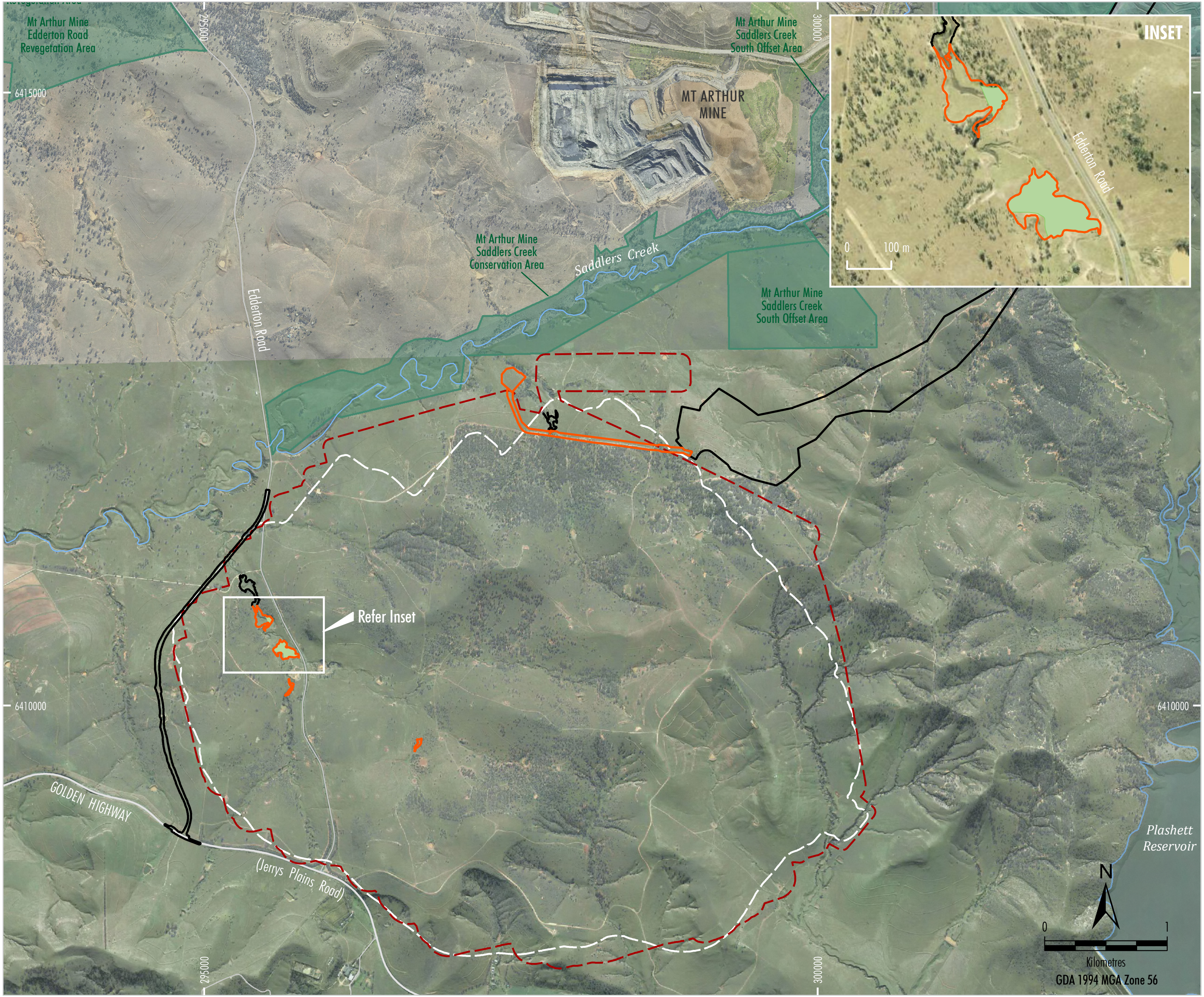
MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Areas Requiring Offset - Areas of Potential Ponding

Figure 26b

SHM-20-04 MOD LW_BDAR_233A



LEGEND

- Approved Surface Development Area
- Approved Extent of Conventional Subsidence (20 mm subsidence contour)
- Modified Extent of Conventional Subsidence (20 mm subsidence contour)
- Development Footprint
- Existing Conservation/Offset Area

Dry Sclerophyll Forests (Shrubby sub-formation)

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

Source: NSW Spatial Services (2022); MSEC (2019, 2022)
Orthophoto Mosaic: 2019, 2020

MALABAR

MAXWELL UNDERGROUND MINE PROJECT

Areas Not Requiring Offset

Figure 27

SHM-20-04 MOD LW_BDAR_234B

Table 24
Impacts that Require an Offset – Ecosystem Credits

Vegetation Zone	PCT	Threatened Ecological Community Listed under the BC Act	Impact area (ha)	Number of Ecosystem Credits Required
2	1606	White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	1.3	56
2a	1606		2.6	36
3	1655	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	0.5	4
3a	1655	Not a TEC	1.7	0
6	1692	Not a TEC	0.6	15
7a	1693	White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	2.5	45
8	201	Not a TEC	0.2	9
8a	201	Not a TEC	1	18
9	1691	Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	1.2	35
9a	1691	Not a TEC	1.7	29
		Total Woodland/Forest	**3.8**	**119**
		Total Derived Native Grassland	**9.5**	**128**
		Total	**13.3**	**247**

Table 25
Impacts that Require an Offset – Species Credits

Common Name	Scientific Name	Loss of Habitat (ha)	Number of Species Credits Required
Leafless Tongue Orchid	*Cryptostylis hunteriana*	2.2	11
Pine Donkey Orchid	*Diuris tricolor*	1.2	17
Tarengo Leek Orchid	*Prasophyllum* petilum	1.2	21
Austral Toadflax	*Thesium australe*	1.8	8
Striped Legless Lizard	*Delma impar*	12.1	156
Squirrel Glider	*Petaurus norfolcensis*	3.8	75
Southern Myotis	*Myotis macropus*	0.3	9
		Total	**297**

10 CONCLUSION

A BDAR was prepared by Hunter Eco for the Project in July 2019 and Development Consent SSD 9526 was granted in December 2020. The Project was then modified in 2021 (Development Consent SSD 9526). The total amount of native vegetation to be disturbed for the Project (as modified) is approximately 166 ha.

This BDAR assesses some relatively minor modifications to the approved Project layout, using the extensive information from the previous BDARs for the Project and Modification 1, along with supplementary sampling. The additional amount of native vegetation to be disturbed as a result of the Modification is approximately 13.3 ha.

The credit calculation has determined the offset requirement for clearance of native vegetation (ecosystem credit requirement) and the offset requirement for clearance of known or potential habitat for the Leafless Tongue Orchid, Pine Donkey Orchid, Tarengo Leek Orchid, Austral Toadflax, Striped Legless Lizard, Southern Myotis and Squirrel Glider (species credit requirements).

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ATTACHMENT A

MAXWELL PROJECT BASELINE FLORA SURVEY REPORT

MALABAR COAL

MAXWELL PROJECT

BASELINE FLORA REPORT

HUNTER ECO

Prepared by
Dr Colin Driscoll

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

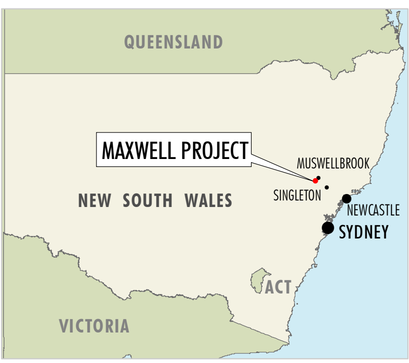
Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar Coal Limited (Malabar), is seeking consent to develop an underground coal mining operation, referred to as the Maxwell Project (the Project).

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*.

SHM-18-03 Maxwell_EIS_App Flora_202B



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

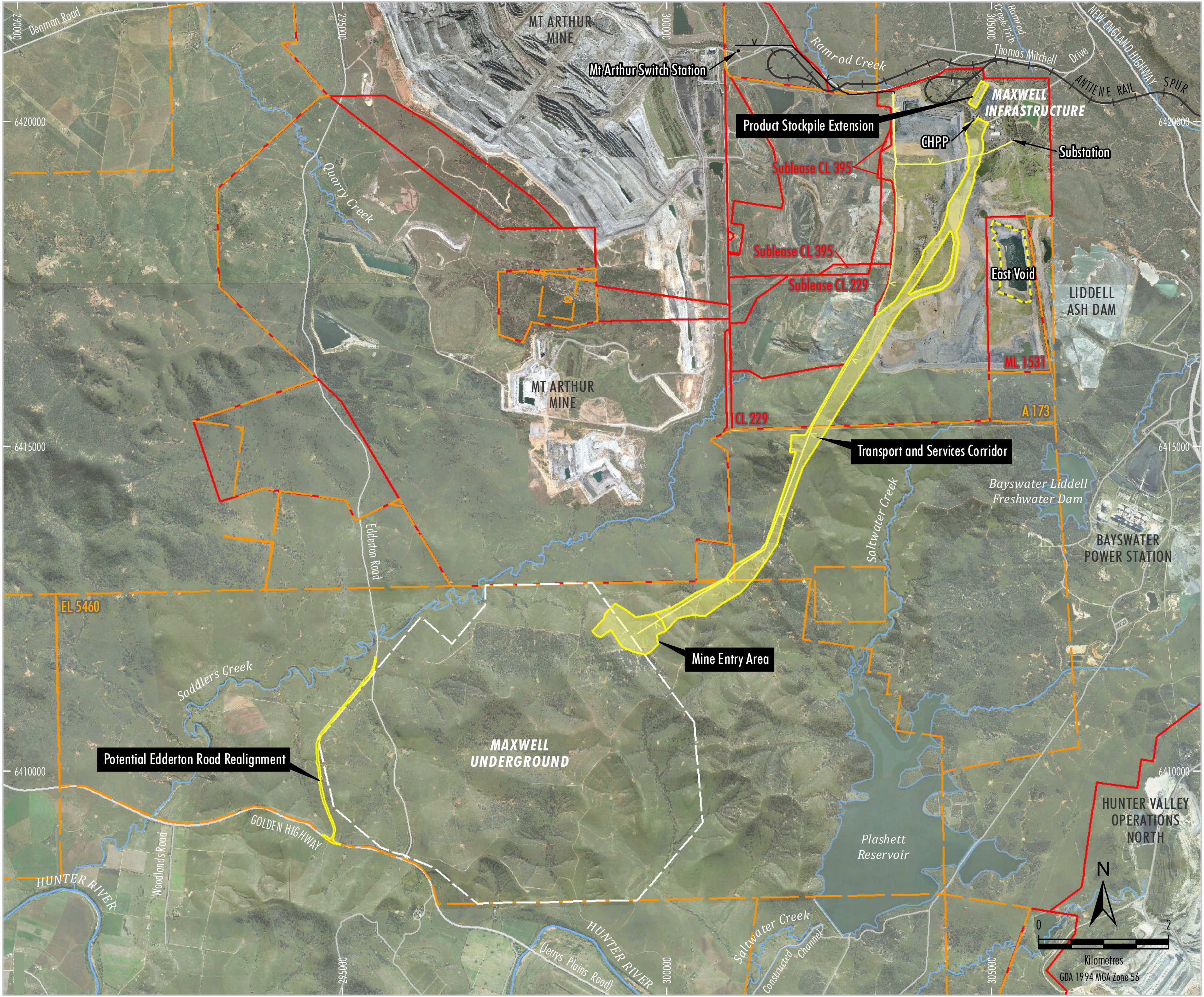
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services and Innovation (2019); Office of Environment and Heritage NSW (2019)

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.

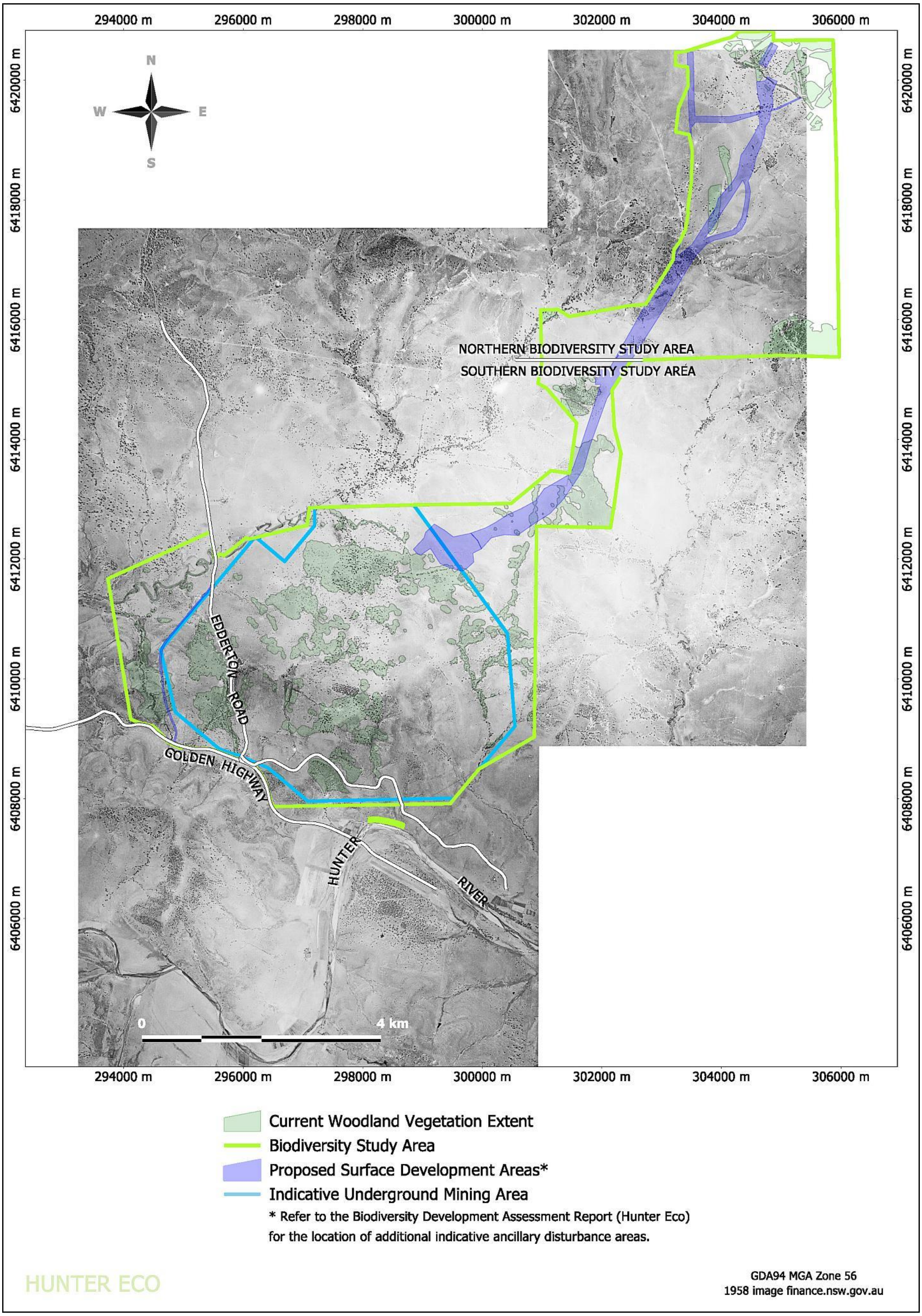


Figure 3: 1958 Aerial Image of the Study Area

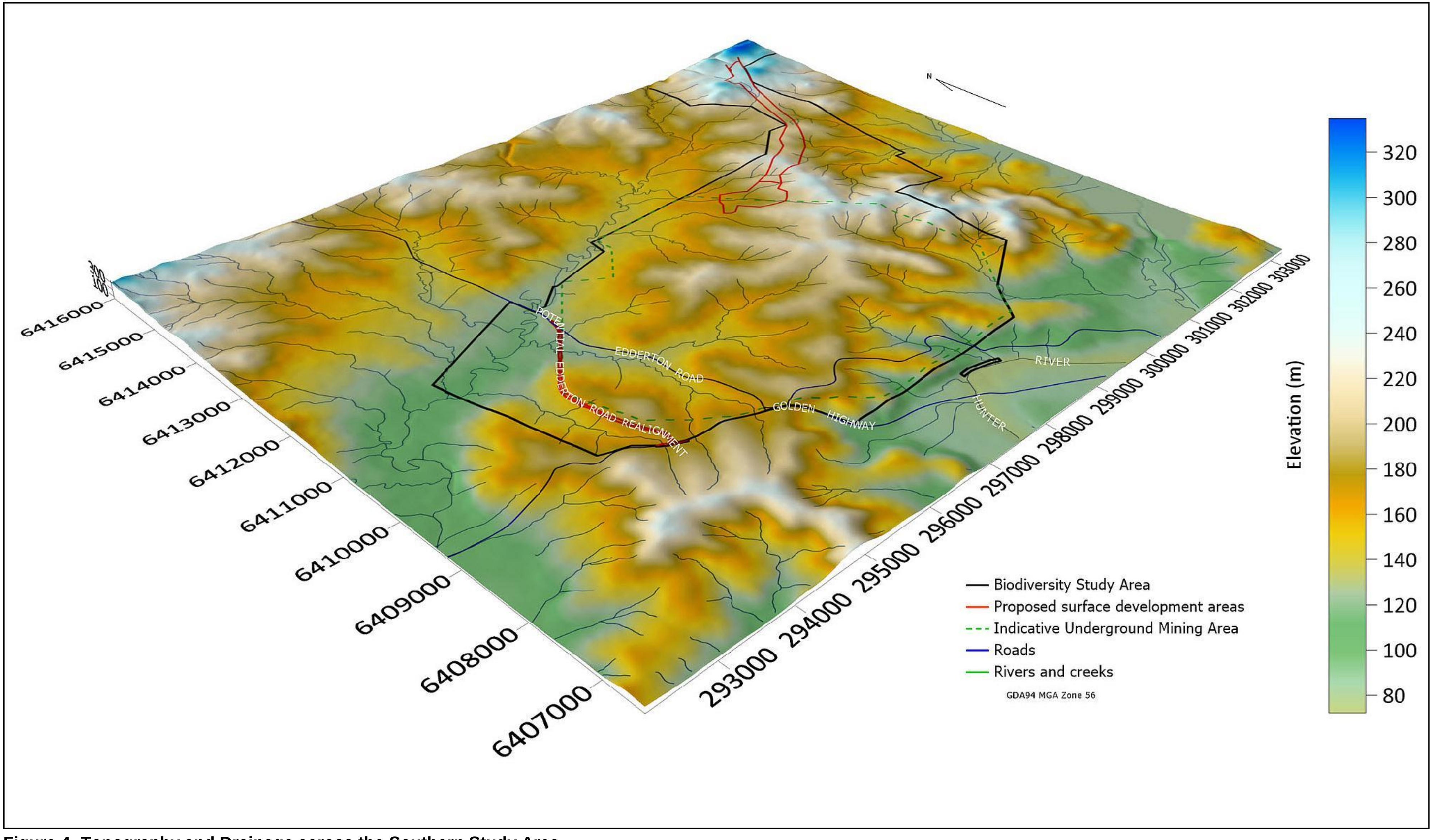


Figure 4: Topography and Drainage across the Southern Study Area

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.

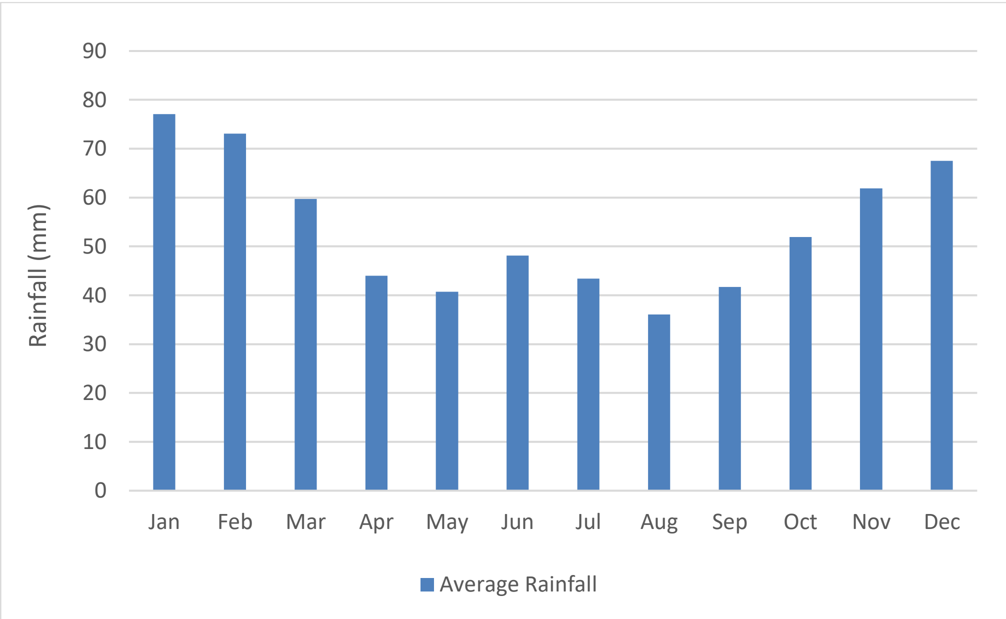


Figure 5: Long-term average monthly rainfall at Jerrys Plains Post Office (Station Number 061086)

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).

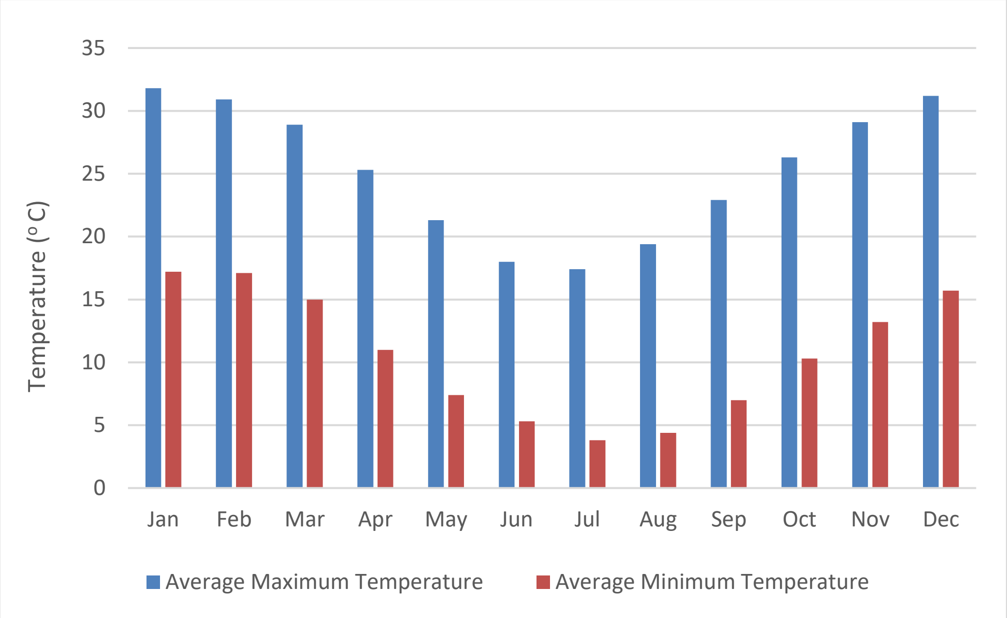


Figure 6: Long-term monthly average maximum and minimum temperatures at Jerrys Plains Post Office (Station Number 061086)

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.

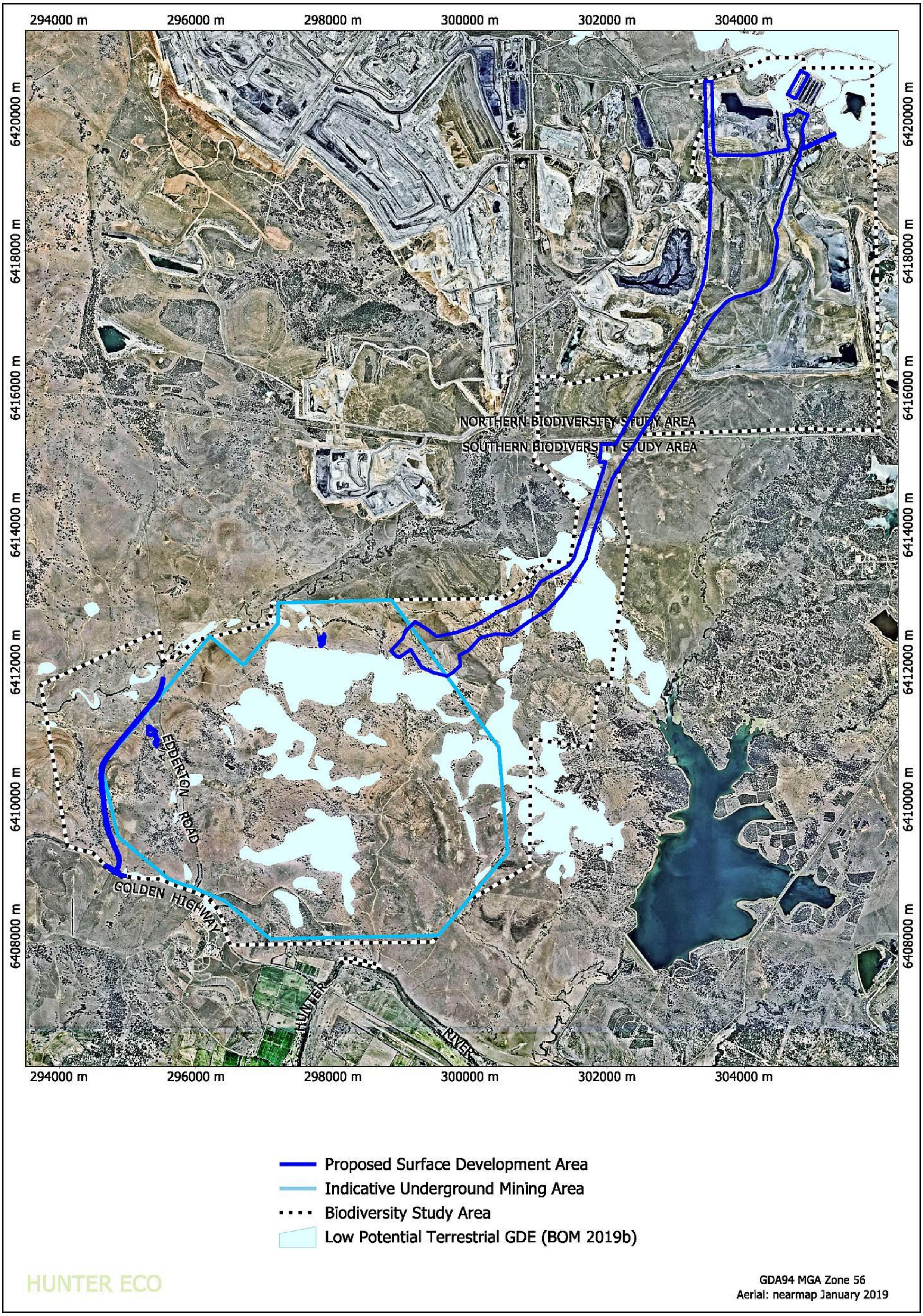


Figure 7: Predicted Areas of Low Potential GDE

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.

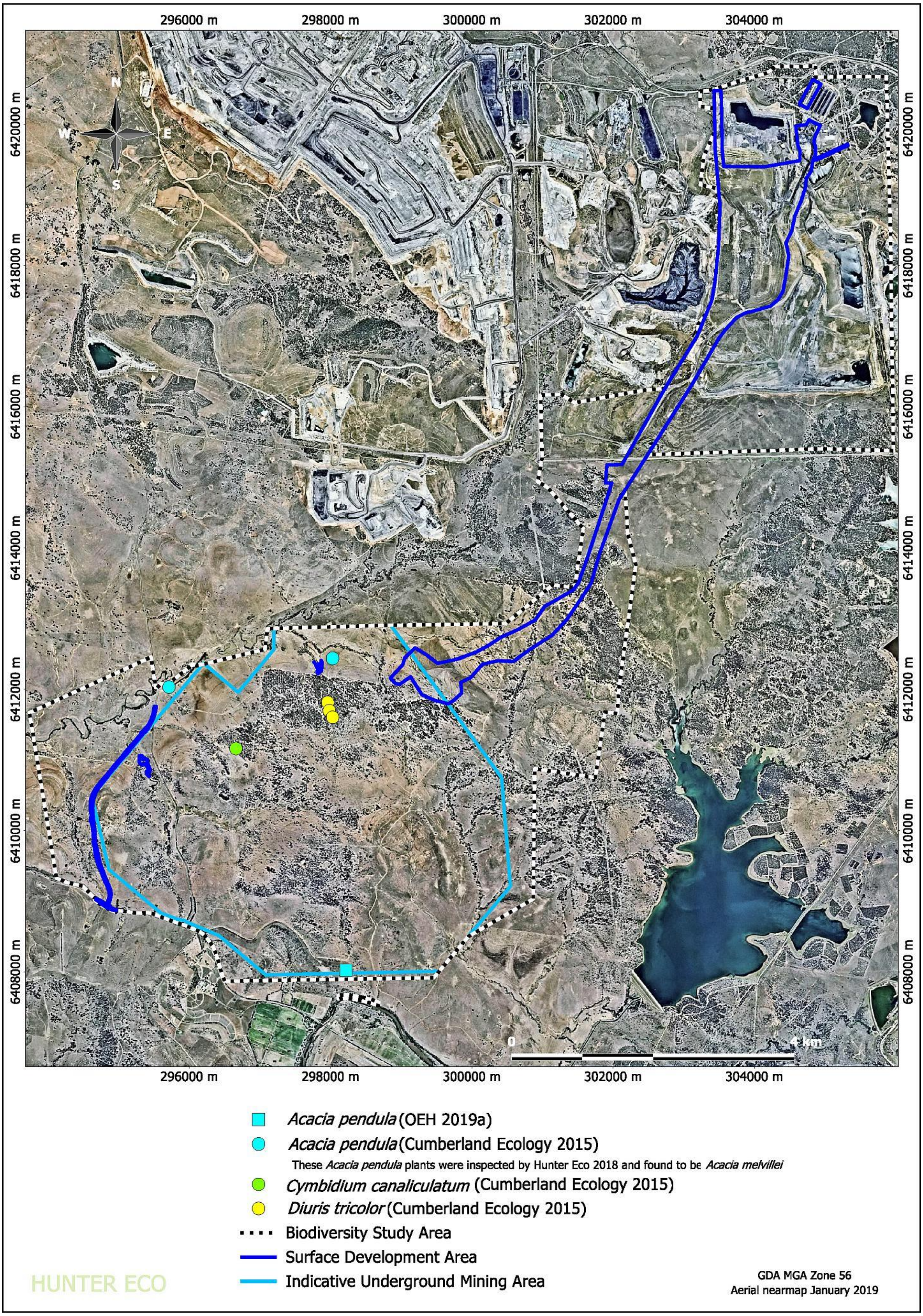


Figure 8: Location of Previously Recorded Flora Species Representative of Endangered Populations

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.

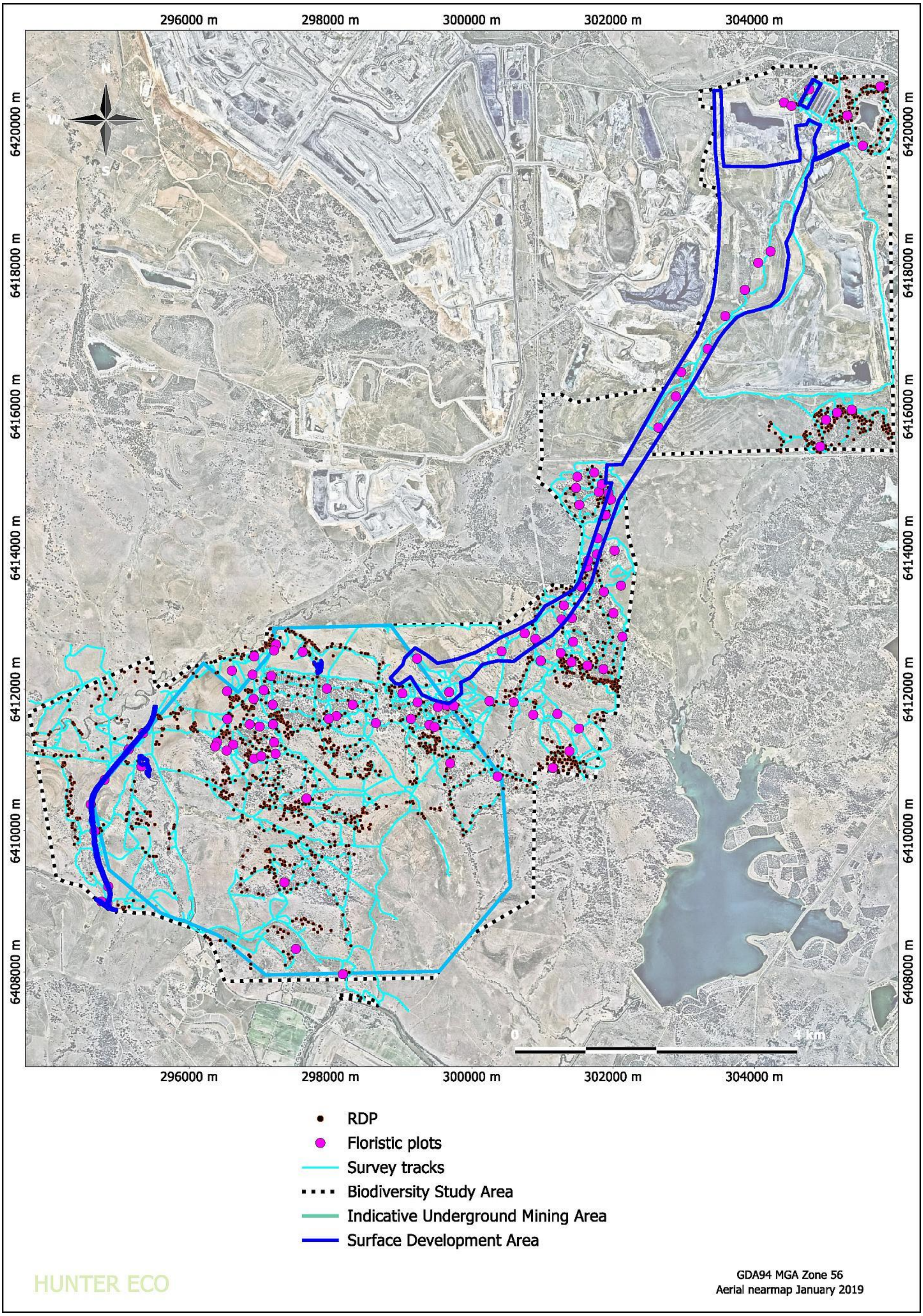
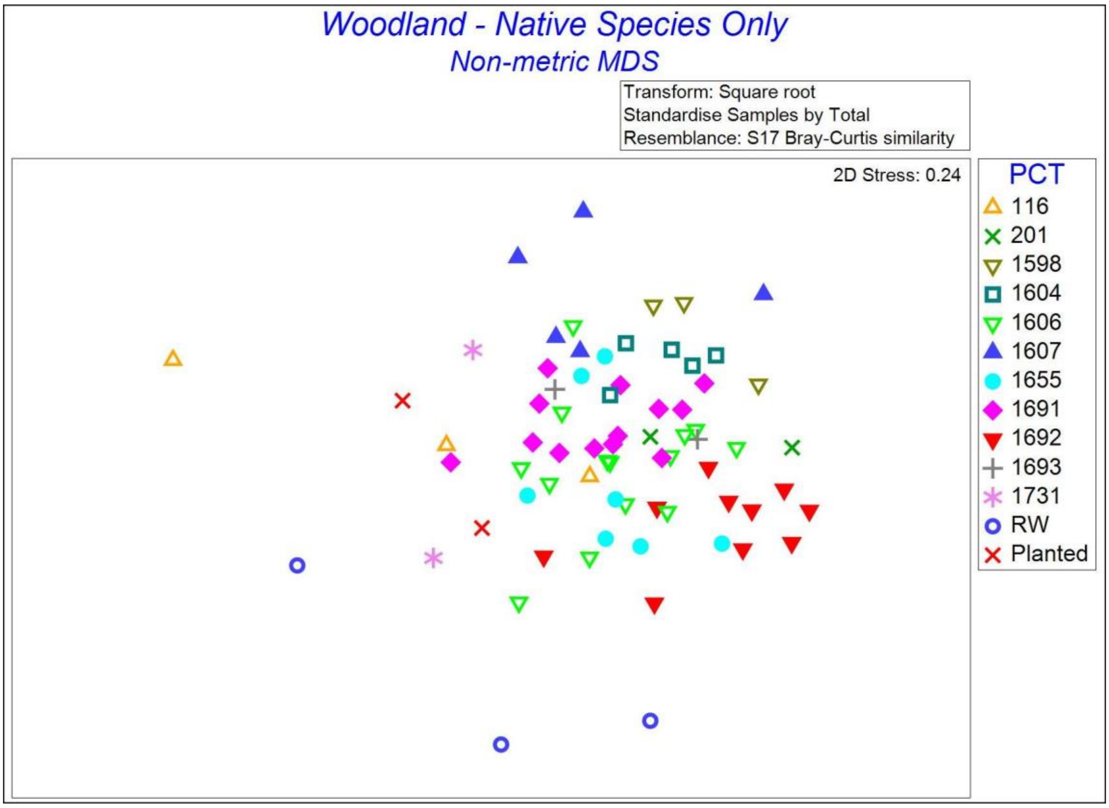
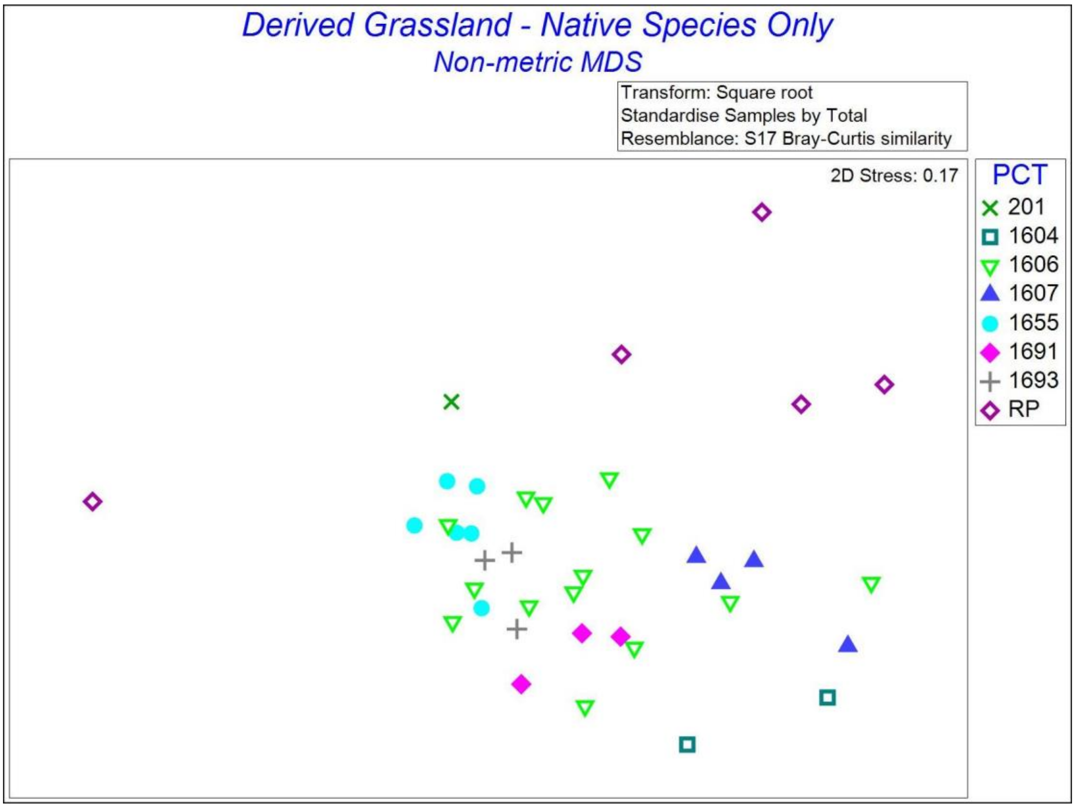


Figure 9: Field Survey Details



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.

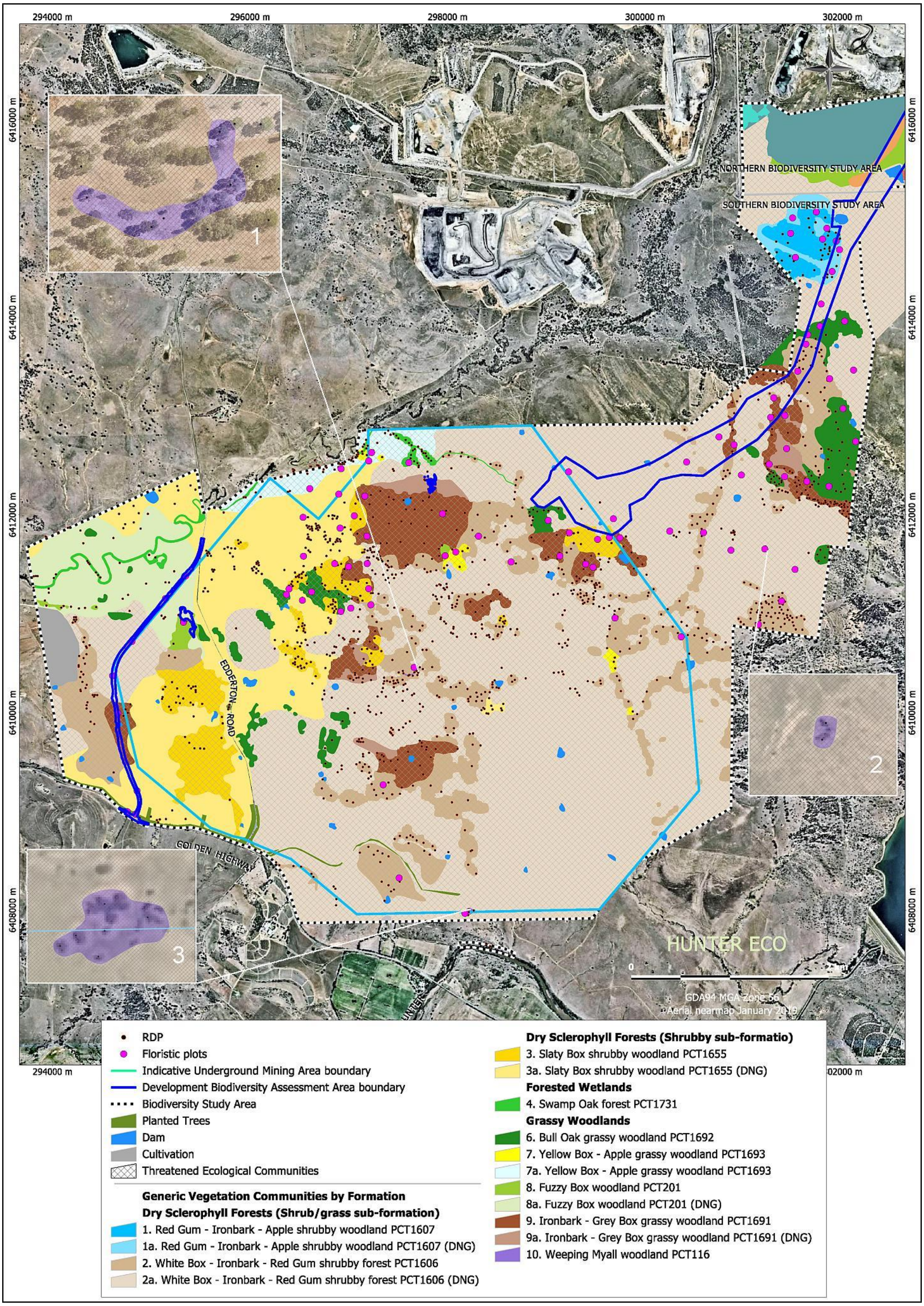


Figure 12: Generic Vegetation Communities Mapped across the Southern Study Area

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.

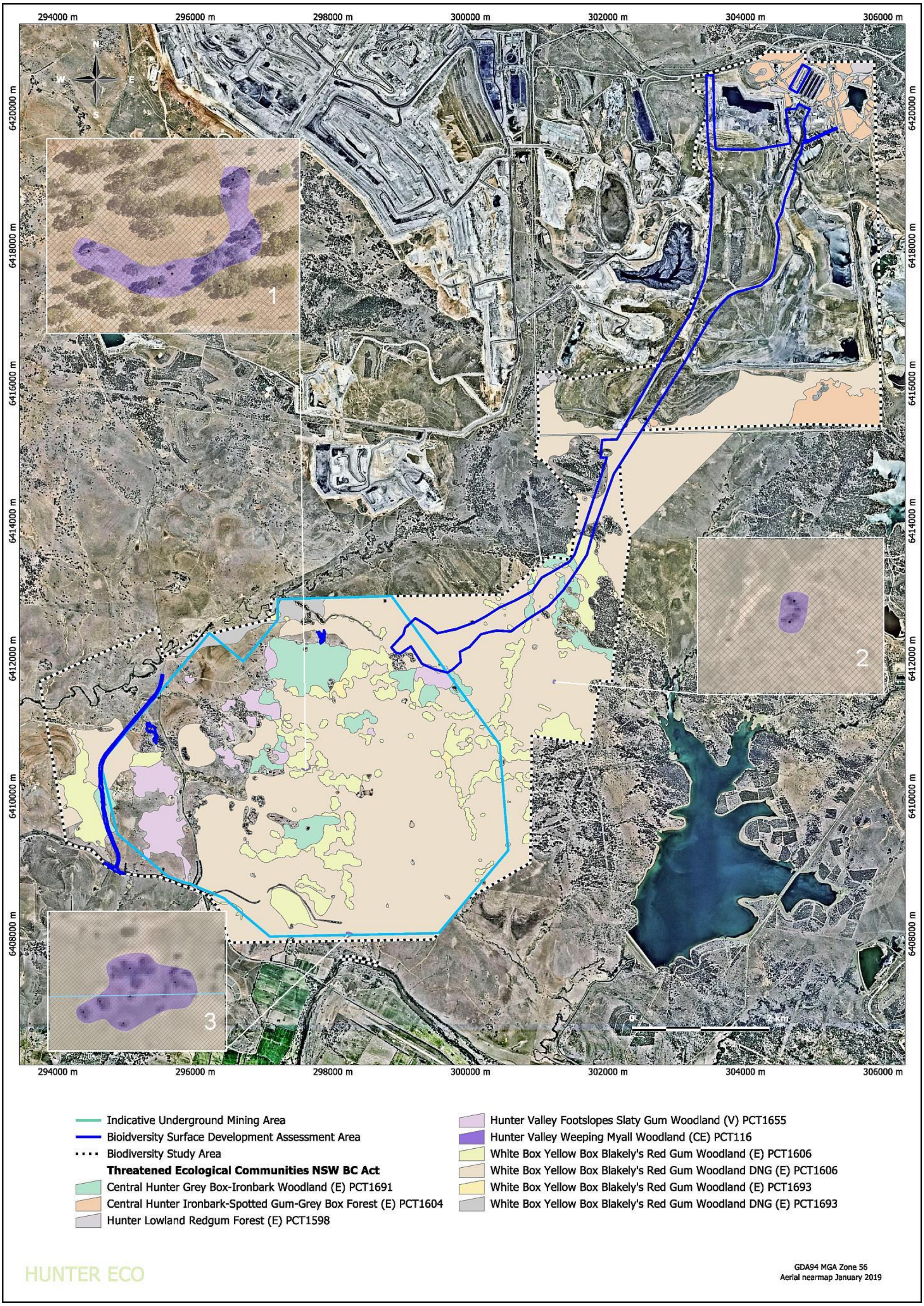


Figure 14: Threatened Ecological Communities NSW BC Act

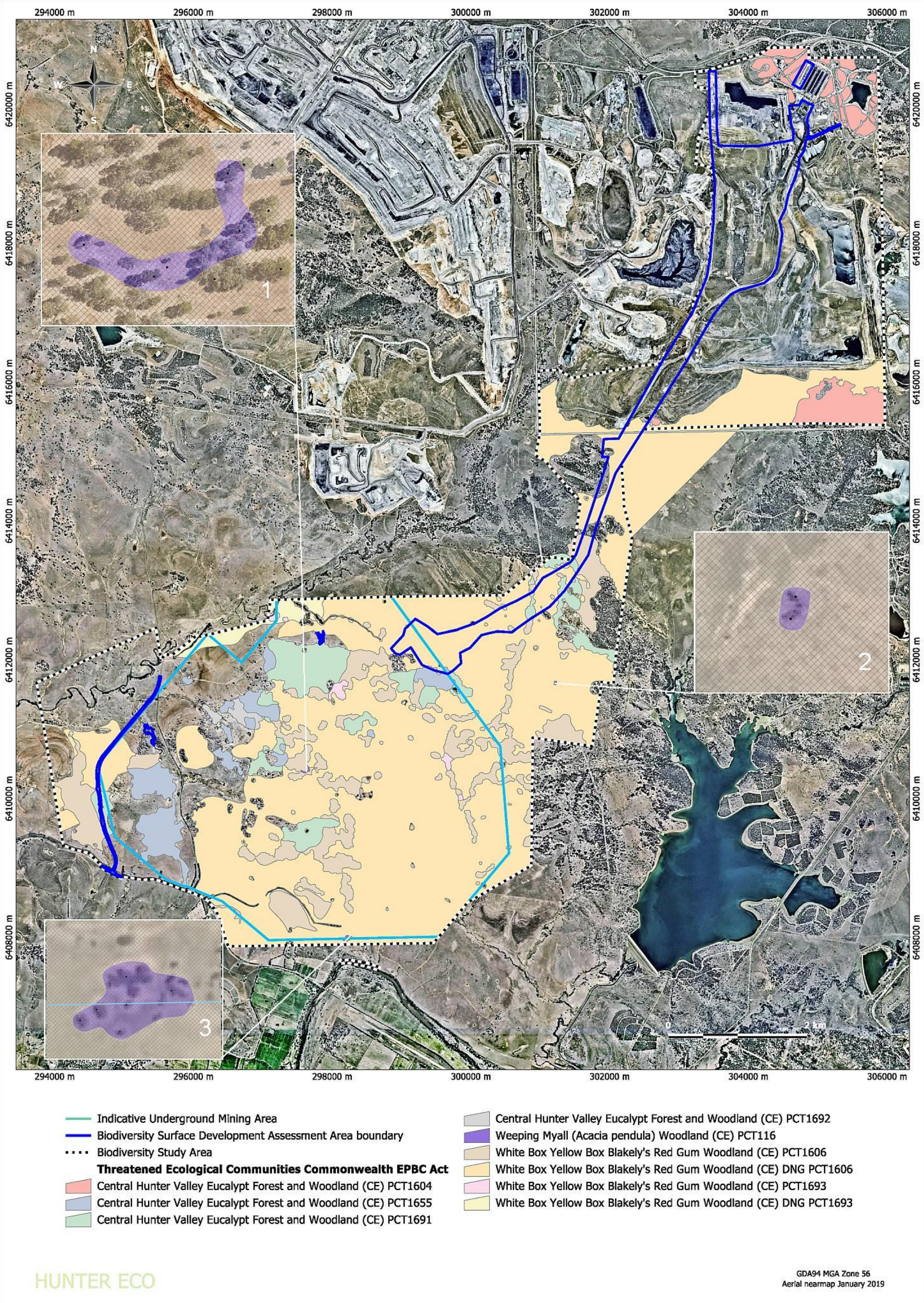


Figure 15: Threatened Ecological Communities Commonwealth EPBC Act

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.

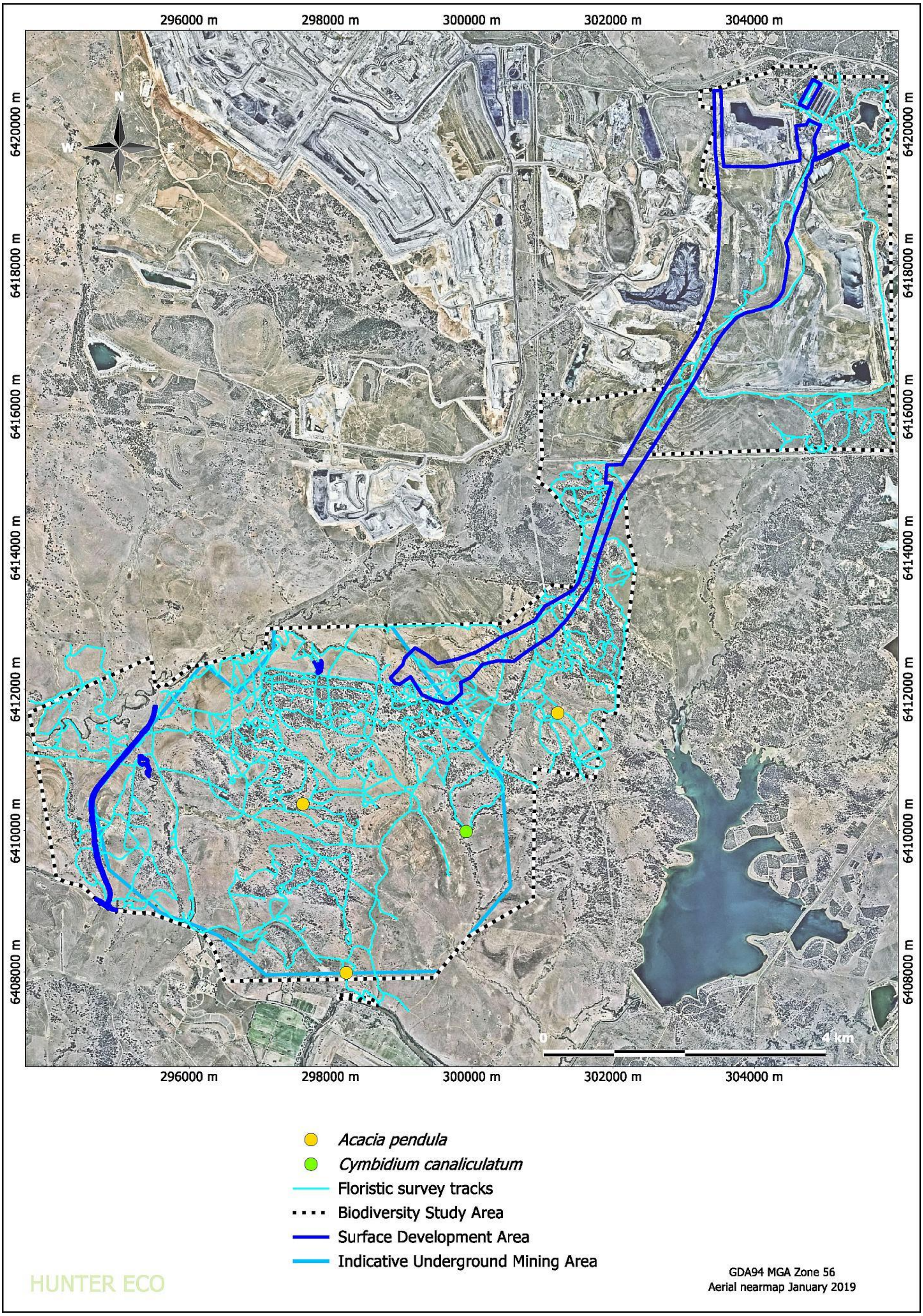


Figure 16: The Location of Individuals from Endangered Populations Recorded by Hunter Eco

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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*

Family and Species
**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

Family and Species
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	·	·	·	·	·	·	·	·

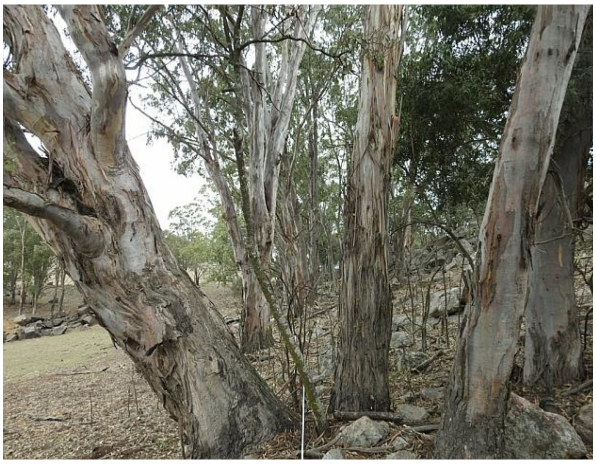
Grassland Communities	**Plant Community Type**							
Family and Species	**201**	**1604**	**1606**	**1607**	**1655**	**1691**	**1693**	**RP**
Austrostipa nodosa								·
Austrostipa scabra subsp. scabra				·				
Austrostipa verticillata			·	·				
Bothriochloa biloba			·					
Bothriochloa decipiens			·	·	·	·	·	·
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

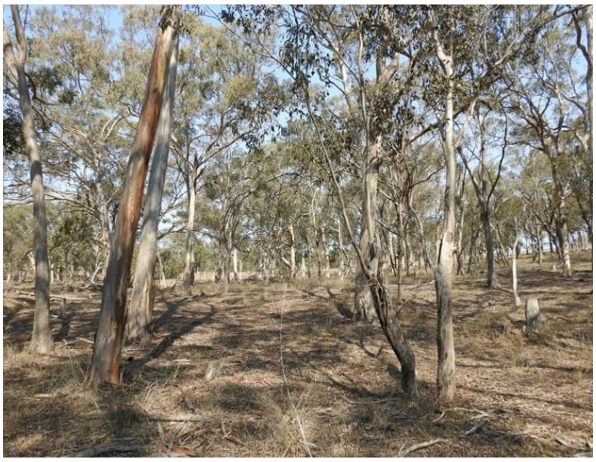
Native species 60; Weeds 23 including High Threat Weeds 3
Plots: 14
Mean species/plot 37.7±10.4SD

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
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		Draft V1C	17/4/2019
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This report should be cited as: '*Future Ecology (2019) Malabar Project Baseline Fauna Survey Report. Prepared for Malabar Coal Limited'*.

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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

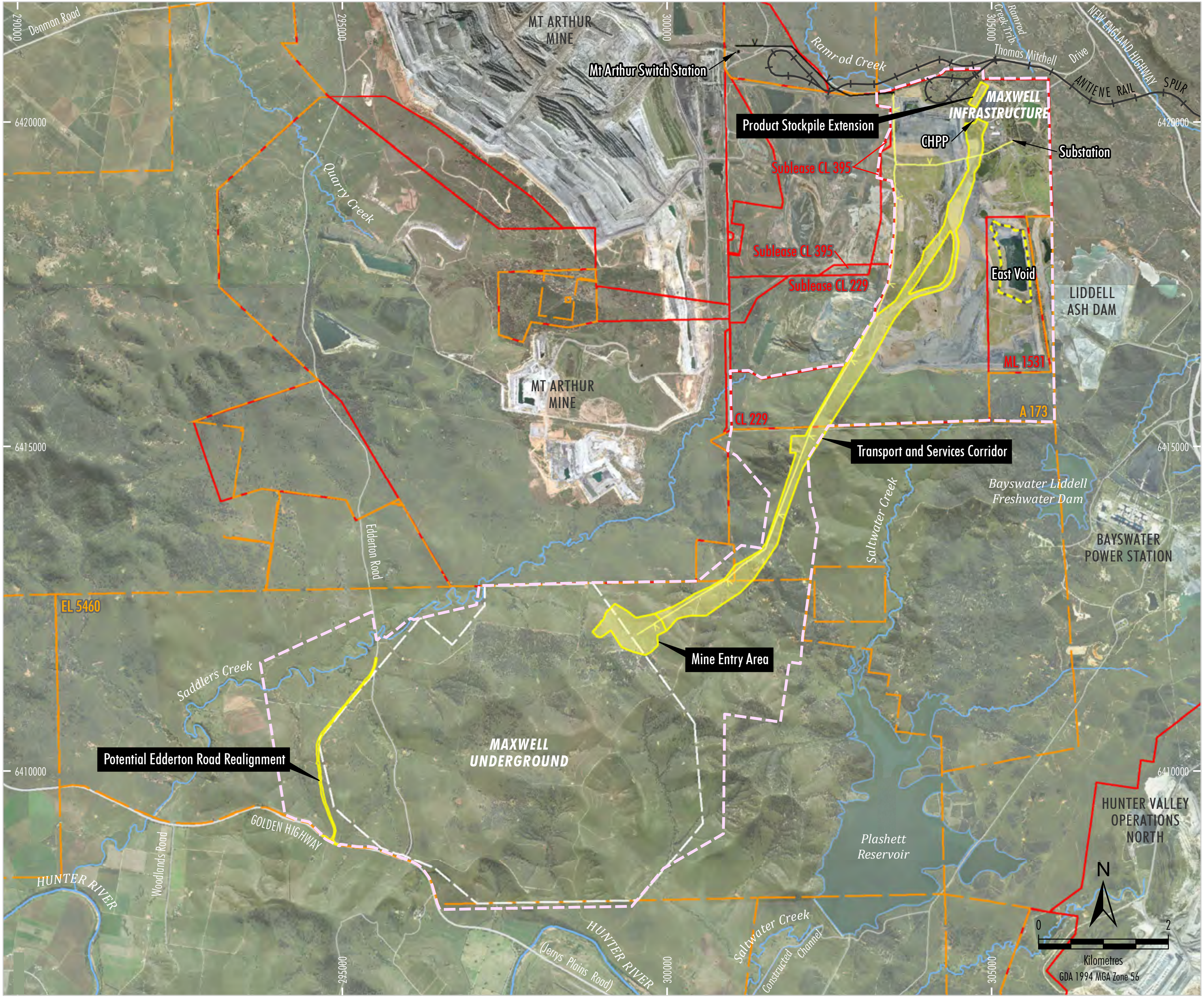
Source: © NSW Department of Planning and Environment (2019); NSW Department of Finance, Services and Innovation (2019); Office of Environment and Heritage NSW (2019)

MALABAR COAL

M A X W E L L   P R O J E C T

Regional Location

Figure 1



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.

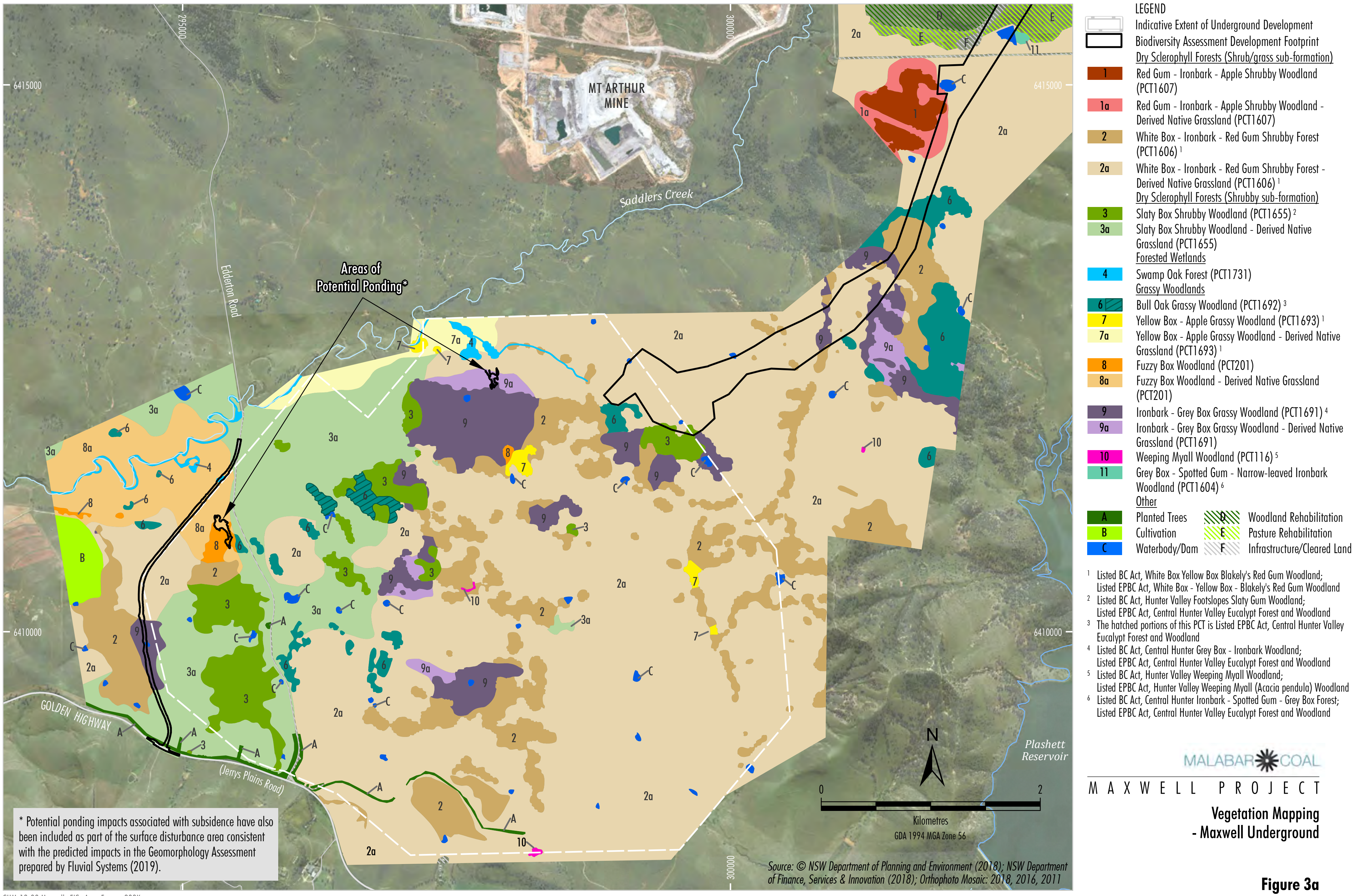
In the eastern portion of the Maxwell Underground area, another series of ephemeral creeks and drainage lines drain moderate to steeply sloping hills before feeding into Saltwater Creek, a 5th order stream immediately upstream of the Hunter River.

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.



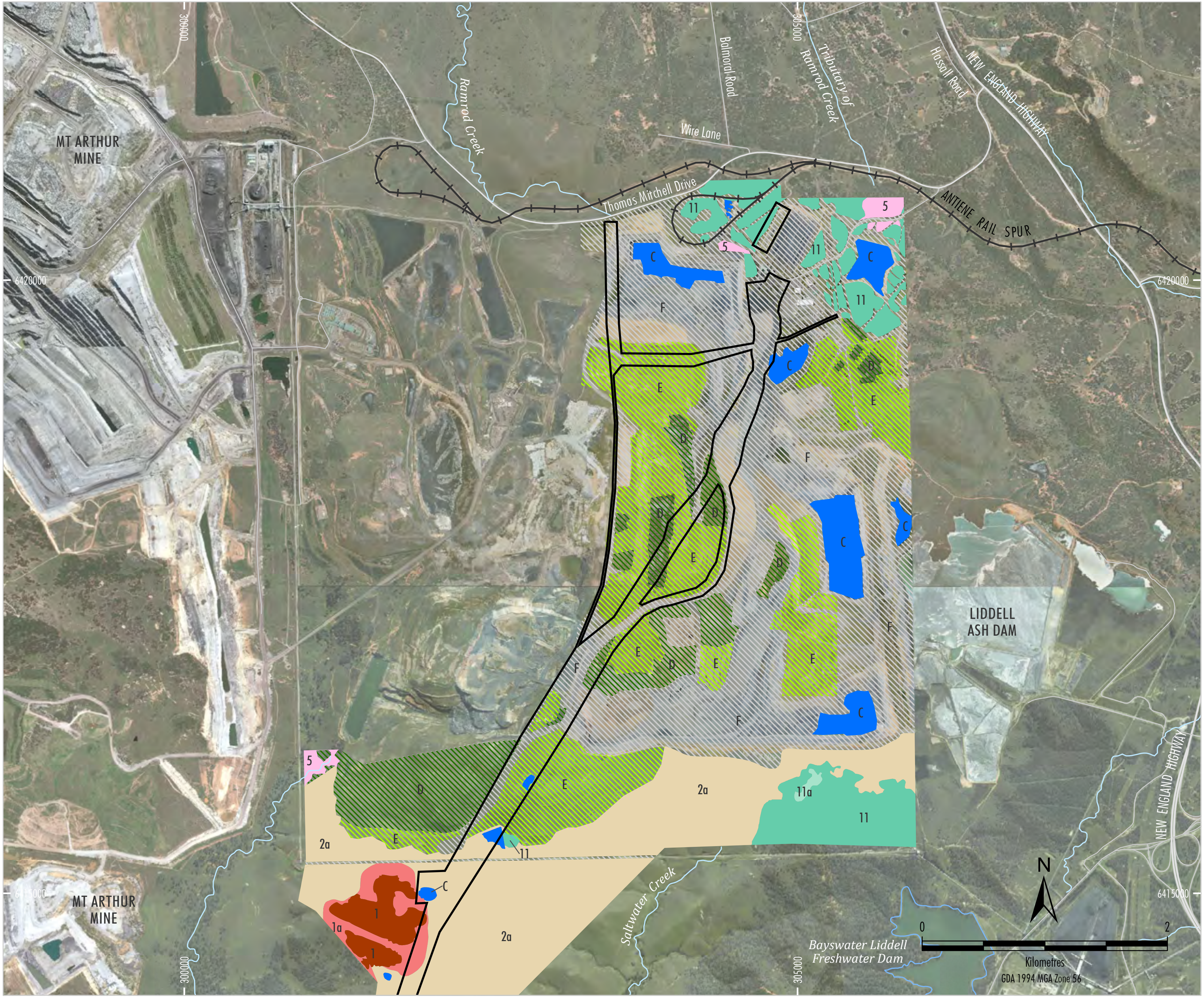
MALABAR COAL

M A X W E L L   P R O J E C T

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)

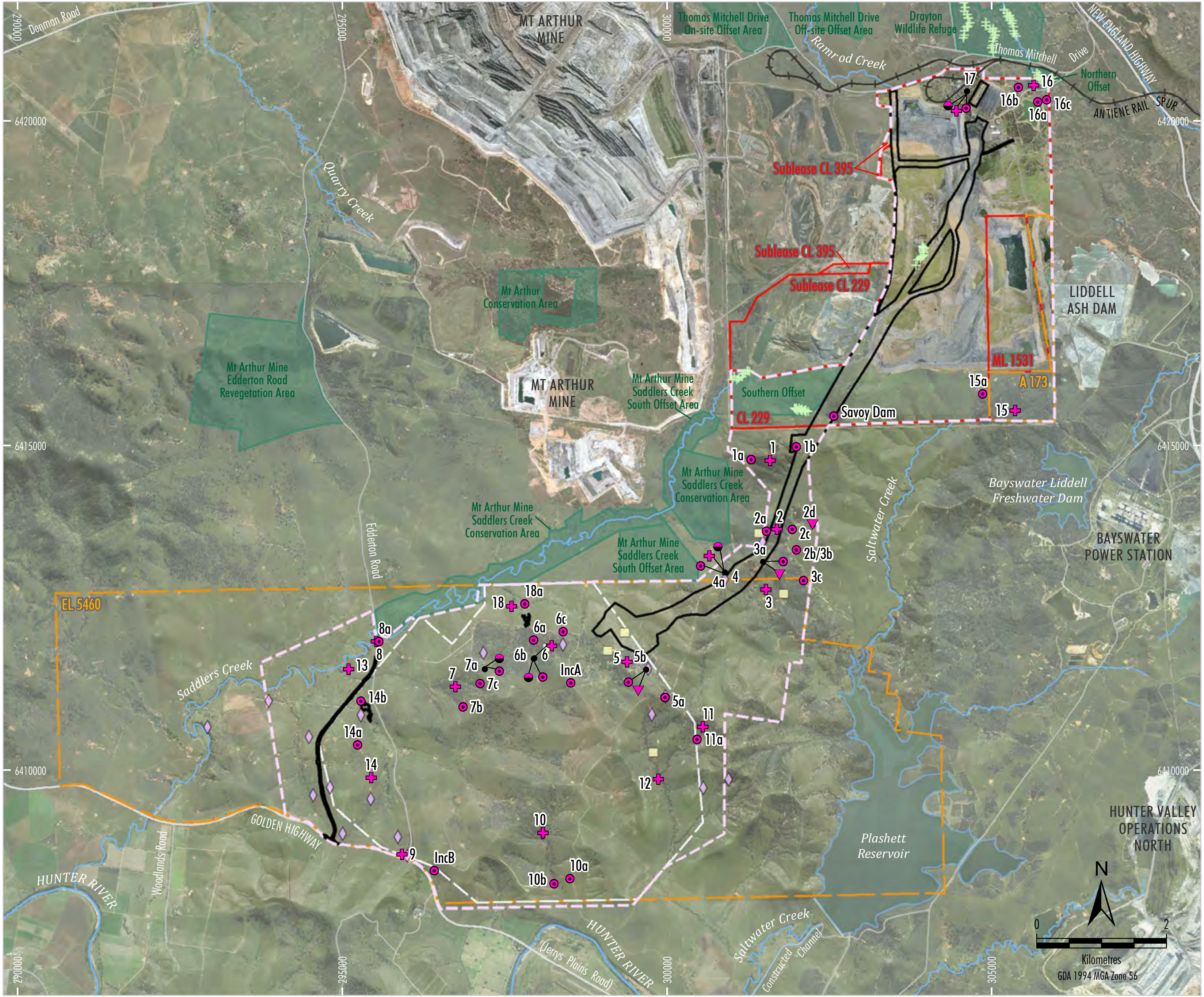
Sources: BOM (2018a), Geoscience Australia (2018a, 2018b), Sydney Observatory (2018), Maxwell Infrastructure CHPP AWS.

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.



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

Future Ecology Sites
- General Fauna Survey Site
- Mammal Survey Site
- Pitfall Trap
- Artificial Habitat (Tiles)

Eco Logical Australia (2017) Sites
- Monitoring Location

Cumberland Ecology (2012) Sites
- Bird Census
- Cage Trap
- Infrared Camera

Ecotone (2000) Sites
- Call Playback

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

MALABAR COAL

M A X W E L L P R O J E C T

Fauna Survey Sites

Figure 4

SHM-18-03 Maxwell_EIS_App_Fauna_213H

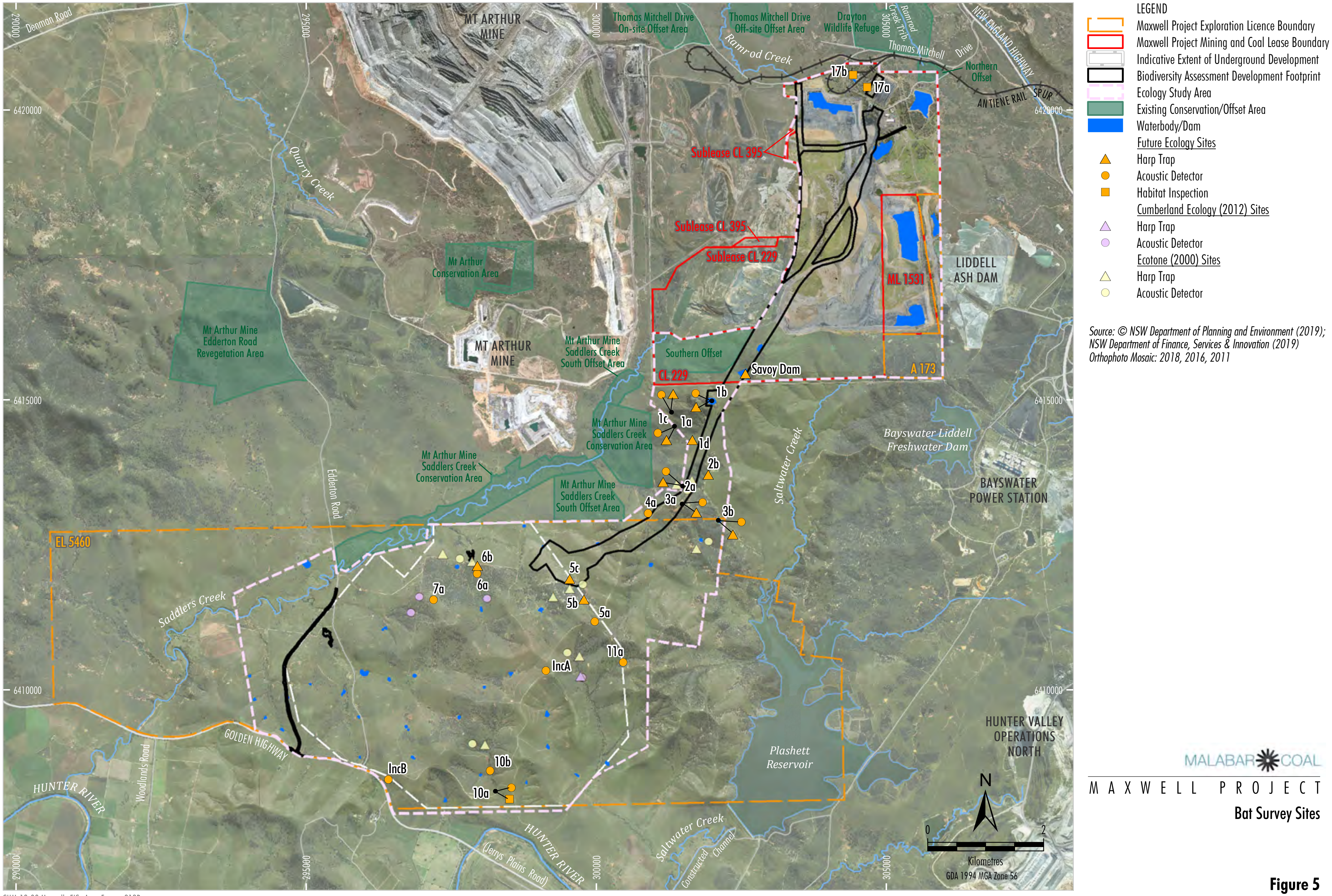
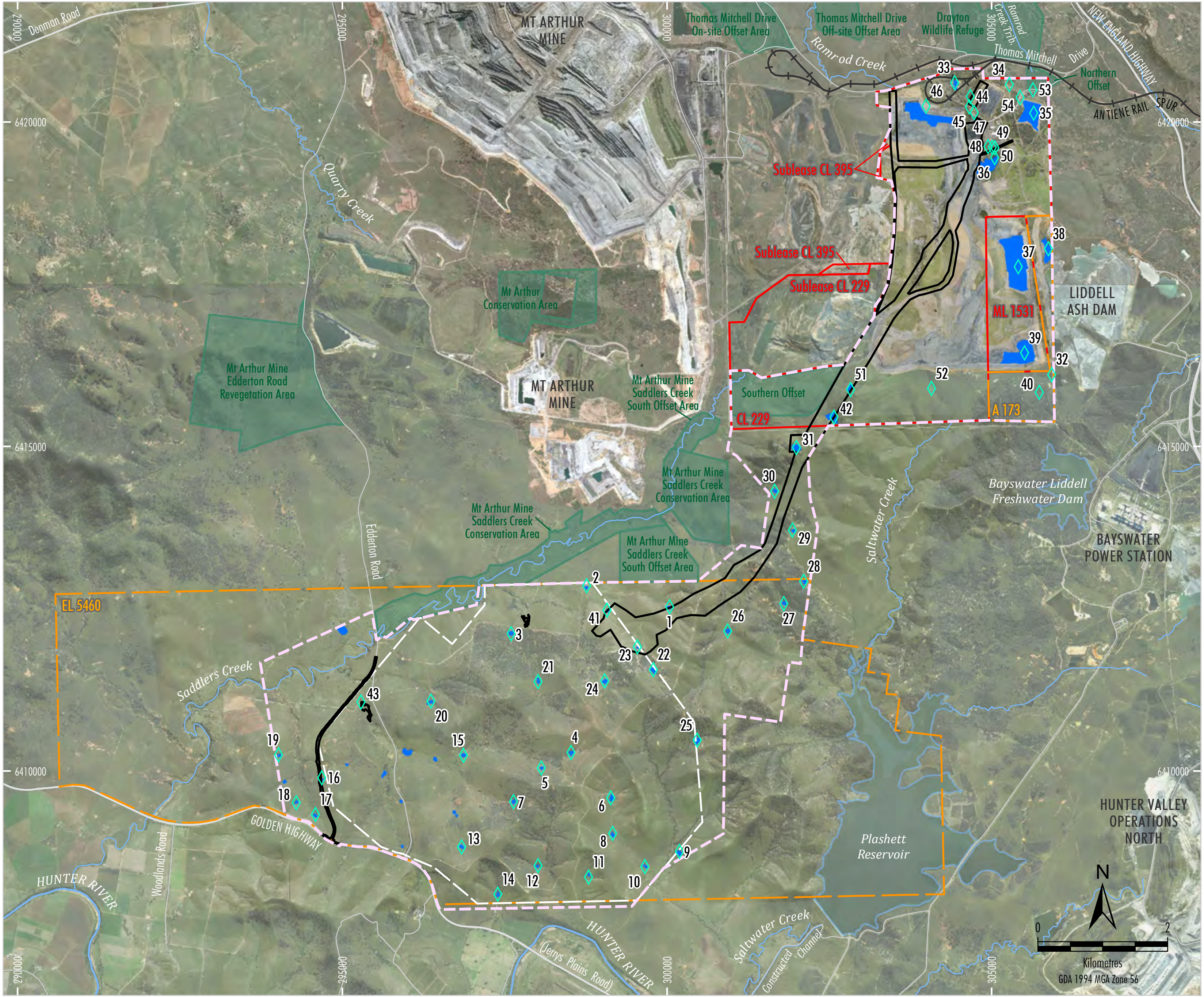


Figure 5

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/3 b, 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 EPBC Act[1]	BC Act[2]	Credit Class[3]	Survey Guideline Requirements	Survey Timing (OEH, 2019a)	Survey Techniques and Effort undertaken by Future Ecology
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.

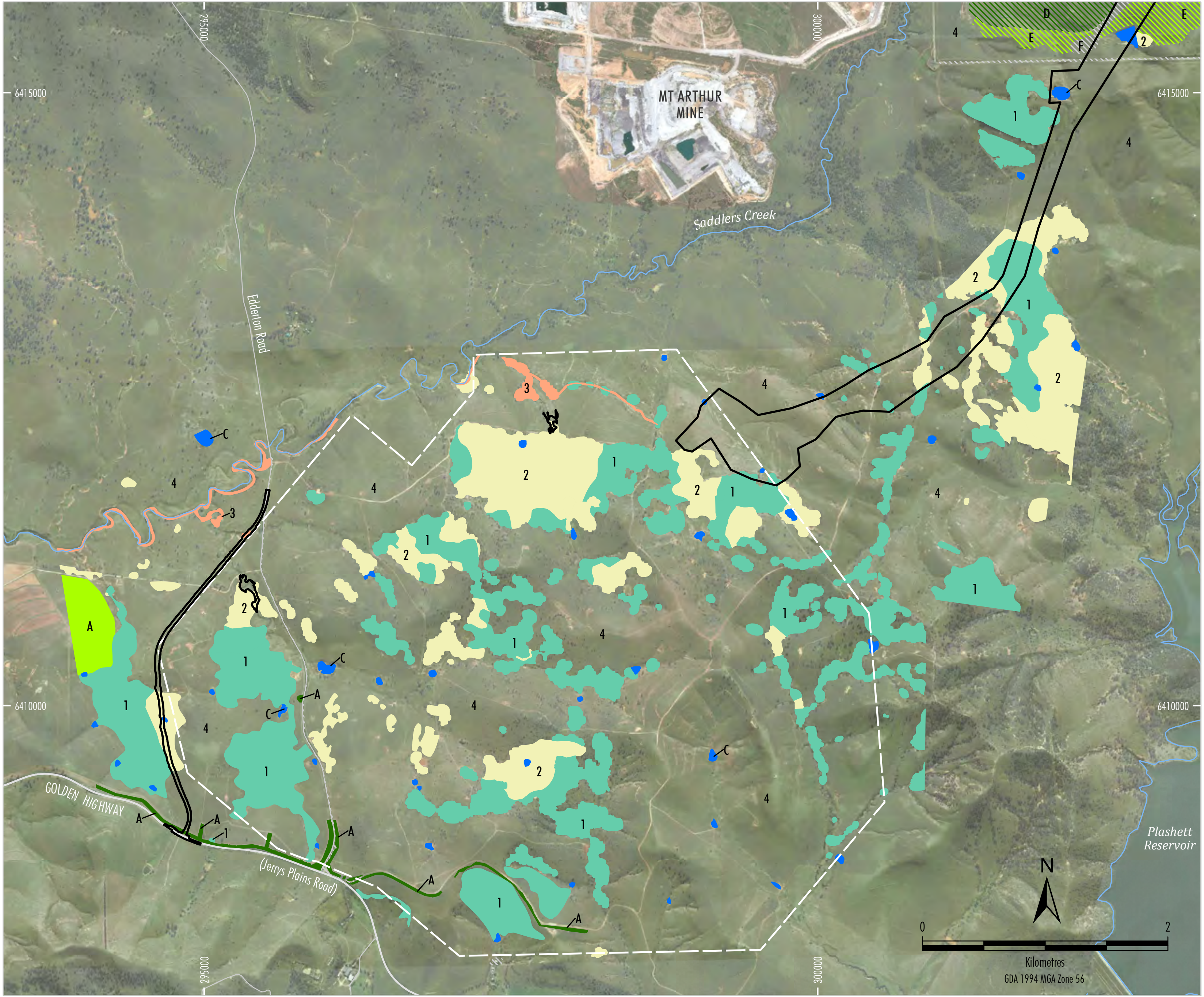
Some relatively small areas of scattered surface rock were observed throughout the study area including at most survey sites. Observed surface rock was generally small (<50 cm diameter) and rocks were mostly located directly on soil rather than rock on rock. The exception to this was at Sites 1 and IncB (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

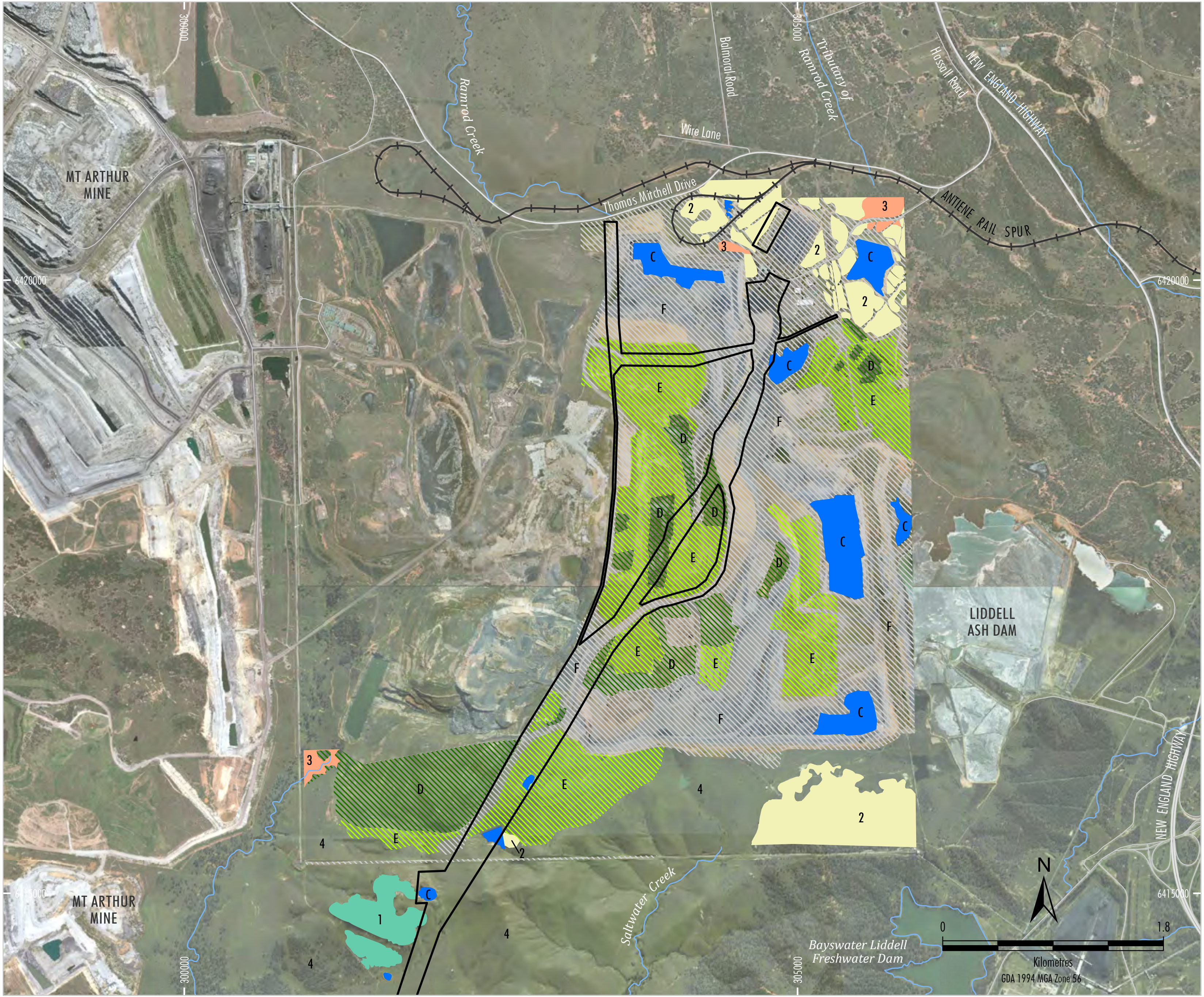
MALABAR COAL

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.

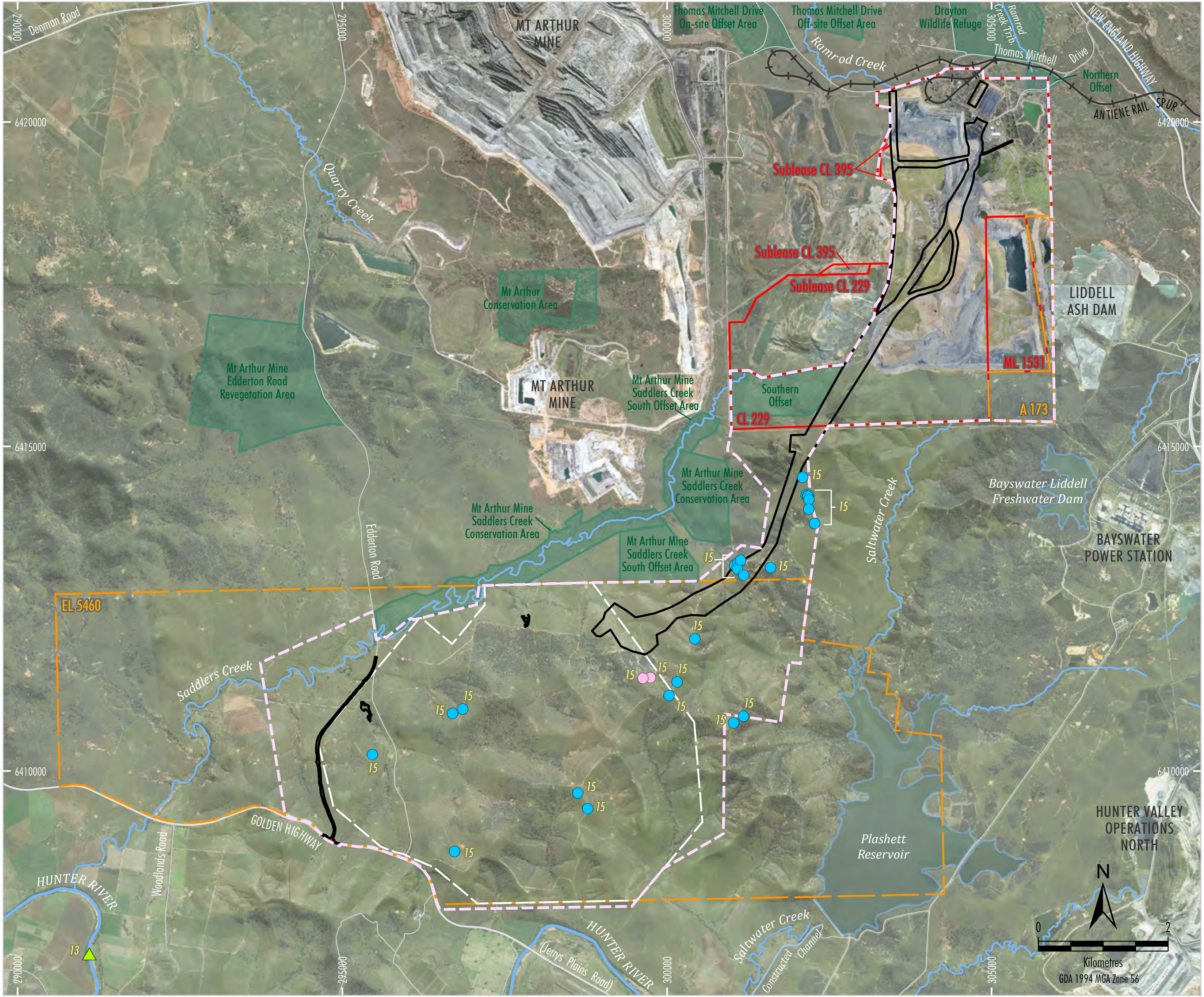
This represents the first record of this species in the Muswellbrook LGA and represents an eastern range extension of its current known distribution with the closest record being from Goulburn River National Park about 80 km to the west of the study area and dated 2000 (OEH, 2019b).

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

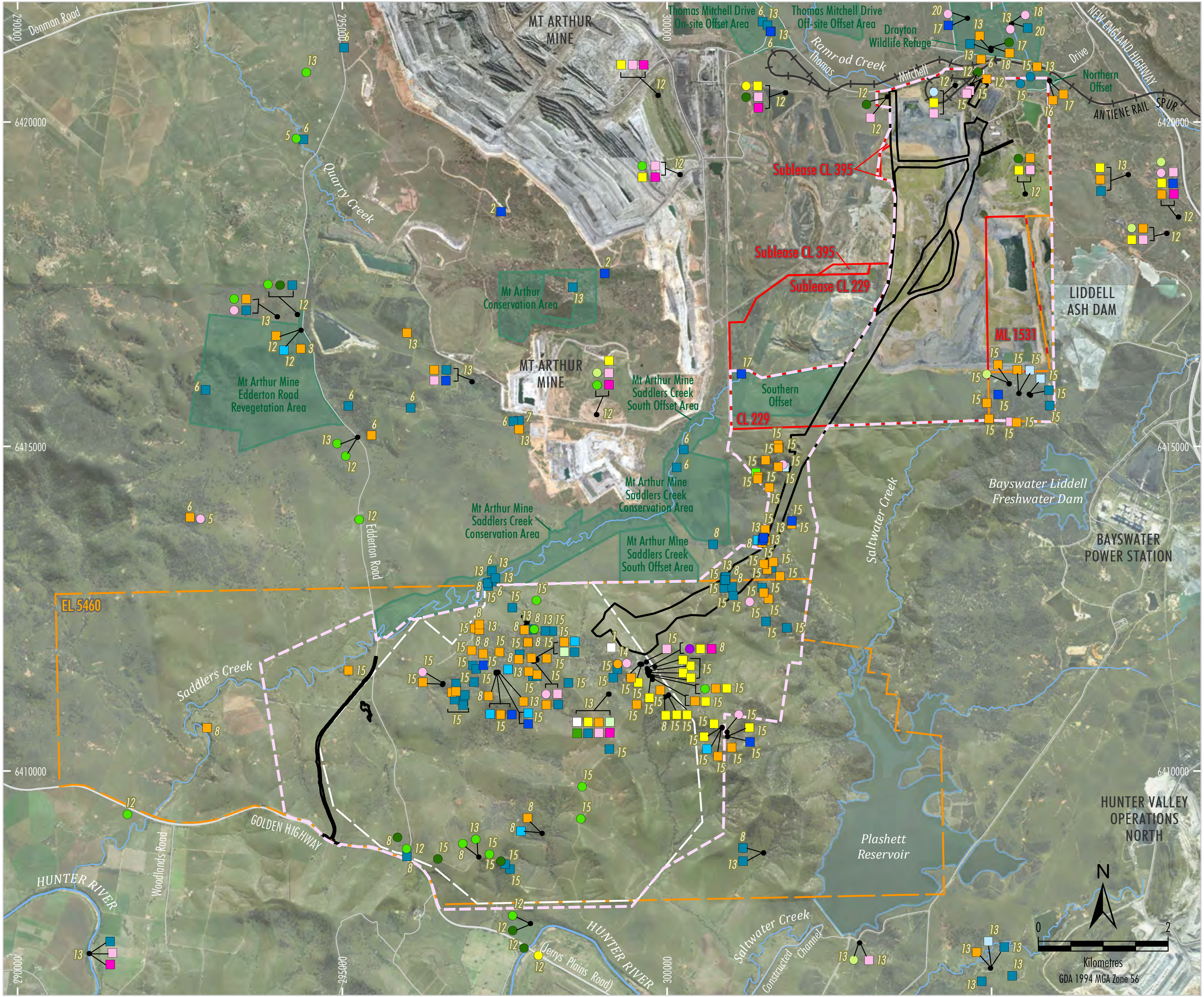
MALABAR COAL

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

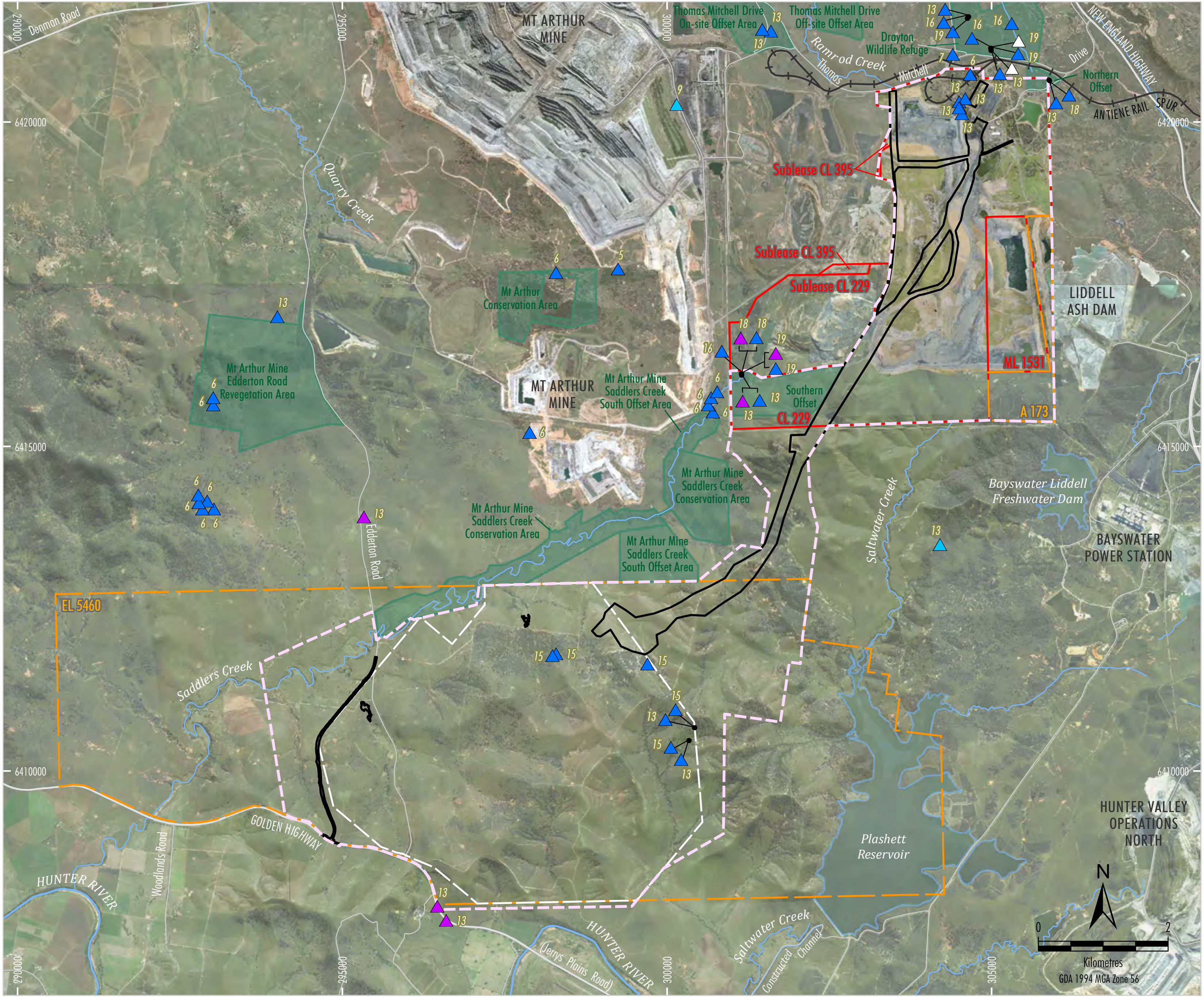
MALABAR COAL

MAXWELL PROJECT

Threatened Birds

Figure 9

SHM-18-03 Maxwell_EIS_App_Fauna_208F



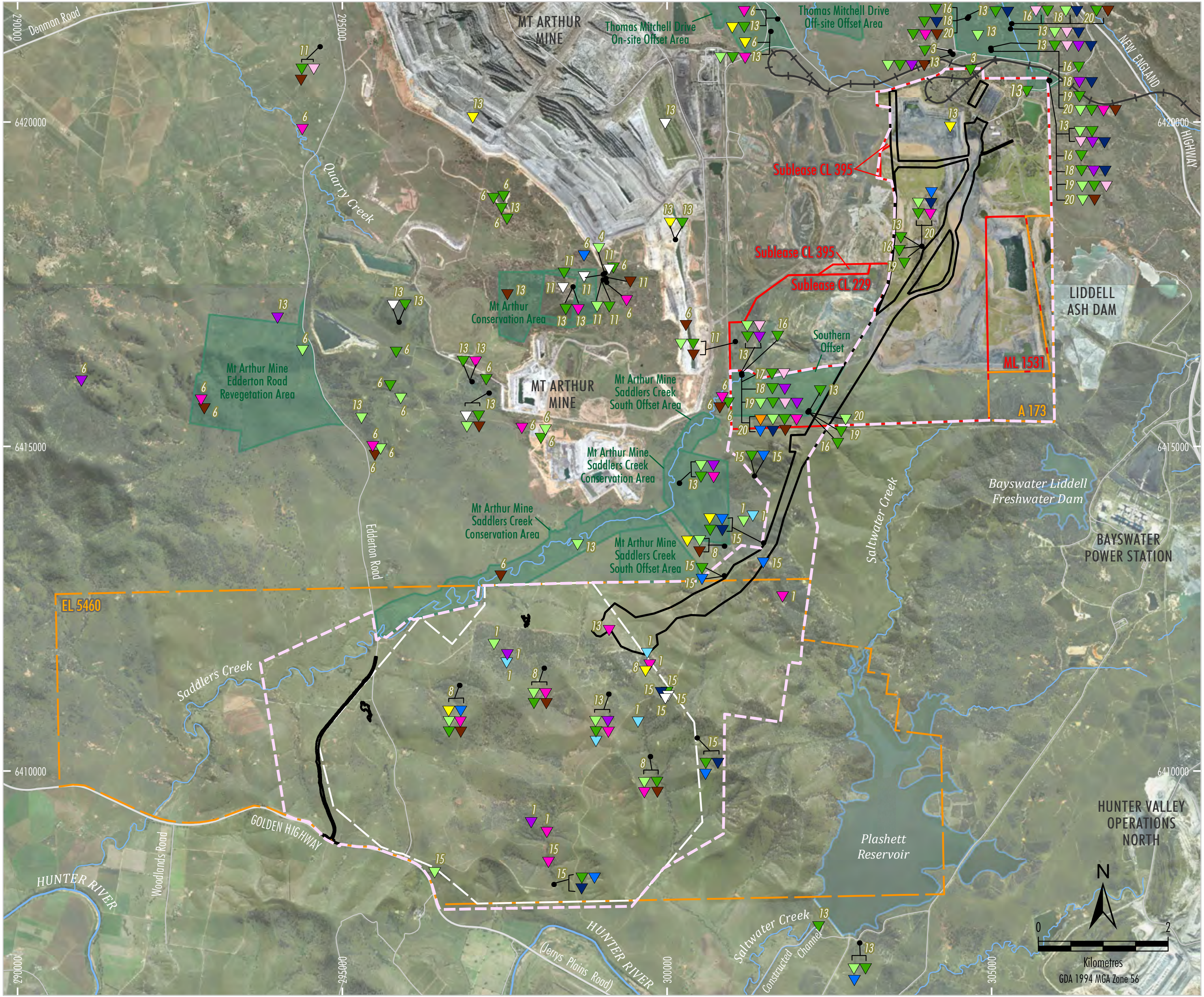
LEGEND
Maxwell Project Exploration Licence Boundary
Maxwell Project Mining and Coal Lease Boundary
Indicative Extent of Underground Development
Biodiversity Assessment Development Footprint
Ecology Study Area
Existing Conservation/Offset Area
Threatened Species
Spotted-tailed Quoll
Brush-tailed Phascogale
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



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

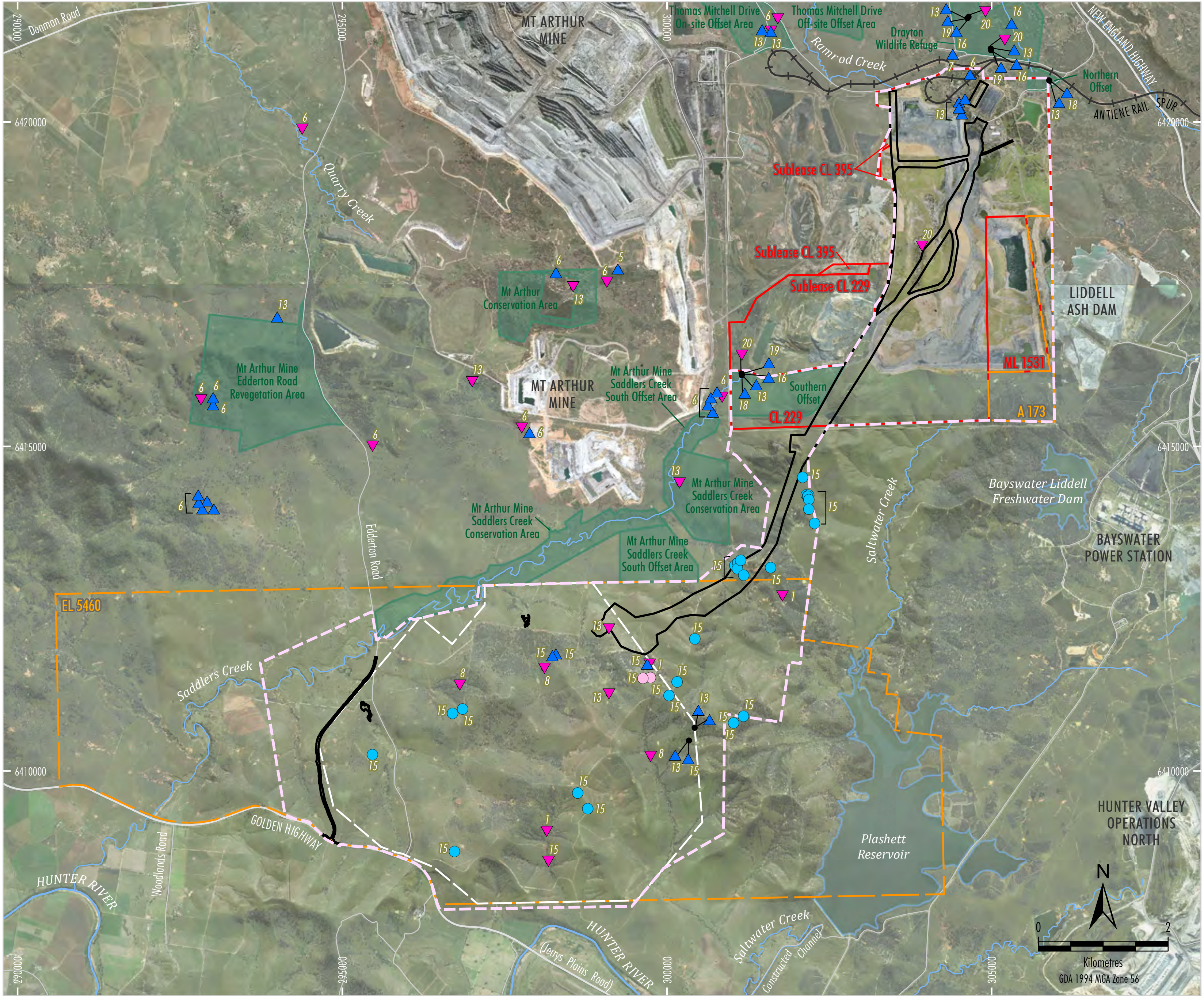
MALABAR COAL

MAXWELL PROJECT

Threatened Bats

Figure 11

SHM-18-03 Maxwell_EIS_App_Fauna_227C



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

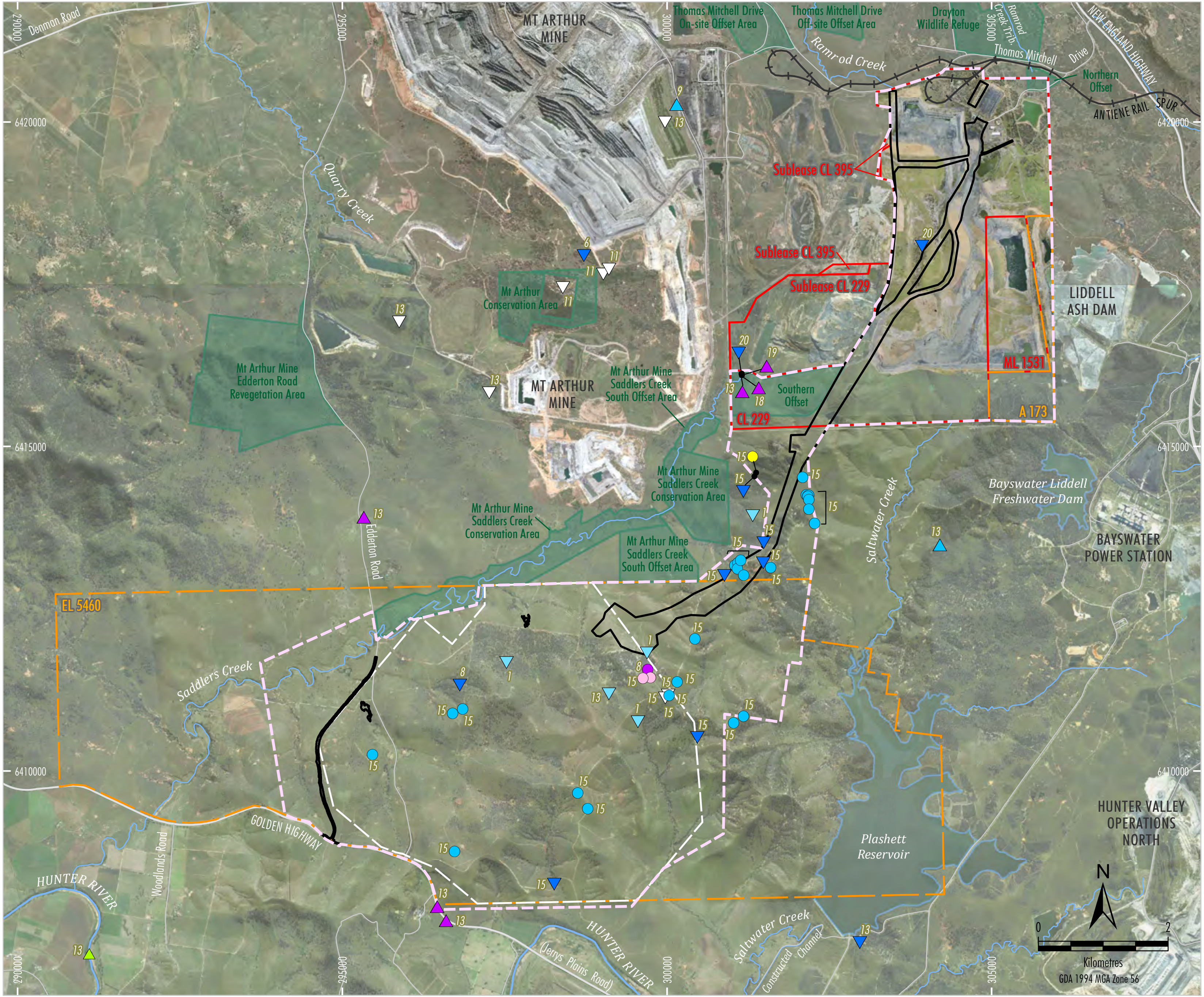
MALABAR COAL

MAXWELL PROJECT

Species Credit Species Relevant to the Study Area

Figure 12

SHM-18-03 Maxwell_EIS_App_Fauna_221E



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).

<u>Striped Legless Lizard (*Delma impar*)</u>

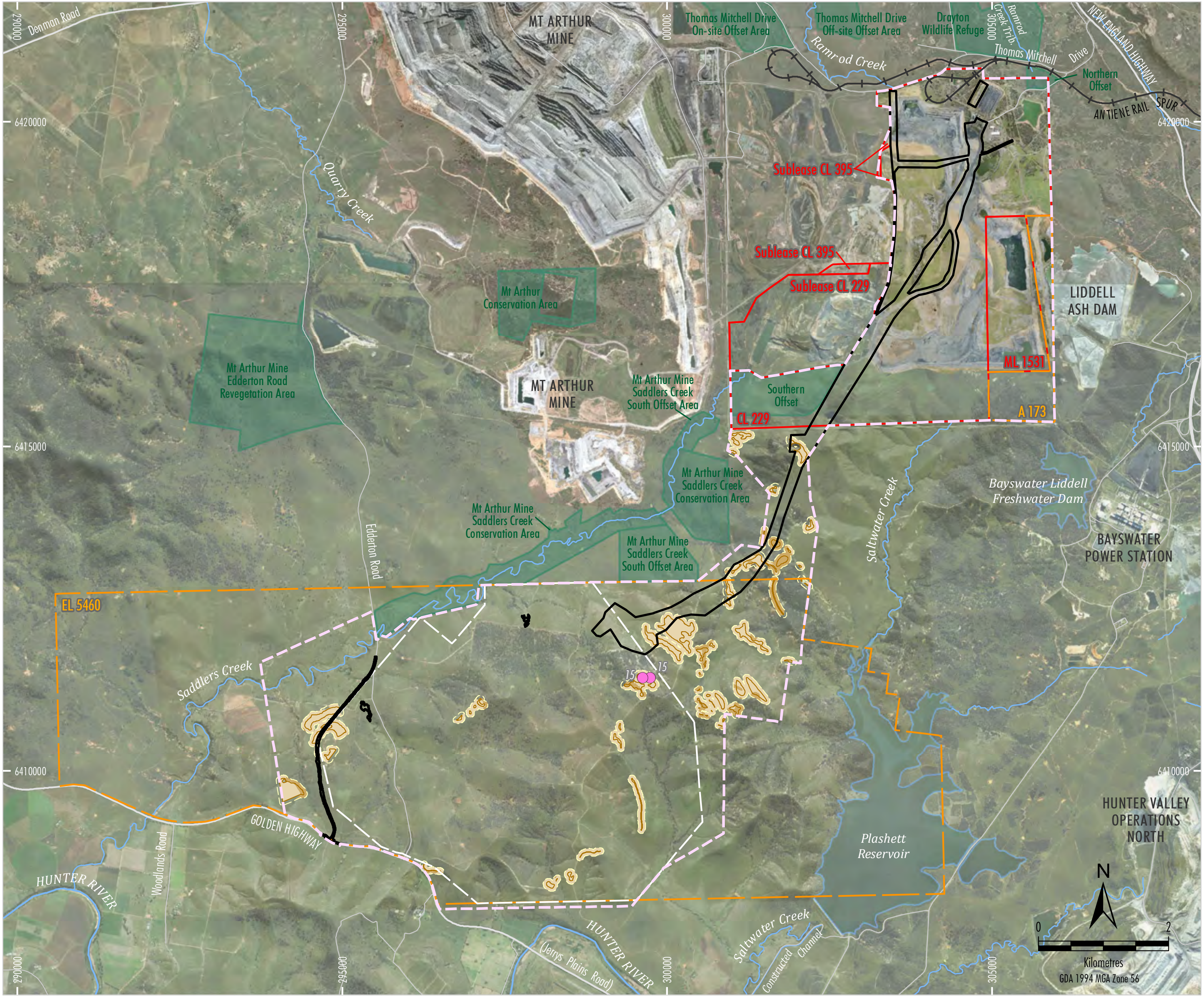
This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'Species Credit Species' in the *Threatened Biodiversity Data Collection* (OEH, 2019a).

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).

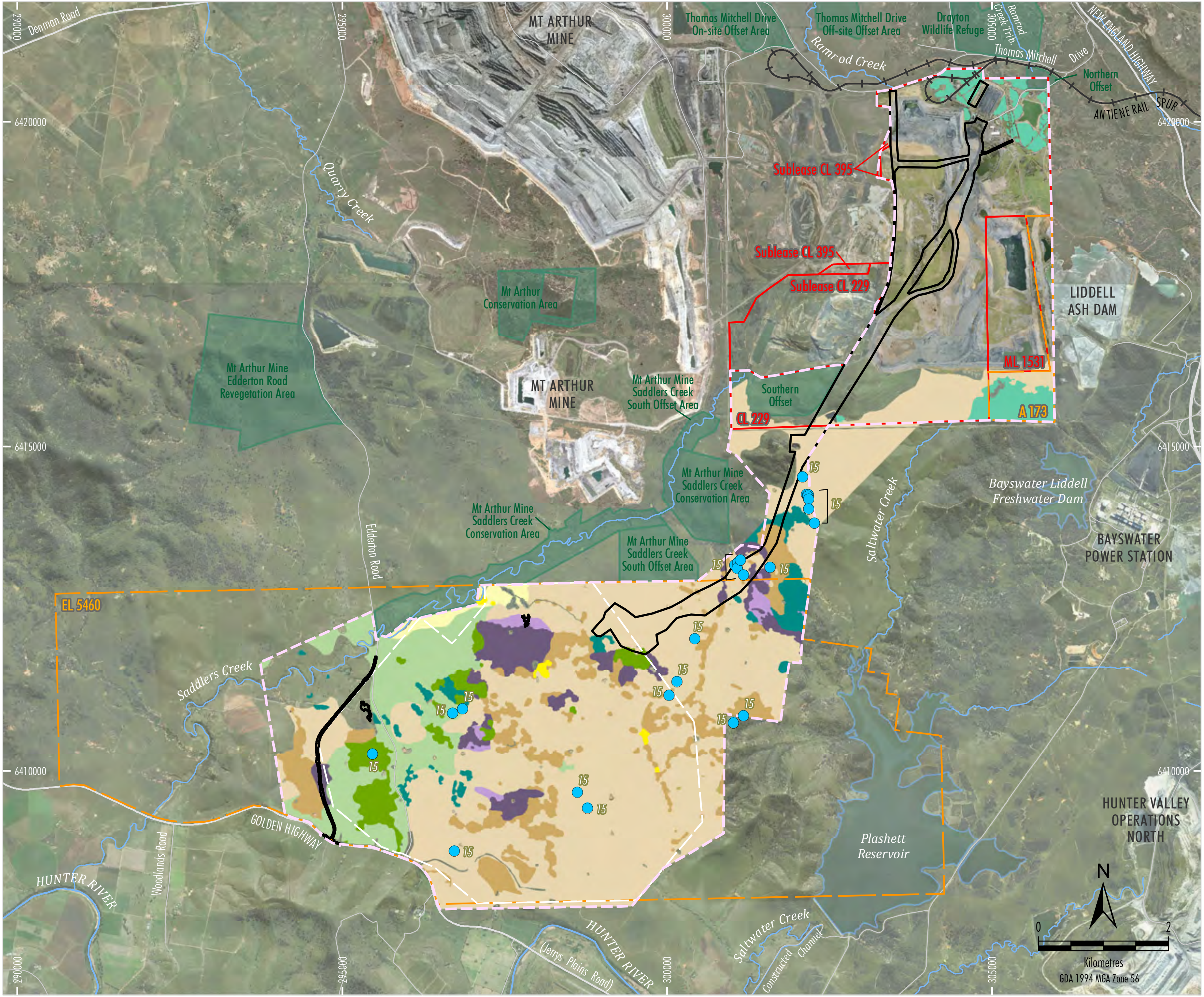
This species has not been previously recorded in the study area (Table 1). A single individual of this species was observed at Site 5 (within PCT 1655) in September 2018 during vegetation surveys (Colin Driscoll Hunter Eco, pers. obs.). (Figure 9). It was not observed during any other survey period.

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).

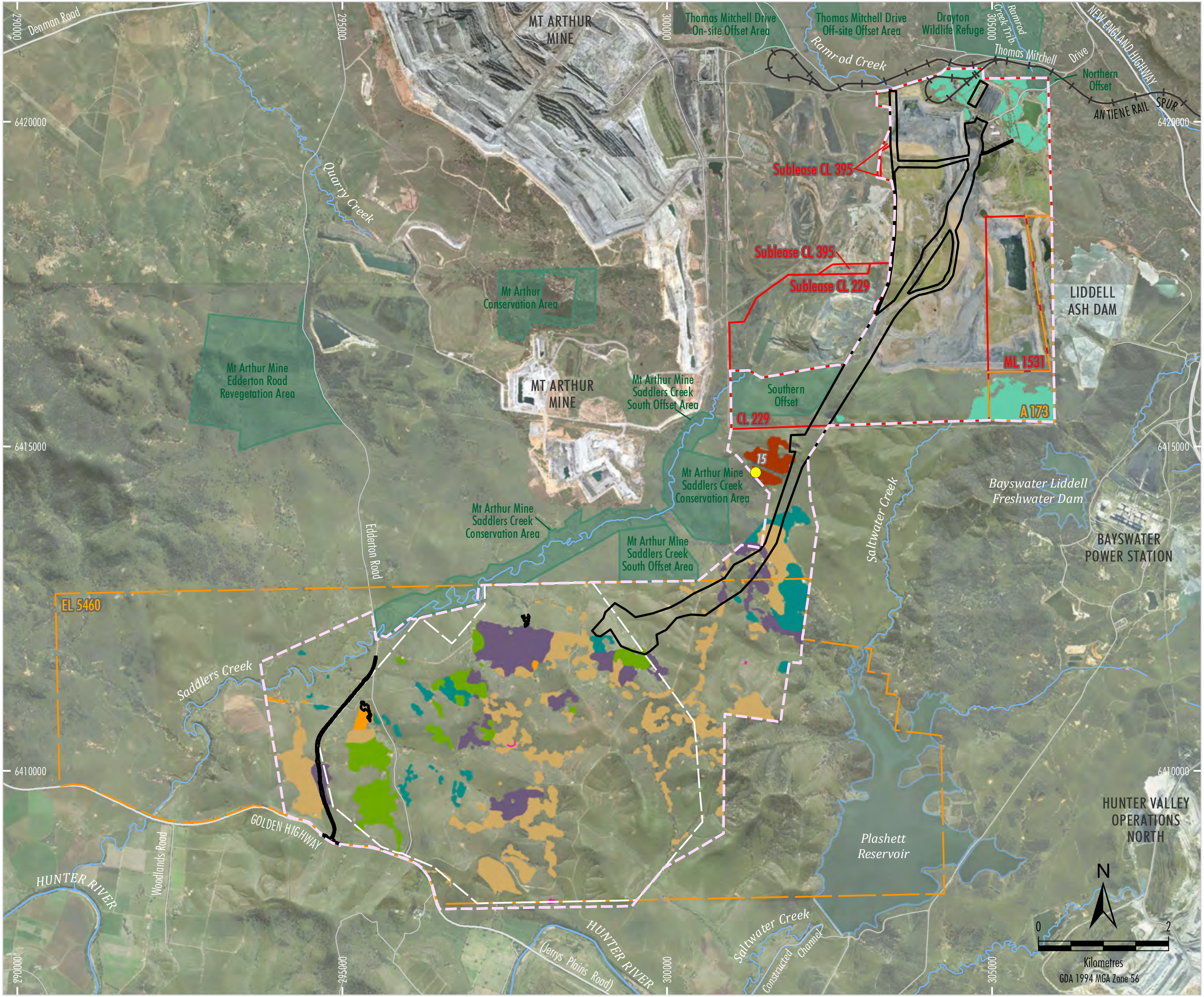
This species has not been previously recorded in the study area (Table 1). It was detected during the 2018 survey period as follows (Figure 9):

- 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

MALABAR COAL

MAXWELL PROJECT

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).

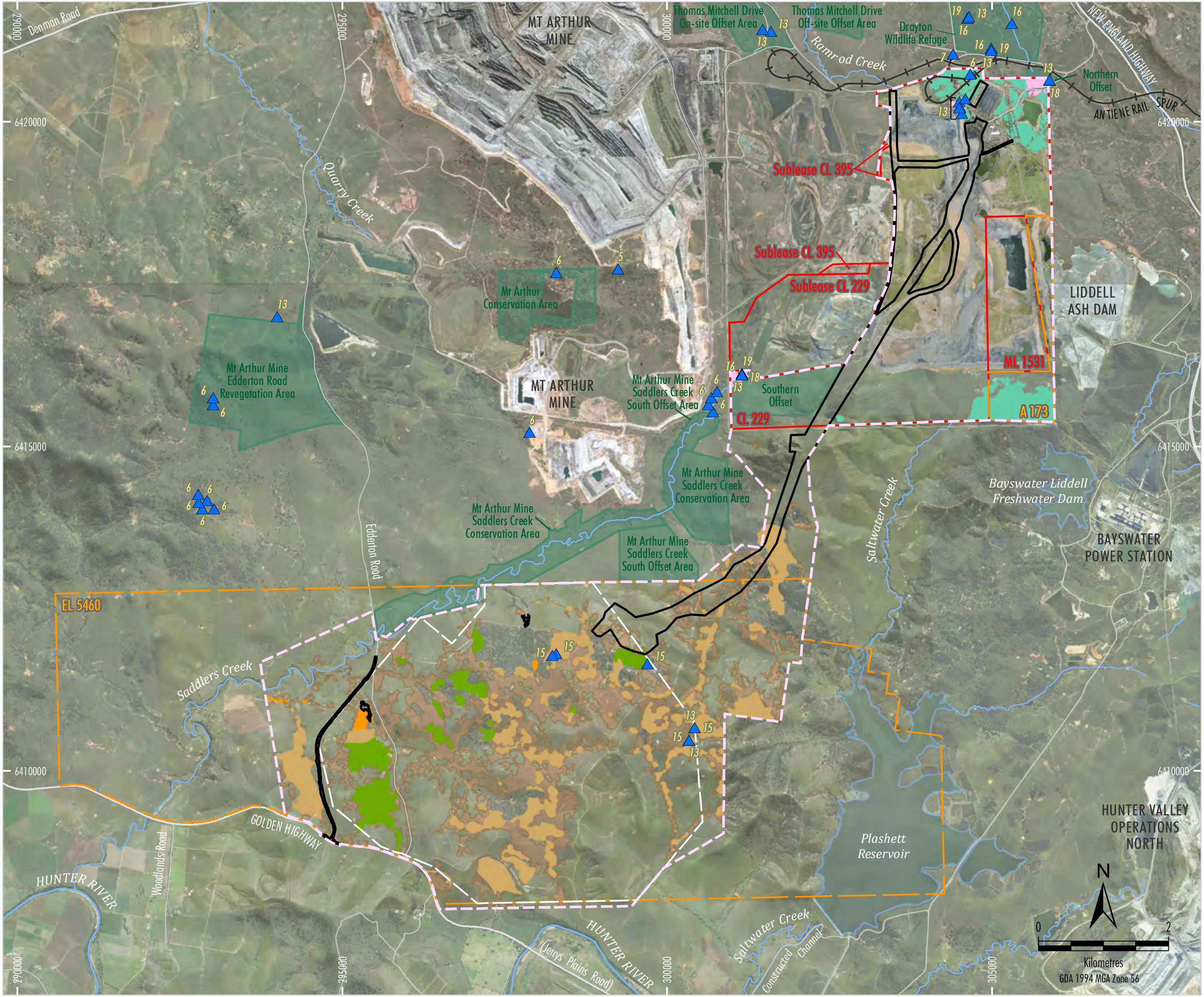
This species has been previously recorded in the study area by Hansen Bailey (2007) (Table 1). It was detected foraging in flowering White Box (*Eucalyptus albens*) trees within the study area during the 2018 survey period as follows (Figure 11):

- 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

MALABAR COAL

M A X W E L L   P R O J E C T

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.

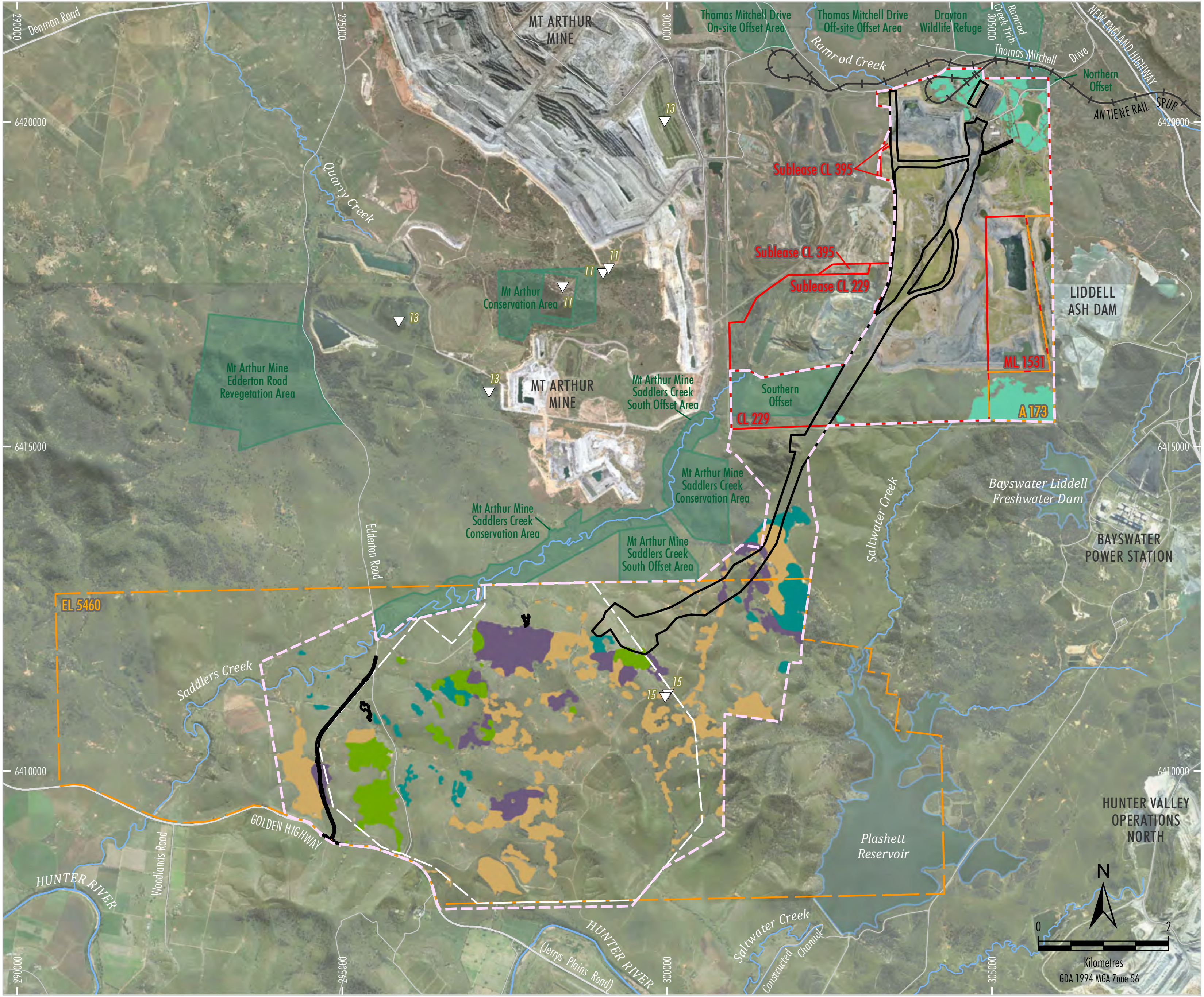
The PCTs assigned to this species in the *Threatened Biodiversity Data Collection* (OEH, 2019a) which have been mapped in the study area would provide potential habitat (Appendix C).

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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M A X W E L L P R O J E C T

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).

<u>Southern Myotis (*Myotis macropus*)</u>

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).

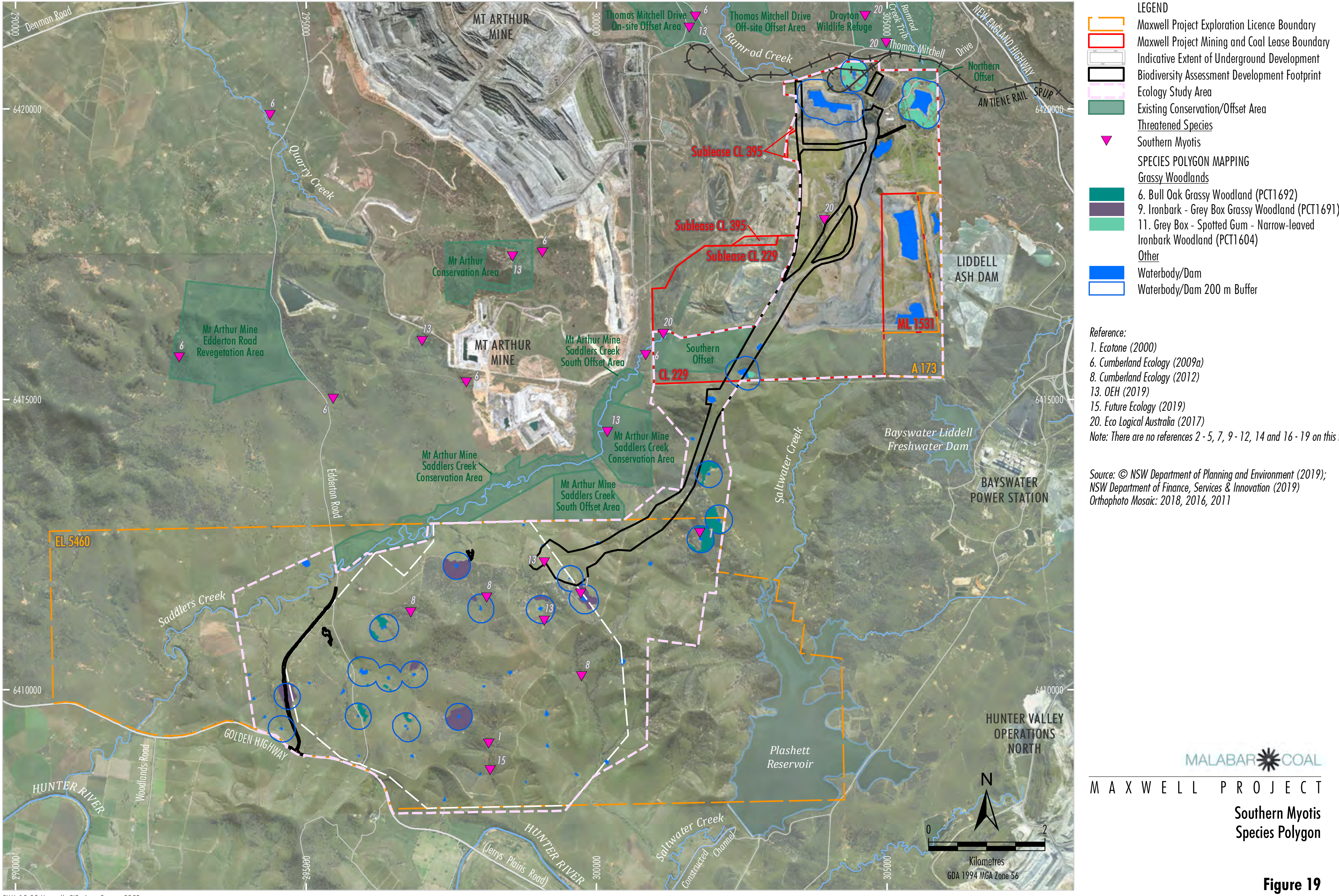
Potential breeding habitat for this species is defined as: "The range of PCTs associated with the species (as per the TBDC) within 200 meters of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3m or wider)" by the *'Species Credit' Threatened Bats and 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.



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).

<u>Swift Parrot (*Lathamus discolor*)</u>

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).

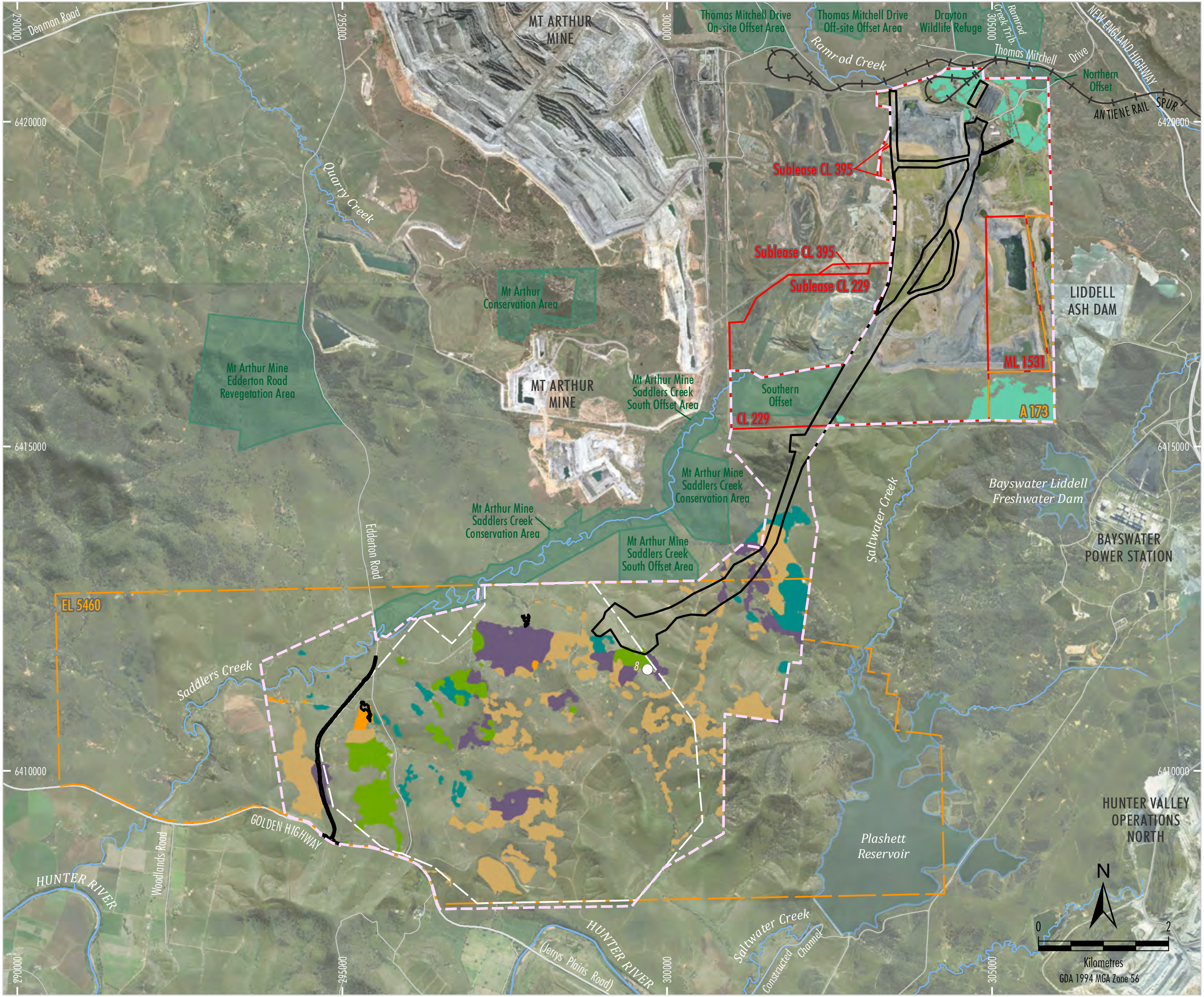
It was not detected during Future Ecology surveys in 2018. It has been previously recorded by others within the study area just south of what is now Site 5 (OEH, 2019b) (Figure 9).

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

MALABAR COAL

MAXWELL PROJECT

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.

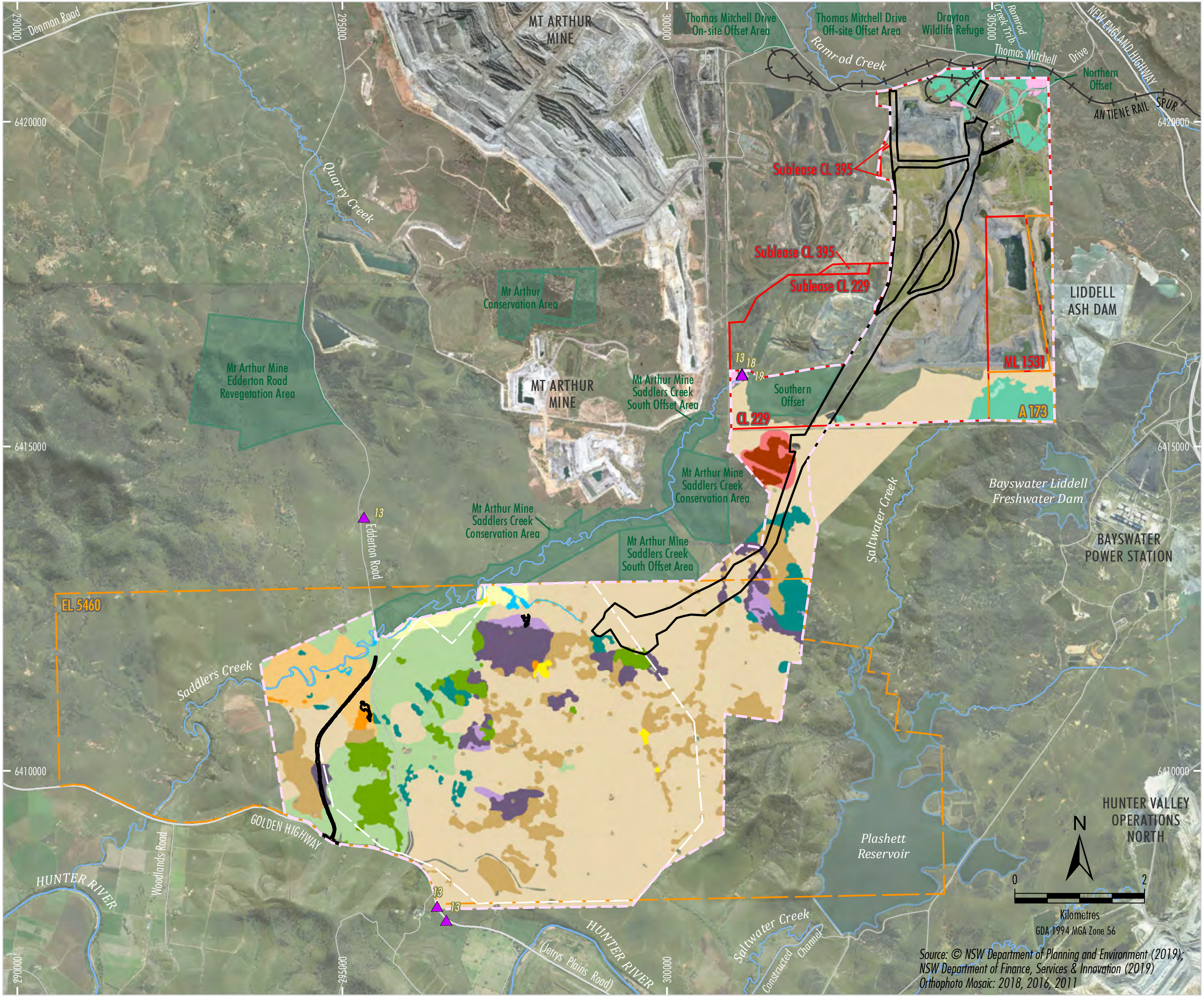
It has been previously observed within the study area by others with a record from around 1 km north of Site 1 within the Maxwell Infrastructure area (Eco Logical Australia, 2016a:2016b; OEH 2019b) (Figure 10).

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.



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

- 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.

MALABAR COAL

M A X W E L L   P R O J E C T

Spotted-tailed Quoll Potential Habitat

Figure 21

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.

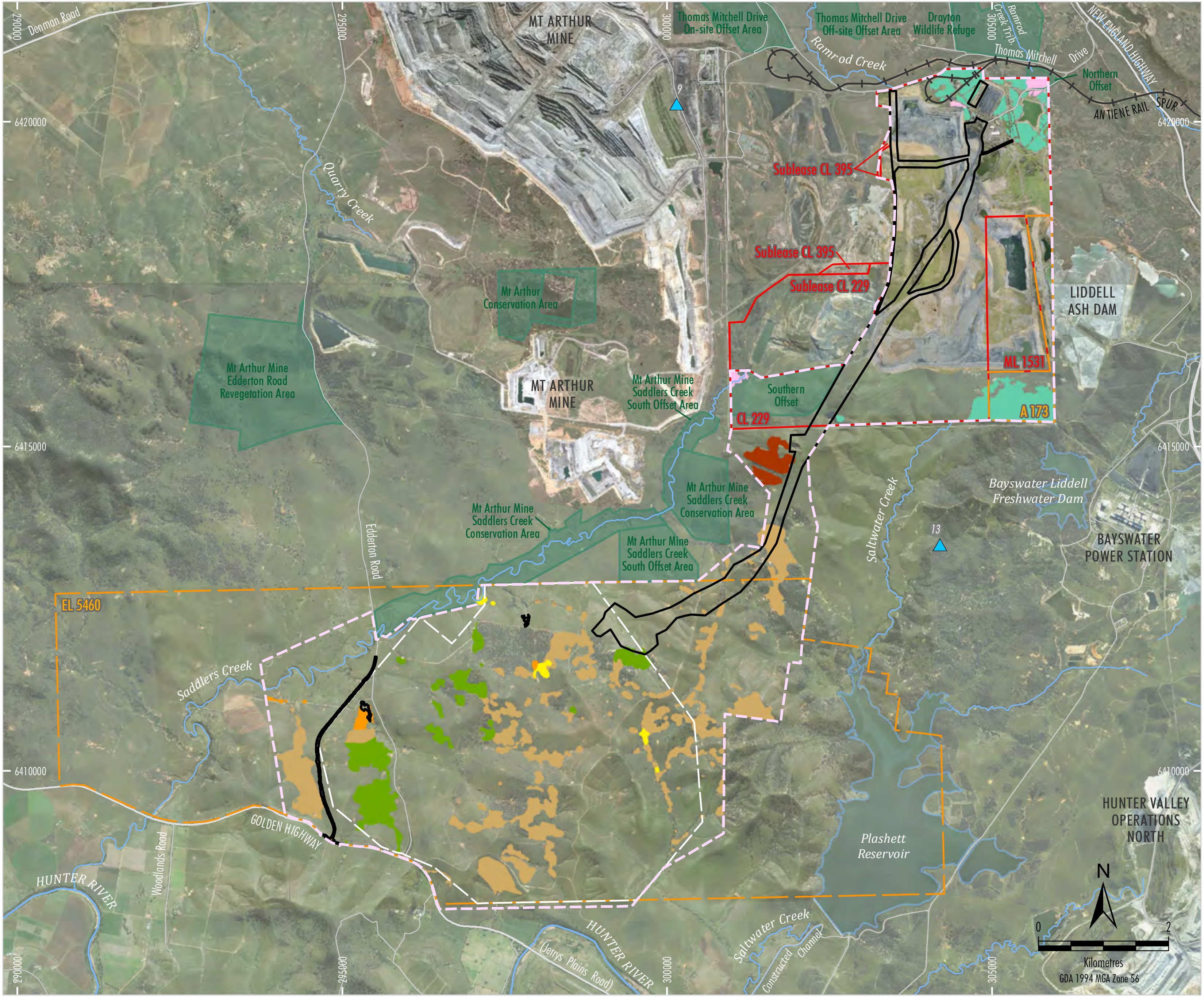
Potential koala habitat is mapped on Figure 22.

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																

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
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		X	O	
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	O		X	O		X	O					X	O		X	O	
Birds	Pied Currawong	*Strepera graculina*													X	O					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		X	O	
Birds	White-winged Chough	*Corcorax melanorhamphos*										X	O		X	O										
Birds	Common Starling	*Sturnus vulgaris*	X						X	O											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*																										

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**
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		X	O
Birds	Magpie-lark	*Grallina cyanoleuca*				X	O											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	O		X	W
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	OW		X	OW		X	O		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	O		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

EXPERT REPORT EXPECTED PRESENCE OF THREATENED TERRESTRIAL ORCHIDS (DIURIS TRICOLOR, PRASOPHYLLUM PETILUM, PTEROSTYLIS CHAETOPHORA) MAXWELL PROJECT

Expert Report

Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*)

Maxwell Project

February 2021

Final Report

Malabar Resources
Thomas Mitchell Drive
Muswellbrook NSW 2333

Dr Stephen Bell

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SUMMARY

Maxwell Ventures Management Pty Ltd, a wholly owned subsidiary of Malabar Resources, propose to establish an underground coal mine within EL5460 (Muswellbrook local government area, Hunter Valley, New South Wales), which will require limited ground disturbance across the Project Area. Never-the-less, proposed disturbances associated with planned development may potentially impact on threatened terrestrial orchids (*Diuris tricolor* [Pine Donkey Orchid], *Prasophyllum petilum* [Tarengo Leek Orchid] or *Pterostylis chaetophora* [Rusty Greenhood]) or their habitat. No records of the three target species exist for the Project Area, and after assessment I considered that 1.6 hectares (ha) of the proposed 320 ha (0.5%) ground disturbance area may provide habitat for two of these species (*Diuris tricolor*, *Prasophyllum petilum*). I do not consider that the third species (*Pterostylis chaetophora*) is likely to occur anywhere within the Project Area.

Diuris tricolor and *Prasophyllum petilum* occupy extensive geographical ranges outside of the Hunter region, however *Pterostylis chaetophora* is endemic here. Populations for *Diuris tricolor* exist close to the Project Area along Thomas Mitchell Drive, and *Prasophyllum petilum* has historically also been recorded at the eastern end of Thomas Mitchell Drive but that colony is presumed extinct. There are no validated populations of *Pterostylis chaetophora* west of North Rothbury (52 kilometres [km] to the south-east), and further inland records at Mangoola Coal (21 km north-west) and Wingen Maid Nature Reserve (55 km north) also remain unvalidated, and may represent a different species.

Following a site inspection of the Project Area in July 2020, I noted observable differences in the floristic composition of the habitats there to other areas where I have seen the three target orchids, and the predominance of former Box (*Eucalyptus 'albemol'* and *Eucalyptus moluccana*) landscapes within these largely cleared lands conflicts with my experience of orchid habitat elsewhere. Differences were supported by a review of ecological information prepared by Hunter Eco for the Project Area, the mapping of which I found to be accurate and acceptable. Numerical analysis of defined vegetation communities revealed clear differences to habitat from elsewhere in the region known to support *Pterostylis chaetophora*, but show one community similar to habitats typical of *Diuris tricolor* and *Prasophyllum petilum*. Additionally, the close proximity of known populations of *Diuris tricolor* (c. 400 metres [m]) and *Prasophyllum petilum* (1300 m) to the northern section of the Project Area suggests that potential habitat for these may also occur in a second community. I therefore considered that the vegetation units defined by Hunter Eco as Ironbark - Grey Box Grassy Woodland Derived Native Grassland (Unit 9a) and Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland (Unit 11) provide the only potential habitat for *Diuris tricolor* and *Prasophyllum petilum*, which together comprise 1.6 ha of the Project Area. Subsequently, Dr Colin Driscoll (Hunter Eco) was commissioned by Malabar Resources to conduct a targeted survey of this area during suitable survey conditions in 2020, and none of the target species were found. *Diuris tricolor* and *Prasophyllum* (syn. *Prasophyllum* sp. Wybong) are therefore unlikely to be present within the Project Area.

In support, a detailed assessment of environmental attributes across all Hunter populations of *Diuris tricolor* (n=983), *Prasophyllum petilum* (n=485) and *Pterostylis chaetophora* (n=128) found differences in geological units, soil landscapes, and (for *Pterostylis chaetophora*) annual rainfall when compared to the Project Area. Of these, soil landscapes were seen as particularly important given they best encapsulate the likely distribution of the necessary mycorrhizal fungi across the region, without which no orchids would germinate and prosper. As a surrogate for fungi distribution, an assessment of all terrestrial orchid observation records (common and threatened) for the upper Hunter Valley demonstrated a scarcity of records in and around the Project Area, suggesting that mycorrhizal fungi were therefore also scarce or localised. This lends further credance to my conclusion that no populations of *Diuris tricolor* or *Prasophyllum petilum* are expected across the bulk of the Project Area.

The combination of geology, soil landscape, floristics, rainfall, and general orchid distribution (as a surrogate for mycorrhizal fungi) suggest that the Project Area is unlikely to support extensive populations of *Diuris tricolor* or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong), and none of *Pterostylis chaetophora*. The areas where I considered the former two species may occur occupy <1% of the total disturbance footprint, but subsequent targeted searches in these areas did not record these species.

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Document cover: View across part of the proposed surface development area (top), and target orchids (from left) *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora*.

Report produced for:

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1. Introduction

1.1 Background

1. I have been engaged by Resource Strategies on behalf of Maxwell Ventures Management Pty Ltd and Malabar Resources (Malabar) to undertake an expert review in relation to the potential occurrence of three threatened orchids (*Diuris tricolor* [Pine Donkey Orchid], *Prasophyllum petilum* [Tarengo Leek Orchid] and *Pterostylis chaetophora* [Rusty Greenhood]). This review will be incorporated into a Biodiversity Development Assessment Report (BDAR) prepared by Hunter Eco (2019), which addresses the proposed Maxwell Project (the Project). This expert review is as required and in accordance with section 5.3 of the New South Wales (NSW) Government's Biodiversity Assessment Method (BAM) (Department of Planning, Industry and Environment [DPIE] 2020). It aims to determine the habitat suitability of the proposed development lands for the subject orchids.
2. As part of my brief, I have been asked to examine the potential for *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora* to occur within lands designated for ground disturbance and/or possible ponding following ground subsidence. These lands occupy 320 hectares (ha), of which approximately 226 ha comprises native vegetation (Hunter Eco 2019). My assessment is required as drought conditions within the Project Area in recent years have impinged on comprehensive surveys for all three orchid species. On 3 July 2020, I undertook an inspection of the Project Area to examine habitat quality and disturbance levels, expanded upon in **Section 4**.

1.2 Project Overview

3. Maxwell Ventures (Management) Pty Ltd, a wholly owned subsidiary of Malabar, has consent to develop an underground coal mining operation, known as the Maxwell Project (the Project), located wholly in the Muswellbrook local government area (LGA). It is proposed to undertake underground mining of coal within Exploration Licence 5460, using a combination of both existing and new infrastructure to support underground mining and coal handling activities. Four seams within the Whittingham Coal Measures would be mined using underground bord and pillar (with partial pillar extraction) in the Whynot Seam, and underground longwall extraction in the Woodlands Hill, Arrowfield and Bowfield Seams.
4. As part of proposed works, Malabar intend to undertake a range of actions which may impact on the existing natural environment across five defined areas (the Project Area):
   - expansion of the existing Product Stockpile Extension area to accommodate mined coal;
   - construction of a Surface Development Area to accommodate underground entrance surface facilities and a transport and services corridor;
   - Edderton Rd Realignment, to allow for potential ground subsidence damage;
   - Ancillary Disturbance Area (Ponding) 1, where ground subsidence may result in water ponding; and
   - Ancillary Disturbance Area (Ponding) 2, where ground subsidence may result in water ponding.

5. The focus of my report is on the 320 ha of proposed Project lands lying west of Lake Liddell and Plashett Reservoir, east of Denman and south-east of Muswellbrook (Figure 1 and 2). Note that the full extent of proposed disturbance areas continues through existing post-mine landforms, but only those lands outside of these areas (i.e. that component constituting the 'controlled action' under the Commonwealth EPBC Act) are addressed in this report.

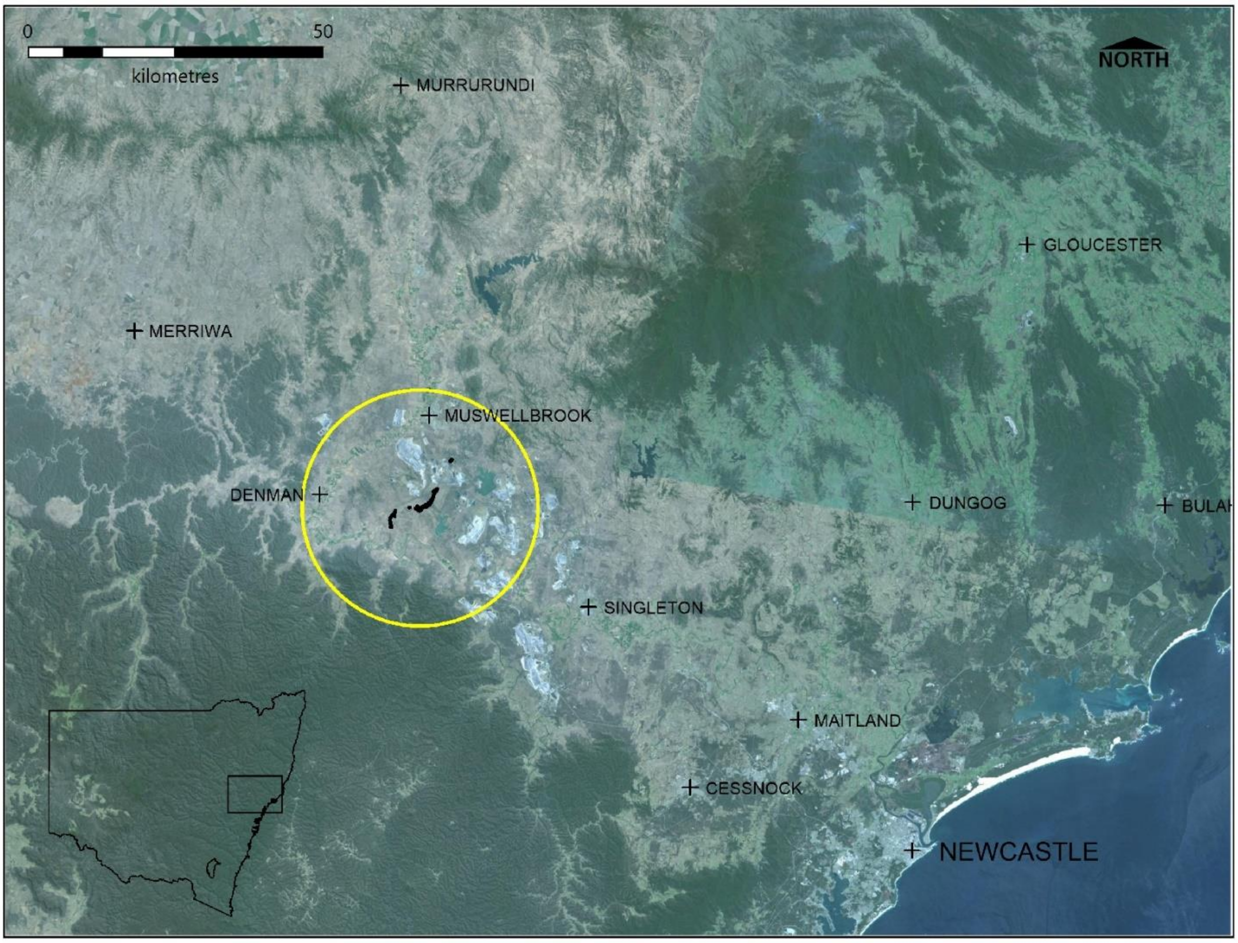


Figure 1 Location of the Project Area (circled) within the context of the Hunter Valley.

6. To assist in later discussions, this area (the Project Area) has been designated into five geographically separate parcels of land (see Table 1).

1.3 Report Criteria & Structure

7. As detailed in the BAM (DPIE 2020), an expert report is required to address the following criteria (Box 3 in section 5.3), and these form the basis of the structure of this report:

   a. identify the species or population (see **Section 2**);

   b. justify the use of an expert report (see **Section 3**);

   c. justify the likelihood of occurrence of the species or population and prepare a species polygon as per subsection 5.2.5 (see **Section 4**);

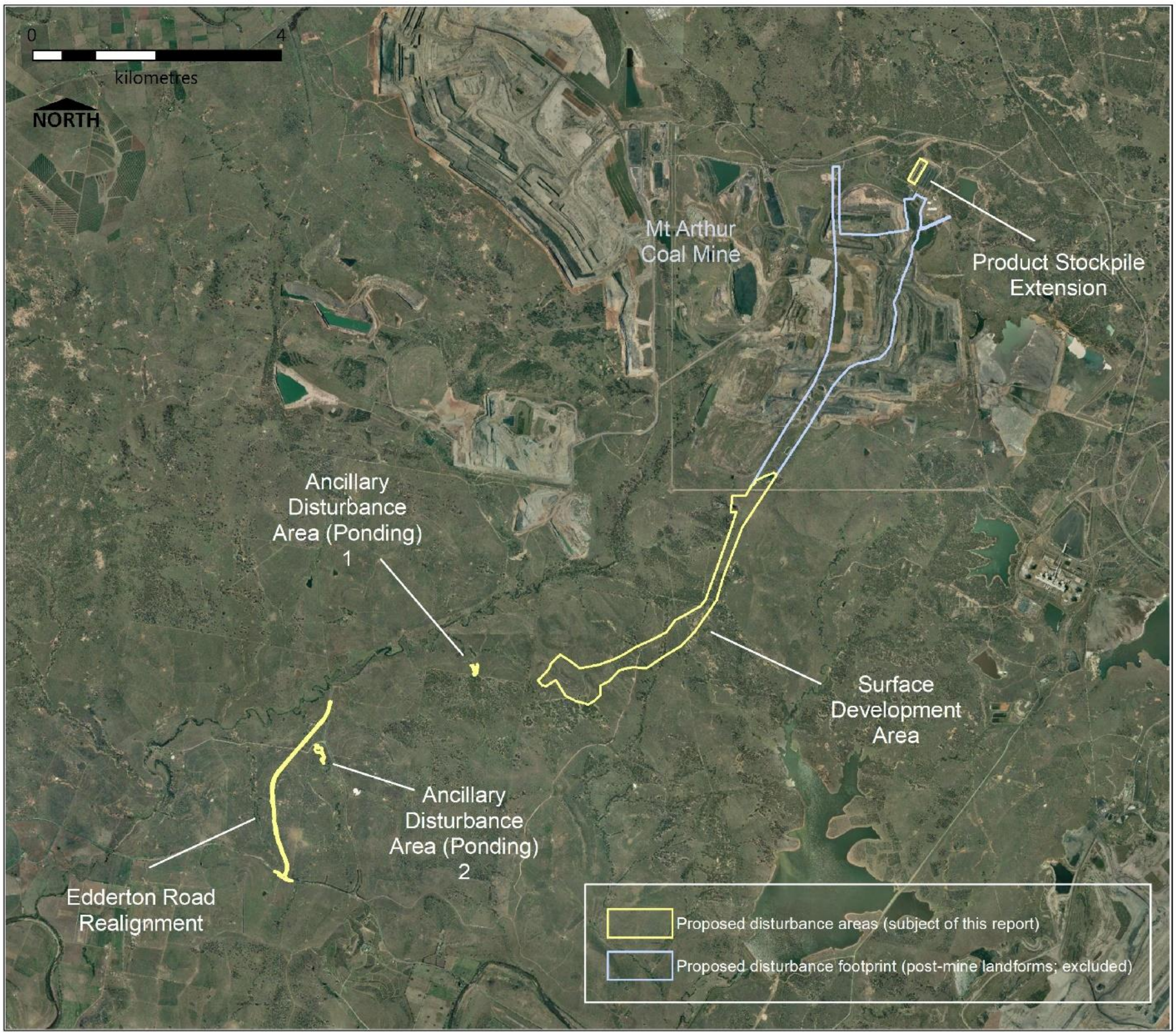


Figure 2 **The Project Area, showing layout of proposed disturbance areas detailed in Table 1. Lands within existing post-mine landscapes are not addressed in this report.**

Table 1 Land parcels comprising the Project Area.

Land Parcel	Details	Size (ha)
Product Stockpile Extension	adjacent to the existing stockpile area, c. 500 metres (m) south of Thomas Mitchell Drive	5.2
Surface Development Area	immediately south of Mt Arthur Coal Mine, c. 2.6 kilometres (km) north-west of Plashett Reservoir	302.9
Edderton Rd Realignment	west of existing Edderton Road (south of Saddlers Creek), c. 1.1 km west of its junction with the Golden Highway	10.2
Ancillary Disturbance Area (Ponding) 1	tributary of Saddlers Creek, c. 2.3 km east of Edderton Road	0.5
Ancillary Disturbance Area (Ponding) 2	tributary of Saddlers Creek, c. 0.3 km west of Edderton Road and 2.2 km north of the Golden Highway – Edderton Road intersection	1.5
Total		320.3

d. estimate the area of habitat (if the species is assessed by area) on the subject land (see **Section 5**), or

e. estimate the maximum number of mature individuals (as identified in the Credit Calculator) for the subject land. Where the expert report is required because the species is assumed to be present, provide evidence such as a reference site, for this estimation (option d. above undertaken);

f. include the information considered in making this determination (see **Section 6**); and

g. state the expert's credentials (see **Section 7**).

1.4 DPIE Approval to Prepare Expert Report

8. I have been approved to prepare this expert report for all three target species by DPIE, see Appendix 1 and the list of approved biodiversity experts available at https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/biodiversity-offsets-scheme/experts.

2. Criterion (a) - The Relevant Species

2.1 Legal Status

9. *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora* are threatened species included in relevant State, Territory and Commonwealth legislation (Table 2). *Diuris tricolor* is listed both as vulnerable in NSW and as an endangered population in the Muswellbrook LGA under the *Biodiversity Conservation Act 2016* (BC Act), while *Prasophyllum petilum* is listed as endangered in NSW (BC Act) and the Australian Capital Territory (ACT) (*Nature Conservation Act 2014*), but under the synonym *Prasophyllum* sp. Wybong (C.Phelps ORG 5269) as critically endangered nationally (*Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act]). *Pterostylis chaetophora* is listed as vulnerable only on the BC Act.

Table 2 Legal status of target orchids within relevant States and Territories.

Legislation	*Diuris tricolor*	*Prasophyllum petilum*	*Pterostylis chaetophora*
Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*	-	Crit. End.	-
NSW *Biodiversity Conservation Act 2016*	Vul. / EPop.	End.	Vul.
ACT *Nature Conservation Act 2014*	-	End.	-
VIC *Flora and Fauna Guarantee Act 1988*	End.	-	-
QLD *Nature Conservation Act 1992*	LC	-	-

Key: Crit. End. = Critically Endangered; End. = Endangered; EPop. = Endangered Population; LC = Least Concern; Vul. = Vulnerable.

Note: *Prasophyllum petilum* is currently listed nationally on the EPBC Act as Endangered (as *Prasophyllum petilum*) and also as Critically Endangered (as *Prasophyllum* sp. Wybong (C.Phelps ORG 5269), in synonymy), because the Australian Plant Census has not yet accepted this synonym.

10. In recent years, there has been some taxonomic confusion over the identity of *Prasophyllum* plants growing in the upper Hunter (Wybong) area. Following an informal review by NSW orchid taxonomists over the past decade, these plants were placed in synonymy with the more widespread *Prasophyllum petilum* (see PlantNet; http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Prasophyllum~petilum), a finding also supported by other orchid experts elsewhere in Australia (e.g. Backhouse *et al.* 2019). As a consequence, *Prasophyllum* sp. Wybong (C.Phelps ORG 5269) is now an accepted synonym of *Prasophyllum petilum*, but remains listed as critically endangered under that phrase name on the EPBC Act.

2.2 Distribution and Known Populations

11. *Diuris tricolor* and *Prasophyllum petilum* are present and co-occur in the upper Hunter Valley region of NSW, but the two species also occupy considerably wider geographical ranges throughout eastern Australia. In contrast, *Pterostylis chaetophora* is endemic to the Hunter region and occupies a smaller and more coastal distribution. However, historical records of *Pterostylis chaetophora* from the Muswellbrook (2005) and Scone (1998) areas are potentially

indicative also of a more inland extent, but these have not yet been verified. Figure 3 shows images of all three species growing *in situ* in the Hunter region.

12. Notes on the distribution of all three species in the following discussion are based on as-held database records from DPIE (extracted under licence ASH20009), augmented with notes and records from published and unpublished reports in the literature (cited accordingly). Records from licence ASH20009 are included with other publicly available data and cited collectively as 'NSW BioNet'.

Figure 3 Target orchids (from left): *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora*.

2.2.1 Diuris tricolor

13. *Diuris tricolor* (Pine Donkey Orchid) is a widespread terrestrial orchid, occurring on the western slopes and plains and tablelands of NSW, and also in the Moreton and Darling Downs districts of Queensland (Stanley & Ross 1989; Jones 1993). Populations of *Diuris tricolor* in the upper Hunter Valley between Denman and Muswellbrook essentially form the eastern extent of an east-west trending meta-population extending along the Goulburn River valley to Mudgee (Figure 4). Records exist for this species at approximately 20 km intervals along this 200 km extent, suggesting that some exchange of genetic material may be occurring with more westerly stands. The Type material of *Diuris tricolor* was collected at Mudgee in the late 1800s.

14. The nearest records of *Diuris tricolor* to the Project Area are an observation in 2009 from land off Saddlers Creek (c. 600 m south of the proposed Ancillary Disturbance Area 1; NSW BioNet; also noted in Cumberland Ecology 2015 and relocated by Hunter Eco 2020), and several observations from 2004-2015 within the Mt Arthur complex along Thomas Mitchell Drive (c. 400 m north of the proposed Product Stockpile Extension area; NSW BioNet; Hunter Eco 2013). The 2009 observation recorded two plants in that year, and follow up surveys found none in November 2010 (outside of peak flowering) but 'at least 30' in 2011 (Cumberland Ecology 2015). Searches since that time have failed to locate any individuals, although several years of drought during this period may have reduced flowering and increased grazing pressure. Along Thomas Mitchell Drive, one observation of *Diuris tricolor* in 2004, three in 2009, one in 2012 and 70 in 2015 (within the Drayton Wildlife Refuge) attest to a sizeable population in that

vicinity. No plants have been observed since 2015 (Hunter Eco 2019), detection again likely to have been negatively impacted by drought.

15. A single, small disjunct population of *Diuris tricolor* was also recorded at North Rothbury in 2016 (noted in Bell 2017a), and represents the most easterly population known within NSW. No individuals have been observed at that location since 2016 due to dry conditions. North Rothbury lies more than 50 km to the south-east of the Project Area.

16. Elsewhere in NSW, *Diuris tricolor* is extensive across the north, central and south western slopes, and extends into south-eastern Queensland. A single record from the Hume region of Victoria suggests that the species is very rare in that state, and indeed Backhouse *et al*. (2016) indicate that it is known from just three plants.

2.2.2 Prasophyllum petilum

17. *Prasophyllum petilum* (Tarengo Leek Orchid) occupies a smaller distributional range than *Diuris tricolor*, with most records from the ACT but with outliers in the Kandos, Denman, Premer and Inverell districts on the tablelands and western slopes of NSW. Until recently, Hunter Valley plants were considered a distinct but un-named taxon, *Prasophyllum* sp. 'Wybong' (C.Phelps ORG 5269), but are now placed in synonymy with *P. petilum* by NSW taxonomic authorities. In support, Backhouse *et al*. (2019) do not include *Prasophyllum* sp. ‘Wybong’ in their comprehensive list of Australian orchid taxa, despite the inclusion of three other un-named taxa with close affinities to *P. petilum*. The Type material of *P. petilum* was collected from Hall (in the ACT) in 1988.

18. The nearest known occurrence of *Prasophyllum petilum* to the Project Area is a site near the eastern end of Thomas Mitchell Drive (NSW BioNet). This observation (made of 10 plants in 1999) was the first of the species for the Hunter Region, and advice from the original observers has confirmed the identity of those plants against current taxonomy (L. Copeland pers. comm.). Surveys subsequent to the initial discovery revealed no plants in 2000, five plants in 2001, no plants in 2002, nine plants in 2003, no plants in 2005 and one plant in 2005 (B. Holzinger pers. comm.). Occasional searches of the site since 2005 have failed to detect any plants, suggesting that the population may now be extinct (B. Holzinger pers. comm.).

19. All other Hunter Valley observations of *Prasophyllum petilum* are from Mangoola Coal (Wybong), approximately 25 km to the north-west, and no other observations are evident from other parts of the Hunter Valley (NSW BioNet; Australasian Virtual Herbarium [AVH]). Plants have been recorded at Mangoola in most years since 2009, although numbers were very low during the drought years of 2017-2019 (Bell 2020a).

20. Outside of the Hunter catchment, the next nearest populations of *Prasophyllum petilum* occur near Kandos, some 140 km to the south-west, and Premer 190 km to the north-west (Figure 4). Hunter Valley populations of *Prasophyllum petilum* are consequently isolated from all others, and opportunities for genetic exchange are minimal. Note that Jeanes (2015a) considered similar populations of *Prasophyllum* in Victoria to represent a different taxon (now described as *P. argillaceum*: Jones & Rouse 2018), implying that *Prasophyllum petilum* is endemic to NSW, a view also supported by Backhouse *et al.* (2019).

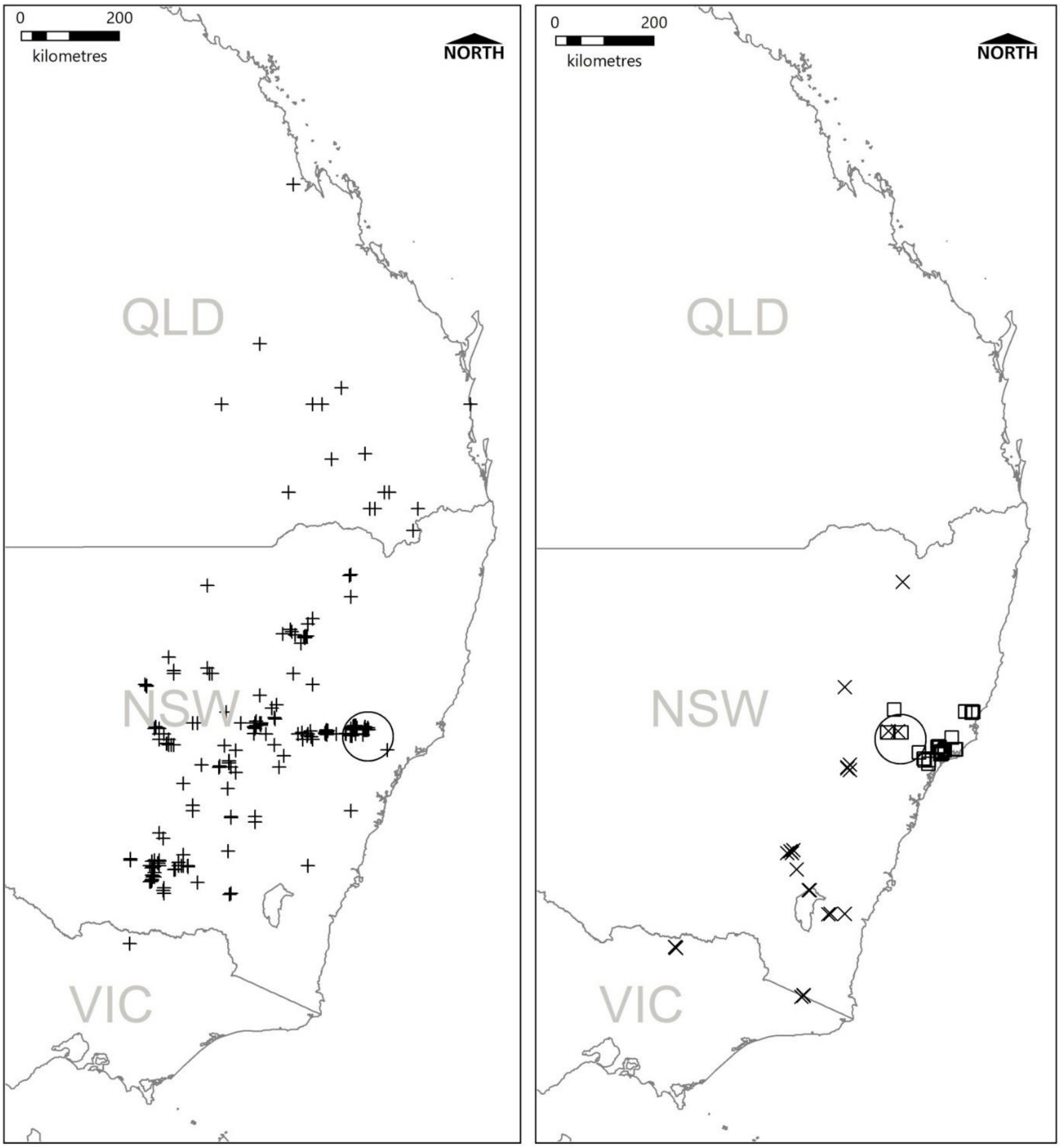


Figure 4 **Distribution of *Diuris tricolor* (+) (left), *Prasophyllum petilum* (X) (right) and *Pterostylis chaetophora* (□) (right) across eastern Australia, shown relative to the Project Area (circled, 50 km radius).** Data from AVH and NSW BioNet, extracted July 2020. Note that near-coastal records of *Diuris tricolor* in south-eastern NSW are erroneous (historical collections with poor positional accuracy), and that Victorian records of *Prasophyllum petilum* represent a different taxon (now described as *P. argillaceum*: Jones & Rouse 2018).

2.2.3 Pterostylis chaetophora

21. *Pterostylis chaetophora* (Rusty Greenhood) is endemic to the broader Hunter Region, extending from southern Taree to Newcastle and Cessnock (Figure 4). The species was previously also thought to occur in Queensland, but those populations have been redetermined as a distinct species with close affinities to *Pterostylis chaetophora* (Backhouse *et al*. 2019). Additionally, two early collections in the AVH from Sydney, and an observation record from

Glenhaven (1949), are thought to be in error or are now locally extinct. Both Hosking and James (1998) and Hunter (2008) report populations of *Pterostylis chaetophora* from Warrabah National Park near Tamworth, but these are considered to be misidentifications as no recent observations have been made there (L. Copeland pers. comm.). The Type material for *Pterostylis chaetophora* was grown from a specimen collected at Neath, near Cessnock in the mid-Hunter Valley in the early 1980s (Clements 1989).

22. NSW BioNet includes 33 distinct observation records, with most occurring in the lower Hunter Valley (east from Cessnock). For the upper Hunter Valley, two collections lodged at the Australian National Herbarium (Canberra) have been identified as *Pterostylis chaetophora*, but there are no other records. The first of these collections was made by John Hoskings in 1998 from Wingen Maid Nature Reserve (c. 50 km north-north-west of the Project Area), and the second in 2005 by Dougall Herd from what is now a biodiversity offset for Mangoola Coal (c. 20 km west-north-west of the Project Area). It is unknown if these populations remain extant or if they may represent the closely related *Pterostylis praetermissa* (L. Copeland pers. comm.). Surveys planned for the 2020 flowering season aim to clarify the identification of orchids at both locations.

23. Consequently, the nearest known confirmed records of *Pterostylis chaetophora* to the Project Area is at Rothbury (c. 53 km south-east of the Project Area). This population has been monitored annually for the last three years, showing heavy grazing of tubers by White-winged Choughs (*Corcorax melanorhamphos*) (Bell 2020b). Columbey National Park, situated near Clarencetown, currently supports the most extensive populations of *Pterostylis chaetophora* (Bell & Hillier 2020), and lies 80 km to the east-south-east of the Project Area.

2.3 Habitat

2.3.1 Diuris tricolor

24. A range of habitats have been documented for *Diuris tricolor* throughout its range (Table 3), although few studies provide sufficient detail on co-occurring ground layer species. This makes it difficult to identify potential habitat at the local scale, although not insurmountable. Most texts document favoured habitat as grassy *Callitris* woodlands, although in Queensland it is 'eucalypt open forest'. In a study of remnant vegetation stands in the South Western Slopes of NSW, Burrows (1999) recorded *Diuris tricolor* at several sites, but all within *Callitris glaucophylla* dominated vegetation. J. Hunter (2010) located the species in areas associated with ironbark and Bulloak in the Pilliga area, while Cunningham *et al.* (2011) noted habitat as *Eucalyptus populnea* for the Tottenham area (west of Dubbo). Clearly, a diversity of habitats support *Diuris tricolor* across the state, and this information alone cannot be used to generalise occupied habitat at specific locations.

25. First-hand experience of *Diuris tricolor* in the Hunter Valley is therefore influential in determining the suitability of an area to support this species. Field evidence and unpublished data from subpopulations of *Diuris tricolor* at Mangoola (near Denman) and Muswellbrook (Bulga Coal's Condran offset property) suggest that it occurs most commonly within grassy woodlands and grasslands derived from former Ironbark (*Eucalyptus crebra*) or Dawson's Box (*Eucalyptus dawsonii*) woodlands, and with minimal amounts in Box (*Eucalyptus 'albemol'*, a purported hybrid between *E. albens* and *E. moluccana*) woodlands. Note that in the central and upper Hunter, populations of *Eucalyptus 'albemol'* have historically and contemporarily been

referred to as either or both of the two supposed parent species, but ongoing taxonomic work suggests this entity to be a distinct species with no evidence of hybridisation (S. Bell & C. Driscoll unpubl. data). At the currently known eastern limit of distribution (North Rothbury), *Diuris tricolor* was recorded in 2016 in open forest of *Eucalyptus crebra, Corymbia maculata* and *Eucalyptus fibrosa*, although no individuals have been seen at that location since (Bell 2017a).

Table 3 Habitat documented for *Diuris tricolor*.

Habitat	Location	Source
Hunter Valley		
native grassland in areas not subject to intensive grazing	Hunter Valley generally	Umwelt 2011a, 2011b, 2013
derived grasslands of *Aristida/Cymbopogon*; *Bothriochloa/Carthamus/Danthonia; Dichanthium/Sporobolus/Chloris* woodlands of *Eucalyptus crebra, E. dawsonii* or *Allocasuarina luehmannii*	Wybong	Bell 2012a
disturbed grassland, often adjoining woodland and forest	Wybong	Umwelt 2012
grassland/open woodland	Wybong	Herd & Herd 2005
grassland	Wybong	Abel Ecology 2005
disturbed grassland	Wybong	Umwelt 2006
grassy woodland within Hunter Floodplain Red Gum Woodland (Threatened Ecological Community [TEC])	Muswellbrook LGA	Cumberland Ecology 2014
Eucalyptus crebra, Corymbia maculata, E. fibrosa grassy forest	North Rothbury	Bell 2017a
ungrazed grasslands on soils of low fertility	Ulan	Ecovision Consulting 2008
derived grassland within *Eucalyptus crebra*	Condran offset (Muswellbrook)	Bell *et al.* 2020
Outside of the Hunter Valley		
grassy *Callitris glaucophylla* woodlands	general	Jones 1993; Burrows 1999; Bishop 2000; Cameron *et al.* 2014; Jeanes 2015b
Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta, Ironbark and *Acacia* shrubland. The understorey is often grassy with herbaceous plants such as *Bulbine* species	general	URS 2009; Jacobs 2017
open grassy woodland often associated with Box-Gum Woodland [TEC]	general	Cumberland Ecology 2014
eucalypt open forest	Queensland	Stanley & Ross 1989
Eucalyptus sideroxylon, E. crebra and *Allocasuarina luehmannii*	Pilliga (NSW)	J. Hunter 2010
Eucalyptus populnea	west of Dubbo (NSW)	Cunningham *et al.* 2011

26. Using the Mangoola Coal population of *Diuris tricolor* as a case study, an assessment of vegetation communities supporting 975 GPS-recorded *Diuris tricolor* locations (n=5120 individual orchids) was undertaken (unpubl.). This involved intersecting in GIS point locations against a pre-1750 vegetation map prepared for the site in 2013 (unpubl. data). In that study, twelve vegetation communities were mapped on the basis of extensive field reconnaissance, where remnant paddock trees and landscape position were used to extrapolate across highly cleared lands. Of those twelve communities, *Diuris tricolor* was found to occur in five, with 61% of all records (n=599) and 60% of all individuals (n=3089) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 5).

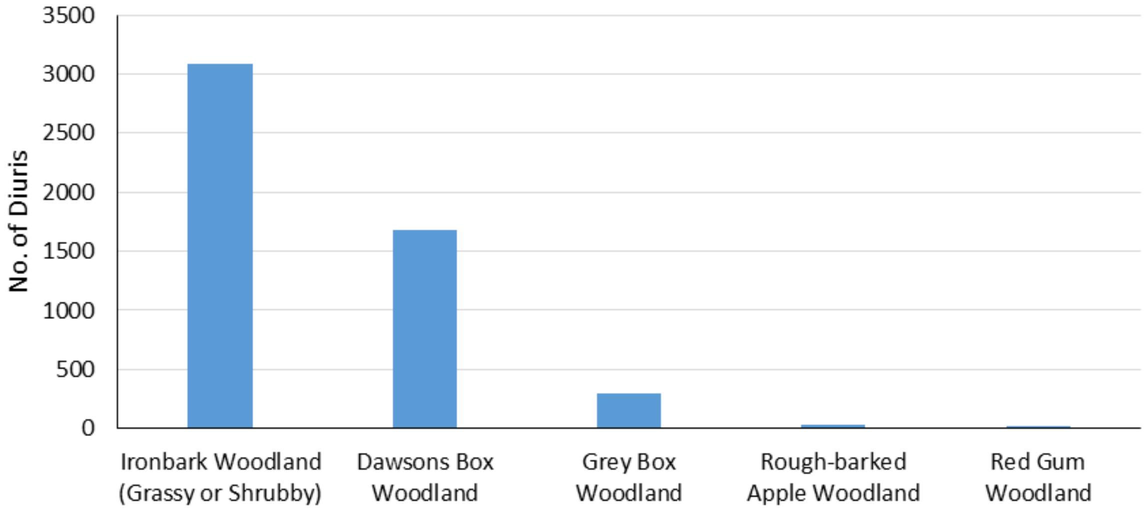


Figure 5 Number of *Diuris tricolor* individuals (n=5120) by pre-1750 vegetation type within the 1492 ha Mangoola Coal study area (unpubl. data). Note that *Diuris tricolor* records almost all located within derived native grasslands (DNGs) from these vegetation types.

27. The next most favoured habitat at Mangoola was Dawson's Box (*Eucalyptus dawsonii*) Woodland with 29% of records (n=280) and 33% of individuals (n=1684), and these two communities combined supported >90% of all *Diuris tricolor* records and individuals. Three other communities comprised relatively minor *Diuris tricolor* habitat: Box (*Eucalyptus 'albemol'*) Woodland (7% of records), Rough-barked Apple (*Angophora floribunda*) Woodland (2% of records), and Red Gum (*Eucalyptus blakelyi*) Woodland (1% of records). In the absence of other similar habitat data from elsewhere in the Hunter Valley, the Mangoola study area provides a strong landscape-scale indication that *Diuris tricolor* is most closely associated with *Eucalyptus crebra* or *Eucalyptus dawsonii* grassy woodlands.

28. At a finer scale, a floristic analysis of derived grasslands undertaken at Mangoola Coal between 2009 and 2011 (comprising 168 plots sampled over 2000 ha) found that *Diuris tricolor* occurred within three of seventeen grassland types, in descending order of importance (Bell 2012a, Bell submitted 1):

- *Aristida/ Cymbopogon* Grassland (Unit 2);
- *Bothriochloa biloba/ Carthamus/ Danthonia* Grassland (Unit 4); and
- *Dichanthium/ Sporobolus/ Chloris* Grassland (Unit 1a).

29. In that study, *Diuris tricolor* was also sparingly present in three woodland communities, those characterised by *Eucalyptus crebra, Eucalyptus dawsonii* or *Allocasuarina luehmannii*.

Combined, the three derived grassland habitats defined encompassed a significantly large proportion of the grasslands included in that study (84% of 1069 ha). Detailed floristic compositions for each of these key grassland communities are replicated in Appendix 2. Knowledge gained from the Mangoola floristic analysis of grassland types has been incorporated into my assessments of suitable *Diuris tricolor* habitat at the Maxwell Project discussed later in this report.

2.3.2 Prasophyllum petilum

30. Information on the habitat of *Prasophyllum petilum* throughout its range is brief but documents variable associations (Table 4). When describing the species, Jones (1991) reported the known habitat at that time (the Type locality only, in the ACT) as being "*moist grassy patches in sparse woodland developed on fertile soils*", while Bishop (2000) describes it as remnant *Themeda* grassland on silty clay loams. The national recovery plan for this species (Department of Environment, Climate Change and Water [DECCW] 2010) provides more detail on floristic associations at the five known sites for which it was written, mostly on the Southern and Central Tablelands of NSW.

31. Notes associated with collections included in AVH indicate that most southern records of *Prasophyllum petilum* occur in grasslands dominated by *Themeda australis, Bothriochloa* spp. and *Danthonia* spp, with associated forbs of *Bulbine* sp., *Dichopogon* sp., *Wurmbea* sp., *Swainsona* sp., *Pimelea curviflora*, *Chrysocephalum* sp., *Ajuga australis*, *Craspedia* sp., *Stackhousia monogyna*, *Eryngium* sp., *Burchardia* sp., *Arthropodium* sp., and *Juncus* sp. Northern records occur in grassland of *Aristida* sp., *Themeda australis* and *Stackhousia monogyna*. With the exception of populations on the North Western Slopes, these habitats at collection locations are very different to those where *Prasophyllum petilum* occurs in the Hunter Valley. In this region plants occur most commonly in grasslands derived from former Ironbark (*Eucalyptus crebra*), Dawson's Box (*Eucalyptus dawsonii*) and Box (*Eucalyptus 'albemol'*) woodlands, co-occurring with species such as *Cymbopogon refractus, Aristida ramosa, Dichanthium sericeum* and *Chloris ventricosa*.

32. Once again, using Mangoola Coal as a case study, an assessment of the vegetation communities supporting 759 GPS-recorded *Prasophyllum petilum* locations (n=4073 individual orchids) was undertaken. This involved intersecting in GIS each point location against a pre-1750 vegetation map prepared for the site in 2013 (unpubl. data). In that study, twelve vegetation communities were mapped on the basis of extensive field reconnaissance, where remnant paddock trees and landscape position were used to extrapolate across highly cleared lands as required. Of those twelve communities, *Prasophyllum petilum* was also found to occur in five (the same as for *Diuris tricolor*), with 58% of all records (n=442) and 59% of all individuals (n=2413) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 6).

33. As for *Diuris tricolor*, the next most favoured habitat was Dawson's Box (*Eucalyptus dawsonii*) Woodland with 22% of records (n=164) and 20% of individuals (n=831), and these two communities combined supported 80% of all *Prasophyllum petilum* records and individuals. Box (*Eucalyptus 'albemol'*) Woodland supported 17% of records (n=130) and 19% of individuals (n=764). Two other communities comprised minor *Prasophyllum petilum* habitat: Red Gum (*Eucalyptus blakelyi*) Woodland, and Rough-barked Apple (*Angophora floribunda*) Woodland (<4% combined). In the absence of other similar habitat data from elsewhere in the Hunter Valley, the Mangoola study area provides a strong landscape-scale indication that *Prasophyllum petilum* is most closely associated with *Eucalyptus crebra* grassy woodlands.

Table 4 Habitat documented for *Prasophyllum petilum*.

Habitat	Location	Source
Hunter Valley		
derived grasslands of *Aristida/Cymbopogon*; *Bothriochloa/Carthamus/Danthonia; Dichanthium/Sporobolus/Chloris;* woodlands of *Eucalyptus crebra, E. dawsonii* or *Allocasuarina luehmannii*	Wybong	Bell 2012a
open eucalypt woodland and grassland	general	Wildthing 2011
Outside of the Hunter Valley		
remnant *Themeda* grassland on silty clay loams	general	Bishop 2000
shrubby and grassy habitats in dry to wet soil, in open eucalypt woodland and grassland	general	Umwelt 2013; Eco Logical Australia 2015
Grassy Box Woodlands with fertile to moderately fertile soils on undulating terrain	general	FloraSearch 2014
wet grassy woodlands on fertile ground	Southern Tablelands region (NSW & ACT)	Rouse 2002
moist grassy patches in sparse woodland developed on fertile soils	Type location (ACT)	Jones 1991
grassy woodland of *Eucalyptus pauciflora* and *E. aggregata*, with a sparse shrub layer of *Hakea microcarpa, Acacia dealbata* and *Leptospermum brevipes* and a ground layer of *Poa sieberiana, Themeda australis* and *Schoenus apogon*	Captains Flat cemetery (NSW)	DECCW 2010
grassy woodland of *Eucalyptus blakelyi* and *E. melliodora*, over *Poa sieberiana* and *Themeda australis*	Hall cemetery (ACT)	DECCW 2010
grassy woodland of *Eucalyptus blakelyi* and *E. melliodora*, over *Themeda australis* and *Sorghum leiocladum*	Ilford cemetery (NSW)	DECCW 2010
natural grassland of *Bothriochloa macra, Pentapogon quadrifidus, Austrodanthonia* spp., *Themeda australis, Schoenus apogon, Drosera peltata, Sebaea ovata* and *Haloragis heterophylla* on a treeless grassy plain	Tarengo TSR (NSW)	DECCW 2010
a treeless frost hollow, surrounded by *Eucalyptus pauciflora*	Steves TSR (NSW)	DECCW 2010

34. Floristic analysis of derived grasslands undertaken at Mangoola Coal between 2009 and 2011 (comprising 168 plots sampled over 2000 ha) found *Prasophyllum petilum* occurring in three of seventeen grassland types, in descending order of importance (Bell 2012a; Bell submitted 1):

- *Aristida/ Cymbopogon* Grassland (Unit 2);
- *Bothriochloa biloba/ Carthamus/ Danthonia* Grassland (Unit 4); and
- *Dichanthium/ Sporobolus/ Chloris* Grassland (Unit 1a).

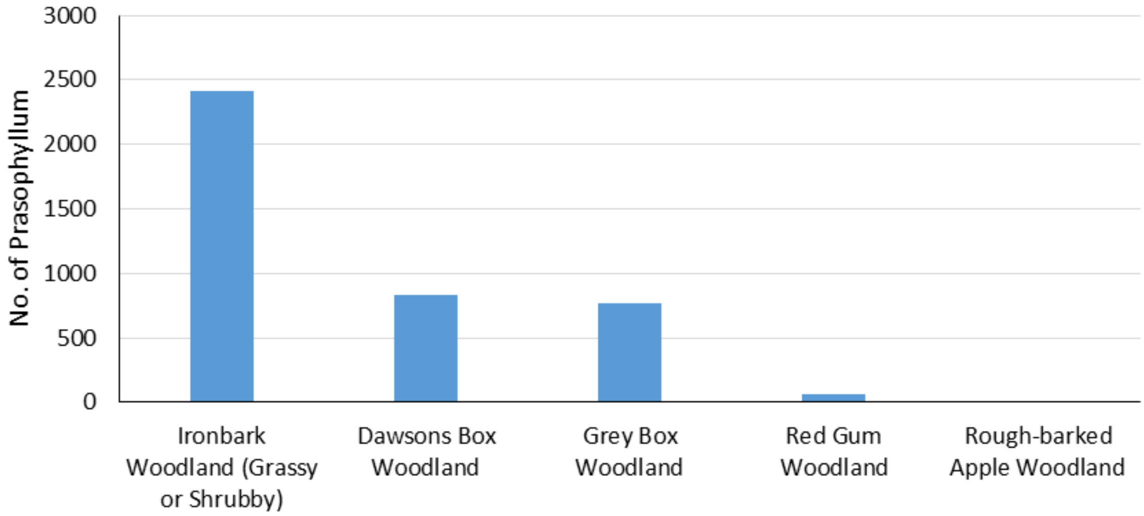


Figure 6 **Number of *Prasophyllum petilum* individuals (n=4073) by pre-1750 vegetation type within the 1492 ha Mangoola Coal study area (unpubl. data).** Note that *Prasophyllum petilum* records almost all located within DNGs from these vegetation types.

35. *Prasophyllum petilum* was also occasionally present in three woodland communities, those characterised by *Eucalyptus crebra, Eucalyptus dawsonii* or *Allocasuarina luehmannii*. Combined, the three derived grassland habitats defined encompassed a significantly large proportion of the grasslands included in that study (84% of 1069 ha). Knowledge gained from the Mangoola floristic analysis of grassland types (see Appendix 2) has been incorporated into my assessments of suitable orchid habitat at the Maxwell Project discussed later in this report.

2.3.3 Pterostylis chaetophora

36. There is little information available on habitat for the Hunter endemic *Pterostylis chaetophora*, although recent monitoring work associated with the NSW Government's *Saving our Species* initiative has collated some information (Bell 2020b). For Columbey National Park, *Pterostylis chaetophora* was found to predominantly occur in vegetation described as Floodplain Redgum-Box Forest and Lower Hunter Spotted Gum – Ironbark Forest (Bell & Hillier 2020: Figure 7). Paget (2008) provided brief notes on habitat for several other populations of the species, which has been added to and expanded upon in Bell and Hillier (2020). Table 5 summarises habitat for *Pterostylis chaetophora* from all known locations.

2.4 Ecology

2.4.1 Orchid Detectability

37. The unpredictability of flowering in orchids from year-to-year is a widely recognised trait in this group of plants (e.g. Gillman & Dodd 1998; Kindlmann & Balounova 2001; McCormick & Jacquemyn 2014), and this is commonly governed by weather (e.g. Wells *et al.* 1998; Kindlmann & Balounova 2001; Pfeifer *et al.* 2006). Many species fail to emerge during dry phases, and although viable populations may persist underground, their presence above ground often leads to an incorrect assumption that no plants are present. In general terms, low rainfall in the three months leading up to flowering place individual orchids under stress, meaning that flowering may be postponed for that season for all but the most robust individuals. Because of this trait,

terrestrial orchids have been described as 'time-travellers' (Brundrett 2016), encapsulating the uncertainty in determining their presence in any given area.

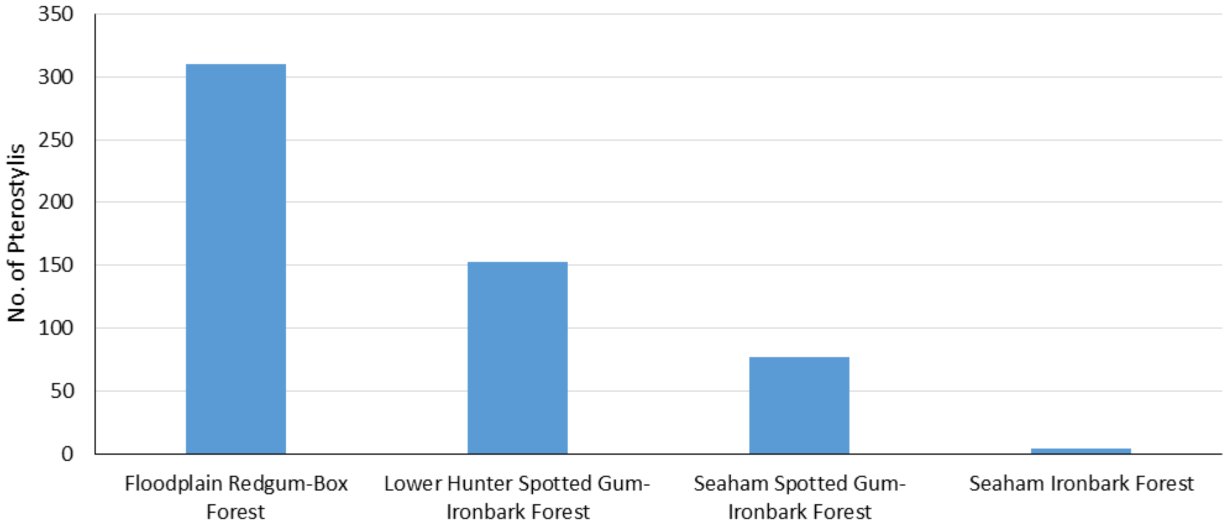


Figure 7 Number of *Pterostylis chaetophora* individuals (n=544) by vegetation type within the 720 ha Columbey National Park study area (after Bell & Hillier 2020).

Table 5 Habitat documented for *Pterostylis chaetophora*.

Habitat	Location	Source
forest of *Eucalyptus fibrosa, Corymbia maculata* and *Eucalyptus umbra*	Columbey National Park, Pindimar, Raymond Terrace, Beresfield	Bell & Hillier 2020
forest of *Eucalyptus moluccana* and/or *Eucalyptus amplifolia*	Columbey National Park	Bell & Hillier 2020
shrubby forest of *Corymbia maculata* and *Eucalyptus fibrosa*, or *Eucalyptus tereticornis, Eucalyptus punctata* and *Angophora floribunda* in dry drainage lines	Kurri	Bell & Hillier 2020
forest of *Eucalyptus tereticornis, Angophora floribunda* and *Eucalyptus crebra*	North Rothbury	Bell (2020b)
Eucalyptus propinqua and *Eucalyptus microcorys* shrubby forest	Purfleet	Paget 2008
grasslands derived from cleared *Eucalyptus propinqua, Eucalyptus acmenoides, Eucalyptus microcorys, Eucalyptus placita* and *Eucalyptus siderophloia* forest	Burrell Creek	Paget 2008
forests of *Eucalyptus placita, Eucalyptus siderophloia, Eucalyptus paniculata* and *Corymbia maculata,* or *Eucalyptus amplifolia* and *Eucalyptus moluccana*	Twelve Mile Creek	Paget 2008

38. Part of the difficulty of detection experienced during drought years is the added stress placed on emerging orchids by herbivores searching for palatable foods: orchids may well emerge every year in some species but they may be quickly consumed by grazing mammals, birds or invertebrates. For example, Duncan and Moloney (2018) found that for the threatened *Diuris fragrantissima* good rainfall increased the probability of flowers setting seed and decreased the probability that plants would be browsed.

39. As a rule of thumb, dry winters in the Hunter Valley generally result in below average flowering in terrestrial orchids, and this has been shown for both *Diuris tricolor* and *Prasophyllum petilum* (Bell 2019a, b). The relationship between rainfall and flowering in these species has been highlighted over a ten-year translocation project undertaken at Mangoola Coal (Bell 2019a, b; Bell 2020; also reported annually in reports to Mangoola Coal). Over the course of nine years of monitoring, the July-to-August pre-flowering rainfall transitioned from three years of near- or below-average rainfall, to three years of above-average rainfall, and three years of well-below average rainfall. Dry years have been reflected in low rates of detection within recipient plots, while wetter years have shown an increase in detection (Figure 8). There are of course other factors contributing to the extent of orchid detection observed (expanded upon in Bell 2020d), but for these two species there is a clear trend associated with winter rainfall. Of the nine recipient plots, all displayed lower detection rates in the drought years of 2017-2019, following three seasons of above average winter falls. A similar downward trend was observed for the five recipient plots (n=440) established within mine rehabilitation, monitored over 3-4 years since 2015, and four control plots of naturally occurring orchids monitored since 2016 (data not presented here).

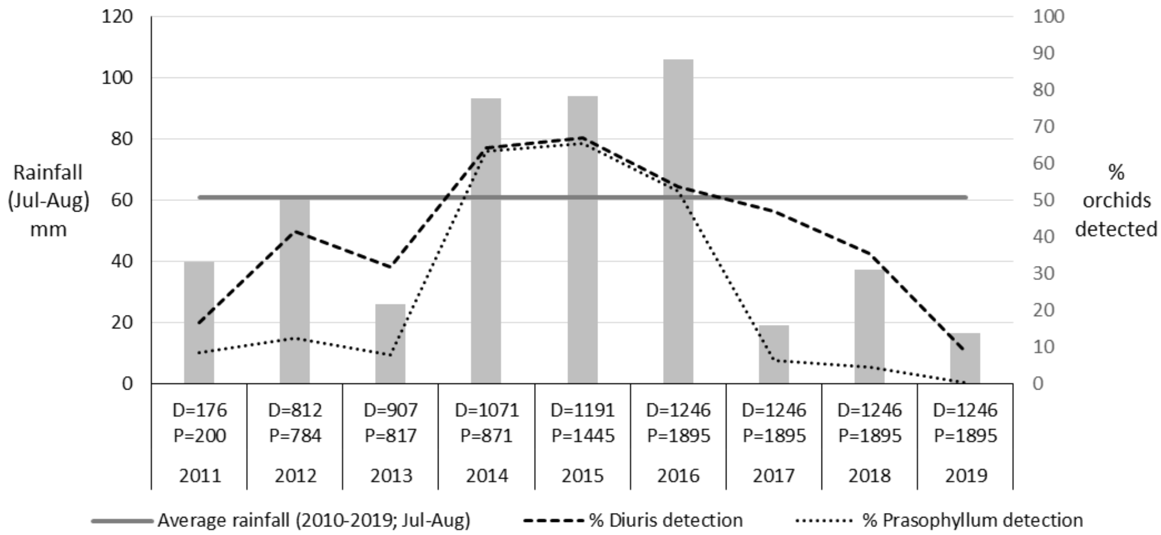


Figure 8 **Rainfall received (July to August) and orchid detection (n=2,592) during the course of monitoring across nine recipient plots within derived grassland at Mangoola Coal, over a period of four to nine years (after Bell 2019a).**

40. Surveying for orchids requires repeat visits to an area to be confident in the presence and magnitude of any residing orchid populations. This is particularly the case for those species where flowering can be protracted over several weeks, although most do experience a ‘peak’ period (e.g. Yare *et al.* 2020). Vizer (2013) found peak flowering in *Diuris tricolor* and

Prasophyllum petilum at Mangoola to occur from mid- to late-September, but that less than 20% of plants would be flowering on any particular day at this time. This implies that a 'one-off' survey, even if conducted on the day of peak flowering, would likely overlook more than 80% of individuals in the population. Capsule production was also found during his study to occur in less than 3% of plants for both species, with herbivory identified as an important limiting factor in seed production. However, peak flowering time likely varies year-to-year, and will depend on available soil moisture and other site conditions. For example, during the 2015 flowering season at Mangoola, *Diuris tricolor* was found to peak in the second week of September, but *Prasophyllum petilum* flowering was still increasing in the first week of October (Bell 2020d).

41. For *Prasophyllum petilum*, Wilson *et al.* (2016) analysed annual monitoring data over a 25-year period from the largest known population on the southern tablelands of NSW, and identified the incidence of frost (nights ≤ -4ºC) as being instrumental in preventing flowering in any one season. Frost damage to emerging plant parts prior to reaching flowering stage prevents detection during monitoring surveys, influencing orchid counts. Warm winters are consequently of benefit to the orchids in that population, although it is unknown if the same applies to the Hunter Valley population where frosts are rarer.

42. Detectability in *Pterostylis chaetophora* appears less reliant on rainfall, although monitoring over three years has shown a weak (but untested) trend in this regard (Bell 2020b). The more coastal distribution of this species suggests that water stress through inadequate rainfall is less likely to influence orchid emergence and persistence, although heavy grazing of tubers by White-winged Choughs has occurred during recent drought conditions at North Rothbury. The geographical range of many members of subgenus *Oligochaetochilus* extends into drier inland habitats, demonstrating some level of adaptation to dry and harsh environments (Kuiter & Findlater-Smith 2017).

2.4.2 Mycorrhizal Fungi

43. Orchid presence in any area is dependent on the availability of co-occurring mycorrhizal fungi present within the soil, and often different fungi are required by different orchid species (Waterman & Bidartondo 2008; McCormick *et al.* 2018), yet co-existence of several orchid species is still possible (Waud *et al.* 2016). Mycorrhizal fungi are necessary for nutrient transfer between soil and orchid, and they are also essential in aiding the germination of orchid seeds (Brundrett 2006). The minute size of orchid seeds means they carry no nutrients and hence associating with the correct fungi immediately after dispersal is imperative. Weston *et al.* (2005) noted a high degree of specificity between a particular species of orchid and their associated species of mycorrhiza, but that there are also commonalities between and within genera. Brundrett (2006) stresses the need for fungi and pollinators with orchids in his three key dimensions of orchid presence: differing levels of interactions between the three dimensions determine the specificity and availability or suitability of habitat.

44. Without intensive survey for the relevant mycorrhizal fungi present in an area, there is no way of knowing whether or not a specific site is capable of supporting an orchid population of any species. Research has shown that mycorrhizal fungi may be widespread in the landscape and occur in a range of habitats, but that it may also be patchy and is not necessarily reflected in observable orchid populations (e.g. Brundrett *et al.* 2003; McCormick & Jacquemyn 2014; Voyron *et al.* 2016). The assumption, therefore, that all potential orchid habitat based on biophysical characteristics (e.g. soil type, elevation, rainfall, co-occurring plant species) can be

equally occupied by a specific orchid species is misleading: without fungi, seed will not germinate and plants will not prosper. Investigation into whether specific abiotic variables, such as rainfall or geological substrate, govern the geographical distribution of mycorrhizal fungi has been identified as a priority for research (Jacquemyn *et al.* 2017), although this work is still in its infancy.

2.4.2.1 Diuris tricolor

45. For *Diuris* sp., the *Tulasnella* genus (family Tulasnellaceae) is the most important mycorrhizal fungi (Weston *et al.* 2005; Smith *et al.* 2010). At Mangoola Coal, seed-baiting techniques were used by Vizer (2013) in an attempt to map the distribution of mycorrhizal fungi, and he found that the distribution of *Diuris tricolor* was actually more restricted than the relevant fungi. This implies that (for the Mangoola area) there may be extensive suitable habitat, complete with mycorrhizal fungi, within a wider area than is currently known to support the species. Similarly, Tierney *et al.* (2017) observed differences in seed germination within soil sampled from different subpopulations of *Diuris platychila*, attributable either to differing concentrations of fungal hyphae within each soil sample or that some samples supported superior strains of fungi.

2.4.2.2 Prasophyllum petilum

46. Weston *et al.* (2005) suggest that the genus *Ceratobasidium* (family Ceratobasidiaceae) is the likely mycorrhizal fungi for *Prasophyllum* sp., supported partially by work on two threatened species in Victoria by McQualter *et al.* (2007) where *Ceratobasidium cornigerum* (and a *Rhizoctonia* sp. were isolated). Within the Hunter Valley, mycorrhizal seed-baiting for *Prasophyllum petilum* was not successful in the study of Vizer (2013), which is not unusual for this genus, and further research in this species is required.

2.4.2.3 Pterostylis chaetophora

47. Like *Prasophyllum* sp., the genus *Ceratobasidium* is thought to be the likely mycorrhizal fungi required for *Pterostylis* sp. (Weston *et al.* 2005). Jusaitis and Sorensen (1993) isolated mycorrhizal fungi from *Pterostylis arenicola* (closely related to *Pterostylis chaetophora*), but did not identify the fungi. Few other studies within this genus are evident in the literature.

2.4.3 Pollination and Seed Production

48. Pollination in *Diuris*, *Prasophyllum* and *Pterostylis* sp. (and most other orchids) is enacted by insects (Adams & Lawson 1993; Weston *et al.* 2005; Hawkeswood 2006). Many orchids rely on mimicry to deceive unsuspecting insects (Adams & Lawson 1993; Schiestl 2005), either by the development of nectar-bearing flowers that appear identical to those of co-occurring species in their habitat (food mimicry), or by individual flowers resembling (often with the aid of pheromones) the females of certain insects (sexual mimicry). Other species offer a nectivorous reward, which when combined with the appropriate scent attract pollinating insects.

49. Once pollination has been enacted, the development of seed capsules progresses over the following weeks, although plants still remain vulnerable to grazing and desiccation during this time. Some studies have shown that, despite relatively high levels of historical and current-day fragmentation of landscapes, pollinators are still able to forage amongst orchids to produce seed (e.g. Brundrett 2019). For many nectarless orchids, this is reliant on the presence of co-occurring food plants to supply the necessary food, and for species with highly specific pollinators this is particularly important (Phillips *et al.* 2015; Brundrett 2019). However, fragmentation and loss of pollinator habitat is widely recognised as detrimental to most orchid

populations (Wraith & Pickering 2018; Phillips *et al.* 2020). Based on observations made at orchid translocation sites at Mangoola Coal over several years (e.g. Bell 2016), capsule development is unhindered in *Diuris tricolor* and *Prasophyllum petilum* despite close proximity to an active coal mine.

2.4.3.1 Diuris tricolor

50. Most *Diuris* sp. mimic co-occurring species of pea (Fabaceae) to attract pollinators (e.g. Backhouse *et al.* 2016; Scaccabarozzi *et al.* 2018), and for *Diuris tricolor* in the Hunter Valley this is likely to be *Templetonia stenophylla* or *Daviesia genistifolia* (pers. obs.; Vizer 2013). Weston *et al.* (2005) indicate that the pollinators of *Diuris* sp. are likely to be various colletid bees from the *Trichocolletes* and *Leioproctus* genera, although Walker (1997) suggested opportunistic native halictid bees were potential pollinators of *Diuris basaltica*. Indsto *et al.* (2006) found male bees of the species *Trichocolletes venustus* to be the primary pollinators of *Diuris maculata* in Sydney.

2.4.3.2 Prasophyllum petilum

51. *Prasophyllum* sp. employ a different strategy to attract pollinators, using nectar and scent to entice various insects to pollinate and be rewarded with food. The likely pollinators of *Prasophyllum* sp. are thought to be colletid and halictid bees, ichneumonid, tiphiid, scoliid and sphecid wasps, syrphid flies, and beetles (Weston *et al.* 2005). For *Prasophyllum odoratum*, Bernhardt & Burns-Balogh (1986) found that polytrophic flies (family Syrphidae) and opportunistic male bees in the genus *Leioproctus* (family Colletidae) were the principle pollinators.

2.4.3.3 Pterostylis chaetophora

52. For *Pterostylis* sp., pollination through sexual deception has been demonstrated for several species (e.g. Bernhardt 1995; Phillips *et al.* 2014; Thalwitzer *et al.* 2018; Reiter *et al.* 2019), and the greenish to rusty colouration of flowers in this genus suggest fungus gnats (order Diptera) as the primary pollinators (Vogel 1973). Kuiter and Findlater-Smith (2017) provide support for this in their overview of pollinators of the Victorian members of *Pterostylis* sp., concluding that fungus gnats (families Mycetophilidae and Sciaridae) almost always enact pollination in these orchids. In their study, Reiter *et al.* (2019) found *Pterostylis boormanii* and *Pterostylis basaltica*, both closely related to *Pterostylis chaetophora* within section and subgenus *Oligochaetochilus* (Janes & Duretto 2010), were pollinated by male fungus gnats (*Xenoplatyura conformis*) of the family Keroplatidae. However, Kuiter and Findlater-Smith (2017) found the ten Victorian members of subgenus *Oligochaetochilus* were all pollinated by one of five species of fungus gnat from a different genus, *Orfelia* (family Mycetophilidae). Both investigations suggest that multiple pollinating fungus gnats may be responsible, perhaps related to geographical location and/or specific habitat requirements, and such a strategy potentially allows a wider distribution in this subgenus.

2.4.4 Reproduction and Dispersal

53. Reproduction in orchids can occur sexually or asexually, through the production of seed or via tuber multiplication ('daughter tuberoids') or through annual replacement. Following sexual reproduction, dispersal limitation is an important factor determining orchid distribution (McCormick & Jacquemyn 2014). Orchid seeds are very small ('dustlike'), produced in exceptionally large numbers within capsules, are very light (Arditti & Ghani 2000; Shefferson *et al.* 2020) and, in some situations, are capable of dispersion by wind over vast distances (Phillips

et al. 2020). In most cases, however, the low stature of terrestrial orchids and the structure of co-occurring vegetation means that seed falls close to the parent plant (Backhouse & Cameron 2005; Jersáková & Malinová 2007). Some species rely on streams for seed dispersal, and others may benefit through fauna movements (Weston *et al.* 2005), but this is rare.

2.4.4.1 Diuris tricolor

54. As a genus, *Diuris* sp. replace their tubers annually and a small number are also capable of spreading vegetatively through daughter tuberoids, although this is rare (Jones 1993). Backhouse *et al.* (2016) hold a differing view, stating that most species can multiply vegetatively but several rely solely on seed dispersal. *Diuris tricolor* is most commonly encountered as individual plants or loose groups, consistent with spread through seed dispersal (pers. obs.).

2.4.4.2 Prasophyllum petilum

55. With few exceptions, nearly all species of *Prasophyllum* replace their tubers annually and do not colonise adjacent habitat through daughter tuberoids. As a consequence, most species rely on seed production and dispersal within favoured habitat (Jones 1993), and most occur as scattered individuals or in loose groups. Within the Hunter Valley, *Prasophyllum petilum* follows this typical pattern in population growth habit (pers. obs.).

2.4.4.3 Pterostylis chaetophora

56. In *Pterostylis* sp., some species are solitary while others form extensive colonies through daughter tuberoids on the ends of long stolons (Jones 1993; Backhouse *et al.* 2016). All species produce replacement tubers at the conclusion of the flowering season, emerging as leaves following good rainfall during Autumn. Members of subgenus *Oligochaetophilus* (including *Pterostylis chaetophora*) are rarely colonising species, generally replacing their tubers annually rather than spreading through daughter tuberoids (Juisaitis & Sorensen 1993). This implies that seed dispersal is the primary means of landscape dispersal for these species. Indeed, in my experience nearly all populations of *Pterostylis chaetophora* occur individually or in small, loose groups (Bell & Hillier 2020).

3. Criterion (b) – Justification for an Expert Report

57. A BDAR for the Project has been prepared by Hunter Eco (2019). This report details the extent of previous and new survey of vegetation, flora and fauna across the wider Maxwell lands including the Project Area. I have relied on this document to provide the most up-to-date information on the biodiversity of the locality, and used it to assist my assessment of the potential presence within the Project Area of the three target orchid species. However, I have used my own experience with these orchids elsewhere, and observations made during a one-day field inspection of the Project Area (detailed in **Section 4**), to inform my assessment.

58. During recent surveys completed for the Project, no threatened flora species were recorded by Hunter Eco (2019). This included sites where *Diuris tricolor* had previously been observed by other workers, but drought conditions would have impacted on flower emergence and persistence during recent years (see **Section 3.2**). Since initial preparation of this report, Hunter Eco (2020) completed additional surveys in and around the Project Area. *Diuris tricolor* was recorded near original records of the known population, however no threatened flora species were recorded within the Project Area.

3.1 Survey Effort

59. Hunter Eco (2019) details (in Table 3 of Attachment A – *Baseline Flora Report*) the extent to which the Project Area and the immediately surrounding lands have been subject to flora and vegetation surveys, particularly in relation to the Mt Arthur Coal Mine and the former proposed Drayton South open cut mine (now the proposed Maxwell Project). Investigations shown there as occurring within the current Project Area include:

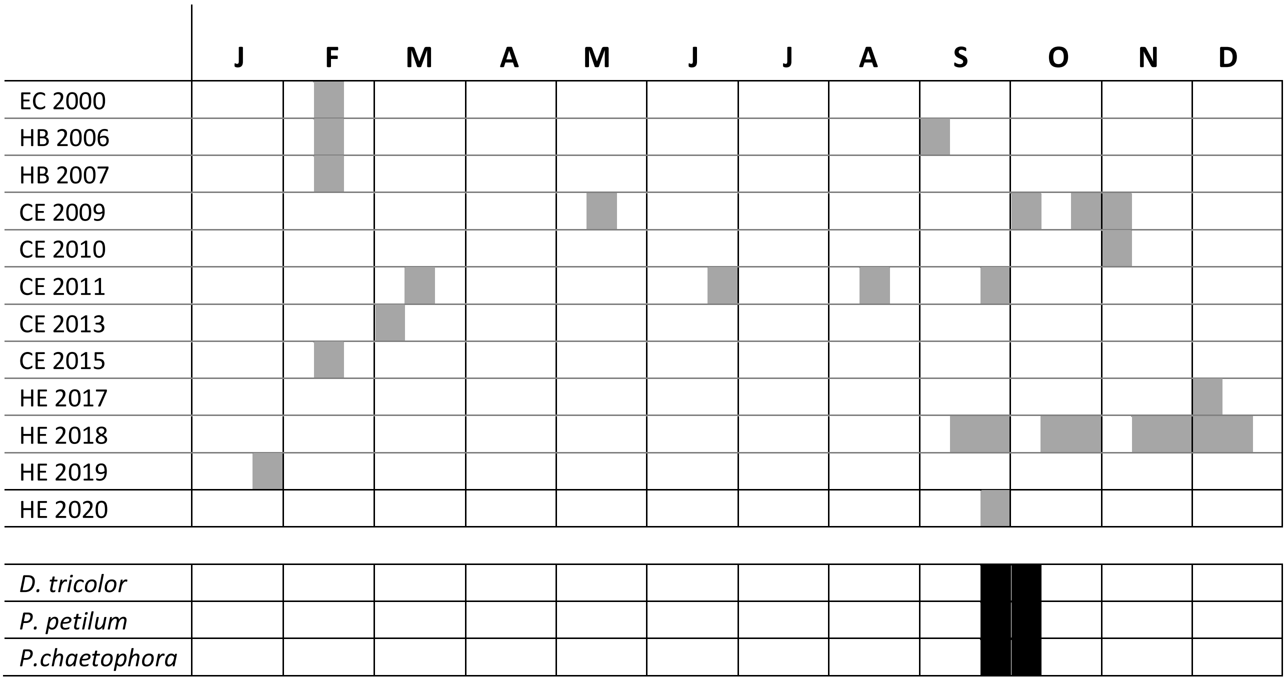
- Hansen Bailey (2007)
- Cumberland Ecology (2009)
- Cumberland Ecology (2012)
- Cumberland Ecology (2015)

60. In addition, flora surveys have been carried out across the Project Area and surrounds by Hunter Eco in 2017, 2018, 2019 and 2020, and other survey periods are noted in Cumberland Ecology (2015). Table 6 summarises the timing of field survey for each of these investigations, relative to expected flowering periods (i.e. detectability) of the three target orchids. One of the target orchids (*Diuris tricolor*) was initially recorded in 2009 near to the Project Area by Cumberland Ecology (now contained within a fenced off area; referred to henceforth as the 'Diuris Conservation Area'), where two individuals were located. Repeat surveys in the area in November 2010 did not locate any plants (not surprising as November falls outside of the flowering period), but 30 plants were recorded in 'Spring' (presumably September or October) 2011. Cumberland Ecology (2015) described the habitat at this location as Hunter Floodplain Red Gum Woodland, although on my inspection there on 3 July 2020 I saw woodland dominated only by *Eucalyptus conica* and *Eucalyptus moluccana,* with patches of *Angophora floribunda* and *Eucalyptus melliodora*.

61. From Table 6 it is evident that few of these survey periods correspond with peak flowering times in the three target orchids. Cumberland Ecology expended three days of effort (incorporating vegetation mapping, habitat assessment, plot sampling and threatened flora searches) on 30 September to 2 October 2009, and one day (targeted orchid and *Acacia*

pendula surveys) on 23 September 2011 (Cumberland Ecology 2015). Hunter Eco undertook targeted orchid surveys over two days on 28 September and 17 October 2018, 10 days of floristic plot survey throughout September and October 2018, and targeted orchid surveys over two days on 28 and 29 September 2020.

Table 6 Field survey effort (grey) and peak orchid flowering periods (black). EC = Ecotone; HB = Hansen Bailey; CE = Cumberland Ecology; HE = Hunter Eco. Survey periods shown include both targeted searches and plot- or transect-based floristic surveys where it may be expected that orchids would be detected if present.



62. Throughout all orchid searches and floristic plot surveys, and from the data available to me, only two terrestrial orchids have been located across the Project Area or surrounds: *Diuris tricolor* by Cumberland Ecology in 2009 and 2011 and by Hunter Eco in 2020, and the common and unlisted *Pterostylis bicolor* by Hunter Eco in 2018 (Hunter Eco 2019), both recorded from the Diuris Conservation Area (C. Driscoll pers. comm.). A low diversity of terrestrial orchids is not unusual for this part of the Hunter Valley; surveys by Kleinfelder across the Bayswater Power Station area immediately adjacent to the east have reported only a *Microtis* sp. across 71 floristic plots (although mostly under drought conditions, discussed in Bell 2020c). Further discussion on the importance of this lack of terrestrial orchids is presented in **Section 4.3**.

3.2 Impact of Drought

63. As noted earlier, terrestrial orchids are sensitive to environmental conditions, and in the Hunter Valley prevailing rainfall patterns are influential in their detection during surveys. The past three years in the central Hunter Valley have been particularly dry. Figure 9 shows that, apart from the very wet months of March 2017, March 2019, and September 2019, below average rainfall has been received at Muswellbrook (c. 10 km to the north) from 2017. Such dry conditions will place all plants under severe water stress, and for emergent geophytes like Spring-flowering orchids, dry Autumn-Winter periods over successive years commonly result in little or no emergence, and increased grazing pressure.

64. The NSW Department of Primary Industries (DPI) Combined Drought Indicator (CDI) provides a further dataset that can help to explain how orchids and other plants respond to climatic conditions. The CDI categorises months into one of six phases of drought on the basis of three indices (rainfall index, plant growth index, soil water index). The Wynn Parish (which includes the Project Area) formally experienced high levels of drought over most of January 2015 to March 2020 (Figure 10). Intense Drought was experienced between April 2018 and October 2018 (encompassing the 2018 orchid flowering period), and again from December 2018 to December 2019. The 2019 orchid flowering season (September-October) and the months leading up to it were also drought affected. Clearly, any targeted orchid surveys undertaken during the 2015 to 2019 flowering seasons would be unlikely to detect representative populations of these species if present.

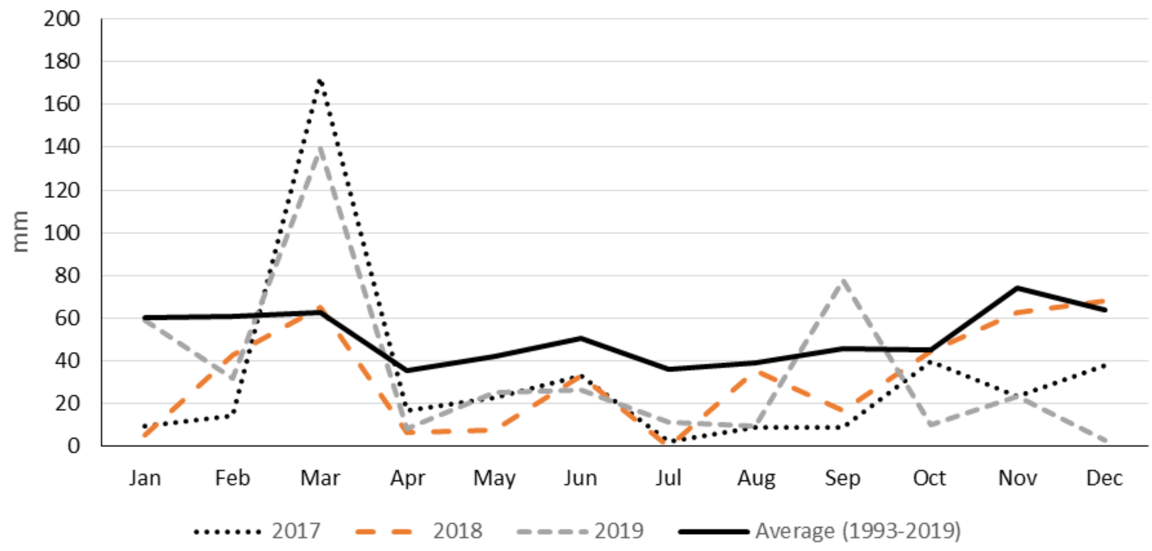


Figure 9 **Monthly and average rainfall for Muswellbrook (station # 61374; c. 25 km from the Project Area) over the past three years.** (Source: Bureau of Meteorology, http://www.bom.gov.au/climate/data/).

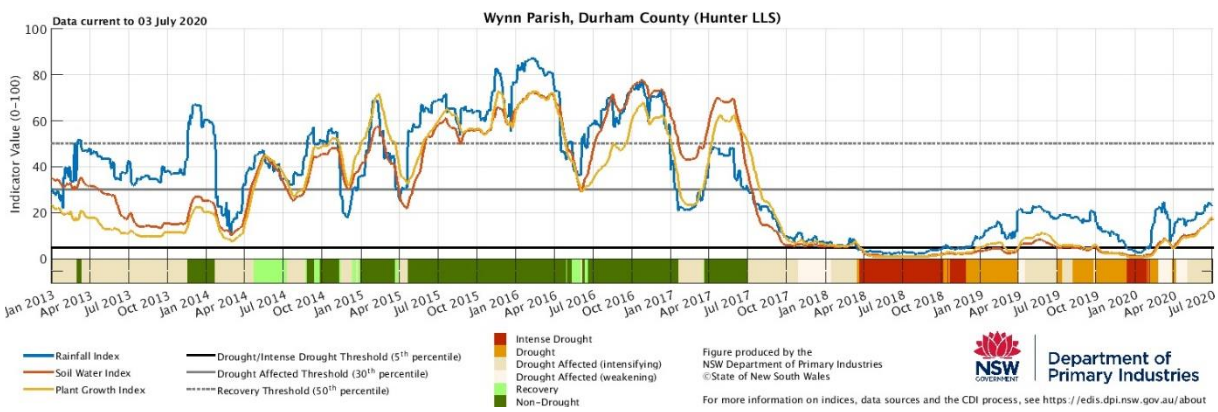


Figure 10 **Drought indices for the Wynn Parish, January 2013 to July 2020, showing Drought conditions prevailing from October 2014 to July 2017 and December 2018 to December 2019, and Intense Drought from April 2018 to December 2018 and December 2019 to January 2020.** (Source: DPI Seasonal Conditions Information Portal, https://edis.dpi.nsw.gov.au/statistics).

65. Most terrestrial orchid species will not emerge to flower during stressful periods, or if leaves are produced at this time then inflorescences may not develop. Given the drought conditions experienced from October 2014 to the present, and in particular during the Autumn and Winter periods leading up to and including September-October orchid flowering from 2015 to 2019, there is clear justification for the preparation of this expert report. Apart from water stress, pressure from herbivory during drought periods escalates considerably (Duncan *et al.* 2005), not only from vertebrate grazers such as macropods and rabbits, but also invertebrates including grasshoppers and caterpillars (Light & MacConnaill 2011; Vizer 2013). Bird species too are known to selectively feed on orchid species, with White-winged Choughs for example extracting orchids out of the ground to consume tubers (Duncan *et al.* 2005; Faast & Facelli 2009; Bell 2020b). Any vegetation present during dry times will be the focus of herbivore browsing, meaning a reduction in the time orchids will be present above ground and hence reduce detection rates during survey. Desiccation through heat and wind in periods of drought will also lessen above-ground periods of flowering orchids.

66. Persistent dry conditions and drought, including below-average rainfall during the crucial Winter period, over at least the last three flowering seasons (2017 to 2019) justify the need for an Expert Report to determine the likely presence of *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora* within the Project Area.

4. Criterion (c) – Likelihood of Species Presence in the Project Area

67. To assist in determining the likely presence or absence of populations of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* within the Project Area, I have examined aspects of previous land-use history, known existing records for all three species within the region, the floristic composition, geology, soil landscapes and soil qualities of habitats within the Project Area and other areas known to support the species. I have also incorporated my own observations made on a single-day site inspection in early July 2020.

4.1 Project Area Attributes

4.1.1 Land-use History

68. As with much of Australia and NSW, the original ecosystems of Hunter Valley have been heavily impacted upon by European colonisation (Bradshaw 2012). The mid-Hunter Valley was one of the first to be opened up for European occupation, spanning out from the nearby settlement of Jerrys Plains in the early 1800s (Burley 1962; C. Hunter 2010). Much of the land was used for the grazing of cattle and sheep, and where necessary the original woodlands were thinned of trees to increase pasture growth (Perry 1955). As a consequence, current day vegetation is the result of 200 years of agricultural occupation, firstly by sheep and then cattle. The Project Area is now almost entirely comprised of derived grasslands, regrowth native and exotic woody vegetation, or planted species (Hunter Eco 2019).

69. Although cattle have historically grazed the Project Area for likely several decades (Hunter Eco 2019), they have been removed or rotated to other areas during recent drought conditions. It is unknown whether or not cattle (or sheep) were present across the Project Area during flora survey times indicated in Table 6 above. All of the derived grasslands which now predominate throughout the Project Area potentially provide potential habitat for orchids including *Diuris tricolor* and *Prasophyllum petilum*, while remnant woodlands may support *Diuris tricolor* or *Pterostylis chaetophora*, but this is further explored in the following sections.

4.1.2 Existing Orchid Records

70. No populations of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* have been recorded within the Project Area (Hunter Eco 2019), although one population of *Diuris tricolor* (c. 30 plants) located by Cumberland Ecology in 2009 and 2011 (and again by Hunter Eco in 2020) lies approximately 600 m from the disturbance footprint (south of the proposed Ancillary Disturbance Area 1), and another (of nearly 200 plants) occurs 400 m north of the Product Stockpile Extension area (NSW BioNet). A historical record of *Prasophyllum petilum* (c. 10 plants) occurs for a site along Thomas Mitchell Drive c. 1300 m east of the Product Stockpile Extension area. As noted in **Section 3.2**, drought conditions coincided with the preparation of documents relating to the proposed development in the area, and as a consequence there is a low likelihood that these species, if present, would have been detected.

71. Evidence of survey effort is shown in Figure 9 (Attachment A) of Hunter Eco (2019), where the extent of data collection made across 1708 Rapid Data Points (RDPs) (used for mapping purposes) and 109 full floristic plots (used for classification) is illustrated across the wider biodiversity survey area. Some RDP and 23 full floristic plots fall within the Project Area, and a portion of floristic plots were likely surveyed in September-October 2018. However, the Intense

Drought occurring at that time (see **Section 3.2**) would have curtailed detection of any terrestrial orchids that may have been present. Examination of surrounding records of the three target orchids may shed some light on the expected presence of *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora* within the Project Area (further examined in **Section 4.2**).

4.1.3 Vegetation Communities

72. Understanding the floristic patterns and vegetation communities in the Project Area is important in gaining an impression of how suitable the lands are to support one or more of the target orchid species. Fortunately, Hunter Eco (2019) has undertaken a numerical analysis of floristic plot data (n=109) to assist in classifying the native vegetation present, and provides detailed community profiles in Appendix 4 of the *Baseline Flora Report*. I have reviewed this classification and the profiles, and am satisfied that it represents a thorough treatise of vegetation community diversity present within the Project Area. This classification, together with other factors and my own notes made during a one-day site inspection (see **Section 4.3**), have been used to formulate an opinion on the likelihood of *Diuris tricolor*, *Prasophyllum petilum* and/or *Pterostylis chaetophora* being present within the Project Area (presented in **Section 4.5**).

4.1.3.1 Plant Community Types

73. Across the broader biodiversity investigation area, Hunter Eco (2019) defined 11 Plant Community Types (PCTs) from their 18 draft field communities, all of which also occur elsewhere in the Hunter Valley. Thirteen (13) communities and eight PCTs (201, 1604, 1606, 1607, 1655, 1691, 1692 and 1731) have been mapped within the Project Area (Table 7). DNGs, which provide substantial habitat for *Diuris tricolor* and *Prasophyllum petilum* in other areas, are represented here by five PCTs (201, 1606, 1607, 1655 and 1691). Collectively, 136 ha of DNG (or 80% of all communities shown in Table 7) are present within the Project Area. Approximately three-quarters of the total proposed disturbance area is comprised of native grasslands derived from White Box – Ironbark – Red Gum Shrubby Forest (Unit 2a), followed by Ironbark - Grey Box Grassy Woodland (Unit 9; 5.7%) and White Box - Ironbark - Red Gum Shrubby Forest (Unit 2; 5.6%). All other communities each occupy <3% of the total Project Area.

74. Examining the floristic composition and condition of defined vegetation communities presented in Hunter Eco (2019) reveals the characteristic species which dominate each community. These data can then be used to compare against similar data from other areas of the Hunter Valley where *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora* are known to occur (see **Section 4.2**). In this regard, Table 8 summarises the key floristic elements of the 13 vegetation communities within the Project Area. To compile this table, I extracted those plant species contributing to the upper 50% of diversity, as shown in the community profiles in Attachment A of Hunter Eco (2019).

75. For the most widespread community within the Project Area (White Box – Ironbark – Red Gum Shrubby Forest DNG; Unit 2a; 74% of all communities shown in Table 7), grasslands dominated by *Aristida ramosa, Rytidosperma caespitosum, Eragrostis alveiformis, Dichanthium sericeum, Eriochloa pseudoacrotricha, Bothriochloa decipiens, Erodium crinitum* and *Chloris divaricata*, with high abundance of exotic species (particularly *Carthamus lanatus* and *Senecio madagascariensis*), characterises these areas (Hunter Eco 2019). In my experience, these relatively diverse grasslands growing on clay-based soils derived from former Box-Gum

landscapes tend not to support extensive populations of *Diuris tricolor, Prasophyllum petilum* or *Pterostylis chaetophora* (or few other terrestrial orchids), however I will reserve this view and further analyse available floristic and environmental data.

Table 7 Vegetation Communities and Plant Community Types identified for the Project Area (from Hunter Eco 2019). Excludes post-mine mapping. Condition classes within PCTs not shown.

Community	**PCT**	**Extent (ha, %)**
1: Red Gum - Ironbark - Apple Shrubby Woodland	1607: Blakely’s Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	0.4 (0.2%)
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	4.9 (2.9%)
2: White Box - Ironbark - Red Gum Shrubby Forest	1606: White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	9.6 (5.6%)
2a: White Box - Ironbark - Red Gum Shrubby Forest (DNG)	1606: White Box -Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG	125.6 (73.6%)
3: Slaty Box Shrubby Woodland	1655: Grey Box – Slaty Box shrub – grass woodland on sandstone slopes of the upper Hunter Valley and Sydney Basin	1.2 (0.7%)
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	2.4 (1.4%)
4: Swamp Oak Forest	1731: Swamp Oak – Weeping Grass grassy riparian forest of the Hunter Valley	0.2 (0.1%)
6: Bull Oak Grassy Woodland	1692: Bull Oak grassy woodland of the central Hunter Valley	2.7 (1.6%)
8. Fuzzy Box Woodland	201: Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	0.5 (0.3%)
8a: Fuzzy Box Woodland (DNG)	201: Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion - DNG	2.8 (1.6%)
9: Ironbark - Grey Box Grassy Woodland	1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	9.6 (5.7%)
9a: Ironbark - Grey Box Grassy Woodland (DNG)	1691: Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - DNG	0.3 (0.2%)
11: Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland	1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	1.3 (0.8%)
Plantation, Dams etc	n/a	9.1 (5.3%)
Total		**170.6 (100%)**

4.1.3.2 Comparative Numerical Analyses

76. To further explore floristic compositions between the Project Area and known orchid habitat elsewhere (Mangoola Coal for *Diuris tricolor* and *Prasophyllum petilum*, and Columbey National Park for *Pterostylis chaetophora*), I undertook numerical analysis using *PRIMER* software (Clarke & Gorley 2006). Both Mangoola and Columbey have had considerable directed survey undertaken for the target orchids, and both have also been the subject of numerical analysis using the same software and procedures as used by Hunter Eco (2019) to classify the vegetation within the Maxwell biodiversity investigation area. It is logical, therefore, to make use of this knowledge base to inform decisions on the suitability of habitat for the three target species.

77. Rather than using raw data for these analyses (which utilised different survey methods: 0.04 ha plots for the Project Area and Columbey but 0.01 ha plots at Mangoola, and surveyed during different seasons), I compared floristic compositions of the available community profiles derived for the Project Area with those profiles shown to support one or more of the target orchids. This included Units 1, 1a, 2, 2a, 3, 3a, 4, 6, 8, 9, 9a and 11 for the Project Area (see Table 8), Units 1a and 2 for Mangoola Coal (Bell submitted 1), and Units 4, 6, 7 and 8 for Columbey (Bell 2009) (Table 9).

78. All data was analysed on a presence-absence basis, meaning that dominant species held equal weight to rare species. Reducing data from cover abundance to presence-absence also lessens the impact of comparing surveys across different years and observers, where species commonly abundant during wet years will persist only in low numbers during drought. While not ideal, this process allowed me to determine if flora diversity (rather than abundance) present in the Project Area (collected during the drought year of 2018) correlated well with that for Mangoola where *Diuris tricolor* and *Prasophyllum petilum* were known to occur (collected between 2009 and 2011, c. average rainfall years), and with Columbey where *Pterostylis chaetophora* is present (collected in 2008 and 2009, above average rainfall years). Analyses with weed species retained and removed from the dataset were undertaken, but this made little difference to the overall result.

79. Because habitats of the three target orchids at the specified locations differ (predominantly DNGs for *Diuris tricolor* and *Prasophyllum petilum*, forest or woodland for *Pterostylis chaetophora*), I created sub-sets of data to reduce 'noise' in the analyses. This resulted in two separate analyses as shown in Table 10. Note that Unit 8a (Fuzzy Box Woodland DNG) for the Project Area was not included as insufficient data prevented development of a floristic list by Hunter Eco (2019). Unit 4 (Swamp Oak Forest) from the Project Area was similarly excluded due to low diversity (six species), and based on past experience the very low likelihood of this habitat supporting terrestrial orchids.

For both analyses, I used the SIMPROF routine in combination with the CLUSTER module in *PRIMER* to identify statistically significant splits in the dataset ($p<0.01$). This provided cluster diagrams where sites supporting similar floristic combinations were grouped and linked to their most similar neighbours. I also ran the MDS (non-metric Multi-Dimensional Scaling) routine with a minimum stress level of 0.01 and 25 restarts to produce ordination plots of the same data. Grouping of similar sample plots (communities or vegetation zones) can be better appreciated across this two-dimensional ordination space than in a cluster diagram, hence the latter is not shown. Note that for the Mangoola and Columbey datasets, my original analyses truncated SIMPER routines at 90% contributions, but these were re-run to 95% to match that done by Hunter Eco (2019) for the Project Area.

Table 8 Dominant species within defined vegetation communities (from Hunter Eco 2019). * = exotic species. Individual % contributions shown only for species contributing >5% of total diversity for that community.

Community	Dominant Species (upper 50%, in decreasing order of importance)
1: Red Gum - Ironbark - Apple Shrubby Woodland	*Eucalyptus blakelyi (25.82), Notelaea microcarpa (10.47), *Galenia pubescens, Brachychiton populneus, *Lycium ferocissimum*
1a: Red Gum - Ironbark - Apple Shrubby Woodland (DNG)	*Aristida ramosa (15.17), *Sida rhombifolia (11.05), *Galenia pubescens (11.05), *Senecio madagascariensis (5.52), *Petrorhagia nanteuilii, Commelina cyanea*
2: White Box - Ironbark - Red Gum Shrubby Forest	*Eucalyptus albens (25.75), Dichondra repens (5.46), Glycine clandesctina (5.25), Brunoniella australis, Acacia salicina, Eremophila debilis*
2a: White Box - Ironbark - Red Gum Shrubby Forest (DNG)	**Carthamus lanatus (10.73), Aristida ramosa (6.39), Rytidosperma caespitosum (6.07), *Senecio madagascariensis (5.48), Glycine clandestina, Eragrostis alveiformis, Dichanthium sericeum, Maireana microphylla, Erodium crinitum, Chloris divaricata*
3: Slaty Box Shrubby Woodland	*Eucalyptus dawsonii (44.84), Aristida ramosa (5.63)*
3a: Slaty Box Shrubby Woodland (DNG)	*Chloris divaricata (11.96), Dichanthium sericeum (10.31), *Carthamus lanatus (6.99), *Medicago sp. (5.55), Rytidosperma caespitosum, Vittadinia pterochaeta, *Lepidium bonariense, Glycine clandestina*
4: Swamp Oak Forest	*Casuarina glauca (54.55)*
6: Bull Oak Grassy Woodland	*Allocasuarina luehmannii (60.10)*
8: Fuzzy Box Woodland	*Eucalyptus conica (26.67), Aristida ramosa (24.44)*
8a: Fuzzy Box Woodland (DNG)	no analysis of data
9: Ironbark - Grey Box Grassy Woodland	*Eucalyptus moluccana (28.58), Eremophila debilis (6.09), Brunoniella australis (5.98), Allocasuarina luehmannii (5.95), Dichondra repens*
9a: Ironbark - Grey Box Grassy Woodland (DNG)	*Aristida ramosa (16.84), Chrysocephalum semipapposum (5.30), Cymbopogon refractus (5.10), Brunoniella australis, Linum marginale, Wahlenbergia communis, Eragrostis leptostachya, *Gomphocarpus fruticosus, *Carthamus lanatus*
11: Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland	*Aristida ramosa (14.27), Lomandra filiformis (9.39), Eucalyptus moluccana (6.41), Eremophila debilis (5.67), Brunoniella australis (5.67), Lomandra multiflora (5.67), Glycine clandestina (5.67)*

Table 9 Vegetation communities previously defined for Mangoola (Bell submitted 1) and Columbey (Bell 2009) shown to support populations of one or more of the target orchid species.

Location	Unit		Target Orchid
Mangoola	1a	Dichanthium/ Sporobolus/ Chloris Grassland	*D. tricolor, P. petilum*
	2	Aristida/ Cymbopogon Grassland	*D. tricolor, P. petilum*
Columbey	4	Floodplain Redgum – Box Forest	*P. chaetophora*
	6	Seaham Ironbark Forest	*P. chaetophora*
	7	Seaham Spotted Gum – Ironbark Forest	*P. chaetophora*
	8	Lower Hunter Spotted Gum – Ironbark Forest	*P. chaetophora*

Table 10 Included datasets in numerical analyses.

Analysis No.	Habitat	Target Orchids	Dataset
1	Derived Native Grasslands	*Diuris tricolor, Prasophyllum petilum*	Project Area (Units 1a, 2a, 3a, 9a) Mangoola (Units 1a, 2)
2	Forests & Woodlands	*Pterostylis chaetophora*	Project Area (Units 2, 3, 6, 9, 11) Columbey (Units 4, 6, 7, 8)

80. For Analysis 1 (Derived Native Grasslands), three significant groups were evident in the dataset, with Unit 9a from the Project Area closely aligning with Units 1a and 2 from Mangoola (Figure 11). The other three DNG types fell distant from Mangoola data and evidently support different floristic compositions. The stress level of 0 shown in Figure 11 is an indication of the relative ease in which all data could be accommodated within two-dimensions. In general, a stress level of <0.2 is considered acceptable in these sorts of analyses, but increases in line with complexities associated with dataset size, multiple observers and seasons. From this grassland analysis, only Unit 9a (Ironbark - Grey Box Grassy Woodland DNG) from the Project Area could be considered as providing potential habitat for *Diuris tricolor* and *Prasophyllum petilum*.

81. For Analysis 2 (Forests & Woodlands), it was clearly evident that the forest and woodland vegetation present within the Project Area is floristically different to that known to support *Pterostylis chaetophora* at Columbey (Figure 12). This is not surprising given the wide geographical separation between these two localities (c. 100 km), however both areas support vegetation characterised by *Eucalyptus moluccana, Eucalyptus crebra* and *Corymbia maculata*, and provide superficially appropriate habitat. Based on this dataset, it is unlikely that any habitat within the Project Area is suitable for *Pterostylis chaetophora*.

82. One conclusion to reach from these analyses is that the floristic composition of nearly all vegetation communities defined for the Project Area differ sufficiently from the DNGs at Mangoola known to support populations of both *Diuris tricolor* and *Prasophyllum petilum*, and also from the forest and woodlands at Columbey known to support *Pterostylis chaetophora*. The one exception to this is the close alignment of Unit 9a (Ironbark - Grey Box Grassy Woodland DNG) from the Project Area with the Mangoola grasslands, suggestive of potential habitat for *Diuris tricolor* and *Prasophyllum petilum*. Acknowledging the different years of data collection between these two locations (2009-11 vs 2018), the different observers collecting

the data and the different methods of data collection (0.04 ha plots vs 0.01 ha plots), I am confident that within these datasets there are sufficient differences between all other grasslands and grassy woodlands present in the Project Area and those at Mangoola Coal. This is supported in part by my own field observations of the Project Area in July 2020 (see **Section 4.5**).

83. Notwithstanding this result, the presence of a known population of c. 200 *Diuris tricolor* occurring within Mt Arthur Coal lands in Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland (Unit 11 of Hunter Eco 2019) approximately 400 m north of the Product Stockpile Extension area, suggests that this species may also occur in this vegetation type within that Project Area. I do not have access to any floristic data from this area to allow more in-depth comparisons, but given its close proximity it is prudent to assume suitable habitat occurs there.

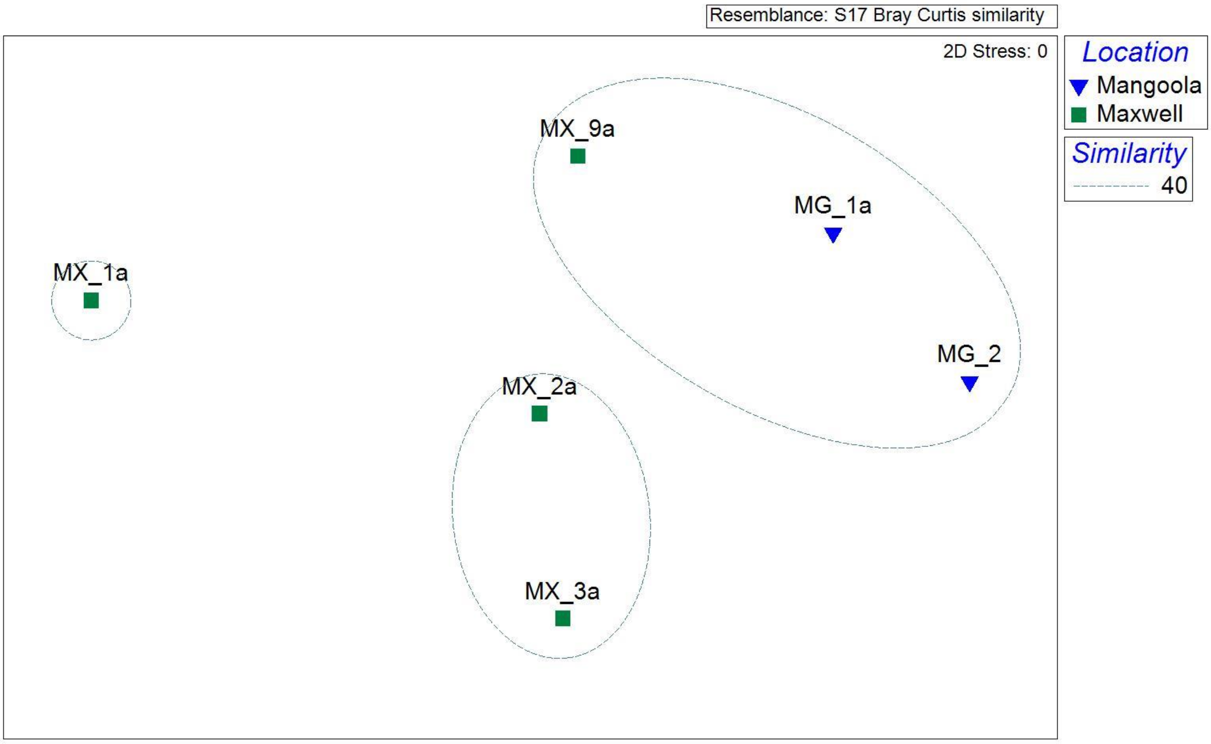


Figure 11 nMDS ordination of floristic compositions comprising Derived Native Grasslands from the Project Area (MX) in relation to that favouring *Diuris tricolor* and *Prasophyllum petilum* at Mangoola Coal (MG). Dotted ellipses show significant groups (p<0.01) defined at a similarity level of 40%. MX_1a = Red Gum - Ironbark - Apple Shrubby Woodland (DNG); MX_2a = White Box - Ironbark - Red Gum Shrubby Forest DNG; MX_3a = Slaty Box Shrubby Woodland DNG; MX_9a = Ironbark - Grey Box Grassy Woodland DNG; MG_1a = Dichanthium/ Sporobolus/ Chloris Grassland; MG_2 = Aristida/ Cymbopogon Grassland. Data for the Project Area from Hunter Eco (2019), that from Mangoola from Bell (submitted 1).

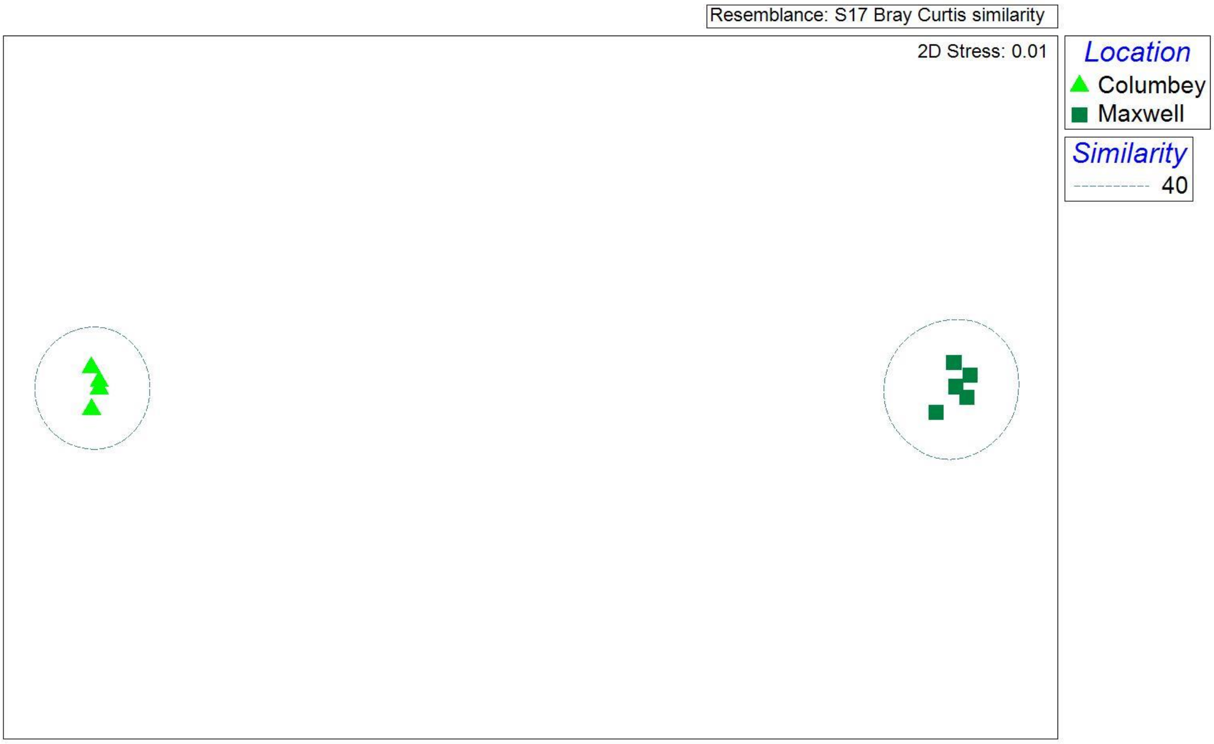


Figure 12 nMDS ordination of floristic compositions comprising forest and woodlands from the Project Area in relation to favoured *Pterostylis chaetophora* habitat at Columbey. Dotted ellipses show significant groups (p<0.01) defined at a similarity level of 40%. Individual community codes not shown, as these are irrelevant to the outcome. Data for the Project Area from Hunter Eco (2019), that from Columbey from Bell (2009).

84. Additionally, following the same reasoning, the historical population of *Prasophyllum petilum* (recorded 1999-2005; c. 10 plants) at the eastern end of Thomas Mitchell Drive suggests a conservative assumption that the Product Stockpile Extension area may also support this species. Data contained within NSW BioNet linked to this population show it to be woodland of *Corymbia maculata, Eucalyptus moluccana* and *Eucalyptus blakelyi*, similar to that which occurs within the Product Stockpile Extension area (pers. obs.).

4.2 Environmental Analysis

85. An assessment of selected environmental attributes (geology, dominant lithology, soil landscape, soil type, soil fertility, soil hydrology, annual rainfall, mean annual temperature) was made of the Project Area with the aim of profiling the broad non-floristic characteristics that may be important in defining habitat for the three target orchids. A number of resources were used to undertake this (Table 11), all performed in GIS against Project Area boundaries. Other commonly used modelling parameters (e.g. slope, aspect, solar radiation, roughness indices, moisture etc) were not explored in any detail, although they have reportedly proven informative for some species (e.g. Janes 2010). However, these attributes are unlikely to be instructive in the open and gently undulating landscapes of the Hunter Valley floor, and in addition they may lead assessment away from the central aim of identifying habitat for orchids and their mycorrhizal fungi. Understanding the biophysical properties of the Project Area is important, though, to allow comparisons with point data from other areas where *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora* occurs (see **Section 4.2.2**).

Table 11 Digital resources utilised to categorise biophysical attributes of the Project Area, and compare these with point data for the three target orchids.

Attribute	Source
Geological Unit	Colquhoun G.P., Hughes K.S., Deyssing L., Ballard J.C., Folkes C.B, Phillips G., Troedson A.L. & Fitzherbert J.A. (2020) *New South Wales Seamless Geology dataset, version 2* [Digital Dataset]. Geological Survey of New South Wales, Department of Regional NSW, Maitland. Available at https://search.geoscience.nsw.gov.au/product/9232
Dominant Lithology	Colquhoun G.P., Hughes K.S., Deyssing L., Ballard J.C., Folkes C.B, Phillips G., Troedson A.L. & Fitzherbert J.A. (2020) *New South Wales Seamless Geology dataset, version 2* [Digital Dataset]. Geological Survey of New South Wales, Department of Regional NSW, Maitland. Available at https://search.geoscience.nsw.gov.au/product/9232
Soil Landscapes	Office of Environment and Heritage (2019) *Soil Landscapes of Central and Eastern NSW - v2*, NSW Office of Environment and Heritage, Sydney. Available at https://datasets.seed.nsw.gov.au/dataset/published-soil-landscapes-of-central-and-eastern-nsw37d37
Great Soil Group	Office of Environment and Heritage (2017) *Great Soil Group (GSG) Soil Type map of NSW*, NSW Office of Environment and Heritage, Sydney. Available at https://datasets.seed.nsw.gov.au/dataset/great-soil-group-gsg-soil-type-map-of-nsw1cf19
Australian Soil Class	Office of Environment and Heritage (2017) *Australian Soil Classification (ASC) Soil Type map of NSW*, NSW Office of Environment and Heritage, Sydney. Available at https://datasets.seed.nsw.gov.au/dataset/australian-soil-classification-asc-soil-type-map-of-nsweaa10
Soil Fertility	Office of Environment and Heritage (2017) *Estimated Inherent Soil Fertility of NSW*, NSW Office of Environment and Heritage, Sydney. Available at https://datasets.seed.nsw.gov.au/dataset/estimated-inherent-soil-fertility-of-nswd793e
Hydrologic Soils	Office of Environment and Heritage (2017) *Hydrologic Groups of Soils in NSW*, NSW Office of Environment and Heritage, Sydney. Available at https://datasets.seed.nsw.gov.au/dataset/hydrologic-groups-of-soils-in-nsw7f9e8
Annual Rainfall	GeoScience Australia, raster layer based on monthly mean precipitation 1976-2005, with grid resolution of 30m. Available at: https://datasets.seed.nsw.gov.au/dataset/anuclim-annual-mean-rainfall-raster-layer
Annual Average Temperature	GeoScience Australia, raster layer based on monthly mean temperatures 1976-2005, with grid resolution of 30m. Available at: https://datasets.seed.nsw.gov.au/dataset/anuclim-annual-mean-temperature-raster-layer

Table 12 Summary of biophysical attributes of the Project Area. See Appendix 3 for further detail.

Project Area	Biophysical Summary
Product Stockpile Extension (5.2 ha)	Part Cessnock Sandstone and part Branxton Formation geology; equally of sandstone and conglomerate lithology; entirely of the Roxburgh soil landscape, supporting Yellow Podzolic (Kurosol) soils of Moderately Low fertility with slow infiltration rates. Annual rainfall is 671 mm (StDev=0.67, n=4) and mean temperature is 16.6° (StDev=0.01, n=4).
Surface Development Area (302.9 ha)	Predominantly of Jerrys Plains Subgroup and Rowan Formation geology, with Mulbring Siltstone and Branxton Formation also well represented; mostly of sandstone lithology, but with siltstone, conglomerate and quartzite also present; largely of the Brays Hill and Liddell soil landscapes, supporting Grey, Brown or Red Clay (Vertosol) soils and Soloths (Kurosols), of Moderate or Moderately Low fertility with very slow infiltration rates. Annual rainfall is 658 mm (StDev=13.4, n=20) and mean temperature is 16.7° (StDev=0.16, n=20).
Edderton Rd Realignment (10.2 ha)	Entirely Jerrys Plains Subgroup geology; of sandstone lithology; on the Bayswater and Brays Hill soil landscapes, supporting Solodic (Sodosols) and Grey, Brown or Red Clay (Vertosol) soils, of Moderately Low and Moderate fertility with very slow infiltration rates. Annual rainfall is 623 mm (StDev=6.64, n=11) and mean temperature is 17.1° (StDev=0.10, n=11).
Ancillary Disturbance Area (Ponding) 1 (0.5 ha)	Entirely Jerrys Plains Subgroup geology; of sandstone lithology; on the Brays Hill soil landscape, supporting Grey, Brown or Red Clay (Vertosol) soils, of Moderate fertility with very slow infiltration rates. Annual rainfall is 628 mm (StDev=0.78, n=2) and mean temperature is 17.1° (StDev=0.01, n=2).
Ancillary Disturbance Area (Ponding) 2 (1.5 ha)	Entirely Jerrys Plains Subgroup geology; of sandstone lithology; on the Bayswater soil landscape, supporting Solodic (Sodosol) soils, of Moderately Low fertility with very slow infiltration rates. Annual rainfall is 619 mm (StDev=0.01, n=2) and mean temperature is 17.2° (StDev=0.01, n=2).

86. The *NSW Flora: Ecological Niche Finder* online resource portal, arising out of the work of Gallagher (2016) and accessible at (http://nswnichefinder.net/index.php), was also considered as a possible tool to better understand the ecological requirements of the target species. The Niche Finder provides broad modelling capabilities for NSW plant taxa across a number of environmental domains, however because the target orchids are classified as sensitive species (location data withheld) this resource was not available.

4.2.1 Project Area

87. Table 12 summarises the environmental characteristics of the Project Area, categorised into the five separate disturbance areas (see also Appendix 3 for graphed details). Nine geological units comprise the Project Area, however sediments of the Jerrys Plain Subgroup are the most common (46%). The Surface Development Area is the most complex area with seven units, the Product Stockpile Extension area has two units, and all others one. Soils derived from sandstone

lithology are dominant (>70%) across most areas, with siltstones and conglomerate present in the Surface Development Area and Product Stockpile Extension area, and a small area of quartzite. Four soil landscapes have been mapped for the area, the two most dominant being Brays Hill and Liddell. These mirror the distribution of the Great Soil Groups, where Grey, Brown and Red Clays dominate over Soloths, Solodic Soils and Yellow Podzolics. Under the Australian Soil Classification scheme, three soil types (Kurosols, Vertosols and Sodosols) occur across the area, and are of either moderately low or moderate fertility.

88. In terms of water infiltration (hydrology), most soils comprise Group D (very slow infiltration rates due to high clay content, high water tables and/or shallow soils over impervious material), although the Product Stockpile Extension area is Group C (slow infiltration rates due to impeded drainage and/or moderately fine textures). For climatic data, average values were computed from GeoScience Australia raster layers at 39 field inspection point locations across the Project Area (see **Section 4.4**), distributed as: Product Stockpile Extension area, n=4; Surface Development Area, n=20; Edderton Rd Realignment, n=11; Ancillary Disturbance Area (Ponding) 1, n=2; Ancillary Disturbance Area (Ponding) 2, n=2. Annual rainfall was consequently found to lie between 619 and 671 mm/year across the Project Area, while mean temperature was around 17^{o}.

4.2.2 Target Orchids Records

89. A compilation of all records for the three target orchids within the Hunter Local Land Services (Hunter LLS) area was interrogated against a range of environmental variables within GIS to determined ecological niches. This process aimed to identify, based on available records, the key environmental factors present within known populations of each species. Data included:

- as-held NSW BioNet records of target orchids obtained under DPIE licence ASH20009;
- currently undatabased but geospatially accurate records from various projects, including recent surveys for *Pterostylis chaetophora* collected under the NSW Government's *Saving our Species* program; and
- other miscellaneous records gleaned from unpublished reports or databases.

Specimen collection data from the AVH was not incorporated as these data have been de-natured and therefore location precision is unreliable.

90. All data was checked for duplication across multiple data sources and positional accuracy, with records >100 m accuracy discarded from analysis. To reduce the influence of high-density point records resulting from targeted surveys over comparatively small search areas, the entire Hunter LLS region was overlain by a 100 m x 100 m grid (i.e. 1 ha squares) and orchid data reduced to presence-absence at this resolution. Centroids of all cells returning a 'true' result were adopted as surrogates for position and used to analyse environmental niches. Duplicates resulting from multiple high-density records within each 100 m grid were reduced to a single record.

91. Cleaning and simplifying orchid location data in this way resulted in an analysis dataset of 983 point locations (centroids) for *Diuris tricolor*, 485 point locations (centroids) for *Prasophyllum petilum* and 128 point locations (centroids) for *Pterostylis chaetophora*. These datasets were individually assessed against those environmental variables shown in Table 11 above. The relative proportion of known orchid occurrences compared to representative locations within the Project Area (n=39) were graphed to illustrate similarities and differences (see Appendix 4), and a summary is provided in Figure 13. For *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis*

chaetophora, there was little correlation between geological unit and soil landscape at locations known to support these species when compared to the Project Area. Additionally, there was also a low correlation in the Australian soil class and annual rainfall for *Pterostylis chaetophora*, and a weak match for annual temperature in this species. Overall, these results suggest there to be little apparent differences in soil type, fertility and hydrology for *Diuris tricolor* and *Prasophyllum petilum*, but some differences for *Pterostylis chaetophora*. It also implies that the Project Area may be too dry (mean 1005 mm/yr vs 640 mm/yr) and perhaps slightly too cool (17.2° vs 16.9°) for *Pterostylis chaetophora*, although this is only minor. The Project Area therefore potentially provides suitable soils and climate for *Diuris tricolor* and *Prasophyllum petilum*, but contingent on the availability of suitable mycorrhizal fungi in the soil and pollinators for ongoing persistence.

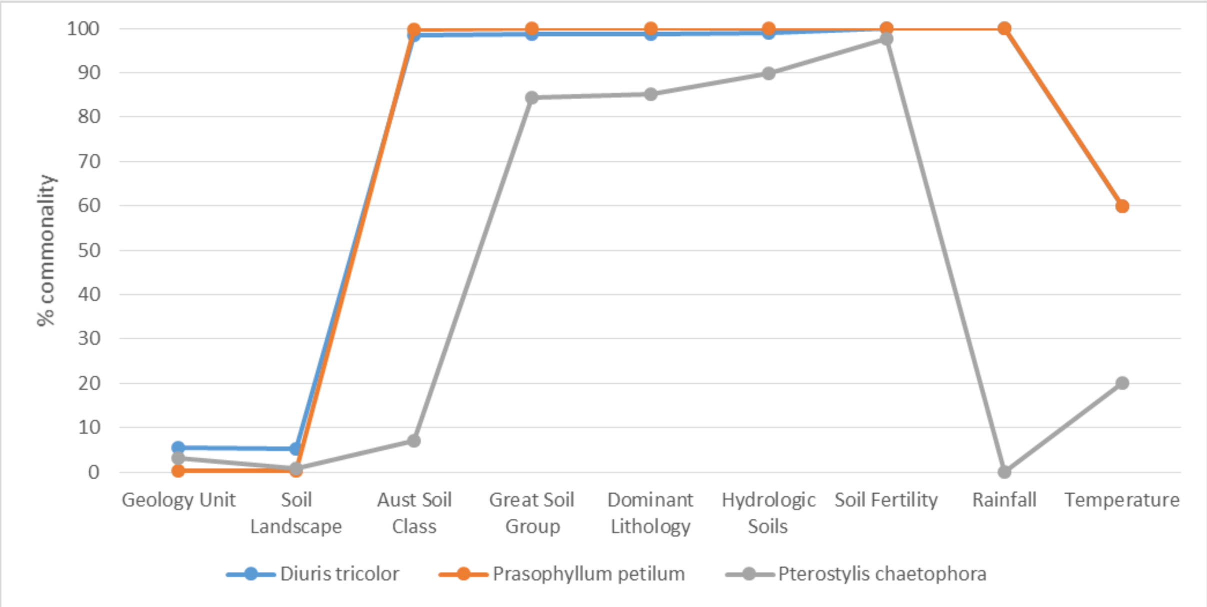


Figure 13 Summary of percentage commonality of selected environmental attributes between known target orchid locations (n=983 *Diuris tricolor*; n=485 *Prasophyllum petilum*; n=128 *Pterostylis chaetophora*) and the Project Area (n=39).

92. The markedly different soil landscapes are perhaps the most informative environmental attribute that might inform suitable habitat for orchids. By definition, soil landscapes attempt to combine elements of soil structure, chemistry and composition with features of the landscapes in which they were formed. This means that related variables such as vegetation, hydrology and topography (which all influence the biology of a soil) are captured within a single map unit type. For orchids this may be particularly telling, as the environments in which the necessary soil mycorrhiza form and persist are likely to be similar within the same soil landscapes, although there is no firm evidence for this to date. Following this logic, the fact that only 5% of 983 locations of *Diuris tricolor* (and <1% of 485 *Prasophyllum petilum* and 128 *Pterostylis chaetophora* locations) shared the same soil landscapes with the Project Area implies that soil biology between the two datasets is likely to differ significantly.

4.3 Orchid Diversity: A Surrogate for Mycorrhizal Fungi

93. The concept of locally high orchid diversity ('hotspots') is well known, and is often reported in the literature (e.g. Seaton 2007; Nurfadilah *et al.* 2013). However, orchid hotspots where

multiple orchid species co-occur are dependent on a diversity of mycorrhizal fungi being present within the soil, and some landscapes evidently support more of these than others (McCormick *et al.* 2018). Several studies have linked the patchy nature of orchid distribution to a similarly patchy distribution of mycorrhizal fungi in the soils (e.g. Voyron *et al.* 2016). In the upper Hunter region, there is a clear orchid hotspot in the Mangoola Coal area (including the target species *Diuris tricolor* and *Prasophyllum petilum*), where 15 species have been recorded (Umwelt 2006; pers. obs.). Elsewhere, other hotspots occur at Barrington Tops (Heinrich & Dowling 2000; Zoete 2000); the Hunter Economic Zone (3300 ha; 23 species) near Cessnock (Bell 2004a); and in Columbey National Park (720 ha; 16 species) near Clarencetown (including the target species *Pterostylis chaetophora*; Bell 2019d). More localised but lower levels of diversity can also occur, such as to the west of Lake Liddell where 5 species occur on the 50 ha Condran biodiversity offset property (Bell & Murray 2013), and at North Rothbury (1500 ha) where 7 species occur (Bell & Driscoll 2005). Along Thomas Mitchell Drive, 8 species were present at the time of the 1999 find of *Prasophyllum petilum*, although these are not databased (B. Holzinger pers. comm.).

94. To test the hypothesis that parts of the upper Hunter may be poorly endowed with mycorrhizal fungi, I examined the distribution of all terrestrial orchid records in the Hunter region, and specifically within the area around the Project Area. This was effectively using orchid presence as a surrogate for mycorrhizal fungi presence. I extracted from the NSW BioNet database all observation records of terrestrial orchid species within the Hunter LLS area, incorporating over 180 taxa. The de-natured locations of this dataset were not an issue for this procedure, as the level of resolution was to remain broad.

95. As indicated in Figure 14 and Figure 15, there is a distinct scarcity of terrestrial orchids of any kind within the Singleton to Muswellbrook region, irrespective of the extensive amount of field surveys that have been conducted over many years in relation to the development (coal mine) industry. Aside from *Diuris tricolor*, the few species recorded on Permian-aged sediments within a 15 km radius of the Project Area (*Calochilus spp.* and *Pterostylis curta* on Mt Arthur, *Pterostylis spp.* and *Diuris punctata* along Thomas Mitchell Drive, *Pterostylis nutans* and *Pterostylis bicolo*r north of Lake Liddell, and *Micortis unifolia* near Ravensworth) are suggestive of a paucity of mycorrhizal fungi in these landscapes.

96. Given the level of survey that has been expended in and around the former Drayton/ Maxwell Project Area, the Mt Arthur Coal mine, the Bayswater and Liddell Power Stations, the Mount Owen mine and Ravensworth Operations, it may be expected that more terrestrial orchids would be present than is indicated through observed records. For example, the ecological assessment of the Mount Owen Continued Operations Project recorded only two species: *Acianthus fornicatus* and a *Pterostylis* spp. (Umwelt 2014), while for the Ravensworth Operations Project no orchids were recorded (Umwelt 2010). Closer to the Project Area (and while under drought conditions), the Bayswater and Liddell Power Stations upgrade project (adjacent to the east) recorded only a single *Microtis* species (Kleinfelder 2017), while at Mt Arthur (adjoining to the north and west), no orchids were recorded (Hunter Eco 2013). The low number of terrestrial orchid records in these landscapes is likely largely the result of very little mycorrhizal fungi within the soils there, and where they do occur, they are limited in extent and/or diversity. Elsewhere, some forms of mycorrhizal fungi (including those associated with orchids) have been shown to be affected by long-term agricultural grazing (e.g. Su & Guo 2007; Ba *et al.* 2012; Oja *et al.* 2017), but it is unknown if this may apply to Hunter landscapes.

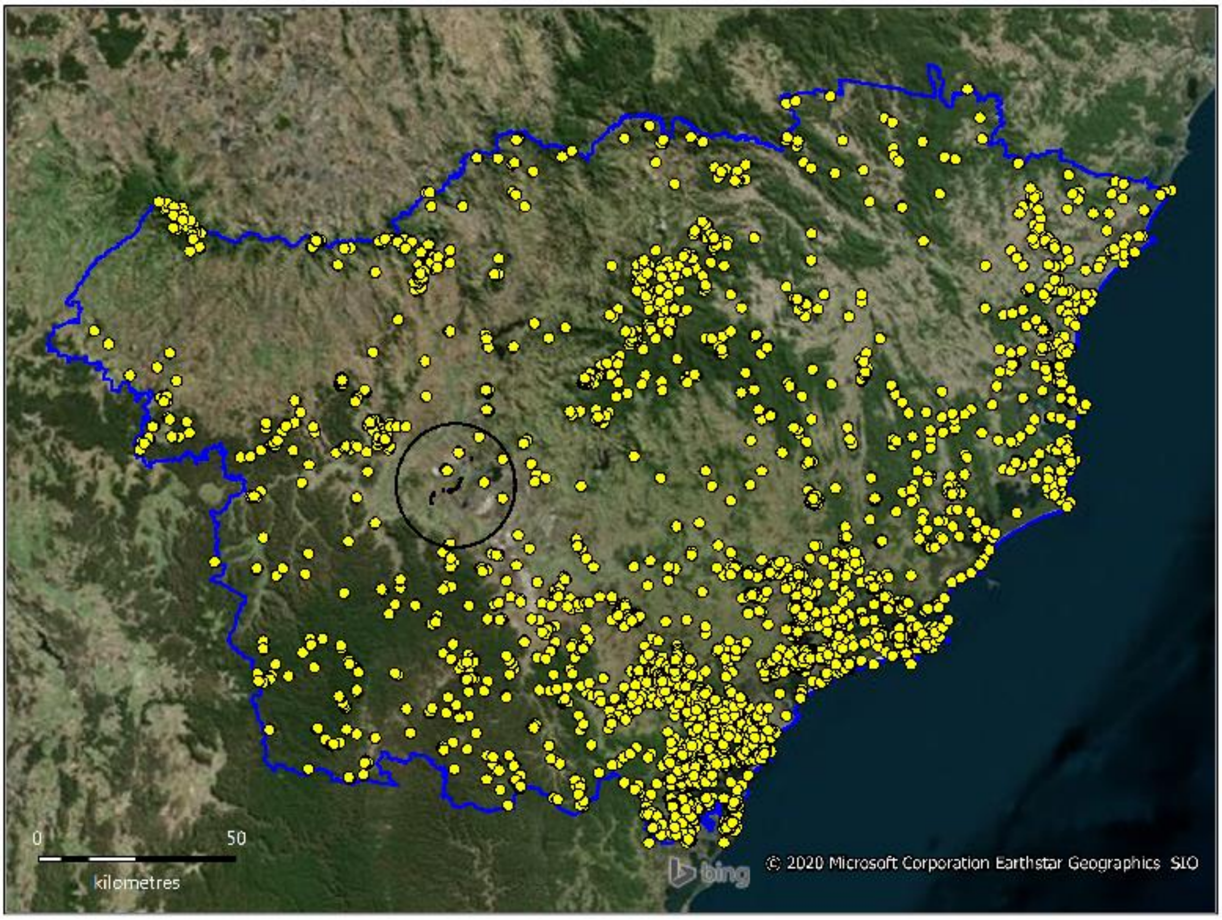


Figure 14 Point locations of all terrestrial orchids (excluding *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora*) for the Hunter Local Land Services area. The Project Area is shown within a 15 km radius circle. Note aggregations of records indicative of diversity 'hotspots' for orchids, and the scarcity of orchid records within the main Hunter Valley region. Data sourced from NSW BioNet, extracted 13 July 2020.

4.4 Field Inspection of the Project Area

97. I inspected all parcels of land that comprise the Project Area on 3 July 2020, in the company of Dr Colin Driscoll (Hunter Eco, on behalf of Resource Strategies). The extreme north of the main surface development area (immediately north of the old quarry) could not be accessed, however I understand that nearly all of this comprises rehabilitated land and its potential to support orchid populations is lessened considerably.

98. Field inspections involved traversing each area in a vehicle, with periodic stops to inspect the ground vegetation and its condition. Notes were made at 39 geo-referenced locations (c. 150-400 m apart) on habitat and key species present (the same locations used for the environmental analysis discussed above), and representative photographs were also taken periodically. A subjective assessment of the likelihood of orchid presence (low, medium, high) was made at each inspection point, based solely on composition and condition of grassland and woodland areas. An inspection was also made of the Diuris Conservation Area near to the Ancillary Disturbance Area (Ponding) 1, first reported in Cumberland Ecology (2012).

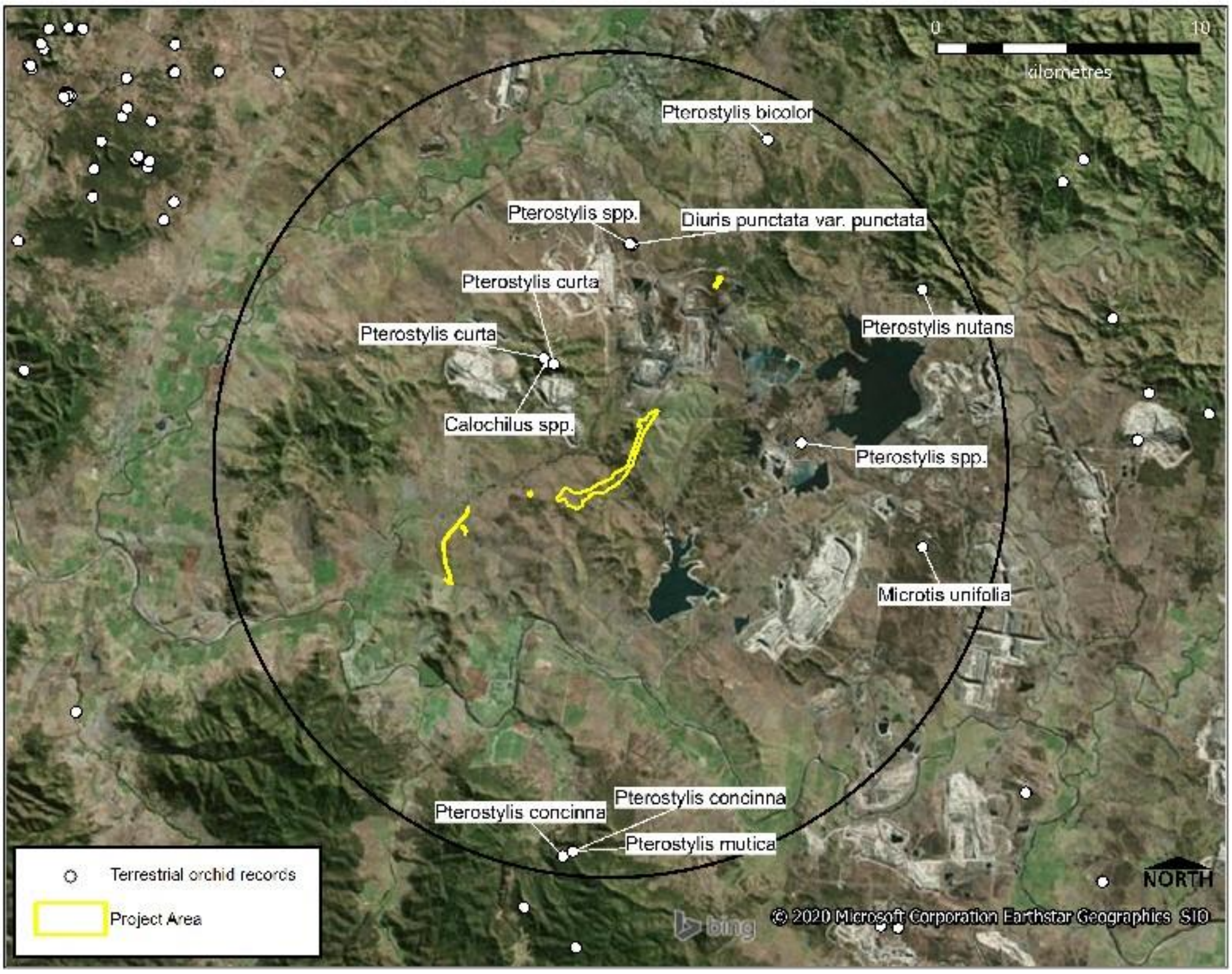


Figure 15 **Terrestrial orchids (excluding *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora*) reported for the Project Area and immediate surrounds (15 km radius shown).** Note the aggregation of records for the Mangoola Coal area in the top left corner. Data sourced from NSW BioNet, extracted 13 July 2020.

99. My initial impression of the grasslands within the Project Area during my inspection were that, although in good condition following the recent rains, they supported a different floristic composition to that occurring elsewhere where *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora* occur. Dominant grass species across most areas included *Chloris truncata, Dichanthium sericeum, Panicum effusum, Chloris ventricosa, Bothriochloa decipiens* and *Microlaena stipoides* var*. stipoides* (Figure 16), with occasional patches of *Bothriochloa biloba*. Within this matrix was an array of flowering herbs and forbs, including *Calotis lappulacea, Glycina tabacina, Vittadinia muelleri, Erodium crinitum, Sida corrugata, Eremophila debilis, Fimbristylis dichotoma* and *Chrysocephalum apiculatum*. Some areas also supported a dominance of *Aristida ramosa*, more typical of habitat I am familiar with that supports *Diuris tricolor* and *Prasophyllum petilum*, however co-occurring with this species were several other grass taxa typical of richer clay-based soils. I saw no areas where the grasses *Entolasia stricta, Themeda triandra* and *Aristida vagans* dominated, such as occurs in areas frequented by *Pterostylis chaetophora*. Weed species were generally sparse or localised around former stock camps or along some drainage lines (including Ancillary Disturbance Areas 1 and 2, where *Juncus acutus* in particular predominated).

Figure 16 Grassland within the Project Area showing grassland dominated by *Bothriochloa decipiens, Dichanthium sericeum* and *Chloris truncata*.

100. As summarised earlier, grassland habitats supporting *Diuris tricolor* and *Prasophyllum petilum* elsewhere in the Hunter Valley are most commonly derived from landscapes of *Eucalyptus crebra*, and tend to be dominated by *Aristida ramosa, Cymbopogon refractus, Bothriochloa decipiens* and *Sporobolus creber* (species all present in the Project Area, but rarely dominating), with other grass species present but subdominant (Figure 17, cf. Figure 16). Herbs and forbs do occur in those habitats, but they are rarely conspicuous or dominant. The grasslands observed within the Project Area appeared more diverse, in keeping with observations made in other parts of the Hunter that landscapes derived from former *Eucalyptus 'albemol'* or *Eucalyptus moluccana* woodland support more species than those derived from *Eucalyptus crebra* (e.g. such as seen at Rixs Creek; Bell 2012b). Indeed, observations of remnant canopy species made during my inspection revealed that almost all of the Project Area appeared to have once supported a woodland of *Eucalyptus 'albemol'* or *Eucalyptus moluccana*, except for some areas where *Eucalyptus dawsonii*, *Eucalyptus blakelyi* or *Eucalyptus conica* occurred.

101. Similarly, *Pterostylis chaetophora* is known predominantly from forested habitats with a grassy ground layer, with *Entolasia stricta, Themeda triandra* and *Aristida vagans* important. While the last of these grass species is common in the upper Hunter Valley (but rare within the Project Area), *Themeda triandra* is now rarely encountered, and *Entolasia stricta* is highly localised normally in sandstone habitats (pers. obs.).

102. Despite these observations, I am conscious of the possibility that these perceived differences in floristic composition may be a reflection on the recent growth following good falls of rain. However, apart from a few areas within the Surface Disturbance Area (Figure 18) where the hardy and grazing-tolerant *Aristida ramosa* dominated some sections, this species formed only a small component of the bulk of lands inspected; it was nearly always present but sub-ordinate to other grasses and herbs. Given the long history of grazing across the Project Area, it may be expected that *Aristida ramosa* would have been the dominant grass species, however clearly soil type rather than past land management appears to drive species composition in these landscapes.

Figure 17 Grassland supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola Coal, dominated by *Aristida ramosa* and *Cymbopogon refractus*.

Figure 18 Grassland within the proposed Surface Area Disturbance area, showing (predominantly) swards of *Aristida ramosa* with *Dichanthium sericeum* and *Chloris truncata*.

103. On the GIS, I then examined the vegetation community mapping presented in Hunter Eco (2019) to determine if it accurately portrayed the diversity and distribution of vegetation that I inspected, and found it to represent well the vegetation patterns within the Project Area. I was satisfied, therefore, that I could use the Hunter Eco vegetation community mapping to create maps of likely orchid habitat, so that if necessary, estimates of the number of hectares anticipated to support viable orchid populations could be calculated (**Section 5**). Additional guidance was provided by my own field notes and data analyses, the plot data collected by Hunter Eco and aerial imagery.

104. In determining the suitability of the Project Area as orchid habitat, I drew on my experience from surveying for *Diuris tricolor* and *Prasophyllum petilum* in the Mangoola area over ten years, and for *Pterostylis chaetophora* in the mid-lower Hunter Valley across four sites over three years. Part of this experience included observations of orchids growing in somewhat surprising situations, which may otherwise be glossed over as unsuitable habitat. For example, observations of *Diuris tricolor* growing on agricultural contour banks (Figure 19), in heavily weed-infested derived grasslands where no other native species were apparent (Figure 20), and proliferating on the manicured lawns of farm homesteads (Figure 21). I have also observed *Diuris tricolor* growing within a former vineyard on raised garden beds, and along the margins of management trails. Likewise, *Pterostylis chaetophora* also commonly grows along trail and road edges (Figure 22) and in other areas where some ground disturbance has occurred. Collectively, observations of orchids growing in such disturbed habitats suggest that perceived low condition of potentially appropriate habitat should not be immediately dismissed as unlikely to support orchids.

Figure 19 ***Diuris tricolor*** **and other orchids growing over a constructed contour bank, Mangoola.**

Figure 20 ***Diuris tricolor*** **growing with exotic weeds in low quality grassland near Mangoola Coal.**

Figure 21 ***Diuris tricolor*** **proliferating in mown lawns of a farm homestead near Mangoola Coal.**

Figure 22 ***Pterostylis chaetophora*** **growing in roadside gutter, Columbey National Park.**

4.5 Concluding Opinion: Are the Target Species Present?

105. Based on the various floristic and environmental analyses discussed earlier in this section, I concluded that there is limited potential for *Diuris tricolor* or *Prasophyllum petilum* to be present within the Project Area, and that it is unlikely for *Pterostylis chaetophora* to occur at all. I based this opinion largely on the preceding analysis of floristic composition of available habitat, geological unit, soil landscape, annual rainfall and the inferred absence or paucity of mycorrhizal fungi (using reported orchid presence and diversity as a surrogate) (Table 13).

106. The two communities potentially supporting *Diuris tricolor* and/or *Prasophyllum petilum* (Units 9a and 11 of Hunter Eco 2019) occur only at Ancillary Disturbance Area 1 and the Product Stockpile Extension area respectively. Since these conclusions were made, Hunter Eco was commissioned to undertake targeted surveys of these two communities and no threatened flora species were recorded within the Project Area. Consequently, *Diuris tricolor* and *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) are unlikely to be present anywhere in the Project Area.

Table 13 Concluding Reasoning for Orchid Presence or Absence.

Species	Factor	Reasoning
Diuris tricolor	floristic composition	Analysis of floristic data (using the upper 95% of species comprising defined vegetation communities within the Project Area) revealed only one community (**Unit 9a: Ironbark - Grey Box Grassy Woodland DNG**) as being closely related to my own defined communities supporting *Diuris tricolor* at Mangoola. This community has been mapped by Hunter Eco (2019) for 0.3 ha of the Project Area, at Ancillary Disturbance Area 1.
		Additionally, the close proximity (c. 400 m) of a population of *Diuris tricolor* to the Product Stockpile Extension area, and in vegetation similar to that present there, suggests that **Unit 11: Grey Box – Spotted Gum – Narrow-leaved Ironbark woodland**, mapped by Hunter Eco (2019) across 1.3 ha of the Project Area, also potentially supports this species.
	geological unit	There is only **minor correlation** (6%) between geological units within the Project Area and those supporting *Diuris tricolor* elsewhere in the region.
	soil landscape	There is only **minor correlation** (5%) between soil landscapes within the Project Area and those supporting *Diuris tricolor* elsewhere in the region.
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there are **very limited and/or highly localised mycorrhizal fungi** present in soils, reducing the likelihood of *Diuris tricolor* or *Prasophyllum petilum* being present.
Prasophyllum petilum	floristic composition	Analysis of floristic data (using the upper 95% of species comprising defined vegetation communities within the Project Area) revealed only one community (**9a - Ironbark - Grey Box Grassy Woodland DNG**) as being closely related to my own defined communities supporting *Prasophyllum petilum* at Mangoola. This community has been mapped by Hunter Eco (2019) for 0.3 ha of the Project Area, at Ancillary Disturbance Area 1.
		Additionally, the relatively close proximity (c. 1300 m) of an historical population of *Prasophyllum petilum* to the Product Stockpile Extension area, and in vegetation similar to that present there, suggests that **Unit 11: Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland**, mapped by Hunter Eco (2019) across 1.3 ha of the Project Area, also potentially supports this species.
	geological unit	There is only **very minor correlation** (0.2%) between geological units within the Project Area and those supporting *Prasophyllum petilum* elsewhere in the region.

Species	Factor	Reasoning
	soil landscape	There is only **very minor correlation** (0.2%) between soil landscapes within the Project Area and those supporting *Prasophyllum petilum* elsewhere in the region.
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there are very limited and/or highly localised mycorrhizal fungi present in the available soils, reducing the likelihood of *Prasophyllum petilum* being present.
Pterostylis chaetophora	floristic composition	Analysis of floristic data (using the upper 95% of species comprising defined vegetation communities within the Project Area) revealed **no relationship** with my own defined communities supporting *Pterostylis chaetophora* at Columbey National Park. Despite superficial similarities of community 11 (Grey Box - Spotted Gum - Narrow-leaved Ironbark Woodland) from within the Project Area to elements of the Columbey vegetation, there are few co-occurring dominants.
	geological unit	There is only **minor correlation** (3%) between geological units within the Project Area and those supporting *Pterostylis chaetophora* elsewhere in the region.
	soil landscape	There is only **very minor correlation** (0.8%) between soil landscapes within the Project Area and those supporting *Pterostylis chaetophora* elsewhere in the region.
	annual rainfall	Annual mean rainfall across all locations supporting *Pterostylis chaetophora* (n=128) is 1005 mm/yr (stdev 98.4), while the annual mean rainfall of the Project Area is **considerably drier** at 640 mm/yr (stdev 20.8).
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there are very limited and/or highly localised mycorrhizal fungi present in the available soils, reducing the likelihood of *Pterostylis chaetophora* being present.

5. Criterion (d) – Size of Population or Habitat

107. In order to determine the extent of potential habitat for *Diuris tricolor*, *Prasophyllum petilum* and/or *Pterostylis chaetophora* within the Project Area, I considered the elements outlined above in Table 13 and used the mapping of Hunter Eco (2019) to spatially represent that habitat. Following my analyses, habitat for *Diuris tricolor* and *Prasophyllum petilum* was considered to potentially occur within vegetation mapped as Ironbark - Grey Box Grassy Woodland DNG (Unit 9a) or Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland (Unit 11) by Hunter Eco (2019). These units have been mapped across 0.3 ha of Ancillary Disturbance Area 1, and 1.3 ha for the Product Stockpile Extension area respectively. No other grasslands or woodlands in the Project Area carry vegetation similar to this, supporting both by my field inspection and the comparative numerical floristic analysis I performed on Hunter Eco (2019)

data. Surveys of these areas by Hunter Eco in 2020 did not record *Diuris tricolor* or *Prasophyllum petilum*, suggesting that these species are unlikely to be present within the Project Area.

108. I do not consider *Pterostylis chaetophora* to be present anywhere within the Project Area. Almost all of the known records of this species occur in more coastal habitats receiving higher rainfall than the Project Area, except for two unconfirmed populations at Mangoola Coal and Wingen Maid Nature Reserve. Those two populations, however, are closely tied (geographically) to remnant Triassic Narrabeen series outcrops, and/or colluvial material derived from those rock types, none of which occur within the Project Area.

109. While rarely recognised in assessments of potential orchid habitat, the occurrence of the required mycorrhizal fungi for each of the three target orchid species (and indeed for all terrestrial orchids) is possibly the most important determiner of orchid presence/absence. Unfortunately, it is the one factor that we know very little about and represents an attribute that cannot be readily determined without significant and comprehensive 'baiting' of soils to map their distribution. As a proxy, in this assessment examination of database records for all orchid species across the Hunter region revealed a clear scarcity of terrestrial orchids from the landscapes in and around the Project Area (irrespective of the extensive flora survey effort that has been expended in this area over many years), implying that mycorrhizal fungi themselves are scarce. With no fungi, there can be no orchids (see **Section 2.4.2**).

110. In an earlier report for the adjacent Bayswater and Liddell Power Station upgrade (Bell 2020c), I conservatively estimated approximately 166 ha of derived grassland as potentially supporting *Diuris tricolor* and no *Prasophyllum petilum*, but based on soil landscapes, floristics and proximate records stated that large populations would be unlikely there. Additional research undertaken since then into soil biology, mycorrhizal fungi and terrestrial orchid diversity in the upper Hunter now supports the contention that only small and highly localised populations appear present in these landscapes. This is reinforced by the known populations of *Diuris tricolor* and *Prasophyllum petilum* along Thomas Mitchell Drive, and in the Diuris Conservation Area near Ancillary Disturbance Area 1. These localised populations, all occurring in or close to woodland (rather than in derived grassland) and often in areas supporting several other orchid species, are suggestive of highly localised mycorrhizal fungi. Given the fact that no orchid species of any kind has ever been recorded within the Project Area (and only 7 species detected historically within a 15 km radius of it, most as single records), it seems highly unlikely that sufficient mycorrhizal fungi occur in the soils there to support *Diuris tricolor* or *Prasophyllum petilum*. It is quite plausible that a prolonged period of agricultural grazing, incorporating soil enrichment and compaction, over at least 150 years across most of the Project Area has altered soil chemistry and depleted the reserves of mycorrhizal fungi, to the point now that they (and consequently the orchids that rely on them) are largely absent from grassland areas.

111. Considering all of the preceding discussion, I consider the extent of potential habitat within the Project Area to be as shown in Figure 23, and comprises:

- 1.6 ha for *Diuris tricolor*
- 1.6 ha for *Prasophyllum petilum*
- 0 ha for *Pterostylis chaetophora*

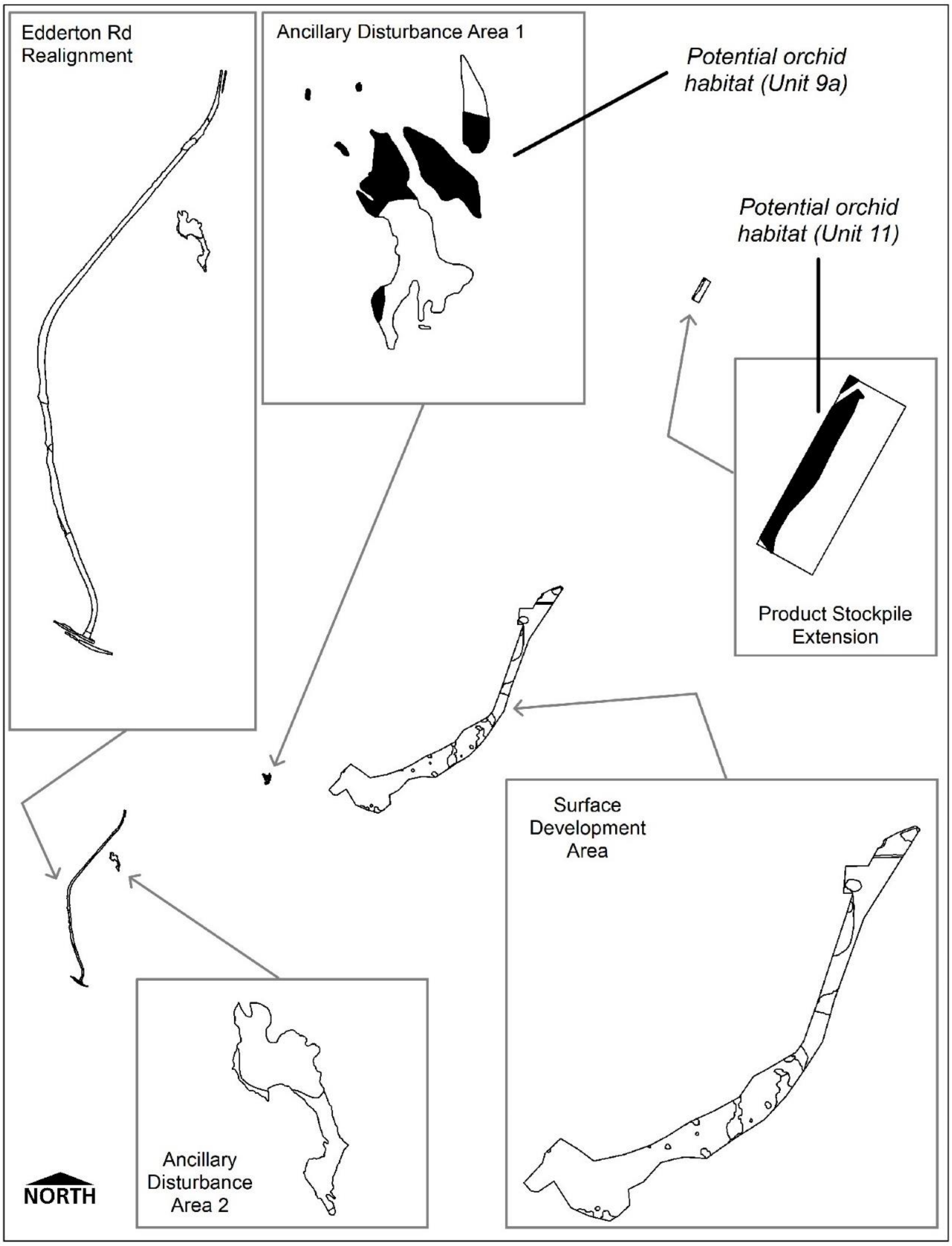


Figure 23 Habitat considered suitable (black shading) for *Diuris tricolor* and *Prasophyllum petilum* within the Project Area. Base mapping from Hunter Eco (2019).

6. Criterion (e) – Documents & Data Reviewed

112. I have been provided with the following reports and datasets from Resource Strategies and DPIE to assist in this review:

- GIS files showing Project boundaries and vegetation community mapping
- flora and vegetation mapping report for the proposed Maxwell Project (Hunter Eco 2019)
- an extract of the NSW BioNet database, under licence ASH20009, detailing as-held records for the three target orchids within the Hunter LLS area

All other published and unpublished reports, papers and maps that form part of this assessment have been cited in the normal way, with publication details contained in **Section 9** or advised within the text.

7. Criterion (f) – Expert Credentials

113. Under the requirements of the BAM (DPIE 2020), an expert report can be prepared by an endorsed person in the place of undertaking field survey. This report must include information on the credentials of the expert, including the following:

a. *the expert's academic qualifications such as relevant degrees, post graduate qualifications*;

I possess three degrees in the science and ecology field: a Bachelor of Science (1988), Bachelor of Science (Honours) (1990) and a Doctor of Philosophy in vegetation science (2013).

b. *their history of experience in the ecological research, habitat assessment and survey method, for the relevant species*;

In regard to the threatened orchid species that are the subject of this expert report (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*), I have been surveying and monitoring these species for between three (*Pterostylis chaetophora*) and 11 (*Diuris tricolor, Prasophyllum petilum*) consecutive years at various locations in the Hunter Valley, including the annual monitoring of over 3000 translocated specimens since 2010. Targeted surveys have incorporated systematic open-ended transect surveys in appropriate habitat, using GPS devices to record tracks searched and orchids located. Separation distances between adjacent search transects vary in relation to quality of habitat and visibility. Search times have only occurred when other known reference populations have been in flower.

c. *a resume detailing projects pertaining to the survey of the relevant species (including the locations and dates of the work), their employers' names and periods of employment (where relevant) over the previous 10 years*;

I am the principal and owner of Eastcoast Flora Survey, established in the Hunter Valley in October 1996 and spanning a continual period of dedicated flora consulting of nearly 25 years. Since 2014, I have also been a Conjoint Fellow at the University of Newcastle (School of Environmental and Life Sciences), where I am a member of two research groups: the Centre for Plant Science and the Conservation Biology Research Group. My full Curriculum Vitae are appended as Appendix 5 to this report.

In relation to the relevant species that are the subject of this report (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*), the following projects and publications pertain to these:

- Bell, S.A.J. (submitted 1) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (submitted).
- Bell, S.A.J. (submitted 2) Successful recruitment following translocation of a threatened terrestrial orchid (*Diuris tricolor*) into mining rehabilitation in the Hunter Valley of NSW. *Ecological Management* and *Restoration* (submitted)
- Bell, S.A.J. (2020) Translocation of threatened terrestrial orchids into non-mined and post-mined lands in the upper Hunter Valley of New South Wales, Australia. *Restoration Ecology* 28 1396-1407.

- Bell, S.A.J. (2020) *Survey and monitoring of the Vulnerable* Pterostylis chaetophora *(Rusty Greenhood) in the Lower Hunter Valley, NSW: 2019 Results*. Unpublished Report to NSW Office of Environment and Heritage. June 2020. Eastcoast Flora Survey.
- Bell, S.A.J. (2020) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor *&* Prasophyllum petilum*): Bayswater Water and Other Associated Operational Works Project*. Unpublished Report to Kleinfelder. May 2020. Eastcoast Flora Survey.
- Bell, S.A.J. (2020) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2019 Results*. Unpublished Report to Mangoola Coal. February 2020.
- Bell, S.A.J. & Hillier, P. (2020) Targeted surveys of a poorly conserved threatened orchid (*Pterostylis chaetophora*) in Columbey National Park (Hunter Valley, NSW) reveal substantial populations and elucidate occupied habitat. *Cunninghamia* 20: 199-207.
- Bell, S.A.J., Murray, M., & Sims, R. (2020) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2019 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2020. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
- Bell, S.A.J. (2019) *Expert Report: Expected presence of threatened terrestrial orchids (*Diuris tricolor *&* Prasophyllum petilum*), Mangoola Coal Continued Operations Project*. Unpublished Report to Umwelt (Australia) Pty Ltd. December 2019.
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- Bell, S. (2019) Translocation success is all about detection: experiences with two threatened orchids from the Hunter Valley of NSW. *Australasian Plant Conservation* 28: 27-31.
- Bell, S.A.J., Murray, M., & Sims, R. (2019) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2018 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2019. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
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- Bell, S.A.J. (2017) *Targeted survey for the threatened* Diuris tricolor *at Persoonia Park, North Rothbury, Hunter Valley*. Unpublished Report to Office of Environment & Heritage. November 2017. Eastcoast Flora Survey.
- Bell, S.A.J. (2017) *Baseline monitoring and survey of the vulnerable* Pterostylis chaetophora *(Orchidaceae) at North Rothbury, Hunter Valley, NSW*. Unpublished Report to NSW Office of Environment & Heritage. October 2017. Eastcoast Flora Survey.
- Bell, S.A.J. & Murray, M. (2017) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2016 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2017. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
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- Bell, S.A.J. (2013) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum *sp. Wybong C.Phelps ORG 5269) at Mangoola Coal: 2013 Results*. Unpublished Report to Mangoola Coal. November 2013. Eastcoast Flora Survey.
- Bell, S.A.J. & Murray, M. (2013) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA*. Unpublished Report to Bulga Surface Operations (Glencore). November 2013. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
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d. *peer-reviewed publications on the species or other evidence that the person is a well-known authority on the species to which the survey relates*;

I have published two papers specifically addressing *Diuris tricolor* and *Prasophyllum petilum*: Bell (2019a, assessing translocation success in these species) and Bell (2020d, comparing translocation efforts in mined and non-mined lands). A third published paper details population size and occupied habitat of *Pterostylis chaetophora* in the lower Hunter (Bell & Hillier 2020), while a fourth presents the results of new recruitment in *Diuris tricolor* in mine rehabilitation (Bell submitted 2).

I have also published on several other threatened orchid species (e.g. *Cryptostylis hunteriana*: Bell 2001a, de Lacey *et al.* 2012a, b, de Lacey *et al.* 2013; *Thelymitra adorata*: Bell *et al.* 2005; *Diuris praecox*: Yare *et al.* 2020) and non-orchid threatened taxa (e.g. *Acacia dangarensis*: Bell & Elliott 2013; *Acacia pendula*: Bell 2018; Bell *et al.* 2007, Bell & Driscoll 2014, 2016; *Acacia wollarensis*: Bell & Driscoll 2017, Bell & Kodela 2018; *Angophora inopina*: Bell 2004b; *Banksia conferta*: Bell 2017b; *Commersonia rosea*: Bell & Copeland 2004, Bell &

Holzinger 2015; *Dracophyllum macranthum*: Bell & Sims 2018; *Eucalyptus expressa*: Bell & Nicolle 2012; *Eucalyptus calidissima*; Bell & Klaphake 2020; *Eucalyptus dealbata* subsp. *aperticola*: Bell & Nicolle 2020; *Hibbertia procumbens*: Bell 2002, Bell & Driscoll 2005b; *Leionema lamprophyllum* subsp. *fractum*: Bell & Walsh 2015; *Monotaxis macrophylla*: Bell & Holzinger 2015; *Senecio linearifolius* var. *dangarensis* and *S. spathulatus* var. *attenuatus*: Mickaill *et al.* 2020), together with those examining a range of significant and threatened species in sandstone habitats of the Hunter Valley (23 taxa; Bell 2001b) and those present in Wollemi National Park (110 taxa; Bell 2008, 2019c). I am also the lead author of a recently published book with CSIRO Publications (Bell *et al.* 2019), detailing 54 of the endemic plant species of the Hunter Region, many of which are threatened species. One other recent paper, of which I am co-author, examined the conservation status of 822 eucalypt taxa from across Australia (Fensham *et al.* 2020).

I have been surveying and monitoring two of the target species for over 10 years in the Hunter Valley (and the third for three years) and am acutely aware of their habitat requirements and variability in flowering from year to year. Additionally, Dr Lachlan Copeland (Eco Logical Australia & orchid taxonomist) has endorsed me as a recognised authority on the field ecology of *Diuris tricolor* and *Prasophyllum petilum* (see letter attached in Appendix 6).

8. Conclusion

114. Maxwell Ventures (Management) Pty Ltd propose to establish an underground coal mine within EL5460, which will require limited ground disturbance across the full Project Area. Never-the-less, proposed disturbances associated with planned expansion of the Product Stockpile Extension area, establishment of Surface Development Areas to accommodate underground entrance surface facilities and a transport/services corridor, proposed Edderton Rd Realignment to avoid potential road damage from subsidence, and Ancillary Disturbance Areas (Ponding) in response to modelled ground subsidence, may impact on terrestrial orchids, if present.

115. No known records of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* exist for the Project Area, and after assessment I considered that approximately 1.6 ha of the proposed 320 ha (0.5%) of ground disturbance area may provide habitat for two of these species (*Diuris tricolor*, *Prasophyllum petilum* [syn. *Prasophyllum* sp. Wybong]). I do not consider that the third target species, *Pterostylis chaetophora*, is likely to occur anywhere within the Project Area.

116. *Diuris tricolor* and *Prasophyllum petilum* occupy extensive geographical ranges outside of the Hunter region, however *Pterostylis chaetophora* is endemic here. Records for *Diuris tricolor* exist close to the Project Area, near Ancillary Disturbance Area 1 and along Thomas Mitchell Drive, and *Prasophyllum petilum* has historically been recorded at the eastern end of Thomas Mitchell Drive but is presumed extinct (B. Holzinger pers. comm.). There are no validated populations of *Pterostylis chaetophora* west of North Rothbury (52 km to the south-east), although two records at Mangoola Coal (21 km north-west) and Wingen Maid Nature Reserve (55 km north) remain unvalidated.

117. Following a single day site inspection of the Project Area in July 2020, I noted observable differences in the floristic composition of habitats to other areas where I know the three target orchids from, and the predominance of former Box (*Eucalyptus 'albemol'* and *Eucalyptus moluccana*) landscapes within these largely cleared lands conflicts with my experience of orchid habitat elsewhere. Differences were supported by a review of ecological information prepared by Hunter Eco (2019) for the Project Area, the mapping of which I found to be accurate and acceptable. Numerical analysis of defined vegetation communities revealed clear differences to habitat from elsewhere in the region known to support *Pterostylis chaetophora*, but one community similar to habitats typical of *Diuris tricolor* and *Prasophyllum petilum*. Additionally, the close proximity of known populations of *Diuris tricolor* (c. 400 m) and *Prasophyllum petilum* (1300 m) to the northern section of the Project Area suggests that potential habitat for these may also occur in a second community. I therefore consider that the vegetation units defined by Hunter Eco (2019) as Ironbark - Grey Box Grassy Woodland DNG (Unit 9a) and Grey Box – Spotted Gum – Narrow-leaved Ironbark Woodland (Unit 11) provide the only potential habitat for *Diuris tricolor* and *Prasophyllum petilum*, which together comprise 1.6 ha (0.5%) of the Project Area. Dr Colin Driscoll (Hunter Eco) was commissioned by Malabar Resources to conduct a targeted survey of this area during suitable survey conditions in 2020, and none of the target species were found. Consequently, *Diuris tricolor* and *Prasophyllum* (syn. *Prasophyllum* sp. Wybong) are unlikely to be present within the Project Area.

118. In support, a detailed assessment of environmental attributes across all Hunter populations of *Diuris tricolor* (n=983), *Prasophyllum petilum* (n=485) and *Pterostylis chaetophora* (n=128) found differences in geological units, soil landscapes, and (for *Pterostylis chaetophora*) annual

rainfall when compared to the Project Area. Of these, soil landscapes were seen as particularly important given they best encapsulate the likely distribution of mycorrhizal fungi across the region, without which no orchids would germinate and prosper. As a surrogate for fungi distribution, an assessment of all terrestrial orchid observation records for the upper Hunter Valley demonstrated a scarcity of orchids in and around the Project Area, suggesting that mycorrhizal fungi were therefore also scarce or localised. This lends further credence to my conclusion that *Diuris tricolor* or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) are unlikely to be present within the Project Area.

119. The combination of geology, soil landscape, floristic, rainfall, and general orchid distribution (as a surrogate for mycorrhizal fungi) suggest that the Project Area is unlikely to support extensive populations of *Diuris tricolor* or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong), and none of *Pterostylis chaetophora*. The areas where I consider the former two species may occur occupy <1% of the total disturbance footprint, but targeted searches in these areas did not record these species.

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Appendix 1 – Dr Stephen Bell DPIE Accreditation

NSW GOVERNMENT | Office of Environment & Heritage

DOC18/211176-1

[redacted]

Dear [redacted]

Recognition of Dr Stephen Bell as an expert for *Diuris tricolor* and *Prasophyllum petilum* (Syn. *Prasophyllum* sp. 'Wybong')

Thank you for your e-mail of the 9 April 2018 in which you request that Dr Stephen Bell be recognised as an expert for *Diuris tricolor* (Pine Donkey Orchid) and *Prasophyllum petilum* (Syn. *Prasophyllum* sp. 'Wybong') (Tarengo Leek Orchid) for the [redacted].

The Office of Environment and Heritage (OEH) has reviewed the information provided by you in support of this request. OEH is satisfied that Dr Stephen Bell satisfies the definition of species expert for *Diuris tricolor* and *Prasophyllum petilum* (Syn. *Prasophyllum* sp. 'Wybong'), in accordance with Section 6.5.2.3. of the Biodiversity Assessment Method.

Please note that this formal recognition of Dr Stephen Bell as an expert only applies to *Diuris tricolor* and *Prasophyllum petilum* (Syn. *Prasophyllum* sp. 'Wybong').

If you require any further information regarding this matter, please contact Steven Cox, Senior Team Leader, Planning Hunter Central Coast, on 4927 3140.

Yours sincerely

Sharon Molloy 14/5/2018

SHARON MOLLOY
Director Hunter Central Coast Branch
Regional Operations Division

Contact officer: STEVEN COX
02 4927 3140

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Planning, Industry & Environment

Our ref: DOC20/443557-1
Your ref: n/a

Dr Stephen Bell

Vegetation Ecologist
East Coast Flora Survey
sajbell@bigpond.com

Dear Dr Bell

Approval of Dr Stephen Bell as an expert for *Pterostylis chaetophora*

I refer to your correspondence dated 9 June 2020 in which you requested that Dr Stephen Bell be considered as an expert for *Pterostylis chaetophora*.

The Biodiversity and Conservation Division (BCD) of the Department of Planning, Industry and Environment has reviewed the information provided in support of this request. BCD is satisfied that Dr Stephen Bell satisfies the definition of a species expert for *Pterostylis chaetophora* in accordance with Section 6.5.2.3 of the Biodiversity Assessment Method.

Please note that this formal recognition of Dr Stephen Bell as an expert only applies to the Hunter Central Coast Region of NSW which comprises the following local government areas; Central Coast, Lake Macquarie, Newcastle, Port Stephens, Mid Coast, Dungog, Maitland, Cessnock, Singleton, Muswellbrook and Upper Hunter.

If you have any further questions in relation to this matter, please contact Steve Lewer, Acting Senior Team Leader Planning, on 4927 3158 or via email at rog.hcc@environment.nsw.gov.au

Yours sincerely

Joe Thompson

JOE THOMPSON
Director Hunter Central Coast Branch
Biodiversity and Conservation Division

Date: 25 June 2020

Level 4/26 Honeysuckle Drive Newcastle NSW 2330 | Locked Bag 1002 Dangar NSW 2309 | dpie.nsw.gov.au | 1

Appendix 2 – Floristic Composition of Grassland Habitat (Bell 2012a)

The derivation of diagnostic species for each defined floristic group has been defined using the SIMPER routine in *PRIMER* on available full floristic plot data. SIMPER analysis provides the relative contributions of each species to the Bray-Curtis similarity within each of the defined vegetation communities. Only those species contributing to a total cumulative contribution of 99% of the average similarity (i.e. the value shown at the top of each floristic table) for each community are listed. These species can be described of as *typical* of that community, and have a consistently large presence within the data as reflected in the ratio of their contribution to the standard deviation (the Sim/SD field in each table) across the within-group similarities (the average similarity). Key canopy species are highlighted.

In the tables:

- Average similarity — is the within-group similarity for all pairs of sample plots comprising the community. Higher average similarity indicates a better-defined community.
- Av.Abund — is the average cover abundance of that species within sample plots comprising the community
- Av.Sim — is the average similarity (contribution) made by each species to the within-group similarity (the overall average similarity).
- Sim/SD — is the ratio of average similarity to standard deviation for each species across all pairs of samples. A high ratio represents a good discriminating species. At least three samples are required for this ratio to be calculated (not available for four communities).
- Contrib% — is the percentage contribution of each species to the overall average similarity for the community.
- Cum.% — is the cumulative percentage contribution of each species, up to a maximum of 99%.

Unit 1a: Dichanthium/ Sporobolus/ Chloris Grassland - Key Diagnostic Species [based on 63 plots]:

Group 1a: Dichanthium/ Sporobolus/ Chloris Average similarity: 45.72					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Dichanthium sericeum subsp. sericeum	2.92	2.68	1.09	5.87	12.92
Senecio madagascariensis *	1.89	2.58	3.58	5.64	18.56
Sporobulus creber	2.02	2.22	1.79	4.87	23.42
Anagallis arvensis *	1.75	2.13	1.86	4.66	28.09
Chrysocephalum semipapposum	1.71	1.92	1.48	4.20	32.29
Centaurium tenuiflorum *	1.67	1.88	1.40	4.10	36.39
Bothriochloa decipiens var. decipiens	2.02	1.82	1.06	3.98	40.37
Glycine tabacina	1.56	1.78	1.47	3.90	44.27
Chloris truncata	1.79	1.41	0.93	3.09	47.36
Gamochaeta americana *	1.38	1.38	1.04	3.02	50.39
Cyclospermum leptophyllum *	1.35	1.22	1.19	2.67	53.05
Fimbristylis dichotoma	1.30	1.21	0.88	2.66	55.71

Aristida ramosa var. ramosa	1.52	1.21	0.89	2.64	58.35
Vittadinia muelleri	1.41	1.20	0.84	2.63	60.99
Cheilanthes sieberi subsp. sieberi	1.27	1.12	0.86	2.44	63.43
Dichelachne micrantha	1.59	1.09	0.76	2.38	65.80
Vulpia muralis *	1.38	1.05	0.77	2.30	68.10
Hypochaeris radicata *	1.21	0.90	0.73	1.97	70.08
Trifolium arvense *	0.97	0.83	0.93	1.81	71.88
Petrorhagia dubia *	1.08	0.81	0.73	1.78	73.66
Asperula conferta	1.06	0.78	0.68	1.70	75.36
Plantago debilis	1.03	0.77	0.67	1.69	77.05
Hypochaeris microcephala var. albiflora *	1.00	0.74	0.62	1.61	78.66
Dichondra repens	0.94	0.61	0.64	1.33	80.00
Oxalis perenans	0.94	0.61	0.61	1.33	81.33
Carthamus lanatus *	0.81	0.39	0.50	0.86	82.19
Briza minor *	0.76	0.38	0.46	0.84	83.02
Eulalia aurea	0.92	0.37	0.36	0.81	83.83
Wahlenbergia communis	0.62	0.35	0.54	0.77	84.61
Convolvulus erubescens	0.62	0.35	0.49	0.76	85.36
Cymbopogon refractus	0.63	0.31	0.46	0.68	86.04
Daucus glochidiatus	0.65	0.31	0.40	0.67	86.71
Sida corrugata	0.65	0.31	0.39	0.67	87.38
Austrodanthonia tenuior	0.65	0.30	0.36	0.65	88.03
Polycarpon tetraphyllum *	0.62	0.28	0.39	0.62	88.65
Triptilodiscus pygmaeus	0.62	0.28	0.33	0.62	89.27
Calocephalus citreus	0.78	0.27	0.33	0.58	89.85
Brunoniella australis	0.57	0.23	0.31	0.51	90.36

Unit 2: Aristida/ Cymbopogon Grassland - Key Diagnostic Species [based on 44 plots]:

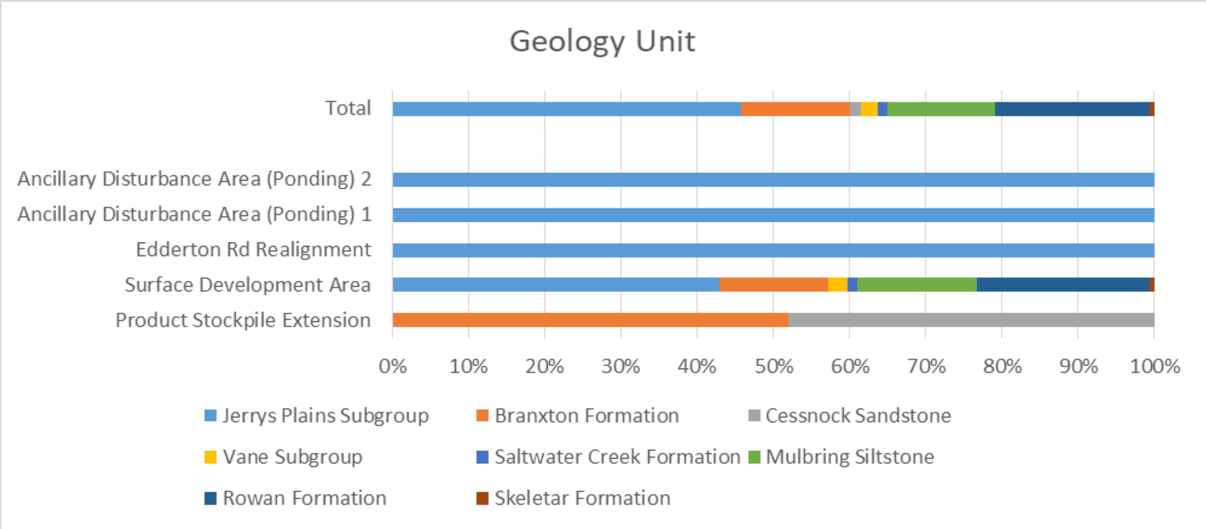
Group 2: Aristida/ Cymbopogon Average similarity: 39.82					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Aristida ramosa var. ramosa	3.43	4.60	2.17	11.55	11.55
Linum trigynum *	2.18	3.01	2.04	7.56	19.11
Cheilanthes sieberi subsp. sieberi	2.07	2.84	2.01	7.14	26.25
Anagallis arvensis *	1.70	2.42	1.73	6.09	32.34
Senecio madagascariensis *	1.66	2.32	1.65	5.84	38.18
Aristida vagans	1.95	1.83	0.90	4.60	42.78
Hypochaeris radicata *	1.75	1.77	1.00	4.44	47.22
Cymbopogon refractus	1.48	1.73	1.19	4.35	51.58
Glycine tabacina	1.14	1.32	1.25	3.32	54.90
Bothriochloa decipiens var. decipiens	1.43	1.23	0.69	3.08	57.98
Vulpia muralis *	1.27	1.20	0.97	3.02	61.00
Sporobulus creber	1.14	0.99	0.68	2.48	63.48
Briza minor *	1.07	0.96	0.79	2.41	65.89
Chrysocephalum apiculatum	1.02	0.81	0.54	2.03	67.92
Triptilodiscus pygmaeus	0.84	0.58	0.50	1.47	69.39

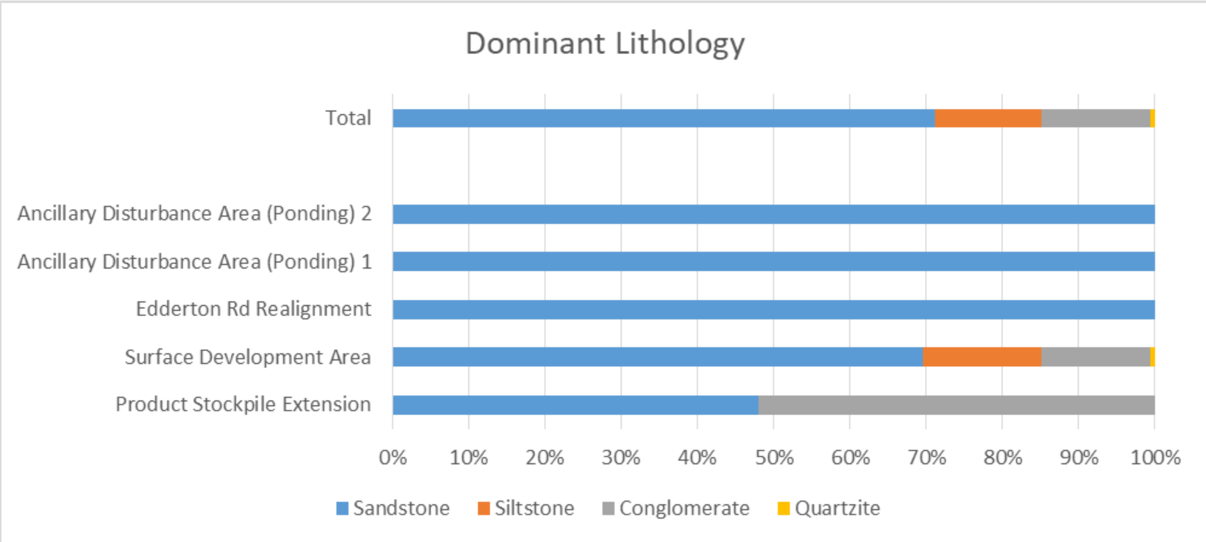
Vittadinia muelleri	0.93	0.58	0.44	1.45	70.83
Dichondra repens	0.77	0.54	0.53	1.35	72.18
Gamochaeta americana *	0.80	0.53	0.52	1.34	73.52
Dichelachne micrantha	0.82	0.52	0.49	1.31	74.83
Taraxacum officionale *	0.80	0.50	0.43	1.26	76.08
Lomandra confertifolia subsp. pallida	0.75	0.48	0.53	1.21	77.30
Tolpis barbata *	0.77	0.46	0.44	1.16	78.46
Lachnagrostis filiformis	0.75	0.44	0.39	1.10	79.56
Centaurium tenuiflorum *	0.70	0.41	0.41	1.03	80.59
Oxalis perenans	0.68	0.39	0.41	0.97	81.56
Richardia stellaris *	0.66	0.38	0.41	0.94	82.51
Chrysocephalum semipapposum	0.77	0.37	0.38	0.94	83.44
Fimbristylis dichotoma	0.68	0.37	0.37	0.93	84.38
Cyclospermum leptophyllum *	0.66	0.36	0.44	0.90	85.27
Petrorhagia dubia *	0.68	0.35	0.37	0.88	86.15
Asperula conferta	0.59	0.31	0.35	0.77	86.93
Sida corrugata	0.57	0.30	0.39	0.75	87.67
Linaria pelisseriana *	0.57	0.25	0.33	0.64	88.31
Glycine clandestina	0.41	0.23	0.41	0.58	88.89
Murdannia graminea	0.50	0.21	0.31	0.53	89.42
Centaurium erythraea *	0.50	0.20	0.25	0.50	89.92

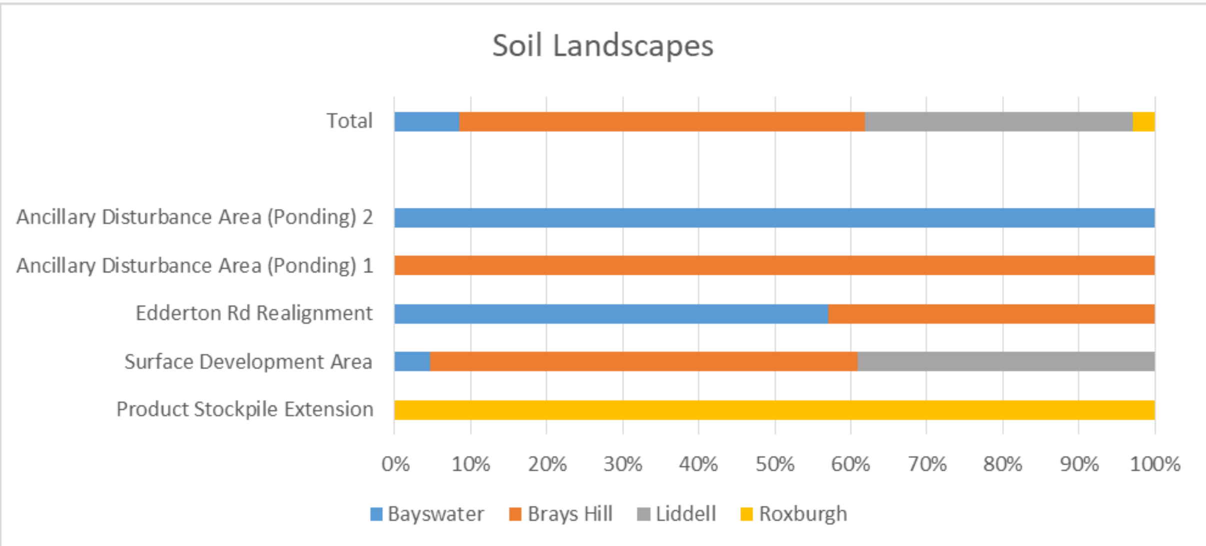
Unit 4: Bothriochloa biloba/ Carthamus/ Danthonia Grassland - Key Diagnostic Species [based on 7 plots]:

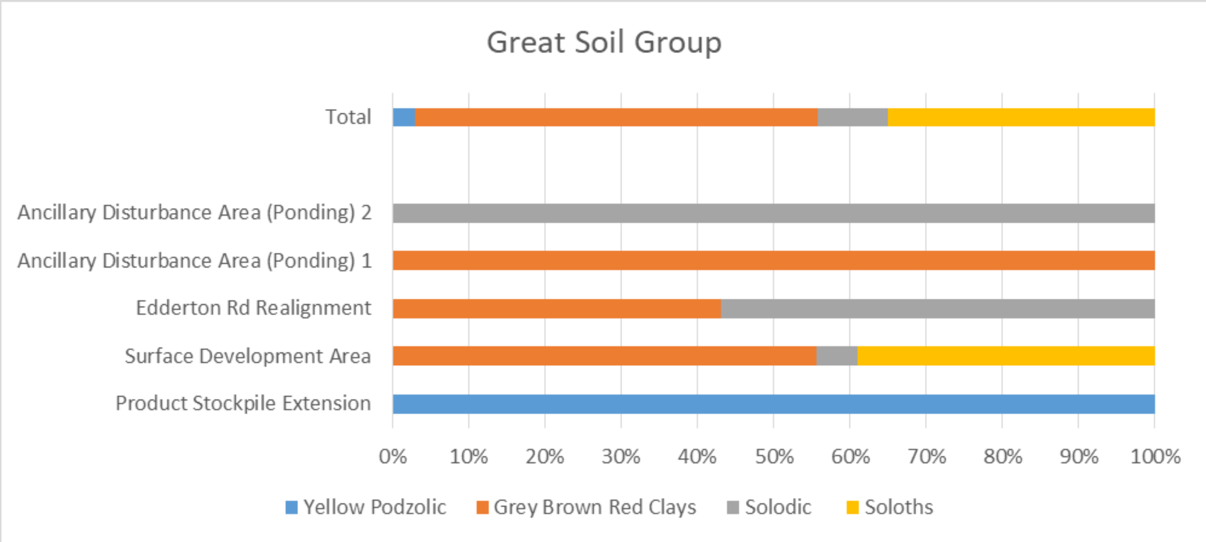
Group 4: Bothriochloa biloba/ Carthamus/ Danthonia Average similarity: 50.03					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Bothriochloa biloba	5.14	13.03	5.61	26.04	26.04
Carthamus lanatus *	2.57	6.41	2.45	12.82	38.86
Chloris truncata	1.86	4.86	4.58	9.72	48.57
Austrodanthonia tenuior	2.14	4.54	1.32	9.08	57.65
Einadia nutans subsp. linifolia	1.71	4.16	3.83	8.31	65.97
Lolium perenne *	1.57	3.31	1.35	6.61	72.58
Austrostipa aristiglumis	1.57	2.20	0.74	4.40	76.97
Vittadinia cuneata var. cuneata	0.86	1.55	0.90	3.11	80.08
Oxalis perenans	1.14	1.34	0.62	2.68	82.76
Senecio madagascariensis *	0.86	1.22	0.92	2.43	85.19
Sporobulus creber	1.00	1.07	0.59	2.13	87.32
Medicago truncatula *	0.86	0.95	0.60	1.90	89.22
Carex inversa	0.86	0.92	0.58	1.84	91.05

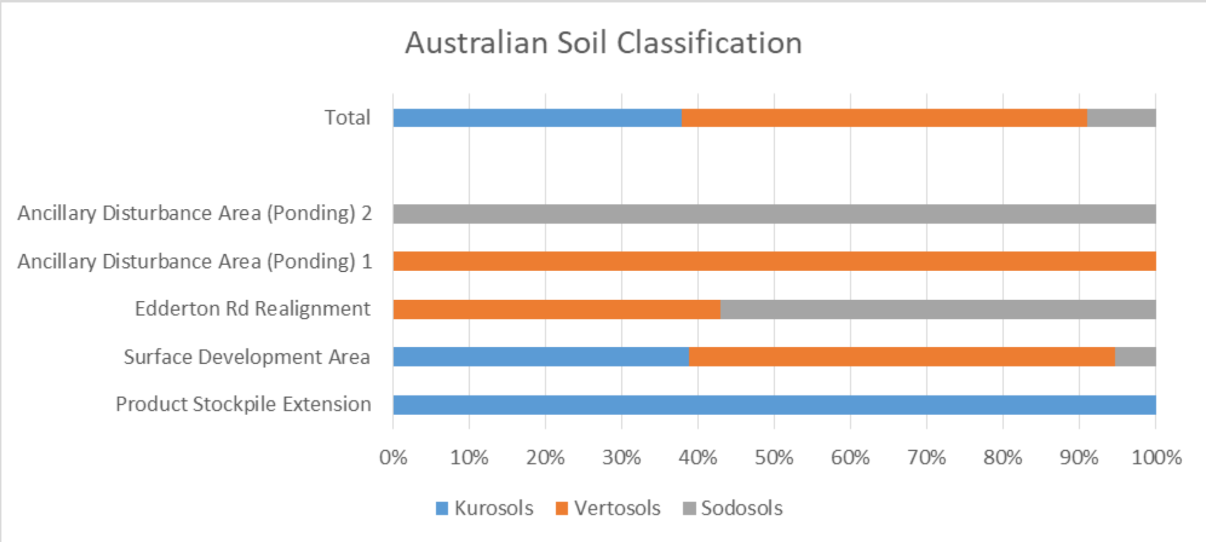
Appendix 3 – Biophysical Attributes of the Project Area

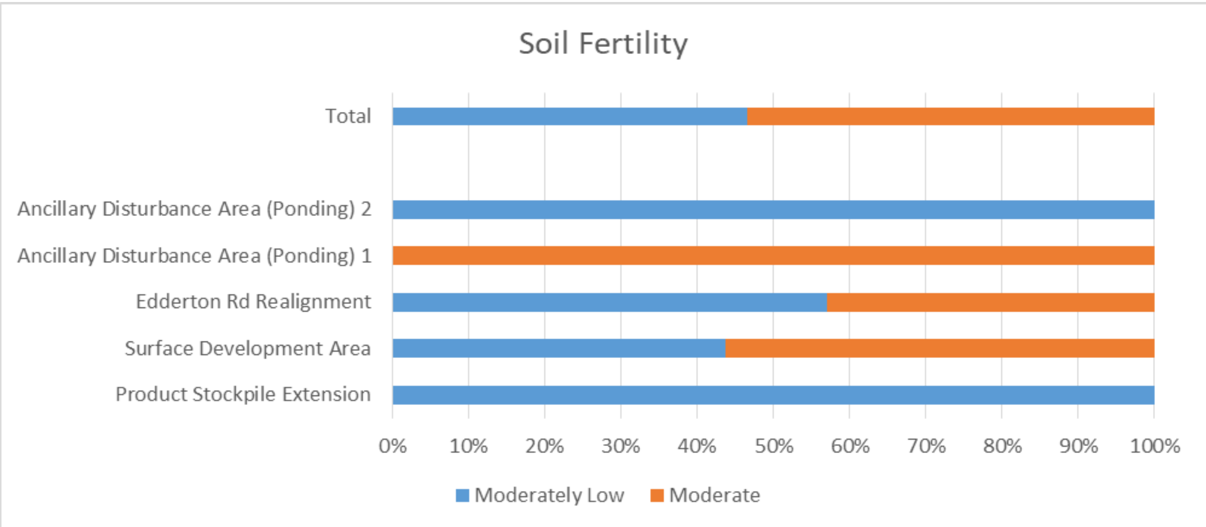


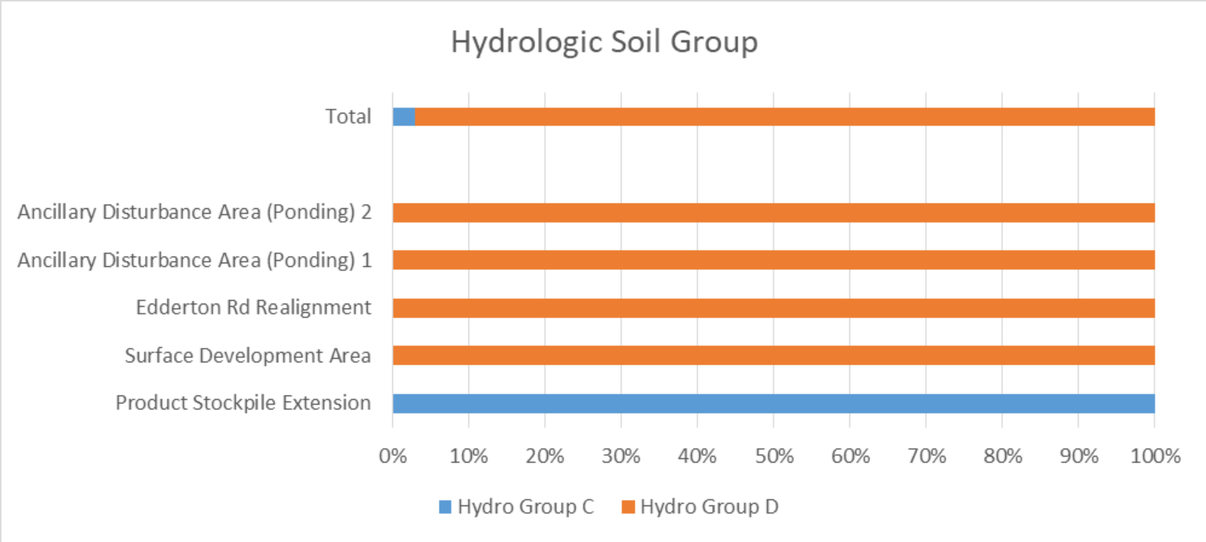


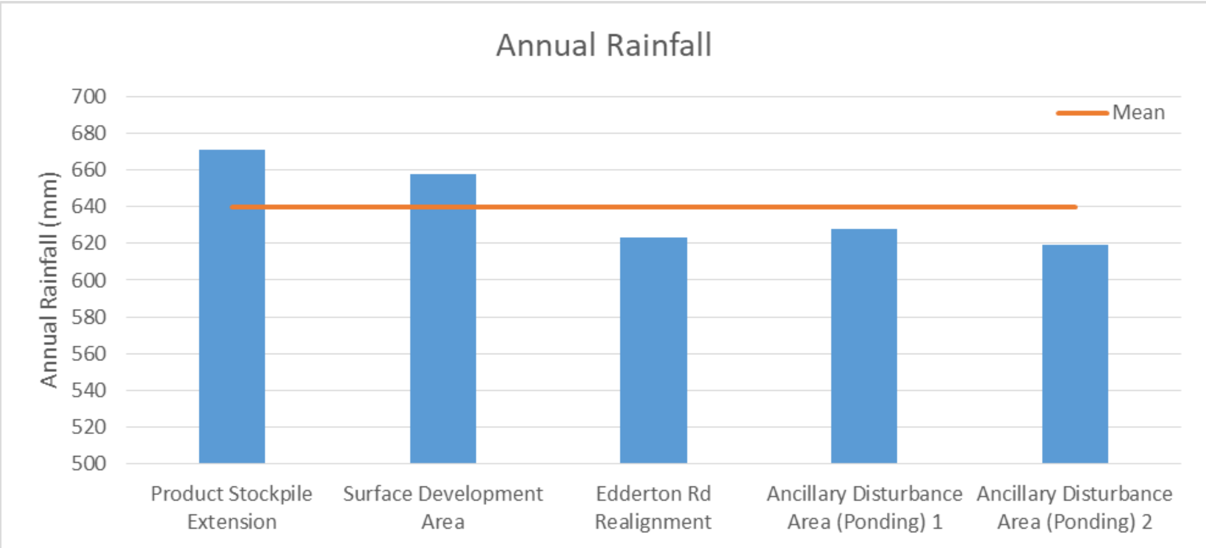


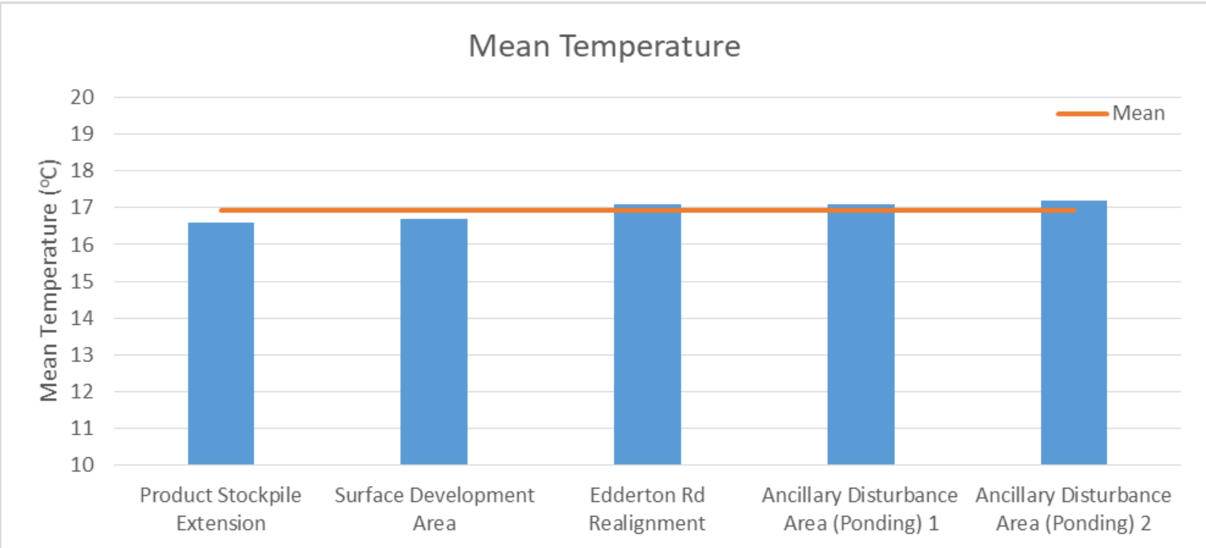

Great Soil Group
Total
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Yellow Podzolic
Grey Brown Red Clays
Solodic
Soloths


Australian Soil Classification
Total
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Kurosols
Vertosols
Sodosols

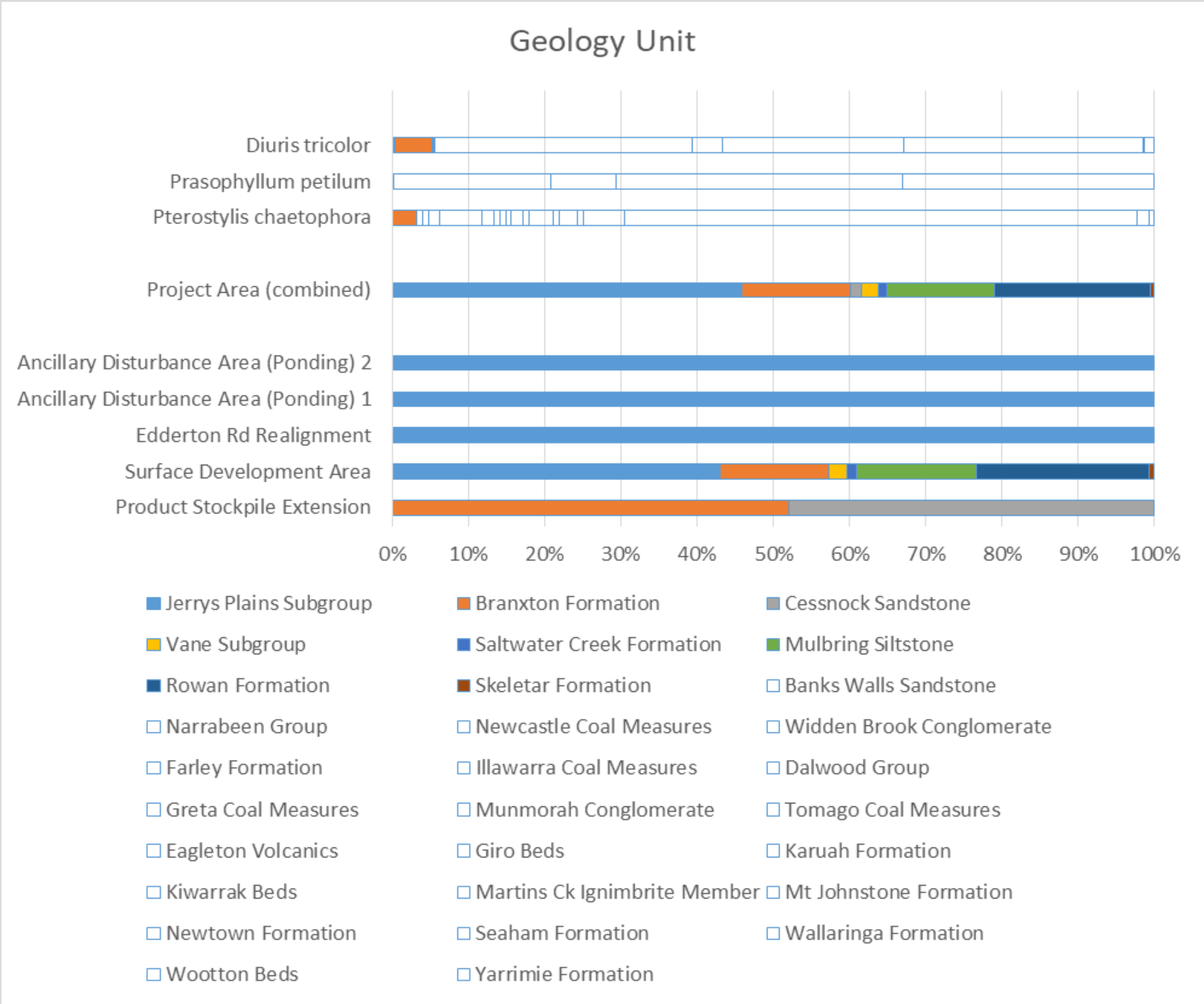

Soil Fertility
Total
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Moderately Low
Moderate

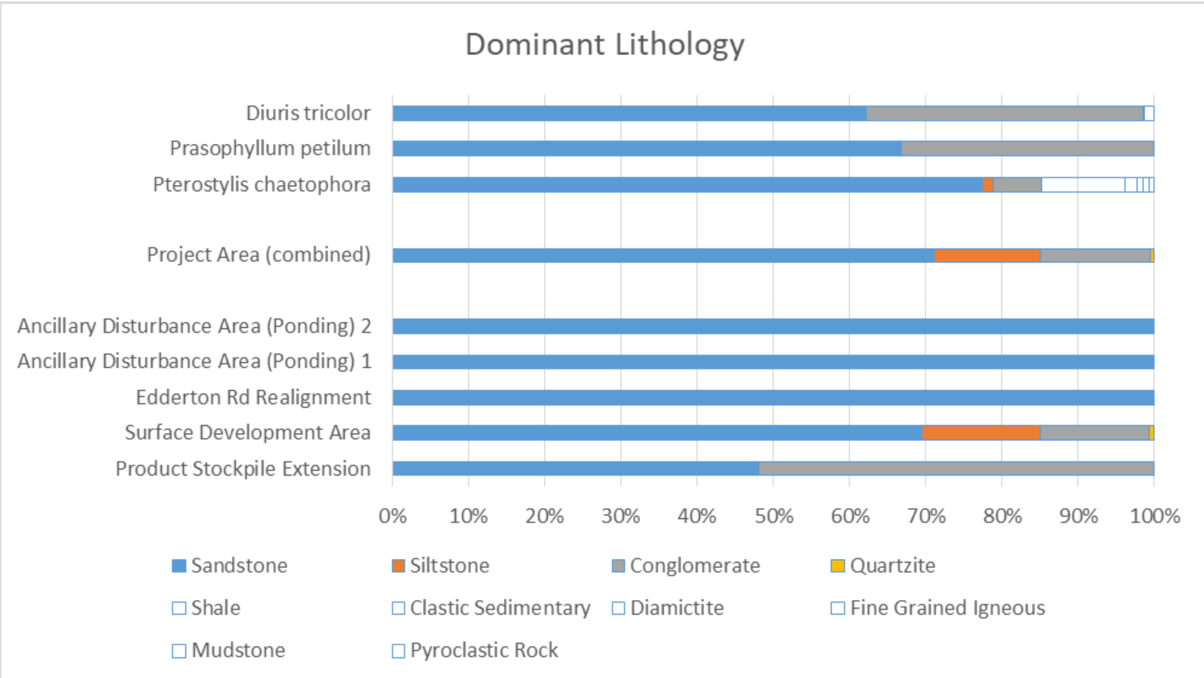

Hydrologic Soil Group
Total
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Hydro Group C
Hydro Group D

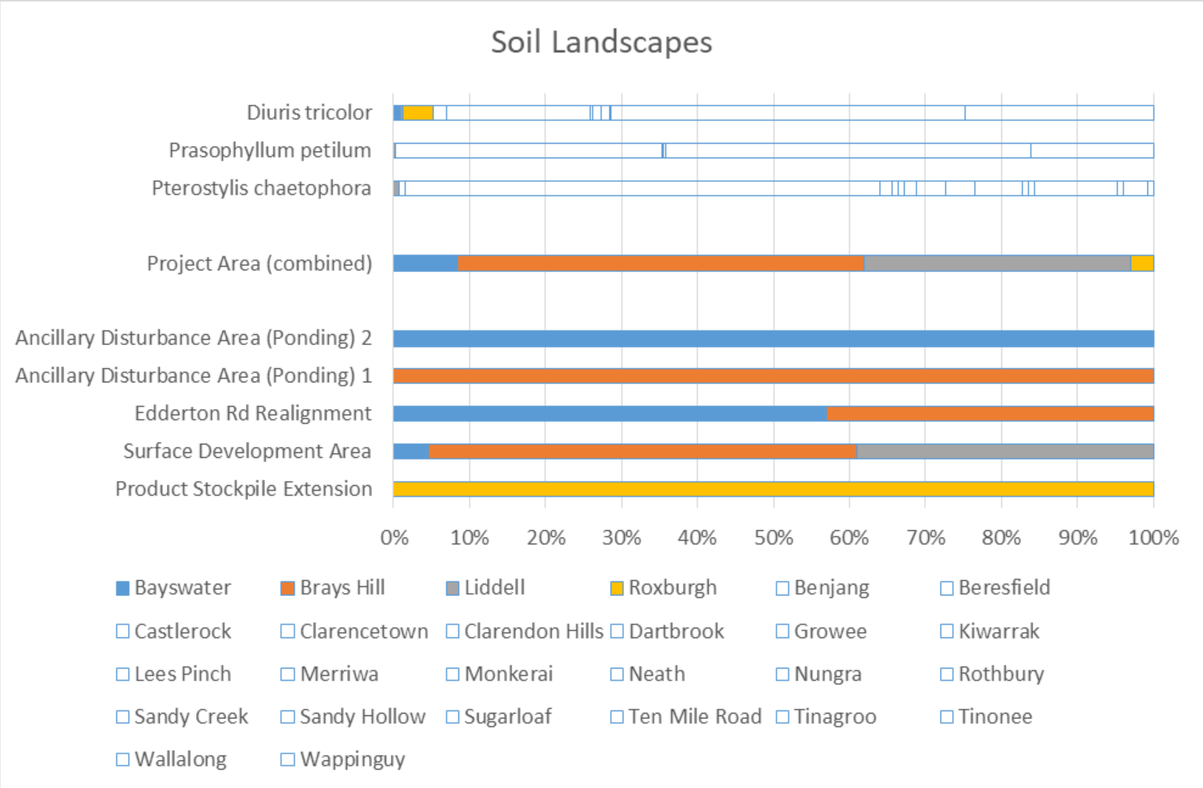

Annual Rainfall
Annual Rainfall (mm)
700 680 660 640 620 600 580 560 540 520 500
Mean
Product Stockpile Extension
Surface Development Area
Edderton Rd Realignment
Ancillary Disturbance Area (Ponding) 1
Ancillary Disturbance Area (Ponding) 2

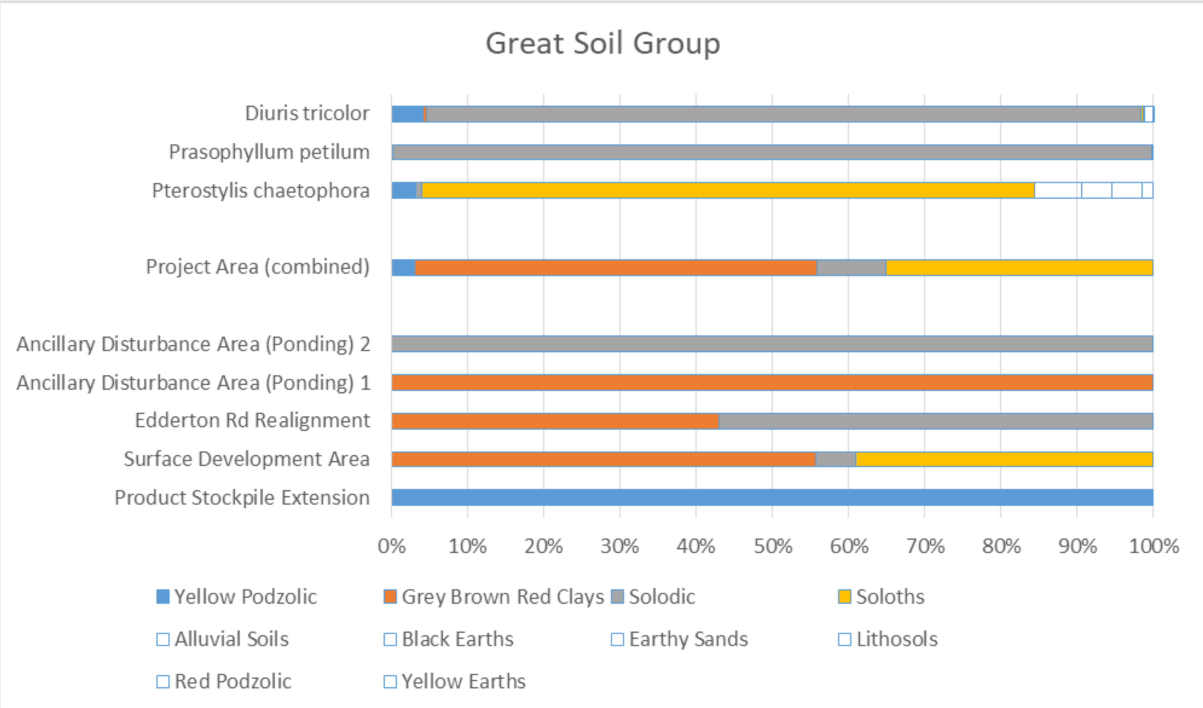

Mean Temperature
Mean Temperature (ºC)
20 19 18 17 16 15 14 13 12 11 10
Mean
Product Stockpile Extension
Surface Development Area
Edderton Rd Realignment
Ancillary Disturbance Area (Ponding) 1
Ancillary Disturbance Area (Ponding) 2

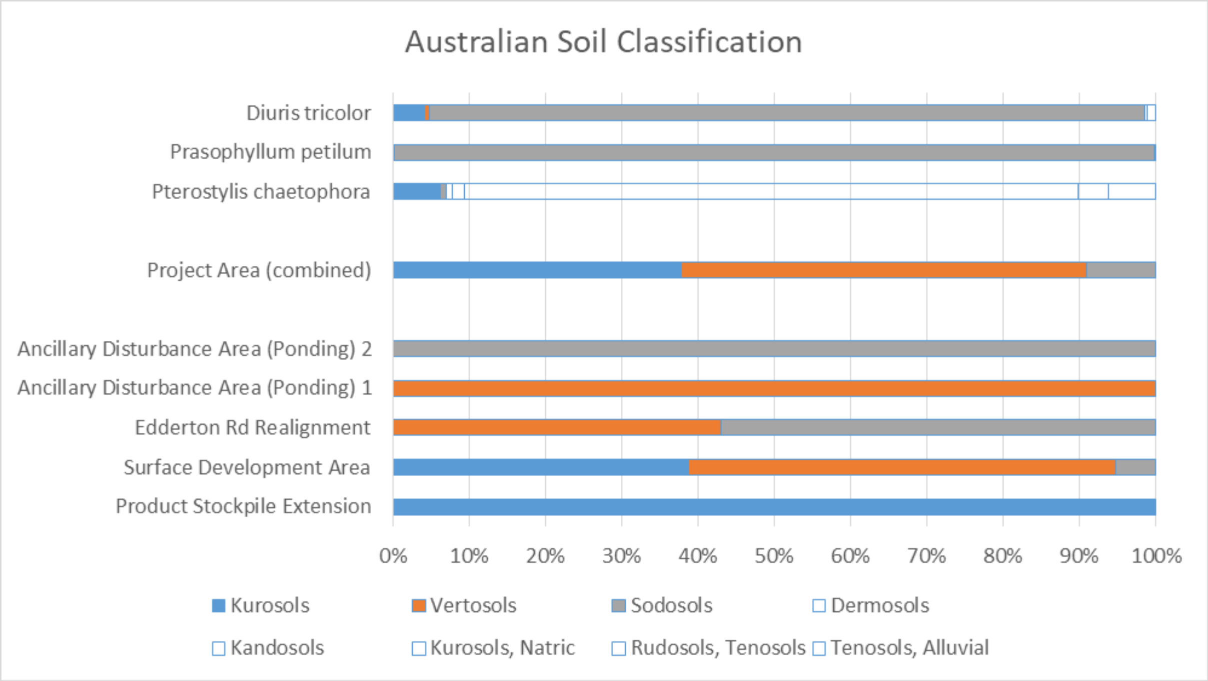
Appendix 4 – Biophysical Attributes of Orchid Locations

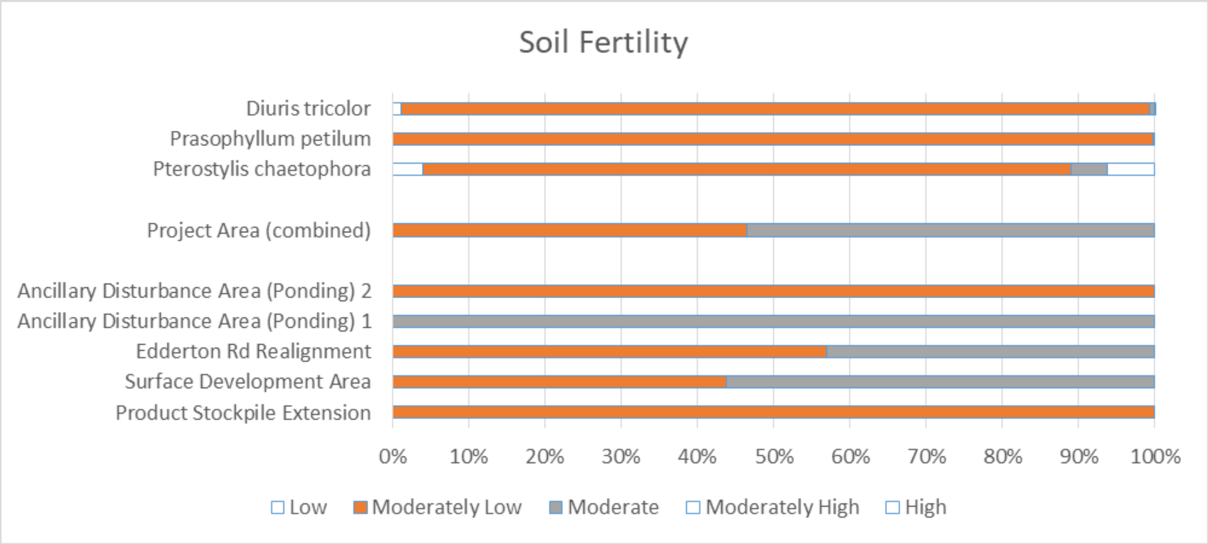


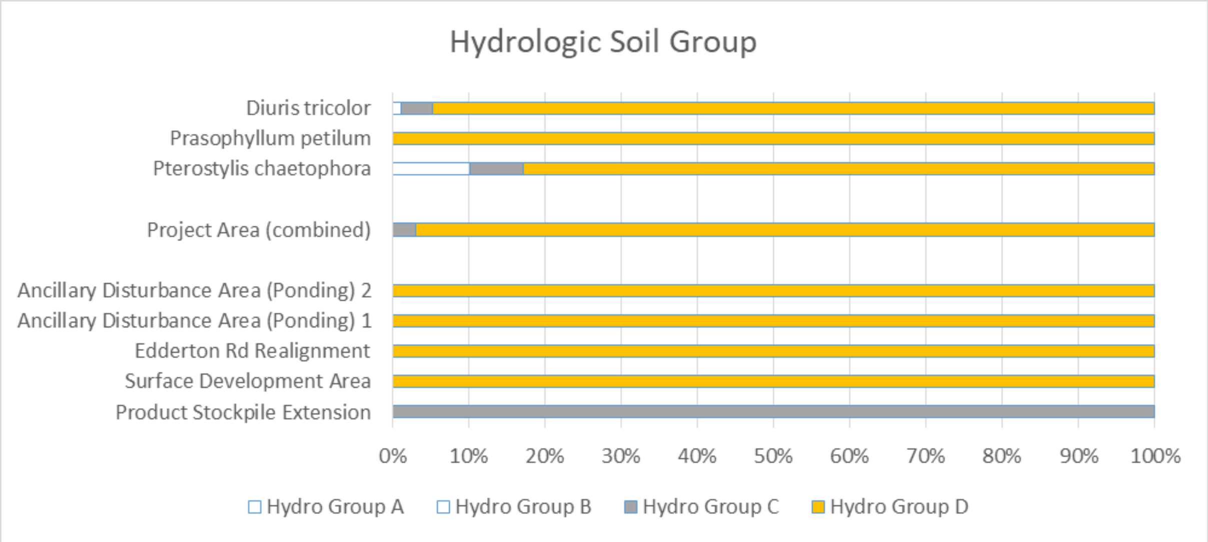


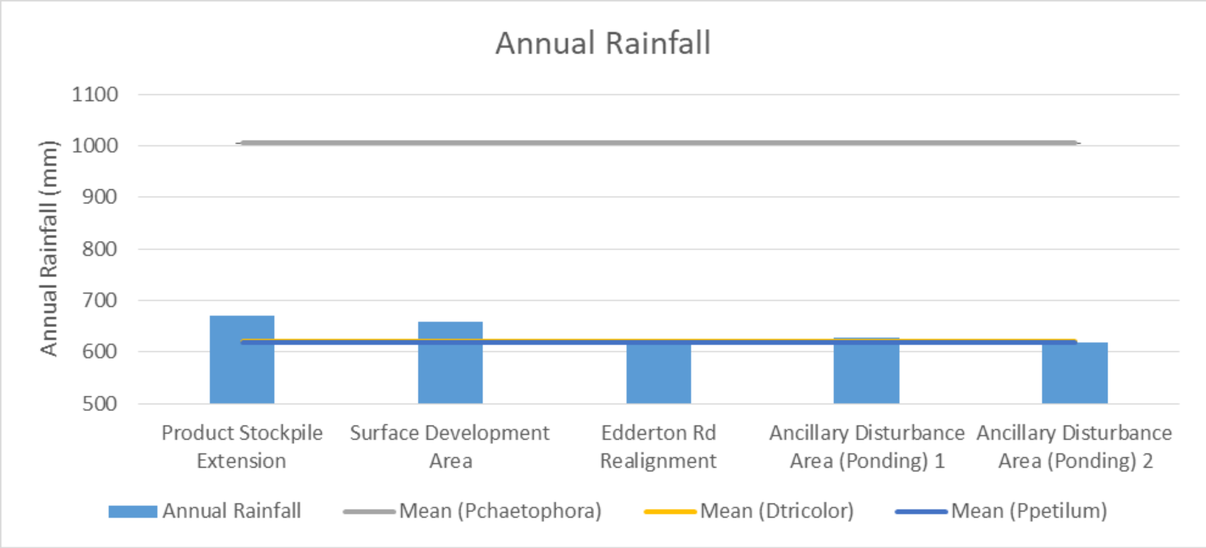

Soil Landscapes
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Bayswater
Brays Hill
Liddell
Roxburgh
Benjang
Beresfield
Castlerock
Clarencetown
Clarendon Hills
Dartbrook
Growee
Kiwarrak
Lees Pinch
Merriwa
Monkerai
Neath
Nungra
Rothbury
Sandy Creek
Sandy Hollow
Sugarloaf
Ten Mile Road
Tinagroo
Tinonee
Wallalong
Wappinguy

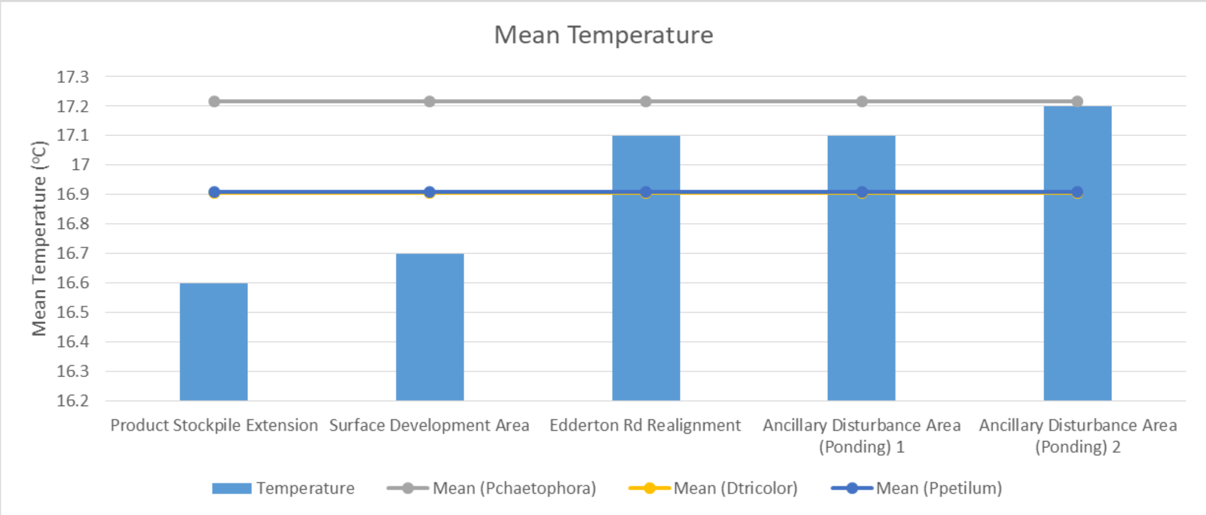

Great Soil Group
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Yellow Podzolic
Grey Brown Red Clays
Solodic
Soloths
Alluvial Soils
Black Earths
Earthy Sands
Lithosols
Red Podzolic
Yellow Earths


Australian Soil Classification
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Kurosols
Vertosols
Sodosols
Dermosols
Kandosols
Kurosols, Natric
Rudosols, Tenosols
Tenosols, Alluvial


Soil Fertility
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Low
Moderately Low
Moderate
Moderately High
High


Hydrologic Soil Group
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Ancillary Disturbance Area (Ponding) 2
Ancillary Disturbance Area (Ponding) 1
Edderton Rd Realignment
Surface Development Area
Product Stockpile Extension
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Hydro Group A
Hydro Group B
Hydro Group C
Hydro Group D


Annual Rainfall
Annual Rainfall (mm)
1100
1000
900
800
700
600
500
Product Stockpile Extension
Surface Development Area
Edderton Rd Realignment
Ancillary Disturbance Area (Ponding) 1
Ancillary Disturbance Area (Ponding) 2
Annual Rainfall
Mean (Pchaetophora)
Mean (Dtricolor)
Mean (Ppetilum)


Mean Temperature
Mean Temperature (ºC)
17.3
17.2
17.1
17
16.9
16.8
16.7
16.6
16.5
16.4
16.3
16.2
Product Stockpile Extension
Surface Development Area
Edderton Rd Realignment
Ancillary Disturbance Area (Ponding) 1
Ancillary Disturbance Area (Ponding) 2
Temperature
Mean (Pchaetophora)
Mean (Dtricolor)
Mean (Ppetilum)

Appendix 5 – Resume: Dr Stephen Bell

Principal — *Eastcoast Flora Survey*, PO Box 216 Kotara Fair NSW 2289

Telephone: (02) 4953 6523
Mobile: (0407) 284 240

e-mail: sajbell@bigpond.com

Profile: http://www.stephenbell.com.au/

Conjoint Fellow — *School of Environmental & Life Sciences, University of Newcastle*, Callaghan NSW 2308

e-mail: stephen.bell@newcastle.edu.au

Profiles: http://www.newcastle.edu.au/profile/stephen-bell
https://www.researchgate.net/profile/Stephen_Bell10

PRÉCIS

Stephen has been involved in native vegetation survey, classification and mapping in the Greater Sydney and Hunter Regions since 1990. During this time, he has undertaken comprehensive surveys for the National Parks and Wildlife Service in over 30 conservation reserves, and has been contracted to the NSW Office of Environment & Heritage (OEH) as Senior Botanist and Team Leader for several large scale regional projects within the Sydney Basin bioregion. Under contract to local Councils, Stephen has co-ordinated and completed LGA-wide vegetation classification and mapping projects for Wyong, Gosford, Cessnock, Pittwater and Lake Macquarie LGAs, and has assisted in similar mapping projects for Blue Mountains LGA. Stephen has also completed several studies on Threatened Ecological Communities and threatened plant species, and published the results of some of these in the scientific literature.

On behalf of the Ecological Society of Australia, Stephen was the ecological expert on the Hunter Regional Vegetation Committee (2003), and from 2017 represents that organization on the NSW Threatened Species Scientific Committee (administering the *Biodiversity Conservation Act 2016*). Stephen was also a past member of the Hunter Threatened Flora Recovery Team, a founding member of the Hunter Rare Plants Committee (a sub-committee of the Hunter Region Botanic Gardens), and since 2014 has been a member of the OEH Species Technical Group which oversees management and expenditure of threatened species throughout NSW via its *Saving our Species* initiative. He is also often called upon by Government for advice regarding the significance of vegetation communities and plant species within the northern Sydney Basin bioregion, and has sat on numerous expert panels in this regard. Stephen has been called upon as an Expert Witness for several cases heard in the NSW Land and Environment Court, where his knowledge on the vegetation of the Sydney Basin bioregion has been used to argue contentious land-use decisions.

Stephen has published several scientific papers on various aspects of the vegetation of the Sydney Basin, including classifications of vegetation within conservation reserves, threatened and rare plant species, and the description of new plant taxa. Stephen has completed over 4500 standard full floristic sampling plots within the Sydney Basin, which are stored and used in vegetation classification analyses. Other skills include extensive multivariate data analysis experience, and GIS mapping. Stephen's PhD thesis, completed on a part-time basis through the University of Newcastle, presented improvements in the recognition, identification and classification of restricted and significant vegetation communities, such as Threatened Ecological Communities (TECs).

In October 1996, Stephen established *Eastcoast Flora Survey*, a specialist botanical consultancy providing high quality services to government and the private sector. Since June 2014, Stephen has also been a Conjoint Fellow in the School of Environmental & Life Sciences at the University of Newcastle (NSW), seeking to raise the output of ecological research on plants and vegetation within the Hunter region.

ACADEMIC QUALIFICATIONS

Doctor of Philosophy (PhD), 2013	*Defining and mapping rare vegetation communities: Improving techniques to assist land-use planning and conservation* (University of Newcastle)
Bachelor of Science (Honours), 1991	*Effects of the weed Scotch Broom on bird communities in open forests on Barrington Tops* (University of Newcastle)
Bachelor of Science, 1989	*Majors in Geography and Biology* (University of Newcastle)

EMPLOYMENT HISTORY

University of Newcastle	Conjoint Fellow (Plant Sciences Group)	June 2014 - Present
Eastcoast Flora Survey	Consultant Botanist (Principal)	Oct. 1996 - Present
Ecotone Ecological Consultants Pty Ltd	Manager - Flora Studies	Jan. 1996 - Oct. 1996
Private Ecological Consultant	Sole trader	Jan. 1991 - Dec. 1995
NSW National Parks and Wildlife Service	Project Officer	Sept. 1993 - Jan. 1994
University of Newcastle, Geography Dept.	Field Tutor (Scientific)	July 1993 - Aug. 1993
NSW National Parks and Wildlife Service	Project Officer	Jan. 1993 - June 1993
University of NSW, School of Biol. Sciences	Research Assistant (Bird ecology)	Sept. 1992 - Jan. 1993
NSW National Parks and Wildlife Service	Technical Officer (Scientific)	Jan. 1992 - June 1992
RZ Mines (Newcastle)	Environmental Research Officer	Oct. 1990 - Dec. 1991
Wayne Perry & Associates P/L	Environmental Officer (Casual)	June 1990 - Oct. 1990

RESEARCH INTERESTS

- Vegetation classification and mapping, at local and regional scales
- Definition and mapping of rare and threatened vegetation communities
- Restoration of threatened grassy woodlands from derived grasslands
- Improving data sampling methods for monitoring and classification
- Re-constructing vegetation distribution using information from historical botanical explorers
- Population ecology and habitat of rare and threatened plants
- Taxonomy and significance of Hunter Region plants

MINISTERIAL APPOINTMENTS

- Committee Member (ESA Rep.), NSW Threatened Species Scientific Committee (July 2017-present)
- Committee Member, NSW Species Technical Group, Flora (*Save Our Species Program*) (2014-present)
- Committee Member (ESA Rep.), Hunter Regional Vegetation Committee (2001-2003)

CONFERENCE & WORKSHOP PRESENTATIONS

- Australian Plant Society (NSW) Annual Conference, August 2019, Newcastle: "*Endemic Plants of the Hunter Region: Trees and Larger Shrubs*".
- Best Practice Mine Rehabilitation Conference, September 2014, Singleton, NSW; The Tom Farrell Institute for the Environment, University of Newcastle: "*Effective Biodiversity Offsets: Improving planning, valuation and monitoring practice*" (with Martin Fallding).

- Plant Identification for Flora of the Hunter Valley, 7th - 8th April 2014, Kurri Kurri, Australian Network for Plant Conservation: "*Introduction to the flora of the Hunter Valley - history, diversity and ecology*".
- HOTSPOTS Fire Project: Awabakal and Worimi Fire Forum, 27th July 2011, Williamtown, Never Never Resources: "*Vegetation of the Worimi Conservation Lands*".
- HOTSPOTS Fire Project: Wanaruah Fire Forum, 17th – 19th August 2010, Sandy Hollow, Upper Hunter Valley, Nature Conservation Council: "*Vegetation of Wanaruah Lands, Sandy Hollow*".
- Coastal Groundwater Dependent Ecosystems Workshop, 3rd – 4th September 2009, South West Rocks, NSW (Geoscience Australia): "*Surveying, classifying and mapping vegetation on the Tomago Sandbeds*".
- Vegetation Management and Biodiversity Conservation in the Hunter Region, May 2000, Singleton, NSW (Hunter Environment Lobby Inc.): "*An evaluation of vegetation survey and threatened plant species listings in the Hunter Region*"

PROFESSIONAL MEMBERSHIPS

- Ecological Society of Australia (ESA)
- Australian Network for Plant Conservation Inc. (ANPC)
- International Association for Vegetation Science (IAVS)
- International Association for Vegetation Science Vegetation Classification Working Group (IAVS VCWG)
- Australasian Systematic Botany Society (ASBS)

PUBLICATION REVIEWER

- *Diversity* (MDPI, Switzerland)
- *Forests* (MDPI, Switzerland)
- *International Journal of Environmental Research and Public Health* (MDPI, Switzerland)
- *Journal of Vegetation Science* (International Association for Vegetation Science)
- *Pacific Conservation Biology* (CSIRO Publishing)
- *Resources* (MDPI, Switzerland)
- *Sustainability* (MDPI, Switzerland)
- *Telopea* (National Herbarium of New South Wales)
- *Vegetation Classification and Survey* (International Association for Vegetation Science)

BOARD MEMBERSHIPS

- 2019 - *Vegetation Classification and Survey* (Editorial Board)
- 2019 - *Sustainability* (Review Board)
- 2019 – *Australian Network for Plant Conservation* (Committee Member)

ACCREDITED BAM SPECIES EXPERT (NSW DPIE)

- *Cryptostylis hunteriana* (Orchidaceae)
- *Diuris praecox* (Orchidaceae)
- *Diuris tricolor* (Orchidaceae)
- *Hibbertia procumbens* (Dilleniaceae)
- *Prasophyllum petilum* (Orchidaceae)
- *Prostanthera junonis* (Lamiaceae)
- *Pterostylis chaetophora* (Orchidaceae)
- *Thelymitra adorata* (Orchidaceae)

PUBLICATIONS (PEER REVIEWED)

Bell, S.A.J. (submitted) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (submitted)

Bell, S.A.J. (submitted) Successful recruitment following translocation of a threatened terrestrial orchid (*Diuris tricolor*) into mining rehabilitation in the Hunter Valley of NSW. *Ecological Management and Restoration* (submitted)

Bell, S.A.J. (in prep) A strategy for assessing population size in threatened plant surveys using a classification of detectability based on key life-form traits, seasonality and disturbance response. *Diversity* (in prep)

Bell, S.A.J. & Hillier, P. (2020) Targeted surveys of a poorly conserved threatened orchid (*Pterostylis chaetophora*) in Columbey National Park (Hunter Valley, NSW) reveal substantial populations and identify occupied habitat. *Cunninghamia* 20: 199-207.

Bell, S.A.J. & Nicolle, D. (2020) Glen Gallic Mallee (*Eucalyptus dealbata* subsp. *aperticola*, Myrtaceae), a new taxon from the sandstone escarpment of the Hunter Valley, New South Wales. *Telopea* 23: 141-150.

Bell, S.A.J. & Driscoll, C. (2020) Data-informed Sampling and Mapping: A new approach to ensure plot-based classifications locate, classify and map rare and restricted vegetation types. *Australian Journal of Botany* doi: 10.1071/bt20024

Mickaill, L., Bell, S., & Beranek, C. (2020) Dispersal potential in two restricted and five wide-ranging *Senecio* (Asteraceae) taxa from central eastern New South Wales, Australia. *Australian Journal of Botany* 68: 333-344.

Bell, S.A.J. (2020) Translocation of threatened terrestrial orchids into non-mined and post-mined lands in the upper Hunter Valley of New South Wales, Australia. *Restoration Ecology* 28: 1396-1407.

Yare, B., Bell, S., & Hunter, N. (2020) Phenology of the threatened *Diuris praecox* (Orchidaceae), a range-restricted terrestrial orchid from central eastern New South Wales. *Cunninghamia* 20:105-113.

Bell, S.A.J. & Klaphake, V. (2020) *Eucalyptus calidissima* (Myrtaceae), a new ironbark species from the Hunter Valley of New South Wales, Australia. *Telopea* 23: 73-87.

Fensham, R., Laffineur, B., Collingwood, T., Beech, E., Bell, S., Hopper, S., Phillips, G., Rivers, M., Walsh, N. & White, M. (2020) Rarity or decline: Key concepts for the Red List of Australian eucalypts. *Biological Conservation* 243 108455

Bell, S.A.J. (2019) Additions and amendments to the rare or threatened vascular plants of Wollemi National Park, central eastern New South Wales. *Cunninghamia* 19: 43-56.

Bell, S.A.J. (2019) *Macrozamia flexuosa* C. Moore (Zamiaceae): a review of distribution, habitat and conservation status of this endemic cycad from the Hunter Region of New South Wales. *Cunninghamia* 19: 7-27.

Bell, S., Rockley, C., & Llewellyn, A. (2019) *Flora of the Hunter Region: Endemic Trees and Larger Shrubs*. CSIRO Publishing. 136 pp. ISBN: 9781486311026

DeLacey, C., Bell, S., Chamberlain, S., & Bossard, K. (in review) Prediction of and realised habitat for a cryptic plant species: the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls. *Cunninghamia* (in review)

Bell, S.A.J. (2018) Fate of a rare flowering event in a population of the endangered *Acacia pendula* (Weeping Myall) from the Hunter Valley of New South Wales. *Cunninghamia* 18: 79-88.

Bell, S.A.J. & Driscoll, C. (2017) *Acacia wollarensis* (Fabaceae, Mimosoideae sect. Botrycephalae), a distinctive new species endemic to the Hunter Valley of New South Wales, Australia. *Telopea* 20: 125-136.

Bell, S.A.J. & Driscoll, C. (2016) Hunter Valley Weeping Myall Woodland – is it really definable and defendable with and without Weeping Myall (*Acacia pendula*)? *Cunninghamia* 16: 15-30.

Bell, S.A.J. & Walsh, N. (2015) *Leionema lamprophyllum* subsp. *fractum* (Rutaceae); a new and highly restricted taxon from the Hunter Valley of New South Wales. *Telopea* 18: 505-512.

Bell, S.A.J. & Driscoll, C. (2014) *Acacia pendula* (Weeping Myall) in the Hunter Valley of New South Wales: early explorers' journals, database records and habitat assessments raise doubts over naturally occurring populations. *Cunninghamia* 14: 179-200.

Bell, S.A.J. & Nicolle, D. (2012) *Eucalyptus expressa* (Myrtaceae): a new and distinctive species from the sandstone ranges north-west of Sydney, New South Wales. *Telopea* 14: 69-76.

Bell, S.A.J. & Stables, M. (2012) Floristic variability, distribution and an extension of range for the endangered Pittwater Spotted Gum Forest, Central Coast, New South Wales. *Cunninghamia* 12(2): 143-152.

Bell, S.A.J. (2009) Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales. *Cunninghamia* 11(2): 241-275.

Bell, S.A.J. (2008) Rare or threatened vascular plant species of Wollemi National Park, central eastern New South Wales. *Cunninghamia* 10(3): 331-371.

Bell, S., Branwhite, B., & Driscoll, C. (2005) *Thelymitra 'adorata'* (Orchidaceae): population size and habitat of a highly restricted terrestrial orchid from the Central Coast of New South Wales. *The Orchadian* 15(1): 6-10.

Bell, S.A.J. (2004) Distribution and habitat of the vulnerable tree species, *Angophora inopina* (Myrtaceae), on the Central Coast of New South Wales. *Cunninghamia* 8(4): 477-484.

Bell, S.A.J. (2004) Vegetation of Werakata National Park, Hunter Valley, New South Wales. *Cunninghamia* 8(3): 331-347.

Bell, S.A.J. & Copeland, L.M. (2004) *Commersonia rosea* (Malvaceae *s.l.*: Lasiopetaleae): a new, rare fire-ephemeral species from the upper Hunter Valley, New South Wales. *Telopea* 10(2): 581-587.

Bell, S.A.J. (2002) Habitat of the endangered *Hibbertia procumbens* (Labill.) DC (Dilleniaceae) from the Central Coast of New South Wales. *Victorian Naturalist* 119(2): 69-74.

Bell, S.A.J. (2001) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* Nicholls (Orchidaceae) from the Central Coast of New South Wales. *Cunninghamia* 7(2): 195-204.

Bell, S.A.J. (2001). Notes on the distribution and conservation status of some restricted plant species from sandstone environments of the upper Hunter Valley, New South Wales. *Cunninghamia* 7(1): 77-88.

Bell, S. (2000) An evaluation of vegetation survey and threatened plant species listings in the Hunter Region. Pp. 19-34 IN *Vegetation Management and Biodiversity Conservation in the Hunter Region - Where to from here?* Ed. by M.Fallding. Proceedings of the Public Workshop. Hunter Environment Lobby. Singleton, 12 May 2000.

PUBLICATIONS (OTHERS)

Bell, S. (in prep) Voucher specimens vs observation records: why 'collecting' is better than 'observing' for plant conservation. *Australasian Plant Conservation* (in prep)

Bell, S. (2020) Check those IDs… the importance of confirming threatened plant identifications before implementing management. *Australasian Plant Conservation* 28: 18-20.

Bell, S. (2019) Translocation 'success' is all about detection: experiences with two threatened orchids from the Hunter Valley of NSW. *Australasian Plant Conservation* 28: 27-31.

Bell, S. (2018) The responsibilities of ecological consultants in disseminating outcomes from threatened species surveys. *Australasian Plant Conservation* 27: 3-6.

Bell, S. & Sims, R. (2018) Extensive populations of *Dracophyllum macranthum* (Ericaceae) in Coorabakh NP suggest a review of threat status. *Australasian Plant Conservation* 27: 11-14.

Bell S.A.J. & Kodela P.G. (2018) *Acacia wollarensis*. In: *Flora of Australia*. Australian Biological Resources Study, Department of the Environment and Energy, Canberra. https://profiles.ala.org.au/opus/foa/profile/Acacia%20wollarensis

Bell, S. (2017) New insights into the ecology of the critically endangered *Banksia conferta* (Proteaceae) from the mid-north coast of NSW. *Australasian Plant Conservation* 26(1): 15-18.

Bell, S. & Holzinger, B. (2015) Wildfire reveals new populations of the endangered *Commersonia rosea* and *Monotaxis macrophylla* in northern Wollemi National Park, NSW. *Australasian Plant Conservation* 23: 2-4.

Bell, S. & Elliott, M. (2013) Preliminary results suggest fire is required to maintain *Acacia dangarensis*, a threatened single-population endemic from the Hunter Valley of NSW. *Australasian Plant Conservation* 22(1): 9-10.

de Lacey, C, Bell, S, Chamberlain, S. & Bossard, K. (2013) Finding the leafless tongue orchid *'Cryptostylis hunteriana'* Nicholls. *Nature New South Wales* Vol. 57 (1) Autumn 2013: 24-25. [online]

de Lacey, C., Bell, S., & Chamberlain, S. (2012) Habitat of the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls throughout its known Australian distribution. *Australasian Plant Conservation* 20(4): 23-25.

de Lacey, C., Bell, S., Chamberlain, S., & Bossard, K. (2012) Habitat of the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls throughout its known Australian distribution. *The Orchadian* 17(4): 162-174.

Bell, S.A.J. (2010) Defining and mapping an endangered ecological community within Lake Macquarie Local Government Area, New South Wales. *Australasian Plant Conservation* 18(3): 18-19.

Bell, S., Peake, T. & Driscoll, C. (2007) Dealing with taxonomic uncertainty in Weeping Myall *Acacia pendula* from the Hunter catchment, New South Wales. *Australasian Plant Conservation*. 16(1): 14-15.

Bell, S. & Driscoll, C. (2005) New records of the endangered *Hibbertia procumbens* from the Central Coast of NSW. *Australasian Plant Conservation* 13(4): 24-25.

Bell, S.A.J., Parsons, J., & Meldrum, R. (2005) Towards the protection and management of hanging swamps on the Somersby Plateau, Central Coast, New South Wales. *Australasian Plant Conservation* 13(3): 10-11.

Bell, S. (2003) Another new and highly restricted mallee from the Hunter Valley, *Eucalyptus castrensis*. *Hunter Flora* 11: 2.

Peake, T., Bell, S., Tame, T., Simpson, J., & Curran, T. (2003) *The Hunter Rare Plants Database: Identification and listing of regionally significant flora for the Hunter Region, New South Wales*. Poster Presentation at the Ecological Society of Australia Annual Conference 2003, Armidale NSW.

Peake, T., Bell, S., Tame, T., Simpson, J., & Curran, T. (2002) *Warkworth Sands Woodland – An Endangered Ecological Community: Distribution, Ecological Significance and Conservation Status*. Hunter Region Botanic Gardens Technical Paper [www.huntergardens.org.au/]

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Appendix 6 – Endorsement: Dr Lachlan Copeland

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5th April, 2018

Reference for orchid expertise of Dr Stephen Bell

To whom it may concern

This letter serves to introduce Dr Stephen Bell of Eastcoast Flora Survey as worthy to fill the role of 'expert' for matters concerning the threatened terrestrial orchids *Diuris tricolor* and *Prasophyllum petilum*. I myself have an extensive knowledge of the orchid flora of New South Wales, Victoria and Queensland gained over several decades of field survey. With Gary Backhouse, Robert Bates and Andrew Brown, I have co-authored the "Checklist of the Orchids of Australia including its Island Territories". In separate publications I have also described 15 new orchid species. I am personally very familiar with *Diuris tricolor* and *Prasophyllum petilum* from throughout their known distributional ranges, and have worked with Stephen on these two species previously.

Stephen has a wealth of experience and professional ability in botany and threatened species management, having worked in the consultancy field since the mid 1990's. In 1996, he established Eastcoast Flora Survey, a small consultancy focusing on vegetation surveys, classification, mapping and threatened species research and management. Over a 20 year period, Stephen has shown himself to be dedicated to presenting an accurate portrayal of the distribution and abundance of native plant species, particularly threatened plant species and ecological communities. He has researched a number of threatened plant species, including several orchids, and has published regularly in the scientific literature on these. In the past, I have personally approached Stephen on numerous occasions to discuss the distribution, abundance and threats of a wide variety of threatened plant species including several orchid taxa.

I first worked with Stephen on surveys for *Diuris* and *Prasophyllum* in the upper Hunter Valley in 2009, and since that time I am aware that he has undertaken annual surveys for these species across a number of offset and development sites, including overseeing and conducting a large translocation program at one mine site requiring detailed monitoring of individual plants, and the monitoring of natural populations elsewhere. Over a nine year period of surveying and monitoring for these species, Stephen is clearly highly regarded as an expert for these taxa in the Hunter Valley. I believe that Stephen would have personally seen more individuals of these two species and know their ecology more intimately than anyone else.

Given the experience detailed above, I have no hesitation in recommending Stephen as an expert in any matters concerning *Diuris tricolor* and *Prasophyllum petilum*, particularly with regard to habitats and status within the Hunter Valley of NSW.

Yours sincerely

Lachlan Copeland

Dr Lachlan Copeland
Senior Botanist,
Eco Logical Australia

ATTACHMENT D
VEGETATION INTEGRITY (SITE CONDITION) DATA

Table D-1

Plot	pct	Area	patchsize	conditionclass	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
210928 P1	1606	1.3	101	Woodland	56	298707	6412132	145	5	5	11	17	0	2	95	0.5	26.1	3.6	0	0.2	1	2	58	44	1	1	1	0	0	1	0.2
210928 P2	1606	2.6	101	Derived_native_grass	56	297529	6412683	67	0	1	5	11	1	2	0	0.1	85.2	75.9	0.1	0.2	0	0	50	0	0	0	0	0	0	0	0.1
210928 P5	1606	2.6	101	Derived_native_grass	56	297351	6412586	327	0	0	1	4	0	1	0	0	75	0.5	0	0.1	0	0	50	0	0	0	0	0	0	0	0.2
210928 P8	1693	2.5	101	Derived_native_grass	56	298064	6412203	135	0	0	5	5	1	0	0	0	40.2	0.6	0.2	0	0	0	50	0	0	0	0	0	0	0	0
210928 P9	1693	2.5	101	Derived_native_grass	56	298362	6412177	120	0	0	5	4	1	0	0	0	80	5.3	0.1	0	0	0	50	0	0	0	0	0	0	0	0
220524 P1	1691	1.7	101	Derived_native_grass	56	297621	6412272	290	0	1	11	11	0	3	0	0.1	110.6	1.3	0	0.3	0	0	72	0	0	0	0	0	0	0	0.4
220524 P2	1691	1.2	101	Woodland	56	297913	6412180	256	5	2	14	8	0	1	85.3	0.2	56.2	0.9	0	0.1	0	0	94	5.5	1	1	1	0	0	1	10.2
220524 P3	1692	0.6	101	Woodland	56	298869	6412059	72	2	5	15	11	1	1	80.1	0.5	27.9	1.1	0.1	0.1	0	0	45	9	1	1	1	1	0	1	0.2
220527 P1	201	1	101	Derived_native_grass	56	294453	6410675	80	0	0	5	5	0	0	0	0	75.2	0.5	0	0	0	0	36	0	0	0	0	0	0	0	20
220527 P2	201	0.2	101	Woodland	56	295447	6410799	310	2	2	15	8	1	0	80.1	0.2	31.5	0.9	0.2	0	1	0	26	38	1	1	0	1	1	1	0.9
220527 P3	1655	1.7	101	Derived_native_grass	56	295619	6410466	107	0	1	8	3	0	0	0	0.1	90.5	0.4	0	0	0	0	22	0	0	0	0	0	0	0	0.2
220527 P4	1655	0.5	101	Woodland	56	295678	6410140	30	1	1	12	6	1	0	5	0.1	60.8	0.7	0.1	0	0	0	20	0	0	0	0	0	0	0	5.2

ATTACHMENT E
THREATENED FLORA AND FAUNA SPECIES KNOWN OR PREDICTED TO OCCUR IN THE LOCALITY

Table E-1
Threatened Flora and Fauna Species Known or Predicted to occur in the Locality

Common Name	Scientific Name	Conservation Status			Potentially Associated with PCTs in the Development Footprint[4]	Database Records			Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]		EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Flora									
White-flowered Wax Plant	*Cynanchum elegans*	E	E	S	Yes	Predicted	-	-	-
-	*Ozothamnus tesselatus*	V	V	S	Yes	-	-	Yes	-
Large-leafed Monotaxis	*Monotaxis macrophylla*	-	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	-	-	-
Slaty Red Gum	*Eucalyptus glaucina*	V	V	S	Yes	Predicted	Yes	-	-
Narrow-leaved Black Peppermint	*Eucalyptus nicholii*	V	V	S	-	-	Yes	-	-
-	*Euphrasia arguta*	CE	CE	S	-	Predicted	-	-	-
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
Tarengo Leek Orchid	*Prasophyllum petilum*	E	E	S	Yes	-	Yes	-	-
-	*Prasophyllum* sp. Wybong	CE	-	S	Yes	Predicted	-	-	-
Singleton Mint Bush	*Prostanthera cineolifera*	V	V	S	Yes	-	-	-	-

Common Name	Scientific Name	Conservation Status			Potentially Associated with PCTs in the Development Footprint[4]	Database Records			Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]		EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Wollemi Mint-bush	*Prostanthera cryptandroides subsp. cryptandroides*	V	V	S	Yes	Predicted	-	-	-
-	*Pterostylis chaetophora*	-	V	S	Yes	-	-	-	-
Illawarra Greenhood	*Pterostylis gibbosa*	E	E	S	-	Predicted	-	-	-
Bodalla Pomaderris	*Pomaderris bodalla*	-	V	S	Yes	-	-	-	-
Rufous Pomaderris	*Pomaderris brunnea*	V	E	S	-	Predicted	-	-	-
Scant Pomaderris	*Pomaderris queenslandica*	-	E	S	Yes	-	-	-	-
Denman Pomaderris	*Pomaderris reperta*	CE	CE	S	Yes	-	-	-	-
Austral Toadflax	*Thesium australe*	V	V	S	Yes	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	Yes	-	Yes	-	M
Striped Legless Lizard	*Delma impar*	V	V	S	Yes	-	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	Yes	-
Grey Falcon	*Falco hypoleucos*	-	E	E	-	Predicted	-	-	-
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
Spotted Harrier	*Circus assimilis*	-	V	E	Yes	-	Yes	Yes	A, M

Common Name	Scientific Name	Conservation Status			Potentially Associated with PCTs in the Development Footprint[4]	Database Records			Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]		EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Red Goshawk	*Erythrotriorchis radiatus*	V	CE	S	-	Predicted	-	-	-
Little Eagle	*Hieraaetus morphnoides*	-	V	S/E	Yes	-	Yes	Yes	A, I
White-throated Needletail	*Hirundapus caudacutus*	V	-	E	Yes	Predicted	Yes	-	-
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	-	Yes	-	M
Gang-gang Cockatoo	*Callocephalon fimbriatum*	E	V	S/E	Yes	Predicted	-	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	Yes	-	-M
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	-	V	E	Yes	-	Yes	-	-

Common Name	Scientific Name	Conservation Status			Potentially Associated with PCTs in the Development Footprint[4]	Database Records			Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]		EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Flame Robin	*Petroica phoenicea*	-	V	E	Yes	-	Yes	Yes	M
Scarlet Robin	*Petroica boodang*	-	V	E	Yes	-	Yes	-	A, M
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	Yes	Predicted	Yes	-	-
Eastern Pygmy-possum	*Cercartetus nanus*	-	V	S	Yes	-	-	-	-
Yellow-bellied Glider	*Petaurus australis australis*	V	V	E	Yes	Predicted	-	-	-
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 Coastal Free-tailed Bat	*Micronomus 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

Common Name	Scientific Name	Conservation Status			Potentially Associated with PCTs in the Development Footprint[4]	Database Records			Recorded in Previous Studies and/or Recent Surveys[8]
		EPBC Act[1]	BC Act[2]	Credit Class[3]		EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Large Bentwing-bat	*Miniopterus orianae 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
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 locality.
[1] Conservation status under the EPBC Act (current as at June 2022). V = Vulnerable; E = Endangered; CE = Critically Endangered; MA = Migratory.
[2] Conservation status under the BC Act (current as at June 2022). V = Vulnerable; E = Endangered; CE = Critically Endangered.
[3] Biodiversity credit class under the TBDC (DPE 2022a) (current as at June 2022). E = Ecosystem; S = Species.
[4] DPE (2022a).
[5] DAWE (2022).
[6] DPE (2022c).
[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).
M = Future Ecology (2019) (Attachment A).
* 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*.

ATTACHMENT F1
BAM BIODIVERSITY CREDIT REPORT

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00028736/BAAS17004/21/00028737	Malabar Coal Maxwell Underground MOD2 vent shaft	16/06/2022
Assessor Name	Report Created	BAM Data version *
Colin Driscoll	30/06/2022	54
Assessor Number	BAM Case Status	Date Finalised
BAAS17004	Finalised	30/06/2022
Assessment Revision	Assessment Type	
1	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.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits

Bull Oak grassy woodland of the central Hunter Valley											
7	1692_Woodland	Not a TEC	58.7	58.7	0.6	PCT Cleared - 53%	High Sensitivity to Gain			1.75		15
											Subtotal	**15**
Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion											
1	201_Woodland	Not a TEC	74.8	74.8	0.2	PCT Cleared - 94%	High Sensitivity to Gain			2.50		9
2	201_Derived_native_grass	Not a TEC	28.4	28.4	1	PCT Cleared - 94%	High Sensitivity to Gain			2.50		18
											Subtotal	**27**
Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin											
3	1655_Woodland	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	19.5	19.5	0.5	PCT Cleared - 36%	High Sensitivity to Gain	Vulnerable Ecological Community	Critically Endangered	1.75		4
4	1655_Derived_native_grass	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	11.5	11.5	1.7	PCT Cleared - 36%	High Sensitivity to Gain	Vulnerable Ecological Community	Critically Endangered	1.75		0

										Subtotal	**4**
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter											
5	1691_Woodland	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	59	59.0	1.2	PCT Cleared - 77%	High Sensitivity to Gain	Endangered Ecological Community	Critically Endangered	2.00		35
6	1691_Derived_native_grass	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	34	34.0	1.7	PCT Cleared - 77%	High Sensitivity to Gain	Endangered Ecological Community	Critically Endangered	2.00		29
											Subtotal	**64**

White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
8	1606_Woodland	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	69.4	69.4	1.3	PCT Cleared - 29%	High Sensitivity to Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	True	56

9	1606_Derived_native_grass	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	22.2	22.2	2.6	PCT Cleared - 29%	High Sensitivity to Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	True	36
											Subtotal	**92**
Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains												
10	1693_Derived_native_grass	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	29	29.0	2.5	Environment Protection and Conservation Act listing status	High Sensitivity to Gain	Not Listed	Critically Endangered	2.50		45
											Subtotal	**45**
											Total	**247**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Cryptostylis hunteriana / Leafless Tongue Orchid (Flora)									
1655_Woodland	19.5	19.5	0.5			Vulnerable	Vulnerable	False	4
1655_Derived_native_grass	11.5	11.5	1.7			Vulnerable	Vulnerable	False	7
								Subtotal	**11**
Delma impar / Striped Legless Lizard (Fauna)									
1655_Woodland	19.5	19.5	0.5			Vulnerable	Vulnerable	False	4
1655_Derived_native_grass	11.5	11.5	1.7			Vulnerable	Vulnerable	False	7
1691_Woodland	59.0	59.0	1.2			Vulnerable	Vulnerable	False	27
1691_Derived_native_grass	34.0	34.0	1.7			Vulnerable	Vulnerable	False	22
1692_Woodland	58.7	58.7	0.6			Vulnerable	Vulnerable	False	13
1606_Woodland	69.4	69.4	1.3			Vulnerable	Vulnerable	False	34
1606_Derived_native_grass	22.2	22.2	2.6			Vulnerable	Vulnerable	False	22
1693_Derived_native_grass	29.0	29.0	2.5			Vulnerable	Vulnerable	False	27
								Subtotal	**156**
Diuris tricolor / Pine Donkey Orchid (Flora)									
201_Woodland	74.8	74.8	0.2			Vulnerable	Not Listed	False	6

201_Derived_native_grass	28.4	28.4	1			Vulnerable	Not Listed	False	11
								Subtotal	**17**
Myotis macropus / Southern Myotis (Fauna)									
1691_Woodland	59.0	59.0	0.3			Vulnerable	Not Listed	False	9
								Subtotal	**9**
Petaurus norfolcensis / Squirrel Glider (Fauna)									
1606_Derived_native_grass	22.2	22.2	1.1			Vulnerable	Not Listed	False	12
201_Derived_native_grass	28.4	28.4	0.3			Vulnerable	Not Listed	False	4
1655_Derived_native_grass	11.5	11.5	0.4			Vulnerable	Not Listed	False	2
201_Woodland	74.8	74.8	0.2			Vulnerable	Not Listed	False	7
1655_Woodland	19.5	19.5	0.5			Vulnerable	Not Listed	False	5
1606_Woodland	69.4	69.4	1.3			Vulnerable	Not Listed	False	45
								Subtotal	**75**
Prasophyllum petilum / Tarengo Leek Orchid (Flora)									
201_Woodland	74.8	74.8	0.2			Endangered	Endangered	False	7
201_Derived_native_grass	28.4	28.4	1			Endangered	Endangered	False	14
								Subtotal	**21**
Thesium australe / Austral Toadflax (Flora)									
1655_Derived_native_grass	11.5	11.5	1.7			Vulnerable	Vulnerable	False	7

1606_Derived_native_grass	22.2	22.2	0.1			Vulnerable	Vulnerable	False	1
								Subtotal	**8**

ATTACHMENT F2
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE)

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00028736/BAAS17004/21/00028737	Malabar Coal Maxwell Underground MOD2 vent shaft	16/06/2022
Assessor Name	Assessor Number	BAM Data version *
Colin Driscoll	BAAS17004	54
Proponent Names	Report Created	BAM Case Status
	30/06/2022	Finalised
Assessment Revision	Assessment Type	Date Finalised
1	Major Projects	30/06/2022

* 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 Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	Critically Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species

Nil

Additional Information for Approval

PCT Outside Ibra Added

PCT
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
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	HBT Cr	No HBT Cr	Total credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.2	0	27	27
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	2.2	0	4	4
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	2.9	0	64	64
1692-Bull Oak grassy woodland of the central Hunter Valley	Not a TEC	0.6	0	15	15
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 Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	3.9	56	36	92
1693-Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	2.5	0	45	45

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	Zone	HBT	Credits	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%	201_Woodland	No	9	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.
	Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands >=90%	201_Derived_native_grass	No	18	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	Zone	HBT	Credits	IBRA region
	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and	-	1606_Woodland	Yes	56	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and

	Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla This includes PCT's: 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 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,					Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	1401, 1512, 1606, 1608, 1611, 1691, 1693, 1695, 1698					
	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla This includes PCT's: 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654,	-	1606_Derived_native_grass	No	36	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.

	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, 1606, 1608, 1611, 1691, 1693, 1695, 1698					
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion This includes PCT's: 1176, 1655	-	1655_Woodland	No	4	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.

	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion This includes PCT's: 1176, 1655	-	1655_Derived_native_grass	No	0	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	Zone	HBT	Credits	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	-	1691_Woodland	No	35	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.

	Class	Trading group	Zone	HBT	Credits	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	-	1691_Derived_native_grass	No	29	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	Zone	HBT	Credits	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% and <70%	1692_Woodland	No	15	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						
1693-Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland This includes PCT's: 74, 75, 83, 101, 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 508, 509, 510, 511, 516, 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, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1606, 1608, 1611, 1693, 1695, 1698	-	1693_Derived_native_grass	No	45	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.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Cryptostylis hunteriana / Leafless Tongue Orchid	**1655_Woodland, 1655_Derived_native_grass**	2.2	11.00
Delma impar / Striped Legless Lizard	**1655_Woodland, 1655_Derived_native_grass, 1691_Woodland, 1691_Derived_native_grass, 1692_Woodland, 1606_Woodland, 1606_Derived_native_grass, 1693_Derived_native_grass**	12.1	156.00
Diuris tricolor / Pine Donkey Orchid	**201_Woodland, 201_Derived_native_grass**	1.2	17.00
Myotis macropus / Southern Myotis	**1691_Woodland**	0.3	9.00
Petaurus norfolcensis / Squirrel Glider	**1606_Derived_native_grass, 201_Derived_native_grass, 1655_Derived_native_grass, 201_Woodland, 1655_Woodland, 1606_Woodland**	3.8	75.00

Prasophyllum petilum / Tarengo Leek Orchid	**201_Woodland, 201_Derived_native_grass**	1.2	21.00
Thesium australe / Austral Toadflax	**1655_Derived_native_grass, 1606_Derived_native_grass**	1.8	8.00

Credit Retirement Options

Like-for-like credit retirement options

Cryptostylis hunteriana / Leafless Tongue Orchid	Spp	IBRA subregion
	Cryptostylis hunteriana / Leafless Tongue Orchid	Any in NSW
Delma impar / Striped Legless Lizard	Spp	IBRA subregion
	Delma impar / Striped Legless Lizard	Any in NSW
Diuris tricolor / Pine Donkey Orchid	Spp	IBRA subregion
	Diuris tricolor / Pine Donkey Orchid	Any in NSW
Myotis macropus / Southern Myotis	Spp	IBRA subregion
	Myotis macropus / Southern Myotis	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

Prasophyllum petilum / Tarengo Leek Orchid	Spp	IBRA subregion
	Prasophyllum petilum / Tarengo Leek Orchid	Any in NSW
Thesium australe / Austral Toadflax	Spp	IBRA subregion
	Thesium australe / Austral Toadflax	Any in NSW

ATTACHMENT F3
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS)

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00028736/BAAS17004/21/00028737	Malabar Coal Maxwell Underground MOD2 vent shaft	16/06/2022
Assessor Name	Assessor Number	BAM Data version *
Colin Driscoll	BAAS17004	54
Proponent Name(s)	Report Created	BAM Case Status
	30/06/2022	Finalised
Assessment Revision	Assessment Type	Date Finalised
1	Major Projects	30/06/2022

* 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 Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	Critically Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

PCT
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
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	HBT Cr	No HBT Cr	Total credits to be retired
201-Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South Western Slopes Bioregion	Not a TEC	1.2	0	27	27.00
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	2.2	0	4	4.00
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	2.9	0	64	64.00
1692-Bull Oak grassy woodland of the central Hunter Valley	Not a TEC	0.6	0	15	15.00
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 Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	3.9	56	36	92.00

1693-Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	2.5	0	45	45.00

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	Zone	HBT	Credits	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%	201_Woodland	No	9	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.
Western Slopes Grassy Woodlands This includes PCT's: 201, 266, 276, 277, 282, 283, 337, 426, 441, 483, 847	Western Slopes Grassy Woodlands >=90%	201_Derived_native_grass	No	18	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	Zone	HBT	Credits	IBRA region
Grassy Woodlands	Tier 1	201_Woodland	No	9	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Grassy Woodlands	Tier 1	201_Derived_native_grass	No	18	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

Class	Trading group	Zone	HBT	Credits	IBRA region

	White Box - Yellow Box - Blakely’s Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla This includes PCT's: 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 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, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	Yes	56	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.

	White Box - Yellow Box - Blakely’s Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla This includes PCT's: 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 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, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Derived_native_grass	No	36	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	Zone	HBT	Credits	IBRA region
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion This includes PCT's: 1176, 1655	-	1655_Woodland	No	4	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.
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion This includes PCT's: 1176, 1655	-	1655_Derived_native_grass	No	0	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	Zone	HBT	Credits	IBRA region
Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 5 or higher threat status	1655_Woodland	No	4	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 5 or higher threat status	1655_Derived_native_grass	No	0	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**					
	Class	Trading group	Zone	HBT	Credits	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	-	1691_Woodland	No	35	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.
	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	-	1691_Derived_native_grass	No	29	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	Zone	HBT	Credits	IBRA region
	Grassy Woodlands	Tier 3 or higher threat status	1691_Woodland	No	35	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Grassy Woodlands	Tier 3 or higher threat status	1691_Derived_native_grass	No	29	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	Zone	HBT	Credits	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% and <70%	1692_Woodland	No	15	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	Zone	HBT	Credits	IBRA region
	Grassy Woodlands	Tier 3 or higher threat status	1692_Woodland	No	15	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1693-Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland This includes PCT's: 74, 75, 83, 101, 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, 401, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 508, 509, 510, 511, 516, 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, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1606, 1608, 1611, 1693, 1695, 1698	-	1693_Derived_native_grass	No	45	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	Zone	HBT	Credits	IBRA region

	Grassy Woodlands	Tier 3 or higher threat status	1693_Derived_native_grass	No	45	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	Vegetation Zone/s	Area / Count	Credits
Cryptostylis hunteriana / Leafless Tongue Orchid	**1655_Woodland, 1655_Derived_native_grass**	2.2	11.00
Delma impar / Striped Legless Lizard	**1655_Woodland, 1655_Derived_native_grass, 1691_Woodland, 1691_Derived_native_grass, 1692_Woodland, 1606_Woodland, 1606_Derived_native_grass, 1693_Derived_native_grass**	12.1	156.00
Diuris tricolor / Pine Donkey Orchid	**201_Woodland, 201_Derived_native_grass**	1.2	17.00
Myotis macropus / Southern Myotis	**1691_Woodland**	0.3	9.00
Petaurus norfolcensis / Squirrel Glider	**1606_Derived_native_grass, 201_Derived_native_grass, 1655_Derived_native_grass, 201_Woodland, 1655_Woodland, 1606_Woodland**	3.8	75.00
Prasophyllum petilum / Tarengo Leek Orchid	**201_Woodland, 201_Derived_native_grass**	1.2	21.00

Thesium australe / Austral Toadflax	**1655_Derived_native_grass, 1606_Derived_native_grass**	1.8	8.00

Credit Retirement Options

Like-for-like options

Cryptostylis hunteriana/ Leafless Tongue Orchid	Spp		IBRA region
	Cryptostylis hunteriana/Leafless Tongue Orchid		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
	Flora	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.
Delma impar/ Striped Legless Lizard	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	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.
Diuris tricolor/ Pine Donkey Orchid	Spp		IBRA region
	Diuris tricolor/Pine Donkey Orchid		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
	Flora	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.
Myotis macropus/ Southern Myotis	Spp		IBRA region
	Myotis macropus/Southern Myotis		Any in NSW

<table>
<tr><td rowspan="3">Myotis macropus/
Southern Myotis</td><td colspan="3">Variation options</td></tr>
<tr><td>Kingdom</td><td>Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Fauna</td><td>Vulnerable</td><td>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.</td></tr>
<tr><td rowspan="4">Petaurus norfolcensis/
Squirrel Glider</td><td>Spp</td><td colspan="2">IBRA region</td></tr>
<tr><td>Petaurus norfolcensis/Squirrel Glider</td><td colspan="2">Any in NSW</td></tr>
<tr><td colspan="3">Variation options</td></tr>
<tr><td>Kingdom</td><td>Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
</table>

	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.
Prasophyllum petilum/ Tarengo Leek Orchid	Spp		IBRA region
	Prasophyllum petilum/Tarengo Leek Orchid		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
	Flora	Endangered	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.
Thesium australe/ Austral Toadflax	Spp		IBRA region
	Thesium australe/Austral Toadflax		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
	Flora	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.