

MACHEnergy

Mount Pleasant Operation

A JOINT VENTURE WITH JCDA Japan Coal Development Australia

Appendix E

Biodiversity Development Assessment Report

MACHEnergy

Mount Pleasant Operation

MOUNT PLEASANT OPTIMISATION PROJECT

BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

HUNTER ECO

Prepared by
Dr Colin Driscoll
BAAS17004

January 2021

28 January 2021

Mount Pleasant Optimisation Project
Biodiversity Development Assessment Report
Statement of Currency

As required by Section 6.15 (1) of the NSW *Biodiversity Conservation Act 2016* this letter certifies that the Mount Pleasant Optimisation Project Biodiversity Assessment Report has been prepared on the basis of the requirements of (and information provided under) the Biodiversity Assessment Method as at 28 January 2021.

Yours Faithfully
HUNTER ECO

Dr Colin Driscoll
BAAS17004

HUNTER ECO · ABN 25 112 984 240
PO Box 1047, Toronto, NSW 2283 **M** 0438 773 029 **E** cd_enviro@bigpond.com

CONTENTS

DEFINITIONS VIII

EXECUTIVE SUMMARY ES-1

1 INTRODUCTION 1

1.1 OVERVIEW OF THE MOUNT PLEASANT OPERATION 1
1.2 PROJECT DESCRIPTION 1
1.3 ASSESSMENT REQUIREMENTS/APPROACH 4
1.4 BIODIVERSITY ASSESSMENT DEVELOPMENT FOOTPRINT 7
1.5 STRUCTURE OF THIS ASSESSMENT 10
1.6 FIELD SURVEYS 10
1.7 PUBLISHED DATABASES 10
1.8 LOCAL DATA 11
1.9 BAM CALCULATOR 11

2 LANDSCAPE FEATURES 12

2.1 REGIONAL SETTING 12
2.2 NATIVE VEGETATION COVER 12
2.3 HABITAT CONNECTIVITY FEATURES 12
2.4 RIVERS AND STREAMS 12
2.5 WETLANDS 15
2.6 AREAS OF GEOLOGICAL SIGNIFICANCE AND SOIL HAZARD FEATURES 15
2.7 AREAS OF OUTSTANDING BIODIVERSITY VALUE 15
2.8 MIGRATORY SPECIES POTENTIAL FLYWAYS 15
2.9 SITE CONTEXT COMPONENTS 15

3 NSW BIODIVERSITY ASSESSMENT 16

3.1 NATIVE VEGETATION 16
3.1.1 Plant Community Types 16
3.1.2 Threatened Ecological Communities 21
3.1.3 Plant Community Types Percent Cleared Value 21
3.2 VEGETATION INTEGRITY ASSESSMENT 21
3.2.1 Vegetation Zones 26
3.2.2 Patch Size 26
3.2.3 Vegetation Integrity Score 26
3.2.4 Local Data 26
3.3 THREATENED SPECIES 27
3.3.1 Ecosystem Credit Species - Habitat Suitability Assessment 27
3.3.1.1 Step 1: Identify Ecosystem Species for Assessment 27
3.3.1.2 Step 2: Assessment of Habitat Constraints and Vagrant Species on the Disturbance Area 35
3.3.2 Species Credit Species - Habitat Suitability Assessment 35
3.3.2.1 Step 1: Identify Species Credit Species for Assessment 35
3.3.2.2 Step 2: Assessment of Habitat Constraints for Species Credit Species on the Disturbance Area 48
3.3.2.3 Step 3: Identify Candidate Species Credit Species for Further Assessment 52
3.3.2.4 Step 4: Determine Presence or Absence of a Candidate Species Credit Species 53
3.3.2.5 Step 5: Determine the Area or Count, and Location of Suitable Habitat for a Species Credit Species 58
3.3.2.6 Step 6: Determine the Habitat Condition within the Species Polygon for Species Assessed by Area 66
3.4 LOCAL DATA 67
3.5 EXPERT REPORTS 67
3.6 PRESCRIBED BIODIVERSITY IMPACT ENTITIES 67

3.6.1 Karst, Caves, Crevices and Cliffs 67
3.6.2 Rock 67
3.6.3 Human Made Structures and Non-native Vegetation 67
3.6.4 Hydrological Processes that Sustain and Interact with the Rivers, Streams and Wetlands 67
3.7 DEVELOPMENT FOOTPRINT CREDIT AMOUNT 68

4 AVOID AND MINIMISE IMPACTS 71

4.1 MEASURES TO AVOID AND MINIMISE IMPACTS 71
4.2 RELINQUISHMENT AREA 74
4.2.1 Plant Community Types 74
4.2.2 Ecosystem Credit Species 76
4.2.3 Species Credit Species 77
4.2.4 Relinquishment Area Credit Summary 79
4.3 DIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT 84
4.3.1 Clearance of Habitat and Vegetation 84
4.3.2 Clearance of Threatened Ecological Communities under the BC Act 88
4.3.3 Cumulative Impacts 90
4.4 INDIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT 91
4.4.1 Inadvertent Impacts on Adjacent Habitat or Vegetation 91
4.4.2 Impacts on Adjacent Habitat or Vegetation from a Change in Land-Use Pattern (Increased Human Activity) 91
4.4.3 Reduced Viability of Adjacent Habitat Due to Edge Effects 91
4.4.4 Reduced Viability of Adjacent Habitat Due to Noise, Dust or Light Spill 91
4.4.5 Terrestrial Groundwater Dependent Ecosystems 92
4.4.6 Potential Impacts on Rivers and Streams 94
4.4.7 Transport of Weeds and Pathogens from the Site to Adjacent Vegetation 94
4.4.8 Increased Risk of Fauna Starvation, Exposure and Loss of Shade or Shelter 94
4.4.9 Indirect Loss of Breeding Habitats 95
4.4.10 Trampling of Threatened Flora Species 95
4.4.11 Inhibition of Nitrogen Fixation and Increased Soil Salinity 95
4.4.12 Fertiliser Drift 95
4.4.13 Rubbish Dumping 95
4.4.14 Wood Collection 95
4.4.15 Bush Rock Removal and Disturbance 95
4.4.16 Increase in Predatory Species Populations 95
4.4.17 Increase in Pest Animal Populations 96
4.4.18 Increased Risk of Fire 96
4.4.19 Disturbance to Specialist Breeding and Foraging Habitat 96
4.5 PRESCRIBED BIODIVERSITY IMPACTS 96
4.5.1 Impacts on Habitat Resources other than Native Vegetation 97
4.5.2 Habitat Fragmentation 98
4.5.3 Fauna Movement 99
4.5.4 Water Quality, Water Bodies and Hydrological Processes that Sustain Threatened Species and Threatened Ecological Communities 100
4.5.5 Wind Turbines 100
4.5.6 Vehicle Strike 100
4.6 STATE ENVIRONMENTAL PLANNING POLICY (KOALA HABITAT PROTECTION) 2020 101
4.7 MEASURES TO MITIGATE AND MANAGE IMPACTS 103

5 IMPACT SUMMARY NSW ASSESSMENT 109

5.1 SERIOUS AND IRREVERSIBLE IMPACTS 109
5.1.1 Introduction 109
5.1.2 Background Information – Box-Gum Woodland CEEC listed under the BC Act 109
5.1.3 Impact Assessment – Box-Gum Woodland CEEC listed under the BC Act 116
5.1.4 Conclusion 118
5.2 IMPACTS ON NATIVE VEGETATION (ECOSYSTEM CREDITS) 118
5.3 IMPACTS ON THREATENED SPECIES (SPECIES CREDITS) 119

6 BIODIVERSITY OFFSET STRATEGY 124

6.1 EXISTING BIODIVERSITY OFFSETS 124
6.2 PROJECT BIODIVERSITY OFFSET STRATEGY 126
6.2.1 Commonwealth Offset 126
6.2.2 NSW Offset 126

7 COMMONWEALTH ASSESSMENT 129

7.1 DESCRIPTION OF THE ACTION 129
7.2 SURVEYS FOR THREATENED SPECIES AND COMMUNITIES LISTED UNDER THE EPBC ACT 129
7.2.1 Survey Scope, Timing and Methodology 129
7.2.2 Occurrence of Threatened Species and their Habitat 131
7.2.3 Occurrence of Threatened Ecological Communities 134
7.3 CREDIT CALCULATION 134
7.3.1 Northern Link Road Options 1 and 2 (Development Footprints 2 and 3) 134
7.3.2 Western Link Road Relinquishment Area 134
7.3.2.1 Plant Community Types 135
7.3.2.2 Ecosystem Credit Species 136
7.3.3 EPBC Act Credit Requirement Summary 136
7.4 IMPACTS ON THREATENED SPECIES AND COMMUNITIES LISTED UNDER THE EPBC ACT 138
7.4.1 Box-Gum Woodland CEEC listed under the EPBC Act 138
7.4.2 Striped Legless Lizard 140
7.4.3 Swift Parrot 141
7.4.4 Regent Honeyeater 142
7.4.5 Koala (combined populations of Queensland, NSW and the Australian Capital Territory) 143
7.4.6 Spotted-tailed Quoll 143
7.4.7 Grey-headed Flying-fox 144
7.4.8 Recovery Plans and Approved Conservation Advices 146
7.4.9 Threat Abatement Plans 146
7.4.10 Summary 147
7.5 IMPACT AVOIDANCE AND MITIGATION MEASURES FOR MATTERS OF NATIONAL SIGNIFICANCE 148
7.6 COMMONWEALTH OFFSET 151
7.6.1 Biodiversity Stewardship Site 153
7.6.2 Payments 153
7.6.3 Timing 153

8 CONCLUSION 154

9 REFERENCES 155

TABLES

Table 1 Development Footprints
Table 2 Plant Community Types within the Development Footprints
Table 3 Threatened Ecological Communities listed under the BC Act
Table 4 Ecosystem Credit Species from the BAM Calculator
Table 5 Threatened Flora and Fauna Species Known or Predicted to Occur in the Locality
Table 6 Initial List of Species Credit Species for Assessment
Table 7 Flora Species Credit Species – Geographic Constraints
Table 8 Previous Flora Studies in the MLs and Surrounds
Table 9 Previous Fauna Studies in the MLs and Surrounds
Table 10 Species Credit Species Habitat Constraints
Table 11 Species Credit Species – Survey and Timing
Table 12 Species Credit Species Presence
Table 13 Striped Legless Lizard Species Polygon Habitat Composition
Table 14 Squirrel Glider Species Polygon Habitat Composition
Table 15 Development Footprint Ecosystem Credit Amount
Table 16 Development Footprint Species Credit Amount
Table 17 Plant Community Types within the Relinquishment Area
Table 18 Vegetation Integrity Score Detail – Relinquishment Area
Table 19 Ecosystem Credit Species from the BAM Calculator – Relinquishment Area
Table 20 Striped Legless Lizard Species Polygon Habitat Composition – Relinquishment Area
Table 21 Squirrel Glider Species Polygon Habitat Composition – Relinquishment Area
Table 22 Relinquishment Area Credit Summary – Species Credits
Table 23 Relinquishment Area Credit Summary
Table 24 Native Vegetation Clearance within the Project Additional Disturbance Area
Table 25 Native Vegetation Net Additional Clearance within the Project Additional Disturbance Area
Table 26 Threatened Ecological Communities Listed under the BC Act
Table 27 Mitigation Measures
Table 28 Monitoring Programme
Table 29 Performance and Completion Criteria
Table 30 Unavoidable Loss of Box-Gum Woodland CEEC Listed under the BC Act
Table 31 Box-Gum Woodland CEEC Listed Under the BC Act within the Relinquishment Area
Table 32 Box-Gum Woodland CEEC Listed Under the BC Act Net Clearance within the Project Additional Disturbance Area
Table 33 Box-Gum Woodland CEEC Listed under the BC Act Communities Mapped for the Sydney Basin Bioregion, Hunter Subregion
Table 34 Amount of Box-Gum Woodland CEEC Listed under the BC Act Mapped within the NSW Reserve System
Table 35 Project Ecosystem Credit Requirements After Relinquishment Area
Table 36 Project Species Credit Requirements After Relinquishment Area
Table 37 Biodiversity Offsets for the Existing/Approved Mount Pleasant Operation
Table 38 Residual Credits
Table 39 EPBC Act Species and Communities Targeted for Survey
Table 40 Threatened Species Listed Under the EPBC Act Recorded During Surveys
Table 41 Threatened Ecological Communities Listed Under the EPBC Act Recorded During Surveys

Table 42 Plant Community Types within the Western Link Road Relinquishment Area
Table 43 Vegetation Integrity Score Detail – Western Link Road Relinquishment Area
Table 44 Ecosystem Credit Species from the BAM Calculator Listed under the EPBC Act – Western link Road Relinquishment Area
Table 45 EPBC Act Credit Requirement Summary
Table 46 MNES Clearance Summary
Table 47 Impact Mitigation Measures Relevant to Threatened Species and Communities Listed Under the EPBC Act
Table 48 Credit Requirement for Threatened Species and Communities Listed Under the EPBC Act

FIGURES

Figure 1 Regional Location
Figure 2 General Arrangement of the Approved Mount Pleasant Operation
Figure 3a Biodiversity Assessment Development Footprint
Figure 3b Biodiversity Assessment Development Footprint Inset
Figure 4 Commonwealth Action Area Footprint
Figure 5 Site Map
Figure 6 Location Map
Figure 7a Vegetation Mapping
Figure 7b Vegetation Mapping Inset
Figure 8a Threatened Ecological Communities listed under the BC Act
Figure 8b Threatened Ecological Communities listed under the BC Act and EPBC Act Inset
Figure 9a Vegetation Integrity Plot Locations
Figure 9b Vegetation Integrity Plot Locations Inset
Figure 10 Threatened Flora
Figure 11 Threatened Reptiles
Figure 12 Threatened Birds
Figure 13 Threatened Mammals
Figure 14 Species Credit Species Relevant to the Project
Figure 15 Striped Legless Lizard Species Polygon
Figure 16 Squirrel Glider Species Polygon
Figure 17 Rehabilitation Domains
Figure 18 Groundwater Dependent Vegetation
Figure 19 Koala Potential Foraging Habitat
Figure 20 Serious and Irreversible Impact Entities
Figure 21a Areas Requiring Offset Before Relinquishment Area
Figure 21b Areas Requiring Offset Before Relinquishment Area Inset
Figure 22a Areas Not Requiring Assessment or Offset
Figure 22b Areas Not Requiring Assessment or Offset Inset
Figure 23 Existing Offset Areas
Figure 24 Commonwealth Listed Species Landscape Distribution
Figure 25 Grey-headed Flying-fox Potential Foraging Habitat

ATTACHMENTS

Attachment A	Mount Pleasant Optimisation Project Baseline Flora Report
Attachment B	Mount Pleasant Optimisation Project Baseline Fauna Survey Report
Attachment C	Vegetation Integrity Data
Attachment D	Expert Report – Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum*, *Pterostylis chaetophora*): Mount Pleasant Optimisation Project
Attachment E	BAM Biodiversity Credit Report - Development Footprint 1
Attachment F	BAM Biodiversity Credit Report (Like for Like) - Development Footprint 1
Attachment G	BAM Biodiversity Credit Report (Variations) - Development Footprint 1
Attachment H	BAM Biodiversity Credit Report - Development Footprint 2
Attachment I	BAM Biodiversity Credit Report (Like for Like) - Development Footprint 2
Attachment J	BAM Biodiversity Credit Report (Variations) - Development Footprint 2
Attachment K	BAM Biodiversity Credit Report - Development Footprint 3
Attachment L	BAM Biodiversity Credit Report (Like for Like) - Development Footprint 3
Attachment M	BAM Biodiversity Credit Report (Variations) - Development Footprint 3
Attachment N	BAM Biodiversity Credit Report - Relinquishment Area
Attachment O	BAM Biodiversity Credit Report (Like for Like) - Relinquishment Area
Attachment P	BAM Biodiversity Credit Report (Variations) - Relinquishment Area
Attachment Q	BAM Biodiversity Credit Report - Western Link Road Relinquishment Area
Attachment R	BAM Biodiversity Credit Report (Like for Like) - Western Link Road Relinquishment Area
Attachment S	BAM Biodiversity Credit Report (Variations) - Western Link Road Relinquishment Area

DEFINITIONS

BAM: *the Biodiversity Assessment Method.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Expert: *a person, approved by the Environmental Agency Head, who has the relevant experience and/or qualifications to provide expert opinion in relation to the biodiversity values to which an expert report relates.*

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

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

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

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

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.*

Sensitivity to Potential Gain: *a component of the biodiversity risk weighting for an entity that considers the ability of a species to respond to improvements in habitat condition at an offset site.*

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

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

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

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

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

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

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

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

EXECUTIVE SUMMARY

MACH Energy Australia Pty Ltd (MACH) is seeking consent for the Mount Pleasant Optimisation Project (the Project) to increase open cut coal extraction and related activities. The Project is in the Upper Hunter Valley of New South Wales (NSW), northwest of Muswellbrook.

The Project would involve mining of additional coal reserves and a staged increase in extraction, handling and processing of run-of-mine coal for export or to domestic customers for use in electricity generation.

MACH is seeking approval for the Project under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval for components of the Project not covered by the existing EPBC Act approval (EPBC 2011/5795).

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

Landscape Features

The Study Area is located in the Hunter River catchment. The land across the Study Area has been used for grazing of cattle and sheep for over 100 years, and as a result the Study Area consists of a mosaic of cleared grassland, woodland and other areas such as farm dams and infrastructure, with a majority of the area being cleared grassland.

Native Vegetation

Native vegetation on the Subject land was identified and mapped in accordance with the BAM and *BioNet Vegetation Classification.* This involved collecting floristic and condition data from 96 plots located in the Subject land, reviewing previous vegetation mapping, ground-truthing vegetation boundaries and statistical analysis of the data.

Eight vegetation communities (Plant Community Types [PCTs]) 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 original woodland community.

Threatened Ecological Communities Listed under the BC Act

Approximately half of the native vegetation in the Development Footprints is represented by threatened ecological communities listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). These comprise mostly *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* (*Box-Gum Woodland CEEC listed under the BC Act*) with smaller portions of *Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* (*Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*).

Threatened Species

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

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

- Tiger Orchid (*Cymbidium canaliculatum*) (a component of the *Cymbidium canaliculatum* population in the Hunter Catchment Endangered Population under the BC Act);
- Striped Legless Lizard (*Delmar impar*) (listed as 'vulnerable' under the BC Act and EPBC Act); and
- Squirrel Glider (*Petaurus norfolcensis*) (listed as 'vulnerable' under the BC Act).

No other threatened flora species listed under the BC Act or EPBC Act were recorded in the Study Area, or were recorded in any past studies. Other threatened fauna species listed under the BC Act or EPBC Act were recorded, however those species are 'ecosystem credit species', and are assessed as such.

Measures to Avoid, Minimise, Mitigate and Manage Impacts

The impact avoidance, mitigation and offset hierarchy has been applied to the Project. A key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project. These areas are collectively referred to as the Relinquishment Area.

The total approved disturbance area to be relinquished is either 509.8 ha if Northern Link Road Option 1 is selected (comprising 497.9 ha of native vegetation and 11.9 ha of cleared land) or 496.5 ha for Northern Link Road Option 2 (comprising 484.9 ha of native vegetation and 11.6 ha of cleared land).

The Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

A total combined area of between approximately 458.8 ha (Road Option 2) and 475.9 ha (Road Option 1) of native vegetation would be cleared for the Project, depending on the road options. After applying the Relinquishment Area, there would be a net benefit on native vegetation and habitat because of:

- less clearance of native vegetation compared to the current approved mine (between approximately 22 ha and 26.1 ha less depending on the revised road alignment options);
- less clearance of *Box-Gum Woodland CEEC listed under the BC Act* compared to the current approved mine (between approximately 226.3 ha and 230.2 ha less);
- less clearance of habitat for the Striped Legless Lizard and Squirrel Glider compared to the current approved mine; and
- less clearance of Tiger Orchids (one) compared to the current approved mine (two).

Although less native vegetation would be cleared overall, it is recognised that there would be a net additional impact on three PCTs (namely, PCTs 1691, 1602 and 1605). The net additional impact on these PCTs is 66.2 ha. The woodland form of PCT 1691 is listed as the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*, however as stated above the Project would result in less clearance of *Box-Gum Woodland CEEC listed under the BC Act.*

MACH have commenced rehabilitation and revegetation activities at the Mount Pleasant Operation. The Mount Pleasant Operation rehabilitation program has been designed to establish an appropriate ground strata, understorey, sub-canopy and canopy within areas of the Mount Pleasant Operation final landform.

Biodiversity Offset Strategy

The majority of the proposed disturbance area (except for the proposed revised Northern Link Road alignment options) is approved to be cleared under an existing EPBC Act approval (EPBC 2011/5795), and MACH have established approximately 12,875 ha of biodiversity offset areas under this approval.

As described above, it is recognised that there would be a net additional impact on three PCTs (namely, PCTs 1691, 1602 and 1605), but a larger net benefit on other biodiversity values from the Relinquishment Area. On balance, the benefits on other biodiversity values outweigh the net additional impacts on biodiversity values because the Relinquishment Area is larger, with a greater area of vegetation which is of a higher conservation status under the BC Act.

The conditions of the approval (if granted) may or may not require MACH to retire biodiversity credits to offset the residual impact on biodiversity values (whether of the number and class specified in the report or of another number and class) to the satisfaction of the NSW Secretary of the Department of Planning and Environment (now the Department of Planning, Industry and Environment).

Commonwealth Assessment

A referral was lodged in July 2020 for new components of the Project (the Action) (EPBC 2020/8735). The Action includes surface disturbance not covered by EPBC 2011/5795, i.e. the revised alignment of the approved Northern Link Road. Two alternative alignments of the western section of the revised Northern Link Road alignment are being considered by MACH but only one of these options would be developed.

The *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* critically endangered ecological community listed under the EPBC Act (*Box-Gum Woodland CEEC listed under the EPBC Act*) is present within the Action area. Northern Link Road Option 1 would clear approximately 20.8 ha of Box-Gum derived native grassland and 5.6 ha of Box-Gum woodland (total of 26.4 ha). Northern Link Road Option 2 of the Action would clear approximately 16.8 ha of Box-Gum derived native grassland and 5.7 ha of Box-Gum woodland (total of 22.5 ha).

The original revised road alignment approved by EPBC 2011/5795 would have resulted in the clearance of approximately 8.5 ha of Box-Gum derived native grassland and 4.9 ha of Box-Gum woodland (total of 13.4 ha). Hence, because this clearance would no longer occur, the net difference is the clearance of approximately 12.3 ha of Box-Gum derived native grassland and 0.7 ha of Box-Gum woodland (total of 13 ha) for Northern Link Option 1 and approximately 8.3 ha of Box-Gum derived native grassland and 0.8 ha of Box-Gum woodland (total of 9.1 ha) for Northern Link Road Option 2. Notably, the majority of derived native grassland is in low condition (Vegetation Integrity score is <15) and does not require an offset under the NSW Biodiversity Offsets Scheme.

The Striped Legless Lizard was not recorded within the Action area; however it is possible that the species utilises potential habitat within the Action area as it was recorded within the mining lease.

Given the proposed revised Northern Link Road alignment options are not covered by the existing EPBC Act approval (EPBC 2011/5795) and are subject to EPBC 2020/8735, additional offsets would be provided for the net impacts to the *Box-Gum Woodland CEEC listed under the EPBC Act* and Striped Legless Lizard. These offset requirements would be met through retirement of biodiversity credits and/or contribution to the Biodiversity Conservation Fund.

Conclusion

The Project involves a re-arrangement of areas proposed to be cleared under previous approvals, resulting in a significant reduction in the residual biodiversity impacts that would otherwise have occurred. This approach is consistent with the BAM whereby impacts on biodiversity are to be avoided and minimised in the first instance and then residual direct impacts from clearing native vegetation and habitat loss are offset.

The outcome of the Project would be (at a minimum) less clearing of native vegetation and habitat at the mine, continued management of over 13,000 ha of biodiversity offset areas, and additional biodiversity offsets for the residual direct impacts from revised alignment of the Northern Link Road.

1 INTRODUCTION

This Biodiversity Development Assessment Report (BDAR) forms part of an Environmental Impact Statement (EIS) which has been prepared to accompany a Development Application for the Mount Pleasant Optimisation Project (the Project) in accordance with Part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979*.

1.1 OVERVIEW OF THE MOUNT PLEASANT OPERATION

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH (95 percent [%] owner) and J.C.D. Australia Pty Ltd (5% owner)[1] .

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (Figures 1 and 2).

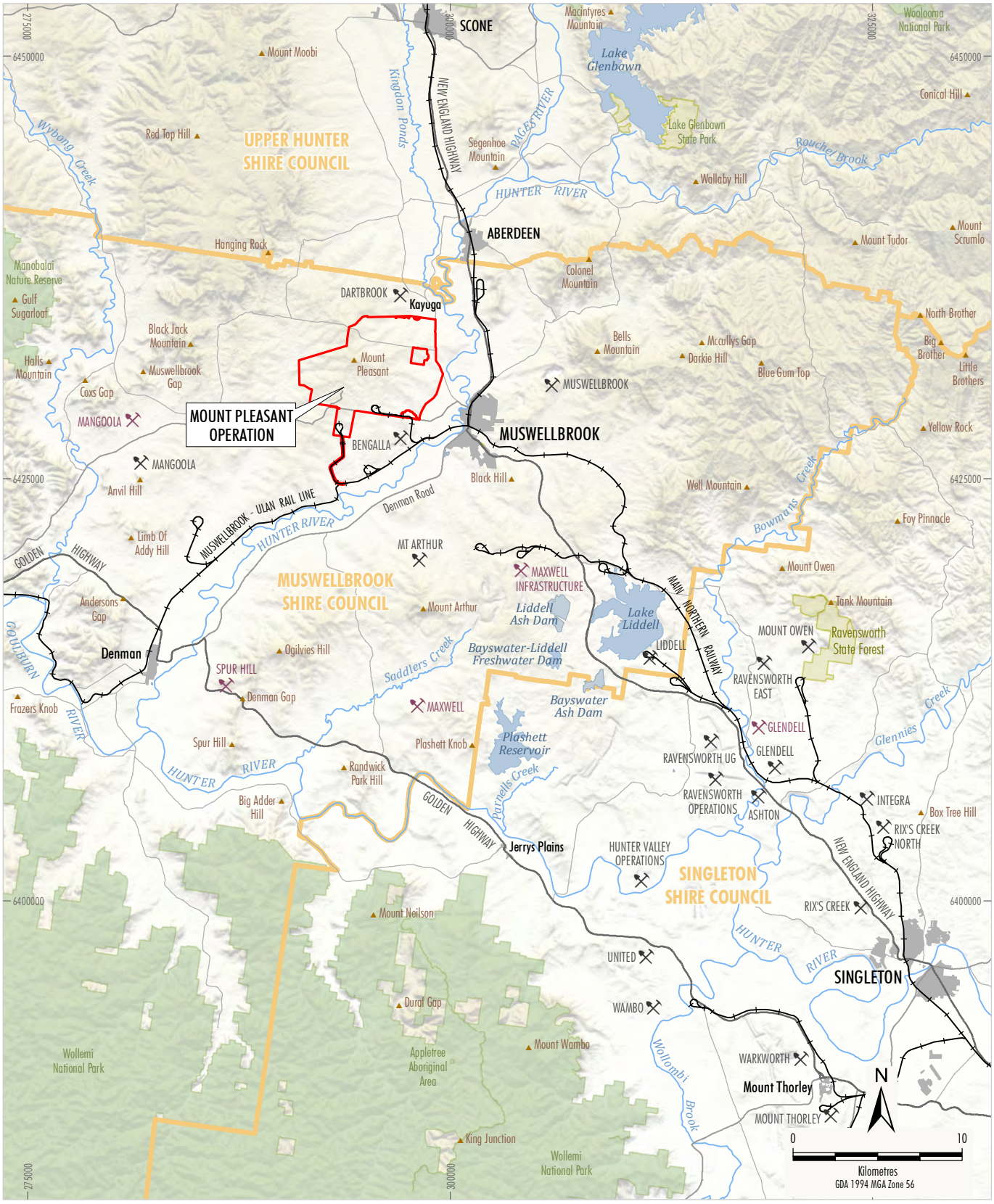
The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately nine trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

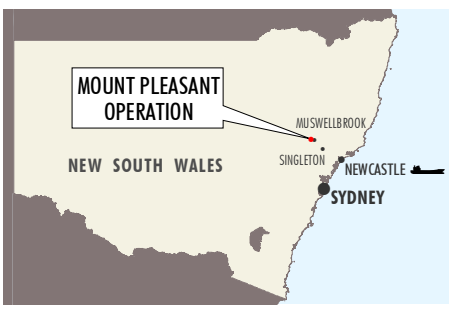
1.2 PROJECT DESCRIPTION

The Project would include the following development:

- increased open cut coal extraction within Mount Pleasant Operation Mining Leases (MLs) by mining of additional coal reserves, including lower coal seams in North Pit;
- staged increase in extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life);
- staged upgrades to the existing Coal Handling and Preparation Plant (CHPP) and coal handling infrastructure to facilitate the handling and processing of additional coal;
- rail transport of up to approximately 17 Mtpa of product coal to domestic and export customers;
- upgrades to workshops, electricity distribution and other ancillary infrastructure;
- existing infrastructure relocations to facilitate mining extensions (e.g. local roads, powerlines and water pipelines);
- construction and operation of new water management and water storage infrastructure in support of the mine;

[1] Throughout this report, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.





LEGEND

- Mining Operation
- Proposed Mining Operation (Application Lodged)
- Railway
- Local Government Boundary
- State Forest/Reserve
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)

Source: NSW Spatial Services (2020)

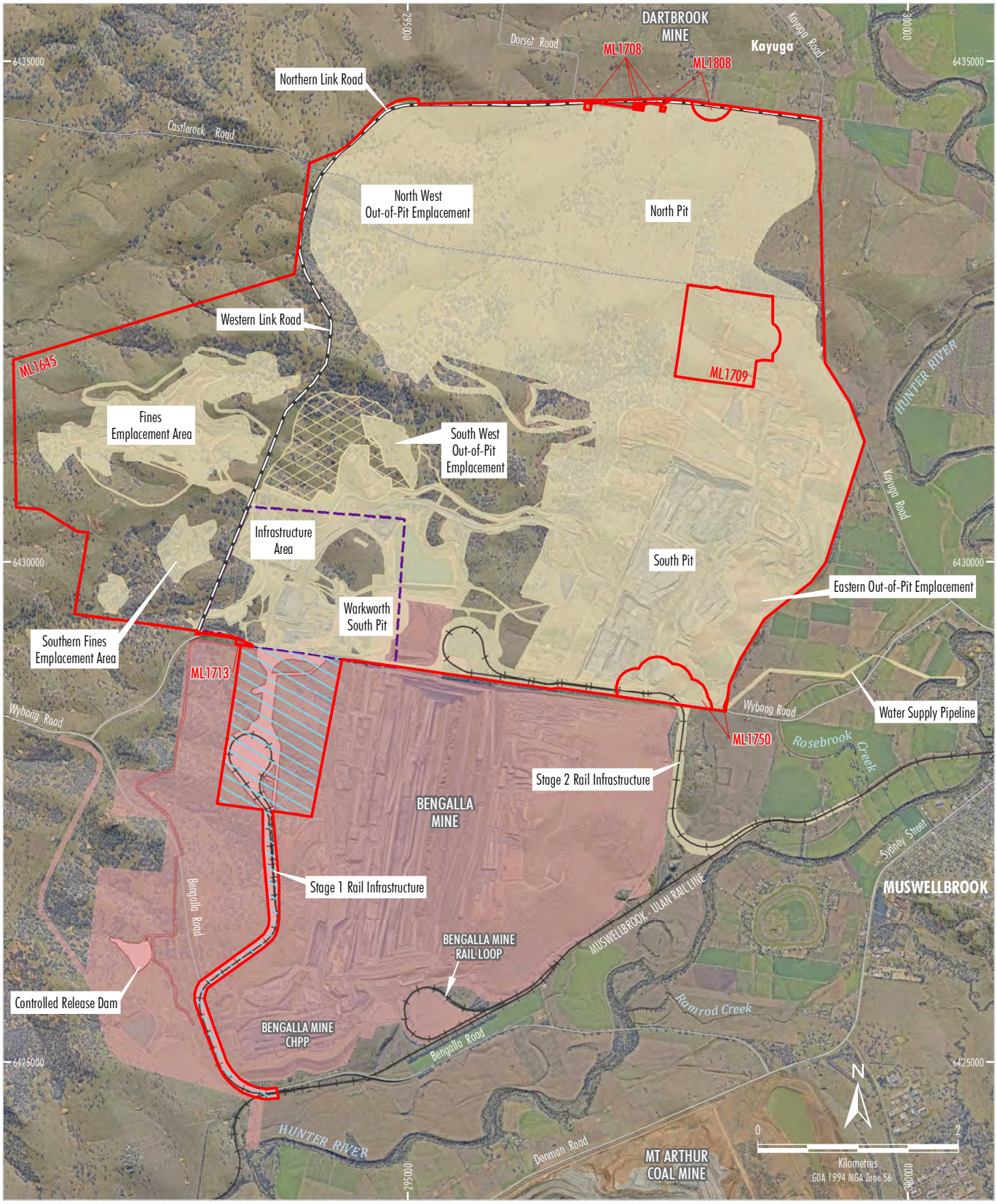
MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Regional Location

Figure 1

MAC-18-02_SSD_EIS_App BDAR_200A



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Approximate Extent of Existing/Approved Surface Development (DA92/97) [1]
- Area Relinquished for Overburden Emplacement and Major Infrastructure
- Infrastructure Area Envelope
- Northern and Western Link Road
- Infrastructure to be removed under the Terms of Condition 37, Schedule 3 (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]

NOTE

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

General Arrangement of the Approved Mount Pleasant Operation

Figure 2

- additional reject dewatering facilities to allow co disposal of fine rejects with waste rock as part of ROM waste rock operations;
- development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability, and varying topographic relief to be more natural in exterior appearance;
- construction and operation of new ancillary infrastructure in support of mining;
- extension to the time limit on mining operations to 22 December 2048;
- an average operational workforce of approximately 600 people, with a peak of approximately 830 people;
- ongoing exploration activities; and
- other associated infrastructure, plant, equipment and activities.

Figures 3a and 3b show the Development Footprints associated with the Project.

1.3 ASSESSMENT REQUIREMENTS/APPROACH

NSW State Assessment

This BDAR was prepared by Dr Colin Driscoll (Hunter Eco), who is an accredited assessor under the NSW *Biodiversity Conservation Act 2016* (BC Act) (assessor accreditation BAAS17004). This document was prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the EIS (including input from the NSW Biodiversity Conservation Division). The SEARs state the following requirements in regard to the biodiversity assessment:

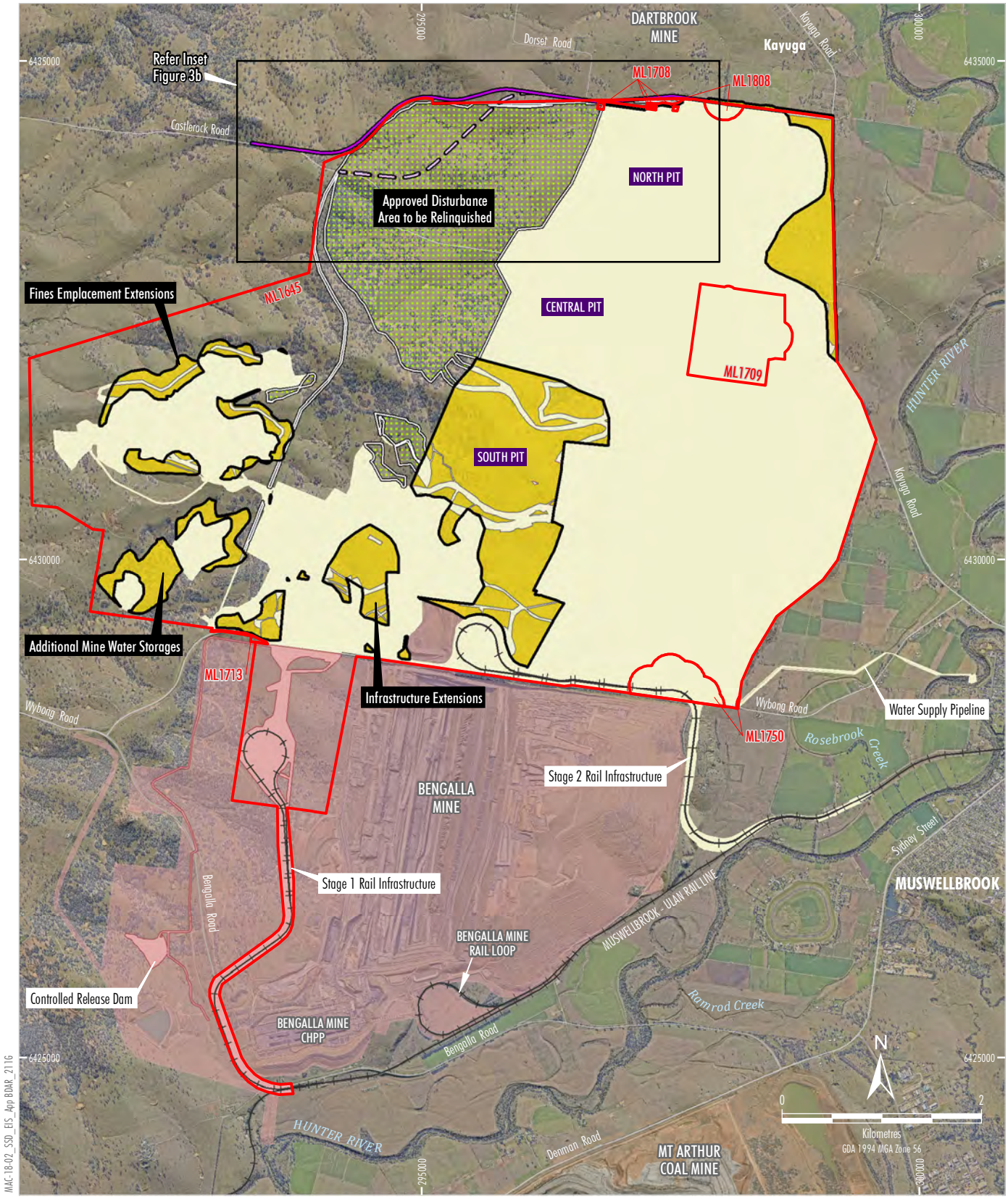
- *accurate predictions of any vegetation to be cleared on site;*
- *an assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report;*
- *in the event that a 'land swap' option is proposed, an assessment of any land identified for relinquishment, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report; and*
- *a strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme.*

This report has also considered the general requirements of the SEARs:

- *a description of the existing environment likely to be affected by the development, using sufficient baseline/background data;*
- *an assessment of the likely impacts for all stages of the development, including any cumulative impacts, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice; [and]*
- *a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the likely impacts of the development […].*

The BC Act commenced in August 2017 and establishes the Biodiversity Offsets Scheme for NSW. The Project has been assessed in accordance with the *Biodiversity Assessment Method, 2017* (BAM) (Office of Environment and Heritage [OEH] 2017) established under section 6.7 of the BC Act[2]. The Project is assessed as a State Significant Development.

[2] A revised BAM was released in October 2020 during finalisation of this BDAR.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]
- Development Footprint 1 - General Extension Areas [1]
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

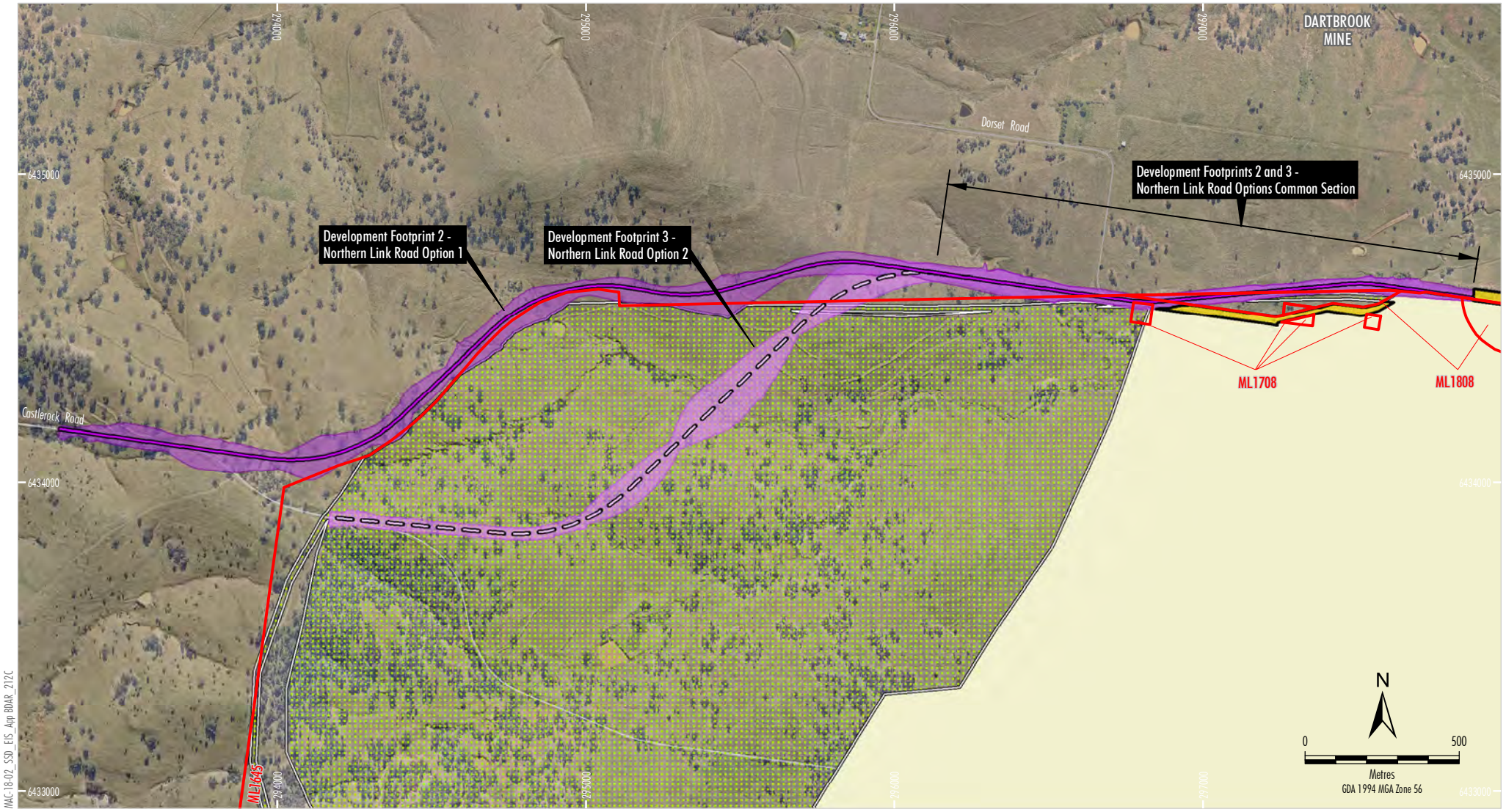
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Biodiversity Assessment Development Footprint

Figure 3a



MAC 18-02_SSD_EIS_App BDAR_212C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)[1]
- Development Footprint 1 - General Extension Areas [1]
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Biodiversity Assessment Development Footprint Inset

Figure 3b

This BDAR provides a terrestrial ecology assessment. In regard to aquatic ecology values, a separate report titled *Mount Pleasant Optimisation Project – Aquatic Ecology Assessment* has been prepared by BIO-ANALYSIS Pty Ltd (BIO-ANALYSIS) (2020) and deals with the potential impacts of the Project on the aquatic ecology values (including aquatic threatened species and communities).

Commonwealth Assessment

The Mount Pleasant Project was previously referred under the EPBC Act in 2011 and determined to be "a controlled action" (EPBC 2011/5795). Approval of the Mount Pleasant Project was granted under the EPBC Act in 2012 (Figure 2).

A referral was lodged on 28 July 2020 for new components of the Project (the Action) (EPBC 2020/8735) (Figure 4), which are not already authorised by the EPBC Act Approval (EPBC 2011/5795) or the Development Consent DA 92/97. The Action includes:

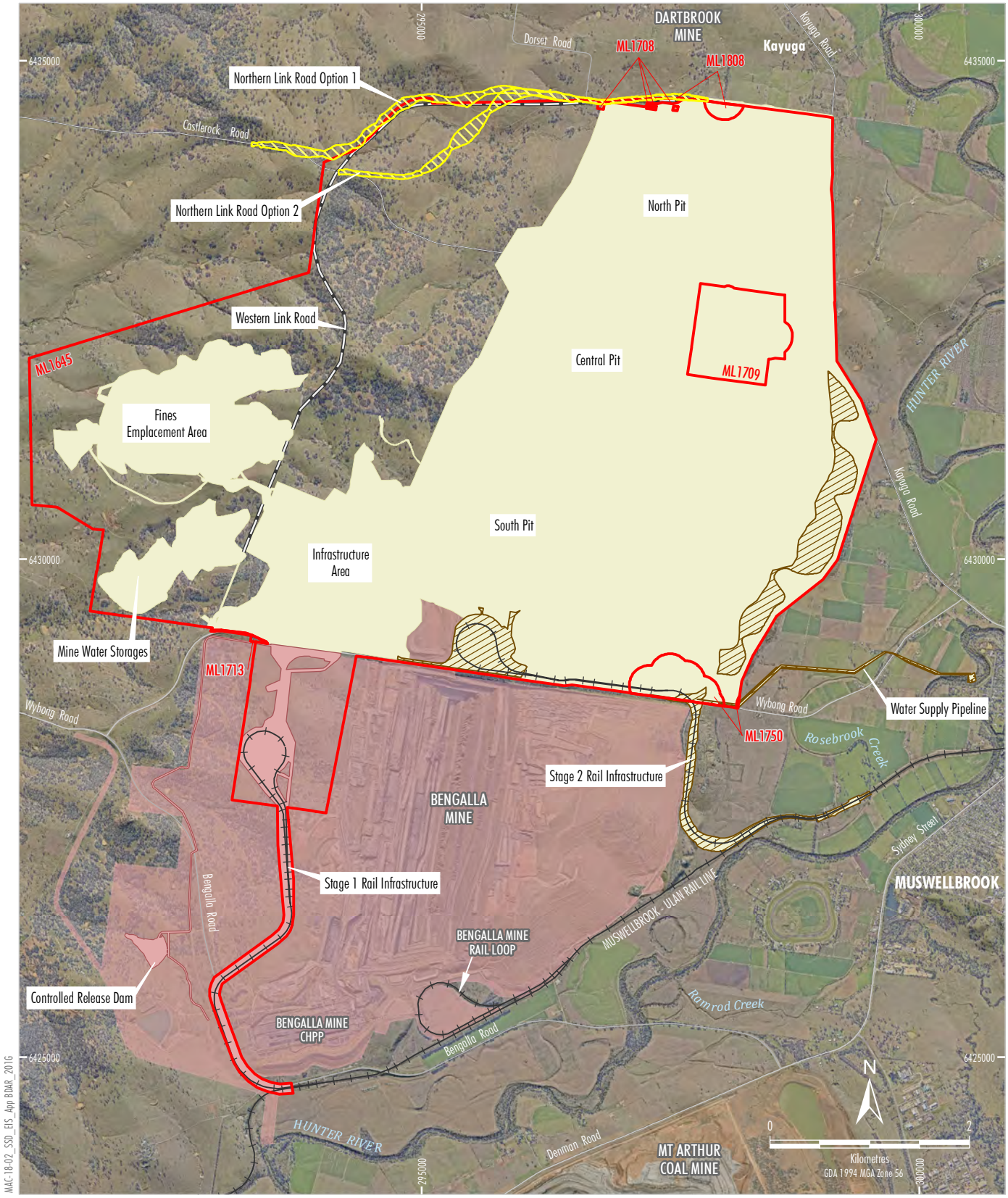
- revised alignment of the approved Northern Link Road to a suitable design standard to compensate for the approved closure of part of Castlerock Road (the approved Western Link Road would no longer be constructed);
- increased open cut coal extraction within the approved Mount Pleasant Project (EPBC 2011/5795) development area, including accessing deeper coal reserves in North Pit;
- staged increase in the extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life); and
- continued use of the controlled release dam and associated infrastructure that was approved through Bengalla Mine State and Federal approvals.

A delegate of the Commonwealth Minister for the Environment and Energy (now Minister of the Environment) determined on 26 August 2020 that the proposed action is a "controlled action" and, therefore, the Project requires approval under section 75 of the EPBC Act. The controlling provisions are "listed threatened species and communities" (sections 18 and 18A of the EPBC Act) and "a water resource, in relation to coal seam gas development and large coal mining development" (sections 24D and 24E of the EPBC Act).

The Action (EPBC 2020/8735) is to be assessed pursuant to the assessment bilateral agreement with the NSW Government. Therefore, this BDAR provides an assessment of potential impacts (in accordance with the supplementary SEARs dated 2 October 2020) to EPBC Act listed threatened species and communities.

1.4 BIODIVERSITY ASSESSMENT DEVELOPMENT FOOTPRINT

A number of previous ecological assessments have been prepared for the Mount Pleasant Operation as described in Section 3.3. The existing/approved surface disturbance area comprised a combination of exotic pastures, derived native grassland (DNG), previous plantings (both native and exotic), scattered mature trees, and patches of woodland. Threatened ecological communities (TECs) were mapped in the existing/approved surface disturbance area and a number of threatened fauna species were recorded as described in Section 3.3.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Commonwealth Action Area
- Western Link Road Relinquishment Area
- Existing /Approved Mount Pleasant Project (EPBC 2011/5795)
- Existing/Approved Surface Development (DA 92/97)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)

NOTE

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Commonwealth Action Area Footprint

Figure 4

NSW State Assessment

Figures 3a and 3b show the Development Footprints associated with the Project as described in Table 1.

Two alternative alignments of the western section of the revised Northern Link Road alignment are being considered by MACH. Option 1 is the currently preferred option as it skirts the ML boundary and would have a disturbance area of approximately 27.4 hectares (ha) of native vegetation. Option 2 is the less preferred option and would have a disturbance area of approximately 23.3 ha (including 10.3 ha of native vegetation outside of the approved footprint). Only one of these options would be developed, with the final alignment to be selected based on detailed engineering design and any associated land access constraints.

Table 1
Development Footprints

Development Footprint	Description
Development Footprint 1	• General Extension Areas associated with the Project, excluding the Northern Link Road options
Development Footprint 2	• Revised alignment of the approved Northern Link Road Option 1
Development Footprint 3	• Revised alignment of the approved Northern Link Road Option 2

The Development Footprints are assessed as two options for the NSW State Assessment:

- NSW Assessment Area with [Northern Link] Road Option 1 ([Development] Footprint 1 + 2); and
- NSW Assessment Area with [Northern Link] Road Option 2 ([Development] Footprint 1 + 3).

The Development Footprints are indicative and may vary slightly following further detailed mine planning and particularly the detailed design of supporting infrastructure. While some changes to the Development Footprints would be expected over the life of the Project, any such changes are expected to be minor and therefore would have no material impact on biodiversity values.

A portion of the approved surface development area of the Mount Pleasant Operation would be relinquished as part of the Project (not cleared) (Figures 3a and 3b). These areas were referred to as the 'land swap option' in the SEARs but are collectively assessed as the Relinquishment Area in this BDAR and are further described in Section 4.2.

As described above, two alternative alignments of the western section of the revised Northern Link Road alignment are being considered by MACH. One of these options, Northern Link Road Option 2 (Development Footprint 3), would run through the target Relinquishment Area. Considering this, if Northern Link Road Option 2 (Development Footprint 3) is selected, the ultimate Relinquishment Area would be approximately 13.5 ha smaller.

The total approved disturbance area to be relinquished is either 509.8 ha if Northern Link Road Option 1 is selected (comprising 497.9 ha of native vegetation and 11.9 ha of cleared land) or 496.5 ha for Northern Link Road Option 2 (comprising 484.9 ha of native vegetation and 11.6 ha of cleared land).

Commonwealth Assessment

As described in Section 1.3, the Mount Pleasant Project was previously referred under the EPBC Act in 2011 and approval was granted in 2012 (EPBC 2011/5795). The existing EPBC Act approval (EPBC 2011/5795) already authorises general surface disturbance associated with the General Extension Areas (Development Footprint 1) (Table 1).

The Action associated with the Project (EPBC 2020/8735) covers surface disturbance associated with the revised alignment of the Northern Link Road (Option 1 or 2) (Figure 4). As described in Section 1.3, as part of the Action, the approved Western Link Road (original revised road alignment approved by EPBC 2011/5795) would no longer be constructed. This area is referred to as the Western Link Road Relinquishment Area (Figure 4).

1.5 STRUCTURE OF THIS ASSESSMENT

This BDAR is structured as follows:

Section 2 Provides landscape features relevant to the Project.

Section 3 Describes native vegetation and threatened species assessment.

Section 4 Provides an assessment of how potential impacts would be avoided and/or minimised.

Section 5 Presents a summary of the NSW assessment and credit requirements.

Section 6 Describes the biodiversity offset strategy in relation to the NSW Assessment.

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

1.6 FIELD SURVEYS

The flora and fauna survey effort for this Project was undertaken in accordance with relevant State and Commonwealth survey guidelines. In addition to the previous surveys and monitoring programmes at the operating mine site, Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B) collected the relevant ecological survey data in accordance with the BAM (OEH 2017). Flora surveys totalling 41 field days were undertaken by Hunter Eco (2020) (Attachment A) in July and August 2018, October and November 2019 and March, April, May, October, November and December 2020. Five fauna field surveys were undertaken by Future Ecology (2020) (Attachment B) in August and December 2018, and July and November 2019. The methods and results of these surveys are provided in Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B).

1.7 PUBLISHED DATABASES

Published databases used in this assessment include:

- *BioNet Atlas* (Department of Planning, Industry and Environment [DPIE] 2020b)[3];
- *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c)[4];
- *BioNet Vegetation Classification* (DPIE 2020d);

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

[4] This website is titled 'Profiles'.

- *Directory of Important Wetlands of Australia* (Department of Agriculture, Water and the Environment [DAWE] 2020a); and
- *Species Profile and Threats Database* (DAWE 2020f).

A full reference list of all information sources used in this BDAR is provided in Section 9.

1.8 LOCAL DATA

It was not necessary to use local data or deviate from the DPIE databases (DPIE 2020c, 2020d).

1.9 BAM CALCULATOR

The BAM Calculator (App last updated: 22/10/2020 [Version: 1.3.0.00]; BAM data last updated: 21/12/2020 [Version: 36]) was used in this assessment.

2 LANDSCAPE FEATURES

This section provides information on the landscape features in accordance with the BAM (OEH 2017). The BAM (OEH 2017) refers to 'Subject land' as the land to which the BAM is applied to assess the biodiversity values of the land (i.e. the landscape features [Section 2], native vegetation [Sections 3.1 and 3.2] and threatened species [Section 3.3]). This section covers Development Footprints 1 to 3, the Relinquishment Area and the Western Link Road Relinquishment Area.

Clearing of vegetation in the Hunter Valley commenced in the early 1800s. Most of the Subject land has been cleared (over 75%) and used for agricultural purposes, primarily grazing, for well over 100 years.

2.1 REGIONAL SETTING

The Subject land is located within Muswellbrook Shire Council Local Government Area (LGA) (Figure 1) within the Hunter Interim Biogeographic Regionalisation for Australia (IBRA) Subregion of the Sydney Basin IBRA Bioregion (DAWE 2020c) (Figure 5). The subregional boundary is to the north-west of the Project as shown on Figure 5. The Subject land is also within the Central Hunter Foothills (99.5%) and Upper Hunter Channels and Floodplain (0.5%) Mitchell Landscapes (Mitchell 2002) (Figure 5).

2.2 NATIVE VEGETATION COVER

Native vegetation cover is assessed on the Subject land within a buffer area surrounding the outside edge of the boundary of the Development Footprints (Figure 6). The BAM (OEH 2017) defines 'Native Vegetation Cover' as:

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

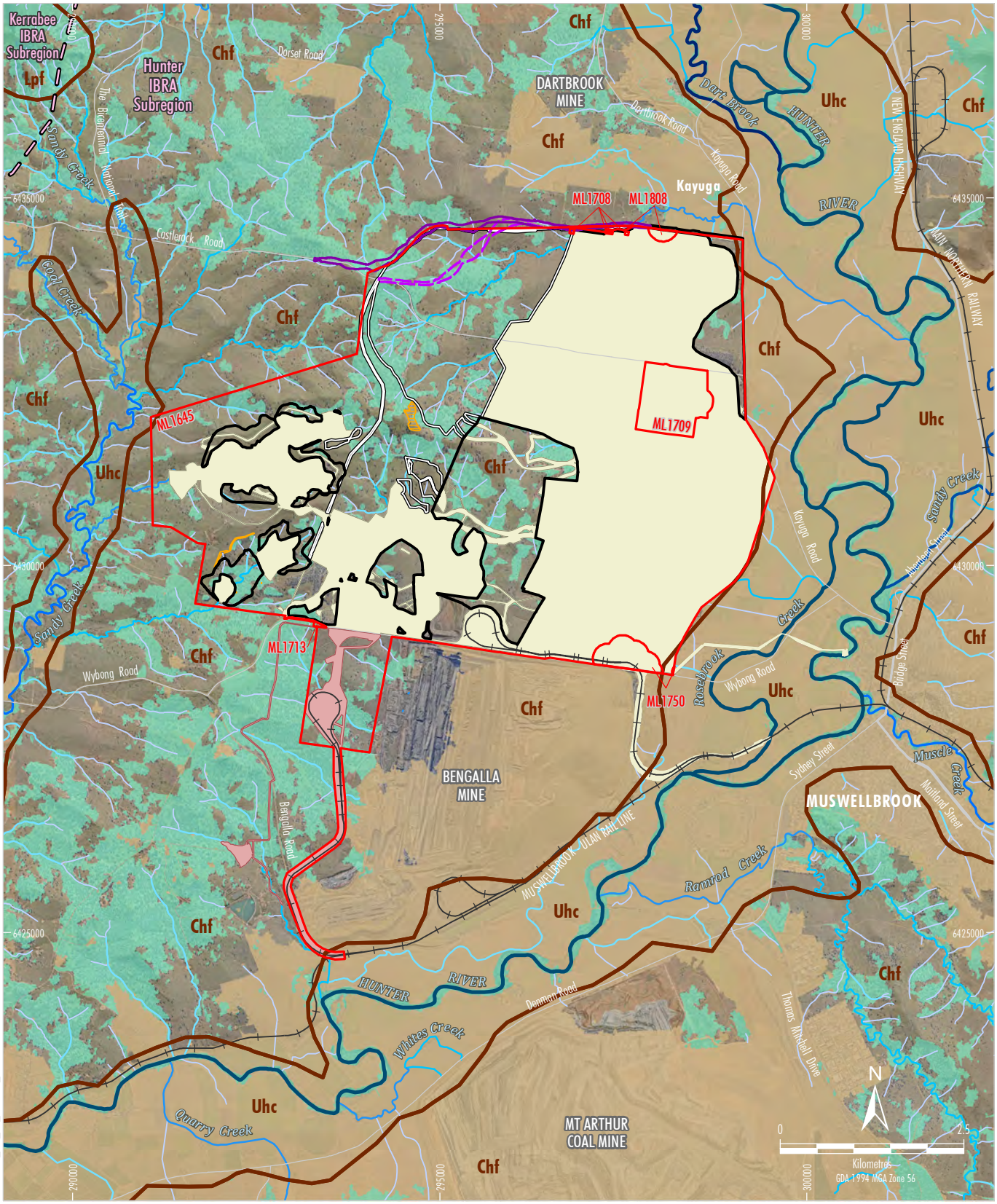
The extent of native vegetation cover as mapped by site surveys (Hunter Eco 2020) (Attachment A) and regional mapping (OEH 2016) is shown on Figure 6. There is approximately 57.1% native vegetation cover within the buffer area for the General Extension Areas (Development Footprint 1), 92.5% native vegetation cover within the buffer area for the Northern Link Road Option 1 (Development Footprint 2) and 91.1% native vegetation cover within the buffer area for the Northern Link Road Option 2 (Development Footprint 3), 83.6% native vegetation cover within the buffer area for the Relinquishment Area and 88.3% native vegetation cover within the buffer area for the Western Link Road Relinquishment Area.

2.3 HABITAT CONNECTIVITY FEATURES

The native vegetation extent/habitat connectivity as mapped by site surveys (Hunter Eco 2020; Future Ecology 2020) (Attachments A and B) and regional mapping (OEH 2016) is shown on Figure 5. Any native vegetation on Figure 5 may facilitate the movement of one or more threatened species across their range. The woodland/forest habitat is fragmented due to past land clearance.

2.4 RIVERS AND STREAMS

Drainage features (and riparian buffer distances based on Strahler stream ordering and the BAM [OEH 2017]) are shown on Figure 5 from the Department of Primary Industries – Water (2020).



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area
- Habitat Connectivity Area
- Not Native Vegetation
- Lightly Embedded Rock Area
- IBRA Subregion Boundary

Mitchell Landscapes

- Chf — Central Hunter Foothills
- Lpf — Lees Pinch Foothills
- Uhc — Upper Hunter Channels and Floodplain

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)
- 6th Order (Riparian Corridor Width 50 m)
- 7th Order (Riparian Corridor Width 50 m)
- 9th Order (Riparian Corridor Width 50 m)

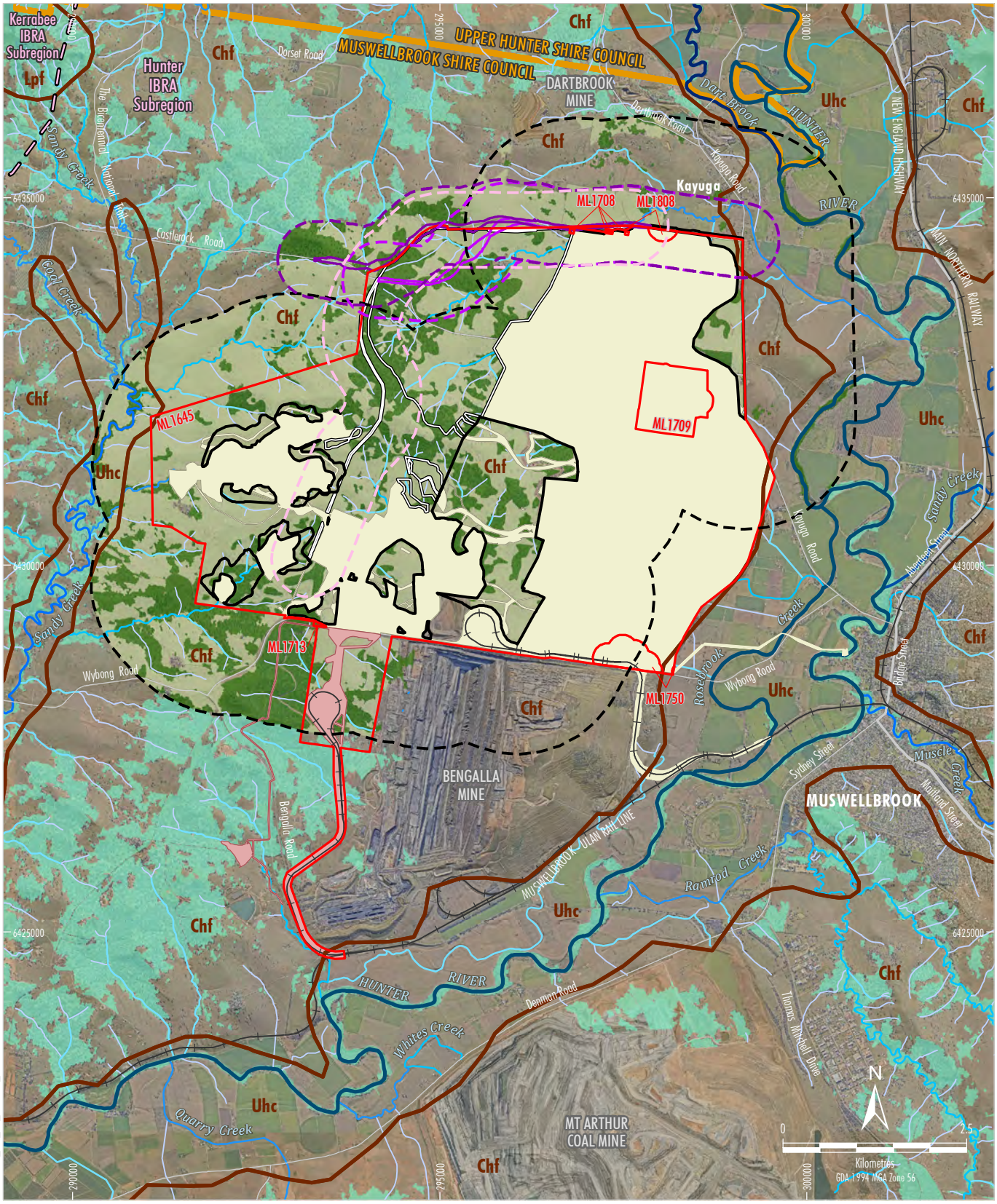
Source: MACH (2020); NSW Spatial Services (2020); Crown Lands and Water (2013); Department of Planning, Industry and Environment (2017) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Site Map

Figure 5



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area
- 1500 m Buffer to Development Footprint 1
- 500 m Buffer to Development Footprint 2
- 500 m Buffer to Development Footprint 3
- 500 m Buffer to Western Link Road Relinquishment Area
- Woodland/Connectivity within the Buffer
- Derived Native Grassland within the Buffer
- Habitat Connectivity Area outside the Buffer
- Local Government Area Boundary
- IBRA Subregion Boundary

Mitchell Landscapes

- Chf Central Hunter Foothills
- Lpf Lees Pinch Foothills
- Uhc Upper Hunter Channels and Floodplain

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)
- 6th Order (Riparian Corridor Width 50 m)
- 7th Order (Riparian Corridor Width 50 m)
- 9th Order (Riparian Corridor Width 50 m)

Source: MACH (2020); NSW Spatial Services (2020); Crown Lands and Water (2013); Department of Planning, Industry and Environment (2017) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Location Map

Figure 6

The Project is located in the Hunter River catchment. A number of small ephemeral creeks and drainage lines traverse the Subject land and drain into the Hunter River. These watercourses are dry for much of the year, with flow likely occurring only during heavy rainfall events. The Hunter River flows in a southerly direction approximately 1 km to the east of the eastern boundary of the ML (Figure 5).

2.5 WETLANDS

There are no important or local wetlands on or adjacent to the Subject land (DAWE 2020a). The closest mapped important wetland (Barrington Tops Swamps) is too far away (over 60 km north-east) to be shown on Figure 5.

2.6 AREAS OF GEOLOGICAL SIGNIFICANCE AND SOIL HAZARD FEATURES

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

2.7 AREAS OF OUTSTANDING BIODIVERSITY VALUE

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

2.8 MIGRATORY SPECIES POTENTIAL FLYWAYS

There are no defined potential flyways for migratory species listed under the EPBC Act that pass over the Subject land. However migratory birds could fly over the Subject land similar to most areas in NSW, e.g. Leaden Flycatcher (*Myiagra rubecula*) and Satin Flycatcher (*Myiagra cyanoleuca*). Migratory species are not a relevant EPBC Act controlling provision for the Project (Section 1.2).

2.9 SITE CONTEXT COMPONENTS

A site-based assessment method described in the BAM (OEH 2017) was used for the General Extension Areas (Development Footprint 1) and Relinquishment Area, whereby a 1,500 metre (m) buffer is placed around the development site. Northern Link Road Options 1 and 2 (Development Footprints 2 and 3) and Western Link Road Relinquishment Area are greater than 3.5 km in length (i.e. Northern Link Road Option 1 [Development Footprint 2] is approximately 6 km, Northern Link Road Option 2 [Development Footprint 3] is approximately 5 km and Western Link Road Relinquishment Area is approximately 7.5 km). These footprints meet the definition of linear shaped development whereby a 500 m buffer is placed around the development.

The extent of native vegetation cover is described in Section 2.2. The patch size relative to the vegetation zone is described in Section 3.2.2. There are no additional features required to be assessed by the SEARs.

Areas not covered by native vegetation on the Site Map (Figure 5) are cropping/grazing, farm dams, disturbed land, dwellings, infrastructure and local roads. There were no notable differences between mapped vegetation extent and aerial imagery.

3 NSW BIODIVERSITY ASSESSMENT

This section provides a description of the native vegetation and threatened species relevant to the Development Footprints.

3.1 NATIVE VEGETATION

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

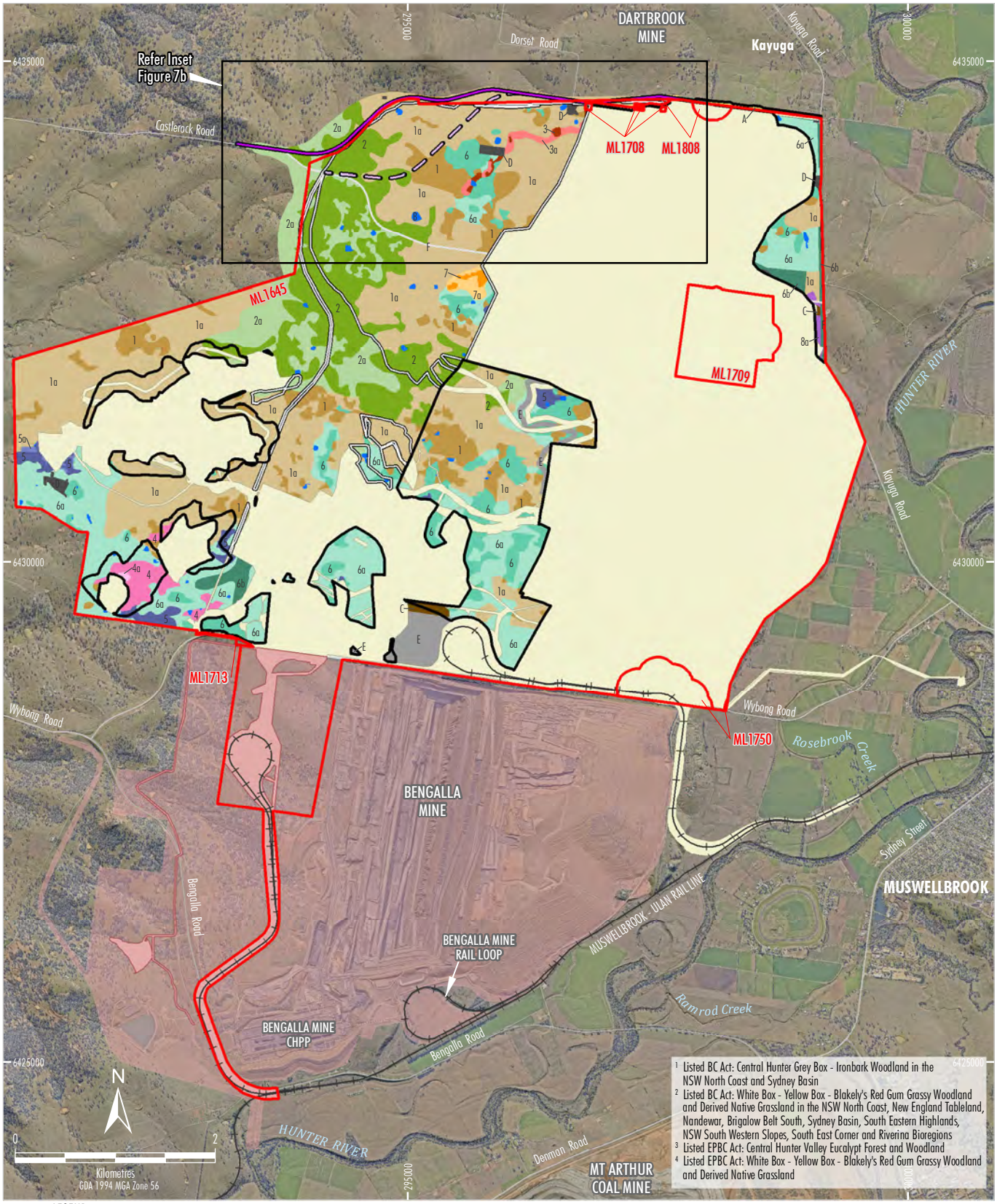
3.1.1 Plant Community Types

Hunter Eco (2020) (Attachment A) identified and mapped Plant Community Types (PCTs) on the Subject land and surrounding area in accordance with the BAM (OEH 2017) and *BioNet Vegetation Classification* (DPIE 2020d) (Figures 7a and 7b) (Table 2). The PCTs in the Development Footprints are assigned to a vegetation class in Table 2. Attachment C provides the Percent Cleared Values from the *BioNet Vegetation Classification* (DPIE 2020d) and the Vegetation Integrity scores (VI scores) (Section 3.2.3).

Hunter Eco (2020) describes the PCT and vegetation zone mapping (including the species relied upon for identification of PCTs) in Attachment A. A site-specific vegetation community name is provided in Table 2 for each vegetation zone. PCTs occurred as either remnant woodland patches or DNG areas with scattered paddock trees.

Table 2 quantifies the PCTs in each Development Footprint as well as the overall impacts associated with NSW Assessment Area with Road Option 1 (Footprint 1 + 2) and NSW Assessment Area with Road Option 2 (Footprint 1 + 3). The native vegetation in the Development Footprints predominantly comprises *Narrow-leaved Ironbark Shrubby Forest* (PCT 1605) in woodland and DNG (approximately 47%, 218.9 ha to 218.7 ha) and *Grey Box x White Box Grassy Woodland* (PCT 483) in woodland and DNG (approximately 46%, 227.6 ha to 223.8 ha).

There are no PCTs that contain hybrid Grey Box x White Box (*Eucalyptus albens* x *moluccana*), or White Box (*Eucalyptus albens*), in combination with Spotted Gum (SG) (*Corymbia maculata*) as canopy species in the *BioNet Vegetation Classification* (DPIE 2020d). PCT 483 is the closest match for this vegetation community and therefore PCT 483 was stratified into different vegetation zones depending on the presence of Spotted Gum (i.e. 483, 483 DNG, 483 SG and 483 SG DNG).



MAC-18-02_SSD_EIS_App BDAR_2136

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 5a Derived Native Grassland (PCT1602)
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- A Cropping/Grazing
- B Dam
- C Disturbed
- D Dwellings
- E Infrastructure
- F Local Roads

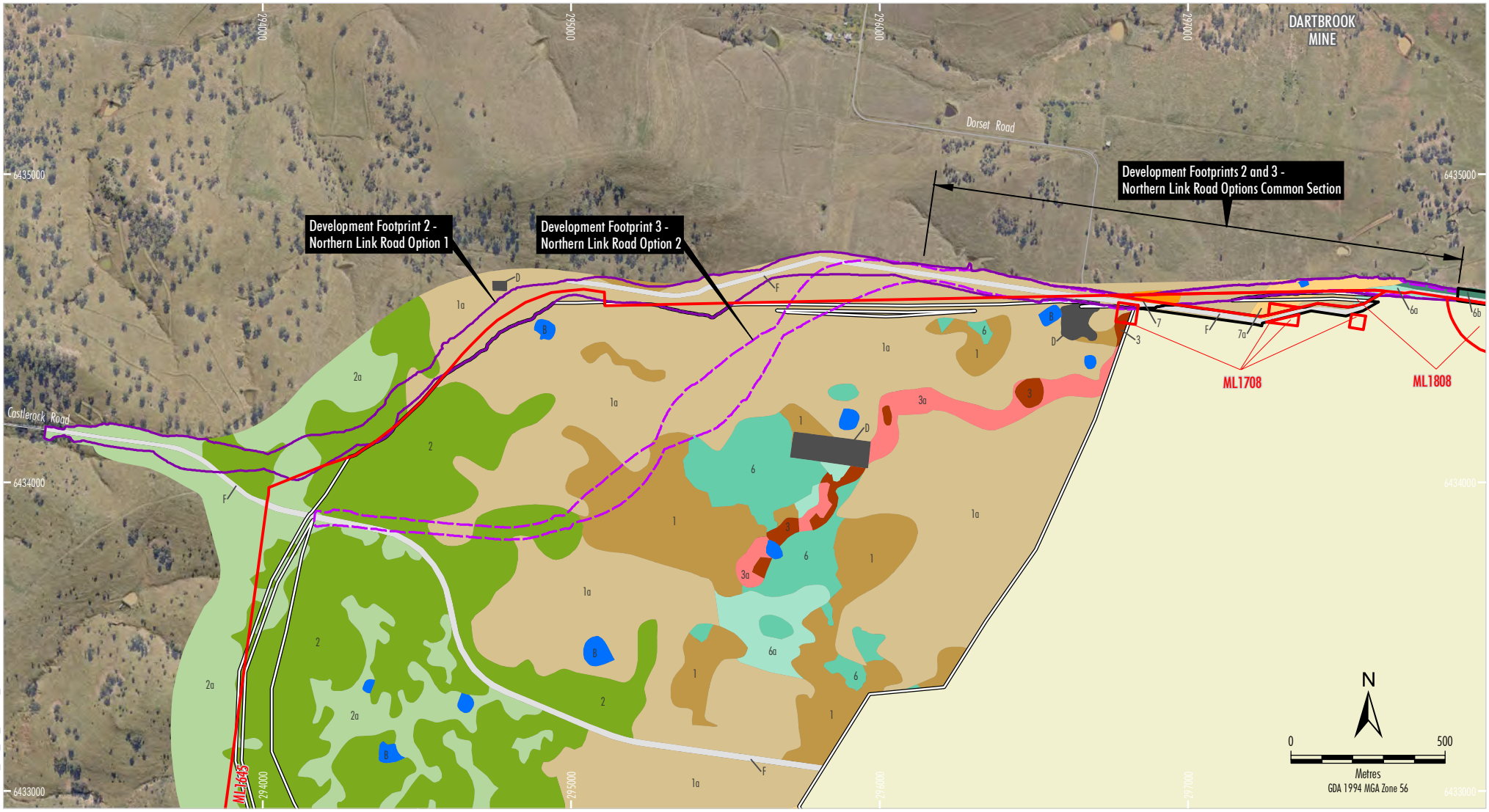
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Mapping

Figure 7a



MAC 18-02_SSD_EIS_App BDAR_2140

LEGEND

Mining Lease Boundary (Mount Pleasant Operation)
Project Continuation of Existing/Approved Surface Development (DA92/97)
Development Footprint 1 - General Extension Areas
Development Footprint 2 - Northern Link Road Option 1
Development Footprint 3 - Northern Link Road Option 2
Relinquishment Area

Grassy Woodlands

1 Grey Box x White Box Grassy Woodland (PCT483) [2,4]
1a Derived Native Grassland (PCT483) [2,4]
2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2,4]
2a Derived Native Grassland (PCT483) [2,4]
3 Forest Red Gum Grassy Open Forest (PCT618) [2,4]
3a Derived Native Grassland (PCT618) [2,4]

Dry Sclerophyll Forests (Shrub/grass sub-formation)

6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
6a Derived Native Grassland (PCT1605)
6b Plantation (PCT1605)
7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2,4]
7a Derived Native Grassland (PCT1606) [2,4]

Other

B Dam
D Dwellings
F Local Roads

[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Mapping Inset

Figure 7b

Table 2
Plant Community Types within the Development Footprints

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
Grassy Woodlands							
Western Slopes Grassy Woodlands							
1	Grey Box x White Box Grassy Woodland[2,4]	483	44.5	0.4	2.6	**44.9**	**47.1**
1a	Derived Native Grassland[2,4]	483 DNG	143.6	14.8	15	**158.4**	**158.6**
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	483 SG	8.7	4.6	2.5	**13.3**	**11.2**
2a	Derived Native Grassland[2,4]	483 SG DNG	6.7	4.3	0.2	**11**	**6.9**
Coastal Valley Grassy Woodlands							
3	Forest Red Gum Grassy Open Forest[2,4]	618	0.1	0.1	0.1	**0.2**	**0.2**
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	1691	16.3	0	0	**16.3**	**16.3**
4a	Derived Native Grassland	1691 DNG	0.9	0	0	**0.9**	**0.9**
Dry Sclerophyll Forests (Shrub/grass sub-formation)							
Hunter-Macleay Dry Sclerophyll Forests							
5	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	1602	7	0	0	**7**	**7**
North-west Slopes Dry Sclerophyll Woodlands							
6	Narrow-leaved Ironbark Shrubby Forest[3]	1605	66.6	0	0	**66.6**	**66.6**
6a	Derived Native Grassland	1605 DNG	140.1	0.6	0.5	**140.7**	**140.6**

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
6b	Plantation	1605 Plantation	11.2	0.4	0.3	**11.6**	**11.5**
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	1606	0.1	0.5	0.5	**0.6**	**0.6**
7a	Derived Native Grassland[2,4]	1606 DNG	0.2	1.7	1.6	**1.9**	**1.8**
Dry Sclerophyll Forests (Shrubby sub-formation)							
Western Slopes Dry Sclerophyll Forests							
8a	Derived Native Grassland	1655 DNG	2.5	0	0	**2.5**	**2.5**
Total Woodland/Forest			**154.5**	**6**	**6**	**160.5**	**160.5**
Total Derived Native Grassland			**294**	**21.4**	**17.3**	**315.4**	**311.3**
Total Native Vegetation			**448.5**	**27.4**	**23.3**	**475.9**	**471.8**
Total Disturbed/Other			**25.1**	**4.5**	**2.6**	**29.6**	**27.7**
Total Area			**473.6**	**31.9**	**25.9**	**505.5**	**499.5**

1 *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions Endangered Ecological Community* (herein referred to as *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*).

2 *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 Critically Endangered Ecological Community* (herein referred to as *Box-Gum Woodland CEEC listed under the BC Act*).

3 *Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community* (herein referred to as *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act*) occurs in the General Extension Areas (Development Footprint 1) covered by EPBC 2011/5795.

4 *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community* (herein referred to as *Box-Gum Woodland CEEC listed under the EPBC Act*).

3.1.2 Threatened Ecological Communities

Hunter Eco (2020) (Attachment A) undertook targeted surveys for potentially occurring TECs listed under the BC Act. TECs listed under the BC Act are shown on Figures 8a and 8b and listed in Table 3.

Table 3
Threatened Ecological Communities listed under the BC Act

Threatened Ecological Community	Conservation Status[1]	Associated PCT	Area (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
Central Hunter Grey Box – Ironbark Woodland EEC	Endangered	1691	16.3	0	0	16.3	16.3
Box-Gum Woodland CEEC	Critically Endangered	483, 618, 1606	203.9	26.4	22.5	230.3	226.4

[1] Conservation status under the BC Act (current as at January 2021).

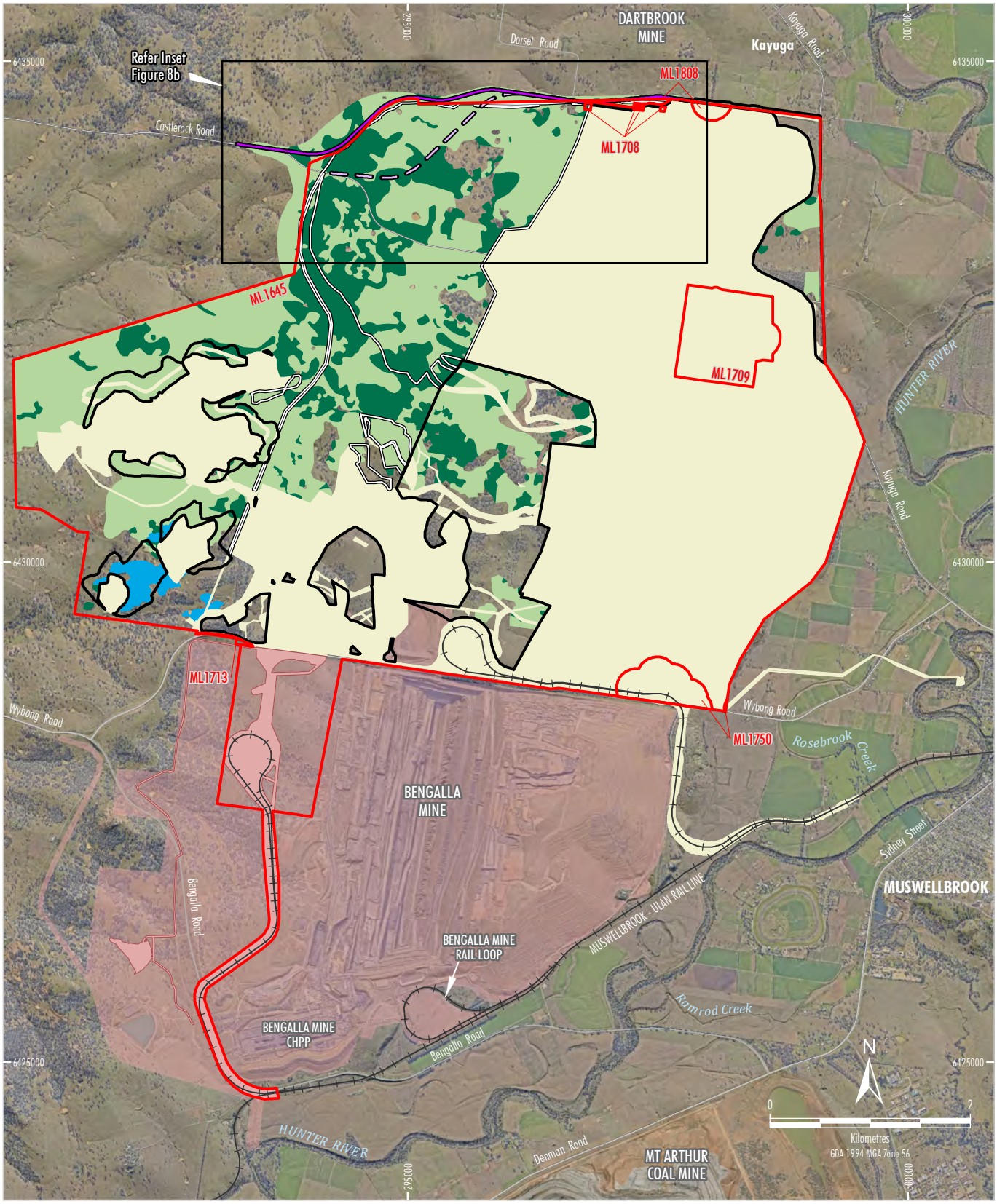
As noted in Table 2 and Figures 7a and 7b, some vegetation zones in the General Extension Areas (Development Footprint 1) equate to TECs listed under the EPBC Act. As noted in Section 1.3, the EPBC Act approval (EPBC 2011/5795) already authorises surface disturbance associated with the General Extension Areas (Development Footprint 1) and therefore TECs listed under the EPBC Act are not relevant to the General Extension Areas (Development Footprint 1) credit calculation. Only the *Box-Gum Woodland CEEC listed under the EPBC Act* is present in the Northern Link Road Options 1 and 2 (Development Footprints 2 and 3) as per Table 3 and Figure 8b.

3.1.3 Plant Community Types Percent Cleared Value

The BAM (OEH 2017) 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* (DPIE 2020d). Percent cleared values for each PCT are provided in Attachment C.

3.2 VEGETATION INTEGRITY ASSESSMENT

Vegetation integrity is a measure of the condition of native vegetation. The vegetation integrity (site condition) plot data was collected by Hunter Eco (2020) (Attachment A). The vegetation integrity (site condition) plots used in the BAM Calculator are shown on Figures 9a and 9b. A total of 96 plots were used in this assessment, with the number of plots meeting or exceeding the requirements per area of each zone. The vegetation integrity (site condition) data is provided in Attachment C.



MAC-18-02_SSD_EIS_App BDAR_218D

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Threatened Ecological Communities

- Box-Gum Woodland CEEC as listed under the BC Act and EPBC Act
- Box-Gum Woodland (DNG) CEEC as listed under the BC Act and EPBC Act
- Central Hunter Grey Box - Ironbark Woodland EEC listed under the BC Act

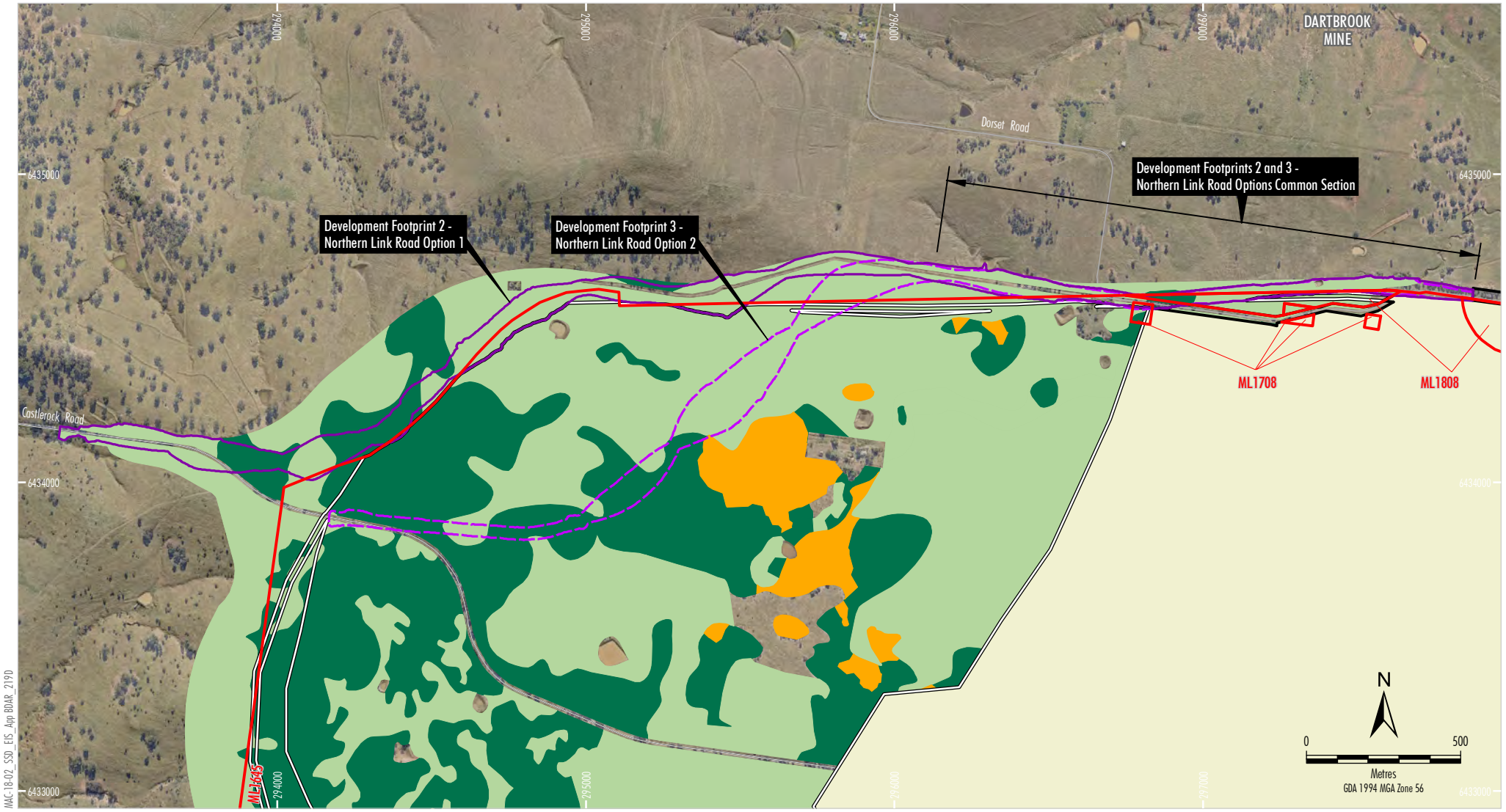
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Ecological Communities Listed Under the BC Act

Figure 8a



MAC 18-02_SSD_EIS_App BDAR_2190

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Threatened Ecological Communities

- Box-Gum Woodland CEEC as listed under the BC Act and EPBC Act
- Box-Gum Woodland (DNG) CEEC as listed under the BC Act and EPBC Act
- Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act

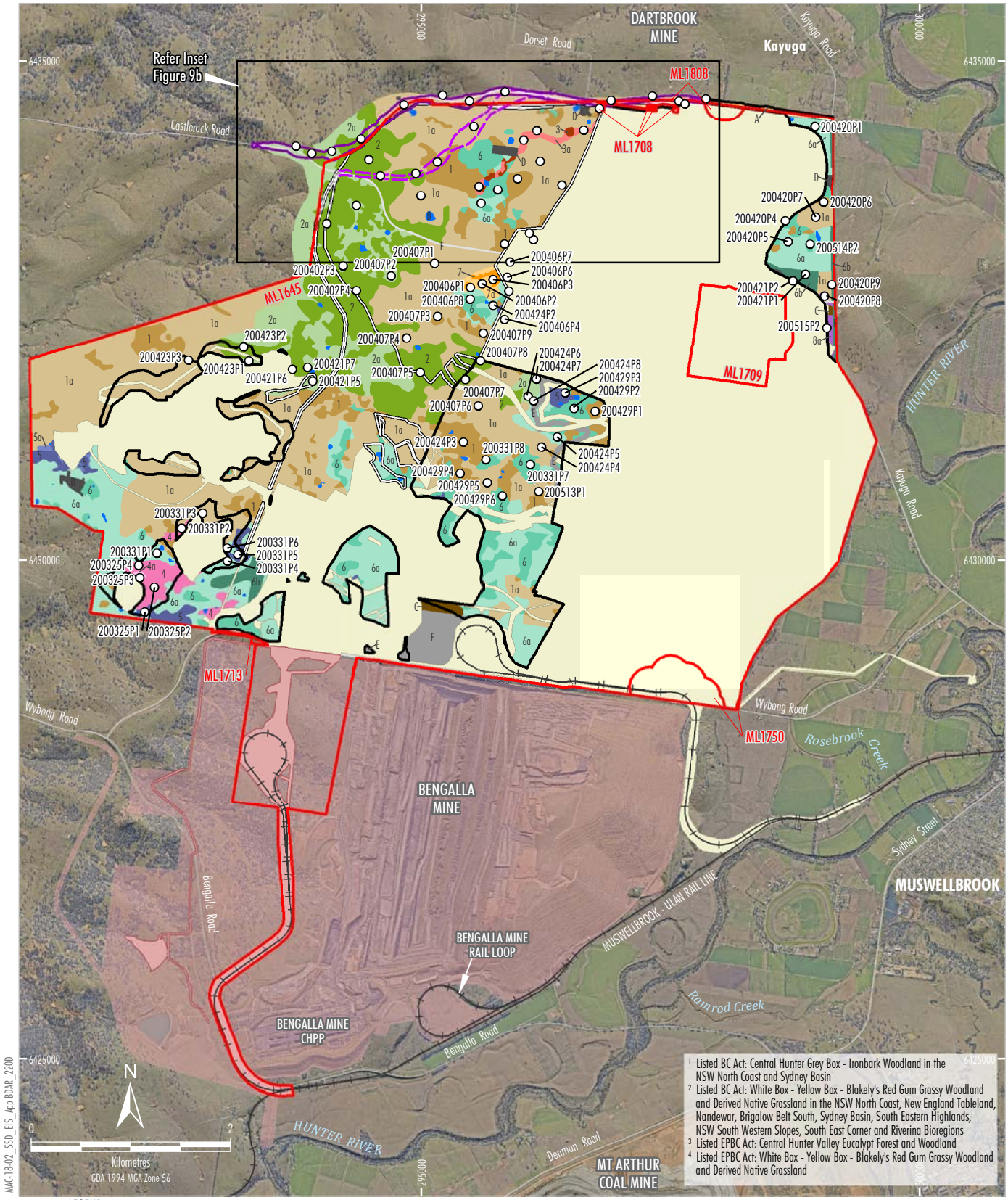
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Ecological Communities Listed Under the BC Act and EPBC Act Inset

Figure 8b



MAC-18-02_SSD_EIS_App BDAR_220D

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 5a Derived Native Grassland (PCT1602)
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- A Cropping/Grazing
- B Dam
- C Disturbed
- D Dwellings
- E Infrastructure
- F Local Roads
- Vegetation Integrity Plot

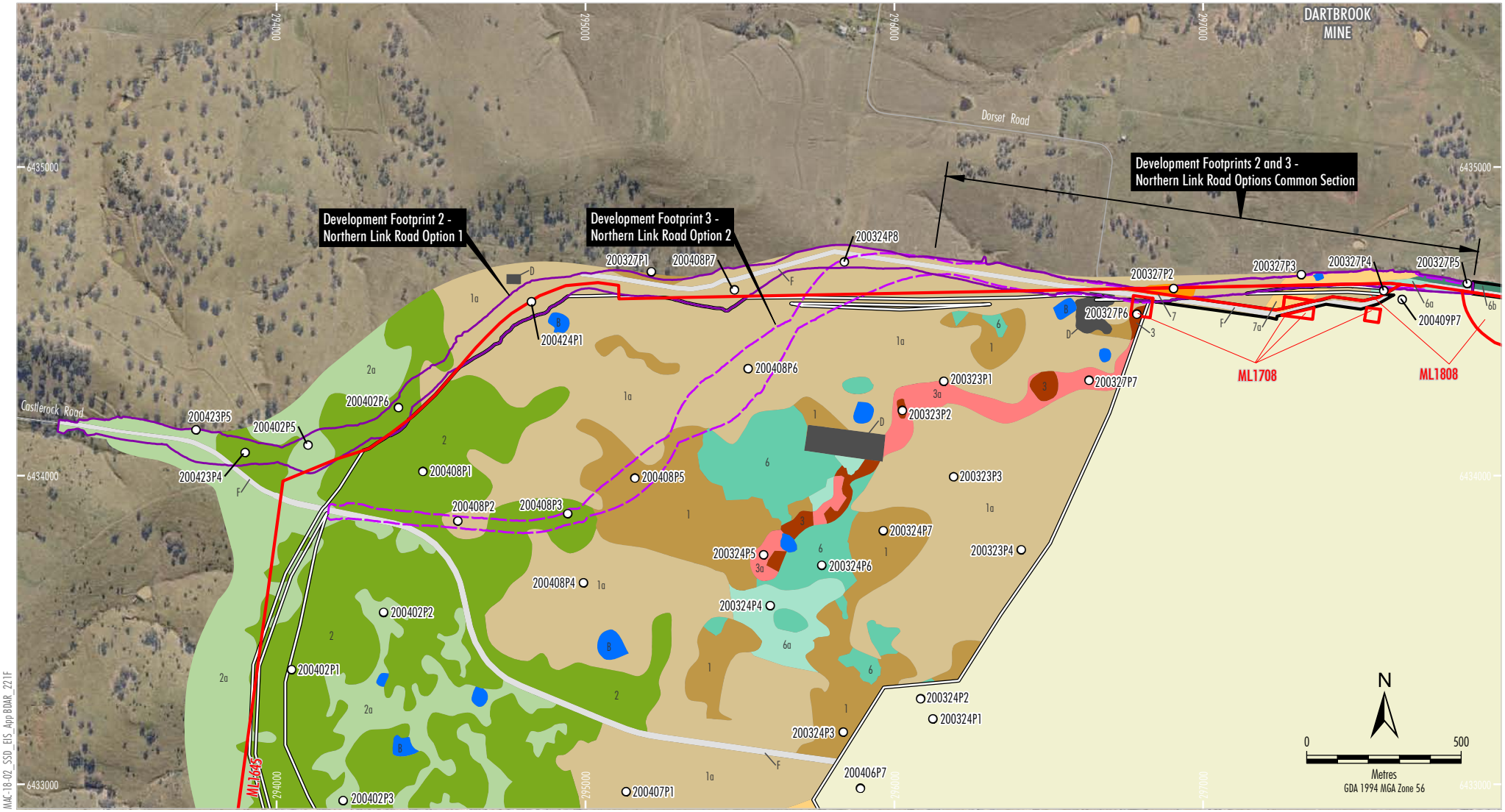
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Integrity Plot Locations

Figure 9a



MAC-18-02_SSD_EIS_AppBDAR_221F

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Other

- B Dam
- D Dwellings
- F Local Roads
- Vegetation Integrity Plot

[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Integrity Plot Locations Inset

Figure 9b

3.2.1 Vegetation Zones

Fifteen vegetation zones (i.e. areas of native vegetation that are the same PCT and similar broad condition states) were mapped in the Development Footprints (Table 2) (Figures 7a and 7b). All of the PCTs recorded in the Development Footprints have a 'sensitivity to loss' value of 'high' or 'very high', with the exception of PCT 1655 which has a 'sensitivity to loss' of 'moderate', according to DPIE (2020d). Sensitivity to loss, being related to the estimated percent cleared since European settlement, is only applicable to the woodland component of the mapped PCTs. PCT 1655 only exists in the Development Footprint in DNG form.

3.2.2 Patch Size

The BAM (OEH 2017) defines 'Patch Size' as:

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

Patch size for the Development Footprints for both woodland and DNG was >100 ha.

3.2.3 Vegetation Integrity Score

The BAM Calculator calculates the 'composition condition score', 'structure condition score' and 'function condition score' for each vegetation zone using input from the plot data (Attachment C). Five out of 15 vegetation zones have hollow bearing trees. Those that do not have hollow-bearing trees are either plantation (Vegetation Zone 6b), moderate grassy woodland (Vegetation Zone 7) or DNG (Vegetation Zones 1a, 2a, 4a, 6a, 7a and 8a).

An overall score of the vegetation integrity for each vegetation zone is calculated in the BAM Calculator using input from the plot data. According to the BAM Calculator, most of the vegetation zones have a VI score requiring an offset (Attachment C). Vegetation zones 1a, 2a, 4a, 6a and 8a in the General Extension Areas (Development Footprint 1), 1a, 2a and 6a in Northern Link Road Option 1 (Development Footprint 2), and 1a and 6a in Northern Link Road Option 2 (Development Footprint 3) have VI scores <15 and therefore do not require an offset (OEH 2017) (Attachment C).

3.2.4 Local Data

It was not necessary to use local data to deviate from the DPIE databases (DPIE 2020c, 2020d).

3.3 THREATENED SPECIES

Threatened species that are 'ecosystem credit species' and/or 'species credit species' are pre-determined by DPIE (2020c) in the *BioNet Threatened Biodiversity Data Collection*. The BAM (OEH 2017) states:

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

3.3.1 Ecosystem Credit Species - Habitat Suitability Assessment

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

Step 1: Identify threatened species for assessment; and

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

These steps are applied below.

3.3.1.1 Step 1: Identify Ecosystem Species for Assessment

A total of 35 ecosystem credit species for assessment are listed in Table 4, of which 32 are from the BAM Calculator (for one or more Development Footprints as represented by the dots in the table) as required by the BAM (OEH 2017). Relevant databases and literature were reviewed for additional ecosystem credit species (Table 5) and as a result, Black Falcon (*Falco subniger*), Spotted Harrier (*Circus assimilis*) and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) were added to Table 4. Species shaded in Table 4 are species with records in the Subject land (conversely species without shading in Table 4 have not been recorded in the Subject land).

There are a number of ecosystem credit species listed in Table 4 with a high 'sensitivity to potential gain' (as defined by DPIE [2020c]) that potentially use habitat across the vegetation zones (e.g. woodland birds). The ecosystem credit calculation uses the highest 'sensitivity to potential gain' class in the credit calculation for a vegetation zone. In this case, the high 'sensitivity to potential gain' would be used in the BAM Calculator to generate the ecosystem credits.

Table 5 provides a summary of the threatened species records in the locality from survey or database records (threatened species shaded in Table 5 are species with records within the Subject land).

Table 4
Ecosystem Credit Species from the BAM Calculator

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Sensitivity to Potential Gain (DPIE 2020c)	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
		BC Act	EPBC Act					
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	●	●	●
Circus assimilis	Spotted Harrier	V	-	E	Moderate	-	-	-
Hieraaetus morphnoides	Little Eagle	V	-	S/E	Moderate	●	●	●
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	High	●	●	●
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	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	●	●	●
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	●	●	●

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Sensitivity to Potential Gain (DPIE 2020c)	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
		BC Act	EPBC Act					
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	●	●	●
Phascolarctos cinereus	Koala	V	V	S/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	●	●	●
Miniopterus orianae oceanensis	Large Bent-winged 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	●	●	●

Note: Shaded species are species with records in the Subject land.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

Table 5
Threatened Flora and Fauna Species Known or Predicted to Occur in the Locality

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Database Records				Recorded in Previous Studies and/or Recent Surveys[7]
		BC Act	EPBC Act		Potentially Associated with PCTs in the Subject land[3]	EPBC Act Protected Matters Search[4]	BioNet Atlas[5]	ALA[6]	
Flora									
Acacia pendula	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	EP	-	S	Yes	-	Yes	Yes	-
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	Yes	-	-	-	-
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	S	Yes	-	Yes	Yes	B, E, I
Cynanchum elegans	White-flowered Wax Plant	E	E	S	Yes	-	-	-	-
Diuris tricolor	Pine Donkey Orchid	V	-	S	Yes	-	Yes	Yes	-
Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook Local Government Area	EP	-	S	Yes	-	Yes	-	-
Eucalyptus camaldulensis	River Red Gum (*Eucalyptus camaldulensis* population in the Hunter Catchment)	EP	-	S	No	-	Yes	Yes	-
Eucalyptus glaucina	Slaty Red Gum	V	V	S	Yes	-	-	Yes	-
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	S	No	-	Yes	-	-
Eucalyptus pumila	Pokolbin Mallee	V	V	S	Yes	-	-	-	-
Euphrasia arguta	-				No	Predicted	-	-	-
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S	Yes	-	-	-	-
Ozothamnus tesselatus	-	V	V	S	Yes	-	-	-	-

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Database Records				Recorded in Previous Studies and/or Recent Surveys[7]
		BC Act	EPBC Act		Potentially Associated with PCTs in the Subject land[3]	EPBC Act Protected Matters Search[4]	BioNet Atlas[5]	ALA[6]	
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	Yes	-	-	-	-
Pomaderris queenslandica	Scant Pomaderris	E	-	S	Yes	-	-	-	-
Pomaderris reperta	Denman Pomaderris	CE	CE	S	Yes	-	-	-	-
Prasophyllum petilum	Tarengo Leek Orchid	E	E	S	No	-	Yes	Yes	-
Prasophyllum sp. Wybong	A Leek-orchid	-	CE	S	No	Predicted	-	-	-
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	Yes	-	-	-	-
Prostanthera cryptandroides subsp. *cryptandroides*	Wollemi Mint-bush	V	V	S	Yes	-	-	-	-
Pterostylis chaetophora	-	V	-	S	Yes	-	-	-	-
Pterostylis gibbosa	Illawarra Greenhood	E	E	S	No	Predicted	-	-	-
Thesium australe	Austral Toadflax	V	V	S	Yes	Predicted	Yes	Yes	-
Amphibians									
Litoria aurea	Green and Golden Bell Frog	E	V	S	Yes	-	-	-	-
Litoria brevipalmata	Green-thighed Frog	V	-	S	Yes	-	-	-	-
Reptiles									
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	Yes	Predicted	-	-	-
Delma impar	Striped Legless Lizard	V	V	S	Yes	Predicted	Yes	Yes	H
Tiliqua occipitalis	Western Blue-tongued Lizard	V	-	E	No	-	-	Yes	-
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	Yes	-	-	-	-
Birds									
Anseranas semipalmata	Magpie Goose	V	-	E	No	-	Yes	Yes	-
Stictonetta naevosa	Freckled Duck	V	-	E	No	-	-	Yes	-
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	E	No	-	Yes	Yes	-

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Database Records				Recorded in Previous Studies and/or Recent Surveys[7]
		BC Act	EPBC Act		Potentially Associated with PCTs in the Subject land[3]	EPBC Act Protected Matters Search[4]	BioNet Atlas[5]	ALA[6]	
Botaurus poiciloptilus	Australasian Bittern	E	E	E	No	Predicted	-	Yes	-
Falco hypoleucos	Grey Falcon	E	-	E	No	-	-	Yes	-
Falco subniger	Black Falcon	V	-	E	No	-	Yes	Yes	C, H
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Yes	-	-	Yes	-
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	Yes	Predicted	Yes	Yes	-
Circus assimilis	Spotted Harrier	V	-	E	No	-	Yes	Yes	H
Erythrotriorchis radiatus	Red Goshawk	CE	V	S	No	Predicted	-	-	-
Hieraaetus morphnoides	Little Eagle	V	-	S/E	Yes	-	Yes	Yes	-
Turnix maculosus	Red-backed Button-quail	V	-	S	No	-	-	Yes	-
Burhinus grallarius	Bush Stone-curlew	E	-	S	Yes	-	-	Yes	-
Rostratula australis	Australian Painted Snipe	E	E	E	No	Predicted	-	Yes	-
Numenius madagascariensis	Eastern Curlew	-	CE	S/E	No	Predicted	-	-	-
Calidris ferruginea	Curlew Sandpiper	E	CE	S/E	No	Predicted	-	-	-
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	Yes	-	Yes	Yes	-
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Yes	-	-	-	-
Glossopsitta pusilla	Little Lorikeet	V	-	E	Yes	-	Yes	Yes	H
Neophema pulchella	Turquoise Parrot	V	-	E	Yes	-	Yes	Yes	-
Lathamus discolor	Swift Parrot	E	CE	S/E	Yes	Predicted	-	Yes	-
Pezoporus wallicus wallicus	Eastern Ground Parrot	V	-	S	No	-	-	Yes	-
Tyto novaehollandiae	Masked Owl	V	-	S/E	Yes	-	Yes	Yes	-
Ninox strenua	Powerful Owl	V	-	S/E	Yes	-	Yes	Yes	-
Ninox connivens	Barking Owl	V	-	S/E	Yes	-	Yes	Yes	-
Hirundapus caudacutus	White-throated Needletail	-	V	S	No	Predicted	-	Yes	G

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Database Records				Recorded in Previous Studies and/or Recent Surveys[7]
		BC Act	EPBC Act		Potentially Associated with PCTs in the Subject land[3]	EPBC Act Protected Matters Search[4]	BioNet Atlas[5]	ALA[6]	
Todiramphus chloris	Collared Kingfisher	V	-	S	No	-	-	Yes	-
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	E	Yes	-	Yes	Yes	C, H
Chthonicola sagittata	Speckled Warbler	V	-	E	Yes	-	Yes	Yes	A, C, D, F, G, H
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	E	Yes	-	Yes	Yes	D
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	Yes	Predicted	Yes	Yes	-
Grantiella picta	Painted Honeyeater	V	V	E	Yes	Predicted	-	Yes	-
Epthianura albifrons	White-fronted Chat	V	-	E	No	-	-	Yes	-
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	E	Yes	-	-	-	-
Petroica phoenicea	Flame Robin	V	-	E	Yes	-	Yes	Yes	H
Petroica boodang	Scarlet Robin	V	-	E	Yes	-	-	Yes	H
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	E	Yes	-	Yes	Yes	C, H
Daphoenositta chrysoptera	Varied Sittella	V	-	E	Yes	-	Yes	Yes	A
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	E	No	-	Yes	Yes	A, C, H
Stagonopleura guttata	Diamond Firetail	V	-	E	Yes	-	Yes	Yes	C
Mammals									
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	Yes	Predicted	Yes	Yes	-
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	Yes	-	Yes	Yes	-
Planigale maculata	Common Planigale	V	-	S	Yes	-	-	-	-
Phascolarctos cinereus	Koala	V	V	S/E	Yes	Predicted	Yes	Yes	-

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Database Records				Recorded in Previous Studies and/or Recent Surveys[7]
		BC Act	EPBC Act		Potentially Associated with PCTs in the Subject land[3]	EPBC Act Protected Matters Search[4]	BioNet Atlas[5]	ALA[6]	
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	Yes	-	-	-	-
Petaurus australis	Yellow-bellied Glider	V	-	E	Yes	-	Yes	Yes	-
Petaurus norfolcensis	Squirrel Glider	V	-	S	Yes	-	Yes	Yes	C, G, H
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S	Yes	Predicted	-	-	-
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	Yes	Predicted	Yes	Yes	C, H
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	E	Yes	-	Yes	Yes	C, F, G^{Po}, H
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	E	Yes	-	Yes	Yes	C, F
Miniopterus australis	Little Bent-winged Bat	V	-	S/E	No	-	Yes	Yes	-
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	S/E	Yes	-	Yes	Yes	A, C, F, H
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E	Yes	Predicted	-	-	-
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	Yes	Predicted	Yes	Yes	-
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	E	Yes	-	Yes	Yes	C^{Po}, F^{Po}, G^{Po}
Myotis macropus	Southern Myotis	V	-	S	Yes	-	Yes	Yes	C
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	E	Yes	-	Yes	Yes	C^{Po}, F^{Po}, G^{Po}
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	Yes	-	Yes	Yes	G

Note: Shaded species are species with records in the Subject land.

1 Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

2 Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

3 DPIE (2020c).

4 DAWE (2020b).

5 DPIE (2020b).

6 Atlas of Living Australia (ALA) (2020).

7 A = Cumberland Ecology (2006). B = Cumberland Ecology (2007). C = Cumberland Ecology (2009a). D = Cumberland Ecology (2010). E = Cumberland Ecology (2015b). F = Eco Logical Australia (ELA) (2017a). G = ELA (2017b). H = Future Ecology (2020). I = Hunter Eco (2020). ^{Po} = Possible recording.

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

A total of eight threatened species listed in Table 4 have not been recorded in the Subject land and are unlikely to be relevant to the Project (i.e. the species in Table 4 that are not highlighted). The BAM (OEH 2017) states:

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

No ecosystem species were removed from the BAM Calculator as the species with the highest 'sensitivity to potential gain' class were recorded in the Project Additional Disturbance Area and therefore removal of any other species would not change the ecosystem credit requirement.

3.3.2 Species Credit Species - Habitat Suitability Assessment

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

Step 1: Identify species credit species for assessment.

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

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

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

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

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

These steps are discussed below.

3.3.2.1 Step 1: Identify Species Credit Species for Assessment

A total of 49 species credit species are listed in Table 6 for assessment, of which 42 are from the BAM Calculator (for one or more Development Footprints as represented by the dots in the table) as required by the BAM (OEH 2017). Relevant databases and literature were reviewed for additional species credit species and as a result, Tarengo Leek Orchid (*Prasophyllum petilum*) (syn. *Prasophyllum* sp. Wybong), Austral Toadflax (*Thesium australe*), Pink-tailed Legless Lizard (*Aprasia parapulchella*), Red Goshawk (*Erythrotriorchis radiatus*), Eastern Curlew (*Numenius madagascariensis*), Curlew Sandpiper (*Calidris ferruginea*) and White-throated Needletail (*Hirundapus caudacutus*) were added to Table 6.

Species shaded in Table 6 are species with records in the Subject land.

Table 6
Initial List of Species Credit Species for Assessment

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
		BC Act	EPBC Act				
Flora							
Acacia pendula	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	EP	-	S	●	●	●
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	●	●	●
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	S	●	●	●
Cynanchum elegans	White-flowered Wax Plant	E	E	S	●	●	●
Diuris tricolor	Pine Donkey Orchid	V	-	S	●	●	●
Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook Local Government Area	EP	-	S	●	-	-
Eucalyptus glaucina	Slaty Red Gum	V	V	S	●	-	-
Eucalyptus pumila	Pokolbin Mallee	V	V	S	●	-	-
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S	●	●	●
Ozothamnus tesselatus	-	V	V	S	●	●	●
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	●	●	●
Pomaderris queenslandica	Scant Pomaderris	E	-	S	●	●	●
Pomaderris reperta	Denman Pomaderris	CE	CE	S	●	-	-
Prasophyllum petilum (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	E	E	S	-	-	-
Prostanthera cineolifera	Singleton Mint Bush	V	V	S	●	-	-
Prostanthera cryptandroides subsp. cryptandroides	Wollemi Mint-bush	V	V	S	●	-	-
Pterostylis chaetophora	-	V	-	S	●	-	-

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
		BC Act	EPBC Act				
Thesium australe	Austral Toadflax	V	V	S	●	●	●
Amphibians							
Litoria aurea	Green and Golden Bell Frog	E	V	S	●	●	●
Litoria brevipalmata	Green-thighed Frog	V	-	S	●	-	-
Reptiles							
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	●	●	●
Delma impar	Striped Legless Lizard	V	V	S	●	●	●
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	●	●	●
Birds							
Lophoictinia isura	Square-tailed Kite	V	-	S/E	●	●	●
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	●	●	●
Erythrotriorchis radiatus	Red Goshawk	CE	V	S	-	-	-
Hieraaetus morphnoides	Little Eagle	V	-	S/E	●	●	●
Burhinus grallarius	Bush Stone-curlew	E	-	S	●	●	●
Numenius madagascariensis	Eastern Curlew	-	CE	S/E	-	-	-
Calidris ferruginea	Curlew Sandpiper	E	CE	S/E	-	-	-
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	●	●	●
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	●	●	●
Lathamus discolor	Swift Parrot	E	CE	S/E	●	●	●
Tyto novaehollandiae	Masked Owl	V	-	S/E	●	●	●
Ninox strenua	Powerful Owl	V	-	S/E	●	●	●
Ninox connivens	Barking Owl	V	-	S/E	●	●	●
Hirundapus caudacutus	White-throated Needletail	-	V	S	-	-	-
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	●	●	●

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
		BC Act	EPBC Act				
Mammals							
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	●	●	●
Planigale maculata	Common Planigale	V	-	S	●	●	●
Phascolarctos cinereus	Koala	V	V	S/E	●	●	●
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	●	●	●
Petaurus norfolcensis	Squirrel Glider	V	-	S	●	●	●
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S	●	●	●
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	●	●	●
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	S/E	●	●	●
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	●	●	●
Myotis macropus	Southern Myotis	V	-	S	●	●	●
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	●	●	●

Note: Shaded species are species with records in the Subject land.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; EP = Endangered Population; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

The main constraint for threatened flora species is that their geographic range must include the IBRA Bioregion (Sydney Basin) and Subregion (Hunter) in which the development is occurring. For some threatened flora species there are geographic constraints within the Hunter Subregion, and these are described in Table 7. No flora species are excluded from further assessment as species credit species based on geographic constraints.

Table 7
Flora Species Credit Species – Geographic Constraints

Scientific Name	Common Name	Geographic Constraint within the Hunter Subregion in the BAM Calculator	Assessment
Acacia pendula	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	Within Hunter River Catchment	The Subject land is within the Hunter River Catchment.
Cryptostylis hunteriana	Leafless Tongue Orchid	None	-
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	Hunter Catchment as defined by Australia's River Basins (Geoscience Australia 1997)	The Subject land is within the Hunter River Catchment.
Cynanchum elegans	White-flowered Wax Plant	None	-
Diuris tricolor	Pine Donkey Orchid	None	-
Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook Local Government Area	Muswellbrook LGA	The Subject land is within the Muswellbrook LGA.
Eucalyptus glaucina	Slaty Red Gum	None	-
Eucalyptus pumila	Pokolbin Mallee	None	-
Monotaxis macrophylla	Large-leafed Monotaxis	None	-
Ozothamnus tesselatus	-	None	-
Pomaderris bodalla	Bodalla Pomaderris	None	-
Pomaderris queenslandica	Scant Pomaderris	None	-
Pomaderris reperta	Denman Pomaderris	None	-
Prasophyllum petilum (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	None	-
Prostanthera cineolifera	Singleton Mint Bush	None	-
Prostanthera cryptandroides subsp. cryptandroides	Wollemi Mint-bush	None	-
Pterostylis chaetophora	-	None	-
Thesium australe	Austral Toadflax	None	-

Note: Shaded species are species that have geographical constraints within the Hunter Subregion.

3.3.2.1.1 Review of Databases and Past Flora Surveys

The following databases were reviewed for any nearby potentially relevant threatened flora species records:

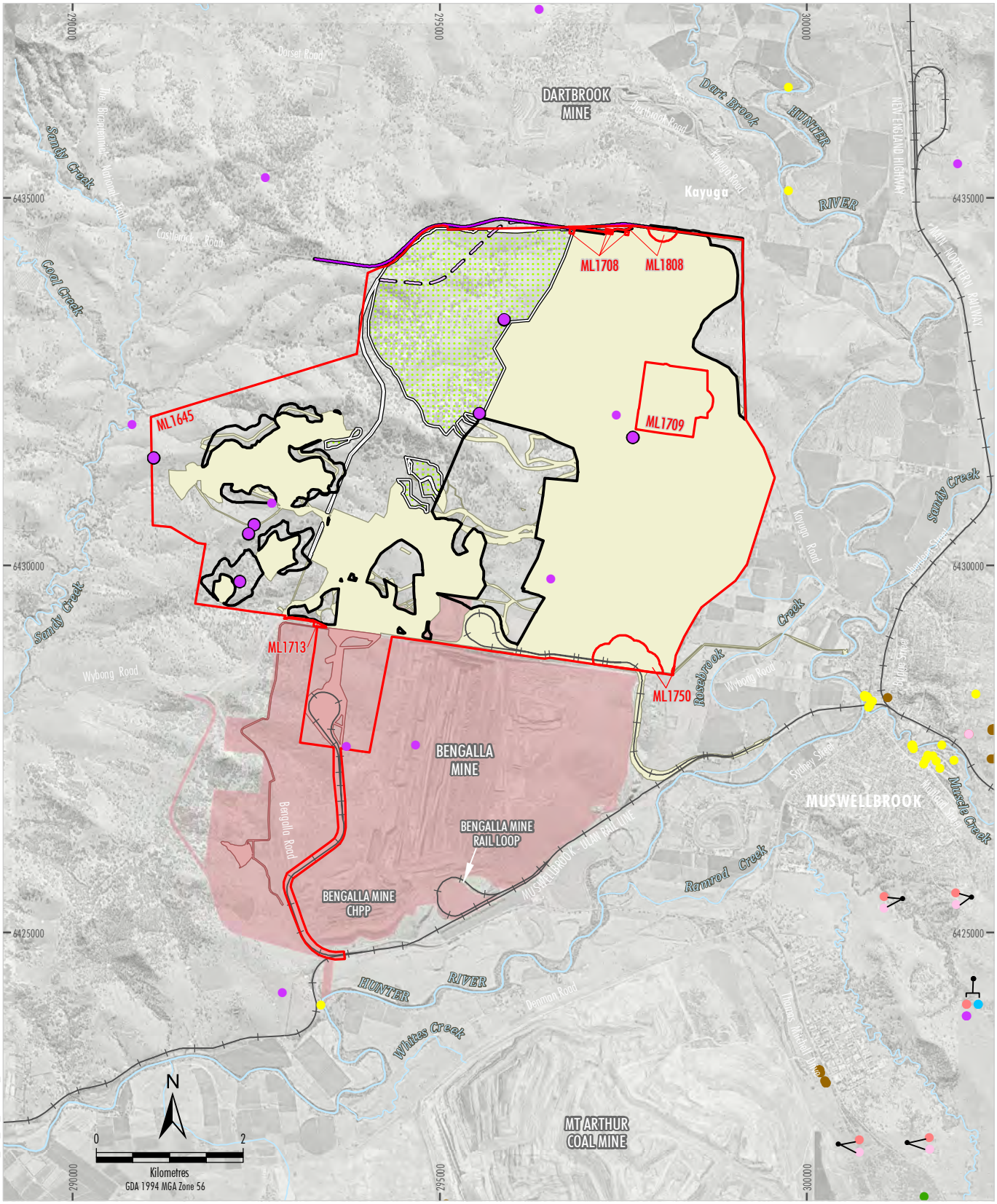
- ALA (ALA 2020);
- *BioNet Atlas* (DPIE 2020b); and
- *Protected Matters Search Tool* (DAWE 2020b).

Flora studies previously undertaken in the MLs and surrounds (Table 8) were also reviewed for any nearby potentially relevant threatened flora species records.

Table 8
Previous Flora Studies in the MLs and Surrounds

Surveys	Timing	Location	Reference
Flora and vegetation surveys for the *Mount Pleasant Mine Environmental Impact Statement*	1994-1997	Mount Pleasant Site	ERM Mitchell McCotter (ERM) (1997)
Targeted flora surveys and floristic plots for the *Proposed Mount Pleasant Open Cut Mine – Flora and Fauna Assessment*	2006	Mount Pleasant Operation	Cumberland Ecology (2006)
Targeted flora surveys, floristic plots and survey and analysis of *Box-Gum Woodland CEEC listed under the BC Act* for the *Mount Pleasant: Ecology Gap Analysis Report*	2007	Mount Pleasant Operation and wider locality	Cumberland Ecology (2007)
Targeted flora surveys and quadrats for the *Mount Pleasant Project – Flora and Fauna Report*	2008-2009	Mount Pleasant Project area and buffer lands	Cumberland Ecology (2009a)
Targeted flora surveys, floristic plots, review of Box-Gum Woodland and description of ecological values for the *Mount Pleasant Project Modification Ecological Assessment*	2008 and 2010	Modified Development Consent Boundary (Infrastructure Area Envelope and Conveyor/Service Corridor Envelope)	Cumberland Ecology (2010)
Flora and vegetation surveys for the *Mount Pleasant Upper Hunter Strategic Assessment BCAM Project – Biodiversity Assessment Report*	2015	Mount Pleasant Biodiversity Assessment Area	Cumberland Ecology (2015b)
Flora surveys for the *Mount Pleasant Operation – South Pit Haul Road Modification*	2016	South Pit Haul Road	ELA (2016)
Flora and vegetation surveys for the *Mount Pleasant Operation – Mine Optimisation Modification Environmental Assessment – Biodiversity Assessment*	2016-2017	South West Out-of-Pit Emplacement and Eastern Out-of-Pit Emplacement	ELA (2016) and Hunter Eco (2017a)
Flora and vegetation surveys for the *Mount Pleasant Operation Rail Modification – Terrestrial Ecology Assessment*	2017	Stage 2 Rail Infrastructure Area	Hunter Eco (2017b)

Attachment A provides a summary of the threatened flora species records in the locality from database and survey records. Threatened flora species records are shown on Figure 10.



MAC-18-02_SSD_EIS_App BDAR_235D

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey Database

Threatened Flora

- Weeping Myall (*Acacia pendula* population in the Hunter Catchment)
- Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)
- Pine Donkey Orchid
- Pine Donkey Orchid population in the Muswellbrook Local Government Area
- River Red Gum (*Eucalyptus camaldulensis* population in the Hunter Catchment)
- Narrow-leaved Black Peppermint
- Tarengo Leek Orchid

Survey Record Sources: Hunter Eco (2020); Future Ecology (2020a); Cumberland Ecology (2010)
Database Record Sources: ALA (2020); DPIE (2020)

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Flora

Figure 10

A description of the previous flora studies is provided below.

Flora Surveys for the Mount Pleasant Mine Environmental Impact Statement

ERM (1997) conducted vegetation mapping and flora surveys in November 1994, July 1995, November 1996 and February 1997. The surveys were undertaken throughout what is now ML 1645 and involved assessment of the likely presence of threatened species and identification of species through field investigation. No threatened flora species or populations listed under the BC Act or EPBC Act were recorded.

Flora Surveys for the Proposed Mount Pleasant Open Cut Mine

Flora surveys including 20 m x 20 m quadrats, targeted flora searches and vegetation mapping were undertaken throughout the Mount Pleasant Operation in November 2006 by Cumberland Ecology (2006). No threatened flora species or populations listed under the BC Act or EPBC Act were recorded.

Flora Surveys for the Mount Pleasant: Ecology Gap Analysis Report

In May 2007, flora surveys within and outside of the *Mount Pleasant: Ecology Gap Analysis* project area including 20 m x 20 m quadrats, random meanders, transects and targeted threatened flora searches were undertaken by Cumberland Ecology (2007). One species credit species was recorded, namely the Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment.

Flora Surveys for the Mount Pleasant Project

Flora surveys within the Mount Pleasant Project area and surrounding buffer lands were conducted by Cumberland Ecology (2009a) in December 2008 and February 2009. Techniques included 20 m x 50 m quadrats, random meanders, transects and targeted threatened flora searches (Cumberland Ecology 2009a). No threatened flora species or populations listed under the BC Act or EPBC Act were recorded.

Flora Surveys for the Mount Pleasant Project Modification

Cumberland Ecology (2010) conducted flora surveys to supplement existing survey data in March 2010 for the Mount Pleasant Project Modification. The surveys were conducted throughout what is now ML 1645 but particularly focused on the infrastructure area envelope and conveyor/service corridor envelope. Survey techniques included 20 m x 20 m quadrats, random meander, transects and targeted threatened flora searches. No threatened flora or populations listed under the BC Act or EPBC Act were recorded within the modification area.

Flora Surveys for the Mount Pleasant Upper Hunter Strategic Assessment BCAM Project

Flora and vegetation mapping surveys were undertaken by Cumberland Ecology (2015b) within the Mount Pleasant MLs. Survey techniques included 20 m x 20 m quadrats, random meander transects, detailed traverses of vegetation boundaries and targeted threatened flora searches through random meander surveys of suitable areas of habitat (Cumberland Ecology 2015b). One species credit species was recorded, namely the Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment. This species was previously recorded in the same location by Cumberland Ecology (2007).

Flora Surveys for the Mount Pleasant Operation – South Pit Haul Road Modification

ELA (2016) conducted flora surveys over two days in October 2016 for the Mount Pleasant Operation South Pit Haul Road Modification. The surveys were focused on the approved South Pit Haul Road and an area within which the approved South Pit Haul Road was proposed to be located. The flora survey involved a combination of random meander surveys to identify areas of potential habitat for target orchid species, and systematic targeted searches along parallel transects within areas considered to represent potential habitat. No threatened flora or any species belonging to the family Orchidaceae were recorded.

Flora Surveys for the Mount Pleasant Operation – Mine Optimisation Modification

Flora surveys were undertaken in late 2016 and early 2017 by Hunter Eco (2017a), with a targeted orchid survey in October 2016 by ELA (2016). The surveys were conducted within the South West Out-of-Pit Emplacement and Eastern Out-of-Pit Emplacement. The flora survey techniques involved 20 m x 20 m floristic plots, vegetation mapping, extensive meanders and targeted searches (Hunter Eco 2017a). No threatened flora species or populations listed under the BC Act or EPBC Act were recorded.

Flora Surveys for the Mount Pleasant Operation Rail Modification – Terrestrial Ecology Assessment

Hunter Eco (2017b) conducted vegetation mapping and floristic plots within the rail modification areas to supplement previous flora surveys in the nearby South West Out-of-Pit Emplacement. A habitat assessment determined that there was no suitable habitat for orchids, and none were recorded during targeted searches by ELA (2016). No other threatened flora species or populations were recorded.

3.3.2.1.2 Review of Databases and Past Fauna Surveys

The following databases were reviewed for any nearby potentially relevant threatened fauna species records:

- ALA (ALA 2020);
- *BioNet Atlas* (DPIE 2020b);
- *BirdLife Australia* (2020); and
- *Protected Matters Search Tool* (DAWE 2020b).

Fauna studies previously undertaken in the MLs and surrounds (Table 9) were also reviewed for any nearby potentially relevant threatened fauna species records.

Table 9
Previous Fauna Studies in the MLs and Surrounds

Surveys	Timing	Location	Reference
Fauna surveys for the *Mount Pleasant Mine Environmental Impact Statement*	1994-1995	Mount Pleasant Site	ERM (1997)
Fauna surveys for the *Proposed Mount Pleasant Open Cut Mine – Flora and Fauna Assessment*	2006	Mount Pleasant Operation	Cumberland Ecology (2006)

Surveys	Timing	Location	Reference
Fauna surveys for the *Mount Pleasant Project – Flora and Fauna Report*	2008-2009	Mount Pleasant Project area and buffer lands	Cumberland Ecology (2009a)
Fauna surveys for the *Mount Pleasant Project Modification Ecological Assessment*	2007, 2009-2010	Conveyor/Service Corridor Envelope	Cumberland Ecology (2010)
Fauna surveys for the *Mount Pleasant Operation Rail Modification*	2017	Stage 2 Rail Infrastructure Area	ELA (2017a and 2017b)

Attachment B provides a summary of the threatened fauna species records in the locality from database and survey records. Threatened fauna species records are shown on Figures 11 to 13.

A description of the previous fauna studies is provided below.

Fauna Surveys for the Mount Pleasant Mine Environmental Impact Statement

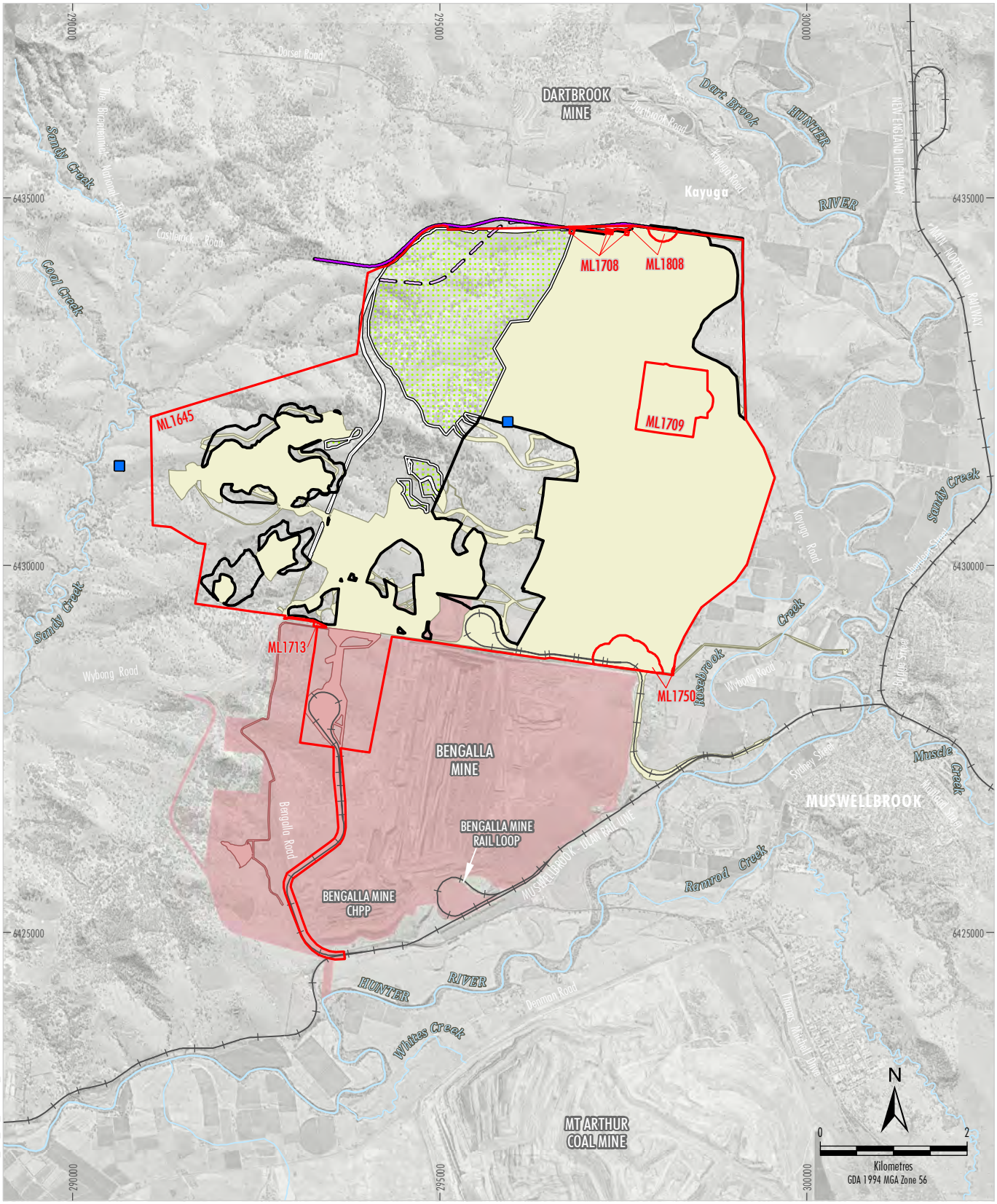
Fauna surveys were undertaken in November 1994 and July and November 1995 by ERM (1997) for the Mount Pleasant Mine EIS. The survey techniques included habitat assessments, trapping, spotlighting, recording bat echolocation calls, playing owl calls and searches for scats and tracks (ERM 1997). ERM (1997) determined that very limited suitable habitat for target threatened species was available on site. No species credit species were recorded.

Fauna Surveys for the Proposed Mount Pleasant Open Cut Mine – Flora and Fauna Assessment

Cumberland Ecology (2006) conducted fauna surveys in October and November 2006 across the Mount Pleasant Operation. The surveys included habitat searches and assessments, call playback, diurnal and nocturnal searches, spotlighting, hair tubes and ultrasonic bat call recording. One potential species credit species was recorded, namely the Large Bent-winged Bat (*Miniopterus orianae oceanensis*), which is a dual species/ecosystem credit species. However, no breeding habitat occurs within the Subject land and therefore it is considered an ecosystem credit species.

Fauna Surveys for the Mount Pleasant Project – Flora and Fauna Report

Fauna surveys were undertaken within the Mount Pleasant Project area and surrounding buffer lands by Cumberland Ecology (2009a) over ten days in February 2009. The survey techniques included habitat searches and assessments, pitfall traps, spotlighting, diurnal searches, Elliott traps, hair tubes, call playback, infrared cameras, harp trapping, ultrasonic bat call recording, trip lining and searches for scats and signs. Four potential species credit species were recorded, namely the Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large Bent-winged Bat and Southern Myotis (*Myotis macropus*). No breeding habitat occurs within the Subject land for the Grey-headed Flying-fox and Large Bent-winged Bat, which are dual species/ecosystem credit species, therefore these are considered ecosystem credit species. The Southern Myotis was not recorded within 200 m of a dam within an associated PCT, therefore this species is also considered an ecosystem credit species.



MAC-18-02_SSD_EIS_App BDAR_225A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey

Threatened Species

- Striped Legless Lizard

Survey Record Sources: Future Ecology (2020a)

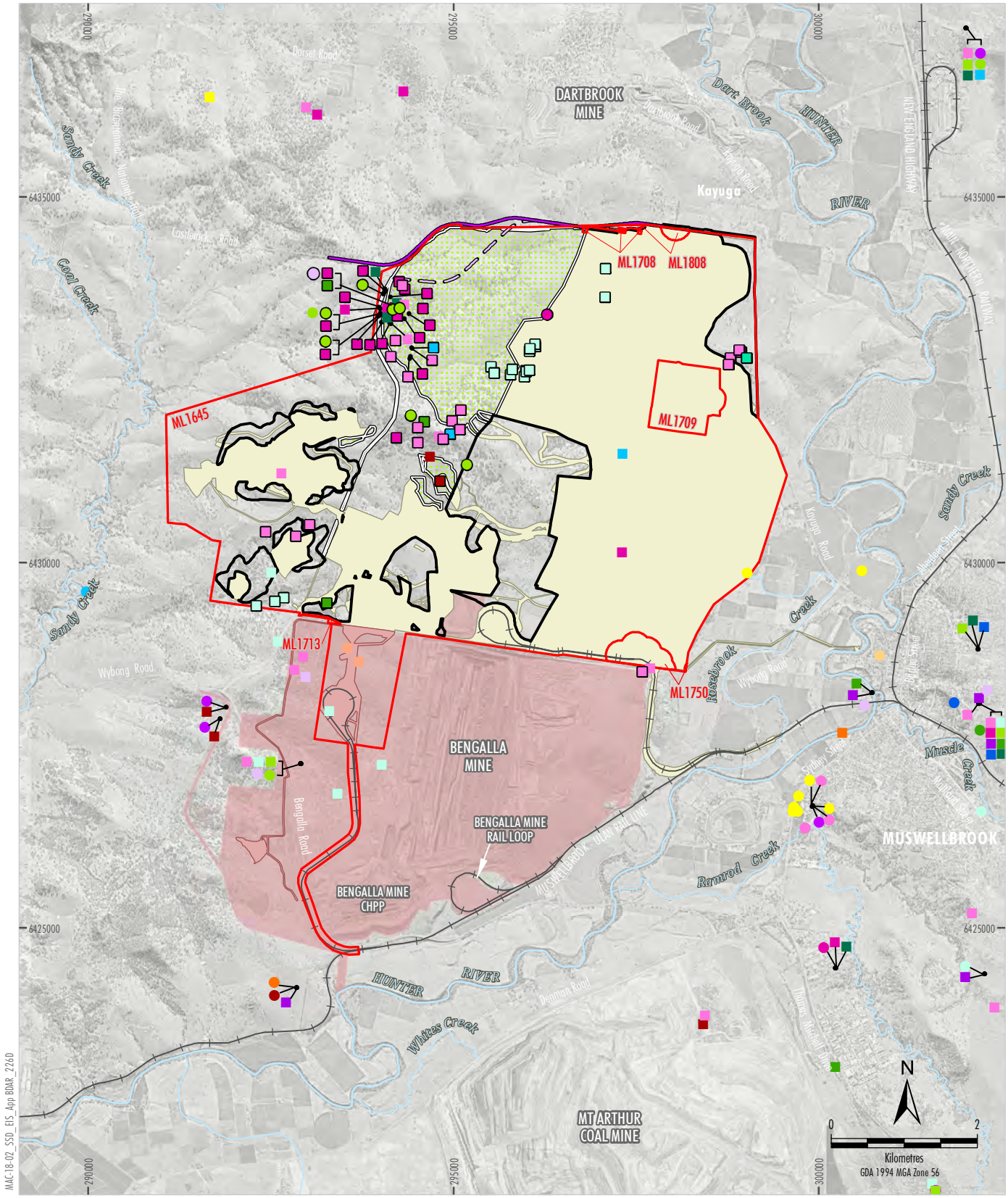
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Reptiles

Figure 11



MAC-18-02_SSD_EIS_App BDAR_226D

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey / Database — Threatened Birds

- Freckled Duck
- Black-necked Stork
- Australasian Bittern
- Grey Falcon
- Black Falcon
- White-bellied Sea-Eagle
- Spotted Harrier

Survey / Database

- Little Eagle
- Red-backed Button-quail
- Australian Painted Snipe
- Glossy Black-Cockatoo
- Little Lorikeet
- Turquoise Parrot
- Masked Owl

Survey / Database

- Powerful Owl
- Barking Owl
- White-throated Needletail
- Brown Treecreeper (eastern subspecies)
- Speckled Warbler
- Black-chinned Honeyeater (eastern subspecies)
- Regent Honeyeater
- White-fronted Chat
- Scarlet Robin
- Flame Robin
- Grey-crowned Babbler (eastern subspecies)
- Varied Sittella
- Dusky Woodswallow
- Diamond Firetail

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017a, 2017b)
Database Record Sources: ALA (2020); Birdlife Australia (2020); DPIE (2020)

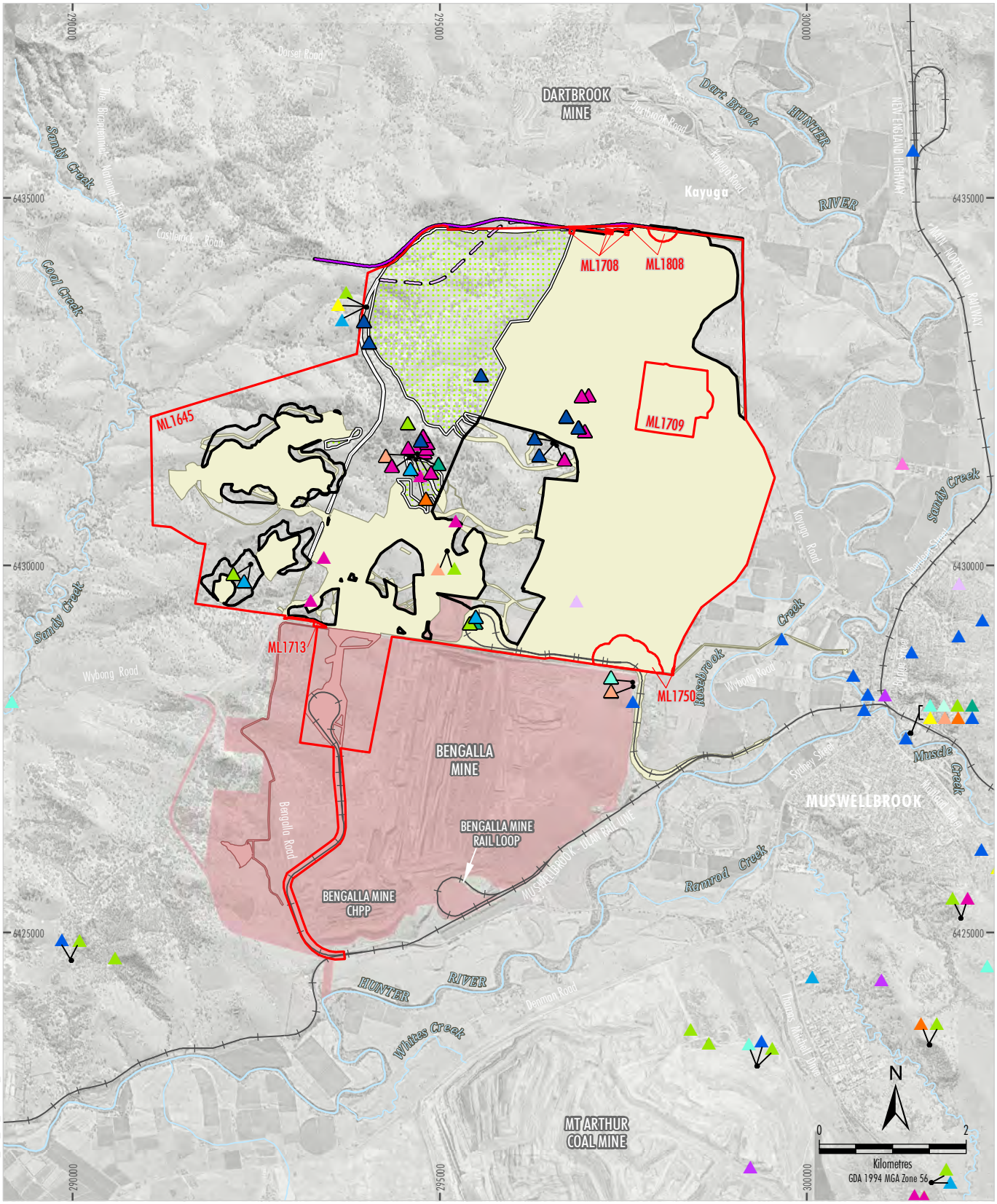
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Birds

Figure 12



MAC-18-02_SSD_EIS_App BDAR_227A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017a, 2017b)
Database Record Sources: ALA (2020); DPIE (2020)

Survey	Database	Threatened Mammals
		Spotted-tailed Quoll
		Brush-tailed Phascogale
		Koala
		Squirrel Glider
		Grey-headed Flying-fox
		Yellow-bellied Sheathtail-bat
		Eastern Coastal Free-tailed Bat
		Little Bent-winged Bat
		Large Bent-winged Bat
		Eastern False Pipistrelle
		Southern Myotis
		Greater Broad-nosed Bat
		Eastern Cave Bat

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Mammals

Figure 13

Fauna Surveys for the Mount Pleasant Project Modification

Cumberland Ecology (2010) conducted fauna surveys during February, July and November across several years for the Mount Pleasant Project Modification within the proposed conveyor/service corridor envelope. The survey techniques included habitat assessments, amphibian and reptile active searches, call playback, pitfall trapping, diurnal bird surveys, spotlighting, Elliott trapping, hair tubes, camera trapping, searches for scats and signs, bat ultrasonic call recording, harp trapping and tripline bat surveys. Four species credit species were recorded, namely the Squirrel Glider, Grey-headed Flying-fox, Large Bent-winged Bat and Southern Myotis. As described above, no breeding habitat for the Grey-headed Flying-fox and Large Bent-winged Bat occurs within the Subject land and the Southern Myotis was not recorded within an associated PCT within 200 m of a dam, therefore these species are considered ecosystem credit species.

Fauna Surveys for the Mount Pleasant Operation – Rail Modification

ELA (2017a) conducted fauna surveys over six days in November 2017 for the Mount Pleasant Operation Rail Modification within the extent of additional disturbance associated with the rail loop and spur, water supply pipeline, electricity transmission line to the pump station and other supporting infrastructure. The survey techniques included habitat assessments, diurnal bird surveys, microbat detection devices, remote camera surveys, nocturnal searches, spotlighting, call playback, active reptile searches, stag watching and opportunistic sightings. One species credit species was recorded, namely the Large Bent-winged Bat, however no breeding habitat occurs within the Subject land and therefore it is considered an ecosystem credit species.

ELA (2017b) conducted fauna surveys over six days in December 2017. The surveys were focused on a portion of the South West Out-of-Pit Emplacement intended to be relinquished as part of the Rail Modification. The survey techniques included habitat assessments, diurnal bird surveys, microbat detection devices and harp trapping, remote camera surveys, spotlighting, stag watching and opportunistic sightings. Two species credit species were recorded, namely the Squirrel Glider and Eastern Cave Bat (*Vespadelus troughtoni*).

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

Habitat constraints are identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) for some species credit species, and the absence of identified habitat precludes the species from further assessment (Table 10). Step 2 is not applicable to a species where no habitat constraints are listed for that species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). Species shaded in Table 10 are species that have habitat constraints present in the Subject land.

Table 10
Species Credit Species Habitat Constraints

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Habitat Constraints identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c)	Assessment
		BC Act	EPBC Act			
Flora						
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	S	*Epiphytic in a range of eucalypts and Angophora.*	Habitat constraint present.
Amphibians						
Litoria aurea	Green and Golden Bell Frog	E	V	S	*Within 1 km of wet areas, within 1 km of swamp, within 1 km of waterbody.*	Habitat constraint present.
Reptiles						
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	*Rocky areas or within 50 m of rocky areas.*	Habitat constraint present.
Birds						
Lophoictinia isura	Square-tailed Kite	V	-	S/E	*Nest trees.*	Habitat constraint present.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	*Living or dead mature trees within suitable vegetation within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines.*	Habitat constraint present.
Hieraaetus morphnoides	Little Eagle	V	-	S/E	*Nest trees – live (occasionally dead) large old trees within vegetation.*	Habitat constraint present.
Burhinus grallarius	Bush Stone-curlew	E	-	S	*Fallen/standing dead timber including logs.*	Habitat constraint present.
Numenius madagascariensis	Eastern Curlew	-	CE	S/E	*As per mapped areas.*	The Subject land is not within a mapped important habitat area for this species (DPIE 2020a).
Calidris ferruginea	Curlew Sandpiper	E	CE	S/E	*As per mapped areas.*	The Subject land is not within a mapped important habitat area for this species (DPIE 2020a).
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	*Breeding: Hollow bearing trees – living or dead tree with hollows greater than 15*	Habitat constraint present.

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Habitat Constraints identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c)	Assessment
		BC Act	EPBC Act			
					centimetres (cm) diameter and greater than 5 m above ground.	
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	*Hollow bearing trees – Eucalypt tree species with hollows greater than 9 cm diameter.*	Habitat constraint present.
Lathamus discolor	Swift Parrot	E	CE	S/E	*As per mapped areas.*	The Subject land is not within a mapped important habitat area for this species (DPIE 2020a).
Tyto novaehollandiae	Masked Owl	V	-	S/E	*Hollow bearing trees – Living or dead trees with hollows greater than 20 cm diameter.*	Habitat constraint present.
Ninox strenua	Powerful Owl	V	-	S/E	*Hollow bearing trees – Living or dead trees with hollow greater than 20 cm diameter.*	Habitat constraint present.
Ninox connivens	Barking Owl	V	-	S/E	*Hollow bearing trees – Living or dead trees with hollows greater than 20 cm diameter and greater than 4 m above the ground.*	Habitat constraint present.
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	*As per mapped areas.*	The Subject land is not within a mapped important habitat area for this species (DPIE 2020a).
Mammals						
Phascolarctos cinereus	Koala	V	V	S/E	*Areas identified via survey as important habitat ('Important' habitat [however this is not a mapped important habitat area] is defined by the density of koalas and quality of habitat determined by on-site survey).*	Assumed no relevant constraints as DPIE (2020c) does not define important habitat. No Koalas were recorded within the Subject land.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S	*Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines.*	Habitat constraint absent in the Subject land.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	*Breeding camps.*	Habitat constraint absent in the Subject land. The nearest known camp is on the Hunter

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Habitat Constraints identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c)	Assessment
		BC Act	EPBC Act			
						River in Muswellbrook township (DAWE 2020d).
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	S/E	*Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC – in cave;" observation type code "E nest-roost;" with numbers of individuals >500.*	Habitat constraint absent in the Subject land.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	*Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops or crevices, or within 2 km of old mines or tunnels.*	Habitat constraint absent in the Subject land.
Myotis macropus	Southern Myotis	V	-	S	*Hollow bearing trees – Within 200 m of riparian zone.* *Bridges, caves or artificial structures within 200 m of riparian zone.* *Waterbodies – These include rivers, creeks, billabongs, lagoons, dams and other waterbodies on or within 200 m of the site.*	Habitat constraint present.
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	*Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within 2 km of old mines, tunnels, old buildings or sheds.*	Habitat constraint absent in the Subject land.

Note: Shaded species are species that have habitat constraints as identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) present in the Subject land.

[1] Conservation status under the BC and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; EP = Endangered Population; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

The following species in the initial list of species credit species (Table 6) can be excluded from further assessment as species credit species based on the absence of habitat constraints as described in Table 10:

- Eastern Curlew;
- Curlew Sandpiper;
- Swift Parrot;
- Regent Honeyeater;
- Brush-tailed Rock-wallaby;
- Grey-headed Flying-fox;
- Large Bent-winged Bat;
- Large-eared Pied Bat; and
- Eastern Cave Bat.

Despite the BAM (OEH 2017) not requiring the above listed species to be targeted during the surveys, Future Ecology (2020) (Attachment B) undertook targeted surveys for the Swift Parrot, Regent Honeyeater, Grey-headed Flying-fox, Large Bent-winged Bat, Large-eared Pied Bat and Eastern Cave Bat in potential foraging habitat. Only one of these species was recorded, the Grey-headed Flying-fox, and not within a breeding camp.

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

Candidate species credit species for further assessment are listed in Table 11, excluding the ten species listed above with habitat constraints absent (Table 10) and excluding a further five species with no suitable habitat, namely the Large-leafed Monotaxis (*Monotaxis macrophylla*), Singleton Mint Bush (*Prostanthera cineolifera*), Wollemi Mint-bush (*Prostanthera cryptandroides* subsp. *cryptandroides*), Green and Golden Bell Frog (*Litoria aurea*) and Green-thighed Frog (*Litoria brevipalmata*).

Large-leafed Monotaxis

A limitation described in Attachment A was the absence of recent, or any, fire that would facilitate the discovery of Large-leafed Monotaxis (if present). This species is fire ephemeral, only growing for a few months after fire.

No fires have been mapped in or near the Study Area (DPIE 2020e). The DPIE (2020e) records cover the time span from 1920 to May 2020. The lack of fire was also confirmed by discussion with a local landholder whose family has been there for three generations.

This species is also reported as growing on rocky ridges and hillsides (DPIE 2020c), which are not present in the Subject land. Given the lack of fire and potentially suitable habitat, it is considered unlikely for this species to be present in the Subject land (even if a fire were to occur in the future). The closest record of Large-leafed Monotaxis is approximately 39 km south-west of the Subject land (DPIE 2020b).

Singleton Mint Bush and Wollemi Mint-bush

The *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) recognises PCT 1655 as potential habitat for Singleton Mint Bush and Wollemi Mint-bush. PCT 1655 only exists in DNG form within the Subject land. Hunter Eco (2020) (Attachment A) conducted a habitat assessment of the occurrence of PCT 1655 and concluded that the DNG form of any PCT was not suitable habitat for these species.

The closest records of these species are approximately 24 km north-west of the Subject land (Singleton Mint Bush) and approximately 22 km south-west of the Subject land (Wollemi Mint-bush) (DPIE 2020b).

Green and Golden Bell Frog and Green-thighed Frog

The *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) recognises PCTs 1602, 1606 and 1691 as potential habitat for the Green and Golden Bell Frog, and PCT 1602 as potential habitat for the Green-thighed Frog. Future Ecology (2020) (Attachment B) inspected the occurrences of PCTs 1602, 1606 and 1691 and searched for habitat such as vegetated pools, flooded areas and dams with bullrushes (*Typha* sp.) and/or spikerushes (*Eleocharis* sp.). Future Ecology (2020) (Attachment B) concluded that there was no potential habitat for these frogs.

The closest record of the Green and Golden Bell Frog is approximately 22 km south-east of the Subject land at Lake Liddell (DPIE 2020b). The closest record of the Green-thighed Frog is approximately 90 km south-east of the Subject land (DPIE 2020b).

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

Hunter Eco (2020) (Attachment A) undertook targeted surveys for candidate flora species credit species and Future Ecology (2020) (Attachment B) undertook targeted surveys for candidate fauna species credit species to determine presence or absence of the species within the survey periods required by the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) (Table 11). The timing, survey techniques and effort of the flora and fauna surveys are detailed in Attachments A and B, respectively. Months in which targeted surveys were undertaken are shaded in Table 11.

Threatened Flora

One threatened flora species was recorded by Hunter Eco (2020) (Attachment A), namely the Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment, recorded within the General Extension Areas (Development Footprint 1) (Figure 14). Tiger Orchid is a species credit species listed as an Endangered Population under the BC Act. The *Cymbidium canaliculatum* population in the Hunter Catchment has a biodiversity risk weighting of '2' (DPIE 2020c). It is not a potential Serious and Irreversible Impact (SAII) entity.

Threatened Fauna

The following species credit fauna species were present in habitat located either within or adjoining the Development Footprints (Future Ecology 2020) (Attachment B) (Figure 14):

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

The Striped Legless Lizard has a biodiversity risk weighting of '1.5' and the Squirrel Glider has a biodiversity risk weighting of '2'. Neither of these species is a potential SAII entity.

Table 11
Species Credit Species – Survey and Timing

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Survey Months for Each Species (DPIE 2020c)											
		BC Act	EPBC Act		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flora																
Acacia pendula	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	EP	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cynanchum elegans	White-flowered Wax Plant	E	E	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Diuris tricolor	Pine Donkey Orchid	V	-	S	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook Local Government Area	EP	-	S	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Eucalyptus glaucina	Slaty Red Gum	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus pumila	Pokolbin Mallee	V	V	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ozothamnus tesselatus	-	V	V	S	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Pomaderris queenslandica	Scant Pomaderris	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris reperta	Denman Pomaderris	CE	CE	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Prasophyllum petilum (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	E	E	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Pterostylis chaetophora	-	V	-	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Survey Months for Each Species (DPIE 2020c)											
		BC Act	EPBC Act		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thesium australe	Austral Toadflax	V	V	S	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
Reptiles																
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Delma impar	Striped Legless Lizard	V	V	S	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes
Birds																
Lophoictinia isura	Square-tailed Kite	V	-	S/E	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Erythrotriorchis radiatus	Red Goshawk	CE	V	S/E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hieraaetus morphnoides	Little Eagle	V	-	S/E	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No
Burhinus grallarius	Bush Stone-curlew	E	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	Yes	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Tyto novaehollandiae	Masked Owl	V	-	S/E	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Ninox strenua	Powerful Owl	V	-	S/E	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Ninox connivens	Barking Owl	V	-	S/E	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hirundapus caudacutus	White-throated Needletail	-	V	S	No	No	No	No	No	No	No	No	No	No	No	No
Mammals																
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	No*	No*	No	No	No*	Yes
Planigale maculata	Common Planigale	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phascolarctos cinereus	Koala	V	V	S/E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

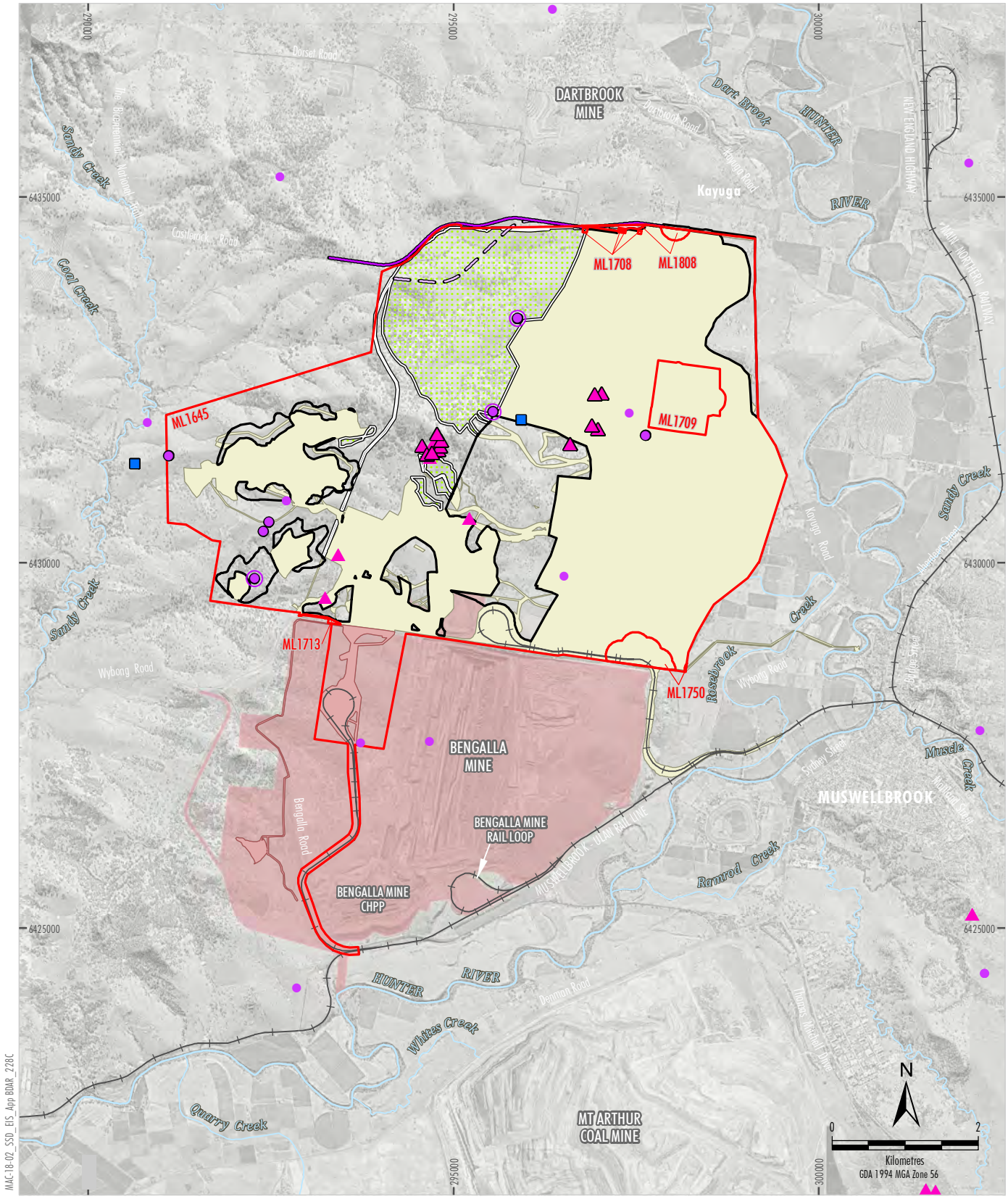
Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Survey Months for Each Species (DPIE 2020c)											
		BC Act	EPBC Act		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes
Petaurus norfolcensis	Squirrel Glider	V	-	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Myotis macropus	Southern Myotis	V	-	S	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes

Note: Months in which surveys for the species are to be conducted in accordance with the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) are denoted with 'Yes'. The shaded month is the month in which targeted surveys were undertaken for the relevant species.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; EP = Endangered Population; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

* Recommended survey months for the Brush-tailed Phascogale were changed in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) after survey commission (i.e. previous data recommended the species could be surveyed for all year). However, the species is capable of being detected throughout the year and considerable camera trapping and hair tube survey effort was undertaken in the Subject land (Future Ecology 2020) (Attachment B).



MAC-18-02_SSD_EIS_App BDAR_228C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey / Database

Threatened Species

- Striped Legless Lizard
- Squirrel Glider
- Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)
- Tiger Orchid Species Polygon (30 m Buffer to Individual Count - not to scale)

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017b)
Database Record Sources: ALA (2020); DPIE (2020)

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Species Credit Species Relevant to the Project

Figure 14

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

Table 12 provides the results of the targeted surveys by Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B) for all the species in Table 11. Hunter Eco (2020) (Attachment A) recorded one species requiring species credits for the Project, namely the Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment. Future Ecology (2020) (Attachment B) recorded two species requiring species credits for the Project, namely the Striped Legless Lizard and Squirrel Glider. Species recorded in the Subject land are shaded in Table 12.

Habitat (Species Polygons) were created for the Striped Legless Lizard and Squirrel Glider (Figures 15 and 16). A Species Polygon for the Tiger Orchid is shown on Figure 14. The extent of the Habitat (Species Polygons) is detailed in Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B). A description is provided below.

Tiger Orchid (Cymbidium canaliculatum population in the Hunter Catchment) (Species Polygon)

Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment, was found to be present in the Subject land in PCT 1691 (Hunter Eco 2020) (Attachment A). The Species Polygon for Tiger Orchid on Figure 14 was mapped as a 30 m buffer around the individual record.

Table 12
Species Credit Species Presence

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Biodiversity Risk Weighting (DPIE 2020c)	Result
		BC Act	EPBC Act			
Flora						
Acacia pendula	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	EP	-	S	2.00	Weeping Myall (*Acacia pendula* population in the Hunter Catchment) was not present (Hunter Eco 2020) (Attachment A).
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S	1.50	Targeted surveys by Hunter Eco (2020) (Attachment A) did not record this species.
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	S	2.00	Present (Hunter Eco 2020) (Attachment A).
Cynanchum elegans	White-flowered Wax Plant	E	E	S	2.00	These species were not recorded by Hunter Eco (2020) (Attachment A), despite targeted surveys.
Eucalyptus glaucina	Slaty Red Gum	V	V	S	2.00	
Eucalyptus pumila	Pokolbin Mallee	V	V	S	3.00	
Monotaxis macrophylla	Large-leafed Monotaxis	E	-	S	2.00	
Ozothamnus tesselatus	-	V	V	S	1.50	
Pomaderris bodalla	Bodalla Pomaderris	V	-	S	2.00	
Pomaderris queenslandica	Scant Pomaderris	E	-	S	2.00	
Pomaderris reperta	Denman Pomaderris	CE	CE	S	3.00	
Thesium australe	Austral Toadflax	V	V	S	1.50	
Diuris tricolor	Pine Donkey Orchid	V	-	S	1.50	Eastcoast Flora Survey (Dr Stephen Bell) has prepared an expert report (Attachment D) for the orchid species Pine Donkey Orchid, Tarengo Leek Orchid (syn. *Prasophyllum* sp. Wybong) and *Pterostylis chaetophora*, due to the prohibitive intensity of survey effort required for these species under the new DPIE (2020f) survey guideline.
Diuris tricolor	Pine Donkey Orchid population in the Muswellbrook Local Government Area	EP	-	S	2.00	
Prasophyllum petilum (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	E	E	S	2.00	
Pterostylis chaetophora	-	V	-	S	2.00	

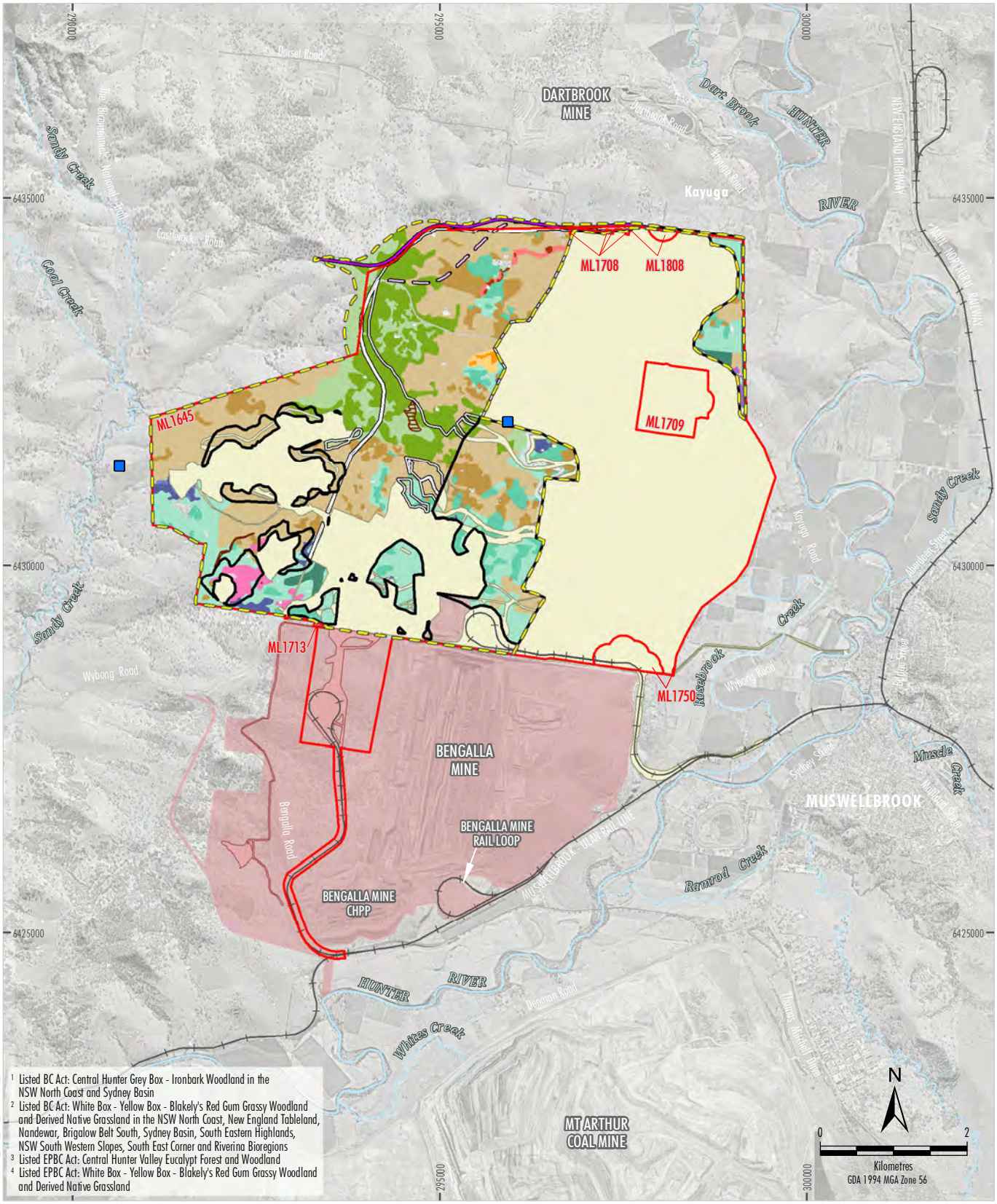
Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Biodiversity Risk Weighting (DPIE 2020c)	Result
		BC Act	EPBC Act			
Reptiles						
Delma impar	Striped Legless Lizard	V	V	S	1.50	This species was recorded within the Subject land under a cow pat (dung) in an open grassy area and outside of the Subject land under a lightly imbedded rock in a grassy open hillside (Future Ecology 2020) (Attachment B) (Figure 15).
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	S	2.00	This species was not recorded by Future Ecology (2020) (Attachment B), despite targeted surveys.
Birds						
Lophoictinia isura	Square-tailed Kite	V	-	S/E	1.50	These species were not recorded by Future Ecology (2020) (Attachment B), despite targeted surveys.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	S/E	2.00	
Hieraaetus morphnoides	Little Eagle	V	-	S/E	1.50	
Burhinus grallarius	Bush Stone-curlew	E	-	S	2.00	
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	S/E	2.00	
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	S/E	2.00	
Lathamus discolor	Swift Parrot	E	CE	S/E	3.00	
Tyto novaehollandiae	Masked Owl	V	-	S/E	2.00	
Ninox strenua	Powerful Owl	V	-	S/E	2.00	
Ninox connivens	Barking Owl	V	-	S/E	2.00	
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	3.00	
Mammals						
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	S	2.00	These species were not recorded by Future Ecology (2020) (Attachment B), despite targeted surveys.
Planigale maculata	Common Planigale	V	-	S	2.00	
Phascolarctos cinereus	Koala	V	V	S/E	2.00	
Cercartetus nanus	Eastern Pygmy-possum	V	-	S	2.00	
Petaurus norfolcensis	Squirrel Glider	V	-	S	2.00	This species was recorded at several locations within the Subject land in nestboxes and during spotlighting (Future Ecology 2020) (Attachment B) (Figure 16).

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Biodiversity Risk Weighting (DPIE 2020c)	Result
		BC Act	EPBC Act			
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	S	3.00	This species was not recorded by Future Ecology (2020) (Attachment B), despite targeted surveys.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	2.00	This species was recorded foraging at several locations within the Subject land (Future Ecology 2020) (Attachment B). No nearby breeding camps, the nearest known Grey-headed Flying-fox camp is in Muswellbrook township approximately 5 km away (DAWE 2020d), therefore the species is considered an ecosystem species in the Subject land.
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	S/E	3.00	This species was recorded at several locations within the Subject land via acoustic recording (Future Ecology 2020) (Attachment B). No nearby caves, tunnels or disused mines in the Subject land therefore the species is considered an ecosystem species in the Subject land.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S	3.00	Calls were recorded at two locations within the Subject land with a 'probable' level of confidence that the calls were from a Large-eared Pied Bat (Future Ecology 2020) (Attachment B). No nearby caves, tunnels or disused mines in the Subject land.
Myotis macropus	Southern Myotis	V	-	S	2.00	Calls were recorded at one location within the Subject land with a 'possible' level of confidence that the calls were from Southern Myotis (Future Ecology 2020) (Attachment B). The calls were not within 200 m of a dam and not within recognised associated PCTs. The species was not caught via traps.
Vespadelus troughtoni	Eastern Cave Bat	V	-	S	3.00	This species was not recorded by Future Ecology (2020) (Attachment B), despite targeted surveys.

Note: Shaded species are species that have been recorded in the Subject land.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c).



[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

MAC-18-02_SSD_EIS_App BDAR_222A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area
- Survey
- Threatened Species
- Striped Legless Lizard

SPECIES POLYGON MAPPING

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 5a Derived Native Grassland (PCT1602)
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Dry Sclerophyll Forests (Shrubby Sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- Lightly Imbedded Rock Area

Survey Record Source: Future Ecology (2020a)

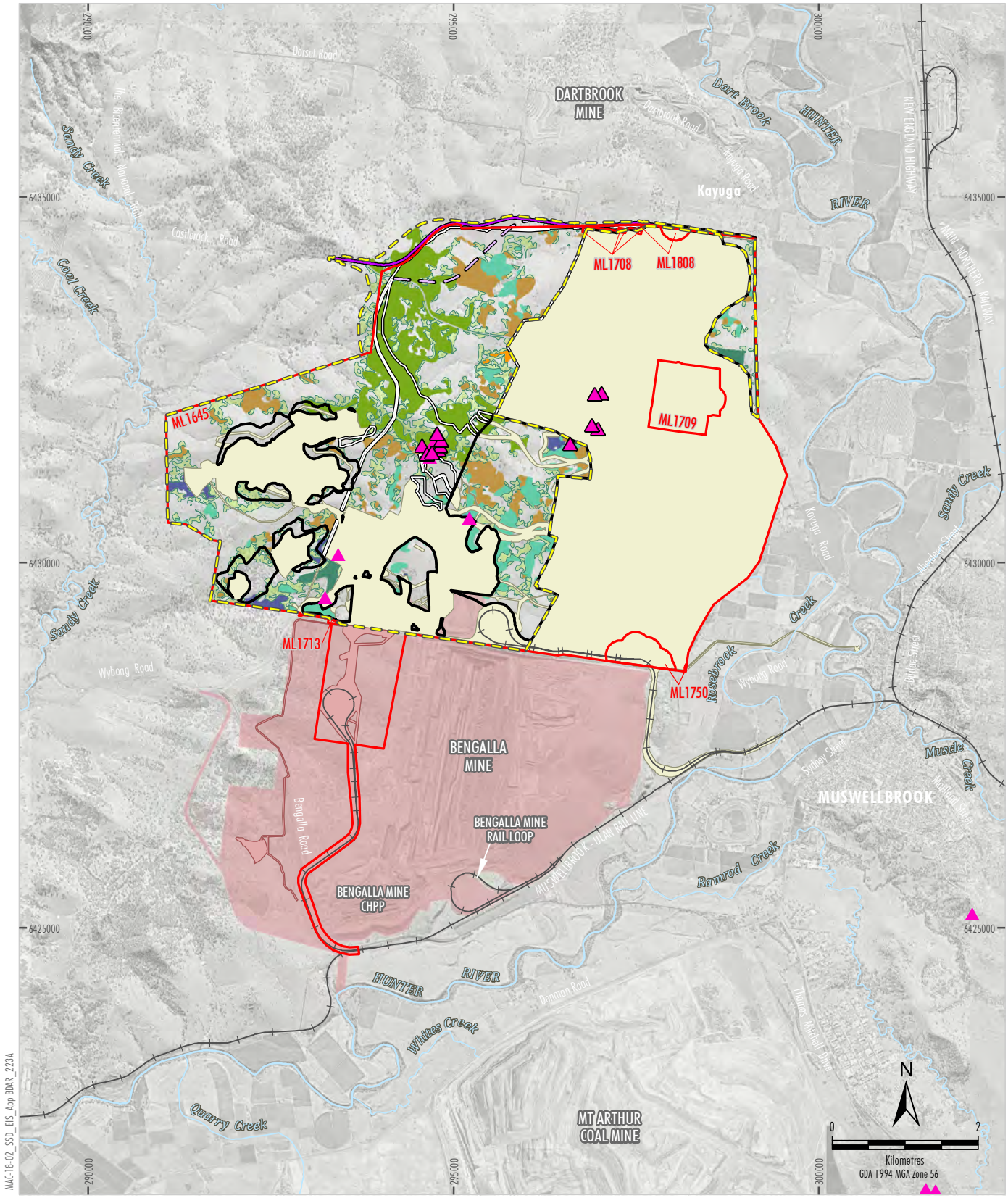
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Striped Legless Lizard Species Polygon

Figure 15



MAC-18-02_SSD_EIS_App BDAR_223A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Survey / Database

Threatened Species

- Squirrel Glider

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017b)
Database Record Sources: ALA (2020); DPIE (2020)

SPECIES POLYGON MAPPING

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2,4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2,4]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2,4]

Other

- Paddock Tree

[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Squirrel Glider Species Polygon

Figure 16

Striped Legless Lizard (Species Polygon)

Habitat for the Striped Legless Lizard has been mapped (Figure 15) as all of the PCTs recognised as habitat in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) for this species (i.e. PCTs 483, 618, 1602, 1605, 1606, 1655 and 1691), as well as the rocky areas identified within those PCTs (Future Ecology 2020) (Attachment B). The habitat composition for the Striped Legless Lizard Species Polygon is provided in Table 13. Table 13 quantifies the PCTs in each Development Footprint as well as the overall impacts associated with NSW Assessment Area with Road Option 1 (Footprint 1 + 2) and NSW Assessment Area with Road Option 2 (Footprint 1 + 3).

Table 13
Striped Legless Lizard Species Polygon Habitat Composition

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
1	Grey Box x White Box Grassy Woodland[2,4]	483	44.5	0.4	2.6	44.9	47.1
1a	Derived Native Grassland[2,4]	483 DNG	143.6	14.8	15	158.4	158.6
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	483 SG	8.7	4.6	2.5	13.3	11.2
2a	Derived Native Grassland[2,4]	483 SG DNG	6.7	4.3	0.2	11	6.9
3	Forest Red Gum Grassy Open Forest[2,4]	618	0.1	0.1	0.1	0.2	0.2
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	1691	16.3	0	0	16.3	16.3
4a	Derived Native Grassland	1691 DNG	0.9	0	0	0.9	0.9
5	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	1602	7	0	0	7	7
6	Narrow-leaved Ironbark Shrubby Forest[3]	1605	66.6	0	0	66.6	66.6
6a	Derived Native Grassland	1605 DNG	140.1	0.6	0.5	140.7	140.6
6b	Plantation	1605 Plantation	11.2	0.4	0.3	11.6	11.5
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	1606	0.1	0.5	0.5	0.6	0.6

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
7a	Derived Native Grassland[2,4]	1606 DNG	0.2	1.7	1.6	1.9	1.8
8a	Derived Native Grassland	1655 DNG	2.5	0	0	2.5	2.5
Total Woodland/Forest			**154.5**	**6**	**6**	**160.5**	**160.5**
Total Derived Native Grassland			**294**	**21.4**	**17.3**	**315.4**	**311.3**
Total Native Vegetation			**448.5**	**27.4**	**23.3**	**475.9**	**471.8**

1 *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

2 *Box-Gum Woodland CEEC listed under the BC Act.*

3 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

4 *Box-Gum Woodland CEEC listed under the EPBC Act.*

Squirrel Glider (Species Polygon)

Habitat for the Squirrel Glider has been mapped (Figure 16) as the PCTs recognised as habitat in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) for this species (i.e. PCT 1606 and Paddock Trees associated with PCTs 1606 and 1655). PCTs 483, 1602 and 1605 are not listed as associated with the species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c), but these PCTs and Paddock Trees have also been mapped as habitat (Figure 16) as they are likely to contain suitable microhabitat components (Future Ecology 2020) (Attachment B). The habitat composition for the Squirrel Glider Species Polygon is provided in Table 14.

Table 14
Squirrel Glider Species Polygon Habitat Composition

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
1	Grey Box x White Box Grassy Woodland[2,4]	483	44.5	0.4	2.6	44.9	47.1
1a	Derived Native Grassland[2,4]	483 DNG	31.9*	3*	2.7*	34.9*	34.6*

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)			Overall Impacts (ha)	
			General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	483 SG	8.7	4.6	2.5	13.3	11.2
2a	Derived Native Grassland[2,4]	483 SG DNG	1.2*	1.1*	0.1*	2.3*	1.3*
3	Forest Red Gum Grassy Open Forest[2,4]	618	N/A	N/A	N/A	N/A	N/A
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	1691	N/A	N/A	N/A	N/A	N/A
4a	Derived Native Grassland	1691 DNG	N/A	N/A	N/A	N/A	N/A
5	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	1602	7	0	0	7	7
6	Narrow-leaved Ironbark Shrubby Forest[3]	1605	66.6	0	0	66.6	66.6
6a	Derived Native Grassland	1605 DNG	33.8*	0.5*	0.4*	34.3*	34.2*
6b	Plantation	1605 Plantation	11.2	0.4	0.3	11.6	11.5
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	1606	0.1	0.5	0.5	0.6	0.6
7a	Derived Native Grassland[2,4]	1606 DNG	0.2*	1*	0.9*	1.2*	1.1*
8a	Derived Native Grassland	1655 DNG	0.4*	0	0	0.4*	0.4*
Total Woodland/Forest			**138.1**	**5.9**	**5.9**	**144**	**144**
Total Derived Native Grassland			**67.5***	**5.6***	**4.1***	**73.1***	**71.6***
Total Native Vegetation			**205.6**	**11.5**	**10**	**217.1**	**215.6**

1 *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

2 *Box-Gum Woodland CEEC listed under the BC Act.*

3 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

4 *Box-Gum Woodland CEEC listed under the EPBC Act.*

* Area associated with Paddock Trees (Hunter Eco 2020) (Attachment A).

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

The VI Score for each vegetation zone associated with the Habitat (Species Polygons) for the Striped Legless Lizard and Squirrel Glider (Figures 15 and 16) are listed in Attachment C.

3.4 LOCAL DATA

It was not necessary to use local data to deviate from the DPIE databases (DPIE 2020c, 2020d).

3.5 EXPERT REPORTS

Eastcoast Flora Survey (Dr Stephen Bell) has prepared an expert report (Attachment D) for the orchid species Pine Donkey Orchid, Tarengo Leek Orchid (syn. *Prasophyllum* sp. Wybong) and *Pterostylis chaetophora*, due to the prohibitive intensity of survey effort required for these species under the new DPIE (2020f) survey guideline. Further, the report concludes that none of these species are likely to be present and no species credits are required.

3.6 PRESCRIBED BIODIVERSITY IMPACT ENTITIES

Prescribed biodiversity impact entities are discussed below.

3.6.1 Karst, Caves, Crevices and Cliffs

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

3.6.2 Rock

Rocky areas providing potential habitat for the Striped Legless Lizard are present in the Subject land as mapped by Future Ecology (2020) (Attachment B). Lightly embedded rock areas are shown on Figure 5. Rocks were generally small (<50 cm diameter) and mostly located directly on soil rather than rock on rock (Future Ecology 2020) (Attachment B).

3.6.3 Human Made Structures and Non-native Vegetation

There are no human made structures (such as buildings) that provide habitat for threatened species in the Development Footprints. There are no areas of non-native vegetation that provide habitat for threatened species in the Development Footprints.

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

The Subject land is located in the Hunter River catchment, with the Hunter River approximately 2.7 km southeast of the Subject land, at its closest point. The following streams (all intermittent) occur in the Subject land and drain to the Hunter River:

- Rosebrook Creek drains the extreme eastern part of the Subject land and is a third order stream downstream of Kayuga and Wybong Roads;
- an un-named stream drains to the north-east of Mount Pleasant across Castlerock and Dorset Roads and is a fourth order stream downstream of Dorset and Kayuga Roads;
- an un-named stream (commonly referred to as Dry Creek) formerly drained to the south of Mount Pleasant but is now captured and diverted as part of the Bengalla Mine Dry Creek Project; and
- Sandy Creek drains to the west and southwest of Mount Pleasant and is a fifth order stream downstream of Wybong Road.

All of these streams are fed by several small ephemeral creeks and drainage lines that originate in the Mount Pleasant ridgeline and spur complex. Dry for much of the year, these watercourses commonly only flow after large rain events.

3.7 DEVELOPMENT FOOTPRINT CREDIT AMOUNT

The ecosystem and species credits for the Development Footprints (prior to application of the Relinquishment Area in Section 4.2) are provided in Tables 15 and 16. For a discussion on the Project ecosystem and species credit requirements after application of the Relinquishment Area, refer to Section 4.2.4.

The credit reports from the BAM Calculator for the Development Footprints are provided in Attachments E to S[5].

[5] It is noted that the credit reports show incorrect TEC listings for PCTs 1602, 1605, 1655 and 1691 due to a BAM Calculator error not allowing manual selection of TECs. This does not affect subsequent credit calculations.

Table 15
Development Footprint Ecosystem Credit Amount

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Biodiversity Risk Weighting*	General Extension Areas (Development Footprint 1)		Northern Link Road Option 1 (Development Footprint 2)		Northern Link Road Option 2 (Development Footprint 3)		Overall Ecosystem Credit Amount	
				Clearance Area (ha) (Table 2)	Ecosystem Credits (Attachment E)	Clearance Area (ha) (Table 2)	Ecosystem Credits (Attachment H)	Clearance Area (ha) (Table 2)	Ecosystem Credits (Attachment K)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
1	Grey Box x White Box Grassy Woodland[2]	483	2.00	44.5	1,780	0.4	13	2.6	83	1,793	1,863
1a	Derived Native Grassland[2]	483 DNG	2.00	143.6	0	14.8	0	15	0	0	0
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2]	483 SG	2.00	8.7	262	4.6	190	2.5	58	452	320
2a	Derived Native Grassland[2]	483 SG DNG	2.00	6.7	0	4.3	0	0.2	2	0	2
3	Forest Red Gum Grassy Open Forest[2]	618	2.00	0.1	4	0.1	4	0.1	4	8	8
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1]	1691	2.00	16.3	434	0	-	0	-	434	434
4a	Derived Native Grassland	1691 DNG	2.00	0.9	0	0	-	0	-	0	0
5	Spotted Gum – Narrow-leaved Ironbark Woodland	1602	2.00	7	168	0	-	0	-	168	168
6	Narrow-leaved Ironbark Shrubby Forest	1605	2.00	66.6	1,556	0	-	0	-	1,556	1,556
6a	Derived Native Grassland	1605 DNG	2.00	140.1	0	0.6	0	0.5	0	0	0
6b	Plantation	1605 Plantation	2.00	11.2	289	0.4	6	0.3	5	295	294
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2]	1606	2.00	0.1	3	0.5	13	0.5	13	16	16
7a	Derived Native Grassland[2]	1606 DNG	2.00	0.2	3	1.7	25	1.6	24	28	27
8a	Derived Native Grassland	1655 DNG	1.75	2.5	0	0	-	0	-	0	0
			Total	**448.5**	**4,499**	**27.4**	**251**	**23.3**	**189**	**4,750**	**4,688**

Note: Highlighted cells are credits.

[1] *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

[2] *Box-Gum Woodland CEEC listed under the BC Act.*

* BAM Calculator.

Table 16
Development Footprint Species Credit Amount

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Risk Weighting (DPIE 2020c)	General Extension Areas (Development Footprint 1)		Northern Link Road Option 1 (Development Footprint 2)		Northern Link Road Option 2 (Development Footprint 3)		Overall Species Credit Amount	
		BC Act	EPBC Act		Clearance Area (ha) (Table 2)	Species Credits (Attachment E)	Clearance Area (ha) (Table 2)	Species Credits (Attachment H)	Clearance Area (ha) (Table 2)	Species Credits (Attachment K)	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	2.00	1 (individual)	2	0	-	0	-	2	2
Delma impar	Striped Legless Lizard	V	V	1.50	448.5	4,341	27.4	293	23.3	225	4,634	4,566
Petaurus norfolcensis	Squirrel Glider	V	-	2.00	205.6	4,354	11.5	268	10	194	4,622	4,548

Note: Highlighted cells are credits.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). EP = Endangered Population; V = Vulnerable.

4 AVOID AND MINIMISE IMPACTS

Section 4.1 describes measures to avoid or minimise impacts on biodiversity throughout the Project life. Section 4.2 describes areas of approved surface disturbance that are not included in the Development Footprints (i.e. would not be required for the Project) and would be relinquished following approval of the Project.

This section has been prepared in consideration of the BAM (OEH 2017) and *Biodiversity Assessment Method Operational Manual* (DPIE 2019a), and SEARs.

4.1 MEASURES TO AVOID AND MINIMISE IMPACTS

The BAM (OEH 2017) and *Biodiversity Assessment Method Operational Manual* (DPIE 2019a) require the consideration of how impacts on biodiversity values can be avoided such that only credits calculated for residual biodiversity impacts of a proposed development are retired via the offset rules.

Prescribed impacts are those that may affect biodiversity values in addition to, or instead of, impacts from clearing vegetation. Prescribed biodiversity impacts, including measures to avoid and minimise prescribed biodiversity impacts, are described in Section 4.5.

Location of the Project

The location of the Project has been selected based upon the presence of coal seams able to be economically mined within MACH's existing tenements. The new mining areas associated with the Project are largely contiguous with the existing approved and operating areas, thereby minimising new disturbance areas that would otherwise be associated with a separate mine. In the absence of approval for the Project, this existing Mount Pleasant Operation infrastructure would be decommissioned, and the potential benefits of its continued use would be lost.

MACH did initially consider the expansion of the Project open cut outside of the approved Mount Pleasant Operation MLs (e.g. expanding mining activities east across Kayuga Road). However, this alternative was discounted before the lodgement of the Project Scoping Report, as it would have had potential environmental outcomes that were not aligned with MACH's objectives (MACH 2019). The development of this Project proposal was therefore focussed on optimising mining operations within the existing Mount Pleasant Operation MLs.

As described in Section 1.4, two alternative alignments of the approved western section of the Northern Link Road are being considered by MACH. Northern Link Road Option 1 is the currently preferred option as it skirts the ML boundary and would have a disturbance area of approximately 27.4 ha of native vegetation (Development Footprint 2 – Figure 3b). Northern Link Road Option 2 is the less preferred option and would have a disturbance area of approximately 23.3 ha of native vegetation (including 10.3 ha of native vegetation outside of the approved footprint) (Development Footprint 3 – Figure 3b). Only one of these options would be developed, with the final alignment to be selected based on detailed engineering design and any associated land access constraints. These are discussed further in the EIS.

Project Design

A key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project. These areas are collectively referred to as the Relinquishment Area. The native vegetation within the Relinquishment Area was approved for the development of the:

- North West Out-of-Pit Emplacement area;
- South West Out-of-Pit Emplacement area;
- Western Link Road; and
- portions of the infrastructure area and Fines Emplacement Area.

The approved North West Out-of-Pit Emplacement and South West Out-of-Pit Emplacement areas are no longer required because the Project includes the revised Eastern Out-of-Pit Emplacement footprint approved via Modification 3 and development of an integrated waste rock emplacement landform. The Western Link Road is no longer proposed as Wybong Road is no longer proposed to be closed.

A review and refinement of the infrastructure area and Fines Emplacement Area identified some areas that are no longer required and can be forgone (not cleared).

As described above, two alternative alignments of the western section of the revised Northern Link Road alignment are being considered by MACH. One of these options, Northern Link Road Option 2 (Development Footprint 3), would run through the target Relinquishment Area. Considering this, if Northern Link Road Option 2 (Development Footprint 3) is selected, the ultimate Relinquishment Area would be approximately 13.5 ha smaller (this comprises 13 ha of native vegetation)[6].

Regardless of which Northern Link Road option is selected, the ultimate Relinquishment Area would avoid and/or minimise impacts on a number of biodiversity values, such as:

- *Box-Gum Woodland CEEC listed under the BC Act and EPBC Act*;
- *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*;
- *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act*; and
- habitat for threatened fauna species listed under the BC Act and EPBC Act, including the Striped Legless Lizard and Squirrel Glider.

The SEARs state the following:

- *in the event that a 'land swap' option is proposed, an assessment of any land identified for relinquishment, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report;*

In order to calculate the residual biodiversity impacts of the proposed development, the biodiversity credits that would otherwise be needed to offset clearance of the Relinquishment Area (Attachment N) have been calculated in Section 4.2.4 so like-for-like credit comparison can be made against the credits generated by proposed additional infill clearance areas (Section 3.7) (Attachments E, H and K).

[6] Note: this has been taken into account in the credit calculations as the full impact of both road options has been subtracted from the overall Relinquishment Area.

In relation to the Project design, the Project also involves:

- maximising, re-use and expansion of existing infrastructure;
- maximising infilling of existing infrastructure areas (existing disturbed areas) avoiding the need for a larger development envelope;
- placement of new infrastructure within the extent of approved disturbance areas in lieu of infrastructure no longer required (e.g. additional water storages would be located where the Southern Fines Emplacement Area was assessed and approved as part of the 1997 EIS) (Figure 2); and
- optimising the capacity of the existing Fines Emplacement Area by employing contemporary emplacement methodology.

When compared to the existing/approved mine, as a consequence of the Project, there would be:

- An overall reduction in the amount of *Box-Gum Woodland CEEC listed under the BC Act* and EPBC Act to be cleared (between approximately 226.3 ha and 230.2 ha less [Section 4.2.4]).
- An overall reduction in the amount of Striped Legless Lizard and Squirrel Glider habitat to be cleared.

It is not possible to avoid some incremental impacts on the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act* (PCT 1691), because it is not present within the Relinquishment Area. The impacts on this EEC are further described in Section 6.2.2.

Construction and Operation

Progressive vegetation clearance and soil clearing would be undertaken ahead of the advancing open cuts. A vegetation clearing protocol would be implemented as outlined in Section 7. The vegetation clearing protocol (Section 4.7) includes best practice measures to avoid accidental clearance in vegetation to be retained.

Rehabilitation

The Project includes development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability and varying topographic relief to be more natural in exterior appearance. The Project would result in a single final void as opposed to the three final voids associated with the originally approved Mount Pleasant Operation final landform.

A mixture of pasture and woodland would be established in the final land use following decommissioning and rehabilitation of Project infrastructure to minimise long-term impacts to vegetation and habitat. The EPBC Act approval (EPBC 2011/5795) requires the establishment of 1,000 ha of *Box-Gum Woodland CEEC listed under the EPBC Act* on the mine rehabilitation.

4.2 RELINQUISHMENT AREA

The NSW Biodiversity Offsets Scheme requires the credits calculated for residual biodiversity impacts of a proposed development to be retired via the offset rules. In order to calculate the residual biodiversity impacts of the proposed development, the biodiversity credits that would otherwise be needed to offset clearance of the Relinquishment Area have been calculated in this section.

Northern Link Road Option 2 (Development Footprint 3) would run through the target Relinquishment Area. Considering this, if Northern Link Road Option 2 (Development Footprint 3) is selected, the ultimate Relinquishment Area would be approximately 13.5 ha smaller (this comprises 13 ha of native vegetation). Note this has been taken into account in the credit calculations as the full impact of both road options has been subtracted from the overall Relinquishment Area calculations.

The total approved disturbance area to be relinquished is either 509.8 ha if Northern Link Road Option 1 is selected (comprising 497.9 ha of native vegetation and 11.9 ha of cleared land) or 496.5 ha for Northern Link Road Option 2 (comprising 484.9 ha of native vegetation and 11.6 ha of cleared land).

4.2.1 Plant Community Types

For the purpose of the credit calculations, the Relinquishment Area covers approximately 497.9 ha of native vegetation, comprising 198.6 ha of woodland and 299.3 ha of DNG (Table 17). Eleven vegetation zones are mapped within the Relinquishment Area. All of these zones are also mapped within and of the same condition as vegetation in the Development Footprints, with the exception of Vegetation Community 3a *Derived Native Grassland* (PCT 618 DNG). The main vegetation community in the Relinquishment Area is Vegetation Community 1a *Derived Native Grassland* (PCT 483 DNG) (244.5 ha, 49%), which is the main vegetation community within each of the Development Footprints. The 'Percent Cleared Value' for each PCT in the Relinquishment Area is listed in Table 17.

Table 17
Plant Community Types within the Relinquishment Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area (ha)	Percent Cleared (DPIE 2020d)
Grassy Woodlands				
Western Slopes Grassy Woodlands				
1	Grey Box x White Box Grassy Woodland[1,3]	483	49.3	90 (+/- 50)
1a	Derived Native Grassland[1,3]	483 DNG	244.5	90 (+/- 50)
2	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	483 SG	119.2	90 (+/- 50)
2a	Derived Native Grassland[1,3]	483 SG DNG	24.3	90 (+/- 50)
Coastal Valley Grassy Woodlands				
3	Forest Red Gum Grassy Open Forest[1,3]	618	2.9	73 (+/- 50)
3a	Derived Native Grassland[1,3]	618 DNG	7.5	73 (+/- 50)
Dry Sclerophyll Forests (Shrub/grass sub-formation)				
Hunter-Macleay Dry Sclerophyll Forests				
5	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	1602	0.4	54
North-west Slopes Dry Sclerophyll Woodlands				
6	Narrow-leaved Ironbark Shrubby Forest[2]	1605	24.2	32

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area (ha)	Percent Cleared (DPIE 2020d)
6a	Derived Native Grassland	1605 DNG	16.7	32
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	1606	2.6	29
7a	Derived Native Grassland[1,3]	1606 DNG	6.3	29
	Total Woodland/Forest		**198.6**	**-**
	Total Derived Native Grassland		**299.3**	**-**
	Total Native Vegetation		**497.9**	**-**
	Total Disturbed/Other		**11.9**	**-**
	Total Area		**509.8**	**-**

1 *Box-Gum Woodland CEEC listed under the BC Act.*

2 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

3 *Box-Gum Woodland CEEC listed under the EPBC Act.*

The vegetation integrity (site condition) plots used in the BAM Calculator are shown on Figures 9a and 9b. The VI score and site condition data for the habitat within the Relinquishment Area are provided in Table 18.

Table 18
Vegetation Integrity and Site Condition Detail – Relinquishment Area

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT Condition Class	Sensitivity to Gain*	Patch Size	Composition Condition Score*	Structure Condition Score*	Function Condition Score*	VI Score*
1	483	Grey Box x White Box Grassy Woodland[1,3]	Woodland	High	>100	77	85.4	43.3	65.8
1a	483	Derived Native Grassland[1,3]	DNG	High	>100	72.8	59.9	1.1	16.9
2	483	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	Woodland	High	>100	88.7	84.5	60.9	77
2a	483	Derived Native Grassland[1,3]	DNG	High	>100	76.4	58.5	3.6	25.2
3	618	Forest Red Gum Grassy Open Forest[1,3]	Woodland	High	>100	67.2	60.7	76.4	67.8
3a	618	Derived Native Grassland[1,3]	DNG	High	>100	60	41.6	7	26
5	1602	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	Woodland	High	>100	70.2	31.5	43.3	45.7
6	1605	Narrow-leaved Ironbark Shrubby Forest[2]	Woodland	High	>100	61.3	49	63.3	57.5
6a	1605	Derived Native Grassland	DNG	High	>100	54	20	12.8	24
7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	Woodland	High	>100	68.6	22.9	29.3	35.8
7a	1606	Derived Native Grassland[1,3]	DNG	High	>100	57.3	23.3	0.9	10.5

1 *Box-Gum Woodland CEEC listed under the BC Act.*

2 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

3 *Box-Gum Woodland CEEC listed under the EPBC Act.*

* BAM Calculator.

4.2.2 Ecosystem Credit Species

As described in Section 3.3.1.1, ecosystem credit species for assessment are identified in the BAM Calculator. A total of 32 ecosystem credit species are listed in Table 19 from the BAM Calculator for the Relinquishment Area. Species shaded in Table 19 are species with records in the Subject land.

Table 19
Ecosystem Credit Species from the BAM Calculator – Relinquishment Area

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Sensitivity to Potential Gain (DPIE 2020c)
		BC Act	EPBC Act		
Birds					
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	-	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
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
Stagonopleura guttata	Diamond Firetail	V	-	E	Moderate
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	High
Phascolarctos cinereus	Koala	V	V	S/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

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Sensitivity to Potential Gain (DPIE 2020c)
		BC Act	EPBC Act		
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	E	High
Miniopterus orianae oceanensis	Large Bent-winged 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

Note: Shaded species are species with records in the Subject land.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

4.2.3 Species Credit Species

As described in Section 3.3.2.5, Habitat (Species Polygons) were created for the Striped Legless Lizard and Squirrel Glider (Figures 15 and 16). A Species Polygon for the Tiger Orchid is shown on Figure 10. Tables 20 and 21 present the habitat composition for the Striped Legless Lizard and Squirrel Glider Species Polygons. Table 22 presents a summary of the area of habitat within the Relinquishment Area and the corresponding credits. The credit report from the BAM Calculator for the Relinquishment Area is provided in Attachment N.

Table 20
Striped Legless Lizard Species Polygon Habitat Composition – Relinquishment Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)
1	Grey Box x White Box Grassy Woodland[1,3]	483	49.3
1a	Derived Native Grassland[1,3]	483 DNG	244.5
2	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	483 SG	119.2
2a	Derived Native Grassland[1,3]	483 SG DNG	24.3
3	Forest Red Gum Grassy Open Forest[1,3]	618	2.9
3a	Derived Native Grassland[1,3]	618 DNG	7.5
5	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	1602	0.4
6	Narrow-leaved Ironbark Shrubby Forest[2]	1605	24.2
6a	Derived Native Grassland	1605 DNG	16.7
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	1606	2.6
7a	Derived Native Grassland[1,3]	1606 DNG	6.3
		Total Woodland/Forest	**198.6**
		Total Derived Native Grassland	**299.3**
		Total Native Vegetation	**497.9**

[1] *Box-Gum Woodland CEEC listed under the BC Act.*

[2] *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

[3] *Box-Gum Woodland CEEC listed under the EPBC Act.*

Table 21
Squirrel Glider Species Polygon Habitat Composition – Relinquishment Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area of Habitat (ha)
1	Grey Box x White Box Grassy Woodland[1,3]	483	49.3
1a	Derived Native Grassland[1,3]	483 DNG	48.3*
2	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	483 SG	119.2
2a	Derived Native Grassland[1,3]	483 SG DNG	11.4*
3	Forest Red Gum Grassy Open Forest[1,3]	618	0
3a	Derived Native Grassland[1,3]	618 DNG	0
5	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	1602	0.4
6	Narrow-leaved Ironbark Shrubby Forest[2]	1605	24.2
6a	Derived Native Grassland	1605 DNG	7.3*
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	1606	2.6
7a	Derived Native Grassland[1,3]	1606 DNG	4.5*
		Total Woodland/Forest	**195.7**
		Total Derived Native Grassland	**71.5***
		Total Native Vegetation	**267.2**

1 *Box-Gum Woodland CEEC listed under the BC Act.*

2 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

3 *Box-Gum Woodland CEEC listed under the EPBC Act.*

* Area associated with Paddock Trees (Hunter Eco 2020) (Attachment A).

Table 22
Relinquishment Area Credit Summary – Species Credits

Scientific Name	Common Name	Conservation Status[1]		Area (ha)	Credits (Attachment N)
		BC Act	EPBC Act		
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	2 (individuals)	4
Delma impar	Striped Legless Lizard	V	V	497.9	7,324
Petaurus norfolcensis	Squirrel Glider	V	-	267.2	7,627

Note: Highlighted cells are credits.

1 Conservation status under the BC Act and/or EPBC Act (current as at January 2021). EP = Endangered Population; V = Vulnerable.

4.2.4 Relinquishment Area Credit Summary

The credit report from the BAM Calculator for the Relinquishment Area is provided in Attachment N.

Table 23 provides the areas and credits associated with the NSW Assessment areas (both road options) and the areas and credits associated with the Relinquishment Area. The net areas and credits after applying the Relinquishment Area are also provided in Table 23.

After applying the Relinquishment Area, there would be a net benefit on native vegetation and habitat. The combined area of native vegetation associated with the approved disturbance to be relinquished (497.9 ha for Road Option 1 and 484.9 ha for Road Option 2) is greater than the combined area of native vegetation associated with the Development Footprints (between 458.8 ha and 475.9 ha). This means the following:

- There would be less clearance of native vegetation compared to the current approved mine (approximately 22 ha less [Road Option 1] or 26.1 ha less [Road Option 2). This equates to between 6,530 and 6,591 excess ecosystem credits in the Relinquishment Area which would be forfeited.
- There would be less clearance of *Box-Gum Woodland CEEC listed under the BC Act* compared to the current approved mine (approximately 226.3 ha less for Road Option 1 or 230.2 ha less for Road Option 2).
- There would be less clearance of habitat for Striped Legless Lizard and Squirrel Glider compared to the current approved mine. This equates to between 2,729 and 2,797 excess species credits for the Striped Legless Lizard in the Relinquishment Area which would be forfeited and between 3,056 and 3,130 excess species credits for the Squirrel Glider in the Relinquishment Area which would be forfeited.
- There would be one less Tiger Orchid, a component of the *Cymbidium canaliculatum* population in the Hunter Catchment, cleared compared to the current approved mine (2 credits).

The like-for-like credits in the Relinquishment Area have been applied to the credits associated with the NSW Assessment areas. Although less native vegetation would be cleared overall, it is recognised that there are not enough like-for-like credits for PCTs 1691, 1602 and 1605 (i.e. a total of between 1,547 and 1,548 ecosystem credits).

Of note, there is an extra 6.3 ha of PCT 1606 DNG in the Relinquishment Area that does not produce any credits.

It is also of note that there would be a total of between 6,530 and 6,591 excess credits.

The clearance impacts on these PCTs are assessed in Section 4.3.1 and MACH's offset strategy is described in Section 6.2.

Table 23
Relinquishment Area Credit Summary

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)		Relinquishment Area		NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)	
			Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and H)	Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and K)	Area (ha) (Table 17)	Credits (Attachment N)	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*
Ecosystem Credits												
1	Grey Box x White Box Grassy Woodland[2]	483	44.9	1,793	47.1	1,863	49.3	1,622	4.4 less clearance	0 *(Deficient by 171 but 171 credits can be used from excess for PCT 483 SG resulting in 0 net credits)*	2.2 less clearance	0 *(Deficient by 241 but 241 credits can be used from excess for PCT 483 SG resulting in 0 net credits)*
1a	Derived Native Grassland[2]	483 DNG	158.4	0	158.6	0	244.5	2,068	86.1 less clearance	Excess 2,068	85.9 less clearance	Excess 2,068
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2]	483 SG	13.3	452	11.2	320	119.2	4,589	105.9 less clearance	Excess 3,966 *(Excess 4,137 but 171 credits can be used for PCT 483 resulting in 3,966 excess credits)*	108 less clearance	Excess 4,028 *(Excess 4,269 but 241 credits can be used for PCT 483 resulting in 4,028 excess credits)*
2a	Derived Native Grassland[2,]	483 SG DNG	11	0	6.9	2	24.3	306	13.3 less clearance	Excess 306	17.4 less clearance	Excess 304
3	Forest Red Gum Grassy Open Forest[2]	618	0.2	8	0.2	8	2.9	98	2.7 less clearance	Excess 90	2.7 less clearance	Excess 90
3a	Derived Native Grassland[2]	618 DNG	0	0	0	0	7.5	97	7.5 less clearance	Excess 97	7.5 less clearance	Excess 97

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)		Relinquishment Area		NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)	
			Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and H)	Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and K)	Area (ha) (Table 17)	Credits (Attachment N)	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1]	1691	16.3	434	16.3	434	0	0	16.3	Deficient by 434	16.3	Deficient by 434
4a	Derived Native Grassland	1691 DNG	0.9	0	0.9	0	0	0	0.9	0	0.9	0
5	Spotted Gum – Narrow-leaved Ironbark Woodland	1602	7	168	7	168	0.4	9	6.6	Deficient by 159	6.6	Deficient by 159
6	Narrow-leaved Ironbark Shrubby Forest	1605	66.6	1,556	66.6	1,556	24.2	696	42.4	Deficient by 860	42.4	Deficient by 860
6a	Derived Native Grassland	1605 DNG	140.7	0	140.6	0	16.7	200	124	0 *(Excess 200 but 200 credits can be used for PCT 1605 Plantation resulting in 0 net credits)*	123.9	0 *(Excess 200 but 200 credits can be used for PCT 1605 Plantation resulting in 0 net credits)*
6b	Plantation	1605 Plantation	11.6	295	11.5	294	0	0	11.6	Deficient by 95 *(Deficient by 295 but 200 credits can be used from excess for PCT 1605 DNG resulting in 95 net credits)*	11.5	Deficient by 94 *(Deficient by 294 but 200 credits can be used from excess for PCT 1605 DNG resulting in 94 net credits)*

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)		Relinquishment Area		NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)	
			Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and H)	Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and K)	Area (ha) (Table 17)	Credits (Attachment N)	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2]	1606	0.6	16	0.6	16	2.6	47	2 less clearance	Excess 3 *(Excess 31 but 28 credits can be used for PCT 1606 DNG resulting in 3 excess credits)*	2 less clearance	Excess 4 *(Excess 31 but 27 credits can be used for PCT 1606 DNG resulting in 4 excess credits)*
7a	Derived Native Grassland[2]	1606 DNG	1.9	28	1.8	27	6.3	0	4.4 less clearance	0 *(Deficient by 28 but 28 credits can be used from excess for PCT 1606 resulting in 0 net credits)*	4.5 less clearance	0 *(Deficient by 27 but 27 credits can be used from excess for PCT 1606 resulting in 0 net credits)*
8a	Derived Native Grassland	1655 DNG	2.5	0	2.5	0	0	0	2.5	0	2.5	0
		Total	**475.9**	**4,750**	**471.8**	**4,688**	**497.9**	**9,732**	**-**	**1,548 credits not in the Relinquishment Area** **6,530 excess credits in the Relinquishment Area**	**-**	**1,547 credits not in the Relinquishment Area** **6,591 excess credits in the Relinquishment Area**
Species Credits												
Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)			1 (individual)	2	1 (individual)	2	2 (individuals)	4	**1 less individual cleared**	**2 excess credits in the Relinquishment Area**	**1 less individual cleared**	**2 excess credits in the Relinquishment Area**

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)		Relinquishment Area		NSW Assessment Area with Road Option 1 (Footprint 1 + 2)		NSW Assessment Area with Road Option 2 (Footprint 1 + 3)	
			Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and H)	Area (ha) (Table 2)	Credits (Tables 15 and 16) (Attachments E and K)	Area (ha) (Table 17)	Credits (Attachment N)	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*	Net of Area of Impact (ha)	Net Credits *(like-for-like credits are discussed in brackets)*
Striped Legless Lizard (*Delma impar*) (Note: numbers include the road options)			475.9	4,595	471.8	4,527	497.9	7,324	**22 less clearance**	**2,729 excess credits in the Relinquishment Area**	**26.1 less clearance**	**2,797 excess credits in the Relinquishment Area**
Squirrel Glider (*Petaurus norfolcensis*)			217.1	4,571	215.6	4,497	267.2	7,627	**50.1 less clearance**	**3,056 excess credits in the Relinquishment Area**	**51.6 less clearance**	**3,130 excess credits in the Relinquishment Area**

Note: Highlighted cells are credits.

[1] *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

[2] *Box-Gum Woodland CEEC listed under the BC Act.*

4.3 DIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

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

4.3.1 Clearance of Habitat and Vegetation

A total combined area of between approximately 458.8 ha (Road Option 2) and 475.9 ha (Road Option 1) of native vegetation would be cleared for the Project, depending on the road options (Table 24).

After applying the measures to avoid and/or minimise impacts on biodiversity values (and particularly the Relinquishment Area [Section 4.2]), the net impact on native vegetation and habitat would be much less. In fact, less native vegetation would be cleared overall (approximately 22 ha less [Project Additional Disturbance Area including Road Option 1] or 26.1 ha less [Project Additional Disturbance Area including Road Option 2]) compared to the current approved mine (Table 24).

The Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

Table 24
Native Vegetation Clearance within the Project Additional Disturbance Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Project Additional Disturbance Area Including Road Option 1 (ha)	Project Additional Disturbance Area Including Road Option 2 (ha)	Relinquishment Area (ha)		Net Impacts (ha)	
					With Road Option 1	With Road Option 2	Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
Grassy Woodlands								
Western Slopes Grassy Woodlands								
1	Grey Box x White Box Grassy Woodland[2,4]	483	44.9	44.5	49.3	46.7	4.4 less clearance	2.2 less clearance
1a	Derived Native Grassland[2,4]	483 DNG	158.4	150.8	244.5	236.7	86.1 less clearance	85.9 less clearance
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	483 SG	13.3	8.7	119.2	116.7	105.9 less clearance	108 less clearance
2a	Derived Native Grassland[2,4]	483 SG DNG	11	6.8	24.3	24.2	13.3 less clearance	17.4 less clearance
Coastal Valley Grassy Woodlands								
3	Forest Red Gum Grassy Open Forest[2,4]	618	0.2	0.2	2.9	2.9	2.7 less clearance	2.7 less clearance
3a	Derived Native Grassland[2,4]	618 DNG	0	0	7.5	7.5	7.5 less clearance	7.5 less clearance
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	1691	16.3	16.3	0	0	16.3 additional clearance	16.3 additional clearance
4a	Derived Native Grassland	1691 DNG	0.9	0.9	0	0	0.9 additional clearance	0.9 additional clearance
Dry Sclerophyll Forests (Shrub/grass sub-formation)								
Hunter-Macleay Dry Sclerophyll Forests								
5	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	1602	7	7	0.4	0.4	6.6 additional clearance	6.6 additional clearance
North-west Slopes Dry Sclerophyll Woodlands								
6	Narrow-leaved Ironbark Shrubby Forest[3]	1605	66.6	66.6	24.2	24.2	42.4 additional clearance	42.4 additional clearance

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Project Additional Disturbance Area Including Road Option 1 (ha)	Project Additional Disturbance Area Including Road Option 2 (ha)	Relinquishment Area (ha)		Net Impacts (ha)	
					With Road Option 1	With Road Option 2	Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
6a	Derived Native Grassland	1605 DNG	140.7	140.6	16.7	16.7	124 additional clearance	123.9 additional clearance
6b	Plantation	1605 Plantation	11.6	11.5	0	0	11.6 additional clearance	11.5 additional clearance
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	1606	0.6	0.6	2.6	2.6	2 less clearance	2 less clearance
7a	Derived Native Grassland[2,4]	1606 DNG	1.9	1.8	6.3	6.3	4.4 less clearance	4.5 less clearance
Dry Sclerophyll Forests (Shrubby sub-formation)								
Western Slopes Dry Sclerophyll Forests								
8a	Derived Native Grassland	1655 DNG	2.5	2.5	0	0	2.5 additional clearance	2.5 additional clearance
Total Woodland/Forest			**160.5**	**155.4**	**198.6**	**193.5**	**38.1 less clearance**	**38.1 less clearance**
Total Derived Native Grassland			**315.4**	**303.4**	**299.3**	**291.4**	**16.1 additional clearance**	**12 additional clearance**
Total Native Vegetation			**475.9**	**458.8**	**497.9**	**484.9**	**22 less clearance**	**26.1 less clearance**

Note: Highlighted cells are PCTs with net additional clearance after application of the Relinquishment Area.

1 *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

2 *Box-Gum Woodland CEEC listed under the BC Act.*

3 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act* occurs in Development Area 1 covered by EPBC 2011/5795.

4 *Box-Gum Woodland CEEC listed under the EPBC Act*, part of which occurs in Development Area 1 covered by EPBC 2011/5795.

Although less native vegetation would be cleared overall after consideration of like-for like credits in the Relinquishment Area (Section 4.2) (Attachments N and O), it is recognised that there would be a net additional impact on three PCTs (namely, PCT 1691, 1602 and 1605) (Table 25). The net additional impact on these PCTs is approximately 66.2 ha (Table 25). The woodland form of PCT 1691 is listed as the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*.

Table 24 also indicates that there would be an additional impact on three other vegetation zones, namely 1605 DNG, Plantation (assigned to PCT 1605) and PCT 1655 DNG. However, these are not included in Table 25 because, as shown in Attachment C, the VI scores for 1605 DNG (4.7 and 6.8) and 1655 DNG (3.9) in the Development Footprints are <17, which is the threshold for assessment and offset of a PCT that is associated with threatened species habitat (as represented by ecosystem credits) (OEH 2017). The Plantation is not a natural vegetation community (noting that Table 23 outlines how it is still offset).

Table 25
Native Vegetation Net Additional Clearance within the Project Additional Disturbance Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Project Additional Disturbance Area Including Road Option 1 (ha) (Table 24)	Project Additional Disturbance Area Including Road Option 2 (ha) (Table 24)	Relinquishment Area (ha) (Table 17)*	Net Impacts (ha)	
						Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
Grassy Woodlands							
Coastal Valley Grassy Woodlands							
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,2]	1691	16.3	16.3	0	16.3	16.3
4a	Derived Native Grassland	1691 DNG	0.9	0.9	0	0.9	0.9
Dry Sclerophyll Forests (Shrub/grass sub-formation)							
Hunter-Macleay Dry Sclerophyll Forests							
5	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	1602	7	7	0.4	6.6	6.6
North-west Slopes Dry Sclerophyll Woodlands							
6	Narrow-leaved Ironbark Shrubby Forest[2]	1605	66.6	66.6	24.2	42.4	42.4
Total Woodland/Forest			**89.9**	**89.9**	**24.6**	**65.3**	**65.3**
Total Derived Native Grassland			0.9	0.9	0	0.9	0.9
Total Native Vegetation			**90.8**	**90.8**	**24.6**	**66.2**	**66.2**

* Applicable to both Northern Link Road options.

[1] *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

[2] *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act* occurs in the General Extension Areas (Development Footprint 1) covered by EPBC 2011/5795.

The total Project Additional Disturbance Area including Road Option 1 is 475.9 ha and the total Project Additional Disturbance Area including Road Option 2 is 458.8 ha. The areas without native vegetation comprise:

- 3 ha is cropping/grazing (for both road options);
- 3.1 ha is previously disturbed land (for both road options);
- 2.4 ha is covered by various mine waterbodies and farm dams (for both road options);
- 12.2 ha is dwellings/infrastructure (for both road options); and
- 7 to 8.9 ha is local roads (8.9 ha for Road Option 1 and 7 ha for Road Option 2).

Surface disturbance areas associated with the Development Footprints 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 17). 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.

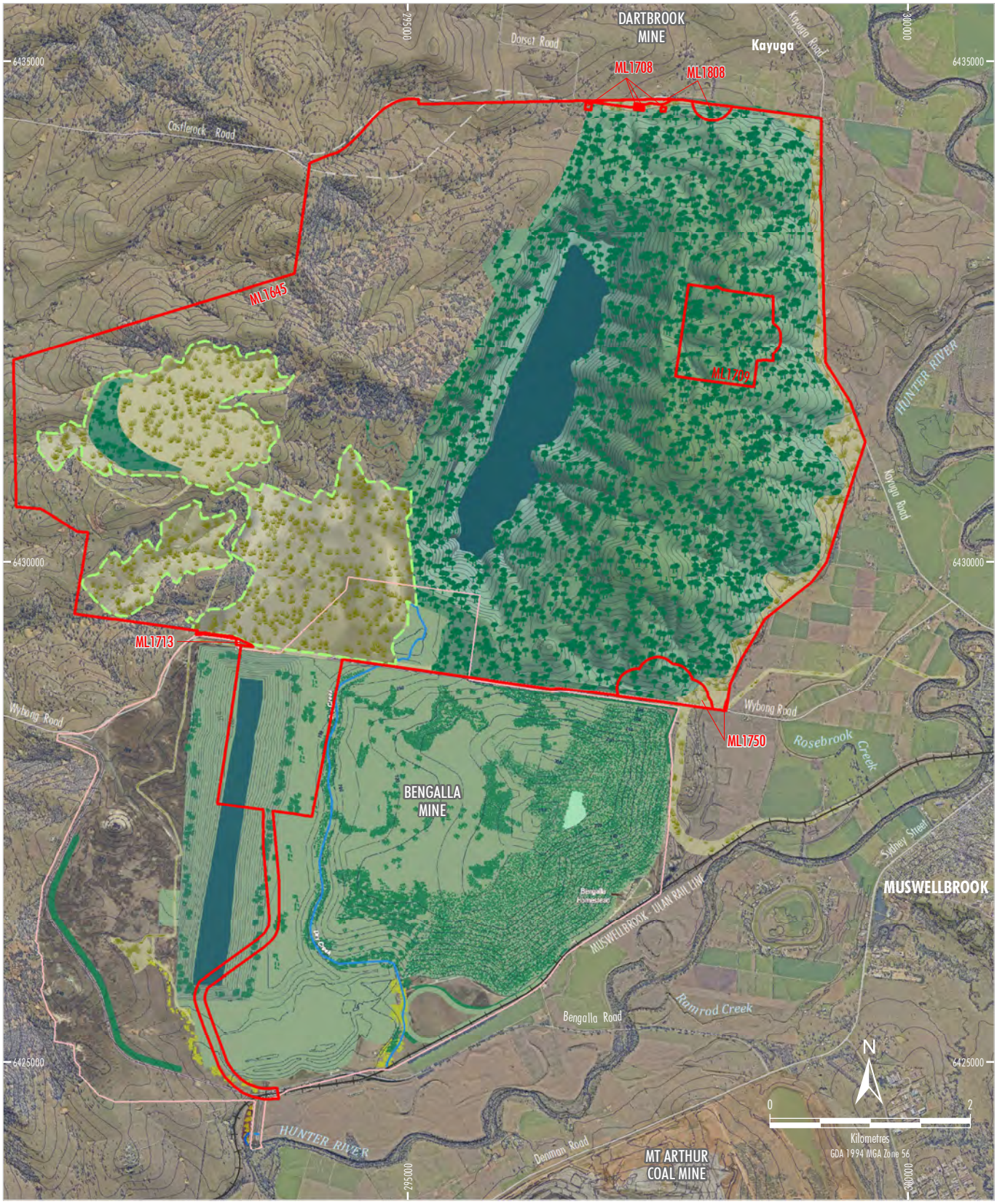
4.3.2 Clearance of Threatened Ecological Communities under the BC Act

Table 25 presents the total incremental native vegetation to be cleared for the Project. Table 26 below summarises the clearance required in terms of TECs.

Table 26
Threatened Ecological Communities Listed under the BC Act

Vegetation Community (Hunter Eco 2020) (Attachment A)	Conservation Status[1]	Project Additional Disturbance Area Including Road Option 1 (ha)	Project Additional Disturbance Area Including Road Option 2 (ha)	Relinquishment Area (ha)		Net Impacts (ha)	
				With Road Option 1	With Road Option 2	Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act	E	16.3	16.3	0	0	**16.3**	**16.3**
Box-Gum Woodland CEEC listed under the BC Act	CE	230.3	213.4	456.6	443.6	**-226.3**	**-230.2**

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered.



MAC-18-02_SSD_EIS_App BDAR_241B

LEGEND

Mining Lease Boundary (Mount Pleasant Operation)

Final Landform Contour (10 m interval)

Secondary/Post-mining Land Use Domains

Domain A - Final Void

Domain C - Agricultural Land

Domain D - Native Woodland/Grassland

Potential High Intensity Agriculture Area

Bengalla Mine Conceptual Final Landform *

Project Boundary (Appendix 2 of Development Consent SSD-5170) (Dated 23 December 2016)

Note: Light vehicle access roads and upslope diversions associated with minimising the catchment of the final void and Fines Emplacement Area are not shown.

** Digitised from Appendix 9 of Development Consent (SSD-5170) and amended in the Mount Pleasant Operation CHPP area.*

Source: MACH (2020); Bengalla Mine (2016); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Rehabilitation Domains

Figure 17

4.3.3 Cumulative Impacts

Cumulative impacts are considered to be the total impact on the environment that would result from the incremental impacts of the Project in addition to past, present and reasonably foreseeable planned developments that may interact with Project impacts. Cumulative impacts include both direct and indirect impacts.

MACH commenced construction activities at the Mount Pleasant Operation in 2016 and mining operations commenced in 2017. The approximate extent of existing/approved surface development for the Mount Pleasant Operation is 2,825 ha and involves the clearance of approximately 1,262 ha of native vegetation[7].

A number of previous ecological assessments have been prepared for the Mount Pleasant Operation as described in Section 3.3. The existing/approved surface disturbance area comprised a combination of exotic pastures, DNG, previous plantings (both native and exotic), scattered mature trees and patches of woodland. TECs were mapped in the existing/approved surface disturbance area and a number of threatened fauna species were recorded as described in Section 3.3.

Key proposed or approved projects that may potentially interact with, or have potential cumulative impacts with the Project include:

- Bengalla Mine immediately adjoining the Mount Pleasant Operation southern boundary (approximately 890 ha of native vegetation clearance) (Cumberland Ecology 2013, 2015a);
- Glencore Mangoola Coal approximately 14 km to the west (approximately 2,261 ha of native vegetation clearance) (Umwelt 2006, 2010; Department of Planning 2009)[8];
- BHP Mt Arthur Coal Mine approximately 8 km to the south (approximately 1,219 ha of native vegetation clearance) (Cumberland Ecology 2009b; Hunter Eco 2013);
- West Muswellbrook Project proposed open cut mine immediately adjoining the Mount Pleasant Operation western boundary (indeterminant); and
- Dartbrook Mine immediately adjoining the Mount Pleasant Operation northern boundary (indeterminant).

The Project would not result in a change to the nature or intensity of impacts on biodiversity values associated with the approved Mount Pleasant Operation, as areas are already approved to be cleared and all additional clearance is assessed in this BDAR.

The Project would involve direct clearance of approximately 160.5 ha (for the Project Additional Disturbance Area including Road Option 1) or 155.4 ha (for the Project Additional Disturbance Area including Road Option 2) of fragmented native woodland/forest and 315.4 ha (for the Project Additional Disturbance Area including Road Option 1) or 303.4 ha (for the Project Additional Disturbance Area including Road Option 2) of DNG.

[7] A portion of the approved surface development would be relinquished as part of the Project (not cleared). These areas cover approximately 497.9 ha of native vegetation and are collectively referred to as the Relinquishment Area (Section 4.2).

[8] It is also noted that the Mangoola Coal Continued Operations (MCCO) Project is currently being assessed by the NSW Government. If approved, a total of 570 ha of native vegetation would be impacted by the MCCO Project, consisting of 356 ha of woodland or open forest and 214 ha of derived native grassland (Umwelt 2019).

Existing biodiversity offsets associated with the Mount Pleasant Operation include the Merriwa East, Merriwa West and Namoi Biodiversity Offset Areas, which contain approximately 11,830 ha of *Box-Gum Woodland CEEC listed under the BC Act and EPBC Act* (Section 6.1). Furthermore, 1,000 ha of land on the mine rehabilitation would be used to establish *Box-Gum Woodland CEEC listed under the BC Act and EPBC Act* as required by the EPBC Act approval (EPBC 2011/5795).

4.4 INDIRECT IMPACTS ON NATIVE VEGETATION AND HABITAT

This section assesses the potential for indirect impact on vegetation and habitat adjacent to the Development Footprints, during construction and operation. Vegetation adjacent to the Development Footprints is shown on Figures 7a and 7b. Threatened fauna records adjacent to the Development Footprints are shown on Figures 11 to 13.

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

4.4.1 Inadvertent Impacts on Adjacent Habitat or Vegetation

A vegetation clearance protocol would be adopted (Section 4.7) to minimise the risk of inadvertent impacts on adjacent habitat or native vegetation in the short-term during construction or operation of the Project, e.g. clearance of vegetation outside of approved disturbance limit.

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

No adverse impacts are likely to result on habitat and vegetation adjacent to the Development Footprints specifically due to the increase in human activity. Vehicle strike is assessed in Section 4.5.6.

4.4.3 Reduced Viability of Adjacent Habitat Due to Edge Effects

Edge effects can occur from a change in physical and/or biological conditions at edges of habitat. No notable edge effects from noise, dust or light spill are likely to result on habitat and vegetation adjacent to the Development Footprints during construction or operation. The Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

The potential impact of noise, dust or light spill is discussed further below in Section 4.4.4. The potential impact of weeds is discussed in Section 4.4.7. Fragmentation is discussed in Section 4.5.2.

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

Consideration of construction activities and their potential for noise generation and air quality impacts are provided in the *Mount Pleasant Optimisation Project Noise & Blasting Assessment* (Wilkinson Murray 2020) and the *Mount Pleasant Optimisation Project Air Quality Impact Assessment* (Todoroski Air Sciences 2020).

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

From field observations, there is no evidence of dust from currently approved operations having impacted surrounding vegetation. It is unlikely that any flora species would be adversely impacted either directly or indirectly by any dust increase generated as a result of the Project. Temporary rehabilitation would be undertaken where practical to minimise the potential for dust generation and dust suppression would occur along the haul road (Section 3 of the EIS).

Lighting is used at the existing Mount Pleasant Operation and would be used for the Project. Night-lighting of the Project construction activities would be kept to a practicable minimum.

4.4.5 Terrestrial Groundwater Dependent Ecosystems

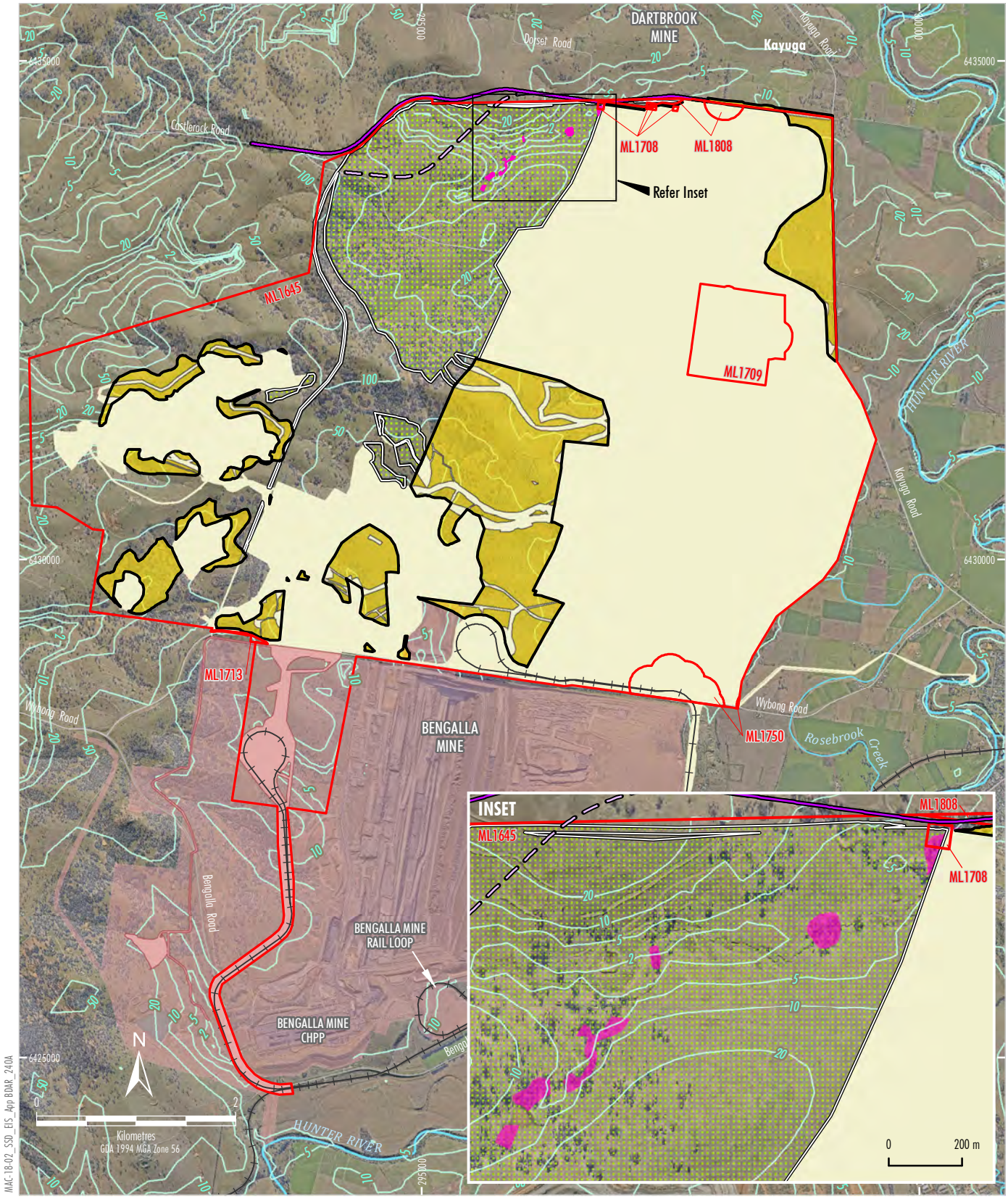
Groundwater dependent ecosystems (GDEs) are ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis for maintenance of the ecosystem (Richardson *et al*. 2011). Terrestrial ecosystems that rely on the subsurface presence of groundwater can require access to groundwater on a permanent (obligate) or intermittent (facultative) basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Doody *et.al.* 2019).

The *Groundwater Dependent Ecosystems Atlas* (GDE Atlas) (Bureau of Meteorology [BoM] 2020) provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Several terrestrial systems within the vicinity of the Project are mapped in the GDE Atlas (BoM 2020) as low, moderate and high potential for groundwater interaction. The majority of remnant terrestrial vegetation in the vicinity of the Project is mapped as having low potential for groundwater interaction.

The potential for remnant terrestrial vegetation in the vicinity of the Project to be groundwater dependant has been reviewed in Attachment A, based on site-specific surveys and review of a Topographic Wetness Model. This review determined that some small patches of the *Forest Red Gum Grassy Open Forest* vegetation community (PCT 618) (Figure 18) could potentially be a facultative GDE.

The tree species in this community (Forest Red Gum [*Eucalyptus tereticornis*], Yellow Box [*Eucalyptus melliodora*] and Grey Box x White Box hybrid [*Eucalyptus moluccana* x *Eucalyptus albens*]) do not require access to groundwater on a permanent (obligate) basis, because they are known to occur elsewhere in the landscape. However, in this specific location on Figure 18, the groundwater is approximately 5 m below ground level (Australasian Groundwater and Environmental Consultants [AGE] 2020). At this depth, it is possible that the trees use the groundwater to meet some of their water requirements.

During mining, the predicted drawdown in the vicinity of the *Forest Red Gum Grassy Open Forest* vegetation community (PCT 618) is negligible (AGE 2020). Larger drawdowns are predicted during the post-mining recovery period (AGE 2020). However, these are not anticipated to impact the condition of the vegetation community on the basis that the community only accesses groundwater on a facultative basis and has persisted despite being subject to groundwater drawdowns from previous mining activities.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Depth to Groundwater Contour (m)

Potential Groundwater Dependent Ecosystems

- Forest Red Gum Grassy Open Forest (PCT618)

Source: MACH (2020); Hunter Eco (2020); AGE (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Groundwater Dependent Vegetation

Figure 18

4.4.6 Potential Impacts on Rivers and Streams

Potential impacts on rivers and streams are assessed by Hydro Engineering and Consulting (HEC) (2020) and BIO-ANALYSIS (2020).

HEC (2020) concludes that the Project would result in negligible or indiscernible impacts to flow, catchment yield, baseflow and water quality in Sandy Creek, Rosebrook Creek, Dry Creek and the Hunter River. BIO-ANALYSIS (2020) concludes that the Project is unlikely to have a significant impact on aquatic ecology in the surrounding waterways.

Prescribed biodiversity impacts, including measures to avoid and minimise prescribed biodiversity impacts, are described in Section 4.5.

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

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

A total of 78 weed species, including 18 High Threat Exotic species, were recorded in the Subject land (Hunter Eco 2020) (Attachment A). Weeds were relatively evenly distributed across the area which means that it is unlikely that there would be any dispersal of weeds from the Biodiversity Assessment Development Area that were not already present in the surrounds. The potential impacts from the Project to surrounding native vegetation associated with introduced flora is likely to be low. Section 4.7 describes mitigation measures.

Myrtle Rust (*Austropuccinia psidii*) is a fungal pathogen affecting new foliage of Myrtaceous species generally in moist coastal areas. It has not been recorded as far inland as the Project Additional Disturbance Area (OEH 2011). *Phytophthora cinnamomi* is a fungal pathogen affecting the roots of trees or shrubs. There is a low probability of this pathogen occurring or establishing in or near the Project Additional Disturbance Area. It prefers moist areas with rainfall >600 millimetres (mm) per year (Department of Environment and Climate Change 2008). Muswellbrook median rainfall is 591 mm (Weatherzone 2020). The nearest record of *Phytophthora cinnamomi* is from the Maitland area (ALA 2020) which has a median rainfall of 938 mm (Weatherzone 2020).

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

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

In principle, native vegetation loss could result in displacement of resident fauna (leading to increased risk of fauna starvation and exposure). Sufficient connectivity would remain around the Development Footprints such that no threatened species are likely to become isolated as a result of the Project. As previously described, the Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

A vegetation clearance protocol would be adopted, which would include a pre-clearance survey to minimise impacts on displaced fauna during vegetation clearance activities (Section 4.7).

4.4.9 Indirect Loss of Breeding Habitats

Fauna breeding habitat resources adjacent to the Project Additional Disturbance Area include trees with hollows and bush rock. The Project is not likely to indirectly impact fauna breeding habitat resources.

4.4.10 Trampling of Threatened Flora Species

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

4.4.11 Inhibition of Nitrogen Fixation and Increased Soil Salinity

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

4.4.12 Fertiliser Drift

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

4.4.13 Rubbish Dumping

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

4.4.14 Wood Collection

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

4.4.15 Bush Rock Removal and Disturbance

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

4.4.16 Increase in Predatory Species Populations

The Project is unlikely to increase predatory species populations (such as Cat and Red Fox). Agricultural activities would continue to occur both inside and outside the Project Additional Disturbance Area, including control of pest animal populations. Section 4.7 describes mitigation measures.

4.4.17 Increase in Pest Animal Populations

A total of 13 pest animal species were identified by Future Ecology (2020) (Attachment B) within the Subject land. These are the Common Starling (*Sturnus vulgaris*), Common Myna (*Sturnus tristis*), House Sparrow (*Passer domesticus*), House mouse (*Mus musculus*), Black Rat (*Rattus rattus*), Dog (*Canis lupus familiaris*), Fox (*Vulpes vulpes*), Cat (*Felis catus*), Brown Hare (*Lepus capensis*), Rabbit (*Oryctolagus cuniculus*), Pig (*Sus scrofa*), European Cattle (*Bos taurus*) and Fallow Deer (*Dama dama*). Relevant pest animal species would be controlled under the MACH Animal Pest Management programme (Section 4.7).

4.4.18 Increased Risk of Fire

Project activities are unlikely to increase fire risk. Bushfire risk would continue to be managed in accordance with MACH's existing Bushfire Management Plan, which assesses fire risks across and adjacent to the Mount Pleasant Operation and identifies management strategies to reduce the risk of unplanned fire.

Bushfire management measures include slashing of vegetation along fire trails, controlled burns where appropriate, maintenance of firebreaks and fire-fighting equipment, rotational livestock grazing to reduce fuel loads and emergency response procedures (Section 4.7).

4.4.19 Disturbance to Specialist Breeding and Foraging Habitat

The BAM (OEH 2017) does not define 'specialist breeding and foraging habitat', although gives the example of 'beach nesting for shorebirds'. No specialist breeding and foraging habitat occurs in the Project Additional Disturbance Area additional to that assessed above in Sections 4.4.1 to 4.4.18.

4.5 PRESCRIBED BIODIVERSITY IMPACTS

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

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

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

(ii) rocks,

(iii) human made structures,

(iv) non-native vegetation,

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

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

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

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

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

These impacts are assessed below in relation to the Project.

4.5.1 Impacts on Habitat Resources other than Native Vegetation

(a) the impacts of development on the following habitat of threatened species or ecological communities:
(i) karst, caves, crevices, cliffs and other geological features of significance,

As described in Section 2.6, there are no karst, caves, crevices, cliffs or other areas of geological significance on, or in the vicinity of, the Subject land.

No areas with rock crevices occur within the Development Footprints, therefore the Project would not impact rock crevices.

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

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

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

As described in Section 3.6.2, rocky areas providing potential habitat for the Striped Legless Lizard are present in the Subject land. The occurrence of rocky areas is associated with the *Box-Gum Woodland CEEC listed under the BC Act* and the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act* as shown on Figure 15.

While rocky areas are not a habitat constraint for the Striped Legless Lizard (DPIE 2020c), this species was recorded under rocks and dried cow manure in an open grassy area (Future Ecology 2020) (Attachment B). The spatial occurrence of the rocky areas is shown on Figure 15. The rocks occur scattered in only two relatively small areas in the Subject land (Future Ecology 2020) (Attachment B).

As described in Section 4.1, a number of measures have been adopted to avoid and minimise land clearance. Those measures that have specifically avoided clearance of rocky areas are:

- locating new mining areas associated with the Project largely within the existing approved and operating mine, thereby minimising new disturbance areas that would otherwise be associated with a separate mine; and
- forgoing development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project.

The Project would not result in the loss of any mapped rocky areas.

There is potential that some Striped Legless Lizard individuals could be lost during land clearance for the Project (if they were to occur within the Development Footprints). A vegetation clearance protocol would be undertaken to mitigate and manage vegetation clearance impacts as outlined in Section 4.7.

No indirect impacts are likely to occur on the rocky areas outside of the Development Footprints due to the Project. As described in Section 4.4.15, removal or disturbance of rocky areas from surrounding native vegetation would not be permitted for the Project.

As the Project would not result in the loss of any rocky areas, there is no habitat for the Striped Legless Lizard or ecological communities associated with rocks that would be impacted by the Project.

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

…

(iii) human made structures,

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

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

…

(iv) non-native vegetation,

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

4.5.2 Habitat Fragmentation

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

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

> *The assessment of the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range must:*
>
> *(a) identify the area/s of connectivity joining different areas of habitat that intersect with the subject land and the areas of habitat that are connected according to Paragraph 4.2.1.3*
>
> *(b) identify the species and ecological communities likely to benefit from the connectivity*
>
> *(c) describe the nature, extent and duration of short and long-term impacts*
>
> *(d) describe, with reference to relevant literature and other reliable published sources of information, the importance of the area of connectivity within the bioregion*
>
> *(e) predict the consequences of the impacts for the bioregional persistence of the suite of threatened species and communities currently benefitting from the connectivity with reference to relevant literature and other published sources of information and taking into consideration mobility, abundance, range and other relevant life history factors.*

Habitat connectivity areas are shown on Figure 5 and woodland/connectivity areas within the assessment buffer areas are shown on Figure 6. There are no defined woodland corridors in the Subject land, however, it is possible that the woodland areas facilitate the movement of species in the landscape.

All threatened species and communities known to occur in the Subject land are likely to benefit from the current level of connectivity, in particular species that are known to use habitat linkages, such as the Squirrel Glider, and species that are unlikely to cross roads (e.g. Striped Legless Lizard [Dorrough and Ash 1999]).

As previously described, the Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure. The Project would impact the current habitat connectivity through construction of and operations in the General Extension Areas (Development Footprint 1) and Northern Link Road Option 1 (Development Footprint 2) or Northern Link Road Option 2 (Development Footprint 3). However, despite the impact to habitat connectivity, sufficient connectivity would remain around the Development Footprints (Figure 5) such that no threatened species are likely to become isolated as a result of the Project.

The surface disturbance areas associated with the Project 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 domains are shown on Figure 17. Revegetation would aim to increase the continuity of woodland vegetation by establishing links between woodland vegetation.

4.5.3 Fauna Movement

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

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

> *The assessment of the impacts of the development on movement of threatened species that maintains their life cycle must:*
>
> *(a) identify movement patterns key to the life cycle of relevant threatened species that intersect with the subject land*
>
> *(b) describe the nature, extent and duration of short and long-term impacts*
>
> *(c) describe, with reference to relevant literature and other reliable published sources of information, the importance of the movement of the threatened species to their life cycle*
>
> *(d) predict the consequences of the impacts for the bioregional persistence of the threatened species, with reference to relevant literature and other published sources of information.*

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

As described in Section 4.5.2, all threatened species and communities known to occur in the Subject land are likely to benefit from the current level of connectivity. However, despite the impact to habitat connectivity, sufficient connectivity would remain around the Development Footprints (Figure 5) such that no threatened species are likely to become isolated as a result of the Project.

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

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

Potential impacts on rivers and streams are described in Section 4.4.6.

4.5.5 Wind Turbines

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

No wind turbines are planned for the Project.

4.5.6 Vehicle Strike

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

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

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

Threatened fauna records adjacent to the Development Footprints are shown on Figures 11 to 16. There is little likelihood of the Striped Legless Lizard becoming roadkill given their preference for covered habitat and low mobility. Given the width of the road, and that the road primarily traverses open grassland with few trees from which to launch or land, 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.

Low speed limits would continue to be imposed on all vehicles using the mine roads and tracks. Vehicle access would continue to be limited to haul roads, access roads and tracks wherever possible.

It is also noted that the Northern Link Road would be developed by the approved Mount Pleasant Operation, irrespective of the Project (Figure 2).

4.6 STATE ENVIRONMENTAL PLANNING POLICY (KOALA HABITAT PROTECTION) 2020

Impacts on the Koala are assessed through the credit calculations (Section 3.7), and an assessment is provided in Section 5.3. This section discusses the *State Environmental Planning Policy (Koala Habitat Protection) 2020* (Koala Habitat Protection SEPP).

Application of Koala Habitat Protection SEPP to the Project

The SEARs list *State Environmental Planning Policy 44* (SEPP 44) as an environmental planning instrument that may be relevant to the environmental assessment of the Project. On 1 March 2020, SEPP 44 was repealed and replaced by the *State Environmental Planning Policy (Koala Habitat Protection) 2019*. In November 2020, the *State Environmental Planning Policy (Koala Habitat Protection) 2019* was repealed and replaced by the Koala Habitat Protection SEPP. Development controls within the Koala Habitat Protection SEPP do not apply to Part 4 development applications (such as the Project) which are determined by a consent authority other than a local council.

The Project is located within a LGA (Muswellbrook) to which the Koala Habitat Protection SEPP applies.

Koala Habitat Values

Potential Koala habitat is defined in the Koala Habitat Protection SEPP as:

> *'areas of native vegetation where 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'*

Forest Red Gum (*Eucalyptus tereticornis*) is the only Koala feed tree species listed in Schedule 2 of the Koala Habitat Protection SEPP that occurs in the Subject land (Hunter Eco 2020) (Attachment A). However, White Box x Grey Box (*Eucalyptus 'albemol'*) is an assumed Koala feed tree as it is a cross with *Eucalyptus albens* which is a Koala feed tree species listed in Schedule 2 of the Koala Habitat Protection SEPP. These tree species occur in PCT 483, PCT 483 SG and PCT 618.

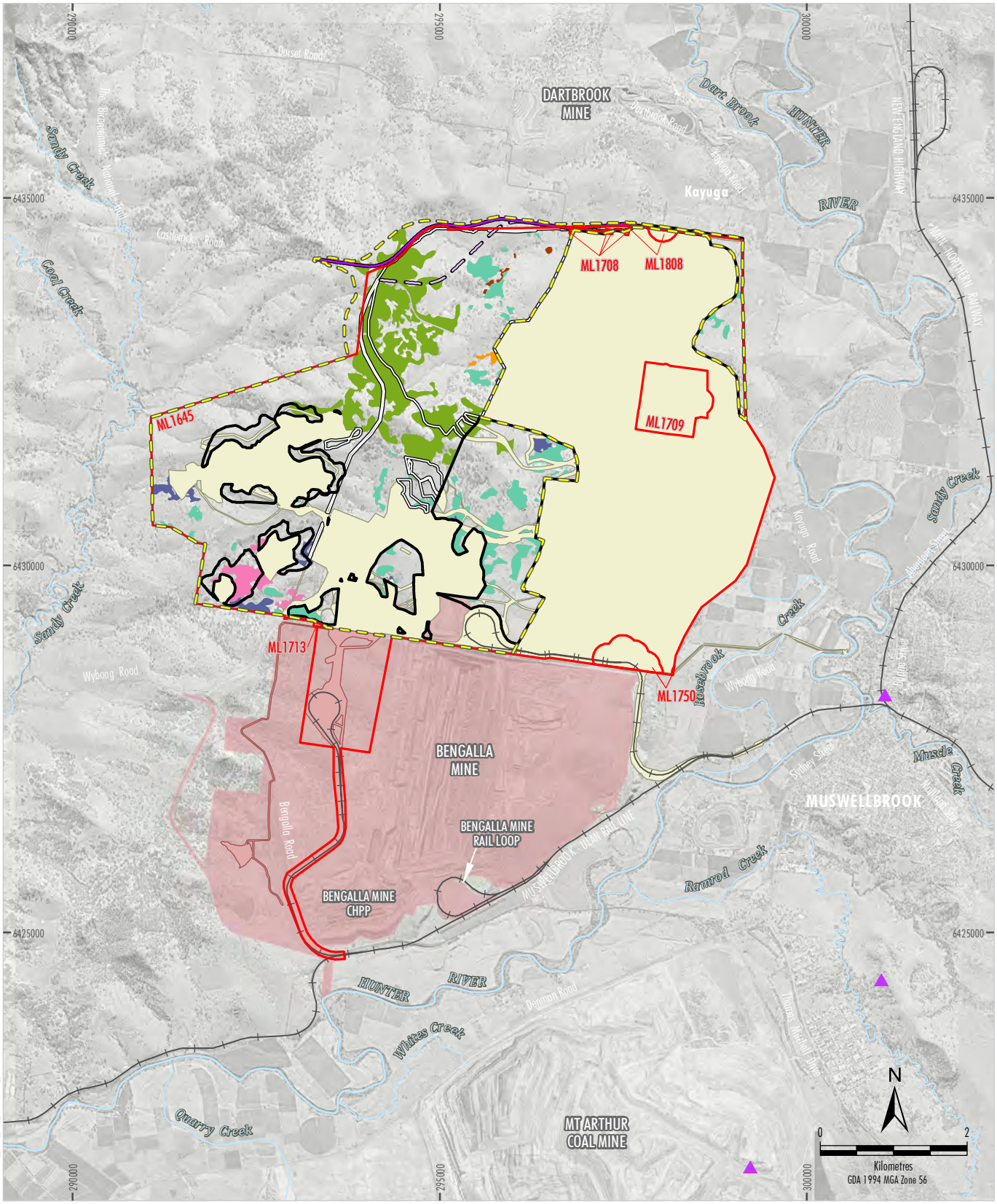
The White Box x Grey Box canopy component was >15% in PCT 483 and PCT 483 SG. However, the Forest Red Gum canopy component was <15% in PCT 618. Thus, only PCT 483 and PCT 483 SG constituted potential Koala habitat as per the Koala Habitat Protection SEPP.

Core Koala habitat is defined in the Koala Habitat Protection SEPP as:

> *'an area of land with a resident population of koalas, evidenced by attributes such as breeding females, being females with young, and recent sightings of and historical records of a population'*

Figure 19 shows the location of potential Koala habitat and Koala (database) records in the wider locality. The Koala habitat identified in the Project Additional Disturbance Area (Figure 19) does not meet the definition of *core koala habitat* because (Future Ecology 2020) (Attachment B):

- the Koala was not recorded during current or previous targeted surveys in the Subject land;
- the Subject land has been assessed by a suitably qualified and experienced person as not being highly suitable Koala habitat;
- there are no historic records of the Koala from the Subject land and none are recorded as being present in the Subject land in the previous 18 years (DPIE 2020b); and
- the closest records are at least 4 km to the north-east and south-east of the Subject land (DPIE 2020b).



MAC-18-02_SSD_EIS_App BDAR_239A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area
- Database

Threatened Species

- Koala

POTENTIAL FORAGING HABITAT

Grassy Woodlands

- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]

[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Database Record Sources: ALA (2020); DPIE (2020)

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Koala
Potential Foraging Habitat

Figure 19

Koala Surveys

The flora and fauna survey reports in Attachments A and B provide a description of the general environment and condition. Targeted surveys for the Koala are described in Future Ecology (2020) (Attachment B). The Spot Assessment Technique (Phillips and Callaghan 2011) was followed along with call-playback, spotlighting and camera traps. No Koalas were recorded using these methods (Future Ecology 2020) (Attachment B). It has not been recorded by any previous surveys in the Action area or surrounds (ERM 1997; Cumberland Ecology 2006, 2009a, 2010; ELA 2017a, 2017b).

Potential Impacts

The Koala has not been recorded at the Mount Pleasant Operation during past or present surveys (Attachment B). The high level of current fragmentation of potential habitat in the Subject land may explain why the Koala appears to be absent. For this reason, the Project is unlikely to directly or indirectly adversely impact the species. Also, it is noted that the Project would result in less clearance of potential Koala habitat compared to the current approved mine (approximately 45.3 ha less [for the Project Additional Disturbance Area including Road Option 1] or 44.9 ha less [for the Project Additional Disturbance Area including Road Option 2).

Management Measures

Measures to generally manage impacts on biodiversity (including potential Koala habitat) are provided in Section 4.7.

4.7 MEASURES TO MITIGATE AND MANAGE IMPACTS

The Project has been designed to avoid and minimise impacts on biodiversity values as described in Section 4.1. Potential impacts on biodiversity at the Mount Pleasant Operation are managed in accordance with an approved Biodiversity Management Plan. The management measures implemented at the existing operations would continue for the Project.

Table 27 provides measures to mitigate and manage impacts from the Project. MACH would be responsible for implementing the measures. Table 27 includes:

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

The techniques used to implement the measure are discussed below Table 27.

After the measures to mitigate and manage impacts, there would be negligible risk to biodiversity with low consequences in the medium to long term. The EIS provides a number of other measures to mitigate and manage other potential impacts from the Project, such as measures to manage erosion and sediment, dust, noise, lighting and groundwater.

Table 27
Mitigation Measures

Potential Impact	Mitigation Measures	Timing/Frequency	Potential Risk of Failure	Likelihood and Consequence of Residual Impacts
Clearing of Native Vegetation and Habitat	Biodiversity Measure 1 – Vegetation Clearance Protocol	Prior to/during native vegetation clearance	Low	Low risk of resident fauna becoming displaced or injured Vegetation clearance is quantified in Table 24
	Biodiversity Measure 2 – Rehabilitation and Revegetation	Over the life of the mine	Low	None
	Biodiversity Measure 3 – Tiger Orchid Relocation	During and following native vegetation clearance	Low	None
Indirect Impacts on Native Vegetation and Habitat	Biodiversity Measure 4 – Weed Management	Over the life of the mine	Moderate	Low
	Biodiversity Measure 5 – Animal Pest Management	Over the life of the mine	Low	Low
	Biodiversity Measure 6 – Speed Limits	Over the life of the mine	Low	None
	Biodiversity Measure 7 – Bushfire Prevention and Control Measures	Over the life of the mine	Low	Low

Biodiversity Measure 1 – Vegetation Clearance Protocol

A Vegetation Clearance Protocol has been established at the Mount Pleasant Operation, which includes:

- delineation of approved native vegetation clearing areas;
- a Ground Disturbance Permit process prior to any ground disturbance activities being carried out on-site;
- pre-clearance survey conducted by an appropriately trained and suitably qualified and/or experienced person(s) prior to native vegetation (excluding grassland and exotic pasture) clearing;
- reuse of trees containing features with the potential to provide significant habitat (i.e. numerous suitable hollows) for nesting threatened birds, hollow-dwelling bats and/or arboreal mammals (e.g. for the Squirrel Glider [*Petaurus norfolcensis*]), wherever practicable;
- management strategies to minimise impacts of ground disturbance on fauna during clearing activities; and
- provision for seed collection during clearance activities.

Biodiversity Measure 2 – Rehabilitation and Revegetation

As described in Section 4.5.2, MACH have commenced rehabilitation and revegetation activities at the Mount Pleasant Operation. The Mount Pleasant Operation rehabilitation program has been designed to establish an appropriate ground strata, understorey, sub-canopy and canopy within areas of the Mount Pleasant Operation final landform. The program has been developed to:

- re-use habitat features salvaged from site/surrounding areas;
- undertake topsoil spreading, establishment and management (including application of soil ameliorants where required);
- monitor weed and pest activity and undertake control measures;
- maintain appropriate bushfire management measures;
- target species composition characteristic of surrounding native vegetation; and
- target vegetation structure which is characteristic of surrounding native vegetation.

Mount Pleasant Operation rehabilitation program has already included the planting and seeding of areas to PCT 1605, and more areas are planned. PCT 1602 is not yet a target PCT for the mine rehabilitation, but this PCT would be added to the Mining Operations Plan and Rehabilitation Management Plan (MOP). It is proposed that than an equivalent area of PCT 1605 and PCT 1602 cleared by the Project, would be rehabilitated (i.e. 66.6 ha of PCT 1605 and 7 ha of PCT 1602).

Biodiversity Measure 3 – Tiger Orchid Relocation

A relocation program for the Tiger Orchid (a component of the *Cymbidium canaliculatum* population in the Hunter Catchment) has been established at the Mount Pleasant Operation so that these tree orchids can be salvaged prior to disturbance and relocated to proximal, suitable habitats in non-disturbance areas. Relocation would continue to be carried out under the supervision of the Environmental Superintendent by a licensed, appropriately qualified and/or experienced person(s) using accepted techniques.

Biodiversity Measure 4 – Weed Management

A weed control program is implemented at the Mount Pleasant Operation to limit the spread and colonisation of both priority and environmental weeds. Weed control measures that would continue to be undertaken at the Mount Pleasant Operation include:

- weed control, including physical removal and/or chemical spraying using herbicides;
- machinery hygiene protocols for all machinery working in/around the Mount Pleasant Operation area;
- management of cattle movement;
- use of erosion and sediment control measures to control nutrient/weed migration; and
- regular inspections and maintenance of topsoil stockpiles.

The weed control program would also be implemented with the Relinquishment Area (Figure 3a).

Biodiversity Measure 5 – Animal Pest Management

An animal pest control program is implemented at the Mount Pleasant Operation. Activities include use of a range of pest control measures, for example:

- destruction of habitat;
- trapping;
- targeted shooting programs; and
- baiting.

The animal pest control program would also be implemented with the Relinquishment Area (Figure 3a).

Biodiversity Measure 6 – Speed Limits

Low speed limits would continue to be imposed on all vehicles using the mine roads and tracks. Vehicle access would continue to be limited to haul roads, access roads and tracks wherever possible.

Biodiversity Measure 7 – Bushfire Prevention and Control Measures

The main objectives of bushfire management are to minimise the risk of bushfires and to rapidly control any outbreaks that might occur. These measures may include:

- slashing of vegetation along roads and internal tracks which are used as fire trails;
- controlled burns under the advice of the NSW Rural Fire Service;
- maintaining firebreaks where required;
- fire-fighting equipment (i.e. water carts, graders and bulldozers);
- rotational livestock grazing to reduce pasture-based fuel loads;
- a network of water supply points to assist the NSW Rural Fire Service with logistical support;
- reporting of any incidence of unplanned bushfire; and
- emergency response procedures in the event of a bushfire.

Bushfire management would also be implemented with the Relinquishment Area (Figure 3a).

Monitoring Programme

The objective of biodiversity monitoring is to evaluate the vegetation and fauna habitat condition at the Mount Pleasant Operation (including recovery and or enhancement of native vegetation) and to identify appropriate management actions to be applied. Biodiversity monitoring includes priority and environmental weed monitoring, vertebrate pest monitoring, monitoring of access and rehabilitation monitoring. A monitoring programme is provided in Table 28.

Table 28
Monitoring Programme

Impact	Mitigation Measures	Monitoring Schedule	Responsibility
Clearing of Native Vegetation and Habitat	Biodiversity Measure 1 – Vegetation Clearance Protocol	Prior to construction: inspection of delineated areas to be cleared and/or retained After clearance: annual review of the vegetation clearance methods and results of implementing the vegetation clearance protocol to identify potential improvements	General Manager, Environmental Superintendent, Mine Manager/Construction Manager and Project Manager
	Biodiversity Measure 2 – Rehabilitation and Revegetation	During operations: annual inspection of vegetation growth	Environmental Superintendent
	Biodiversity Measure 3 – Tiger Orchid Relocation	Prior to and during construction and operations: visual inspection of potential habitat resources to be salvaged	Environmental Superintendent
Indirect Impacts on Native Vegetation and Habitat	Biodiversity Measure 4 – Weed Management	During construction and operations: ongoing visual inspection of vehicles entering site and biannual visual inspections to identify high threat weed infestations in disturbance/rehabilitation areas (mapping extent, identifying species, and estimating cover) Reduced inspections to annually for the life of the Project once vegetation has established in rehabilitation areas and risk of weeds has reduced	Environmental Superintendent
	Biodiversity Measure 5 – Animal Pest Management	During construction and operations: at least biannual inspections to identify what, where, when and how to target appropriate resources to control and minimise animal pest populations Follow-up inspections to assess effectiveness of control measures	Environmental Superintendent
	Biodiversity Measure 6 – Speed Limits	During construction and operations: vehicle access limited to roads and tracks and monitoring of vehicle speeds on site Signage inspected annually as well as opportunistically	Environmental Superintendent
	Biodiversity Measure 7 – Bushfire Prevention and Control Measures	During construction and operations: visual inspection to identify all bushfire hazards and monitor fuel loads at six monthly intervals	General Manager and Environmental Superintendent

Performance and Completion Criteria

Performance and completion criteria are provided in Table 29.

Table 29
Performance and Completion Criteria

Mitigation Measures	Performance Criteria	Method	Completion Criteria
Biodiversity Measure 1 – Vegetation Clearance Protocol	Areas to be cleared and/or retained are clearly delineated and mapped No adjacent vegetation outside of delineated areas is cleared	Clearance authorisation process with final signoff for the areas to be cleared by the General Manager or delegate All staff involved in vegetation clearance works to be made aware of clearing limits Pre-clearance fauna surveys	Ongoing for the life of the Project
Biodiversity Measure 2 – Rehabilitation and Revegetation	Revegetation of cleared areas	Revegetation using natural regeneration or seed collected from felled trees Tubestock planting is undertaken where practical and feasible	Revegetation of cleared areas
Biodiversity Measure 3 – Tiger Orchid Relocation	Disturbance modified to avoid Tiger Orchid if possible Otherwise relocation of Tiger Orchid attempted	Orchid salvaged prior to disturbance and relocated to proximal, suitable habitats in non-disturbance areas	Loss of Tiger Orchid avoided
Biodiversity Measure 4 – Weed Management	Number of infestations of identified weed species equal to or less than baseline dataset Percent cover for identified weed species equal to or less than baseline dataset Weeds identified during monitoring have been controlled	Survey at existing infestation locations Control of high threat weeds using ecologically appropriate methods for the target weed	Ongoing for the life of the Project
Biodiversity Measure 5 – Animal Pest Management	Animal pest identified during monitoring have been controlled	Use of baiting, trapping, mustering or shooting as appropriate to manage animal pest species	Ongoing for the life of the Project
Biodiversity Measure 6 – Speed Limits	Limited vehicle access and limited fauna strikes due to vehicle speed	Enforcement of speed limits	Ongoing for the life of the Project
Biodiversity Measure 7 – Bushfire Prevention and Control Measures	No incidence of unplanned bushfire Any outbreak of fire is contained	Comply with relevant Australian Standards Undertake fuel reduction burns as required Implementation of appropriate firefighting equipment	Ongoing for the life of the Project

5 IMPACT SUMMARY NSW ASSESSMENT

5.1 SERIOUS AND IRREVERSIBLE IMPACTS

5.1.1 Introduction

Under the BC Act, there is a small list of threatened species and communities that are considered by the NSW Government to be at risk of a serious and irreversible impact. These species/communities are named SAII Entities. There are established principles and thresholds for impacts on SAII Entities that are considered below, but the onus is on the approval authority to decide if an impact is serious and irreversible.

There is one SAII Entity relevant to the Project, namely the *Box-Gum Woodland CEEC listed under the BC Act* (Figure 20).

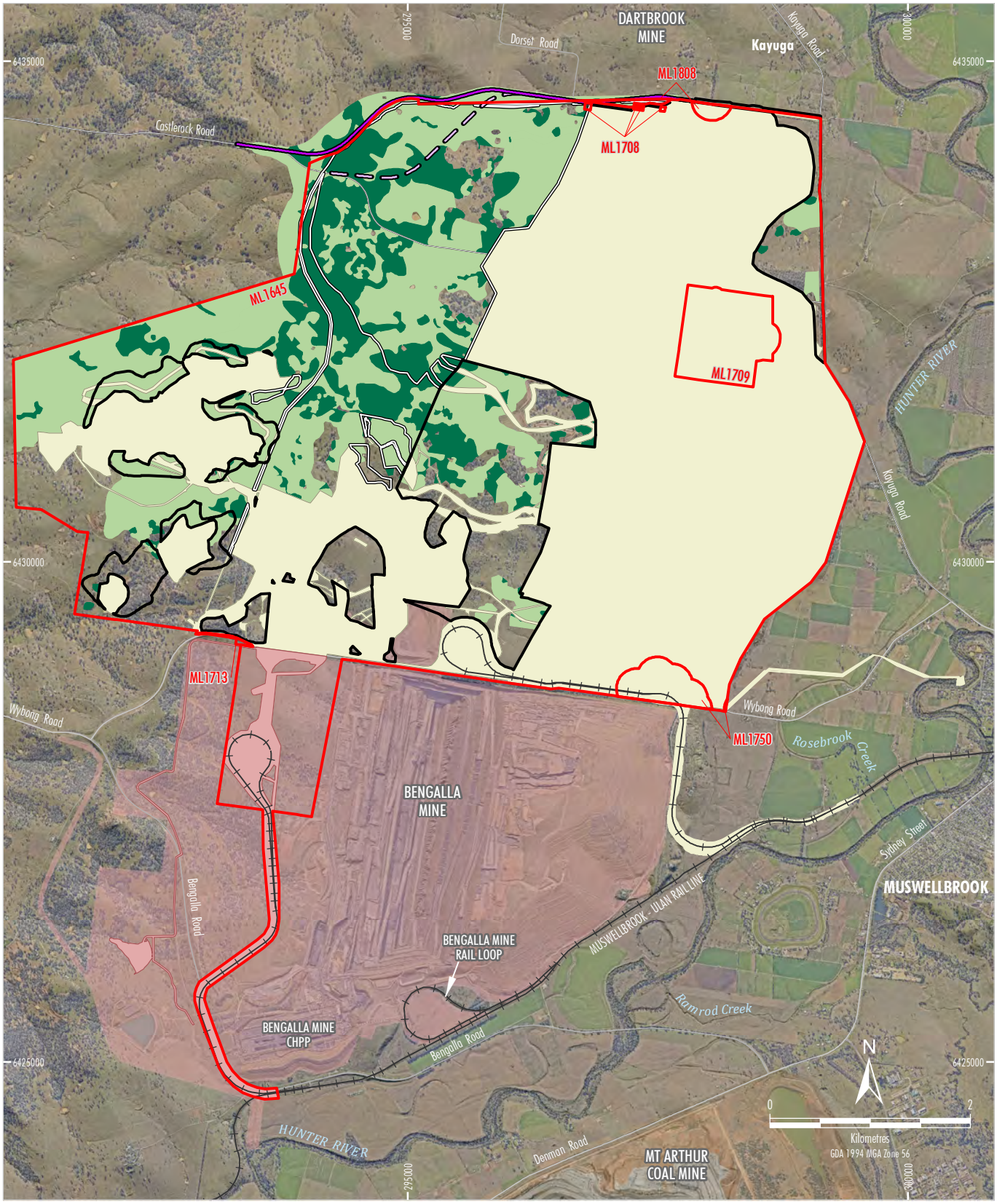
5.1.2 Background Information – Box-Gum Woodland CEEC listed under the BC Act

The *Box-Gum Woodland CEEC listed under the BC Act* is a SAII entity according to the BAM Calculator. The amount of unavoidable loss of *Box-Gum Woodland CEEC listed under the BC Act* from the Project is provided in Table 30, showing a total loss of 230.3 ha (comprising 74.4% DNG) for the Project Additional Disturbance Area including Road Option 1 or 213.4 ha (comprising 74.7% DNG) for the Project Additional Disturbance Area including Road Option 2.

Table 30
Unavoidable Loss of Box-Gum Woodland CEEC Listed under the BC Act

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	Clearance Area (ha)		VI Score*		
			Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2	General Extension Areas (Development Footprint 1)	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
1	483	Grey Box x White Box Grassy Woodland	44.9	44.5	80	66.5	64.1
1a		Derived Native Grassland	158.4	150.8	10.8	14.4	14.9
2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland	13.3	8.7	60.3	82.5	46.4
2a		Derived Native Grassland	11	6.8	8.2	14.8	15.2
3	618	Forest Red Gum Grassy Open Forest	0.2	0.2	73.7	73.7	73.7
7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum	0.6	0.6	50.6	50.6	50.6
7a		Derived Native Grassland	1.9	1.8	29.7	29.7	29.7
Total Box-Gum Woodland/Forest			**59**	**54**	-	-	-
Total Box-Gum Derived Native Grassland			**171.3**	**159.4**	-	-	-
Total Box-Gum Woodland CEEC listed under the BC Act			**230.3**	**213.4**	-	-	-

* BAM Calculator.



MAC-18-02_SSD_EIS_App BDAR_232C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Threatened Ecological Communities

- Box-Gum Woodland CEEC listed under the BC Act
- Box-Gum Woodland (DNG) CEEC listed under the BC Act

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Serious and Irreversible Impact Entities

Figure 20

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

> *The assessor is required to provide the following further information in the BDAR or BCAR about potential ecological communities:*
>
> *(a) the action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII*
>
> *(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone*
>
> *(c) a description of the extent to which the impact exceeds the threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact*
>
> *(d) the extent and overall condition of the potential TEC within an area of 1000ha, and then 10,000ha, surrounding the proposed development footprint*
>
> *(e) an estimate of the extant area and overall condition of the potential TEC remaining in the IBRA subregion before and after the impact of the proposed development has been taken into consideration*
>
> *(f) an estimate of the area of the potential TEC that is in the reserve system within the IBRA region and the IBRA subregion*
>
> *(g) the development, clearing or biodiversity certification proposal's impact on:*
>
> *(i) abiotic factors critical to the long-term survival of the potential TEC; for example, how much the impact will lead to a reduction of groundwater levels or the substantial alteration of surface water patterns*
>
> *(ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants*
>
> *(iii) the quality and integrity of an occurrence of the potential TEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the potential TEC*
>
> *(h) direct or indirect fragmentation and isolation of an important area of the potential TEC*
>
> *(i) the measures proposed to contribute to the recovery of the potential TEC in the IBRA subregion.*

These are addressed below.

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

A key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas (the Relinquishment Area) which would significantly reduce the potential residual biodiversity impacts from the Project on the *Box-Gum Woodland CEEC listed under the BC Act* (Table 31).

Table 31
Box-Gum Woodland CEEC Listed under the BC Act within the Relinquishment Area

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	Relinquishment Area (ha)	
			With Road Option 1	With Road Option 2
1	483	Grey Box x White Box Grassy Woodland	49.3	46.7
1a		Derived Native Grassland	244.5	236.7
2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland	119.2	116.7

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	Relinquishment Area (ha)	
			With Road Option 1	With Road Option 2
2a		Derived Native Grassland	24.3	24.2
3	618	Forest Red Gum Grassy Open Forest	2.9	2.9
3a		Derived Native Grassland	7.5	7.5
7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum	2.6	2.6
7a		Derived Native Grassland	6.3	6.3
Total Box-Gum Woodland/Forest			**174**	**168.9**
Total Box-Gum Derived Native Grassland			**282.6**	**274.7**
Total Box-Gum Woodland CEEC listed under the BC Act			**456.6**	**443.6**

Measures to mitigate and manage impacts are described in Section 4.7.

(b) the area (ha) and condition of the TEC to be impacted directly and indirectly by the proposed development. The condition of the TEC is to be represented by the vegetation integrity score for each vegetation zone[9]

Clearance *of Box-Gum Woodland CEEC Listed under the BC Act*, net of Relinquishment Area foregone clearance, is shown in Table 32.

Table 32
Box-Gum Woodland CEEC Listed under the BC Act Net Clearance within the Project Additional Disturbance Area

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	Project Additional Disturbance Area Including Road Option 1 (Table 30)	Project Additional Disturbance Area Including Road Option 2 (Table 30)	Relinquishment Area (ha) (Table 31)		Net Impacts (ha)	
					With Road Option 1	With Road Option 2	Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
1	483	Grey Box x White Box Grassy Woodland	44.9	44.5	49.3	46.7	4.4 less clearance	2.2 less clearance
1a		Derived Native Grassland	158.4	150.8	244.5	236.7	86.1 less clearance	85.9 less clearance
2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland	13.3	8.7	119.2	116.7	105.9 less clearance	108 less clearance
2a		Derived Native Grassland	11	6.8	24.3	24.2	13.3 less clearance	17.4 less clearance
3	618	Forest Red Gum Grassy Open Forest	0.2	0.2	2.9	2.9	2.7 less clearance	2.7 less clearance
3a		Derived Native Grassland	0	0	7.5	7.5	7.5 less clearance	7.5 less clearance
7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum	0.6	0.6	2.6	2.6	2 less clearance	2 less clearance

[9] Refer to Table 30 for vegetation integrity scores.

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	Project Additional Disturbance Area Including Road Option 1 (Table 30)	Project Additional Disturbance Area Including Road Option 2 (Table 30)	Relinquishment Area (ha) (Table 31)		Net Impacts (ha)	
					With Road Option 1	With Road Option 2	Project Additional Disturbance Area Including Road Option 1	Project Additional Disturbance Area Including Road Option 2
7a		Derived Native Grassland	1.9	1.8	6.3	6.3	4.4 less clearance	4.5 less clearance
Total Box-Gum Woodland/Forest			**59**	**54**	**174**	**168.9**	**115 less clearance**	**114.9 less clearance**
Total Box-Gum Derived Native Grassland			**171.3**	**159.4**	**282.6**	**274.7**	**111.3 less clearance**	**115.3 less clearance**
Total Box-Gum Woodland CEEC listed under the BC Act			**230.3**	**213.4**	**456.6**	**443.6**	**226.3 less clearance**	**230.2 less clearance**

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

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

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

There is no specific mapping of the *Box-Gum Woodland CEEC listed under the BC Act* (extent and overall condition) surrounding the proposed Development Footprint, other than the mapping completed by Hunter Eco (2020) (Attachment A). A total of approximately 1,195 ha of *Box-Gum Woodland CEEC listed under the BC Act* was mapped in the Subject land (Hunter Eco 2020) (Attachment A).

The regional vegetation mapping of Peake (2006) classifies all woodland patches (Peake [2006] was a remnant vegetation mapping project that did not include classifying DNG) within the Project Additional Disturbance Area as the one community, Map Unit (MU) 11 *Upper Hunter White Box – Ironbark Grassy Woodland*. MU 11 was assigned as threatened under the NSW *Threatened Species Conservation Act 1995* (now the BC Act) referring to the equivalent of what is now the *Box-Gum Woodland CEEC* listed under the BC Act. Sivertsen *et al*. (2011) showed no communities meeting the description of *Box-Gum Woodland CEEC listed under the BC Act* woodland and DNG within the Project Additional Disturbance Area.

The vegetation mapping of Peake (2006) shows 56.9 ha of *Box-Gum Woodland CEEC listed under the BC Act* equivalent (MU 11) within a 1,000 ha area around the Development Footprints and 612.6 ha within a 10,000 ha area. The Hunter Eco (2020) (Attachment A) vegetation mapping indicates that there was 2.84 times more DNG Box-Gum vegetation than woodland vegetation. Thus, there would be approximately 218.5 ha of combined DNG and woodland *Box-Gum Woodland CEEC listed under the BC Act* within the 1,000 ha area and 2,352.4 ha within the 10,000 ha area.

Furthermore, there would be an additional approximately 456.6 ha (with Road Option 1) or 443.6 ha (with Road Option 2) of *Box-Gum Woodland CEEC listed under the BC Act* preserved in the Relinquishment Area within the Subject land.

The loss of approximately 230 ha of *Box-Gum Woodland CEEC listed under the BC Act* represents approximately 34% of the estimated area within a 1,000 ha area surrounding the proposed Development Footprints and 8% of the estimated area within a 10,000 ha area surrounding the Development Footprints.

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

This information was obtained from Sivertsen *et al*. (2011) as this was a regional project, although incomplete in some areas. This mapping was completed prior to the development of PCTs so used a bespoke map unit coding system. All map units containing White Box, Blakely's Red Gum or Yellow Box were selected as likely representative of *Box-Gum Woodland CEEC listed under the BC Act*. Table 33 shows the areas of vegetation likely representative of *Box-Gum Woodland CEEC listed under the BC Act* mapped by Sivertsen *et al*. (2011) for the IBRA Sydney Basin Bioregion, Hunter Subregion. Table 32 shows a net gain of 226.3 ha (for Project Additional Disturbance Area including Road Option 1) or 230.2 ha (for Project Additional Disturbance Area including Road Option 2) of vegetation likely representative of *Box-Gum Woodland CEEC listed under the BC Act* due to the Project which equates to an added 3.4-3.5% of the 6,561 ha mapped for the Subregion (noting that Sivertsen *et al*. [2011] did not map *Box-Gum Woodland CEEC listed under the BC Act* within the Project Additional Disturbance Area).

Table 33
Box-Gum Woodland CEEC Listed under the BC Act Communities Mapped for the Sydney Basin Bioregion, Hunter Subregion

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

Source: Sivertsen *et al.* (2011).

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

Table 34 lists the map units and areas of vegetation likely representative of the *Box-Gum Woodland CEEC listed under the BC Act* mapped by Sivertsen *et al.* (2011) for the IBRA Sydney Basin Bioregion, Hunter Subregion limited to communities in the reserve system.

Table 34
Amounts of Box-Gum Woodland CEEC Listed under the BC Act Mapped within the NSW Reserve System

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

Source: Sivertsen *et al.* (2011).

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

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

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

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

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

As previously described, the Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

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

While there would be some further fragmentation of *Box-Gum Woodland CEEC listed under the BC Act* as a result of the Project, there would be no direct or indirect isolation of important areas of *Box-Gum Woodland CEEC listed under the BC Act* as it would remain connected around the Development Footprints (Figure 20).

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

A key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project on the *Box-Gum Woodland CEEC listed under the BC Act*.

5.1.3 Impact Assessment – Box-Gum Woodland CEEC listed under the BC Act

Clause 6.7 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 (2019b) *Guidance to assist a decision-maker to determine a serious and irreversible impact.*

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

A key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project and result in a net benefit for the *Box-Gum Woodland CEEC listed under the BC Act*.

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

As shown in Table 33, *Box-Gum Woodland CEEC listed under the BC Act* does not have a very small population size with approximately 6,561 ha being mapped within the Hunter Subregion, as well as being State-wide. MACH proposes to forgo development (clearance) of *Box-Gum Woodland CEEC listed under the BC Act* resulting in a net benefit for the threatened community compared to the currently approved mine.

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

Box-Gum Woodland CEEC listed under the BC Act is found across NSW so does not have a limited geographic distribution.

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

The occurrence of *Box-Gum Woodland CEEC listed under the BC Act* in the Project Additional Disturbance Area is comprised of flora species that readily seed and germinate under suitable conditions. The *Box-Gum Woodland CEEC listed under the BC Act* 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 (National Parks and Wildlife Service 2002).

5.1.4 Conclusion

For the reasons outlined in this section, even if it was conservatively assumed that the vegetation clearance required for the Project would not be reversible, the Project is unlikely to have a serious and irreversible impact on the *Box-Gum Woodland CEEC listed under the BC Act*. MACH proposes to forgo development (clearance) of the *Box-Gum Woodland CEEC listed under the BC Act* resulting in a net benefit for the threatened community compared to the currently approved mine.

5.2 IMPACTS ON NATIVE VEGETATION (ECOSYSTEM CREDITS)

Table 35 provides the ecosystem credit requirements after the application of the Relinquishment Area in Section 4.2. Figures 21a and 21b show areas requiring offset if there was no proposed Relinquishment Area and Figures 22a and 22b show areas not requiring assessment or offset.

As described in Section 4.2.4, the Relinquishment Area would provide excess ecosystem credits. Section 6.2 describes the offset strategy for the Project.

Table 35
Project Ecosystem Credit Requirements After Relinquishment Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Biodiversity Risk Weighting*	Residual Total Ecosystem Credit Requirement	
				NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
1	Grey Box x White Box Grassy Woodland[2,4]	483	2.00	0^	0^
1a	Derived Native Grassland[2,4]	483 DNG	2.00	0	0
			Subtotal for PCT 483	**0**	**0**
2	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	483 SG	2.00	0	0
2a	Derived Native Grassland[2,4]	483 SG DNG	2.00	0	0
			Subtotal for PCT 483	**0**	**0**
3	Forest Red Gum Grassy Open Forest[2,4]	618	2.00	0	0
3a	Derived Native Grassland[2,4]	618 DNG	2.00	0	0
			Subtotal for PCT 618	**0**	**0**
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	1691	2.00	434	434
4a	Derived Native Grassland	1691 DNG	2.00	0	0
			Subtotal for PCT 1691	**434**	**434**
5	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	1602	2.00	159	159
			Subtotal for PCT 1602	**159**	**159**
6	Narrow-leaved Ironbark Shrubby Forest[3]	1605	2.00	860	860
6a	Derived Native Grassland	1605 DNG	2.00	0	0
6b	Plantation	1605 Plantation	2.00	95^	94^
			Subtotal for PCT 1605	**955**	**954**

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Biodiversity Risk Weighting*	Residual Total Ecosystem Credit Requirement	
				NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	1606	2.00	0	0
7a	Derived Native Grassland[2,4]	1606 DNG	2.00	0^	0^
			Subtotal for PCT 1606	**0**	**0**
8a	Derived Native Grassland	1655 DNG	1.75	0	0
			Subtotal for PCT 1655	**0**	**0**
			Total Credits	**1,548**	**1,547**

Note: Highlighted cells are credits.

[1] *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

[2] *Box-Gum Woodland CEEC listed under the BC Act.*

[3] *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

[4] *Box-Gum Woodland CEEC listed under the EPBC Act.*

* BAM Calculator.

^ These credit requirements are reduced after application of like-for-like credits from the Relinquishment Area (Table 23).

5.3 IMPACTS ON THREATENED SPECIES (SPECIES CREDITS)

Table 36 provides the species credit requirements after the application of the Relinquishment Area in Section 4.2.

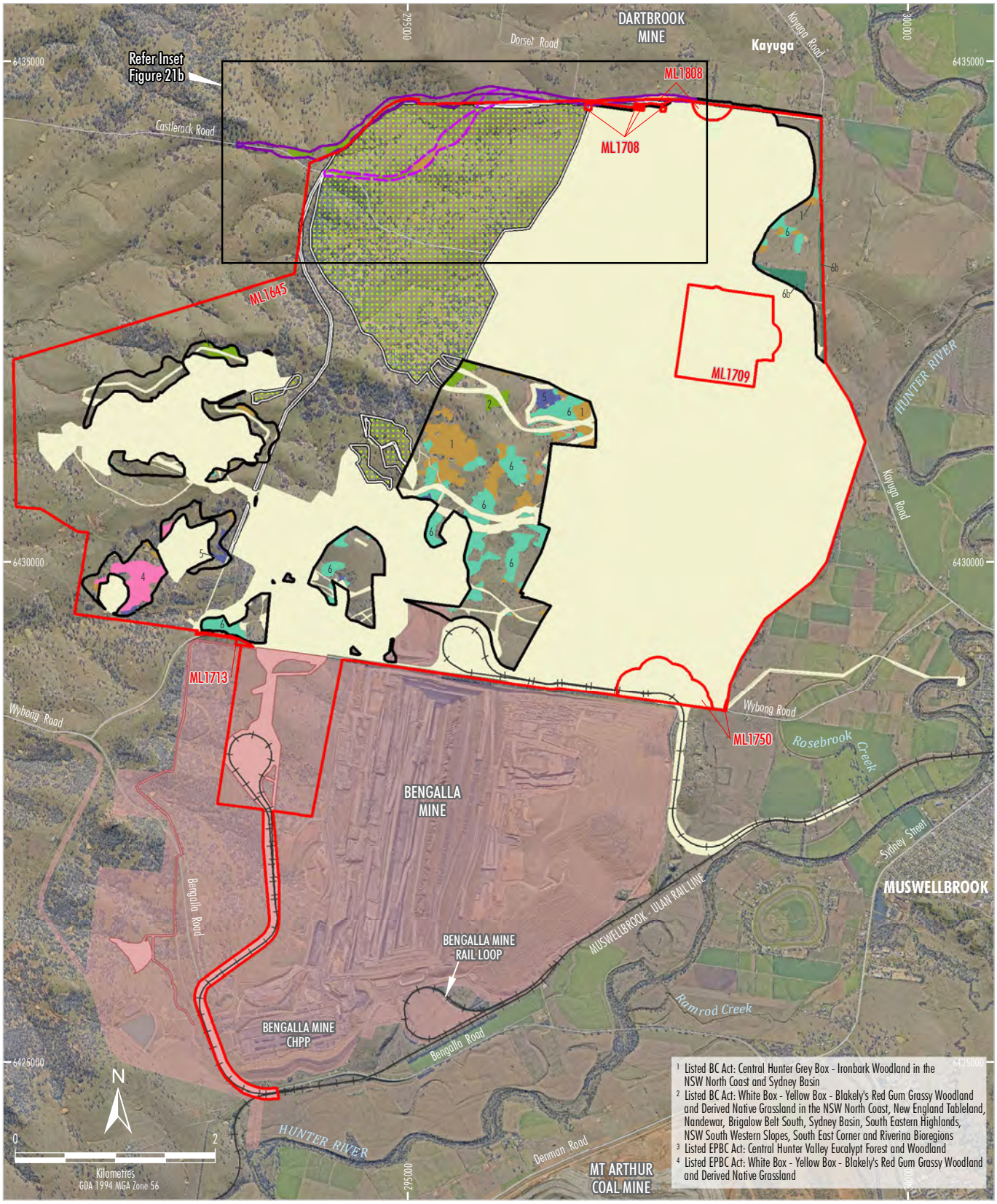
As described in Section 4.2.4, the Relinquishment Area would provide excess species credits. Section 6.2 describes the offset strategy for the Project.

Table 36
Project Species Credit Requirements After Relinquishment Area

Scientific Name	Common Name	Conservation Status[1]		Residual Total Species Credit Requirement	
		BC Act	EPBC Act	NSW Assessment Area with Road Option 1 (Footprint 1 + 2)	NSW Assessment Area with Road Option 2 (Footprint 1 + 3)
Cymbidium canaliculatum	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)	EP	-	0	0
Delma impar	Striped Legless Lizard	V	V	0	0
Petaurus norfolcensis	Squirrel Glider	V	-	0	0

Note: Highlighted cells are credits.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). EP = Endangered Population; V = Vulnerable.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

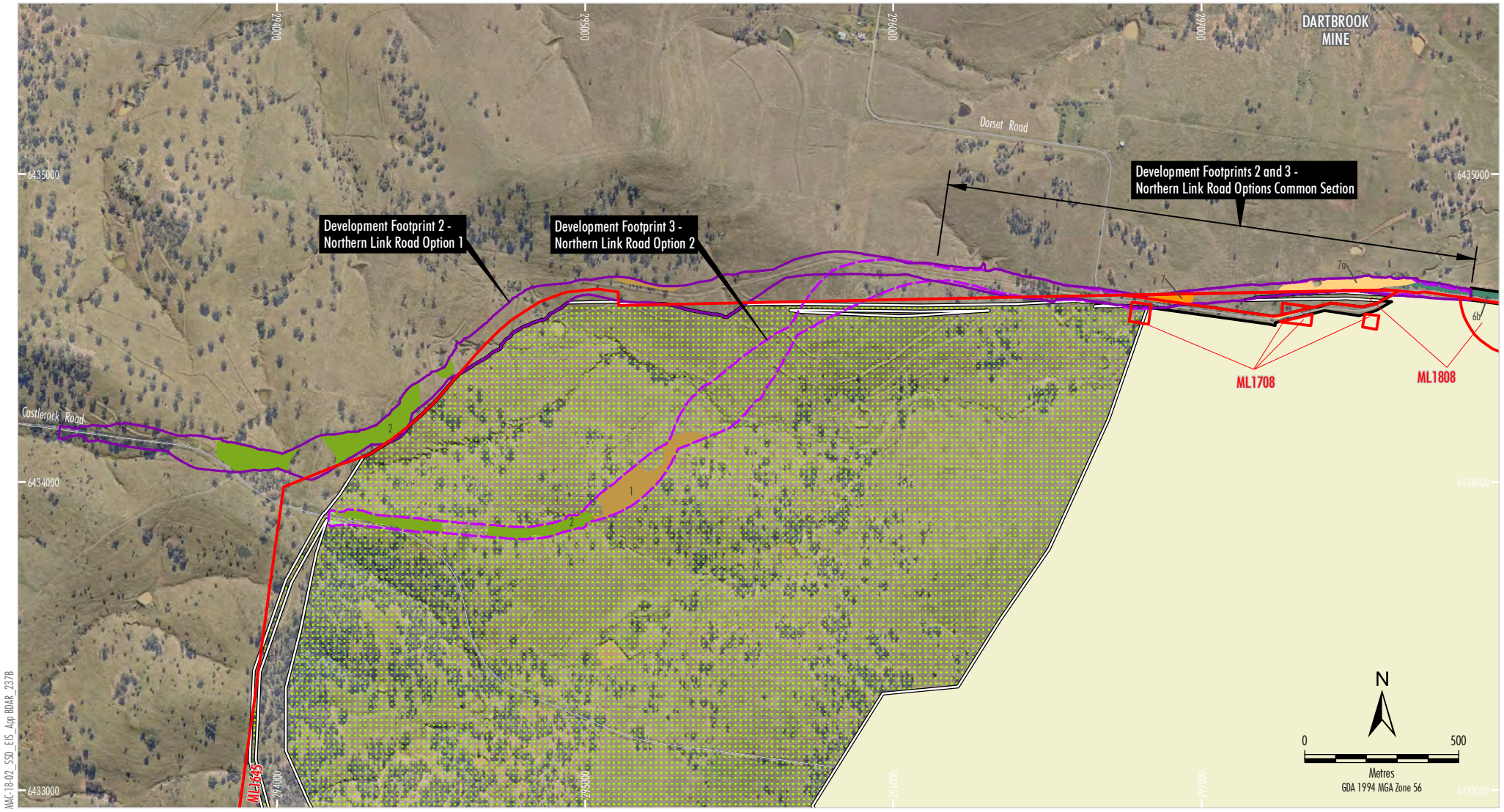
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Areas Requiring Offset Before Relinquishment Area

Figure 21a



MAC-18-02_SSD_EIS_App BDAR_237B

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

[2] Listed 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

[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland

[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

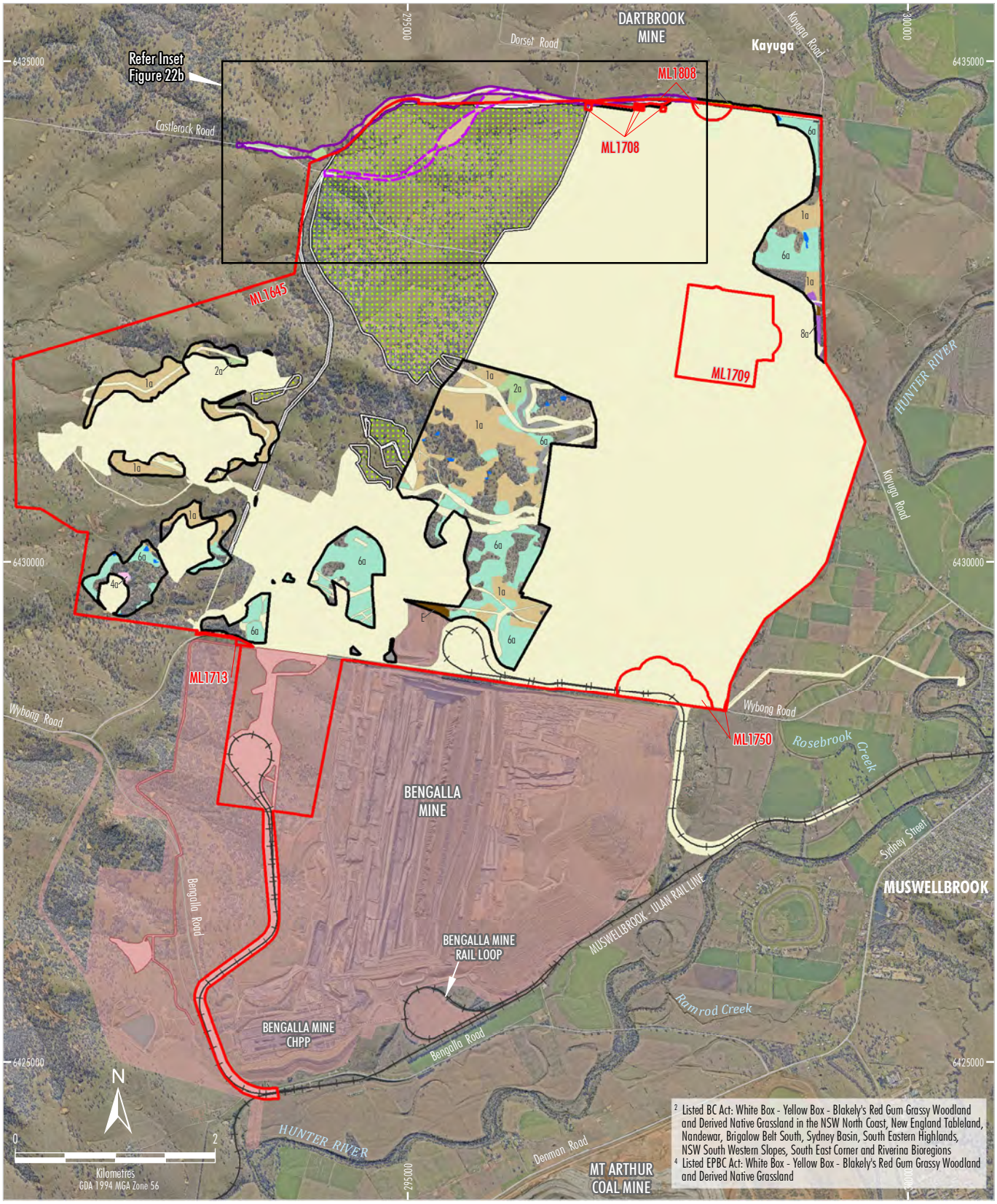
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Areas Requiring Offset Before Relinquishment Area Inset

Figure 21b



[2] Listed 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

[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1a Derived Native Grassland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 6a Derived Native Grassland (PCT1605)

Dry Sclerophyll Forests (Shrubby Sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- A Cropping/Grazing
- B Dam
- C Disturbed
- D Dwellings
- E Infrastructure
- F Local Roads

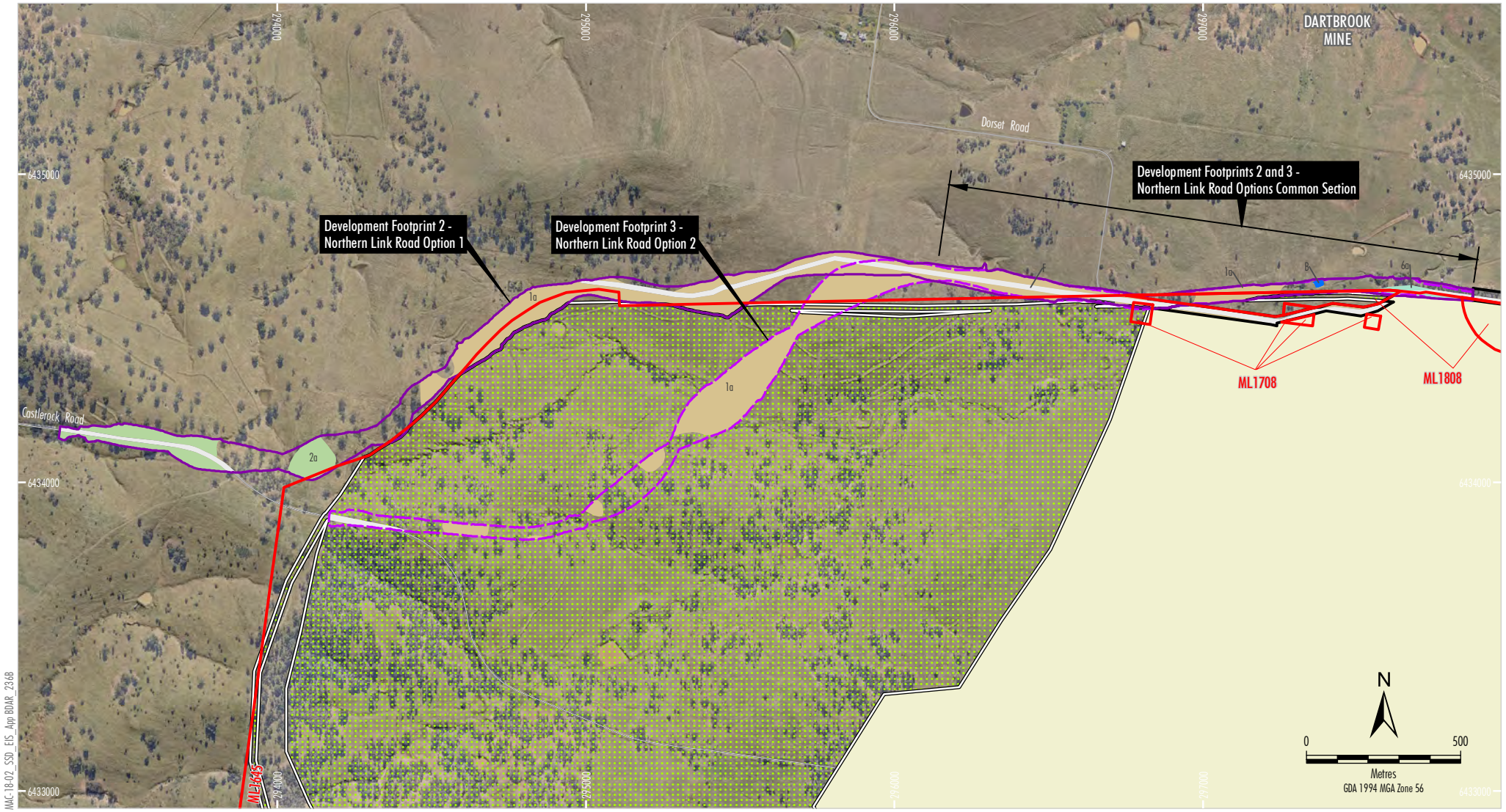
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Areas Not Requiring Assessment or Offset

Figure 22a



MAC-18-02_SSD_EIS_App BDAR_236B

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Derived Native Grassland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 6a Derived Native Grassland (PCT1605)

Other

- B Dam
- D Dwellings
- F Local Roads

[2] Listed 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

[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Areas Not Requiring Assessment or Offset Inset

Figure 22b

6 BIODIVERSITY OFFSET STRATEGY

6.1 EXISTING BIODIVERSITY OFFSETS

The Mount Pleasant Operation has already offset the approved biodiversity impacts of the mine, with the establishment of major biodiversity offsets of some 12,875 ha on a number of properties with a combined area of 15,590 ha (Table 37) (Figure 23). These properties are managed by MACH in accordance with an Offset Management Plan (MACH 2020).

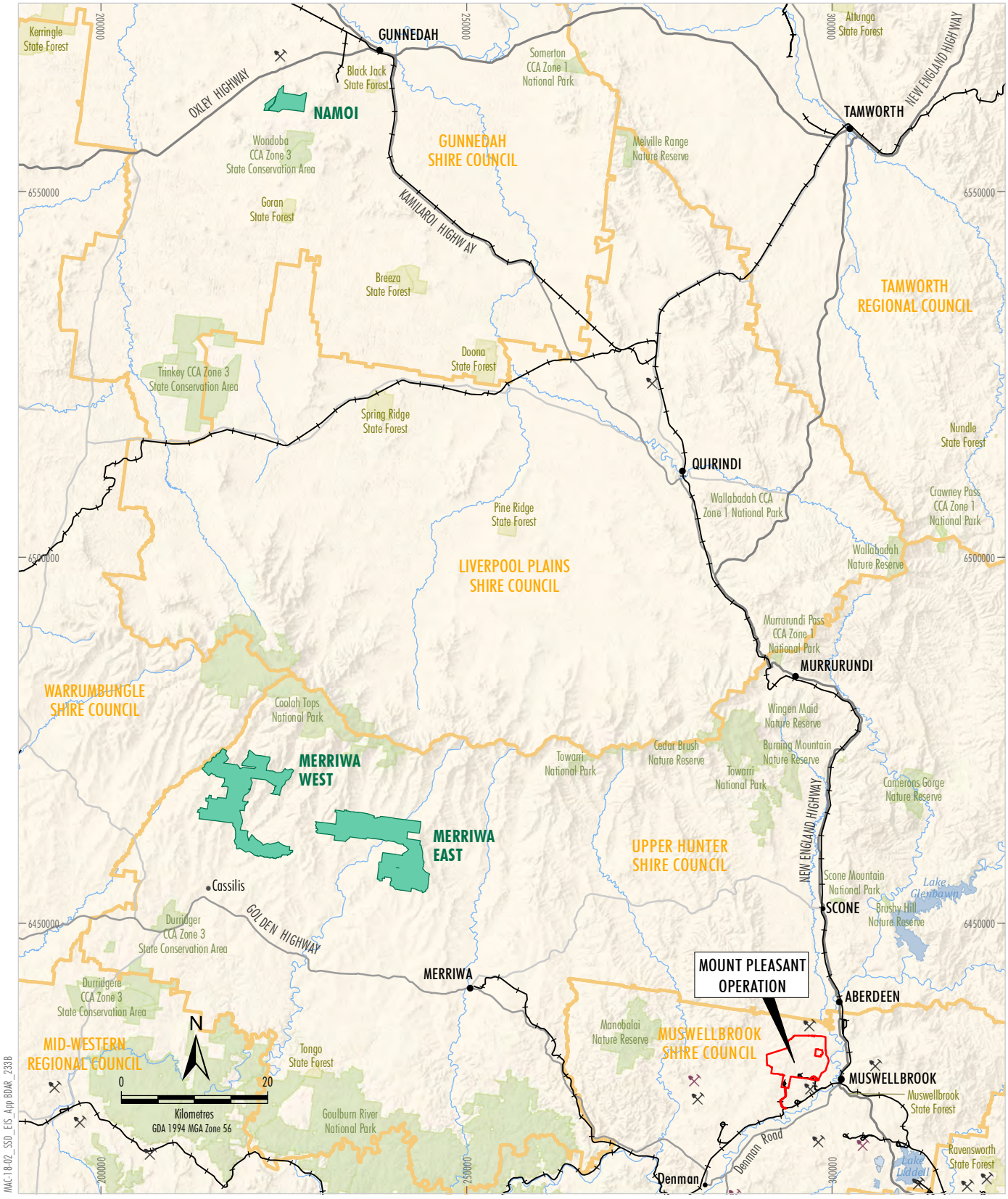
Table 37
Biodiversity Offsets for the Existing/Approved Mount Pleasant Operation

Biodiversity Management Area	Description
Merriwa East	• Located approximately 85 km north-west of Mount Pleasant Operation, approximately 20 km north-west of Merriwa township. • Sightings of the Spotted-tailed Quoll (*Dasyurus maculatus*) (listed as Endangered under the EPBC Act and Vulnerable under the NSW BC Act) have been reported on the Merriwa East Biodiversity Management Area. • Threatened birds recorded at the Merriwa East Biodiversity Management Area include the Speckled Warbler (*Chthonicola sagittata*), Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) and Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*). • Hunter Valley populations of Tiger Orchid listed under the BC Act have been recorded on the Merriwa East Biodiversity Offset Area.
Merriwa West	• Located approximately 100 km north-west of Mount Pleasant Operation, approximately 5 km north of the Cassilis township. • Sightings of the Spotted-tailed Quoll (listed as Endangered under the EPBC Act and Vulnerable under the NSW BC Act) have been reported on the Merriwa West Biodiversity Management Area. • Threatened birds recorded at the Merriwa West Biodiversity Management Area include the Dusky Woodswallow (*Artamus cyanopterus cyanopterus*), Diamond Firetail (*Stagonopleura guttata*), Varied Sittella (*Daphoenositta chrysoptera*) and the Little Lorikeet (*Glossopsitta pusilla*).
Namoi	• Located approximately 180 km north north-west of Mount Pleasant Operation, approximately 20 km south-west of the Gunnedah township. • The Koala (listed as Vulnerable under the EPBC Act and BC Act) has been recorded consistently within the Namoi Biodiversity Management Area. • Threatened birds recorded at the Namoi Biodiversity Management Area include the Spotted Harrier (*Circus assimilis*), Speckled Warbler (*Chthonicola sagittata*), Dusky Woodswallow (*Artamus cyanopterus cyanopterus*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), and the Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*).

The Mount Pleasant Operation Development Consent DA 92/97 was granted in December 1999, prior to the implementation of offsetting policies in NSW. While no biodiversity offsets were required for the original development under DA 92/97, biodiversity offsets were established for the existing/approved Mount Pleasant Operation under the Commonwealth approval (EPBC 2011/5795).

Under the Commonwealth approval (EPBC 2011/5795), MACH is required to register a legally binding conservation covenant over the offset areas in late 2021. MACH is working with DAWE to secure the offset areas via a Conservation Agreement under the EPBC Act.

Also required under the Commonwealth approval (EPBC 2011/5795) is the provision of $2 million in funding over the life of the Project to deliver activities that implement priority recovery actions for the Regent Honeyeater and Swift Parrot. To date, MACH has already provided $1.8 million of this funding.



LEGEND

- Mining Operation
- Proposed Mining Operation (Application Lodged)
- Local Government Area
- State Forest
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)
- Existing Biodiversity Management Area (including Offset Areas)

Source: MACH (2020); NSW Spatial Services (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Existing Biodiversity Management Areas

Figure 23

6.2 PROJECT BIODIVERSITY OFFSET STRATEGY

As described in Section 4.1, a key outcome from planning the design of the Project is that MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the residual biodiversity impacts from the Project. On balance, the benefits on other biodiversity values outweigh the net additional impacts on biodiversity values because the Relinquishment Area is larger, with a greater area of vegetation which is of a higher conservation status under the BC Act. As previously described, the Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

The SEARs require a strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme. MACH's Offset Strategy is described below.

6.2.1 Commonwealth Offset

An additional biodiversity offset would be provided for the residual impacts on MNES associated with the revised Northern Link Road alignment Option 1 or 2 under EPBC 2020/8735. This is discussed further in Section 7.6.

6.2.2 NSW Offset

The conditions of the approval (if granted) may require MACH to retire biodiversity credits to offset the residual impact on biodiversity values (whether of the number and class specified in the report or of another number and class) to the satisfaction of the NSW Secretary of the Department of Planning and Environment (DP&E) (now the DPIE).

Application of the Relinquishment Area

As described in Section 4.2.4, the like-for-like credits in the Relinquishment Area have been applied to the credits associated with the NSW Assessment areas. Although less native vegetation would be cleared overall, it is recognised that there are not enough like-for-like credits for PCTs 1691, 1602 and 1605 (i.e. a total of between 1,547 and 1,548 ecosystem credits [Tables 23 and 35]).

Application of the Variation Rules

As described in Section 4.2.4, between 6,530 and 6,591 excess ecosystem credits in the Relinquishment Area would be forfeited for PCTs that do not match like-for-like credits for PCTs 1691, 1602 and 1605.

The BC Regulation contains variation rules that provide some flexibility by allowing offsetting with a broader suite of biodiversity that is the same, or more threatened, than the biodiversity impacted. The variation rules require that:

- *Impacts on native vegetation must be offset with vegetation that is in the same region as the impact (based on the IBRA region and nearby IBRA subregions) and:*
    - *Is in the same vegetation formation and is in the same or higher offset trading group*
    - *In addition, if the impacted vegetation contained hollow bearing trees then the offset site must also contain hollow bearing trees or artificial hollows.*

'Variation rules' under the BC Act do not apply to this situation because credits are not being sought. However, if the variation rules concept was applicable to this Project, the shortfall of 434 credits of PCT 1691 could be offset with 434 alternate credits in the same formation (Table 38), of which there are an excess of between 6,530 and 6,591 credits, depending on the road option. PCT 1691 is listed as the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*; however, the available credits are of a higher offset trading group, being part of a critically endangered ecological community (*Box-Gum Woodland CEEC listed under the BC Act and EPBC Act*). The shortfall of 159 credits of PCT 1602 could be partially offset with between 3 and 4 alternate credits in the same formation (depending on the road option) (Table 38).

Table 38
Residual Credit Summary

NSW Assessment Area with Road Option 1 or 2 Credit Amount (Tables 23 and 35)	**Excess Credits in the Relinquishment Area (and how they might apply under the variation rules)**
Grassy Woodlands Formation	
434 credits of PCT 1691 (Vegetation Community 4 *Narrow-leaved Ironbark – Grey Box Grassy Woodland*) equating to the *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act*	A total of between 6,530 and 6,591 credits equating to the *Box-Gum Woodland CEEC listed under the BC Act and EPBC Act* comprising: • 2,068 credits of PCT 483 DNG (Vegetation Community 1a Derived Grassland of *Grey Box x White Box Grassy Woodland*). • 3,966 (Road Option 1) or 4,028 (Road Option 2) credits of PCT 483 SG (Vegetation Community 2 *Grey Box x White Box – Spotted Gum Grassy Woodland*) (In NSW, PCT 483 is estimated to be 90% cleared [DPIE 2020d]). • 306 (Road Option 1) or 304 (Road Option 2) credits of PCT 483 SG DNG (Vegetation Community 2a Derived Grassland of *Grey Box x White Box – Spotted Gum Grassy Woodland*). • 90 credits of PCT 618 (Vegetation Community 3 *Forest Red Gum Grassy Open Forest*) (In NSW, PCT 618 is estimated to be 73% cleared [DPIE 2020d]). • 97 credits of PCT 618 DNG (Vegetation Community 3a Derived Grassland of *Forest Red Gum Grassy Open Forest*). The 434 credits of PCT 1691 could be offset using 434 credits of any of the woodland PCTs above, leaving an excess of 3,622 (Road Option 1) or 3,684 (Road Option 2) woodland credits. The excess credits of PCT 483 DNG, 483 SG DNG and 618 DNG cannot be used to offset PCT 1691 because these DNG vegetation zones do not contain hollow-bearing trees, leaving an excess of 2,471 (Road Option 1) or 2,469 (Road Option 2) DNG credits.
Dry Sclerophyll Forests Formation	
159 credits of PCT 1602 (Vegetation Community 5 *Spotted Gum – Narrow-leaved Ironbark Woodland*)	A total of between 3 and 4 credits equating to the *Box-Gum Woodland CEEC listed under the BC Act and EPBC Act* comprising: • 3 (Road Option 1) or 4 (Road Option 2) credits of PCT 1606 (Vegetation Community 7 *White Box – Narrow-leaved Ironbark – Blakely's Red Gum*) (In NSW, PCT 1606 is estimated to be 29% cleared [DPIE 2020d]). Approximately 5% of the credit requirement (9 credits out of a required 168) can be met through like-for-like credits in the Relinquishment Area and approximately 2% of the credit requirement (3 or 4 credits out of a required 168) can be met through application of the variation rules*. This leaves a credit requirement of 156 (Road Option 1) or 155 (Road Option 2) credits for PCT 1602.

NSW Assessment Area with Road Option 1 or 2 Credit Amount (Tables 23 and 35)	Excess Credits in the Relinquishment Area (and how they might apply under the variation rules)
860 credits of PCT 1605 (Vegetation Community 6 *Narrow-leaved Ironbark Shrubby Forest*)	No additional alternative credits in the same formation. PCT 1605 is *Narrow-leaved Ironbark Shrubby Forest* which occurs in larger (fragmented) patches in the General Extension Areas (Development Footprint 1) (Figure 7a). Plantation assigned to PCT 1605 occurs in small patches within all Development Footprints (Figures 7a and 7b). Narrow-leaved Ironbark is a common tree in the Subject land and is found in association with a number of PCTs. In NSW, PCT 1605 is estimated to be 32% cleared (DPIE 2020d). Approximately 45% of the credit requirement (696 credits out of a required 1,556) for PCT 1605 and approximately 68% (200 credits out of a required 294 or 295) for PCT 1605 Plantation can be met through like-for-like credits in the Relinquishment Area.
Between 94 (Road Option 2) and 95 (Road Option 1) credits of PCT 1605 (Vegetation Community 6b Plantation of *Narrow-leaved Ironbark Shrubby Forest*)	

Note: Highlighted cells outline insufficient credits in the Relinquishment Area.

* It is noted that PCT 1602 is not included in the BAM Biodiversity Credit Report (Variations) (Attachment G), however it was included in a previous version of the report, dated 22/10/2020. This omission is understood to be the result of a BAM Calculator error.

PCT 1602 and PCT 1605

There are not enough like-for-like credits for PCT 1602 and PCT 1605 in the Relinquishment Area or enough alternative credits in the same formation (Table 38). The Project would clear <50 ha (net) of these two PCTs combined (Table 25), as well as Plantation assigned to PCT 1605.

In this case, MACH propose to forgo development (clearance) of native vegetation within a number of existing approved disturbance areas which would reduce the impacts on a larger area of a critically endangered ecological community (*Box-Gum Woodland CEEC listed under the BC Act and EPBC Act*)[10], but result in the clearance of these two PCTs, neither of which are threatened under the BC Act. In other words, a large area of a higher offset trading group is available to be relinquished for a substantially smaller area of a lower offset trading group, however, they are of different formations under the BAM.

Further, as described previously, the Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

As described in Section 4.7, MACH has commenced rehabilitation and revegetation activities at the Mount Pleasant Operation. The rehabilitation program has already included the planting and seeding of areas to PCT 1605, and more areas are planned. PCT 1602 is not yet a target PCT for the mine rehabilitation, but this PCT would be added to the MOP. It is proposed that an equivalent area of PCT 1605 and PCT 1602 cleared by the Project would be rehabilitated (i.e. 66.6 ha of PCT 1605 and 7 ha of PCT 1602).

It is noted that under the BC Act, the conditions of the approval (if granted) may or may not require MACH to retire biodiversity credits, to offset the residual impact on biodiversity values (whether of the number and class specified in the report or of another number and class) to the satisfaction of the NSW Secretary of the DP&E (now the DPIE).

[10] In NSW, PCT 483 is estimated to be 90% cleared [DPIE 2020d].

7 COMMONWEALTH ASSESSMENT

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

7.1 DESCRIPTION OF THE ACTION

As described in Section 1.3, the Mount Pleasant Project was previously referred under the EPBC Act in 2011 and approval was granted in 2012 (EPBC 2011/5795). The EPBC Act approval (EPBC 2011/5795) already authorises surface disturbance associated with the General Extension Areas (Development Footprint 1) (Table 1).

As described in Section 1.3, a referral was lodged on 28 July 2020 for new components of the Project (the Action) (EPBC 2020/8735) (Figure 4), which are not already authorised by the EPBC Act Approval (EPBC 2011/5795) or the Development Consent DA 92/97.

The approved Mount Pleasant Operation includes the closure of a section of Castlerock Road and development of the Northern Link Road to connect Dorset Road and Castlerock Road, to the west of the Mount Pleasant Operation MLs (Figure 2). The Action includes the revised alignment of the approved Northern Link Road to a suitable design standard to improve the safety of the intersection between the Northern Link Road and Castlerock Road and compensate for the approved closure of part of Castlerock Road (the approved Western Link Road would no longer be constructed as Wybong Road would now remain open). The revised Northern Link Road alignment would remain a public road managed by the Muswellbrook Local Council.

Two alternative alignments of the western section of the revised Northern Link Road alignment are being considered by MACH. Option 1 is the currently preferred option as it skirts the ML boundary and would have a disturbance area of approximately 29.3 ha (Development Footprint 2 – Figure 3b). Option 2 is the less preferred option and would have a disturbance area of approximately 23.8 ha (Development Footprint 3 – Figure 3b). Only one of these options would be developed, with the final alignment to be selected based on detailed engineering design and any associated land access constraints. The revised Northern Link Road alignment options are herein collectively referred to as the Action area.

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

Detailed surveys for EPBC Act listed threatened species and communities have been completed by Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B) across the Subject land (including the Action area).

7.2.1 Survey Scope, Timing and Methodology

EPBC Act listed threatened species and communities to target during the surveys were identified by undertaking database reviews (including DAWE 2020b) prior to field surveys (Hunter Eco 2020; Future Ecology 2020) (Attachments A and B). Species were evaluated for their known presence or likelihood of occurring within the Subject land based on known habitat preferences. EPBC Act listed threatened species and communities targeted during the surveys are listed in Table 39.

Flora surveys were undertaken between October 2019 and December 2020 (Hunter Eco 2020) (Attachment A) and fauna surveys were undertaken between August 2018 and November 2019 (Future Ecology 2020) (Attachment B).

Table 39
EPBC Act Species and Communities Targeted for Survey

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]
		BC Act	EPBC Act	
Flora				
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	S
Cynanchum elegans	White-flowered Wax Plant	E	E	S
Eucalyptus glaucina	Slaty Red Gum	V	V	S
Eucalyptus pumila	Pokolbin Mallee	V	V	S
Ozothamnus tesselatus	-	V	V	S
Pomaderris reperta	Denman Pomaderris	CE	CE	S
Prasophyllum petilum (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	E	E	S
Thesium australe	Austral Toadflax	V	V	S
Reptiles				
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	S
Delma impar	Striped Legless Lizard	V	V	S
Birds				
Erythrotriorchis radiatus	Red Goshawk	CE	V	S
Rostratula australis	Australian Painted Snipe	E	E	E
Lathamus discolor	Swift Parrot	E	CE	S/E
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E
Grantiella picta	Painted Honeyeater	V	V	E
Mammals				
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E
Phascolarctos cinereus	Koala	V	V	S/E
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	S
Community				
Central Hunter Valley Eucalypt Forest and Woodland listed under the EPBC Act		E	CE	E
Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland		E	E	E
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland		CE	CE	E
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia		E	CE	E
Lowland Rainforest of Subtropical Australia		E	CE	E
Subtropical and Temperate Coastal Saltmarsh		E	V	E
Warkworth Sands Woodland of the Hunter Valley		E	CE	E
Box-Gum Woodland CEEC listed under the EPBC Act		CE	CE	E

Note: Shaded species are species with records in the Subject land.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021).
CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

Surveys by Hunter Eco (2020) (Attachment A) and Future Ecology (2020) (Attachment B) were undertaken in accordance with published Commonwealth guidelines and policy statements and follow guidelines set in the BAM (OEH 2017). Further details of the survey scope, timing and methodology are provided in Attachments A and B. Species shaded in Table 39 are species with records in the Subject land.

7.2.2 Occurrence of Threatened Species and their Habitat

No threatened flora species listed under the EPBC Act were recorded in the Action area or immediate surrounds (Hunter Eco 2020) (Attachment A). Two threatened fauna species listed under the EPBC Act were recorded during the surveys, namely the Striped Legless Lizard and Grey-headed Flying-fox (Future Ecology 2020) (Attachment B) (Table 40).

It is considered unlikely that the other species listed in Table 39 use the habitat within the Subject land.

Based on the information available in the EPBC Act Referral (EPBC 2020/8735), DAWE considered (in the input into the SEARs) that the Action is likely to have a significant impact on the Swift Parrot and Regent Honeyeater. However, the Action is unlikely to have a material adverse impact on these species as neither species has been recorded at the Mount Pleasant Operation during past or present surveys (Figure 24), no breeding habitat for these species is present (Future Ecology 2020) (Attachment B), and the DPIE (2020a) do not recognise the Subject land as important habitat for these species (negating the need for species credits). The Swift Parrot and Regent Honeyeater are ecosystem credit species (Table 4). These species are further discussed in Sections 7.4.3 and 7.4.4.

Based on the information available in the EPBC Act Referral, DAWE considered (in the input into the SEARs) that there was a real chance or possibility that the Action would significantly impact the Austral Toadflax (*Thesium australe*) and Slaty Red Gum (*Eucalyptus glaucina*). Targeted surveys for these two flora species have subsequently been undertaken and neither species was recorded in the Action area and surrounds (Hunter Eco 2020) (Attachment A) or known to occur nearby (Figure 24). Therefore, it is considered unlikely that the Action would adversely (or significantly) impact either of these species.

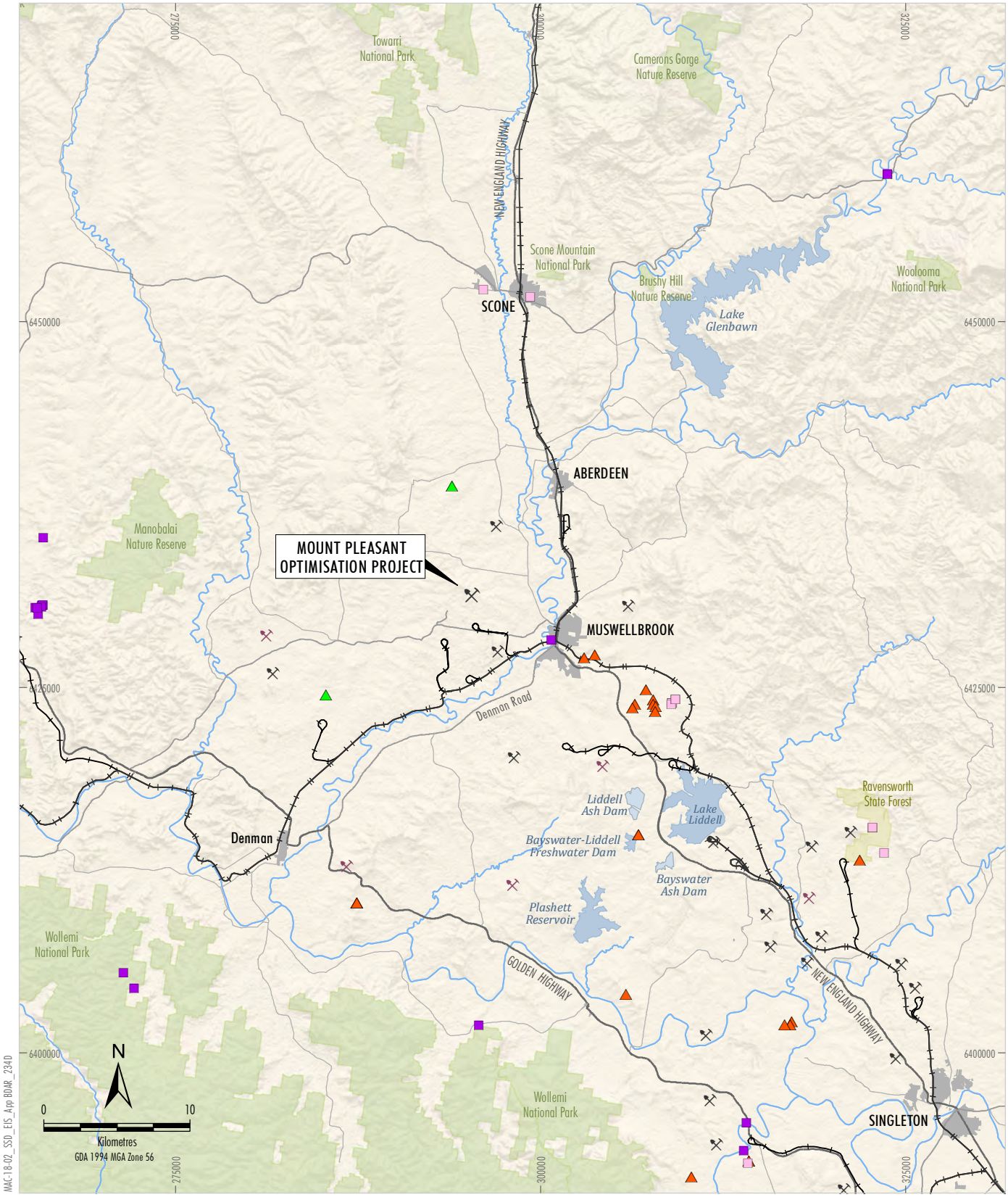
The Spotted-tailed Quoll, Koala, Grey-headed Flying-fox and Corben's Long-eared Bat are ecosystem credit species (Table 4).

Table 40
Threatened Species Listed Under the EPBC Act Recorded During Surveys

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Occurrence	Habitat
		EPBC Act	BC Act			
Reptiles						
Delma impar	Striped Legless Lizard	V	V	S	This species was recorded once under a cow pat (dung) in an open grassy area within PCT 483 and once under a lightly imbedded rock in a grassy open hillside with no trees (Future Ecology 2020) (Attachment B).	The Striped Legless Lizard is found mainly in Natural Temperate Grassland dominated by perennial, tussock-forming grasses such as Kangaroo Grass (*Themeda triandra*), spear-grasses (*Austrostipa sp.*) and poa tussocks (*Poa sp.*), and occasionally wallaby grasses (*Rytidosperma sp.*) (DPIE 2020c). It 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 (DPIE 2020c). It is sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter, and sometimes utilises dried cowpats for shelter (DPIE 2020c). Potential habitat for the Striped Legless Lizard within the Subject land occurs throughout all PCTs (DPIE 2020c), including small areas of scattered lightly imbedded surface rock (Future Ecology 2020) (Attachment B).
Mammals						
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	This species was recorded foraging across several occasions within the Subject land within PCT 483. It was only ever observed to be foraging and not roosting, and there are no known camps in the Subject land (Future Ecology 2020; DAWE 2020d) (Attachment B).	The Grey-headed Flying-fox forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, and in urban gardens and cultivated fruit crops (DPIE 2020c). Roosting camps used for mating and rearing young are documented and monitored via the *National Flying-fox monitoring viewer* (DPIE 2020c; DAWE 2020d). Potential foraging habitat for the Grey-headed Flying-fox within the Subject land occurs within woodland forms of PCTs 1605, 1606 and 1691 (DPIE 2020c), as well as PCT 483 in which it was recorded (Future Ecology 2020) (Attachment B).

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.



LEGEND

- Mining Operation
- Proposed Mining Operation (Application Lodged)
- State Forest
- National Parks and Wildlife Estate

Threatened Species

- Slaty Red Gum
- Austral Toadflax
- Regent Honeyeater
- Swift Parrot

Source: MACH (2020); NSW Spatial Services (2020); DPIE (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Commonwealth Listed Species Landscape Distribution

Figure 24

7.2.3 Occurrence of Threatened Ecological Communities

One TEC listed under the EPBC Act was recorded during the surveys (Hunter Eco 2020) (Attachment A), which would be subject to clearing as part of the Action (Table 41).

Table 41
Threatened Ecological Communities Listed Under the EPBC Act Recorded During Surveys

Threatened Ecological Community	Conservation Status[1]	Clearance Area (ha)	
		Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act	CE	0	0
Box-Gum Woodland CEEC listed under the EPBC Act	CE	26.4	22.5

[1] Conservation status under the EPBC Act (current as at January 2021). CE = Critically Endangered.

Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483 and 483 SG), *White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley* (PCT 618) and *White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter* (PCT 1606) were assessed as components of the TEC, including the DNG variants. The main identifying characteristics were the presence of:

- White Box x Grey Box in the canopy of PCT 483 and 483 variant (Spotted Gum or SG);
- White Box x Grey Box and Yellow Box in the canopy of PCT 618; and
- White Box x Grey Box in the canopy of PCT 1606.

Details provided in Attachment A show that PCTs 483, 483 SG, 618 and 1606 meet the condition thresholds (Threatened Species Scientific Committee [TSSC] 2006) for this TEC with a predominantly native understorey and at least 12 native understorey species in any patch excluding grasses, with all patches >0.1 ha; there was also more than one *Important Species* present in each PCT.

7.3 CREDIT CALCULATION

There are two components to the credit calculation as described below.

7.3.1 Northern Link Road Options 1 and 2 (Development Footprints 2 and 3)

The credit calculation for Northern Link Road Options 1 and 2 (Development Footprints 2 and 3) are provided in Section 3.7 and Attachments H and K. Like-for-like credit requirements are provided in Attachments I and L.

7.3.2 Western Link Road Relinquishment Area

The NSW Biodiversity Offsets Scheme requires the credits calculated for residual biodiversity impacts of a proposed development to be retired via the offset rules. The credit calculation for the Western Link Road component of the Relinquishment Area is provided below and in Attachment Q. Like-for-like credit requirements are provided in Attachment R.

7.3.2.1 Plant Community Types

The PCTs within the Western Link Road Relinquishment Area are listed in Table 42. Highlighted cells are PCTs that equate to the *Box-Gum Woodland CEEC listed under the EPBC Act*.

Table 42
Plant Community Types within the Western Link Road Relinquishment Area

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Area (ha)
Grassy Woodlands			
Western Slopes Grassy Woodlands			
1	Grey Box x White Box Grassy Woodland[1,3]	483	0.6
1a	Derived Native Grassland[1,3]	483 DNG	6.5
2	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	483 SG	4.1
2a	Derived Native Grassland[1,3]	483 SG DNG	1.7
Dry Sclerophyll Forests (Shrub/grass sub-formation)			
Hunter-Macleay Dry Sclerophyll Forests			
5	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	1602	0.1
North-west Slopes Dry Sclerophyll Woodlands			
6a	Derived Native Grassland	1605 DNG	0.5
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	1606	0.2
7a	Derived Native Grassland[1,3]	1606 DNG	0.3
		Total Woodland/Forest	**5**
		Total Derived Native Grassland	**9**
		Total Native Vegetation	**14**
		Total Disturbed/Other	**0.4**
		Total Area (ha)	**14.4**

1 *Box-Gum Woodland CEEC listed under the BC Act.*

2 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

3 *Box-Gum Woodland CEEC listed under the EPBC Act.*

The VI scores for the Western Link Road Relinquishment Area are listed in Table 43. Highlighted cells are PCTs that equate to the *Box-Gum Woodland CEEC listed under the EPBC Act*.

Table 43
Vegetation Integrity Score Detail – Western Link Road Relinquishment Area

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT Condition Class	Sensitivity to Gain*	Patch Size	Composition Condition Score*	Structure Condition Score*	Function Condition Score*	VI Score*
1	483	Grey Box x White Box Grassy Woodland[1,3]	Woodland	High	>100	88.2	83.5	39.9	66.5
1a	483	Derived Native Grassland[1,3]	DNG	High	>100	67.9	57.6	1	15.8

Veg Zone	PCT ID	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT Condition Class	Sensitivity to Gain*	Patch Size	Composition Condition Score*	Structure Condition Score*	Function Condition Score*	VI Score*
2	483	Grey Box x White Box – Spotted Gum Grassy Woodland[1,3]	SG Woodland	High	>100	90.2	83.4	88.9	87.5
2a	483	Derived Native Grassland[1,3]	SG DNG	High	>100	75.3	59.2	35.1	53.9
5	1602	Spotted Gum – Narrow-leaved Ironbark Woodland[2]	Woodland	High	>100	84.4	37.6	51.3	54.6
6a	1605	Derived Native Grassland	DNG	High	>100	57.7	20.2	0.1	4.3
7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1,3]	Woodland	High	>100	63.1	50	41	50.6
7a	1606	Derived Native Grassland[1,3]	DNG	High	>100	54	47.9	10.1	29.7

1 *Box-Gum Woodland CEEC listed under the BC Act.*

2 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

3 *Box-Gum Woodland CEEC listed under the EPBC Act.*

* BAM Calculator.

7.3.2.2 Ecosystem Credit Species

The Ecosystem Species from the BAM Calculator for the Western Link Road Relinquishment Area are listed in Table 44.

Table 44
Ecosystem Species from the BAM Calculator listed under the EPBC Act – Western Link Road Relinquishment Area

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Sensitivity to Potential Gain (DPIE 2020c)
		BC Act	EPBC Act		
Birds					
Lathamus discolor	Swift Parrot	E	CE	S/E	Moderate
Anthochaera phrygia	Regent Honeyeater	CE	CE	S/E	High
Grantiella picta	Painted Honeyeater	V	V	E	Moderate
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	V	E	E	High
Phascolarctos cinereus	Koala	V	V	S/E	High
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	High
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	E	High

1 Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

2 Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

7.3.3 EPBC Act Credit Requirement Summary

The EPBC Act Credit Requirement Summary is listed in Table 45.

Table 45
EPBC Act Credit Requirement Summary

Veg Zone	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT ID	Northern Link Road Option 1 (Development Footprint 2)		Northern Link Road Option 2 (Development Footprint 3)		Western Link Road Relinquishment Area		Northern Link Road Option 1 Net Impact		Northern Link Road Option 2 Net Impact	
			Area (ha) (Table 2)	Credits (Attachment H)	Area (ha) (Table 2)	Credits (Attachment K)	Area (ha) (Table 42)	Credits (Attachment Q)	Net Area (ha)	Credit Requirement Based on Net Impact	Net Area (ha)	Credit Requirement Based on Net Impact
Ecosystem Credits for Box-Gum Woodland CEEC listed under the EPBC Act												
1	Grey Box x White Box Grassy Woodland[1]	483	0.4	13	2.6	83	0.6	20	- 0.2	0	2	63
1a	Derived Native Grassland[1]	483 DNG	14.8	0	15	0	6.5	51	8.3	0	8.5	0
2	Grey Box x White Box – Spotted Gum Grassy Woodland[1]	483 SG	4.6	190	2.5	58	4.1	179	0.5	11	- 1.6	0
2a	Derived Native Grassland[1]	483 SG DNG	4.3	0	0.2	2	1.7	46	2.6	0	- 1.5	0
3	Forest Red Gum Grassy Open Forest[1]	618	0.1	4	0.1	4	N/A	N/A	0.1	4	0.1	4
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[1]	1606	0.5	13	0.5	13	0.2	5	0.3	8	0.3	8
7a	Derived Native Grassland[1]	1606 DNG	1.7	25	1.6	24	0.3	4	1.4	21	1.3	20
		Total	**26.4**	**245**	**22.5**	**184**	**13.4**	**305**	**-**	**44**	**-**	**95**
Species Credits												
Striped Legless Lizard (*Delma impar*)			23.3	293	27.4	225	N/A	N/A	N/A	**293**	N/A	**225**

Note: Highlighted cells are credits.

[1] *Box-Gum Woodland CEEC listed under the EPBC Act.*

7.4 IMPACTS ON THREATENED SPECIES AND COMMUNITIES LISTED UNDER THE EPBC ACT

As described in Section 7.1, the Action includes the revised alignment of the approved Northern Link Road to a suitable design standard to improve the safety of the intersection between the Northern Link Road and Castlerock Road and compensate for the approved closure of part of Castlerock Road (the approved Western Link Road would no longer be constructed as Wybong Road would now remain open). The revised Northern Link Road alignment would remain a public road managed by the Muswellbrook Local Council.

This section provides a detailed analysis of the nature and extent of the likely direct, indirect and consequential impacts relevant to specific protected matters, including likely short-term and long-term impacts. Potential impacts on the following species and communities are assessed below:

- *Box-Gum Woodland CEEC listed under the EPBC Act*;
- Striped Legless Lizard;
- Swift Parrot;
- Regent Honeyeater;
- Spotted-tailed Quoll;
- Koala; and
- Grey-headed Flying-fox.

The assessments are in accordance with relevant Commonwealth guidelines and policy statements (DAWE 2020e). The impacts of the Action on protected matters are known or predictable. Table 46 summarises the clearance of potential habitat for the threatened fauna species listed above. There are no other adverse impacts on these species that would occur as a result of the Action.

Table 46
MNES Clearance Summary

Scientific Name	Common Name	Conservation Status[1]		Biodiversity Credit Class[2]	Clearance Area (ha)	
		BC Act	EPBC Act		Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)
Delma impar	Striped Legless Lizard	V	V	S	27.4	23.3
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	S/E	5.9	5.9

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). V = Vulnerable.

[2] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). E = Ecosystem; S = Species.

7.4.1 Box-Gum Woodland CEEC listed under the EPBC Act

The *Box-Gum Woodland CEEC listed under the EPBC Act* is present within the Action area (Figure 8b). Northern Link Road Option 1 (Development Footprint 2) would clear approximately 20.8 ha of DNG and 5.6 ha of woodland (total of 26.4 ha). Northern Link Road Option 2 (Development Footprint 3) would clear approximately 16.8 ha of DNG and 5.7 ha of woodland (total of 22.5 ha) (Table 45).

The Western Link Road Relinquishment Area would have resulted in the clearance of approximately 8.5 ha of DNG and 4.9 ha of woodland (total of 13.4 ha) of the *Box-Gum Woodland CEEC listed under the EPBC Act*. Hence, the net difference is approximately +12.3 ha of DNG and +0.7 ha of woodland (total of 13 ha) for Northern Link Road Option 1 (Development Footprint 2) and approximately +8.3 ha of DNG and +0.8 ha of woodland (total of 9.1 ha) for Northern Link Road Option 2 (Development Footprint 3) (Table 45).

The clearance would occur in the short-term for construction of the road. In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor. As described in Section 5.1, a number of measures have been adopted to avoid and minimise clearance. Those measures that have specifically avoided clearance of *Box-Gum Woodland CEEC listed under the EPBC Act* include that the greater part of the road has been placed in DNG which is of poor quality as indicated by VI scores of between 14.4 and 15.2 (Table 30).

The *Box-Gum Woodland CEEC listed under the EPBC Act* adjacent to the Action area (Figure 8b) 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 (Rawlings *et al*. 2010; TSSC 2006; Department of Environment, Climate Change and Water [DECCW] 2010).

The Project is unlikely to indirectly impact the *Box-Gum Woodland CEEC listed under the EPBC Act* adjacent to the road as it is a narrow feature in a wide, predominantly DNG landscape subject to grazing. Potential indirect impacts from the Action on native vegetation and habitat are described in Section 5.3.

Mitigation measures for the *Box-Gum Woodland CEEC listed under the EPBC Act* are outlined in Section 7.5 and include the following:

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

As described earlier, based on the information available in the EPBC Act Referral, DAWE considered (in the input into the SEARs) that the Action is likely to have a significant impact on the *Box-Gum Woodland CEEC listed under the EPBC Act*. However, the net loss of between 0.7 ha and 0.8 ha of woodland and between 8.3 ha and 12.3 ha of DNG of the *Box-Gum Woodland CEEC listed under the EPBC Act* is not considered significant in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment [DotE] 2013).

The Project would reduce the extent of the community and result in some additional fragmentation of an already fragmented occurrence of the *Box-Gum Woodland CEEC listed under the EPBC Act*. The Project is unlikely to:

- modify or destroy abiotic factors (such as water, nutrients, or soil) necessary for an ecological community's survival;
- cause a substantial change in the species composition in the occurrence of the ecological community;
- cause a substance reduction in the quality or integrity of an occurrence of an ecological community (e.g. assist invasive species to become established or kill or inhibit the growth of species in the ecological community through the use of fertilisers, herbicides or other chemicals or pollutants); or

- interfere with the recovery of the ecological community.

The impacts on the *Box-Gum Woodland CEEC listed under the EPBC Act* 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 8.3) (Attachments I and L).

7.4.2 Striped Legless Lizard

This species was not recorded within the Action area during targeted surveys undertaken in 2018 and 2019 by Future Ecology (2020) (Attachment B), however it was recorded approximately 3 km to the south-east and 6 km to the south-west (Figure 15). A single individual was recorded at each location, with one under a cow pat (dung) and the other under a lightly imbedded rock.

The Project would result in the direct clearance of approximately 27.4 ha (Northern Link Road Option 1 [Development Footprint 2]) or 23.3 ha (Northern Link Road Option 2 [Development Footprint 3]) of potential habitat for the Striped Legless Lizard (Figure 15) (Table 45). PCTs 483, 618, 1605 and 1606 in woodland and DNG forms within the Action area are recognised as potential habitat for the Striped Legless Lizard (DPIE 2020c) (Figure 15).

The revised road alignment options would result in slightly more clearing of potential habitat for the Striped Legless Lizard compared to the original revised road alignment approved by EPBC 2011/5795. Approximately 27.4 ha (Northern Link Road Option 1 [Development Footprint 2]) or 23.3 ha (Northern Link Road Option 2 [Development Footprint 3]) of potential habitat would be cleared for the Action compared to the Western Link Road Relinquishment Area (approximately 13.9 ha).

The Striped Legless Lizard was not recorded within the Action area. Given its presence in the surrounds, it is possible that the Striped Legless Lizard utilises potential habitat within the Action area. However, much of the habitat within the Action area is generally poor and subject to ongoing disturbance from grazing and other agricultural practices (Future Ecology 2020) (Attachment B).

Despite the condition of the potential habitat in the Action area, the habitat may form part of 'habitat critical to the survival of the species' according to the TSSC (2016a) and the local population could be considered an important population (as defined by the Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2011). The reason for this is that within the Upper Hunter area the species is currently only known from the near Muswellbrook Common (approximately 5 km east of the Subject land) (DPIE 2020b) and another site near Jerrys Plains approximately 15 km southeast (Future Ecology 2019).

In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor. The previously unrecorded population of this species would persist in the surrounding locality due to the amount of known habitat and the occurrence of the species outside both road alignment options (Figure 15).

The Project is unlikely to indirectly impact the Striped Legless Lizard adjacent to the road as the Action would include measures to manage environmental weeds spreading from the Action area considering that the Striped Legless Lizard is a grassland specialist (DAWE 2020f).

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 2020f). The creation of barriers to lizard movements can cause populations to become fragmented (DAWE 2020f). The Northern Link Road could potentially limit the movement of the Striped Legless Lizard; however, this species was only recorded to the south of the proposed Northern Link Road alignments (Figure 15). Therefore, based on available data, the population is unlikely to be significantly fragmented.

Best practise mitigation measures as outlined in *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (DSEWPaC 2011) have been considered for the Striped Legless Lizard, and would include (Section 7.5):

- the salvage and re-use of material for habitat (e.g. surface rocks);
- weed management; and
- feral animal management (e.g. feral cats).

It is conservatively considered that the Action is likely to have a significant impact on the Striped Legless Lizard in the short to medium-term in consideration of the *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar* (DSEWPaC 2011) and *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013). This conclusion is made considering that the local population of the Striped Legless Lizard in the Action area represents a range extension for the species and therefore could be considered an important population (as defined by DotE 2013).

This species is classified as a species credit species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c). 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 biodiversity credits for the Striped Legless Lizard (Section 7.3) (Attachments I and L).

7.4.3 Swift Parrot

It is unlikely that the woodland within the revised road alignment options is used by the Swift Parrot because this species was not recorded during recent surveys undertaken by Future Ecology (2020) (Attachment B), nor has it been recorded by any previous surveys in the Action area or surrounds (ERM 1997; Cumberland Ecology 2006, 2009a, 2010; ELA 2017a, 2017b).

DPIE (2020a) do not recognise the location as a Mapped Important Area for the Swift Parrot.

The Project would result in the direct clearance of potential foraging habitat for the Swift Parrot (Table 45). If the potential foraging habitat in the Action area is removed, it is likely to be of little consequence to the Swift Parrot given the occurrence of similar potential habitat in the surrounding landscape and the lack of records in the immediate region.

No recognised threats to the Swift Parrot (TSSC 2016b) are likely to occur indirectly as a result of the Action. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor.

As described earlier, based on the information available in the EPBC Act referral, DAWE considered (in the input into the SEARs) that the Action is likely to have a significant impact on the Swift Parrot. The Project may not have a material adverse impact on the Swift Parrot as this species has not been recorded in the Action area, no breeding habitat for this species is present (as it breeds in Tasmania), and DPIE (2020a) do not recognise the Subject land as important habitat for this species (negating the need for species credits).

This species is classified as an ecosystem credit species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) given DPIE (2020a) do not recognise the location as a Mapped Important Area (Table 10). The impacts on the Swift Parrot would be offset in accordance with the NSW Biodiversity Offsets Scheme and would result in the retirement of the required number and class of ecosystem credits (Section 7.3) (Attachments I and L).

7.4.4 Regent Honeyeater

This species was not recorded within the Action area or surrounds during targeted searches undertaken in 2018 and 2019 by Future Ecology (2020) (Attachment B), nor has it been recorded by any previous surveys in the Action area or surrounds (ERM 1997; Cumberland Ecology 2006, 2009a, 2010; ELA 2017a, 2017b). The closest database record is approximately 9 km to the south of the Action area (Figure 12).

No known or potential breeding habitat for the Regent Honeyeater occurs in the Action area and DPIE (2020a) do not recognise the location as a Mapped Important Area.

The revised road alignment options would result in slightly more clearance of potential foraging habitat for this species, compared to the original revised road alignment approved by EPBC 2011/5795. Approximately 6 ha (for either option) of potential foraging habitat would be cleared for the Action compared to the original revised road alignment approved by EPBC 2011/5795 (approximately 5 ha). After taking account of the fact that the original road alignment would not be constructed, the net impact would be clearance of approximately +1 ha of potential habitat for either revised Northern Link Road alignment option.

In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor.

The Regent Honeyeater potential foraging habitat adjacent to the Action area is mostly located in an agricultural grazing property and as such is subject to a number of existing recognised threats, namely, livestock grazing, habitat fragmentation, weeds and lack of fire (DotE 2015a, 2016). The Project is unlikely to indirectly impact the Regent Honeyeater (were it to use the woodland potential habitat adjacent to the Action area) as potential indirect impacts would be managed (Section 7.3).

If the potential foraging habitat in the Action area 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.

As described earlier, based on the information available in the EPBC Act referral, DAWE considered (in the input into the SEARs) that the Action is likely to have a significant impact on the Regent Honeyeater. The Project may not have a material adverse impact on the Regent Honeyeater as this species has not been recorded in the Action area, no breeding habitat for this species is present, and the DPIE (2020a) do not recognise the Subject land as important habitat for these species (negating the need for species credits). To be conservative and consistent with the DAWE input into the SEARs, the BDAR assesses the Regent Honeyeater as if the Action could significantly impact the species.

This species is classified as an ecosystem credit species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) given DPIE (2020a) do not recognise the location as a Mapped Important Area (Table 10). The impacts on Regent Honeyeater would be offset in accordance with the NSW Biodiversity Offsets Scheme and would result in the retirement of the required number and class of ecosystem credits (Section 7.3) (Attachments I and L).

7.4.5 Koala (combined populations of Queensland, NSW and the Australian Capital Territory)

This species was not recorded within the Action area or surrounds during targeted call-playback, spotlighting and camera trapping surveys, scat searches and habitat assessments undertaken in 2018 and 2019 by Future Ecology (2020) (Attachment B). It has not been recorded by any previous surveys in the Action area or surrounds (ERM 1997; Cumberland Ecology 2006, 2009a, 2010; ELA 2017a, 2017b). Database records show the Koala has been previously recorded approximately 9 km (and further) to the southeast of the Action area (DPIE 2020b).

Of the vegetation types that occur within the Action area, PCTs 483 SG, 618, 1691, 1602, 1605 and 1606 in their woodland forms are recognised as potential habitat for the Koala (DPIE 2020c; Hunter Eco 2020; Future Ecology 2020) (Attachments A and B) (Figure 19).

Approximately 5.2 ha (Northern Link Road Option 1 [Development Footprint 2]) or 3.1 ha (Northern Link Road Option 2 [Development Footprint 3]) of potential habitat (plus paddock trees within associated DNG forms that may potentially be utilised by the Koala) would be cleared for the Action. If the Northern Link Road Option 2 (Development Footprint 3) is developed, this would result in less clearance of potential habitat for this species compared to the original revised road alignment approved by EPBC 2011/5795 (approximately 4.4 ha).

The Koala is unlikely to be adversely or significantly impacted by the Action, considering the *EPBC Act referral guidelines for the vulnerable koala* (DotE 2014), given that:

- no habitat critical to the survival of the Koala would be cleared; and
- the action is not likely to interfere substantially with the recovery of the koala through the introduction or exacerbation of key threats in areas of habitat critical to the survival of the Koala.

7.4.6 Spotted-tailed Quoll

The Spotted-tailed Quoll was not recorded within the Action area or surrounds during targeted surveys by Future Ecology (2020) (Attachment B). There is a single database record within existing/approved surface development from June 2006 with a 10,000 m accuracy (DPIE 2020b).

Northern Link Road Option 1 (Development Footprint 2) is the currently preferred option as it skirts the ML boundary and would have a disturbance area of approximately 27.4 ha of native vegetation (Development Footprint 2 – Figure 3b). Option 2 is the less preferred option and would have a disturbance area of approximately 23.3 ha of native vegetation (Development Footprint 3 – Figure 3b).

In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor.

The Spotted-tailed Quoll potential habitat adjacent to the Action Area 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 (DAWE 2020f). The Project is unlikely to indirectly impact the Spotted-tailed Quoll (were it to use the woodland potential habitat adjacent to the Action Area) as potential indirect impacts would be managed (Section 7.3).

Spotted-tailed Quoll are susceptible to vehicle strike (Department of Environment, Land, Water and Planning [DELWP] 2016; DAWE 2020f). The revised Northern Link Road alignment is not likely to pose a significant incremental risk to Spotted-tailed Quoll.

Potential habitat for this species is widespread. It is considered that the Action is not likely to have a significant impact on the Spotted-tailed Quoll in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DotE 2013).

This species is classified as an ecosystem credit species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) and as such has been included in the ecosystem credit calculations for the Action (Tables 15 and 33) (Attachments H and K).

7.4.7 Grey-headed Flying-fox

The Action is not likely to adversely or significantly impact this species. No breeding camps are known to occur within the Action area or immediate surrounds (DAWE 2020d) and none were found during recent daytime searches and habitat assessments, therefore breeding habitat is absent from the Action area (Future Ecology 2020) (Attachment B).

This species was recorded at eight locations within the ML and surrounds during targeted surveys undertaken in 2018 and 2019 by Future Ecology (2020) (Attachment B) (Figure 25).

The Project would result in the direct clearance of net +0.6 ha (Northern Link Road Option 1 [Development Footprint 3]) or +0.7 ha (Northern Link Road Option 2 [Development Footprint 3]) of potential foraging habitat for the Grey-headed Flying-fox (Table 45). If the potential foraging habitat in the Action area is removed, it is likely to be of little consequence to the Grey-headed Flying-fox given the occurrence of similar potential habitat in the surrounding landscape and the lack of breeding habitat in the Action area.

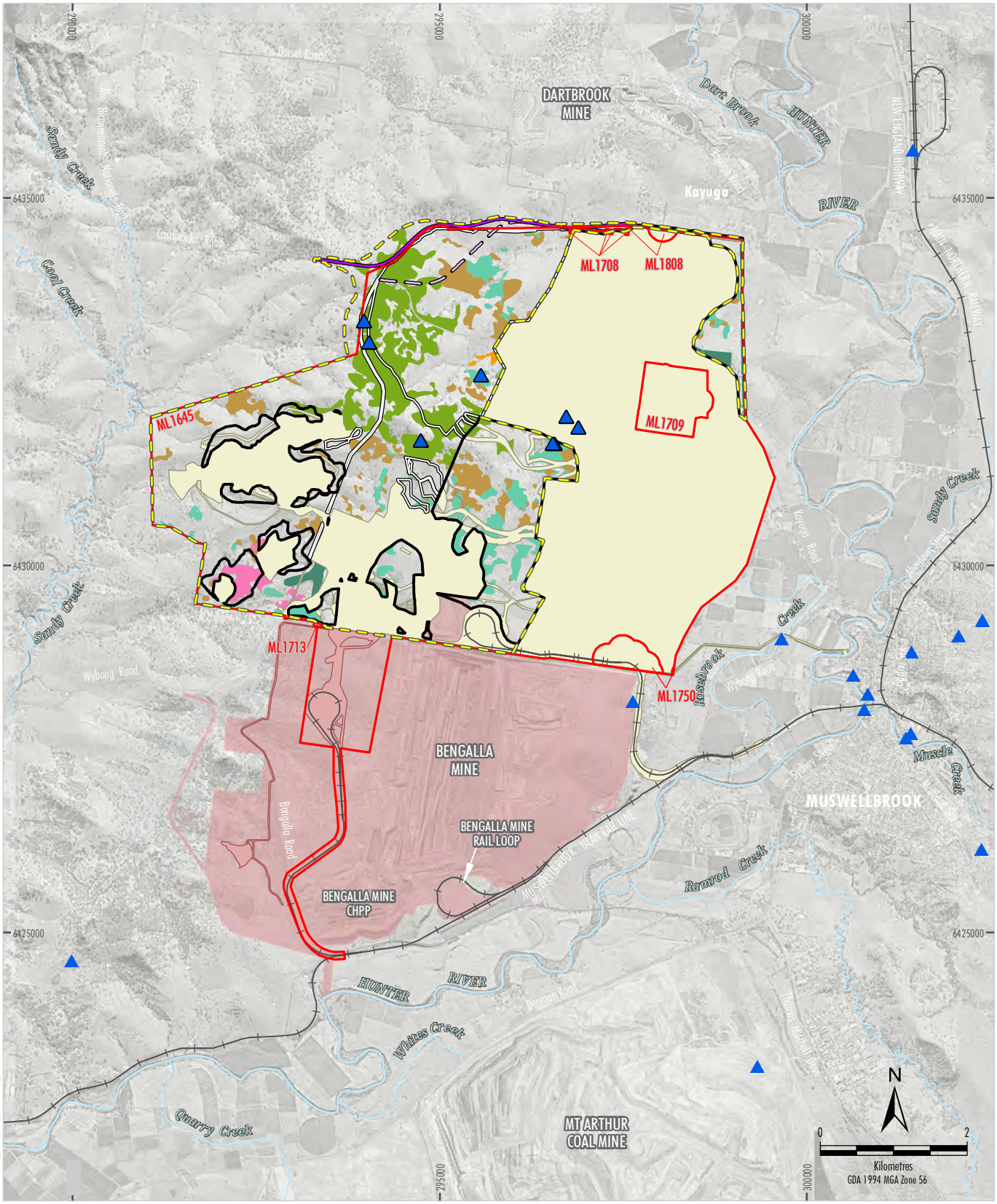
In the long-term, the surface disturbance areas associated with the development of the Northern Link Road would be progressively rehabilitated, where not within the relocated public road corridor.

No recognised threats to the Grey-headed Flying-fox (DAWE 2020f) are likely to occur indirectly as a result of the Action. General potential indirect impacts on woodland potential habitat would be managed (Section 7.3).

It is considered that the Action is not likely to have a significant impact on the Grey-headed Flying Fox in consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* (DotE 2013) given that:

- no potential breeding habitat has been recorded (Future Ecology 2020) (Attachment B) or is known to occur within the Action area or surrounds (DAWE 2020d); and
- potential foraging habitat for this species is relatively common across the wider locality (as indicated by the numerous records of this species within the extent of surrounding towns and state forests [DPIE 2020b]).

This species is classified as an ecosystem credit species in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020c) and as such has been included in the ecosystem credit calculations for the Action (Tables 15 and 33) (Attachments H and K). This species was excluded as a species credit species due to no breeding camps in the Subject land (Table 10).



MAC-18-02_SSD_EIS_App BDAR_238A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Survey / Database

Threatened Species

- Grey-headed Flying-fox

Survey Record Sources: Future Ecology (2020a, 2020b)
Database Record Sources: ALA (2020); DPIE (2020)

POTENTIAL FORAGING HABITAT

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]

[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Grey-headed Flying-fox Potential Foraging Habitat

Figure 25

7.4.8 Recovery Plans and Approved Conservation Advices

This assessment has taken into consideration approved Commonwealth Conservation Advice for the species and communities which may be impacted (or significantly impacted) by the Action.

In particular, the following Conservation Advice is relevant to the Action:

- *Conservation Advice* Delma impar *striped legless lizard* (TSSC 2016a) (including the *Referral Guidelines for the Vulnerable Striped Legless Lizard,* Delma impar [DSEWPaC 2011]);
- *Conservation Advice* Lathamus discolor *Swift Parrot* (TSSC 2016b);
- *Conservation Advice* Anthochaera phrygia *Regent Honeyeater* (DotE 2015a); and
- Conservation Advice Dasyurus maculatus maculatus (southeastern mainland population) *Spotted-tailed Quoll, south eastern mainland* (TSSC 2020).

There is no approved Conservation Advice for the *Box-Gum Woodland CEEC listed under the EPBC Act* or for the Grey-headed Flying-fox (DAWE 2020f).

The key threats to these species and communities include vegetation clearing and landscape fragmentation, introduction of weeds, predation (particularly by feral cats and foxes), removal of fallen timber and bush rock, habitat degradation by livestock and altered fire regimes.

This assessment has taken into consideration approved Recovery Plans for the species and communities which may be impacted by the Action.

The following Recovery Plans are relevant to the Action:

- National Recovery Plan for *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECCW 2010);
- *National Recovery Plan for the Striped Legless Lizard (*Delma impar*) 1999-2003* (Smith and Robertson 1999);
- *National Recovery Plan for the Swift Parrot (*Lathamus discolor*)* (Saunders and Tzaros 2011);
- *National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*)* (DotE 2016); and
- *National Recovery Plan for the Spotted-tailed Quoll* Dasyurus maculatus (DELWP 2016).

There are no approved recovery plans in respect of the Grey-headed Flying-fox (DAWE 2020f).

7.4.9 Threat Abatement Plans

This assessment has taken into consideration approved Threat Abatement Plans for the species and communities which may be impacted by the Action:

- *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (Department of the Environment and Energy [DEE] 2017).

  This Threat Abatement Plan is relevant to the *Box-Gum Woodland CEEC listed under the EPBC Act* (DAWE 2020f).
- *Threat Abatement Plan for competition and land degradation by rabbits* (DEE 2016).

  This Threat Abatement Plan is relevant to Striped Legless Lizard and the Regent Honeyeater (DAWE 2020f).

- *Threat abatement plan for predation by feral cats* (DotE 2015b).

  This Threat Abatement Plan is relevant to the Striped Legless Lizard, Swift Parrot and Spotted-tailed Quoll (DAWE 2020f).

- *Threat abatement plan for predation by the European red fox* (Department of the Environment, Water, Heritage and the Arts [DEWHA] 2008).

  This Threat Abatement Plan is relevant to the Striped Legless Lizard and Spotted-tailed Quoll (DAWE 2020f).

The following Threat Abatement Plans apply to species and communities affected by the action, but are not considered relevant to the location of the Action:

- *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads*; and
- *Threat abatement plan for disease in natural ecosystems caused by* Phytophthora cinnamomic.

There are no Threat Abatement Plans relevant to the Grey-headed Flying-fox (DAWE 2020f).

7.4.10 Summary

Based on the information available in the EPBC Act Referral, DAWE considered (in the input into the SEARs) that the Action is likely to have a significant impact on:

- *Box-Gum Woodland CEEC listed under the EPBC Act*;
- Striped Legless Lizard;
- Swift Parrot; and
- Regent Honeyeater.

After taking account of the fact that the original road alignment would not be constructed, the net impact would be clearance of approximately +1 ha of woodland and mostly DNG. Approximately +12.4 net ha of DNG, +0.6 net ha of woodland and +0.4 net ha of plantation would be cleared for Option 1 (total of 13.4 ha) or approximately +8.3 net ha of DNG and +0.7 net ha of woodland and +0.3 net ha of plantation for Option 2 (total of 9.4 ha).

Given the very small area of additional woodland proposed to be cleared (approximately 1 ha), it is considered unlikely that the Action would have a material adverse impact on the threatened woodland birds or *Box-Gum Woodland CEEC listed under the EPBC Act*. However, mitigation and offset measures are provided in Sections 7.5 and 7.6.

The habitat for the Striped Legless Lizard includes the DNG and therefore it is conservatively considered that the Action is likely to have a significant impact on the Striped Legless Lizard. Mitigation and offset measures are provided in Sections 7.5 and 7.6.

7.5 IMPACT AVOIDANCE AND MITIGATION MEASURES FOR MATTERS OF NATIONAL SIGNIFICANCE

As described in Section 4.1, where practical, the Project (inclusive of the Action under the EPBC Act) has been located and designed to avoid and minimise impacts on biodiversity values, including native vegetation and potentially occurring threatened species.

The revised Northern Link Road alignment would remain a public road managed by Muswellbrook Local Council. Table 47 provides information on proposed avoidance and mitigation measures to manage the relevant impacts for the following MNES:

- *Box-Gum Woodland CEEC listed under the EPBC Act*;
- Striped Legless Lizard;
- Swift Parrot; and
- Regent Honeyeater.

Included is a description and assessment of the expected or predicted effectiveness of the mitigation measures, and any statutory policy basis for the mitigation measures (e.g. conservation advice or recovery plan for the species or community, relevant threat abatement plans [e.g. DotE 2015b; DEE 2016, 2017; DEWHA 2008]).

Table 47
Impact Mitigation Measures Relevant to Threatened Species and Communities Listed Under the EPBC Act

Matter	Impact	Mitigation Measure (Table 27)	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
Box-Gum Woodland CEEC listed under the EPBC Act	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol (Biodiversity Measure 1)	Effective if clearly delineated.	Rawlings *et al*. (2010), TSSC (2006) and DECCW (2010) describe protection of the TEC.
	Indirect Impacts on Native Vegetation and Habitat	Weed Management (Biodiversity Measure 4)	Effective when done in a controlled manner.	Rawlings *et al*. (2010), TSSC (2006) and DECCW (2010) describe weed management of the TEC.
		Bushfire Management (Biodiversity Measure 7)	Effective when applied.	Standard practice.
Striped Legless Lizard	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol (Biodiversity Measure 1)	Effective if clearly delineated.	DSEWPaC (2011).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation (Biodiversity Measure 2)	Effective when applied.	DSEWPaC (2011).
		Salvage and Re-Use of Material for Habitat Enhancement within Mine Site Rehabilitation (Biodiversity Measure 2	Effective when applied.	
	Indirect Impacts on Habitat	Feral Animal Management (Biodiversity Measure 5)	Effective if ongoing during development and operational stages.	DSEWPaC (2011).
	Uncontrolled Spread of Weeds	Weed Management (Biodiversity Measure 4)	Effective when applied.	DSEWPaC (2011).

Matter	Impact	Mitigation Measure (Table 27)	Impact Mitigation Measures/Effectiveness	Basis for the Mitigation Measures
Swift Parrot	Clearance Impacts on Native Vegetation and Habitat	Vegetation Clearance Protocol (Biodiversity Measure 1)	Effective if clearly delineated.	TSSC (2016b) and Saunders and Tzaros (2011).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation (Biodiversity Measure 2)	Effective when applied.	TSSC (2016b) and Saunders and Tzaros (2011).
	Indirect Impacts on Native Vegetation and Habitat	Feral Animal Management (Biodiversity Measure 5)	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 (Biodiversity Measure 1)	Effective if clearly delineated.	DotE (2015a, 2016).
	Loss of Habitat	Mine Site Rehabilitation and Revegetation (Biodiversity Measure 2)	Effective when applied.	DotE (2015a, 2016).
	Indirect Impacts on Native Vegetation and Habitat	Feral Animal Management (Biodiversity Measure 5)	Effective if ongoing during development and operational stages.	DotE (2015a, 2016).

7.6 COMMONWEALTH OFFSET

A summary of the specific number and class of like-for-like biodiversity credits for threatened species and communities listed under the EPBC Act are listed in Table 48 (Attachments I and L).

The conservation benefit associated for EPBC Act listed threatened species and communities with the proposed offset strategy is that larger areas of habitat (compared to that which would be cleared) would be conserved and enhanced under the NSW Biodiversity Offsets Scheme in perpetuity.

Table 48
Credit Requirement for Threatened Species and Communities Listed Under the EPBC Act

Scientific Name	Common Name	Conservation Status[1]		Disturbance Area (ha) (Table 45)		Net Credit Requirement (Table 45)	
		BC Act	EPBC Act	Northern Link Road Option 1 (Development Footprint 2)	Northern Link Road Option 2 (Development Footprint 3)	Northern Link Road Option 1 (Development Footprint 2) (Attachment I)	Northern Link Road Option 2 (Development Footprint 3) (Attachment L)
Ecosystem Credits							
Box-Gum Woodland CEEC listed under the EPBC Act		CE	CE	26.4	22.5	44 *(11 credits of PCT 483 SG, 4 credits of PCT 618, 8 credits of PCT 1606 and 21 credits of PCT 1606 DNG)*	95 *(63 credits of PCT 483, 4 credits of PCT 618, 8 credits of PCT 1606 and 20 credits of PCT 1606 DNG)*
Species Credits							
Delma impar	Striped Legless Lizard	V	V	27.4	23.3	293	225

Note: Highlighted cells are credits.

[1] Conservation status under the BC Act and/or EPBC Act (current as at January 2021). CE = Critically Endangered; E = Endangered; V = Vulnerable.

Like-for-like biodiversity credits are defined under the BC Regulation as:

…

(2) In the case of impacts on threatened ecological communities, like-for-like biodiversity credits represent:

(a) the same threatened ecological community located in:

(i) the same or an adjoining Interim Biogeographic Regionalisation of Australia subregion as the impacted site, or

(ii) any such subregion that is within 100 kilometres of the outer edge of the impacted site, and

(b) if the threatened ecological community contains hollow bearing trees—vegetation that contains hollow bearing trees.

(3) In the case of impacts on the habitat of threatened species that are ecosystem credit species or other native vegetation (other than impacts on threatened ecological communities), like-for-like biodiversity credits represent:

(a) the same class of native vegetation located in:

(i) the same or an adjoining Interim Biogeographic Regionalisation of Australia subregion as the impacted site, or

(ii) any such subregion that is within 100 kilometres of the outer edge of the impacted site, and

(b) the same or a higher offset trading group, and

(c) if the impacted habitat contains hollow bearing trees—vegetation that contains hollow bearing trees.

(4) In the case of impacts on threatened species that are species credit species, like-for-like biodiversity credits represent the same threatened species.

A class of credits is defined in the BAM (OEH 2017) as:

A class of credits is formed where the biodiversity credit shares the same attributes. For ecosystem credits, the attributes are as follows:

(a) name of the PCT impacted by development, clearing or conferral of biodiversity certification

(b) name of any CEEC or EEC or vulnerable ecological community (VEC) associated with the PCT identified in (a)

(c) name of the offset trading group for the PCT or TEC as identified in Table 5

(d) vegetation class of the PCT identified in (a)

(e) vegetation formation of the PCT identified in (a)

(f) presence or absence of hollow bearing trees

(g) IBRA subregion in which the development, clearing or biodiversity certification occurs.

…

For species credits, name of the threatened species being impacted at the development site, clearing site or land to be certified is the only attribute that needs to be shared in order to be in the same class of credits.

Trading groups for ecosystem credits are defined in the BAM (OEH 2017) as:

Very high threat status
Tier 1: Name of the critically endangered ecological community
Tier 2: PCTs in the same vegetation class with a percent cleared value ≥90% (being the name of the vegetation class – percent cleared value ≥90%)

High threat status
Tier 3: Name of the endangered ecological community
Tier 4: PCTs in the same vegetation class with a percent cleared value ≥70% and <90% (being the name of the vegetation class – percent cleared value ≥70% and <90%)

Moderate threat status
Tier 5: Name of the vulnerable ecological community
Tier 6: PCTs in the same vegetation class with a percent cleared value
≥50% and <70% (being the name of the vegetation class – percent cleared value ≥50% and <70%)

Low threat status
Tier 7: PCTs in the same vegetation class with a percent cleared value <50% (being the name of the vegetation class – percent cleared value <50%)

The reports detailing the like-for-like credit requirements from the BAM Calculator are provided in Attachments I and L.

The credits required for threatened species and communities listed under the EPBC Act are required to be like-for-like credits. The number and class of like-for-like biodiversity credits for threatened species and communities listed under the EPBC Act are provided in Table 48.

7.6.1 Biodiversity Stewardship Site

MACH may choose to establish a Biodiversity Stewardship Site on land owned by MACH. A Biodiversity Stewardship Site Management Plan, including management actions to improve biodiversity values, is required for all Biodiversity Stewardship Sites.

7.6.2 Payments

Payments could be made to the NSW Biodiversity Conservation Fund, administered by the NSW Biodiversity Conservation Trust (BCT), instead of retiring credits for a portion or all of the biodiversity credit requirement. The total cost of the payment would be determined at the time of applying to the BCT to make a payment into the NSW Biodiversity Conservation Fund.

7.6.3 Timing

Credits would be retired (or payments made) according to the timing that would be specified in the Commonwealth approval, to the satisfaction of the Commonwealth Minister of the Environment.

8 CONCLUSION

This BDAR was prepared in accordance with the BAM and the SEARs for the Project.

The Project involves a re-arrangement of areas proposed to be cleared, resulting in a significant reduction in the residual biodiversity impacts that would otherwise occur. This approach is consistent with the BAM, whereby impacts on biodiversity are to be avoided and minimised in the first instance and then residual direct impacts from clearing native vegetation and habitat loss are offset.

The Relinquishment Area is predominantly a single, contiguous, large area of native vegetation, whereas the Project clearance areas are many dissected areas around the existing mine infrastructure.

The outcome of the Project would be (at a minimum) less clearing of native vegetation and habitat at the mine, continued management of over 13,000 ha of biodiversity offset areas, and additional biodiversity offsets for the revised alignment of the Northern Link Road that comprises the Action disturbance area under the EPBC Act.

9 REFERENCES

Atlas of Living Australia (2020) *Atlas of Living Australia Database with Search Co-ordinates: -32.23755 150.94161, -32.23697 150.94092, -32.34377 150.94092, -32.35247 150.71433, -32.13178 150.70884, -32.12946 150.93955.*
Website: http://www.ala.org.au.

Australasian Groundwater and Environmental Consultants (2020) *Mount Pleasant Optimisation Project – Groundwater Impact Assessment.* Prepared for MACH Energy Australia Pty Ltd.

BIO-ANALYSIS Pty Ltd (2020) *Mount Pleasant Optimisation Project – Aquatic Ecology Assessment.* Prepared for MACH Energy Australia Pty Ltd.

BirdLife Australia (2020) *BirdLife Australia Atlas Database with Search Co-ordinates: -32.23755 150.94161, -32.23697 150.94092, -32.34377 150.94092, -32.35247 150.71433, -32.13178 150.70884, -32.12946 150.93955.*

Bureau of Meteorology (2020) *Groundwater Dependent Ecosystems Atlas.*
Website: http://www.bom.gov.au/water/groundwater/gde/.

Cumberland Ecology (2006) *Proposed Mount Pleasant Open Cut Mine – Flora and Fauna Assessment.* Prepared for Coal & Allied Operations Pty Ltd.

Cumberland Ecology (2007) *Mount Pleasant: ecology gap analysis report*. Prepared for Coal & Allied Operations Pty Ltd.

Cumberland Ecology (2009a) *Mount Pleasant Project – Flora and Fauna Report*. Prepared for Coal & Allied Operations Pty Ltd.

Cumberland Ecology (2009b) *Mt Arthur Coal Consolidation Project Ecological Assessment*. Prepared for Hansen Bailey Pty Ltd on behalf of Hunter Valley Energy Coal.

Cumberland Ecology (2010) *Mount Pleasant Project Modification Ecological Assessment*. Prepared for Coal & Allied Operations Pty Ltd.

Cumberland Ecology (2013) *Continuation of Bengalla Mine Project Ecological Impact Assessment*. Prepared for Hansen Bailey on behalf of Bengalla Mining Company Pty Limited.

Cumberland Ecology (2015a) *Bengalla Mine – Section 96(2) Modification to SSD-5170 Ecological Assessment.* Prepared for Hansen Bailey on behalf of Bengalla Mining Company Pty Limited.

Cumberland Ecology (2015b) *Mount Pleasant Upper Hunter Strategic Assessment BCAM Project - Biodiversity Assessment Report.* Prepared for Rio Tinto Coal Australia.

Department of Agriculture, Water and the Environment (2020a) *Directory of Important Wetlands of Australia.*
Website: http://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands.

Department of Agriculture, Water and the Environment (2020b) *EPBC Act Protected Matters Search Tool.* Database search within the following area: -32.21 150.80667, -32.21028 150.80667, -32.21306 150.81611, -32.21389 150.825,-32.21 150.83056, -32.20694 150.83694, -32.20778 150.85528, -32.20667 150.85556, -32.20528 150.83389, -32.20583 150.82444, -32.21028 150.81556, -32.20972 150.80917, -32.21 150.80667.

Department of Agriculture, Water and the Environment (2020c) *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Regions) – States and Territories.* Website: http://www.environment. gov.au/land/nrs/science /ibra/australias-bioregions-maps.

Department of Agriculture, Water and the Environment (2020d) *National Flying-fox monitoring viewer*. Website: http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf.

Department of Agriculture, Water and the Environment (2020e) *New South Wales Bilateral Agreement Information*. Website: https://www.environment.gov.au/protection/environment-assessments/bilateral-agreements/nsw.

Department of Agriculture, Water and the Environment (2020f) *Species Profile and Threats Database.* Website: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Department of Environment and Climate Change (2008) *Statement of Intent 1: Infection of native plants by* Phytophthora cinnamomi. Published by the New South Wales Department of Environment and Climate Change, April 2008.

Department of Environment, Climate Change and Water (2010) *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water New South Wales, Sydney. Website: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national. In effect under the EPBC Act from 22-Mar-2013.

Department of Environment, Land, Water and Planning (2016) *National Recovery Plan for the Spotted-tailed Quoll* Dasyurus maculatus. Australian Government, Canberra. Website: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/spotted-tailed-quoll. In effect under the EPBC Act from 06-May-2016.

Department of Planning (2009) *Mangoola Coal Mine Mod 2 – Relocate Water Supply Pipeline: Development Assessment and Systems Performance.*

Department of Planning, Industry and Environment (2019a) *Biodiversity Assessment Method Operational Manual.* Published by the New South Wales Environment, Energy and Science Department of Planning, Industry and Environment, September 2019.

Department of Planning, Industry and Environment (2019b) *Guidance to assist a decision-maker to determine a serious and irreversible impact*. Published by the New South Wales Environment, Energy and Science Department of Planning, Industry and Environment, September 2019.

Department of Planning, Industry and Environment (2020a) *Biodiversity Offsets and Agreement Management System (BOAMS).* Website: https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/biodiversity-offsets-scheme/biodiversity-offsets-and-agreement-management-system.

Department of Planning, Industry and Environment (2020b) *BioNet Atlas Search*. Website: https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx?who=0b679421-e424-47ea-b672-f30693729a7e.

Department of Planning, Industry and Environment (2020c) *BioNet Threatened Biodiversity Data Collection*. Website: https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx.

Department of Planning, Industry and Environment (2020d) *BioNet Vegetation Classification*. Website: http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx?ReturnUrl=%2fNSWVCA20PRapp%2fdefault.aspx.

Department of Planning, Industry and Environment (2020e) *National Parks and Wildlife Service Fire History – Wildfires and Prescribed Burns.* State Government of New South Wales and Department of Planning, Industry and Environment 2010. Website: https://datasets.seed.nsw.gov.au/dataset/fire-history-wildfires-and-prescribed-burns-1e8b6.

Department of Planning, Industry and Environment (2020f) *Surveying Threatened Plants and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method.* Published by the New South Wales Environment, Energy and Science Department of Planning, Industry and Environment, April 2020.

Department of Primary Industries – Water (2020) Website: https:// www.dpi.nsw.gov.au/about-us/publications/pdi/2018/water.

Department of Sustainability, Environment, Water, Population and Communities (2011) *Environment Protection and Biodiversity Conservation Act 1999 Referral Guidelines for the Vulnerable Striped Legless Lizard, Delma impar.* Commonwealth of Australia, 2011.

Department of the Environment (2013) *Matters of National Environmental Significance Significant Impact Guidelines 1.1.* Commonwealth of Australia, 2013.

Department of the Environment (2014) *EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory).* Commonwealth of Australia, 2014.

Department of the Environment (2015a) *Conservation Advice* Anthochaera phrygia *regent honeyeater*. Canberra: Department of the Environment. Website: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82338-conservation-advice.pdf. In effect under the EPBC Act from 08-Jul-2015.

Department of the Environment (2015b) *Threat abatement plan for predation by feral cats*. Canberra, Australian Capital Territory: Commonwealth of Australia. Website: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.

Department of the Environment (2016) *National Recovery Plan for the Regent Honeyeater* (Anthochaera phrygia). Canberra, Australian Capital Territory: Commonwealth of Australia. Website: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-regent-honeyeater-anthochaera-phrygia-2016. In effect under the EPBC Act from 04-May-2016 as *Anthochaera phrygia*.

Department of the Environment and Energy (2016) *Threat abatement plan for competition and land degradation by rabbits*. Canberra, Australian Capital Territory: Commonwealth of Australia. Website: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016. In effect under the EPBC Act from 07-Jan-2017.

Department of the Environment and Energy (2017) *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa) (2017)*. Canberra, Australian Capital Territory: Commonwealth of Australia. Website: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017.

Department of the Environment, Water, Heritage and the Arts (2008) *Threat abatement plan for predation by the European red fox*. Department of the Environment, Water, Heritage and the Arts, Canberra.
Website: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

Doody, T. M., Hancock, P. J. and Pritchard, J. L. (2019) *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems.* Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

Dorrough, J. and Ash, J. E. (1999) Using past and present habitat to predict the current distribution and abundance of a rare cryptic lizard, *Delma impar* (Pygopodidae). *Australian Journal of Ecology*, 24(6): 614-624.

Eco Logical Australia (2016) *Targeted surveys for Diuris tricolor and Prasophyllum petilum – Mount Pleasant Operation.* Prepared for MACH Energy Australia Pty Ltd.

Eco Logical Australia (2017a) *Mount Pleasant Operation Rail Modification – Terrestrial Fauna Survey Report*. Prepared for MACH Energy Australia Pty Ltd.

Eco Logical Australia (2017b) *Mount Pleasant Operation Rail Modification – Portion of South West Out of Pit Emplacement – Terrestrial Fauna Survey Report.* Prepared for MACH Energy Australia Pty Ltd.

ERM Mitchell McCotter (1997) *Mount Pleasant Mine Environmental Impact Statement.* Prepared for Coal & Allied Pty Ltd.

Future Ecology (2019) *Maxwell Project Baseline Fauna Survey Report.* Prepared for Malabar Coal Limited.

Future Ecology (2020) *Mount Pleasant Optimisation Project – Baseline Fauna Survey Report*. Prepared for MACH Energy Australia Pty Ltd.

Geoscience Australia (1997) *Australia's River Basins 1997*. Bioregional Assessment Source Dataset. Website: http://data.bioregionalassessments.gov.au/dataset/d4561e86-2d13-4dcb-bf9e-aae75ba4850c.

Hunter Eco (2013) *Mt Arthur Coal Open Cut Modification Ecological Assessment*. Prepared for Hunter Valley Energy Coal.

Hunter Eco (2017a) *Mount Pleasant Operation – Mine Optimisation Modification Biodiversity Assessment.* Prepared for MACH Energy Australia Pty Ltd.

Hunter Eco (2017b) *Mount Pleasant Operation Rail Modification – Terrestrial Ecology Assessment*. Prepared for MACH Energy Australia Pty Ltd.

Hunter Eco (2020) *Mount Pleasant Optimisation Project – Baseline Flora Report.* Prepared for MACH Energy Australia Pty Ltd.

Hydro Engineering & Consulting Pty Ltd (2020). *Mount Pleasant Optimisation Project Surface Water Assessment.* Prepared for MACH Energy Australia Pty Ltd.

Keith, D. (2004) *Ocean shores to desert dunes: The native vegetation of New South Wales and the ACT.* Department of Environment and Conservation.

MACH Energy Australia Pty Ltd (2019) *Mount Pleasant Operation (DA 92/97) – Environmental Management Strategy (02)*. Effective Date 14 January 2019.

MACH Energy Australia Pty Ltd (2020) *Mount Pleasant Operation – Offset Management Plan.*

Mitchell, P. (2002) *NSW Landscapes Mapping: Background and Methodology*. Report prepared for the New South Wales National Parks and Wildlife Service.

National Parks and Wildlife Service (2002) *White Box-Yellow Box-Blakely's Red Gum (Box-Gum) Woodland fact-sheet.* Published by the New South Wales National Parks and Wildlife Service.

Office of Environment and Heritage (2011) *Management plan for myrtle rust on the national parks estate.* Published by the New South Wales Office of Environment and Heritage, October 2011.

Office of Environment and Heritage (2016) *State Vegetation Type Map: Upper Hunter Region Version 1.0. VIS_ID 4894.*
Website: https://datasets.seed.nsw.gov.au/dataset/state-vegetation-type-map-upper-hunter-v1-0-vis_id-4894

Office of Environment and Heritage (2017) *Biodiversity Assessment Method*. Published by the New South Wales Office of Environment and Heritage for the New South Wales Government, August 2017.

Peake, T. C. (2006) *The Vegetation of the Central Hunter Valley, New South Wales.* A report on the findings of the Hunter Remnant Vegetation Project. Hunter-Central Rivers Catchment Management Authority, Paterson.

Phillips, S. and Callaghan, J. (2011) The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*. *Australian Zoologist,* 35(3): 774-780.

Rawlings, K., Freudenberger, D. and Carr, D. (2010) *A Guide to Managing Box Gum Grassy Woodlands.* Commonwealth of Australia, 2010.

Richardson, S., Irvine, E., Froend, R., Boon, P., Barber, S. and Bonneville, B. (2011) *Australian groundwater-dependent ecosystems toolbox part 1: assessment framework.* Waterlines report, National Water Commission, Canberra.

Saunders, D.L. and C.L. Tzaros (2011) *National Recovery Plan for the Swift Parrot* (Lathamus discolor). Birds Australia, Melbourne.
Website: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-swift-parrot-lathamus-discolor. In effect under the EPBC Act from 10-Feb-2012.

Sivertsen, D., Roff, A., Somerville, M., Thonell, J. and Denholm, B. (2011) *Hunter Native Vegetation Mapping.* Geodatabase Guide (Version 4.0), Internal Report for the New South Wales Office of Environment and Heritage, Department of Premier and Cabinet, Sydney.

Smith, W.J.S. and P. Robertson (1999) *National Recovery Plan for the Striped Legless Lizard* (Delma impar) *1999-2003*. New South Wales National Parks and Wildlife Service & Wildlife Profiles Pty Ltd.
Website: http://www.environment.gov.au/resource/national-recovery-plan-striped-legless-lizard-delma-impar-1999-2003. In effect under the EPBC Act from 16-Jul-2000.

Threatened Species Scientific Committee (2006) *Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.*
Website: http://www.environment.gov.au/biodiversity/threatened/communities/box-gum.html. In effect under the EPBC Act from 18-May-2006.

Threatened Species Scientific Committee (2016a) *Conservation Advice* Delma impar *striped legless lizard*. Canberra: Department of the Environment and Energy.
Website: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1649-conservation -advice-16122016.pdf. In effect under the EPBC Act from 16-Dec-2016.

Threatened Species Scientific Committee (2016b) *Conservation Advice* Lathamus discolor *swift parrot*. Canberra: Department of the Environment.
Website: http://www.environment.gov.au/biodiversity/threatened/species/pubs/744-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2020) *Conservation Advice* Dasyurus maculatus maculatus *(southeastern mainland population) Spotted-tailed Quoll, south eastern mainland*. Canberra: Department of Agriculture, Water and the Environment.
Website: http://www.environment.gov.au/biodiversity/threatened/species/pubs/75184-conservation-advice-01092020.pdf. In effect under the EPBC Act from 01-Sep-2020.

Todoroski Air Sciences (2020) *Mount Pleasant Optimisation Project Air Quality Impact Assessment*. Prepared for MACH Energy Australia Pty Ltd.

Umwelt (2006) *Ecological Assessment Anvil Hill Project*. Prepared for Centennial Hunter Pty Limited.

Umwelt (2010) *Ecological Assessment – Proposed Mine Plan Modification, Mangoola Coal*. Prepared for Xstrata Mangoola Pty Limited.

Umwelt (2019) *Mangoola Coal Continued Operations Project Environmental Impact Statement.* Prepared for Mangoola Coal Operations Pty Limited.

Weatherzone (2020) *Australian Weather.*
Website: https://www.weatherzone.com.au/.

Wilkinson Murray (2020) *Mount Pleasant Optimisation Project Noise & Blasting Assessment.* Prepared for MACH Mount Pleasant Operations.

January 2021

ATTACHMENTS

ATTACHMENT A
MOUNT PLEASANT OPTIMISATION PROJECT BASELINE FLORA REPORT

MACH Energy

MOUNT PLEASANT OPTIMISATION PROJECT



BASELINE FLORA REPORT

Prepared by
Dr Colin Driscoll

December 2020

HUNTER ECO · ABN 25 112 984 240
PO Box 1047, Toronto, NSW 2283 **P** +61 2 4959 8016 **M** 0438 773 029 **E** cd_enviro@bigpond.com

CONTENTS

EXECUTIVE SUMMARY **ES-1**

1 INTRODUCTION **1**

1.1 OVERVIEW OF THE MOUNT PLEASANT OPERATION 1
1.2 OVERVIEW OF THE PROJECT 1

2 OBJECTIVES, GUIDELINES AND SOURCES **6**

3 REGIONAL SETTING **7**

4 DESCRIPTION OF THE STUDY AREA AND SURROUNDS **7**

4.1 LANDUSE HISTORY 7
4.2 MITCHELL LANDSCAPES 7
4.3 TOPOGRAPHY AND DRAINAGE 7
4.4 FIRE HISTORY 10
4.5 GEOLOGY AND SOILS 10
4.6 CLIMATE 10

5 BACKGROUND INFORMATION **12**

5.1 REGIONAL SURVEYS 12
5.2 LOCAL SURVEYS 12

6 METHODS **14**

6.1 IDENTIFYING NATIVE PLANT COMMUNITY TYPES 14
6.2 ASSESSING VEGETATION INTEGRITY (SITE CONDITION) 17
6.3 THREATENED ECOLOGICAL COMMUNITIES 18
6.4 ENDANGERED POPULATIONS 19
6.5 THREATENED FLORA SPECIES 22
6.6 KOALA HABITAT PROTECTION SEPP 28
6.7 GROUNDWATER DEPENDENT ECOSYSTEMS 28
6.8 LIMITATIONS 31

7 RESULTS **32**

7.1 GENERIC COMMUNITIES 32
7.2 FLORISTIC PLOT DATA ANALYSIS 32
7.3 PLANT COMMUNITY TYPE ASSIGNMENT 33
7.4 THREATENED ECOLOGICAL COMMUNITY ASSIGNMENT 33
7.5 VEGETATION COMMUNITY CONDITION 44
7.6 THREATENED ECOLOGICAL COMMUNITIES LISTED UNDER THE BC ACT 44
7.7 THREATENED ECOLOGICAL COMMUNITIES LISTED UNDER THE EPBC ACT 45
7.8 FLORA SPECIES 46
7.9 THREATENED FLORA SPECIES 46
7.10 ENDANGERED POPULATIONS 46
7.11 GROUNDWATER DEPENDENT ECOSYSTEMS 48
7.12 POTENTIAL KOALA HABITAT 48

8 CONCLUSION 49

9 REFERENCES 50

APPENDIX 1 COMBINED FLORISTIC LIST 53

APPENDIX 2 COMMUNITY PROFILES 61

1. GREY BOX X WHITE BOX GRASSY WOODLAND (PCT483) 61
1A. DERIVED NATIVE GRASSLAND (PCT483) 63
2. GREY BOX X WHITE BOX - SPOTTED GUM GRASSY WOODLAND (PCT483 SG) 65
2A. DERIVED NATIVE GRASSLAND (PCT483 SG) 67
3. FOREST RED GUM GRASSY OPEN FOREST (PCT618) 69
3A. DERIVED NATIVE GRASSLAND (PCT618) 70
4. NARROW-LEAVED IRONBARK - GREY BOX GRASSY WOODLAND (PCT1691) 72
4A. DERIVED NATIVE GRASSLAND (PCT1691) 74
5. SPOTTED GUM - NARROW-LEAVED IRONBARK WOODLAND (PCT1602) 74
5A. DERIVED NATIVE GRASSLAND (PCT1602) 76
6. NARROW-LEAVED IRONBARK SHRUBBY FOREST (PCT1605) 77
6A. DERIVED NATIVE GRASSLAND (PCT1605) 79
6B. PLANTATION (PCT1605) 80
7. WHITE BOX - NARROW-LEAVED IRONBARK - BLAKELY'S RED GUM (PCT1606) 82
7A. DERIVED NATIVE GRASSLAND (PCT1606) 84
8A. DERIVED NATIVE GRASSLAND (PCT1655) 86

APPENDIX 3 PLOT FIELD DATA 88

APPENDIX 4 VEGETATION INTEGRITY DATA 116

TABLES

Table 1 Vegetation Communities Mapped over the Study Area by Regional Studies 12

Table 2 Summary of Ecology Reports from the Immediate Region of, and Including, the Study Area 12

Table 3 Floristic Survey Days 14

Table 4 Threatened Ecological Communities Possibly Occurring Within 20 km of the Study Area 18

Table 5 Endangered Populations 19

Table 6 Threatened Flora Species Potentially Occurring in the Study Area and Associated Seasonal Detectability 23

Table 7 Threatened Flora Species Not Associated with Any PCT Mapped for the Study Area and/or Excluded by Geographic Constraints 25

Table 8 Plant Community Type Assignment 34

Table 9 Vegetation Communities Mapped Across the Study Area Grouped by Formation 35

Table 10 Threatened Ecological Community Assignment 38

Table 11 Threatened Ecological Communities Recorded Across the Study Area 49

FIGURES

Figure 1 Project Location 2
Figure 2a Project General Arrangement 3
Figure 2b Project General Arrangement Inset 4
Figure 3 1953 Aerial Image of the Study Area 8
Figure 4 Topography Across the Study Area (Hatched) 9
Figure 5 Long-term Average Monthly Rainfall at Spring Creek (Castle Vale) 10
Figure 6 Long-term Monthly Average Maximum and Minimum Temperatures at Scone Airport. 11
Figure 7 Rapid Data Points and Vegetation Integrity Plots 16
Figure 8 Location of Previously Recorded Flora Species Representative of Endangered Populations 21
Figure 9 Orchid Survey Meander Tracks 2019 and 2020 26
Figure 10 Threatened Flora Survey Transects 27
Figure 11 GDE Atlas Low Probability Terrestrial GDEs and Topographic Wetness Index Model Output 30
Figure 12 Bootstrap Regions for the Five Main Woodland Generic Communities 33
Figure 13 Generic Vegetation Communities Mapped Across the Study Area 37
Figure 14 Threatened Ecological Communities NSW BC Act 42
Figure 15 Threatened Ecological Communities Commonwealth EPBC Act 43
Figure 16 The Main Families and Number of Species 46
Figure 17 *Cymbidium canaliculatum* Records 47

EXECUTIVE SUMMARY

MACH Energy Australia Pty Ltd is seeking consent for the Mount Pleasant Optimisation Project (the Project) to increase open cut coal extraction and related activities. The Project is in the Upper Hunter Valley of New South Wales (NSW), northwest of Muswellbrook.

The Project would involve mining of additional coal reserves and a staged increase in extraction, handling and processing of run-of-mine coal for export or to domestic customers for use in electricity generation.

This is a baseline report of the flora and vegetation communities across a Study Area encompassing works associated with the Project. 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 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 land across the Study Area has been used for grazing of cattle and sheep for over 100 years, and as a result, the Study Area is a mosaic of majority cleared grassland with patches of woodland. Eight 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/or 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	
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin	Endangered
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	Critically Endangered
Threatened Ecological Communities Listed Under the EPBC Act	
Central Hunter Valley Eucalypt Forest and Woodland	Critically Endangered
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered

One threatened flora species listed under the BC Act has been previously recorded in the Study Area, namely *Cymbidium canaliculatum* (Tiger Orchid). This species is a component of the *Cymbidium canaliculatum population in the Hunter Catchment* Endangered Population under the BC Act. All previously recorded locations were inspected during the current survey to confirm their presence/absence and identity, and the species was opportunistically targeted during all surveys. No other threatened flora species listed under the BC Act or EPBC Act were recorded in the Study Area, or were recorded in any past studies.

1 INTRODUCTION

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

1.1 Overview of the Mount Pleasant Operation

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95 percent [%] owner) and J.C.D. Australia Pty Ltd (5% owner)[1] .

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (Figures 1, 2a and 2b).

The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately nine trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

1.2 Overview of the Project

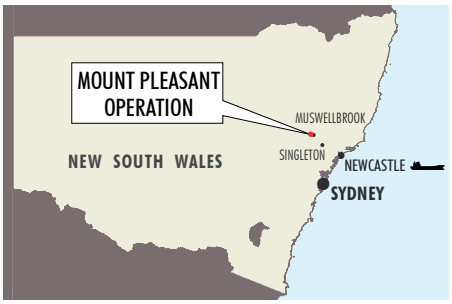
The Project would include the following development:

- increased open cut coal extraction within Mount Pleasant Operation Mining Leases (MLs) by mining of additional coal reserves, including lower coal seams in North Pit;
- staged increase in extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life);
- staged upgrades to the existing Coal Handling and Preparation Plant (CHPP) and coal handling infrastructure to facilitate the handling and processing of additional coal;
- rail transport of up to approximately 17 Mtpa of product coal to domestic and export customers;
- upgrades to workshops, electricity distribution and other ancillary infrastructure;
- existing infrastructure relocations to facilitate mining extensions (e.g. local roads, powerlines and water pipelines);
- construction and operation of new water management and water storage infrastructure in support of the mine;

[1] Throughout this report, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.



MAC-18-02 SSD_EIS_App Figure 1_Rev E



LEGEND

- Mining Operation
- Proposed Mining Operations (Application Lodged)
- Railway
- Local Government Boundary
- State Forest/Reserve
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)

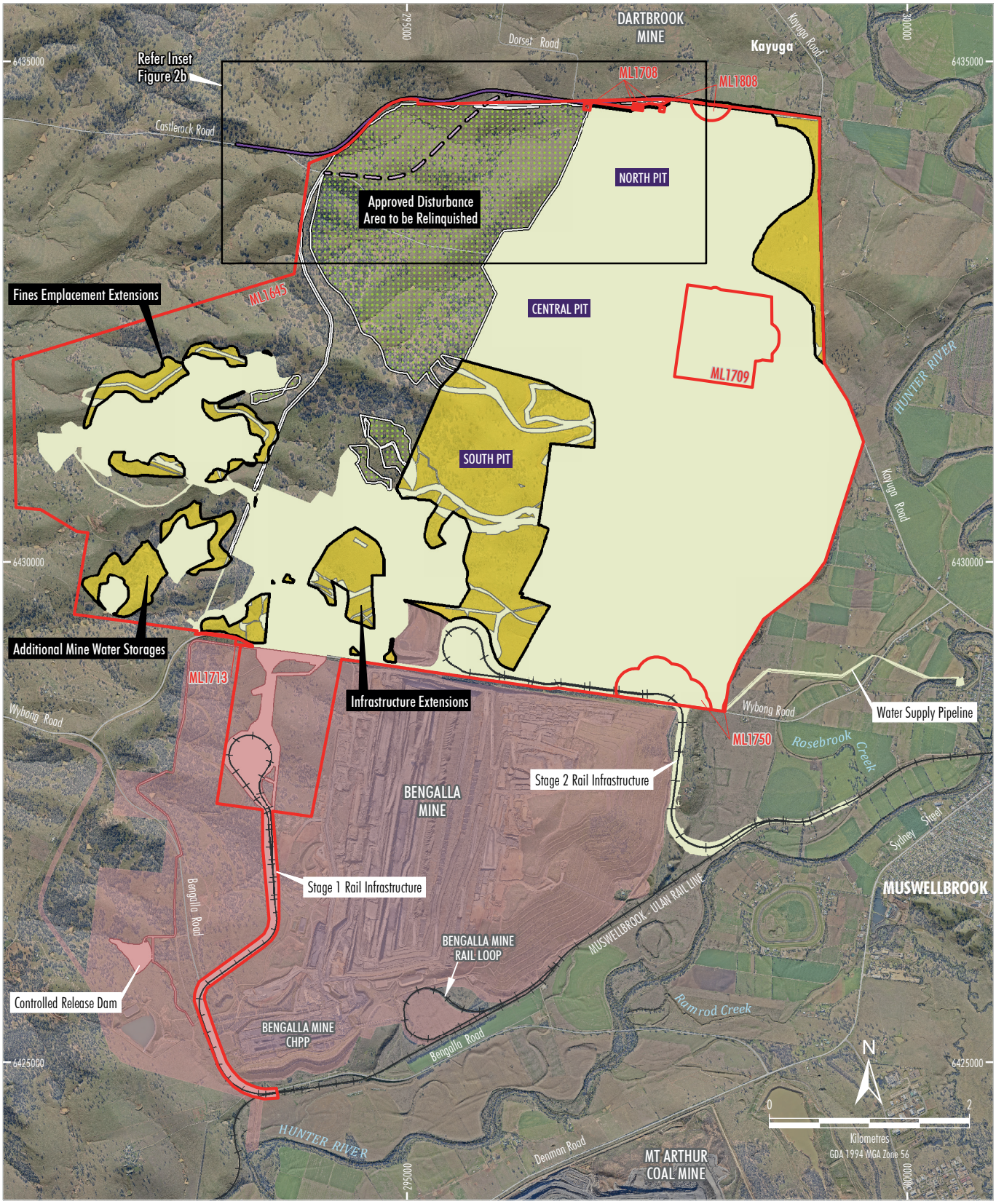
Source: NSW Spatial Services (2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project Location

Figure 1



MAC-18-02 SSD_EIS_App Flora_202B

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]
- General Extension Areas [1]
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

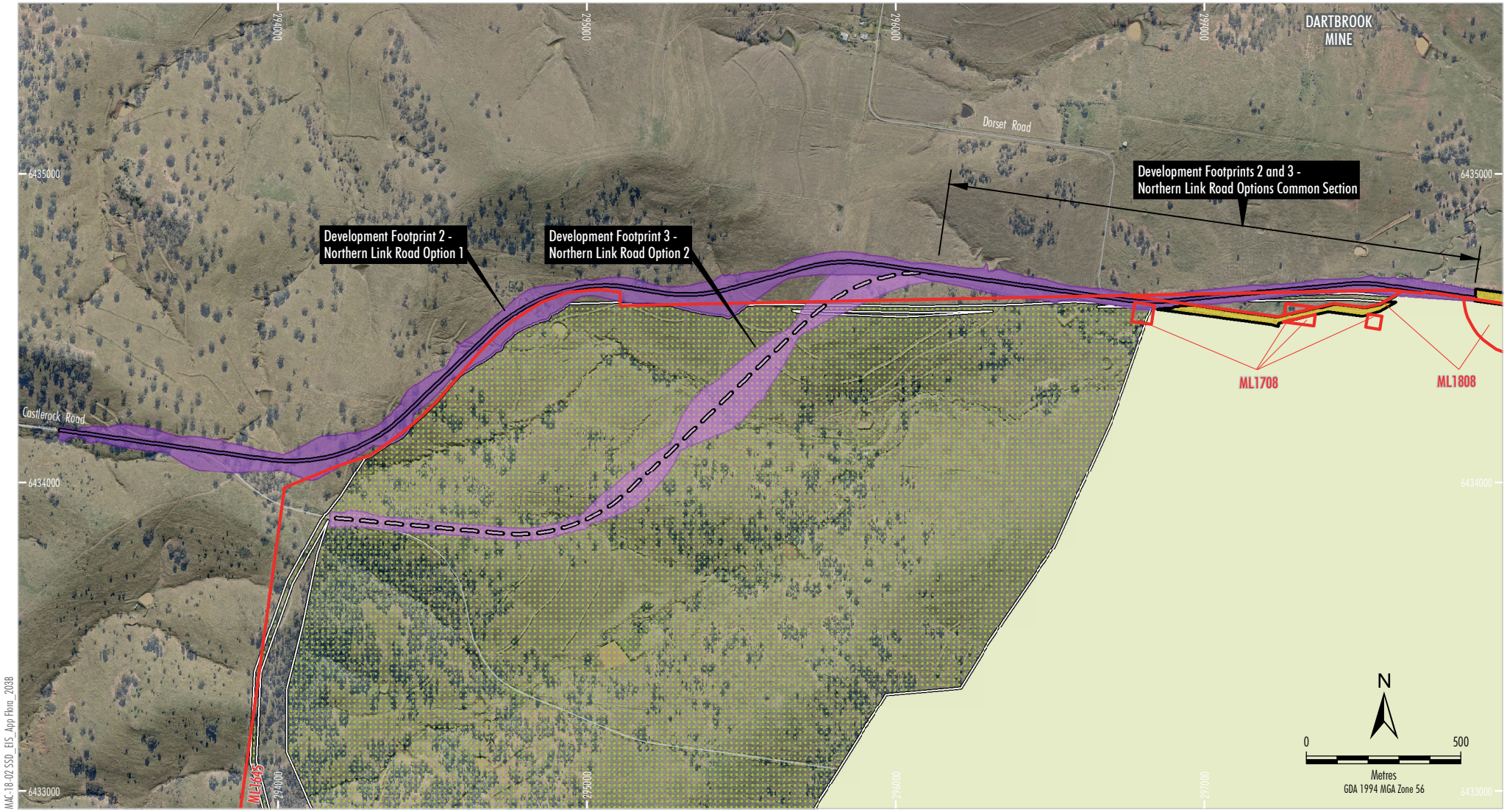
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement

Figure 2a



MAC-18-02 SSD_EIS_App Flora_203B

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- General Extension Areas [1]
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 1 Surface Development [3]
- Northern Link Road Option 2 Centreline
- Northern Link Road Option 2 Surface Development

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement
Inset

Figure 2b

- additional reject dewatering facilities to allow co-disposal of fine rejects with waste rock as part of ROM waste rock operations;
- development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability, and varying topographic relief to be more natural in exterior appearance;
- construction and operation of new ancillary infrastructure in support of mining;
- extension to the time limit on mining operations to 22 December 2048;
- an average operational workforce of approximately 600 people, with a peak of approximately 830 people;
- ongoing exploration activities; and
- other associated infrastructure, plant, equipment and activities.

Figures 2a and 2b show the Development Footprints associated with the Project.

2 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;
- target species, communities and populations listed as threatened under the NSW *Biodiversity Conservation Act, 2016* (BC Act) and/or the Commonwealth EPBC Act; and
- where threatened species are present, determine the number of individuals or area of habitat, which is used to calculate species credits.

The following methods, guidelines and policies were consulted in the methodology of this study:

- NSW *Biodiversity Assessment Method, 2017* (BAM) (Office of Environment and Heritage [OEH] 2017);
- *Surveying Threatened Plants and Their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (the Guide) (Department of Planning, Industry and Environment [DPIE] 2020g);
- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Department of Primary Industries, Office of Water 2012);
- *State Environmental Planning Policy* (Koala Habitat Protection) 2020; 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 Atlas* (DPIE 2020a);
- *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b);
- *BioNet Vegetation Classification* (DPIE 2020c);
- *PlantNET, The NSW Plant Information Network System* (Royal Botanic Gardens and Domain Trust [RBG] 2020);
- Commonwealth *Species Profile and Threats Database* (SPRAT) (Department of Agriculture, Water and the Environment [DAWE] 2020b); and
- *Atlas of Living Australia* (ALA) (ALA 2020).

3 REGIONAL SETTING

The Study Area is located in:

- Sydney Basin Bioregion, Hunter Subregion;
- Central Western Slopes Botanical Division;
- Hunter Local Land Service Region; and
- Muswellbrook Local Government Area (LGA).

4 DESCRIPTION OF THE STUDY AREA AND SURROUNDS

The Study Area size is approximately 1,687 hectares (ha) and consists of a mosaic of cleared grassland, woodland and other areas such as dams and infrastructure, with a majority of the area being cleared grassland (64%).

4.1 Landuse History

Agricultural industries within the wider locality include cattle grazing, horse breeding and viticulture. The land across the Study Area has been used for grazing of cattle and sheep for over 100 years. Figure 3 shows that the tree density was substantially lower back in 1953.

4.2 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 2016). The Study Area lies entirely within the Central Hunter Foothills landscape which is 75% cleared and is classified as an over-cleared landscape.

4.3 Topography and Drainage

The landform features a central multi-branched ridge system falling away in all directions. Maximum elevation is approximately 360 metres (m) Australian Height Datum (AHD) falling to approximately 200 m AHD. Topography across the Study Area is shown on Figure 4.

The study area is located in the Hunter River catchment, with the Hunter River approximately 2.7 km southeast of the study area, at its closest point. The following streams (all intermittent) occur in the study area and drain to the Hunter River:

- Rosebrook Creek drains the extreme eastern part of the study area and is a 3rd order stream downstream of Kayuga and Wybong Roads;
- An un-named stream drains to the north-east of Mount Pleasant across Castlerock and Dorset Roads and is a 4th order stream downstream of Dorset and Kayuga Roads;
- An un-named stream (commonly referred to as Dry Creek) formerly drained to the south of Mount Pleasant but is now captured and diverted as part of the Bengalla Mine Dry Creek Project; and
- Sandy Creek drains to the west and southwest of Mount Pleasant and is a 5th order stream downstream of Wybong Road.

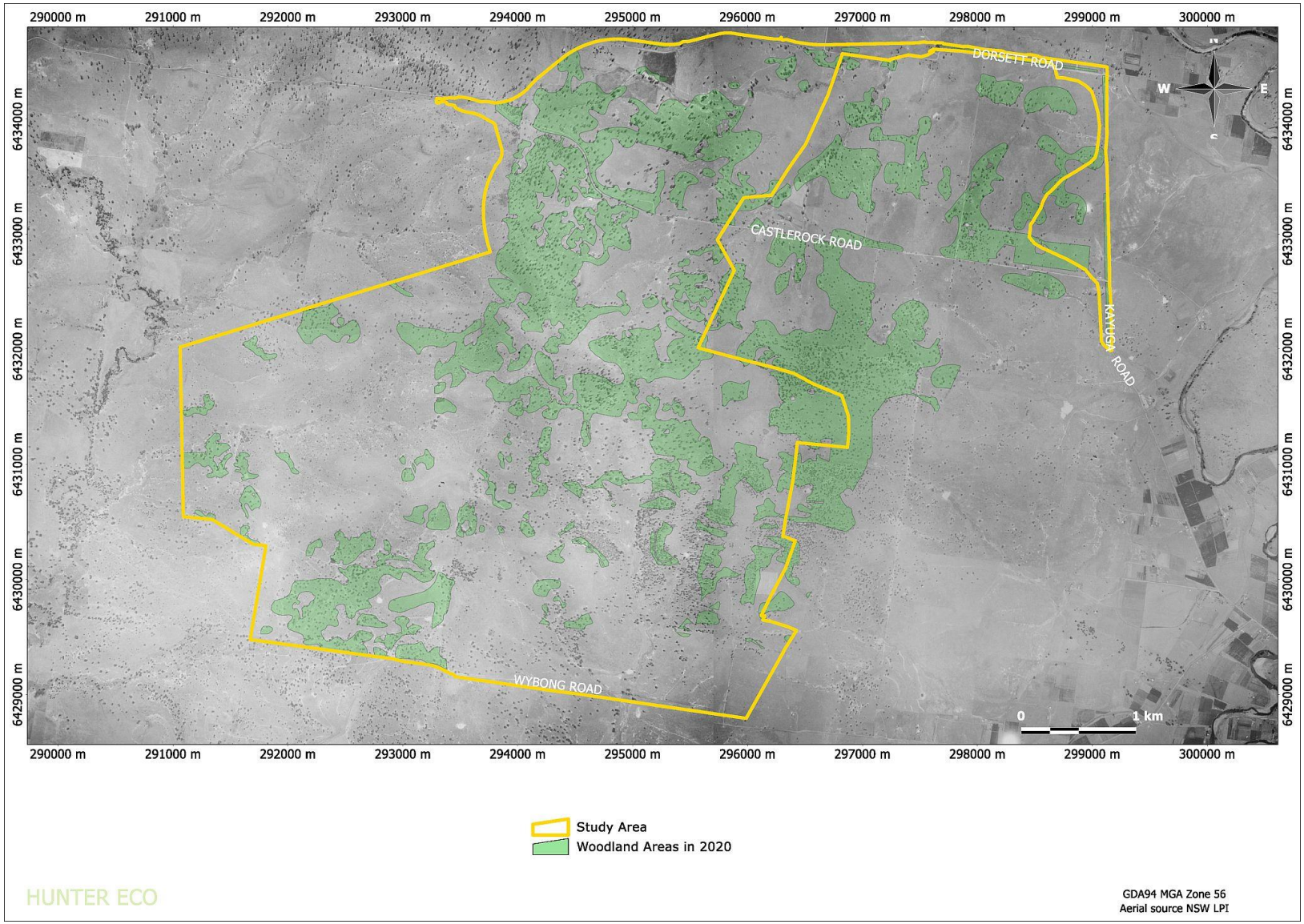


Figure 3: 1953 Aerial Image of the Study Area

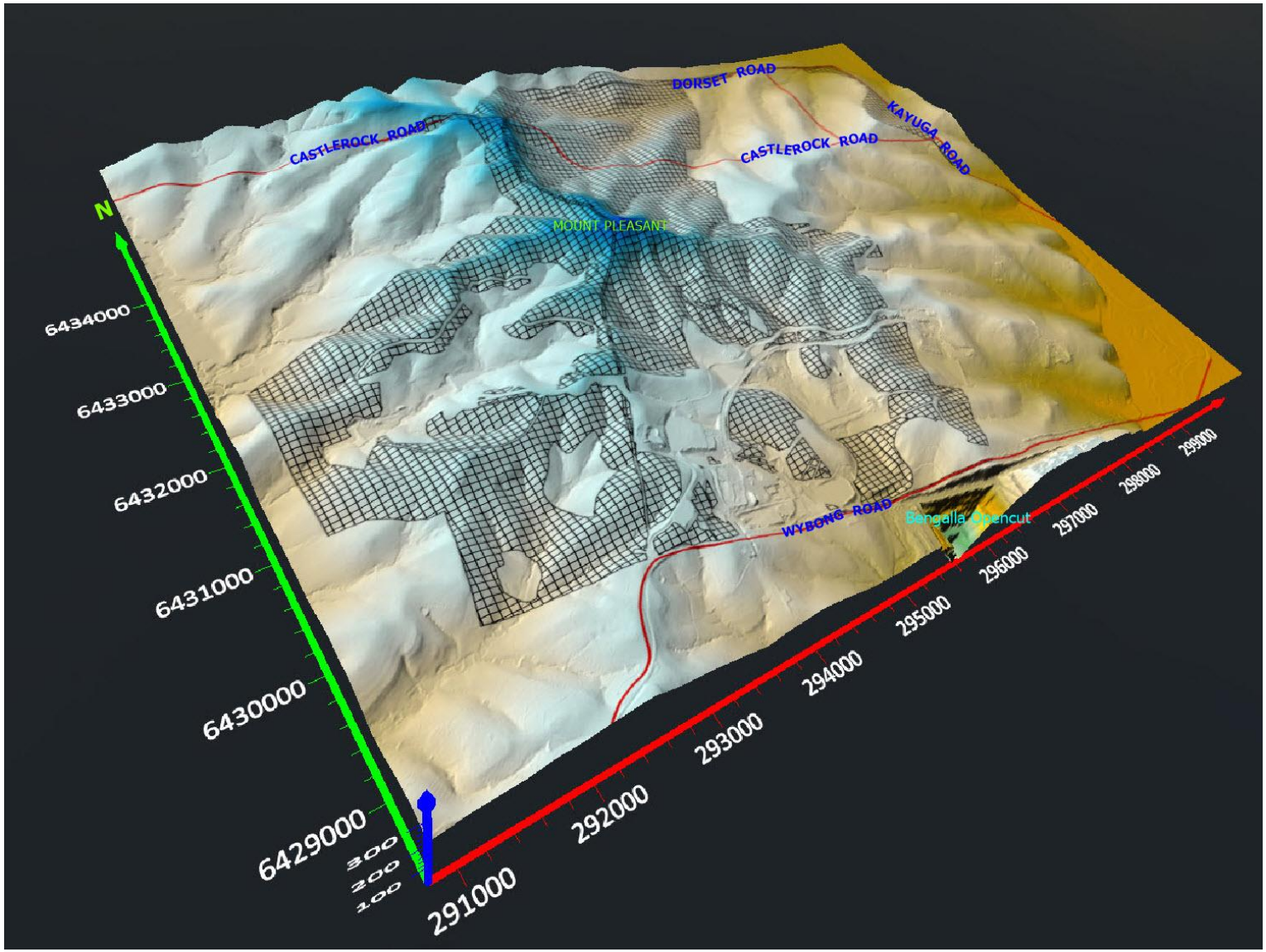


Figure 4: Topography Across the Study Area (Hatched)

All of these streams are fed by several small ephemeral creeks and drainage lines that originate in the Mount Pleasant ridgeline and spur complex. Dry for much of the year, these watercourses commonly only flow after large rain events.

4.4 Fire History

The *NSW Parks and Wildlife Service [NPWS] Fire History - Wildfires and Prescribed Burns* (DPIE 2020e) was searched for evidence of either wildfire or prescribed burns in or near the Study Area. No fires have been mapped in or near the Study Area with the nearest fire approximately 5 km to the south. The DPIE (2020e) records cover the time span from 1920 to May 2020. The lack of fire was also confirmed by discussion with a local landholder whose family has been there for three generations.

4.5 Geology and Soils

As expected for a coal-bearing area, the entirety of the Study Area is of Permian age, Sydney Basin Hunter Sequence, Singleton Supergroup with lithology of coal, claystone, siltstone, sandstone and tuff. The Australian Soil Classification (Isbell 2016) map shows the majority of the area to be Kurosols with some Vertosols in the northwest.

4.6 Climate

The Study Area is located in the 650 millimetre (mm) average annual rainfall band (Bureau of Meteorology [BoM] 1976 – 2005 [BoM 2020a]). Figure 5 shows the mean and highest monthly rainfall from the Spring Creek (Castle Vale) weather station (Site 61192) which is located approximately 8 km west of Mount Pleasant. Monthly minimum rainfall is not shown as it varied between 0 and 1 mm.

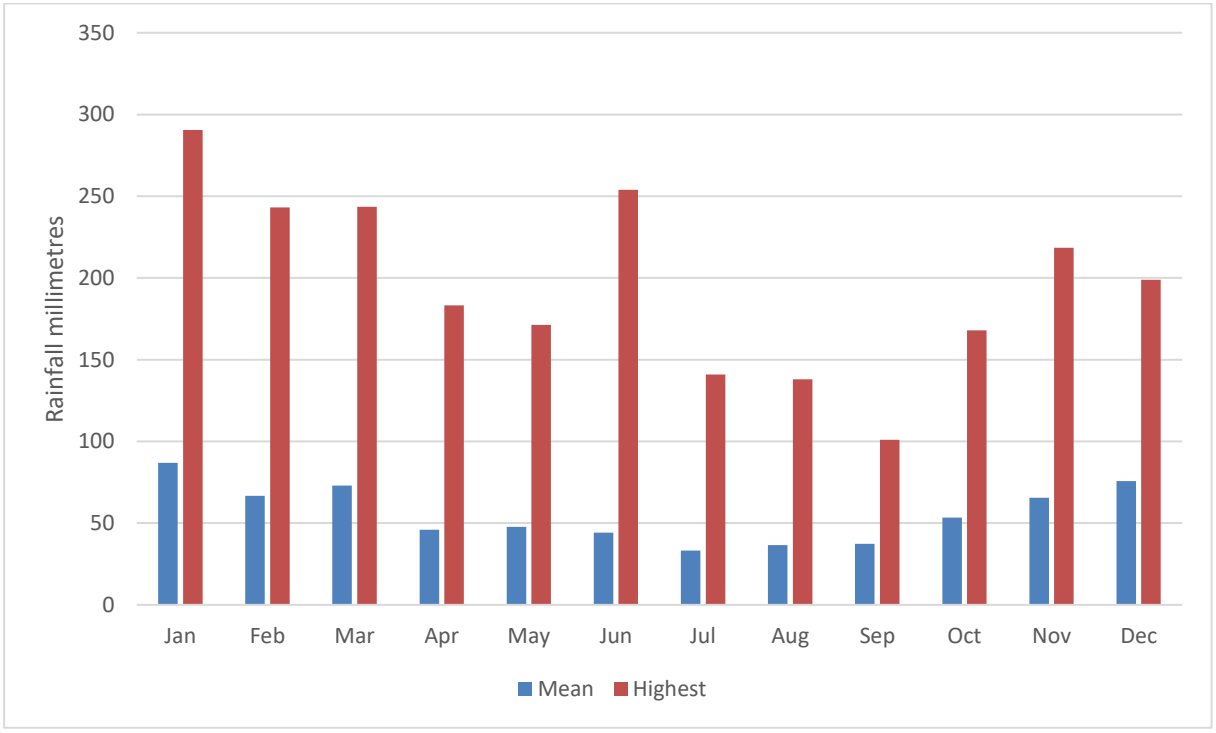


Figure 5: Long-term Average Monthly Rainfall at Spring Creek (Castle Vale)

Figure 6 shows the mean maximum and minimum monthly temperatures from the Scone Airport weather Station (Site 61363), the nearest station with long-term temperature records. A comparison of Figures 5 and 6 illustrates that the coolest months of the year during winter are also the driest months.

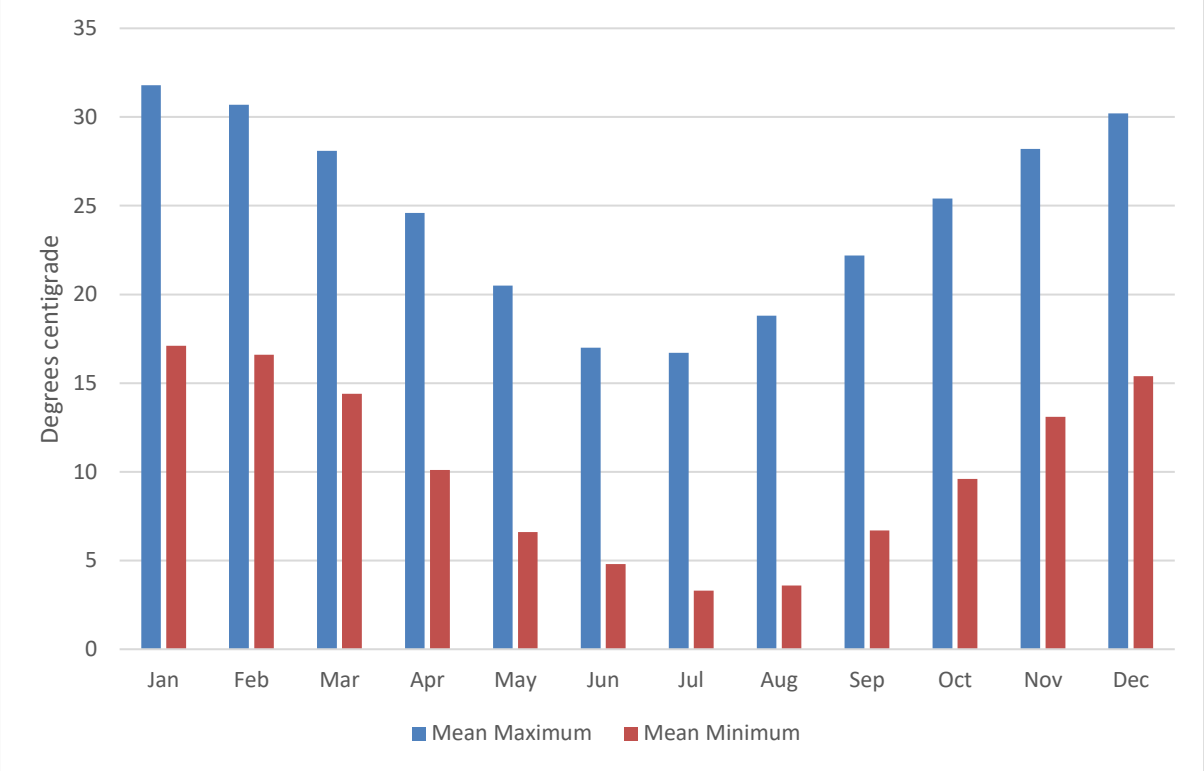


Figure 6: Long-term Monthly Average Maximum and Minimum Temperatures at Scone Airport

5 BACKGROUND INFORMATION

5.1 Regional Surveys

There are two regional vegetation classification and mapping surveys that include the Study Area:

- Greater Hunter Native Vegetation Mapping (GHM) (Sivertsen *et al*. 2011) which mapped 567 ha of vegetation in five communities in the Study Area; and
- Hunter Remnant Vegetation Project (HRVP) (Peake 2006) which mapped 289 ha of vegetation in one community in the Study Area.

Table 1 shows the dominant vegetation communities mapped by each of the above sources across the Study Area and the proportion of the total area of mapped vegetation.

Table 1: Vegetation Communities Mapped over the Study Area by Regional Studies

Vegetation Community	Area (ha)	Proportion*
Greater Hunter Vegetation Mapping (Sivertsen *et al*. 2011)		
White Box/ Sticky Daisy Bush/ Bead Bush shrubby woodland with semi-evergreen vine thicket elements of the Central Hunter Valley	121.2	0.22
Narrow-leaved Ironbark/ Grey Box/ Spotted Gum shrub/ grass open forest of the central and lower Hunter	12.9	0.02
Narrow-leaved Ironbark/ Native Olive shrubby open forest of the central and upper Hunter	80.4	0.15
Grey Box/ Grey Gum/ Rough-barked Apple/ Blakely's Red Gum grassy open forest of the central Hunter	4.2	0.01
Narrow-leaved Ironbark/ Grey Box grassy woodland of the central and upper Hunter	348.6	0.64
Total Mapped Area	**567.3**	**1.04**
Hunter Remnant Vegetation Project (Peake 2006)		
Upper Hunter White Box - Ironbark Grassy Woodland	289	0.53

*The proportion of the total vegetation area mapped in the Study Area for this Project (544 ha).

5.2 Local Surveys

Several flora surveys have been conducted across the study area and surrounds (Table 2).

Table 2: Summary of Ecology Reports from the Immediate Region of, and Including, the Study Area

Report	Year	Content
Mount Pleasant Mine Environmental Impact Statement (ERM 1997).	1994 - 1997	Flora, vegetation communities and fauna.
Proposed Mount Pleasant Open Cut Mine – Flora and Fauna Assessment (Cumberland Ecology 2006).	Nov-06	Flora and Fauna Assessment, 11 floristic plots, targeted flora survey.
Mount Pleasant Mine: Survey Analysis of Box-Gum Woodland (Cumberland Ecology 2007a).	May-07	Survey and Analysis of Box-Gum Grassy Woodland.
Mount Pleasant: Ecology Gap Analysis Report (Cumberland Ecology 2007b).	Oct-07	Ecology Gap Analysis Report, 68 floristic plots within the project area,

Report	Year	Content
		15 in the wider locality, targeted flora survey.
Mount Pleasant Project - Flora and Fauna Report (Cumberland Ecology 2009).	Summer 08/09	Flora and Fauna Report, 14 20 x 50 m quadrats, random meander, transects, targeted threatened flora surveys.
Mount Pleasant Project Modification Ecological Assessment (Cumberland Ecology 2010).	2010	Description of ecological values. Flora, vegetation and fauna. Six floristic plots, targeted threatened flora surveys.
Mount Pleasant Upper Hunter Strategic Assessment BCAM Project. Biodiversity Assessment Report (Cumberland Ecology 2015).	2015	Flora and vegetation surveys.
Mount Pleasant Operation - Mine Optimisation Modification Environmental Assessment, Biodiversity Assessment (Hunter Eco 2017a).	2017	Flora and vegetation surveys.
Mount Pleasant Operation Rail Modification, Terrestrial Ecology Assessment (Hunter Eco 2017b).	2017	Flora and vegetation surveys.

The previous mapping in the study area was undertaken by Cumberland Ecology (2010). Since 2010, the vegetation survey methodology and vegetation classification system has changed in NSW. Therefore, this survey by Hunter Eco has produced a more contemporary vegetation map for the Study Area.

6 METHODS

Collection of Rapid Data Points (RDPs) (see Section 6.2) was conducted by Dr Colin Driscoll of Hunter Eco who has been conducting biodiversity surveys in the Hunter Valley since the 1980s. Collection of floristic plot and transect data was conducted by Dr Colin Driscoll and Dr Stephen Bell of Eastcoast Flora Survey. Dr Bell has been conducting flora surveys in the Hunter region since 1990. Table 3 shows the survey days, and on all occasions the weather was warm and mostly dry.

Table 3: Floristic Survey Days

Date	Activity	Date	Activity	Date	Activity
9-Jul-18	RDP	19-Nov-19	Orchid survey	24-Apr-20	Floristic Plots
10-Jul-18	RDP	23-Mar-20	Floristic Plots	29-Apr-20	Floristic Plots
11-Jul-18	RDP	24-Mar-20	Floristic Plots	13-May-20	Floristic Plots
12-Jul-18	RDP	25-Mar-20	Floristic Plots	14-May-20	Floristic Plots
13-Jul-18	RDP	27-Mar-20	Floristic Plots	15-May-20	Floristic Plots
23-Jul-18	RDP	31-Mar-20	Floristic Plots	16-Nov-20	Threatened species targeted surveys
24-Jul-18	RDP	2-Apr-20	Floristic Plots	17-Nov-20	Threatened species targeted surveys
25-Jul-18	RDP	6-Apr-20	Floristic Plots	18-Nov-20	Threatened species targeted surveys
26-Jul-18	RDP	7-Apr-20	Floristic Plots	19-Nov-20	Threatened species targeted surveys
27-Jul-18	RDP	8-Apr-20	Floristic Plots	20-Nov-20	Threatened species targeted surveys
27-Aug-18	RDP	9-Apr-20	Floristic Plots	25-Nov-20	Threatened species targeted surveys
2-Oct-19	Orchid survey	20-Apr-20	Floristic Plots	7-Dec-20	Threatened species targeted surveys
3-Oct-19	Orchid survey	21-Apr-20	Floristic Plots	9-Dec-20	Threatened species targeted surveys
18-Nov-19	Orchid survey	23-Apr-20	Floristic Plots	11-Dec-20	Threatened species targeted surveys

6.1 Identifying Native Plant Community Types

PCTs are described in the *BioNet Vegetation Classification* (DPIE, 2020c). The PCTs in the Study Area were identified by comparing the floristic composition recorded in the field with PCT descriptions provided in *BioNet Vegetation Classification* (DPIE, 2020c). 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 (TECs) 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 (2008) and further elaborated in Bell and Driscoll (2020). 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 RDPs and provide an understanding of floristic variation across the Study Area (a total of 3,214 RDPs were sampled in the Study Area [Figure 7]);
- 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[2] 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.

The BAM (OEH 2017) defines derived vegetation as:

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) …*

Using an aerial photograph, the Study Area was divided into woodland and derived native grassland areas based on the observed tree canopy density with derived grassland areas having severely reduced canopy cover. Ultimately these woodland and grassland areas were subdivided into PCT coverage.

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 conservative 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.

[2] Braun-Blanquet was not used to record the foliage cover score for a growth form group.

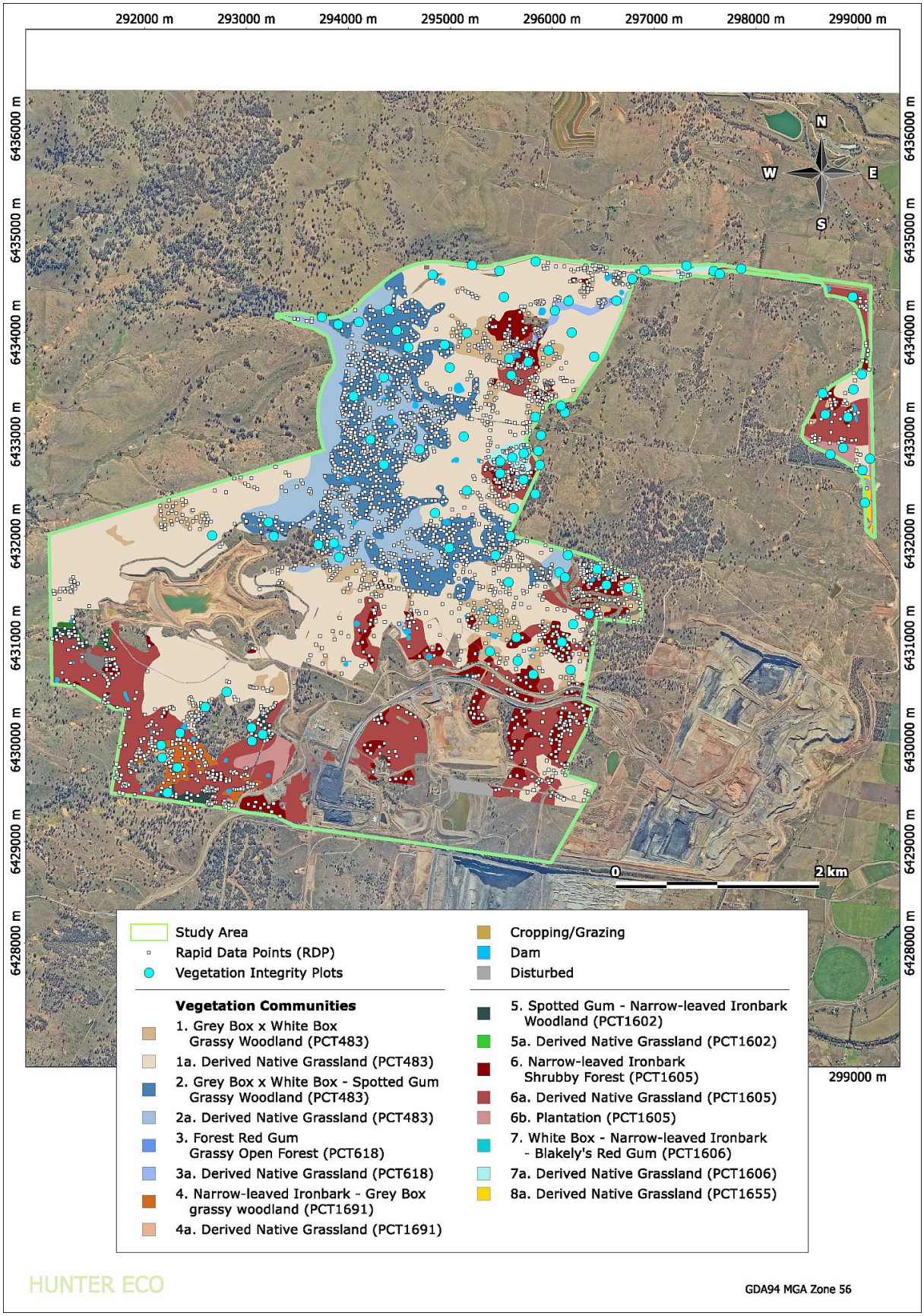


Figure 7: Rapid Data Points and Vegetation Integrity Plots

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 2015). Primer 7 was also used for similarity percentage analysis which calculates the relative contributions of individual species to a community.

6.2 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.

A total of 96 Vegetation Integrity Plots were sampled in the Study Area (Figure 7). 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 (DPIE 2020f);
- 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, exotic high threat exotic (DPIE 2020d; DPIE 2020f)

The following data were collected in the 20 m x 50 m plot:

- a record of the number of large trees[3], tree stem size class, tree regeneration[4], length of fallen logs[5], 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[6] 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.

---

[3] The number of large trees is a count of all living stems with a DBH equal to or greater than the large tree benchmark for the relevant PCT.

[4] Regeneration is based on the presence or absence of living trees with stems <5 cm DBH (OEH 2017).

[5] Total length in m of all woody material greater than 10 cm in diameter that is dead and entirely or in part on the ground (OEH 2017).

[6] 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).

6.3 Threatened Ecological Communities

TEC records from within 20 km of the Study Area were extracted from the BioNet Atlas (DPIE 2020a). TECs listed under the EPBC Act predicted to occur were also extracted using the Commonwealth *Protected Matters Search Tool* (DAWE 2020a). 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 (DPIE 2020d and DAWE 2020b).

Table 4 provides a list of TEC extracted from the BioNet Atlas (DPIE 2020a). Table 4 also includes TEC from the Commonwealth *Protected Matters Search Tool* (DAWE 2020a).

Table 4: Threatened Ecological Communities Possibly Occurring Within 20 km of the Study Area

Community Name (BC Act)	Conservation Status[1]		Likelihood of Occurring[2]
	BC Act	EPBC Act	
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	E	CE[A]	Present (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[A]	Absent.
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	V	Out of range, does not occur in the Muswellbrook LGA.
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. The Project is not on a coastal floodplain.
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	E	-	Absent. No *Eucalyptus camaldulensis* (River Red Gum) and the Project is not on a major floodplain.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	E	-	Absent. *Eucalyptus tereticornis* not present in combination with *Eucalyptus punctata* (Grey Gum), *Angophora costata* (Smooth-barked Apple), *Corymbia maculata* (Spotted Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark) or *Eucalyptus moluccana* (Grey Box).
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	V	CE[A]	Absent. No Slaty Gum woodland present.
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions	E	-	Absent - no Vine Thicket.
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	CE	CE	Absent. No *Acacia pendula* (Weeping Myall).
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	CE	Out of range, does not occur in the Muswellbrook LGA. No littoral habitat.
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	E	-	Absent - no *Eucalyptus fibrosa* (Red Ironbark).
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	V	-	Absent - no rainforest.

Community Name (BC Act)	Conservation Status[1]		Likelihood of Occurring[2]
	BC Act	EPBC Act	
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E	CE	Absent – no lowland rainforest habitat.
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.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	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	-	Absent. 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	CE	Out of range, does not occur in the Muswellbrook LGA.
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	CE[B]	Present (Cumberland Ecology 2015; Hunter Eco this report).

[1] Conservation status under the BC Act and/or EPBC Act. CE = Critically Endangered; E = Endangered; V = Vulnerable.

[2] Likelihood of occurring was assessed against information provided in the DPIE (2020d) *NSW Threatened Species Scientific Committee Final Determinations* and DAWE (2020b) SPRAT.

[A] Central Hunter Valley Eucalypt Forest and Woodland.

[B] White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

6.4 Endangered Populations

Table 5 shows the endangered populations extracted from the *BioNet Atlas* (DPIE 2020a).

Table 5: Endangered Populations

Endangered Population	PCT Association	Likelihood of Occurrence
Acacia pendula population in the Hunter Catchment	1605, 1606, 1655, 1691	Absent, no *Acacia pendula* recorded.
Cymbidium canaliculatum population in the Hunter Catchment	1605, 1606, 1655, 1691	Present (Cumberland Ecology 2007b; DPIE 2020a; Hunter Eco this report).
Eucalyptus camaldulensis population in the Hunter Catchment	None	Absent, no *Eucalyptus camaldulensis* recorded.
Pine Donkey Orchid population in the Muswellbrook LGA	1606, 1655, 1691	Unlikely, *Diuris tricolor* (Pine Donkey Orchid) has not been recorded in any survey from 1997 to 2019.

Targeted surveys for the *Acacia pendula population in the Hunter Catchment* (which is also listed as a TEC 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* (Tiger Orchid) and *Diuris tricolor* are components of the endangered populations *Cymbidium canaliculatum population in the Hunter Catchment* and *Pine Donkey Orchid population in the Muswellbrook LGA,* respectively. As such, targeted surveys for these endangered populations were undertaken during the threatened flora surveys as detailed in Section 6.5.

Figure 8 shows the location of the one flora species, *Cymbidium canaliculatum*, representing an endangered population that has previously been recorded in the Study Area. Two records were from Cumberland Ecology (2007b, referenced in Cumberland Ecology 2015). One record from DPIE (2020a) is misleading in its exact location as the location has been denatured to a position on a 1 km grid. The DPIE (2020a) record is likely to be one of the Cumberland Ecology records submitted to the *BioNet Atlas*. All of these locations were inspected during the current survey to confirm their presence/absence and identity.

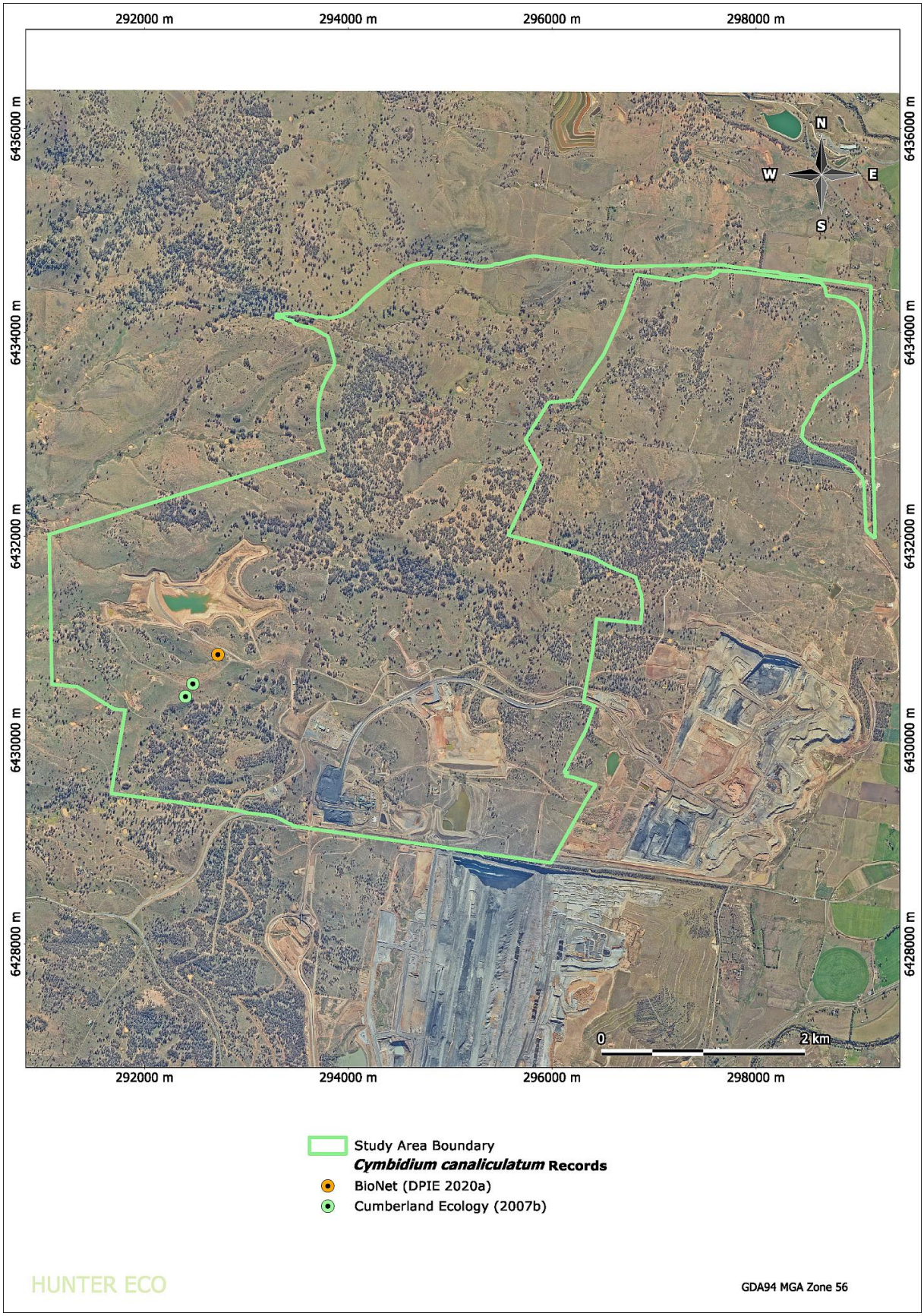


Figure 8: Location of Previously Recorded Flora Species Representative of Endangered Populations

6.5 Threatened Flora Species

To establish a candidate list of threatened species to target (Table 6), 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* (DPIE 2020a);
- threatened flora species predicted to occur in the Commonwealth *Protected Matters Search Tool* (DAWE 2020a);
- threatened flora species records from the Study Area (Cumberland Ecology 2015); and
- threatened flora species listed in the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b) as associated with the various PCTs likely to occur in the Study Area.

These species were evaluated for their likelihood of occurring based on known habitat preferences as described in PlantNET (RBG 2020) and the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b) (Table 6) and any geographic constraints (Table 7).

Despite a number of previous targeted and general surveys, no terrestrial orchid species have been recorded within the Mount Pleasant Operation MLs. However, further detailed targeted and opportunistic surveys were conducted. The shaded month in Table 6 is the month in which targeted surveys were undertaken for the relevant species.

2019 Orchid Surveys

Surveys were conducted from 1 October 2019 to 3 October 2019 during which the weather was mild, clear and dry with light breeze. The surveys were conducted by Dr Colin Driscoll (Hunter Eco) assisted by Garon Staines (Future Ecology).

A total of 33 km of random meander were searched for *Diuris tricolor*, and any other terrestrial orchid species across the Study Area. Through the open grassy ground cover, visibility was 20 m either side of the meander transect which amounts to having surveyed 148 ha (Figure 9).

At the time, Muswellbrook area along with a large portion of NSW was undergoing a prolonged rainfall deficit which is reflected in generally sparse, dry groundcover. Consequently, the majority of the survey areas did not appear suitable for these orchids.

2019 Tree Orchid Surveys

One arboreal orchid species was considered to potentially occur prior to the survey, namely *Cymbidium canaliculatum* (Endangered Population under the BC Act). As described earlier in this section, the primary survey method for development of a vegetation map was the collection of RDPs where individual trees were identified and their location geographic coordinates recorded (Section 6.1). Over 3,200 trees were recorded in this manner (Figure 7) and *Cymbidium canaliculatum* individuals were recorded (Figure 8).

2020 Threatened Species Surveys

In October, November and December 2020, targeted surveys for threatened species were undertaken in accordance with the Guide (DPIE 2020g) within the Development Footprints (Figures 2a, 2b and 10). The Guide (DPIE 2020g) requires surveys to be conducted along parallel transects with spacing varying according to the life form of the target species. Where a group of species is to be included in the search of a PCT, the transect spacing is the minimum required within that group.

Table 6: Threatened Flora Species Potentially Occurring in the Study Area and Associated Seasonal Detectability

Family Name	Scientific Name	Common Name	Conservation Status[1]		BioNet Atlas (DPIE 2020a)	PMST (DAWE 2020a)	PCT Association (DPIE 2020b)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
			BC Act	EPBC Act															
Apocynaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E	-	-	1606	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asteraceae	*Ozothamnus tesselatus*	-	V	V	-	-	1606, 1655[B]	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Euphorbiaceae	*Monotaxis macrophylla*	Large-leafed Monotaxis[A]	E	-	-	-	483, 1602 1605, 1606	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Fabaceae (Mimosoideae)	*Acacia pendula*	Weeping Myall (*Acacia pendula* population in the Hunter Catchment)	EP	-	✔	-	1655, 1691, 1605, 1606	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lamiaceae	*Prostanthera cineolifera*	Singleton Mint Bush	V	V	-	-	1655[B]	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Lamiaceae	*Prostanthera cryptandroides* subsp. *cryptandroides*	Wollemi Mint-bush	V	V	-	-	1655[B]	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Myrtaceae	*Eucalyptus glaucina*	Slaty Red Gum	V	V	-	-	1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Myrtaceae	*Eucalyptus pumila*	Pokolbin Mallee	V	V	-	-	1655[B]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Orchidaceae	*Pterostylis chaetophora*	-	V	-	-	-	1602, 1691	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	-	-	1606, 1655[B]	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes
Orchidaceae	*Diuris tricolor*	Pine Donkey Orchid (population in the Muswellbrook LGA)	V, EP	-	✔	-	1606, 1655, 1691	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Orchidaceae	*Cymbidium canaliculatum*	Tiger Orchid (*Cymbidium canaliculatum* population in the Hunter Catchment)[C]	EP	-	✔	-	483[D], 1655, 1605, 1606, 1691	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Family Name	Scientific Name	Common Name	Conservation Status[1]		BioNet Atlas (DPIE 2020a)	PMST (DAWE 2020a)	PCT Association (DPIE 2020b)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
			BC Act	EPBC Act															
Orchidaceae	*Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong)	Tarengo Leek Orchid	E	E	-	✔	1606, 1655, 1691	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Rhamnaceae	*Pomaderris bodalla*	Bodalla Pomaderris	V	-	-	-	1606	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Rhamnaceae	*Pomaderris queenslandica*	Scant Pomaderris	E	-	-	-	1605, 1606, 1655[B]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rhamnaceae	*Pomaderris reperta*	Denman Pomaderris	CE	CE	-	-	1655[B]	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Santalaceae	*Thesium australe*	Austral Toadflax	V	V	✔	✔	1606, 1655	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes

Note: Months in which surveys for the species are to be conducted in accordance with the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b) 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 December 2020). CE = Critically Endangered; E = Endangered; EP = Endangered Population; V = Vulnerable.

A *Monotaxis macrophylla* (Large-leafed Monotaxis) can be excluded as a target species because it is a known fire ephemeral only appearing for a few months following fire, and there have been no fires in the Subject land in living memory (DPIE 2020e).

B A habitat assessment was undertaken and this species is not considered to be associated with the DNG form of any PCT. PCT 1655 only exists as DNG within the Study Area.

C Habitat constraint as per the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b): Epiphytic in a range of eucalypts and Angophora; Fallen/standing dead timber including logs, cut stumps or logs on ground.

D *Cymbidium canaliculatum* is not associated with this PCT as per the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b) but has previously been recorded in the Study Area in associated trees (Cumberland Ecology 2015).

Table 7: Threatened Flora Species Not Associated with Any PCT Mapped for the Study Area and/or Excluded by Geographic Constraints

Family Name	Scientific Name	Common Name	Conservation Status[1]		BioNet Atlas (DPIE 2020a)	PMST (DAWE 2020a)	Associated with PCTs in the Study Area	Geographic Constraint
			BC Act	EPBC Act				
Malvaceae	*Lasiopetalum longistamineum*[A]	-	V	V	-	-	No	Not listed for the Hunter Subregion
Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	✔	-	No	Not listed for the Sydney Basin Bioregion
Orchidaceae	*Pterostylis gibbosa*	Illawarra Greenhood	E	E	-	✔	No	-
Orobanchaceae	*Euphrasia arguta*	-	CE	CE	-	✔	No	Not listed for the Sydney Basin Bioregion

[1] Threatened species status under the BC Act and/or EPBC Act (current as at December 2020). CE = Critically Endangered; E = Endangered; V = Vulnerable.

[A] Habitat constraint as per the *BioNet Threatened Biodiversity Data Collection* (DPIE 2020b): Enriched alluvial gullies or within 200 m.

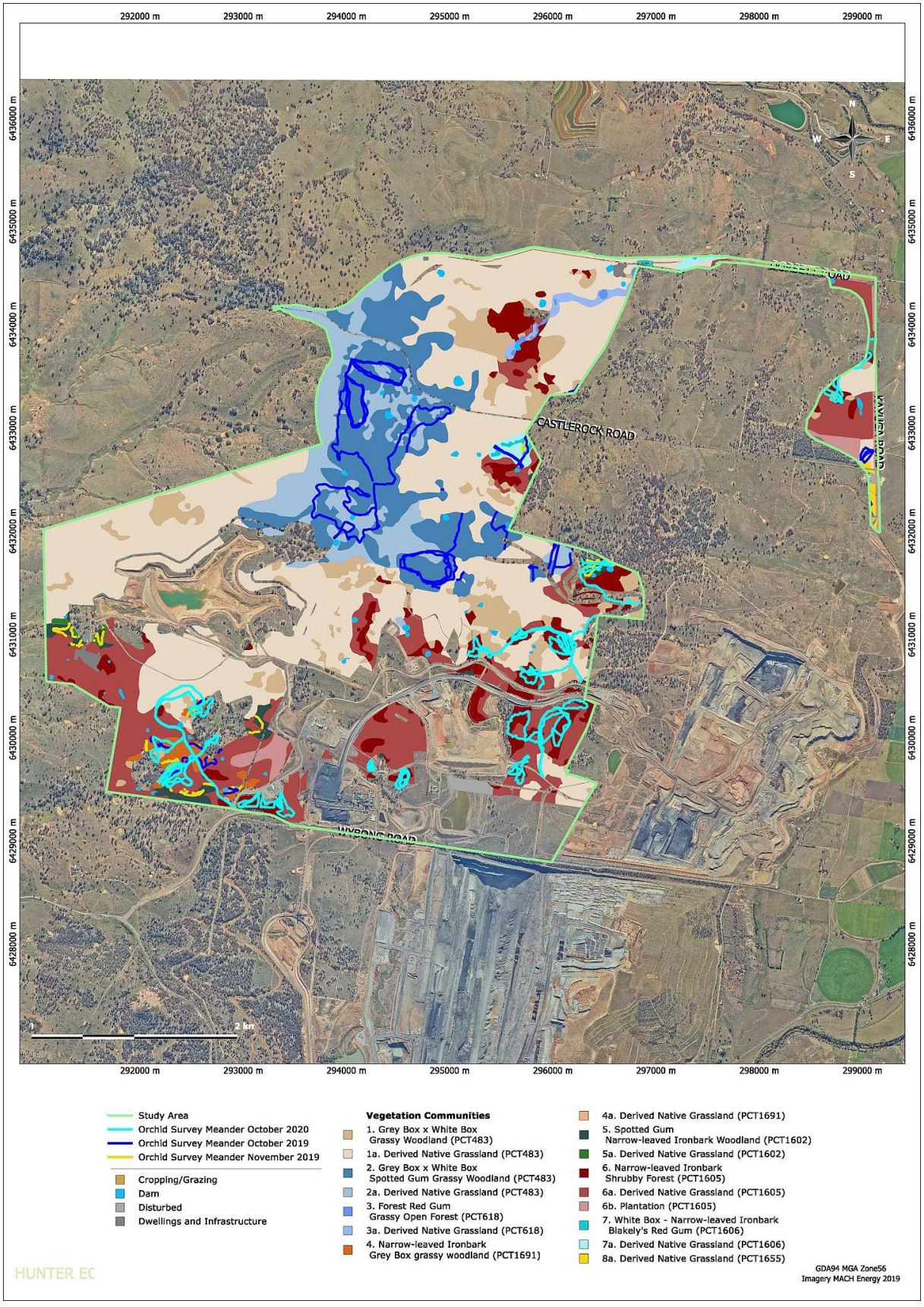


Figure 9: Orchid Survey Meander Tracks 2019 and 2020

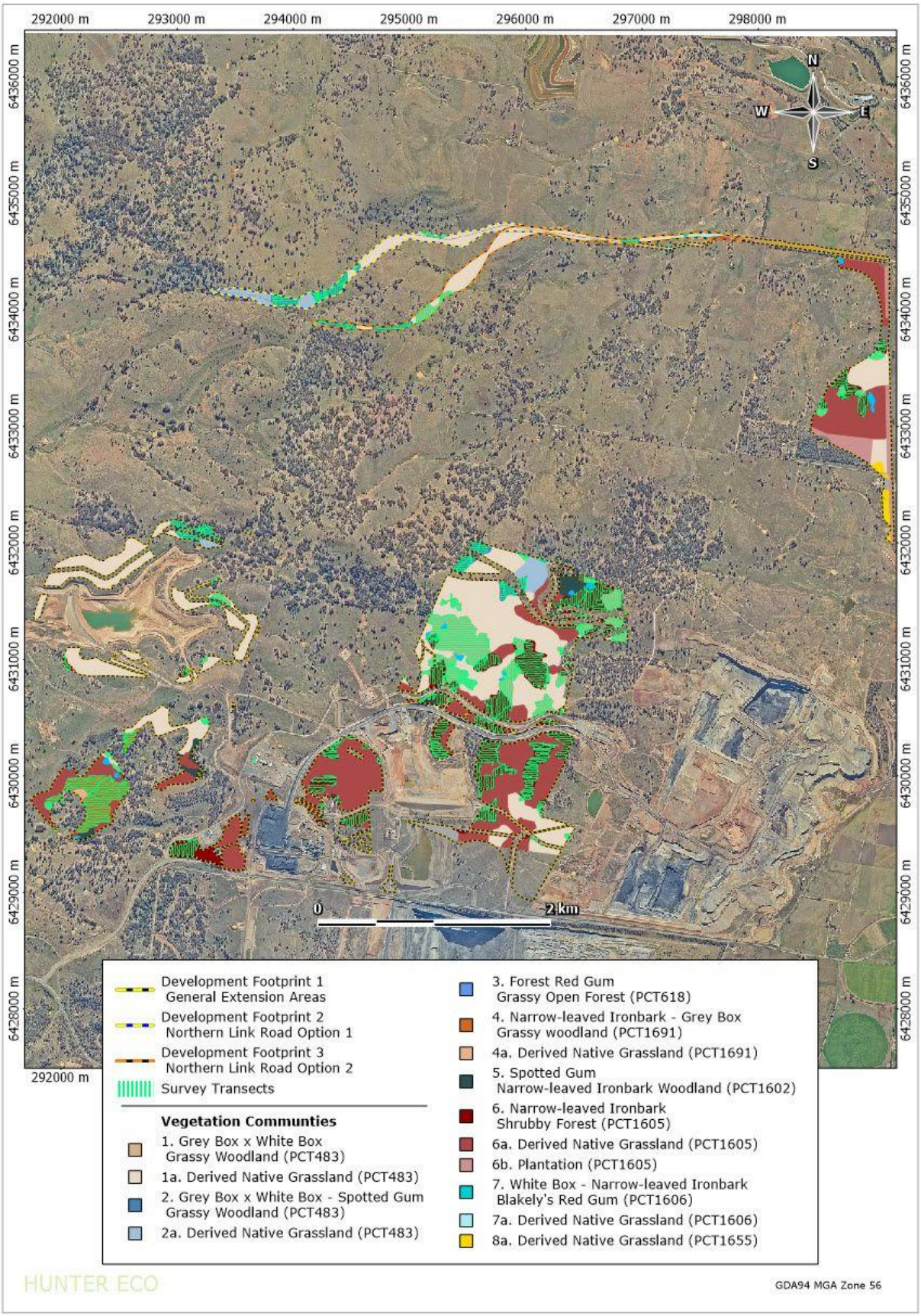


Figure 10: Threatened Flora Survey Transects

A random meander survey specifically targeting *Diuris tricolor* and *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) (Tarengo Leek Orchid) was conducted on 1 and 2 October 2020 through PCTs 1605 and 1691 (Figure 9).

PCTs 483, 1605, 1606 and 1691 were surveyed using 20 m transects in November and December 2020, targeting threatened shrubs, herbs and *Cymbidium canaliculatum* (Figure 10). The threatened herb *Thesium australe* (Austral Toadflax) is generally associated with patches of *Themeda triandra* (Kangaroo Grass). No *Themeda triandra* was recorded during surveys across the study area, and particularly in PCTs 1606 and 1655 with which *Thesium australe* is associated. Therefore, no targeted surveys were conducted for *Thesium australe.*

Surveys were also conducted with consideration of previously unrecorded threatened species potentially being present. In other words, all threatened flora species were targeted irrespective of habitat suitability or likelihood of occurring. All flora species encountered were positively identified, so it is unlikely that any potential occurrence of a species which was not expected to occur was misidentified (and therefore not recorded).

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 undertaken 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 as per the Guide (DPIE 2020g) to estimate overall distribution and density via extrapolation.

6.6 Koala Habitat Protection SEPP

In consideration of *State Environmental Planning Policy (Koala Habitat Protection) 2020* (Koala Habitat Protection SEPP), this report documents the tree species composition of each PCT and the presence and abundance of Koala tree species within each mapped PCT. This was accomplished through Quadrats (20 x 20 m) selected randomly within each PCT and the RDP procedure (Section 6.1) in which dominant canopy trees were identified at 3,214 locations throughout the Study Area.

Potential koala habitat means areas of native vegetation where trees of the types listed in Schedule 2 of the Koala Habitat Protection SEPP constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

Assessment for evidence of Koala presence across the Study Area was conducted by Future Ecology (2020) and no Koalas were found.

6.7 Groundwater Dependent Ecosystems

There are two types of Groundwater Dependent Ecosystem (GDE) relevant to terrestrial ecosystems: 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.

Depth to water is an important consideration for identifying potential GDEs, 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 5 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) with facultative vegetation tolerant of this variability. Thus, GDEs may be present at times when groundwater investigations do not detect any or few aquifers.

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 2020b), which provides a model of potential GDE across Australia, was consulted for the Hunter catchment. The GDE Atlas (BoM 2020b) provides modelled distribution of Aquatic, Terrestrial and Subterranean GDE. Figure 11 shows an extract from the GDE Atlas for the Study Area that indicates vegetation potentially dependent on terrestrial groundwater but rated as low potential 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 assist with the assessment a Topographic Wetness Index model (Conrad *et al*. 2015) was prepared that simulates increasing soil moisture as a result of downslope flow from rainfall. Figure 11 also shows Topographic Wetness and that the moist areas with potential for GDE occur along drainage lines flowing north east. The GDE Atlas includes these areas but also includes areas along dry ridges, unlikely to support groundwater dependent vegetation.

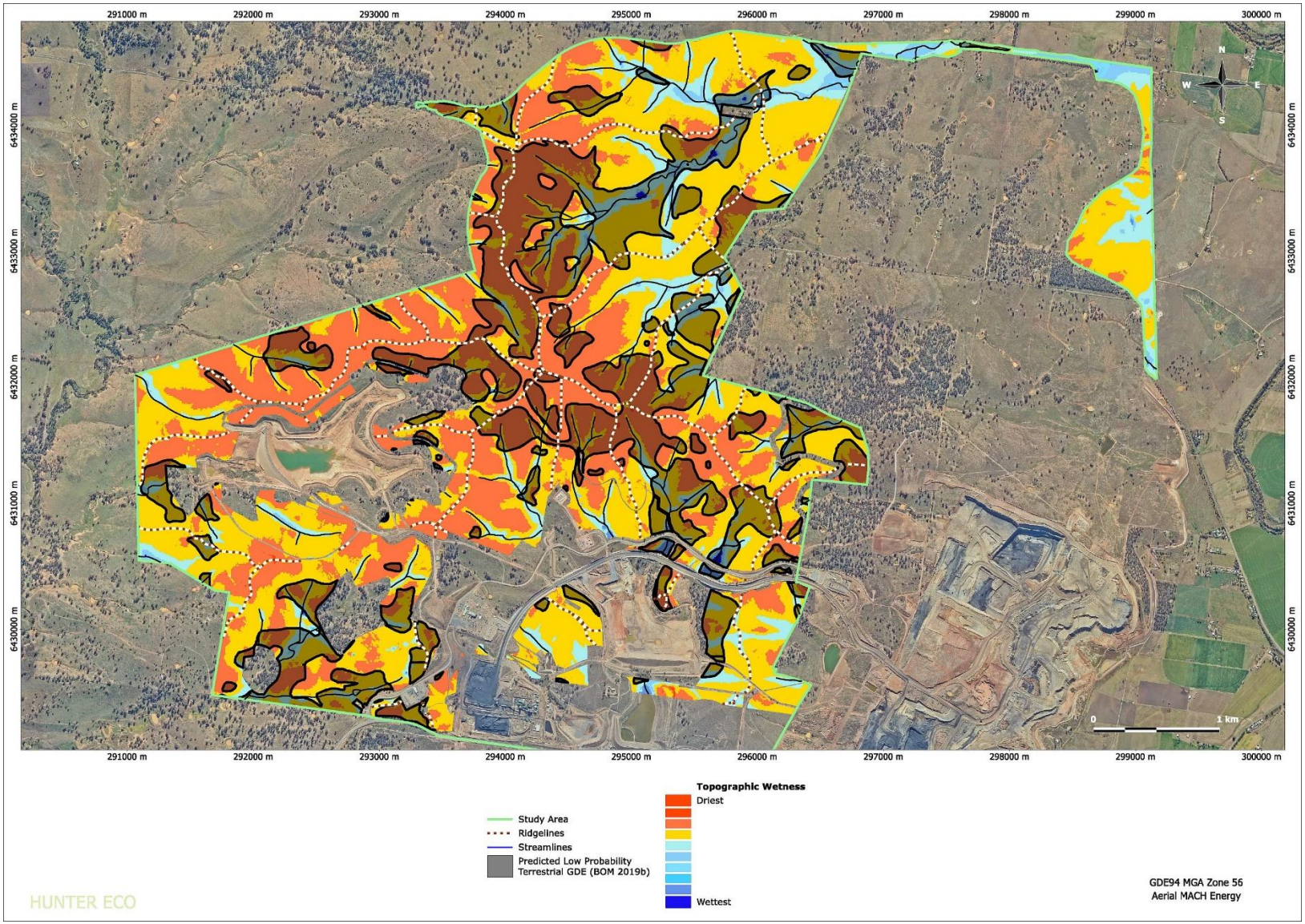


Figure 11: GDE Atlas Low Probability Terrestrial GDEs and Topographic Wetness Index Model Output

6.8 Limitations

A limitation was the absence of recent, or any, fire that would facilitate the discovery of *Monotaxis macrophylla* (if present). This species is fire ephemeral, only growing for a few months after fire.

As described in Section 4.4, no fires have been mapped in or near the Study Area (DPIE, 2020e). The DPIE (2020e) records cover the time span from 1920 to May 2020. The lack of fire was also confirmed by discussion with a local landholder whose family has been there for three generations.

This species is also reported as growing on rocky ridges and hillsides (DPIE 2020b), which are not present in the study area. Given the lack of fire and potentially suitable habitat, it is considered unlikely for this species to be present in the study area (even if a fire were to occur in the future).

7 RESULTS

7.1 Generic Communities

Initially, a heuristic assessment of likely discrete vegetation assemblies was made using the data from 3,214 RDP collected across the Study Area. The assessment was primarily based on the grouping of dominant canopy species and these groups were referred to as generic communities. These generic communities were then assigned to the most appropriate PCT and mapped across the Study Area. The BAM (OEH 2017, section 5.2.1.5) requires that derived grassland is assigned to the most likely PCT existing prior to clearing. Areas of derived grassland were assigned a PCT based on paddock tree species and adjoining woodland types. Floristic sample plots (Section 6.2) were randomly placed in these communities.

7.2 Floristic Plot Data Analysis

Plot data were analysed in Primer 7 (Clarke and Gorley 2015) using similarity analysis whereby plots were grouped according to the degree of similarity in their floristic content. The plot data consisted of 96 plots from the Study Area augmented by an additional 30 plots collected from across existing approved (but not yet disturbed) mine areas in order to provide wider context. Preliminary analysis showed that weeds were distributed randomly across the Study Area with no association with any Generic Communities, either woodland or grassland. Weeds were then excluded from further analysis with only native species included.

Similarity analysis of both woodland and grassland generic communities using hierarchical agglomerative clustering and non-metric multidimensional scaling did not result in clear separation of these or any distinct alternative groups.

Further analysis was conducted using the ANOSIM (analysis of similarities) module in Primer 7 to test whether there were significant differences between overall floristic content of the generic communities for woodland and grassland separately. The outcome was that no significant difference could be detected between grassland generic communities indicating that grassland had effectively the same floristic composition across the Study Area.

However, there was a significant difference between woodland generic communities and further analysis was justified. This was conducted in Primer 7 using the bootstrap averages routine (with replacement) of the plot data collected from within woodland areas mapped for each vegetation community (Figure 12). Bootstrapping involves taking random samples from the plot data for each vegetation community then running 100 iterations of the ordination. The plot shows the bounds of where 95% of the values fall. If there was very little (if any) difference between community floristic compositions, the points would be scattered randomly across the graph or the 95% boundaries would substantially overlap. Figure 12 shows the relative similarity relationship between the five generic communities indicating that they have different floristic content. Communities 1 and 2 are marginally but significantly different with their closeness explained by the fact that Community 2 includes Spotted Gum as co-dominant with White Box x Grey Box hybrid while Community 1 has a canopy dominated only by White Box x Grey Box hybrid. Because of the small area (less than 50 ha) mapped for generic communities 3 and 4 they could not be included in the analysis.

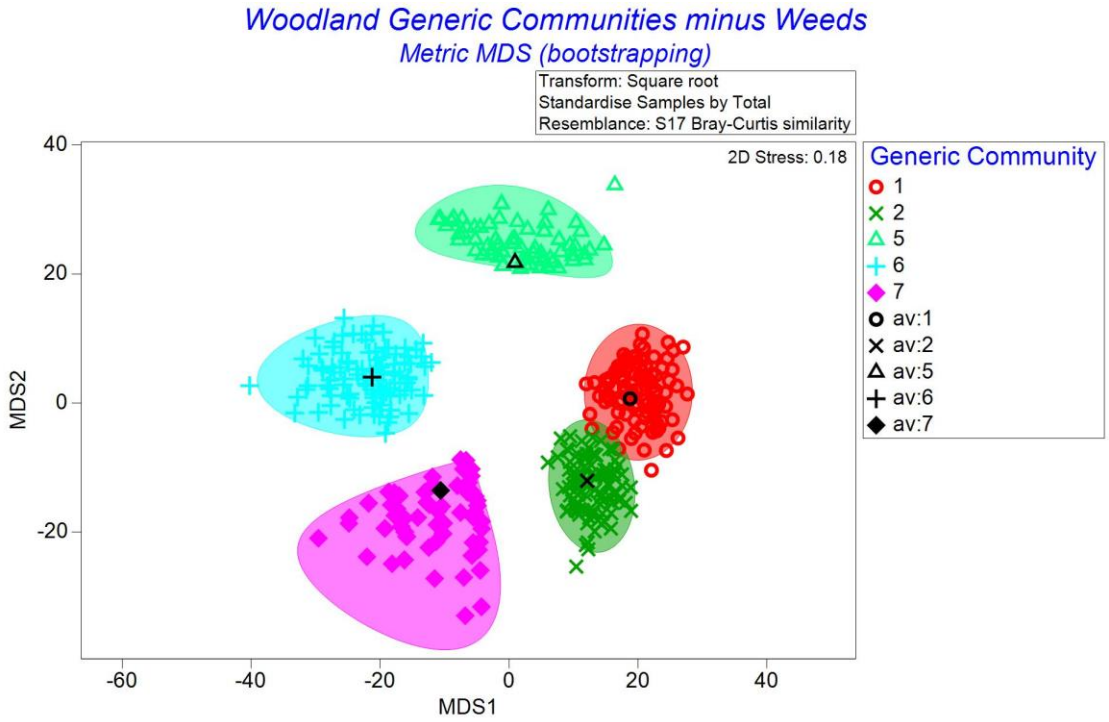


Figure 12: Bootstrap Regions for the Five Main Woodland Generic Communities

7.3 Plant Community Type Assignment

To assign the generic communities to a PCT, all PCTs having the locally characteristic species in the upper stratum were extracted from the *BioNet Vegetation Classification* (DPIE 2020c). These PCT were then filtered to include only those PCTs with an approved status and that occur in the Sydney Basin Bioregion, Hunter Subregion. The floristic content of the selected PCT was compared with that recorded in the Study Area plots and the final selection made on the best fit. Table 8 provides a summary of the assignment process for each.

Overall, 15 vegetation zones (PCTs and condition types) were mapped across the Study Area comprising 8 PCTs. Table 9 lists the mapped communities along with the hectares of each occurring in the Study Area. Figure 13 shows the distribution of these communities. Several communities were present in both remnant woodland 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 2.

7.4 Threatened Ecological Community Assignment

The *BioNet Vegetation Classification* (DPIE 2020c) assigns probable TECs to all PCTs and Table 10 provides details of these assignments for each PCT mapped across the Study Area. Figures 14 and 15 show the TECs under the BC Act and/or EPBC Act mapped across the Study Area.

Table 8: Plant Community Type Assignment

Vegetation Community	PCT Assignment Comments	PCT Name (DPIE, 2020c)
1. Grey Box x White Box Grassy Woodland	PCT 483 is the only match for this vegetation community, noting that is it not on basalt hills.	PCT 483 *Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley*
2. Grey Box x White Box - Spotted Gum Grassy Woodland	PCT 483 is the closest match for this vegetation community. There are no PCTs that contain hybrid Grey Box x White Box (*Eucalyptus albens* x *moluccana*), or White Box (*Eucalyptus albens*), in combination with Spotted Gum (*Corymbia maculata*) as canopy species.	PCT 483 *Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region*, upper Hunter Valley. Note, for analysis purposes the community was stratified as PCT 483 Spotted Gum (SG).
3. Forest Red Gum Grassy Open Forest	PCT 618 is the only match for this combination of canopy species.	PCT 618 *White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley*
4. Narrow-leaved Ironbark - Grey Box Grassy Woodland	Seven PCTs containing Narrow-leaved Ironbark (*Eucalyptus crebra*) and Grey Box (*Eucalyptus moluccana)* were options. All PCTs other than PCT 1691 contained canopy species not present in the Study Area.	PCT 1691 *Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter*
5. Spotted Gum - Narrow-leaved Ironbark Woodland	Options were: PCT 1600 and PCT 1601 both of which included Red Ironbark (*Eucalyptus fibrosa*) which was not present in the Study Area; PCT 1604 which included Grey Box (*Eucalyptus moluccana*) which was absent from this vegetation community; and PCT 1602 which was a good match for the vegetation community.	PCT 1602 Spotted Gum - *Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter*
6. Narrow-leaved Ironbark Shrubby Forest	There were 32 PCTs containing Narrow-leaved Ironbark (*Eucalyptus crebra*) in the canopy. PCT 1605 was the only option matching the vegetation community with just Narrow-leaved Ironbark in the canopy.	PCT 1605 *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*
7. White Box - Narrow-leaved Ironbark - Blakely's Red Gum	There were 12 PCTs containing Blakely's Red Gum (*Eucalyptus blakelyi*) in the canopy. PCT 1606 was the only option matching the combination of canopy species recorded in the vegetation community present.	PCT 1606 White Box - *Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter*
8. Slaty Box Woodland	PCT 1655 was selected as the likely match due to the dominance of Slaty Box (*Eucalyptus dawsonii*).	PCT 1655 *Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin*

Table 9: Vegetation Communities Mapped Across the Study Area Grouped by Formation

#	Vegetation Community	PCT Number / Vegetation Zone	PCT Name (DPIE, 2020c)	Class	Area (ha)
Grassy Woodlands					
1	Grey Box x White Box Grassy Woodland (PCT483)	483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Western Slopes Grassy Woodlands	138
1a	Derived Native Grassland (PCT483)	483 DNG	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Western Slopes Grassy Woodlands	664.9
2	Grey Box x White Box – Spotted Gum Grassy Woodland (PCT483 SG)	483 SG	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Western Slopes Grassy Woodlands	236.3
2a	Derived Native Grassland (PCT483 SG)	483 SG DNG	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Western Slopes Grassy Woodlands	129.3
3	Forest Red Gum Grassy Open Forest (PCT618)	618	White Box x Grey Box – Red Gum – Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Coastal Valley Grassy Woodlands	3
3a	Derived Native Grassland (PCT618)	618 DNG	White Box x Grey Box – Red Gum – Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Coastal Valley Grassy Woodlands	7.3
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland (PCT1691)	1691	Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Coastal Valley Grassy Woodlands	23.3
4a	Derived Native Grassland (PCT1691)	1691 DNG	Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Coastal Valley Grassy Woodlands	0.8
Dry Sclerophyll Forests (Shrub/grass sub-formation)					
5	Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602)	1602	Spotted Gum – Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter	Hunter-Macleay Dry Sclerophyll Forests	21.5
5a	Derived Native Grassland (PCT1602)	1602 DNG	Spotted Gum - Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter	Hunter-Macleay Dry Sclerophyll Forests	1.6

#	Vegetation Community	PCT Number / Vegetation Zone	PCT Name (DPIE, 2020c)	Class	Area (ha)
6	Narrow-leaved Ironbark Shrubby Forest (PCT1605)	1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	105.4
6a	Derived Native Grassland (PCT1605)	1605 DNG	Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	257.3
6b	Plantation (PCT1605)	1605 Plantation	Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	22
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum (PCT1606)	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	3.2
7a	Derived Native Grassland (PCT1606)	1606 DNG	White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter	North-west Slopes Dry Sclerophyll Woodlands	12.9
Dry Sclerophyll Forests (Shrubby sub-formation)					
8a	Derived Native Grassland (PCT1655)	1655 DNG	Grey Box – Slaty Box shrub-grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Western Slopes Dry Sclerophyll Forests	3.2
				Subtotal	**1,630**
Other					
Cropping/Grazing					2.9
Dam					9.4
Disturbed					4.9
Dwellings and Infrastructure					40.1
				Total	**1,687.3**

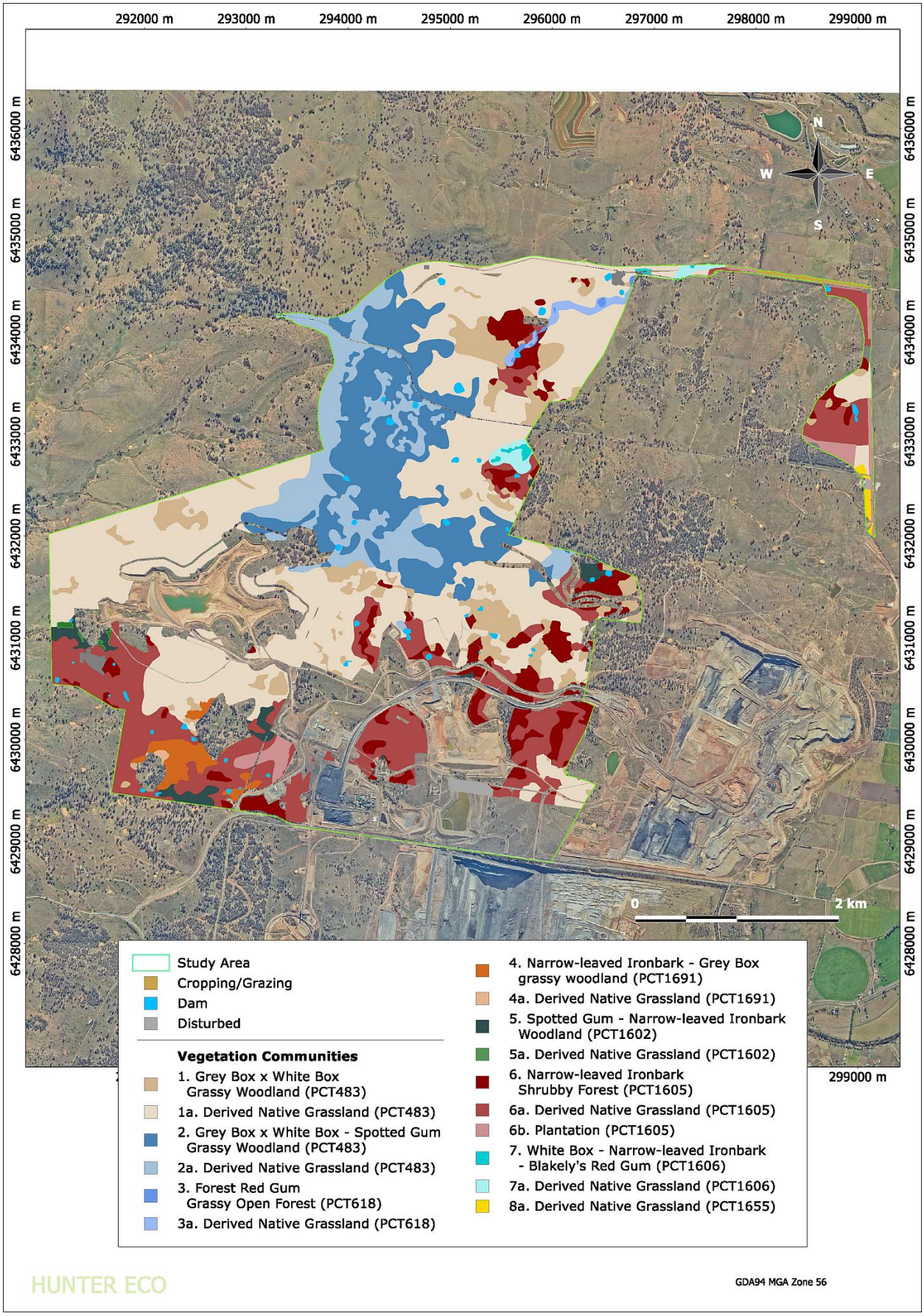


Figure 13: Generic Vegetation Communities Mapped Across the Study Area

Table 10: Threatened Ecological Community Assignment

#	Vegetation Community	PCT Name (DPIE 2020c)	Potentially Associated TEC (DPIE 2020c)	Assigned TEC (Figures 14 and 15)	Rationale for Assigned TEC
1	Grey Box x White Box Grassy Woodland (PCT483)	1. Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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 vegetation community met the relevant NSW and Commonwealth listing advice, including a dominance of White Box and a predominantly native understorey.
1a	Derived Native Grassland (PCT483)		BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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	Derived native grassland is included in both the NSW and Commonwealth Scientific Committees determination for this community.
2	Grey Box x White Box – Spotted Gum Grassy Woodland (PCT483 SG)	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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 vegetation community met the relevant NSW and Commonwealth listing advice, including a dominance of White Box and a predominantly native understorey.
2a	Derived Native Grassland (PCT483 SG)		BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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	Derived native grassland is included in both the NSW and Commonwealth Scientific Committees determination for this community.

#	Vegetation Community	PCT Name (DPIE 2020c)	Potentially Associated TEC (DPIE 2020c)	Assigned TEC (Figures 14 and 15)	Rationale for Assigned TEC
3	Forest Red Gum Grassy Open Forest (PCT618)	White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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	Canopy species White Box (in the form of the 'albemol' hybrid) and Yellow Box were present in a grassy woodland.
3a	Derived Native Grassland (PCT618)		As above	As above	Derived native grassland is included in both the NSW and Commonwealth Scientific Committees determination for this community.
4	Narrow-leaved Ironbark – Grey Box Grassy Woodland (PCT1691)	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland 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 EBPC Act CE Central Hunter Valley Eucalypt Forest and Woodland [1]	The vegetation community met the relevant NSW and Commonwealth listing advice for these two TECs. This community did not contain canopy species characteristic of White Box Yellow Box Blakely's Red Gum Woodland or Hunter Lowland Redgum Forest.
4a	Derived Native Grassland (PCT1691)		As above	Not a TEC	Derived native grassland is **not** included in the NSW or Commonwealth Scientific Committees determination for this community.
5	Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602)	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	BC Act E Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	EBPC Act CE Central Hunter Valley Eucalypt Forest and Woodland [1]	The vegetation community met the relevant and Commonwealth listing advice for this TEC. Lower Hunter Spotted Gum Ironbark Forest is characterised by the presence of *Eucalyptus fibrosa* (Red Ironbark) which was not present in the Study Area.

#	Vegetation Community	PCT Name (DPIE 2020c)	Potentially Associated TEC (DPIE 2020c)	Assigned TEC (Figures 14 and 15)	Rationale for Assigned TEC
5a	Derived Native Grassland (PCT1602)		As above	Not a TEC	Not a TEC.
6	Narrow-leaved Ironbark Shrubby Forest (PCT1605)	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	BC Act E Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions BC Act E Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	EBPC Act CE Central Hunter Valley Eucalypt Forest and Woodland [1]	The NSW Threatened Species Scientific Committee determination for Central Hunter Grey Box – Ironbark Woodland lists only two Eucalypt species as characterising this TEC, Narrow-leaved Ironbark and Grey Box. Other tree species may be present: *Angophora floribunda* (Rough-barked Apple) (absent in PCT 1605); *Brachychiton populneus* (Kurrajong) (abundant across Mount Pleasant but rarely in PCT 1605); *Acacia pendula* (absent across Mount Pleasant); and *Allocasuarina luehmannii* (Buloke) (rarely in PCT 1605). Hunter Lowland Redgum Forest is characterised by the presence of *Eucalyptus tereticornis* (Forest Red Gum) which was not present in this community.
6a	Derived Native Grassland (PCT1605)		As above	Not a TEC	Derived native grassland is **not** included in the NSW Threatened Species Scientific Committee determination for this community.
6b	Plantation (PCT1605)		As above	Not a TEC	Not a TEC.

#	Vegetation Community	PCT Name (DPIE 2020c)	Potentially Associated TEC (DPIE 2020c)	Assigned TEC (Figures 14 and 15)	Rationale for Assigned TEC
7	White Box – Narrow-leaved Ironbark – Blakely's Red Gum (PCT1606)	White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	BC Act CE White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act CE White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	BC Act CE 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 vegetation community met the relevant NSW and Commonwealth listing advice, including a dominance of White Box and a predominantly native understorey.
7a	Derived Native Grassland (PCT1606)		As above	As above	Derived native grassland is included in both the NSW and Commonwealth Scientific Committees determination for this community.
8a	Derived Native Grassland (PCT1655)	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	Not a TEC	Not a TEC	Not a TEC.

[1] The EPBC Act TEC *Central Hunter Valley Eucalypt Forest and Woodland* was not listed as associated in DPIE (2020c). Association was assessed by reference to Department of the Environment and Energy (2016).

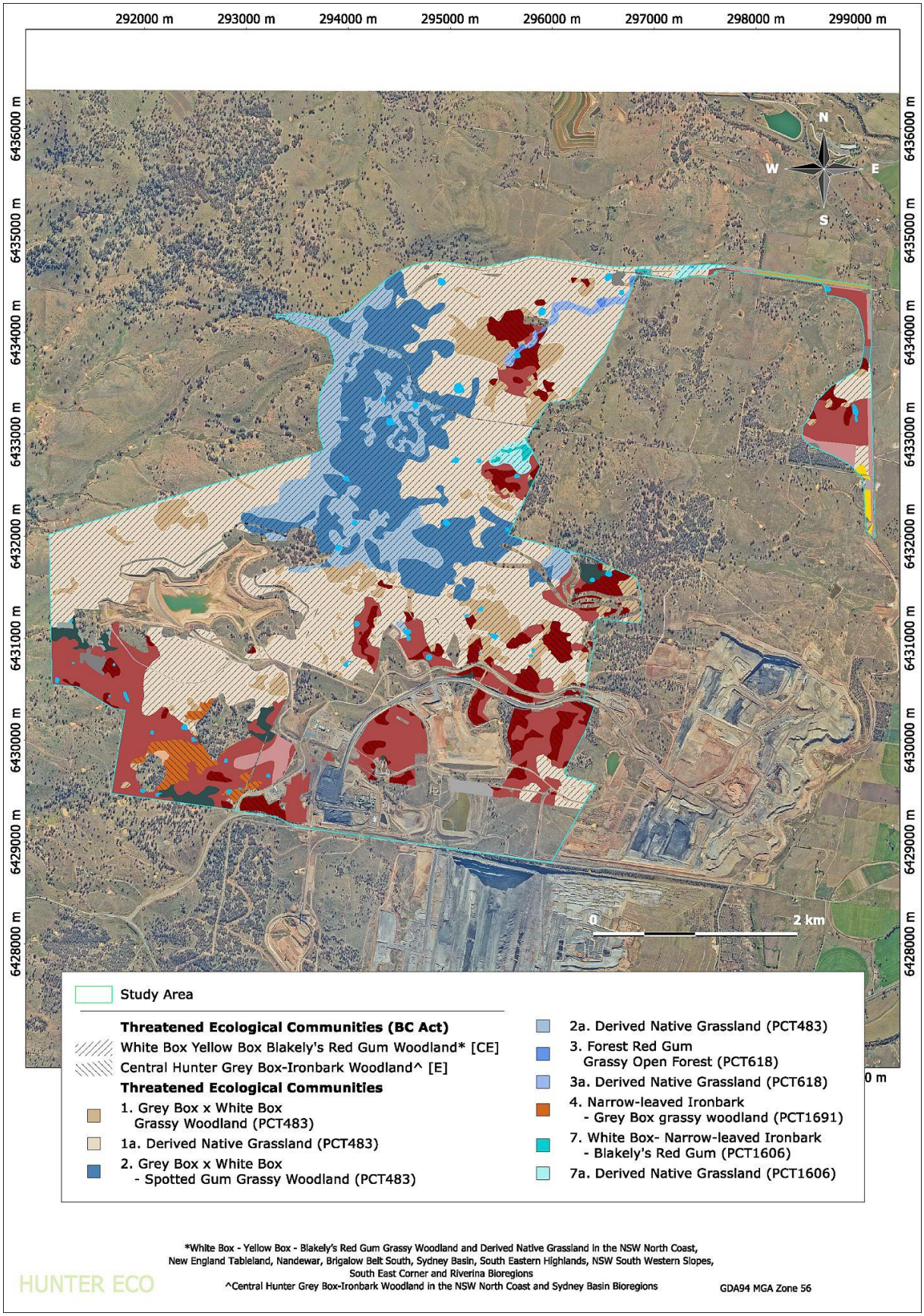


Figure 14: Threatened Ecological Communities NSW BC Act

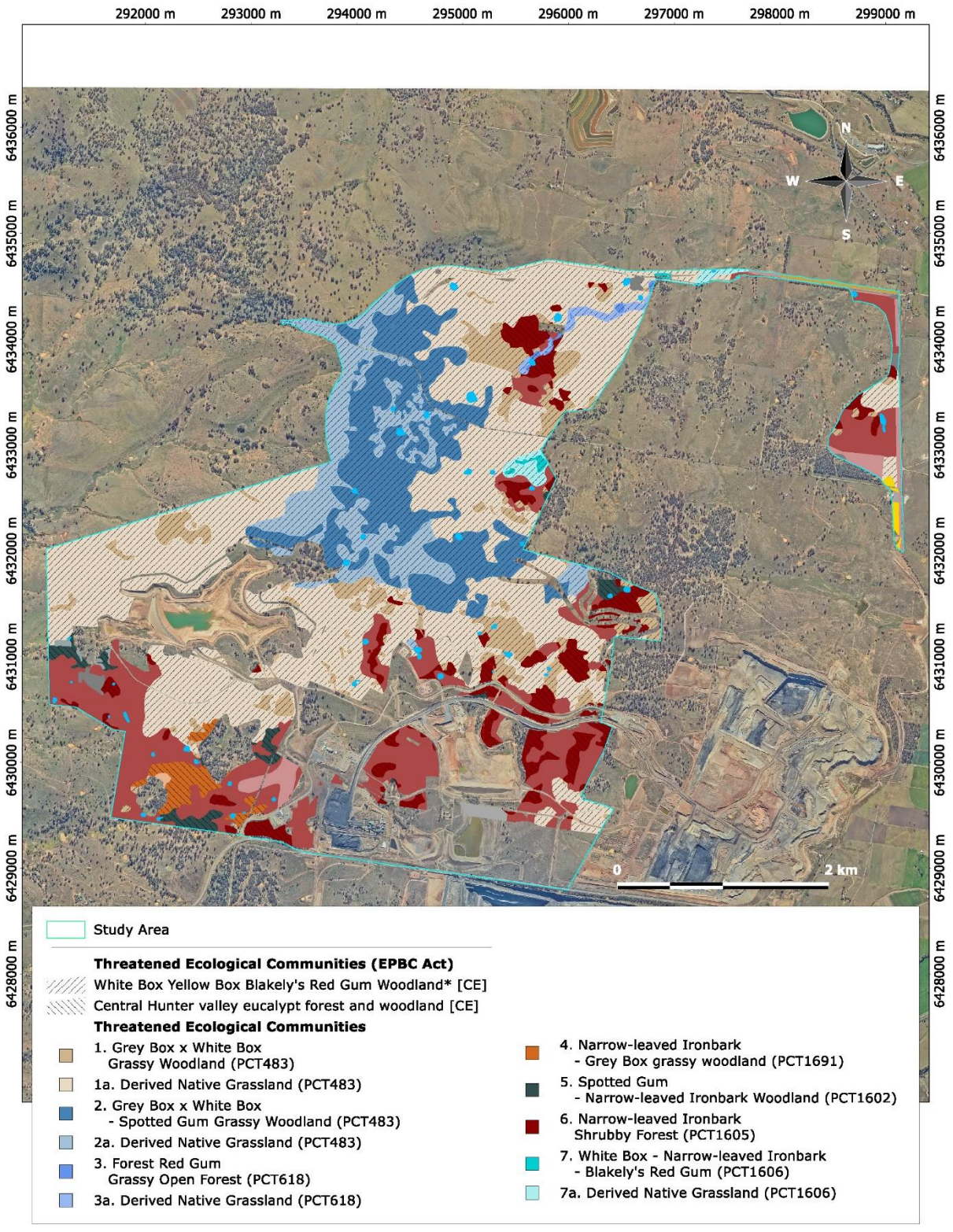


Figure 15: Threatened Ecological Communities Commonwealth EPBC Act

7.5 Vegetation Community Condition

Overall, the Study Area consisted of a grassy landscape divided into grassy woodland and derived native grassland with few paddock trees. As already noted, the floristic composition of the derived grassland was similar across the Study Area with no detectable difference between areas possibly being derived from different woodland vegetation. The grassy woodland canopy across all PCT ranged from young re-growth to senescing hollow-bearing trees. There were also some same-aged (approximately 15-20 years old) planted stands of mixed eucalypt and other species.

7.6 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

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 is listed as critically endangered under the BC Act (short title Box-Gum Woodland). The *BioNet Vegetation Classification* (DPIE 2020c) assigned this TEC to the following PCTs:

- PCT 483 *Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley*;
- PCT 618 *White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley*; and
- PCT 1606 *White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter*.

Box-Gum Woodland is primarily characterised by a canopy dominated by *Eucalyptus albens* (White Box), *Eucalyptus blakelyi* (Blakely's Red Gum) or *Eucalyptus melliodora* (Yellow Box) with an open canopy and perennial grassy understorey with few shrubs. In the upper Hunter White Box is generally replaced with a putative hybrid of White Box and Grey Box often called 'albemol' and variably identified as 'Grey Box x White Box' or 'White Box x Grey Box'. In the Study Area, PCT 483 was an open grassy woodland with the canopy dominated by 'albemol'. The NSW Threatened Species Scientific Committee *Final Determination* for Box-Gum Woodland (DPIE 2020h) also describes a variant with *Corymbia maculata*) as a co-dominant canopy species in the upper Hunter referenced to Peake (2006) which describes this variant as occurring along Castlerock Road. There are no PCTs that include Spotted Gum with White Box or the hybrid 'albemol' so for this report the combination was assigned to a PCT 483 variant (Spotted Gum or SG).

PCT 483 and its Spotted Gum variant were widespread across the Study Area. PCTs 618 and 1606 were restricted to ephemeral drainage lines in the middle to northern portion of the Study Area.

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. The *BioNet Vegetation Classification* (DPIE 2020c) assigned this TEC to *Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter* (PCT 1605) and *Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunte*r (PCT 1691).

It is considered here that PCT 1605 does not match the determination by the NSW Scientific Committee (DPIE 2020d) of this TEC because the only eucalypt listed for the PCT is Narrow-leaved Ironbark, thus no Grey Box. This is consistent with the RDP records showing that 99% of the canopy consisted of Narrow-leaved Ironbark to the complete exclusion of Grey Box. By comparison PCT 1691 contains both canopy species.

PCT 1691 was located predominantly in the south of the Study Area and made up less than 5% of the mapped woodland.

7.7 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. *Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley* (PCT 483 and 483 SG), *White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley* (PCT 618) and *White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter* (PCT 1606) were assessed as components of the TEC, including the derived native grassland variants. The main identifying characteristics were the presence of:

- White Box x Grey Box in the canopy of PCT 483 and 483 variant (Spotted Gum or SG);
- White Box x Grey Box and Yellow Box in the canopy of PCT 618; and
- White Box and White Box x Grey Box in the canopy of PCT 1606.

Details provided in Appendix 2 show that PCTs 483, 483 SG, 618 and 1606 meet the condition thresholds (Threatened Species Scientific Committee 2006) for this TEC with a predominantly native understorey and at least 12 native understorey species in any patch excluding grasses, with all patches >0.1 ha and at least one *Important Species* present in each PCT.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland was dispersed across the majority of the Study Area (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. *Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter* (PCT 1602), *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter* (PCT 1605) and *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 TEC given the presence of:

- Narrow-leaved Ironbark and Spotted Gum for PCT 1602;
- Narrow-leaved Ironbark and White Box x Grey Box for PCT 1605; and
- Narrow-leaved Ironbark, Grey Box and White Box x Grey Box for PCT 1691;

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.

Central Hunter Valley Eucalypt Forest and Woodland was present in small patches scattered across the Study Area (Figure 15).

7.8 Flora Species

There were 253 flora species recorded comprised of 171 genera from 60 families, including 78 weed species and 18 high threat weed species. The dominant families in species richness (number of species) (Figure 16) were clearly Poaceae (grasses) and Asteraceae (daisies). The nine families shown in Figure 16 contained over 60% of the total flora species recorded. The ground and midstorey strata of woodland areas were dominated by grasses and forbs with very few shrubs. The canopy and upper strata of woodland areas were dominated almost entirely by eucalypts (Myrtaceae).

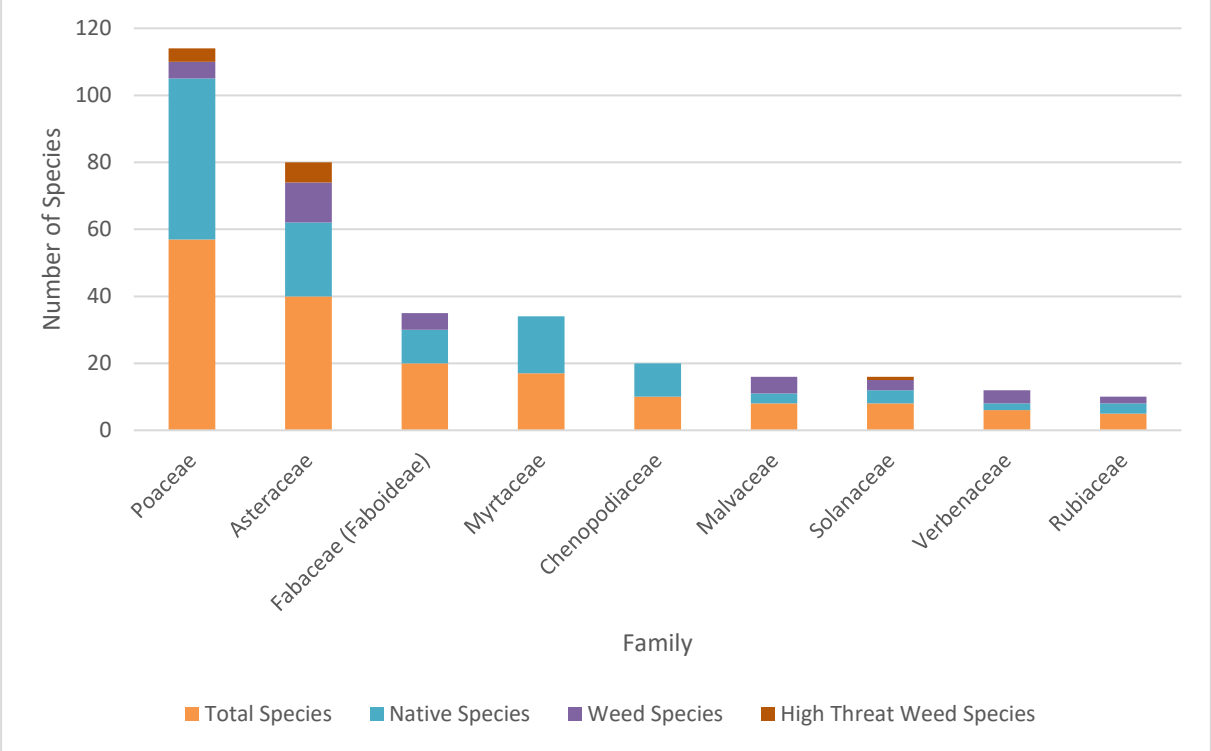


Figure 16: The Main Families and Number of Species

7.9 Threatened Flora Species

Other than the species indicative of Endangered Populations, no threatened flora species listed under the BC Act or EPBC Act were recorded across the Study Area.

7.10 Endangered Populations

The Endangered Population *Cymbidium canaliculatum population in the Hunter Catchment* was represented by six *Cymbidium canaliculatum* records (Figure 17).

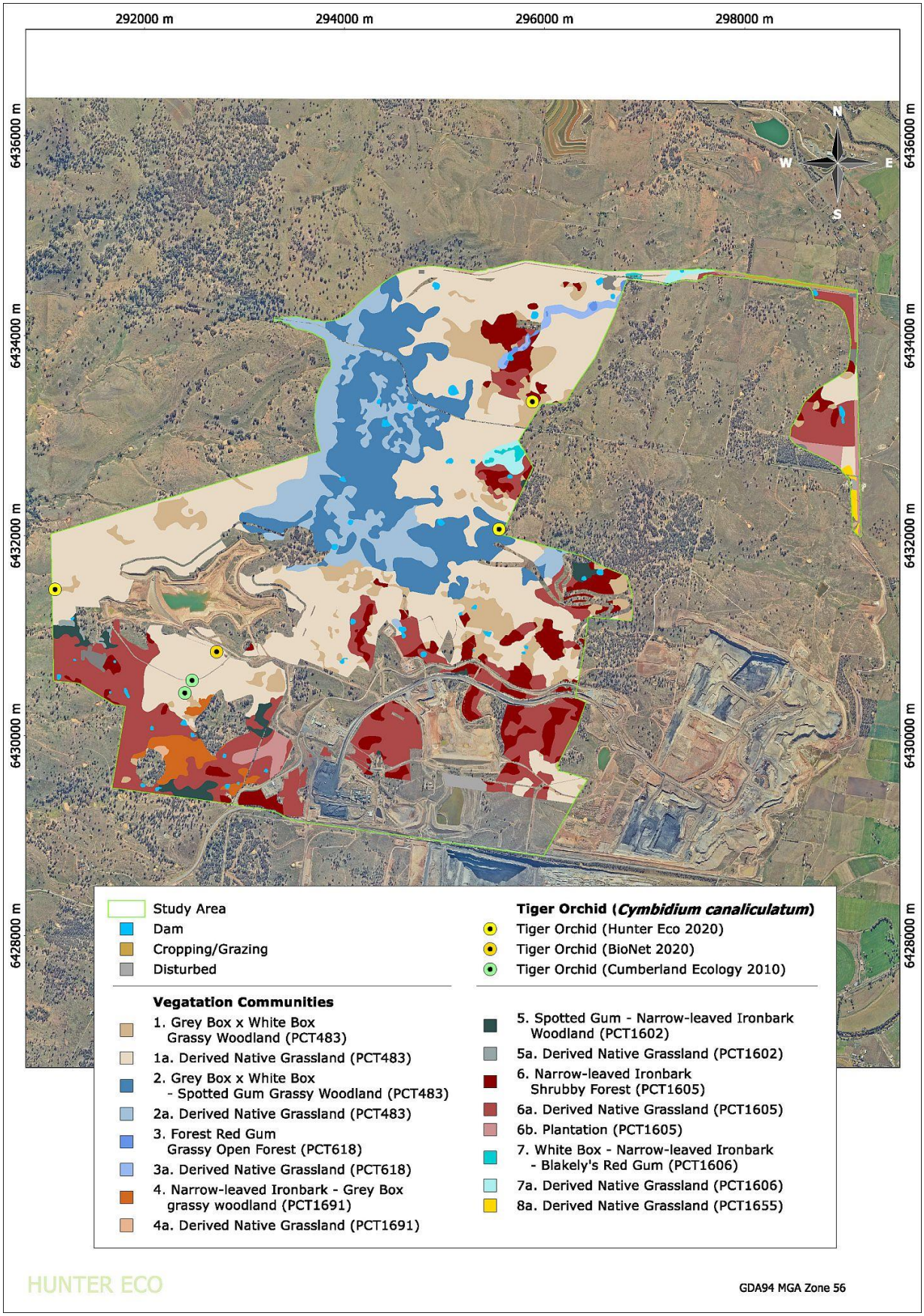


Figure 17: *Cymbidium canaliculatum* Records

7.11 Groundwater Dependent Ecosystems

The Topographic Wetness model shown in Figure 11 shows that there is potential for GDE to occur along an ephemeral drainage line in the north of the Study Area. PCT 618 Forest Red Gum Grassy Open Forest is mapped along the drainage line (Figure 13). Dominant tree species were Forest Red Gum (*Eucalyptus tereticornis*), Yellow Box (*Eucalyptus melliodora)* and Grey Box x White Box hybrid (*Eucalyptus moluccana* x *Eucalyptus albens*). There were a few scattered Narrow-leaved Ironbark (*Eucalyptus crebra*).

Considering that this community is restricted to the drainage lines suggests that they favour areas of higher moisture content and the groundwater assessment indicates that the groundwater is approximately 5 m below ground level in this location, which indicates also that the vegetation community is likely to have facultative groundwater dependence. While the streamlines are ephemeral, erosion and the incised stream beds indicate that there are periods of significant stormwater flow that could recharge transient aquifers.

Elsewhere across the Study Area there are no indications of other potential GDE.

7.12 Potential Koala Habitat

Forest Red Gum (*Eucalyptus tereticornis*) is the only Koala feed tree species listed in Schedule 2 of the Koala Habitat Protection SEPP that occur in the Subject land, however, White Box x Grey Box (*Eucalyptus 'albemol'*) is an assumed Koala feed tree as it is a cross with *Eucalyptus albens* which is a Koala feed tree species listed in Schedule 2 of the Koala Habitat Protection SEPP. These tree species occur in PCT 483 SG and PCT 618.

Separate to the Koala Habitat Protection SEPP, potential habitat for the Koala was also identified in woodland forms of PCT 1691, 1602, 1605 and 1606 after consideration of OEH (2018) which recognises *Eucalyptus moluccana, Eucalyptus crebra, Corymbia maculate, Eucalyptus melliodora* and *Angophora floribunda* as potential habitat trees.

Assessment for evidence of Koala presence across the Study Area was conducted by Future Ecology (2020) and no Koalas were found (i.e. no core Koala habitat occurs in the Study Area). This is further discussed with the Biodiversity Development Assessment Report for the Project.

8 CONCLUSION

Eight 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 TECs listed under the BC Act and/or the EPBC Act. The threatened communities found to be present are listed in Table 11.

Table 11: Threatened Ecological Communities Recorded Across the Study Area

Threatened Ecological Community	Conservation Status
Threatened Ecological Communities Listed under the BC Act	
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin	Endangered
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	Critically Endangered
Threatened Ecological Communities Listed Under the EPBC Act	
Central Hunter Valley Eucalypt Forest and Woodland	Critically Endangered
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered

One threatened flora species listed under the BC Act has been previously recorded in the Study Area, namely *Cymbidium canaliculatum*. This species is a component of the *Cymbidium canaliculatum population in the Hunter Catchment* Endangered Population under the BC Act. All previously recorded locations were inspected during the current survey to confirm their presence/absence and identity, and the species was opportunistically targeted during all surveys. No other threatened flora species listed under the BC Act or EPBC Act were recorded in the Study Area, or were recorded in any past studies.

9 REFERENCES

Atlas of Living Australia (2020) *Atlas of Living Australia*. Database search within the following area: -32.2376 150.9416, -32.2370 150.9409, -32.3438 150.9409, -32.3525 150.7143, -32.1318 150.7088, -32.1295 150.9396, -32.2376 150.9416.
https://www.ala.org.au/

Bell, S.A.J. and Driscoll, C. (2020) Data-informed Sampling and Mapping: an approach to ensure plot-based classifications locate, classify and map rare and restricted vegetation types. *Australian Journal of Botany*, accepted.

Bureau of Meteorology (2020a) *Climate Data Online*.
http://www.bom.gov.au/climate/data/?ref=ftr

Bureau of Meteorology (2020b) *The Groundwater Dependent Ecosystems Atlas*.
http://www.bom.gov.au/water/groundwater/gde/

Canadell, J., Jackson, R. B., Ehleringer, J. B., Mooney, H. A., Sala, O. E., & Schulze, E.-D. (1996) Maximum rooting depth of vegetation types at the global scale. *Oecologia*, 108(4): 583–595. http://doi.org/10.1007/BF00329030

Clarke, K.R., Gorley, R.N. (2015) PRIMER v7: User Manual/Tutorial. PRIMER-E, Plymouth. 91 pp.

Conrad, O., Bechtel, B., Bock, M., Dietrich, H., Fischer, E., Gerlitz, L., Wehberg, J., Wichmann, V., and Böhner, J. (2015) System for Automated Geoscientific Analyses (SAGA) v. 2.1.4, Geosci. Model Dev., 8, 1991-2007, doi:10.5194/gmd-8-1991-2015.

Cumberland Ecology (2006) *Proposed Mount Pleasant Open Cut Mine - Flora and Fauna Assessment*. Cumberland Ecology Pty Ltd, Carlingford Court.

Cumberland Ecology (2007a) *Mount Pleasant Mine: survey analysis of Box-Gum Woodland*. Cumberland Ecology Pty Ltd, Carlingford Court.

Cumberland Ecology (2007b) *Mount Pleasant: ecology gap analysis report*. Cumberland Ecology Pty Ltd, Carlingford Court, NSW.

Cumberland Ecology (2009) *Mount Pleasant Project - Flora and Fauna Report*. Cumberland Ecology Pty Ltd, Carlingford Court, NSW.

Cumberland Ecology (2010) *Mount Pleasant Project Modification Ecological Assessment* for Coal & Allied Operations Pty Limited.

Cumberland Ecology (2015) *Mount Pleasant Upper Hunter Strategic Assessment BCAM Project*. *Biodiversity Assessment Report*.

Department of Agriculture, Water and the Environment (2020a) *Protected Matters Search Tool*.
http://www.environment.gov.au/epbc/pmst/

Department of Agriculture, Water and the Environment (2020b) *Species Profile and Threats Database*.
http://www.environment.gov.au/epbc/what-is-protected/threatened-species-ecological-communities

Department of Environment and Climate Change (2008) *Vegetation of the Cessnock-Kurri Region, Cessnock LGA, New South Wales: Survey, Classification & Mapping*. Unpublished Report to Department of Environment & Climate Change. Eastcoast Flora Survey. November 2007.

Department of Planning, Industry and Environment (2020a) *BioNet Atlas*. -32.3136 150.7728, -32.3136 150.9855, -32.4929 150.9855, -32.4929 150.7728. https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx?who=0b679421-e424-47ea-b672-f30693729a7e

Department of Planning, Industry and Environment (2020b) *BioNet Threatened Biodiversity Data Collection*. https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx Data Accessed: March 2019.

Department of Planning, Industry and Environment (2020c) *BioNet Vegetation Classification*. http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx?ReturnUrl=%2fNSWVCA20PRapp%2fdefault.aspx

Department of Planning, Industry and Environment (2020d) *NSW Threatened Species Scientific Committee Final Determinations*. https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations

Department of Planning, Industry and Environment (2020d) *High threat weeds list*. https://www.lmbc.nsw.gov.au/bamcalc/app/assets/HighThreatWeedsV2_(4).xlsx

Department of Planning, Industry and Environment (2020e) *National Parks and Wildlife Service Fire History - Wildfires and Prescribed Burns*. State Government of New South Wales and Department of Planning, Industry and Environment 2010. https://datasets.seed.nsw.gov.au/dataset/fire-history-wildfires-and-prescribed-burns-1e8b6

Department of Planning, Industry and Environment (2020f) *Native species by growth form list*. https://www.lmbc.nsw.gov.au/bamcalc/app/assets/NativeSpeciesByGrowthFrom_PowerQuery.xlsx

Department of Planning, Industry and Environment (2020g) *Surveying threatened plants and their habitats: NSW survey guide for the Biodiversity Assessment Method*. Published by the Environment, Energy and Science Department of Planning, Industry and Environment, April 2020.

Department of Planning, Industry and Environment (2020h) *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland final determination*. https://bit.ly/3jyFmF1

Department of Primary Industries, Office of Water (2012) *Risk assessment guidelines for groundwater dependent ecosystems*. http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/547682/gde_risk_assessment_guidelines_volume_1_final_accessible.pdf

Department of the Environment (2013) *Draft survey guidelines for Australia's threatened orchids*, Commonwealth of Australia, 2013.
Department of the Environment and Energy (2016) *Central Hunter Valley eucalypt forest and woodland*: *a nationally-protected ecological community*, Commonwealth of Australia 2016.

Eamus, D., Froend, R., Loomes, R. Hosea, G., & Murray, B. (2006) A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany*, 54, 97–114.

ERM (1997) *Mount Pleasant Mine Environmental Impact Statement* for Coal & Allied Operations Pty Ltd. ERM Mitchell McCotter.

Future Ecology (2020) *Mount Pleasant Optimisation Project – Baseline Fauna Survey Report*. Report prepared for MACH Energy Australia Pty Ltd.

Hatton, T., Evans, R., (1998) *Dependence of ecosystems on groundwater and its significance to Australia*. Occasional paper no 12/98. Land and Water Resources Research and Development Corporation. August 1998.

Hunter Eco (2017a) *Mount Pleasant Operation - Mine Optimisation Modification Environmental Assessment*, *Biodiversity Assessment*.

Hunter Eco (2017b) *Mount Pleasant Operation Rail Modification – Terrestrial Ecology Assessment*.

Isbell (2016) *The Australian Soil Classification*. The National Committee on Soil and Terrain. CSIRO Publishing January 2016.

Mitchell, P. (2002) *NSW Landscapes Mapping: Background and Methodology*. Report prepared for the New South Wales National Parks and Wildlife Service.

Office of Environment and Heritage (2016) *NSW (Mitchell) landscapes – version 3.1*. https://datasets.seed.nsw.gov.au/dataset/nsw-mitchell-landscapes-version-3-1

Office of Environment and Heritage (2017) *Biodiversity Assessment Method, 2017 – Dated August 2017.*

Office of Environment and Heritage (2018) *A review of koala tree use across New South Wales*. New South Wales Office of Environment and Heritage July 2018.

Peake, T.C. (2006). *The Vegetation of the Central Hunter Valley, New South Wales*. A report on the findings of the Hunter Remnant Vegetation Project. Hunter–Central Rivers Catchment Management Authority, Paterson.

Royal Botanic Gardens (2020) *PlantNET*, The NSW Plant Information Network System. http://plantnet.rbgsyd.nsw.gov.au/

Sivertsen, D., Roff, A., Somerville, M., Thonell, J., and Denholm, B. (2011) *Hunter Native Vegetation Mapping*. Geodatabase Guide (Version 4.0), Internal Report for the Office of Environment and Heritage, Department of Premier and Cabinet, Sydney, Australia.

Threatened Species Scientific Committee (2006) *Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.* In effect under the EPBC Act from 18-May-2006.

APPENDIX 1 COMBINED FLORISTIC LIST

Arranged by families

*Weed species **High threat weed species

Acanthaceae
Brunoniella australis
Rostellularia adscendens var. adscendens
Aizoaceae
***Galenia pubescens*
Alliaceae
**Nothoscordum gracile*
Amaranthaceae
***Alternanthera pungens*
**Amaranthus powellii*
**Gomphrena celosioides*
Alternanthera nana
Anthericaceae
Arthropodium milleflorum
Arthropodium species B sensu Harden (1993)
Apiaceae
Daucus glochidiatus
Hydrocotyle laxiflora
Apocynaceae
**Gomphocarpus fruticosus*
Marsdenia viridiflora subsp. viridiflora
Parsonsia lanceolata
Asphodelaceae
**Asphodelus fistulosus*
Asteraceae
***Bidens pilosa*
***Bidens subalternans*
***Carthamus lanatus*
***Senecio madagascariensis*
***Xanthium occidentale*
***Xanthium spinosum*
**Cirsium vulgare*
**Conyza bonariensis*
**Conyza sp.*
**Cyanthillium cinereum var. cinereum*
**Hypochaeris albiflora*
**Lactuca serriola*
**Leontodon rhagadioloides subsp. cretica*
**Schkuhria pinnata*

**Soliva sessilis*
**Sonchus asper*
**Sonchus oleraceus*
**Tagetes minuta*
Brachyscome ciliaris
Calotis lappulacea
Cassinia sifton
Cassinia uncata
Chrysocephalum apiculatum
Cymbonotus lawsonianus
Eclipta platyglossa
Glossocardia bidens
Lactuca serriola
Lagenophora stipitata
Leiocarpa panaetioides
Minuria leptophylla
Ozothamnus diosmifolius
Solenogyne bellioides
Vittadinia cervicularis var. subcervicularis
Vittadinia cuneata var. cuneata
Vittadinia cuneata var. hirsuta
Vittadinia gracilis
Vittadinia muelleri
Vittadinia pterochaeta
Vittadinia pustulata
Vittadinia sulcata
Boraginaceae
**Echium plantagineum*
Hackelia suaveolens
Brassicaceae
***Carrichtera annua*
**Capsella bursa-pastoris*
**Hirschfeldia incana*
**Lepidium africanum*
**Rapistrum rugosum*
Cactaceae
***Opuntia aurantiaca*
***Opuntia humifusa*
***Opuntia stricta var. stricta*
Campanulaceae
Wahlenbergia communis
Wahlenbergia luteola

Caryophyllaceae
**Cerastium glomeratum*
**Paronychia brasiliana*
Casuarinaceae
Allocasuarina gymnanthera
Allocasuarina luehmannii
Casuarina cunninghamiana subsp. cunninghamiana
Casuarina glauca
Celastraceae
Denhamia silvestris
Chenopodiaceae
Atriplex semibaccata
Dysphania carinata
Einadia hastata
Einadia nutans subsp. linifolia
Einadia polygonoides
Enchylaena tomentosa
Maireana enchylaenoides
Maireana microphylla
Sclerolaena muricata var. muricata
Clusiaceae
***Hypericum perforatum*
Commelinaceae
Commelina cyanea
Convolvulaceae
Convolvulus graminetinus
Dichondra repens
Dichondra sp. Inglewood (J.M.Dalby 86/93) Qld Herbarium
Evolvulus alsinoides var. decumbens
Cucurbitaceae
**Citrullus amarus*
**Cucumis myriocarpus subsp. leptodermis*
Cyperaceae
**Cyperus rotundus*
Carex inversa
Cyperus gracilis
Fimbristylis dichotoma
Scleria mackaviensis
Euphorbiaceae
Chamaesyce drummondii
Fabaceae (Faboideae)
**Medicago sativa*

**Medicago sp.*
**Trifolium glomeratum*
**Trifolium sp.*
Cullen tenax
Desmodium gunnii
Desmodium varians
Glycine clandestina
Glycine tabacina
Oxytes brachypoda
Rhynchosia minima
Swainsona galegifolia
Templetonia stenophylla
Zornia dyctiocarpa var. dyctiocarpa
Fabaceae (Mimosoideae)
Acacia decora
Acacia paradoxa
Acacia salicina
Neptunia gracilis f. gracilis
Geraniaceae
**Erodium cicutarium*
**Erodium moschatum*
Erodium crinitum
Geranium solanderi var. solanderi
Goodeniaceae
Goodenia pinnatifida
Hypoxidaceae
Hypoxis pratensis var. pratensis
Lamiaceae
**Lamium amplexicaule*
**Marrubium vulgare*
**Prunella vulgaris*
**Salvia reflexa*
**Salvia verbenaca*
**Stachys arvensis*
Mentha satureioides
Linaceae
**Linum trigynum*
Linum marginale
Lobeliaceae
Lobelia purpurascens
Lomandraceae
Lomandra confertifolia subsp. pallida

Lomandra filiformis subsp. coriacea
Lomandra glauca
Lomandra multiflora subsp. multiflora
Loranthaceae
Amyema miquelii
Malvaceae
**Malva parviflora*
**Modiola caroliniana*
**Sida rhombifolia*
**Sida spinosa*
Abutilon oxycarpum
Sida corrugata
Sida hackettiana
Meliaceae
Melia azedarach
Myoporaceae
Eremophila debilis
Myoporum montanum
Myrtaceae
Angophora floribunda
Corymbia maculata
Eucalyptus albens
Eucalyptus albens x moluccana
Eucalyptus blakelyi
Eucalyptus conica
Eucalyptus crebra
Eucalyptus dawsonii
Eucalyptus melliodora
Eucalyptus microcarpa
Eucalyptus moluccana
Eucalyptus sideroxylon
Eucalyptus tereticornis
Nyctaginaceae
Boerhavia dominii
Oleaceae
Notelaea microcarpa var. microcarpa
Oxalidaceae
Oxalis perennans
Papaveraceae
**Argemone ochroleuca subsp. ochroleuca*
Phormiaceae
Dianella longifolia var. longifolia

Dianella revoluta var. revoluta
Phyllanthaceae
Phyllanthus virgatus
Pittosporaceae
Bursaria spinosa
Plantaginaceae
**Plantago lanceolata*
Plantago debilis
Poaceae
***Cenchrus clandestinus*
***Cenchrus longisetus*
***Hyparrhenia hirta*
***Paspalum dilatatum*
**Cynodon dactylon*
**Eleusine tristachya*
**Setaria parviflora*
**Urochloa panicoides*
Anthosachne scabra
Aristida leichhardtiana
Aristida ramosa
Austrostipa aristiglumis
Austrostipa scabra subsp. falcata
Austrostipa scabra subsp. scabra
Austrostipa verticillata
Bothriochloa decipiens var. decipiens
Bothriochloa macra
Chloris truncata
Chloris ventricosa
Cymbopogon refractus
Dichanthium sericeum subsp. sericeum
Dichelachne micrantha
Digitaria brownii
Digitaria diffusa
Digitaria divaricatissima
Enteropogon acicularis
Eragrostis brownii
Eragrostis lacunaria
Eragrostis leptostachya
Eragrostis sororia
Eriochloa pseudoacrotricha
Eulalia aurea
Microlaena stipoides var. stipoides

Panicum buncei
Panicum effusum
Panicum queenslandicum var. queenslandicum
Panicum simile
Paspalidium aversum
Paspalidium criniforme
Paspalidium distans
Poa sieberiana var. hirtella
Rytidosperma caespitosum
Rytidosperma fulvum
Rytidosperma longifolium
Rytidosperma racemosum var. racemosum
Rytidosperma setaceum
Rytidosperma tenuius
Sorghum leiocladum
Sporobolus caroli
Sporobolus creber
Themeda avenacea
Tragus australianus
Walwhalleya subxerophila
Polygonaceae
Rumex brownii
Portulacaceae
Portulaca oleracea
Primulaceae
**Lysimachia arvensis*
Pteridaceae
Cheilanthes distans
Cheilanthes sieberi subsp. sieberi
Rosaceae
Acaena sp.
Rubiaceae
**Richardia stellaris*
**Sherardia arvensis*
Asperula conferta
Galium leiocarpum
Psydrax odorata
Scrophulariaceae
**Kickxia elatine subsp. crinita*
Mimulus gracilis
Veronica plebeia

Solanaceae
***Lycium ferocissimum*
**Datura ferox*
**Solanum nigrum*
**Solanum rostratum*
Solanum brownii
Solanum campanulatum
Solanum cinereum
Solanum prinophyllum
Stackhousiaceae
Stackhousia muricata
Sterculiaceae
Brachychiton populneus subsp. populneus
Thymelaeaceae
Pimelea curviflora var. sericea
Verbenaceae
**Glandularia aristigera*
**Verbena bonariensis*
**Verbena rigida var. rigida*
Verbena gaudichaudii
Violaceae
Viola betonicifolia subsp. betonicifolia
Zygophyllaceae
Tribulus micrococcus

APPENDIX 2 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 90% which results in some discrepancies with the *Species Richness* data which have been determined from the total species list for each community.

1. Grey Box x White Box Grassy Woodland (PCT483)




Plant Community Type

PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Status

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

General Description

This community covered 25% of the mapped woodland areas. The dominant canopy species was Grey Box x White Box hybrid (*Eucalyptus moluccana* x *Eucalyptus albens*) making up over 99% of the total canopy species. Narrow-leaved Ironbark (*Eucalyptus crebra*) occurred sporadically and generally towards the edges of the mapped areas. There were no tall shrubs present with the ground cover consisting of forbs (51 species) and grasses (42 species). While there were a number of weed species present (36 species), including high threat weeds (10 species), they were in low abundance.

Species Richness

Native species 113; Weeds 36 including High Threat Weeds 10 Plots: 14 Mean species/plot 57±10.6SD

Key Diagnostic Species

Average similarity: 53.30						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Tree	*Eucalyptus albens x moluccana*	3.57	3.37	7.18	6.33	6.33
Shrub	*Solanum cinereum*	1.29	0.85	1.38	1.59	65.2
	Eremophila debilis	1.43	1.04	1.35	1.96	51.19
Forb	*Vittadinia cuneata* var. *hirsuta*	0.79	0.27	0.51	0.51	89.6
	Mentha satureioides	0.93	0.39	0.62	0.73	84.29
	Vittadinia pustulata	1	0.47	0.54	0.89	82.82
	Dysphania carinata	1	0.48	0.72	0.9	81.93
	Phyllanthus virgatus	1.07	0.6	0.71	1.12	78.84
	Asperula conferta	1.14	0.6	0.74	1.12	79.96
	Wahlenbergia communis	1.21	0.7	0.75	1.31	76.45
	Dichondra repens	1.21	0.76	1.12	1.43	71.12
	Rostellularia adscendens var. *adscendens*	1.29	0.77	0.8	1.45	69.69
	Chamaesyce drummondii	1.36	0.87	0.93	1.64	61.97
	Glossocardia bidens	1.36	0.95	1.03	1.77	56.81
	Sida corrugata	1.43	1.03	0.97	1.93	53.12
	Einadia polygonoides	1.5	1.15	1.44	2.16	47.27
	Oxalis perennans	1.57	1.17	1.42	2.19	45.12
	Calotis lappulacea	1.64	1.38	1.97	2.6	35.81
	Chrysocephalum apiculatum	1.71	1.49	1.85	2.79	33.21
	Brunoniella australis	1.79	1.6	2.04	3.01	27.51
Grass	*Carex inversa*	0.79	0.27	0.42	0.51	90.11
	Digitaria brownii	0.79	0.29	0.41	0.54	89.09
	Rytidosperma tenuius	1.07	0.29	0.41	0.55	88.54
	Microlaena stipoides var. *stipoides*	0.93	0.33	0.44	0.62	86.25
	Digitaria divaricatissima	0.93	0.4	0.6	0.74	83.56
	Austrostipa verticillata	1.5	0.7	0.88	1.32	75.14
	Cyperus gracilis	1.21	0.72	0.87	1.35	73.82
	Enteropogon acicularis	1.14	0.73	1.08	1.36	72.48
	Sporobolus creber	1.29	0.79	0.94	1.48	68.24
	Paspalidium criniforme	1.43	0.83	1.09	1.55	66.76
	Austrostipa scabra subsp. *falcata*	1.5	0.87	0.92	1.64	63.61
	Eriochloa pseudoacrotricha	1.43	0.94	1.05	1.76	60.34
	Lomandra confertifolia subsp. *pallida*	1.43	0.94	0.92	1.77	58.58
	Eragrostis lacunaria	1.71	1.27	1.71	2.38	40.59
	Panicum queenslandicum var. *queenslandicum*	1.71	1.28	1.82	2.4	38.21
	Cymbopogon refractus	1.86	1.55	2.57	2.91	30.42
	Dichanthium sericeum subsp. *sericeum*	2.14	1.66	2.03	3.12	24.5
	Aristida ramosa	2.29	1.95	2.48	3.66	18.05
	Bothriochloa decipiens var. *decipiens*	2.29	2.13	4.76	3.99	14.39
	Chloris ventricosa	2.86	2.17	2.9	4.07	10.39

Average similarity: 53.30						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.07	0.57	0.63	1.07	81.03
Other	*Convolvulus graminetinus*	1.57	1.25	1.86	2.34	42.92
	Glycine tabacina	1.86	1.78	2.29	3.33	21.38
Weed	*Sonchus oleraceus*	0.79	0.31	0.64	0.59	87.44
	Solanum nigrum	0.79	0.33	0.61	0.63	85.63
	Lysimachia arvensis	1.5	1.02	1.17	1.92	55.04
	Medicago sp.	1.5	1.05	1.16	1.96	49.23
HTE	*Bidens subalternans*	0.64	0.3	0.66	0.56	88
	Opuntia stricta var. *stricta*	0.57	0.32	0.66	0.59	86.85
	Senecio madagascariensis	0.79	0.38	0.79	0.72	85.01
	Galenia pubescens	1.43	0.68	1	1.27	77.72

1a. Derived Native Grassland (PCT483)





Plant Community Type

PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Status

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

General Description

This community made up over 61% of the total mapped derived native grassland. There were 41 forb species and 26 grass species. However, grass species dominated cover with *Dichanthium sericeum subsp. sericeum*, *Panicum queenslandicum var. queenslandicum*, *Bothriochloa decipiens var. decipiens* and *Eriochloa pseudoacrotricha* most abundant.

Species Richness

Native species 82; Weeds 46 including High Threat Weeds 3

Plots: 14 Mean species/plot 37.7±5.6SD

Key Diagnostic Species

Average similarity: 58.36						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum.%**
Shrub	*Eremophila debilis*	1.3	0.96	1.09	1.64	76.54
	Solanum cinereum	1.4	0.97	1.11	1.67	74.9
Forb	*Dysphania carinata*	0.9	0.46	0.65	0.79	90.5
	Dichondra repens	1.1	0.64	0.66	1.09	85.85
	Chamaesyce drummondii	1.2	0.76	0.7	1.3	82.33
	Einadia polygonoides	1.2	0.79	0.69	1.36	81.04
	Erodium crinitum	1.3	0.91	0.87	1.56	79.68
	Oxalis perennans	1.5	1.23	1.18	2.1	69.41
	Vittadinia muelleri	1.5	1.24	1.16	2.13	67.31
	Brunoniella australis	1.6	1.4	1.26	2.41	58.39
	Vittadinia pustulata	1.6	1.4	1.26	2.41	60.8
	Chrysocephalum apiculatum	1.6	1.43	1.64	2.46	55.99
	Wahlenbergia communis	1.9	2.11	4.19	3.62	42.5
Grass	*Rytidosperma caespitosum*	1	0.52	0.53	0.9	89.71
	Enteropogon acicularis	1.1	0.54	0.53	0.92	88.81
	Digitaria brownii	1.4	0.68	0.64	1.16	84.75
	Lomandra confertifolia subsp. *pallida*	1.2	0.73	0.7	1.26	83.59
	Digitaria divaricatissima	1.8	1.19	0.89	2.03	71.45
	Sporobolus creber	1.5	1.3	1.15	2.23	63.03
	Eriochloa pseudoacrotricha	2.2	1.64	1.05	2.8	48.56
	Chloris truncata	2.1	1.9	1.88	3.26	45.76
	Panicum queenslandicum var. *queenslandicum*	2.3	2.14	1.77	3.66	38.89
	Cymbopogon refractus	2.2	2.16	3.95	3.71	35.22
	Bothriochloa decipiens var. *decipiens*	2.6	2.35	1.83	4.02	23.48
	Aristida ramosa	2.4	2.42	8.48	4.14	15.32
	Chloris ventricosa	2.4	2.42	9.04	4.14	19.46
	Dichanthium sericeum subsp. *sericeum*	3.7	3.7	3.93	6.34	6.34
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.4	1.04	0.92	1.79	73.23
Other	*Convolvulus graminetinus*	1.6	1.44	1.64	2.46	53.53
	Glycine tabacina	2	2.34	12.8	4.02	31.52
Weed	*Sonchus oleraceus*	0.9	0.57	0.89	0.98	87.89
	Stachys arvensis	1.1	0.62	0.66	1.06	86.91
	Sida rhombifolia	1.3	0.92	0.87	1.58	78.12
	Sida spinosa	1.6	1.26	1.17	2.15	65.18
	Medicago sp.	1.6	1.46	1.26	2.51	51.07
	Lysimachia arvensis	2	2.34	12.8	4.02	27.5
HTE	*Carthamus lanatus*	2.9	2.82	3.49	4.84	11.18

2. Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483 SG)





Plant Community Type

PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Status

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

General Description

This community made up approximately 43% of the total mapped woodland communities. The canopy was dominated (64%) by Grey Box x White Box hybrid (*Eucalyptus moluccana* x *Eucalyptus albens*) but also included 31% Spotted Gum (*Corymbia maculata*). Narrow-leaved Ironbark (*Eucalyptus crebra*) and Grey Box (*Eucalyptus moluccana*) were also present at approximately 2% each. These two low abundance species were found in small patches rather than being dispersed through the community. There were no tall shrubs and ground cover was comprised of forbs (58 species) and grasses (37 species).

As noted in Section 7.4 there are no PCTs having Spotted Gum in combination with White Box x Grey Box hybrid or White Box itself. This community was described in ERM (1997) and subsequently in Cumberland Ecology (2010). Peak (2006) noted the presence of this community along Castlerock Road, however only one floristic sample plot was recorded which was insufficient data to determine whether this constituted a discrete vegetation community.

In the absence of any associated PCT, this community has been assessed as being part of NSW State and Commonwealth Box-Gum TEC given that it is a grassy woodland dominated by Grey Box x White Box hybrid. It does not meet the description of the EPBC Act *Central Hunter Valley Eucalypt Forest and Woodland* because the Spotted Gum content is less than 50% (31%) of the canopy cover.

Species Richness

Native species 120; Weeds 37 including High Threat Weeds 9
Plots: 14
Mean species/plot 58±7.5SD

Key Diagnostic Species

Average similarity: 50.35						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum.%**
Tree	*Notelaea microcarpa* var. *microcarpa*	0.79	0.31	0.63	0.62	87.79
	Brachychiton populneus subsp. *populneus*	0.86	0.33	0.63	0.65	86.53
	Corymbia maculata	1.43	0.5	0.44	1	76.85
	Eucalyptus albens x moluccana	2.71	2.07	1.52	4.1	4.1
Shrub	*Solanum cinereum*	1	0.54	0.89	1.08	74.82
	Eremophila debilis	1.5	1.08	1.4	2.13	53.19
Forb	*Vittadinia cuneata* var. *hirsuta*	0.71	0.22	0.42	0.44	90.37
	Boerhavia dominii	0.79	0.27	0.42	0.53	89.41
	Glossocardia bidens	0.79	0.27	0.42	0.54	88.88
	Dysphania carinata	0.86	0.34	0.5	0.67	85.22
	Mentha satureioides	0.93	0.4	0.61	0.79	83.03
	Plantago debilis	1	0.43	0.62	0.85	81.43
	Arthropodium Species B sensu Harden (1993)	1	0.47	0.54	0.93	78.77
	Calotis lappulacea	1.07	0.52	0.63	1.02	75.84
	Phyllanthus virgatus	1.21	0.69	0.76	1.38	67.55
	Pimelea curviflora var. *sericea*	1.21	0.7	0.89	1.39	66.17
	Sida corrugata	1.21	0.71	0.77	1.4	64.78
	Einadia polygonoides	1.29	0.8	0.92	1.58	61.86
	Oxalis perennans	1.5	1.09	1.36	2.16	51.05
	Chrysocephalum apiculatum	1.5	1.12	1.84	2.23	48.89
	Rostellularia adscendens var. *adscendens*	1.57	1.17	1.21	2.33	46.66
	Wahlenbergia communis	1.64	1.28	1.51	2.53	41.88
	Chamaesyce drummondii	1.64	1.29	1.48	2.55	39.35
	Dichondra repens	1.71	1.41	1.59	2.8	36.8
	Asperula conferta	1.86	1.67	2.37	3.31	21.94
	Brunoniella australis	2	1.96	10.93	3.9	8.01
Grass	*Rytidosperma tenuius*	0.86	0.26	0.42	0.51	89.92
	Sporobolus creber	0.79	0.28	0.51	0.55	88.33
	Austrostipa scabra subsp. *falcata*	0.86	0.34	0.51	0.67	85.88
	Eriochloa pseudoacrotricha	1.07	0.38	0.6	0.75	84.55
	Carex inversa	0.93	0.38	0.53	0.76	83.8
	Eragrostis lacunaria	0.93	0.41	0.6	0.82	82.24
	Microlaena stipoides var. *stipoides*	1.29	0.58	0.75	1.16	73.74
	Panicum queenslandicum var. *queenslandicum*	1.36	0.61	0.81	1.21	71.41
	Austrostipa verticillata	1.57	0.67	0.81	1.33	68.88
	Dichanthium sericeum subsp. *sericeum*	1.5	0.83	0.88	1.65	60.28
	Paspalidium criniforme	1.5	0.89	0.93	1.76	58.63
	Cyperus gracilis	1.43	0.96	1.13	1.9	55.09
	Cymbopogon refractus	2	1.46	1.85	2.9	31.17
	Lomandra confertifolia subsp. *pallida*	1.86	1.55	2.14	3.07	28.28
	Chloris ventricosa	2.5	1.64	1.53	3.26	25.21

Average similarity: 50.35						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum.%**
	Bothriochloa decipiens var. *decipiens*	2.21	1.69	1.96	3.36	15.27
	Aristida ramosa	2.07	1.69	2.36	3.36	18.63
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.14	0.59	0.76	1.17	72.58
Other	*Convolvulus graminetinus*	1.57	1.23	1.85	2.44	44.33
	Glycine tabacina	2	1.96	10.93	3.9	11.91
Weed	*Lepidium africanum*	1	0.47	0.61	0.93	79.7
	Sida rhombifolia	1	0.5	0.74	0.99	77.83
	Medicago sp.	1.29	0.76	0.8	1.52	63.38
	Sonchus oleraceus	1.21	0.9	2.03	1.78	56.87
	Lysimachia arvensis	1.71	1.42	1.59	2.82	33.99
HTE	*Bidens pilosa*	0.86	0.32	0.64	0.63	87.16
	Senecio madagascariensis	1	0.44	0.62	0.88	80.57
	Bidens subalternans	1.21	0.66	1.12	1.32	70.2

2a. Derived Native Grassland (PCT483 SG)





Plant Community Type

PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Status

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

General Description

This community made up approximately 12% of the total mapped derived native grassland and consisted mainly of forbs (33 species) and grasses (27 species). Dominant grass species were *Dichanthium sericeum* subsp. *sericeum Chloris ventricosa, Aristida ramosa* and *Bothriochloa decipiens* var. *decipiens.*

Species Richness

Native species 71; Weeds 37 including High Threat Weeds 9 Plots: 10 Mean species/plot 45±6.3 SD

Key Diagnostic Species

Average similarity: 53.03						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum.%**
Shrub	*Solanum cinereum*	1	0.55	0.65	1.03	86.86
Forb	*Chamaesyce drummondii*	0.82	0.41	0.43	0.77	88.53
	Erodium crinitum	1.14	0.63	0.66	1.2	85.83
	Chrysocephalum apiculatum	1.09	0.8	0.83	1.5	80.46
	Brunoniella australis	1.18	0.83	0.71	1.56	78.96
	Vittadinia muelleri	1.32	1.1	0.94	2.07	73.85
	Wahlenbergia communis	1.32	1.11	1.05	2.09	71.78
	Oxalis perennans	1.36	1.21	0.97	2.29	67.49
	Einadia polygonoides	1.59	1.55	1.29	2.92	52.39
Grass	*Rytidosperma tenuius*	0.86	0.4	0.43	0.75	89.28
	Enteropogon acicularis	0.86	0.4	0.47	0.75	90.03
	Digitaria brownii	1.27	0.7	0.6	1.31	84.63
	Chloris ventricosa	1.59	1.31	1.02	2.46	62.77
	Chloris truncata	1.86	1.33	0.88	2.51	60.3
	Sporobolus creber	1.5	1.41	1.16	2.66	57.8
	Eragrostis lacunaria	1.68	1.46	1.24	2.74	55.14
	Cymbopogon refractus	2.05	2.1	1.89	3.95	49.47
	Aristida ramosa	2.27	2.29	1.96	4.32	37.14
	Digitaria divaricatissima	2.32	2.29	1.76	4.32	41.46
	Eriochloa pseudoacrotricha	2.59	2.78	2.35	5.24	28.35
	Bothriochloa decipiens var. *decipiens*	2.55	2.82	4.91	5.31	23.12
	Panicum queenslandicum var. *queenslandicum*	2.95	3.02	2.23	5.7	12.31
	Dichanthium sericeum subsp. *sericeum*	3.36	3.51	2.33	6.61	6.61
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.36	1.17	0.9	2.21	69.69
Other	*Convolvulus graminetinus*	1.41	1.29	1.2	2.43	65.2
	Glycine tabacina	1.91	2.37	3.02	4.47	32.82
Weed	*Sonchus oleraceus*	0.82	0.48	0.67	0.91	87.77
	Medicago sp.	1.09	0.72	0.63	1.36	83.32
	Stachys arvensis	1.14	0.8	0.69	1.5	81.96
	Sida spinosa	1.36	0.92	0.77	1.74	77.39
	Sida rhombifolia	1.23	0.96	0.83	1.81	75.66
	Lysimachia arvensis	1.82	2.15	2.1	4.06	45.52
HTE	*Carthamus lanatus*	2.91	2.92	1.89	5.5	17.81

3. Forest Red Gum Grassy Open Forest (PCT618)





Plant Community Type

PCT 618 White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

Status

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

General Description

This community made up only approximately 0.5% of the mapped woodland and was restricted to one ephemeral creekline in the north of the Study Area with woodland patches along its length. Dominant tree species were Forest Red Gum (*Eucalyptus tereticornis*), Yellow Box (*Eucalyptus melliodora)* and Grey Box x White Box hybrid (*Eucalyptus moluccana* x *Eucalyptus albens*). There were a few scattered Narrow-leaved Ironbark (*Eucalyptus crebra*). The ground cover consisted of forbs (22 species) and grasses (24 species).

Species Richness

Native species 54; Weeds 18 including High Threat Weeds 7
Plots: 2
Mean species/plot 45±9.0SD

Key Diagnostic Species

Average similarity: 27.33

BAM Growth Form Group	Scientific Name	Av. Abund	Av. Sim	Sim/ SD	Contrib %	Cum. %
Forb	*Calotis lappulacea*	1	1.24	N/A	4.55	86.36
	Dichondra repens	2	2.48	N/A	9.09	27.27
Grass	*Austrostipa verticillata*	2.5	2.48	N/A	9.09	18.18
	Eriochloa pseudoacrotricha	2	2.48	N/A	9.09	36.36
	Microlaena stipoides var. *stipoides*	2	2.48	N/A	9.09	54.55
Other	*Glycine clandestina*	1.5	1.24	N/A	4.55	90.91
	Glycine tabacina	2	2.48	N/A	9.09	45.45

Average similarity: 27.33						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Weed	*Plantago lanceolata*	1	1.24	N/A	4.55	77.27
	Sida rhombifolia	1.5	1.24	N/A	4.55	81.82
	Hypochaeris albiflora	2	2.48	N/A	9.09	9.09
HTE	*Bidens subalternans*	1.5	1.24	N/A	4.55	59.09
	Galenia pubescens	1	1.24	N/A	4.55	63.64
	Paspalum dilatatum	1.5	1.24	N/A	4.55	68.18
	Senecio madagascariensis	1	1.24	N/A	4.55	72.73

3a. Derived Native Grassland (PCT618)





Plant Community Type

PCT 618 White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

Status

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

General Description

This community made up approximately 0.7% of the mapped derived native grasslands and consisted mainly of forbs (18 species) and grasses (24 species).

Species Richness

Native species 47; Weeds 27 including High Threat Weeds 8
Plots: 3
Mean species/plot 45±3.1SD

Key Diagnostic Species

Average similarity: 51.31						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Forb	*Brunoniella australis*	1.33	0.79	0.58	1.55	80.89
	Oxalis perennans	1.33	0.79	0.58	1.55	88.63
	Vittadinia muelleri	1.33	0.79	0.58	1.55	90.17
	Chrysocephalum apiculatum	1.67	1.67	2.69	3.25	61
	Einadia polygonoides	2	2.54	16.69	4.95	44.56
Grass	*Chloris ventricosa*	1.33	0.79	0.58	1.55	83.99
	Cymbopogon refractus	1.67	0.79	0.58	1.55	85.53
	Enteropogon acicularis	1.67	0.79	0.58	1.55	87.08
	Austrostipa verticillata	1.33	0.85	0.58	1.66	74.49
	Digitaria brownii	1.33	0.85	0.58	1.66	76.14
	Paspalidium aversum	1.33	0.85	0.58	1.66	77.8
	Lomandra confertifolia subsp. *pallida*	1.33	0.89	0.58	1.74	71.18
	Aristida ramosa	2	2.54	16.69	4.95	34.67
	Bothriochloa decipiens var. *decipiens*	2.33	2.54	16.69	4.95	39.62
	Eriochloa pseudoacrotricha	2.33	2.54	16.69	4.95	49.51
	Digitaria divaricatissima	3	2.96	3.9	5.77	24.78
	Dichanthium sericeum subsp. *sericeum*	3.67	4.23	5.41	8.25	19.01
	Panicum queenslandicum var. *queenslandicum*	5	5.52	5.3	10.76	10.76
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.33	0.79	0.58	1.55	82.44
Other	*Glycine tabacina*	2	2.54	16.69	4.95	54.46
	Convolvulus graminetinus	1.67	1.69	2.28	3.3	57.76
Weed	*Lysimachia arvensis*	1.33	0.79	0.58	1.55	79.35
	Sonchus oleraceus	1.33	0.85	0.58	1.66	72.83
	Plantago lanceolata	1.33	0.89	0.58	1.74	67.69
	Sida spinosa	1.67	0.89	0.58	1.74	69.44
	Rapistrum rugosum	1	1.27	16.69	2.47	65.95
HTE	*Bidens subalternans*	1	1.27	16.69	2.47	63.47
	Carthamus lanatus	2	2.54	16.69	4.95	29.73

4. Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691)




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 made up only approximately 4.2% of the mapped woodland and consisted of a mixed canopy dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) and Grey Box (*Eucalyptus moluccana*). Other tree species present were Grey Box x White Box hybrid (*Eucalyptus albens* x *Eucalyptus moluccana*), Kurrajong (*Brachychiton populneus* subsp*. populneus),* Bulloke (*Allocasuarina luehmannii*) and Native Olive (*Notelaea microcarpa* var. *microcarpa*). There were seven mostly low shrub species including *Bursaria spinosa*, 30 forb and 27 grass species.

Species Richness

Native species 77; Weeds 18 including High Threat Weeds 6
Plots: 3
Mean species/plot 57±4.1SD

Key Diagnostic Species

Average similarity: 57.98

BAM Growth Form Group	Scientific Name	Av. Abund	Av. Sim	Sim/ SD	Contrib %	Cum. %
Tree	*Brachychiton populneus* subsp. *populneus*	1	1.12	43.5	1.92	68.65
	Eucalyptus crebra	3.33	3.35	43.5	5.77	5.77
	Eucalyptus moluccana	3	3.35	43.5	5.77	11.55
Shrub	*Maireana microphylla*	1	0.38	0.58	0.65	89.88
	Bursaria spinosa	1	1.12	43.5	1.92	70.57
	Solanum cinereum	1	1.12	43.5	1.92	76.34
	Eremophila debilis	2	2.23	43.5	3.85	35.28
Forb	*Brunoniella australis*	1.33	0.72	0.58	1.25	85.36
	Chrysocephalum apiculatum	1.33	0.72	0.58	1.25	86.61
	Mentha satureioides	1.33	0.75	0.58	1.29	80.23

Average similarity: 57.98						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Vittadinia sulcata	1.33	0.75	0.58	1.29	82.82
	Wahlenbergia communis	1.33	0.75	0.58	1.29	84.11
	Einadia polygonoides	1.33	1.12	43.5	1.92	72.49
	Calotis lappulacea	1.67	1.48	2.45	2.55	64.8
	Dichondra repens	1.67	1.49	2.27	2.57	54.54
	Pimelea curviflora var. *sericea*	1.67	1.49	2.27	2.57	59.68
	Rostellularia adscendens var. *adscendens*	1.67	1.49	2.27	2.57	62.25
	Sida corrugata	2	2.23	43.5	3.85	46.83
Grass	*Lomandra glauca*	1	0.38	0.58	0.65	89.22
	Cymbopogon refractus	1.33	0.75	0.58	1.29	78.94
	Rytidosperma longifolium	1.33	0.75	0.58	1.29	81.52
	Austrostipa verticillata	1.33	0.76	0.58	1.31	77.65
	Lomandra multiflora subsp. *multiflora*	1.33	1.12	43.5	1.92	74.42
	Bothriochloa decipiens var. *decipiens*	2	1.49	2.27	2.57	49.4
	Cyperus gracilis	1.67	1.49	2.27	2.57	51.97
	Enteropogon acicularis	1.67	1.49	2.27	2.57	57.11
	Aristida ramosa	2.33	2.23	43.5	3.85	19.89
	Chloris ventricosa	2	2.23	43.5	3.85	23.74
	Eragrostis leptostachya	2	2.23	43.5	3.85	31.43
	Lomandra confertifolia subsp. *pallida*	2	2.23	43.5	3.85	42.98
	Microlaena stipoides var. *stipoides*	2.67	2.61	3.92	4.49	16.04
Fern	*Cheilanthes distans*	1	0.38	0.58	0.65	88.57
Other	*Desmodium varians*	2	2.23	43.5	3.85	27.58
	Glycine tabacina	2	2.23	43.5	3.85	39.13
Weed	*Glandularia aristigera*	0.67	0.38	0.58	0.65	87.92
	Sida spinosa	0.67	0.37	0.58	0.65	90.52
	Sida rhombifolia	1	1.12	43.5	1.92	66.72
HTE	*Galenia pubescens*	1	0.38	0.58	0.65	87.26

4a. Derived Native Grassland (PCT1691)



Plant Community Type

PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Status

Not a TEC

General Description

This community made up only 0.07% of the mapped derived native grasslands and consisted mainly of forbs (12 species) and grasses (14 species).

Species Richness

Native species 31; Weeds 10 including High Threat Weeds 2 Plots: 1 Mean species/plot N/A

Key Diagnostic Species

No data, only one plot needed.

5. Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602)





Plant Community Type

PCT 1602 Spotted Gum - Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter

Status

Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland

General Description

This community made up only approximately 4% of the mapped woodland with the canopy dominated by Spotted Gum (*Corymbia maculata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). Shrub cover consisted of 10 mostly low species and ground cover consisted of 47 forb species and 30 grass species.

Species Richness

Native species 99; Weeds 28 including High Threat Weeds 8 Plots: 6 Mean species/plot 59±6.5SD

Key Diagnostic Species

Average similarity: 58.05						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Tree	*Brachychiton populneus* subsp. *populneus*	1.8	1.27	2.8	2.18	59.16
	Eucalyptus crebra	2.8	2.14	2.15	3.68	8.75
	Corymbia maculata	3.2	2.94	12.66	5.07	5.07
Shrub	*Maireana microphylla*	1	0.57	1.16	0.97	87.91
	Solanum cinereum	1	0.98	12.66	1.69	72.68
	Eremophila debilis	1.8	1.56	3.12	2.69	46.72
Forb	*Chamaesyce drummondii*	1	0.37	0.59	0.63	89.52
	Templetonia stenophylla	1	0.37	0.57	0.63	90.15
	Rostellularia adscendens var. *adscendens*	1.2	0.57	0.62	0.97	88.89
	Pimelea curviflora var. *sericea*	1.2	0.62	0.62	1.06	82.96
	Wahlenbergia communis	1.2	0.67	1.08	1.15	79.68
	Phyllanthus virgatus	1.2	0.68	1.01	1.17	78.54
	Dysphania carinata	1.6	1.13	1.16	1.95	67.31
	Stackhousia muricata	1.6	1.23	1.16	2.13	63.41
	Chrysocephalum apiculatum	1.6	1.3	2.23	2.24	56.98
	Oxalis perennans	1.8	1.55	3.44	2.66	54.74
	Glossocardia bidens	1.8	1.56	3.12	2.69	49.41
	Brunoniella australis	2	1.96	12.66	3.38	19.05
	Calotis lappulacea	2	1.96	12.66	3.38	22.43
	Dichondra repens	2	1.96	12.66	3.38	25.81
	Sida corrugata	2	1.96	12.66	3.38	35.94
Grass	*Enteropogon acicularis*	1	0.58	1.15	1	84.99
	Eragrostis leptostachya	1.2	0.64	0.62	1.11	80.79
	Fimbristylis dichotoma	1.2	0.64	0.62	1.11	81.9
	Chloris ventricosa	1.4	0.85	1.06	1.47	77.36
	Austrostipa verticillata	2	0.94	0.98	1.62	74.31
	Lomandra multiflora subsp. *multiflora*	1.4	1.08	3.57	1.85	69.16
	Microlaena stipoides var. *stipoides*	1.8	1.23	1.16	2.13	61.28
	Cymbopogon refractus	1.8	1.56	3.12	2.69	44.03

Average similarity: 58.05						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Cyperus gracilis	1.8	1.58	2.85	2.72	38.66
	Aristida ramosa	2	1.96	12.66	3.38	15.68
	Lomandra confertifolia subsp. *pallida*	2	1.96	12.66	3.38	32.56
	Bothriochloa decipiens var. *decipiens*	2.4	2.06	5.46	3.55	12.3
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.8	1.56	3.12	2.69	41.35
Other	*Convolvulus graminetinus*	0.8	0.6	1.15	1.03	83.99
	Desmodium varians	1.4	0.92	0.98	1.59	75.89
	Glycine tabacina	2	1.96	12.66	3.38	29.18
Weed	*Hypochaeris albiflora*	0.8	0.57	1.16	0.97	86.94
	Lysimachia arvensis	1.6	1.13	1.16	1.95	65.36
	Sida rhombifolia	1.8	1.55	3.44	2.66	52.07
HTE	*Galenia pubescens*	1	0.57	1.16	0.97	85.97
	Senecio madagascariensis	1.4	1.07	4.49	1.84	70.99

5a. Derived Native Grassland (PCT1602)



Plant Community Type

PCT 1602 Spotted Gum - Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter

Status

Not a TEC

General Description

This community made up approximately 0.1% of the mapped derived native grasslands and was dominated by 14 grass species (Poaceae). The remainder consisted of scattered small herbs, twiners and low shrubs. There were also juvenile Narrow-leaved Ironbark (*Eucalyptus crebra*).

Species Richness

Native species 37; Weeds 12 including 6 High Threat Weeds
Plots: 1
Mean species/plot: N/A only one plot

Key Diagnostic Species
N/A only one plot

6. Narrow-leaved Ironbark Shrubby Forest (PCT1605)




Plant Community Type

PCT 1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter

Status

Listed EPBC Act, CE: Central Hunter Valley Eucalypt Forest and Woodland

General Description

This community made up approximately 19% of the mapped woodland and was the second most abundant community present. Canopy was clearly dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) making up 99% of the tree species with 1% being Grey Box x White Box hybrid (*Eucalyptus moluccana* x *Eucalyptus albens*) mostly recorded at the edges of the mapped areas. Ground cover consisted of 37 grass species and 37 forb species.

Species Richness

Native species 94; Weeds 36 including High Threat Weeds 10
Plots: 13
Mean species/plot 45±9.8SD

Key Diagnostic Species

Average similarity: 50.35

BAM Growth Form Group	Scientific Name	Av. Abund	Av. Sim	Sim/ SD	Contrib %	Cum. %
Tree	*Eucalyptus crebra*	3.77	4.48	4.86	8.91	8.91
Shrub	*Abutilon oxycarpum*	0.92	0.46	0.48	0.91	85.35
	Solanum cinereum	1.08	0.91	1.39	1.81	63.08
	Eremophila debilis	1.46	1.27	1.32	2.53	46.18
Forb	*Oxalis perennans*	0.92	0.42	0.58	0.84	87.09
	Brunoniella australis	1.08	0.6	0.6	1.2	77.8
	Sida hackettiana	1.23	0.6	0.56	1.2	79
	Dysphania carinata	1.08	0.67	0.86	1.32	75.32
	Einadia polygonoides	1.08	0.69	0.69	1.37	72.63
	Dichondra repens	1.08	0.69	0.86	1.37	74

Average similarity: 50.35						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Einadia hastata	1.23	0.74	0.69	1.47	71.26
	Sida corrugata	1.15	0.8	0.85	1.58	69.79
	Rostellularia adscendens var. *adscendens*	1.23	0.8	0.74	1.6	68.21
	Wahlenbergia communis	1.31	0.96	0.86	1.9	61.27
	Chrysocephalum apiculatum	1.69	1.72	1.85	3.42	40.43
	Calotis lappulacea	2.08	2.17	3.11	4.31	13.22
	Phyllanthus virgatus	0.77	0.36	0.55	0.71	89.43
Grass	*Digitaria divaricatissima*	0.69	0.4	0.58	0.8	88.72
	Sporobolus creber	0.92	0.42	0.58	0.84	87.92
	Rytidosperma tenuius	1	0.45	0.58	0.9	86.25
	Eragrostis leptostachya	0.92	0.49	0.57	0.97	84.44
	Fimbristylis dichotoma	1	0.58	0.58	1.16	82.49
	Panicum effusum	1.08	0.65	0.69	1.28	76.61
	Eragrostis lacunaria	1.15	0.87	0.98	1.74	66.61
	Chloris ventricosa	1.46	0.9	0.85	1.79	64.87
	Austrostipa scabra subsp. *falcata*	1.46	0.96	0.86	1.9	59.37
	Cyperus gracilis	1.31	1.02	0.99	2.03	57.47
	Lomandra confertifolia subsp. *pallida*	1.46	1.11	0.9	2.2	55.45
	Cymbopogon refractus	1.38	1.16	1.25	2.3	53.24
	Enteropogon acicularis	1.38	1.19	1.03	2.37	50.95
	Eriochloa pseudoacrotricha	1.77	1.62	1.39	3.22	43.65
	Austrostipa verticillata	2	1.77	1.61	3.51	37.01
	Aristida ramosa	2.08	2.07	2.21	4.11	29.87
	Bothriochloa decipiens var. *decipiens*	2.08	2.1	2.15	4.17	21.65
	Microlaena stipoides var. *stipoides*	2.08	2.14	2.19	4.26	17.48
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.08	0.59	0.6	1.17	80.17
Other	*Glycine tabacina*	1.85	2.07	2.2	4.11	25.76
Weed	*Solanum nigrum*	0.77	0.35	0.55	0.7	90.13
	Cynodon dactylon	1.23	0.49	0.36	0.98	83.47
	Sida rhombifolia	1.69	1.83	2.72	3.63	33.5
HTE	*Senecio madagascariensis*	0.85	0.58	0.89	1.16	81.33
	Galenia pubescens	1.92	1.21	0.87	2.39	48.57

6a. Derived Native Grassland (PCT1605)




Plant Community Type

PCT 1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter

Status

Not a TEC

General Description

This community made up approximately 24% of the mapped derived native grasslands and consisted mainly of forbs (34 species) and grasses (35 species).

Species Richness

Native species 83; 39 Weeds including High Threat Weeds 9 Plots: 15 Mean species/plot 41±7.3SD

Key Diagnostic Species

Average similarity: 53.12						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Shrub	*Solanum cinereum*	1.13	0.94	1.13	1.77	77.24
Forb	*Dysphania carinata*	0.93	0.45	0.47	0.85	90.67
	Vittadinia muelleri	1	0.59	0.67	1.11	86.82
	Calotis lappulacea	0.93	0.61	0.64	1.14	85.71
	Einadia polygonoides	1.07	0.69	0.6	1.3	83.33
	Wahlenbergia communis	1.2	0.84	0.8	1.58	82.03
	Oxalis perennans	1.2	0.87	0.79	1.63	78.87
	Brunoniella australis	1.27	0.96	0.82	1.8	75.47
	Chrysocephalum apiculatum	1.4	1.22	1.01	2.29	67.67
	Erodium crinitum	1.6	1.48	1.19	2.79	55.49
Grass	*Fimbristylis dichotoma*	0.87	0.45	0.48	0.85	89.83
	Chloris ventricosa	1.27	0.84	0.8	1.58	80.45
	Panicum queenslandicum var. *queenslandicum*	1.67	1.1	0.77	2.07	71.83
	Sporobolus creber	1.47	1.26	1.04	2.38	63.09
	Cymbopogon refractus	1.73	1.35	0.93	2.53	60.71

Average similarity: 53.12						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Eragrostis lacunaria	1.93	1.54	1.15	2.9	52.7
	Chloris truncata	2.13	1.74	1.24	3.27	46.87
	Panicum effusum	1.87	1.97	1.63	3.71	43.6
	Digitaria brownii	2.2	2.09	1.42	3.94	32.14
	Dichanthium sericeum subsp. *sericeum*	2.4	2.1	1.57	3.95	28.2
	Eriochloa pseudoacrotricha	2.27	2.22	1.59	4.19	24.25
	Digitaria divaricatissima	2.47	2.49	1.52	4.68	20.06
	Bothriochloa decipiens var. *decipiens*	2.73	2.71	2.08	5.1	10.47
	Aristida ramosa	2.87	2.85	3.29	5.37	5.37
Fern	*Cheilanthes sieberi* subsp. *sieberi*	2.07	2.61	8.36	4.91	15.38
Other	*Convolvulus graminetinus*	1	0.57	0.58	1.07	88.98
	Glycine tabacina	1.8	2.07	2.3	3.89	36.03
Weed	*Stachys arvensis*	1	0.58	0.65	1.09	87.9
	Sonchus oleraceus	1	0.66	0.77	1.24	84.57
	Sida spinosa	1.6	0.98	0.8	1.84	73.67
	Medicago sp.	1.4	1.22	0.98	2.29	65.38
	Sida rhombifolia	1.47	1.42	1.03	2.68	58.17
	Lysimachia arvensis	1.6	1.56	1.28	2.93	49.8
HTE	*Galenia pubescens*	1.2	1.11	1.34	2.09	69.76
	Carthamus lanatus	2.27	2.05	1.57	3.86	39.89

6b. Plantation (PCT1605)





Plant Community Type

Artificial vegetation community

Status

Not a TEC

General Description

This community comprised approximately 4% of the mapped woodland and consisted of a number of tree species that had been planted in previously cleared areas several years ago. The canopy generally consisted of Eucalypt species many not from the immediate region and several from

other States. There were also a number of *Acacia*, *Allocasuarina*, *Casuarina* and *Melaleuca* species. These plantations were assigned to PCT 1605 as being the most likely original pre-clearing community.

Species Richness

Native species 89; 28 Weeds including High Threat Weeds 6
Plots: 6
Mean species/plot 53±6.0SD

Key Diagnostic Species

Average similarity: 48.10

BAM Growth Form Group	Scientific Name	Av. Abund	Av. Sim	Sim/ SD	Contrib %	Cum. %
Tree	*Eucalyptus sideroxylon*	1	0.45	0.48	0.94	81.75
	Eucalyptus albens x moluccana	1.33	0.86	0.79	1.79	67.55
	Casuarina glauca	1.33	0.87	0.79	1.81	65.76
Shrub	*Enchylaena tomentosa*	1.33	1.18	4.26	2.46	51.4
	Eremophila debilis	1.83	1.88	2.98	3.9	26.46
Forb	*Wahlenbergia communis*	0.67	0.23	0.48	0.47	90.22
	Chamaesyce drummondii	1.17	0.36	0.41	0.75	86.86
	Einadia polygonoides	1	0.4	0.48	0.84	86.11
	Oxalis perennans	1	0.44	0.48	0.91	82.65
	Boerhavia dominii	1	0.53	0.72	1.1	78.68
	Portulaca oleracea	1.33	0.56	0.67	1.16	77.58
	Chrysocephalum apiculatum	0.83	0.75	1.35	1.55	72.4
	Vittadinia cuneata var. *hirsuta*	1.67	0.89	0.77	1.86	63.95
	Erodium crinitum	1.67	1.49	1.35	3.1	39.77
	Brunoniella australis	2	2.22	13.11	4.62	9.27
	Calotis lappulacea	2	2.22	13.11	4.62	13.89
Grass	*Enteropogon acicularis*	0.83	0.27	0.45	0.57	89.28
	Aristida ramosa	1	0.3	0.46	0.62	88.14
	Lomandra multiflora subsp. *multiflora*	0.83	0.32	0.43	0.66	87.52
	Rytidosperma tenuius	1	0.42	0.48	0.86	84.41
	Sporobolus creber	0.67	0.43	0.79	0.89	83.55
	Austrostipa aristiglumis	1	0.5	0.75	1.04	80.81
	Lomandra glauca	1.17	0.64	0.74	1.33	75.21
	Digitaria divaricatissima	0.83	0.72	1.36	1.49	73.89
	Panicum queenslandicum var. *queenslandicum*	1.5	0.96	1.18	2	58.21
	Panicum effusum	1.5	1.15	1.19	2.39	56.21
	Chloris ventricosa	1.67	1.43	1.36	2.98	48.94
	Cymbopogon refractus	1.67	1.49	1.35	3.1	42.87
	Eriochloa pseudoacrotricha	1.67	1.54	3.02	3.19	36.67
	Eragrostis lacunaria	2	1.55	2.84	3.21	33.47
	Dichanthium sericeum subsp. *sericeum*	2	1.83	3.77	3.8	30.26
	Lomandra confertifolia subsp. *pallida*	2	2.22	13.11	4.62	18.51
	Bothriochloa decipiens var. *decipiens*	2.5	2.24	1.35	4.65	4.65
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.67	1.16	1.17	2.42	53.82

Average similarity: 48.10						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Other	*Convolvulus graminetinus*	0.83	0.27	0.45	0.57	88.71
	Glycine tabacina	1.17	0.79	1.2	1.65	69.2
Weed	*Urochloa panicoides*	0.67	0.41	0.79	0.86	85.27
	Sida rhombifolia	1.33	0.58	0.63	1.2	76.42
	Plantago lanceolata	1.17	0.79	1.2	1.65	70.85
	Medicago sp.	1.83	1.49	1.35	3.1	45.96
	Lysimachia arvensis	2.17	1.95	2.75	4.05	22.56
HTE	*Galenia pubescens*	0.5	0.23	0.48	0.48	89.75
	Bidens subalternans	1	0.52	0.73	1.08	79.77
	Opuntia stricta var. *stricta*	1.33	0.92	1.18	1.92	62.09
	Lycium ferocissimum	1.33	0.94	1.15	1.96	60.17

7. White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606)





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, 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

General Description

This community made up only approximately 0.6% of the mapped woodland and was found along an ephemeral drainage line in the north of the Study Area. It was characterised by patches of Blakely's Red Gum (*Eucalyptus blakelyi*) along with Rough-barked Apple (*Angophora floribunda*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). Ground cover consisted of forbs (34 species) and grasses (32 species).

Species Richness

Native species 84; Weeds 39 including High Threat Weeds 10 Plots: 6 Mean species/plot 60±3.9SD

Key Diagnostic Species

Average similarity: 53.00						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Tree	*Eucalyptus blakelyi*	3	2.08	1.14	3.92	12.86
Shrub	*Enchylaena tomentosa*	0.6	0.31	0.62	0.58	89.18
	Eremophila debilis	1.8	1.56	2.95	2.95	29.74
Forb	*Glossocardia bidens*	0.8	0.3	0.62	0.56	90.31
	Dysphania carinata	1	0.37	0.57	0.7	87.33
	Sida corrugata	1	0.39	0.56	0.74	86.63
	Stackhousia muricata	1.2	0.57	0.62	1.08	83.79
	Einadia polygonoides	1.4	0.61	0.62	1.15	78.32
	Oxalis perennans	1.2	0.67	1.06	1.27	74.65
	Dichondra repens	1.2	0.69	1.06	1.3	73.38
	Brunoniella australis	1.6	1.16	1.16	2.2	49.79
	Wahlenbergia communis	1.6	1.16	1.16	2.2	56.38
	Calotis lappulacea	1.6	1.25	2.99	2.36	43.12
	Phyllanthus virgatus	1.8	1.56	2.95	2.95	32.69
	Chrysocephalum apiculatum	2	1.94	24.22	3.66	16.52
Grass	*Panicum effusum*	1.2	0.37	0.58	0.7	88.02
	Fimbristylis dichotoma	1.2	0.56	0.62	1.05	84.84
	Sporobolus creber	1.2	0.56	0.62	1.05	85.89
	Eragrostis lacunaria	1.2	0.66	1.06	1.25	77.17
	Lomandra confertifolia subsp. *pallida*	1.6	0.86	1.03	1.62	69.17
	Chloris ventricosa	1.4	0.87	1.04	1.64	67.55
	Lomandra glauca	1.4	0.89	1.03	1.68	65.92
	Cyperus gracilis	1.4	0.9	1.01	1.7	64.24
	Digitaria brownii	1.6	1.15	1.16	2.16	58.55
	Digitaria divaricatissima	1.8	1.15	1.16	2.16	60.71
	Dichanthium sericeum subsp. *sericeum*	1.8	1.16	1.16	2.2	51.99
	Rytidosperma tenuius	1.6	1.16	1.16	2.2	54.19
	Eriochloa pseudoacrotricha	1.6	1.19	1.16	2.24	45.37
	Panicum queenslandicum var. *queenslandicum*	1.6	1.25	2.85	2.37	40.77
	Microlaena stipoides var. *stipoides*	2.2	1.49	1.09	2.8	38.4
	Enteropogon acicularis	1.8	1.54	3.23	2.91	35.6
	Cymbopogon refractus	2.2	1.94	24.22	3.66	20.19
	Bothriochloa decipiens var. *decipiens*	3	2.22	5.68	4.19	8.95
	Aristida ramosa	3	2.52	4.93	4.76	4.76
Fern	*Cheilanthes sieberi* subsp. *sieberi*	1.4	0.85	1.05	1.61	70.78
Other	*Glycine tabacina*	2	1.94	24.22	3.66	23.85
Weed	*Gomphrena celosioides*	0.8	0.31	0.62	0.58	88.6

Average similarity: 53.00						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Schkuhria pinnata	1	0.57	1.16	1.08	81.64
	Verbena bonariensis	0.8	0.57	1.16	1.08	82.72
	Verbena rigida var. *rigida*	0.8	0.59	1.16	1.12	79.44
	Sida spinosa	1.2	0.69	1.05	1.31	72.08
	Sida rhombifolia	1.6	1.18	1.16	2.23	47.6
	Plantago lanceolata	1.8	1.56	2.95	2.95	26.79
HTE	*Bidens subalternans*	0.8	0.3	0.62	0.56	89.74
	Opuntia stricta var. *stricta*	0.8	0.59	1.16	1.11	80.56
	Galenia pubescens	1.4	0.67	1.01	1.27	75.92
	Senecio madagascariensis	1.2	0.97	24.22	1.83	62.54

7a. Derived Native Grassland (PCT1606)





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, 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

General Description

This community made up approximately 1.2% of the mapped derived native grasslands and consisted mainly of forbs (23 species) and grasses (24 species).

Species Richness

Native species 54; Weeds 42 including High Threat Weeds 11
Plots: 5
Mean species/plot 46±8.8SD

Key Diagnostic Species

Average similarity: 53.85						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Shrub	*Solanum cinereum*	1.17	0.67	0.7	1.25	84.03
Forb	*Chrysocephalum apiculatum*	1.33	0.87	0.78	1.62	76.92
	Calotis lappulacea	1.33	0.92	1.11	1.7	71.96
	Dysphania carinata	1.5	0.92	1.11	1.71	70.26
	Einadia polygonoides	1.5	1.12	1.17	2.09	66.81
	Vittadinia pustulata	1.5	1.15	1.23	2.14	64.73
	Wahlenbergia communis	1.67	1.39	1.35	2.58	62.59
	Erodium crinitum	1.67	1.47	1.34	2.72	57.43
	Oxalis perennans	1.83	1.85	2.8	3.43	33.55
Grass	*Panicum buncei*	1	0.46	0.48	0.85	90.07
	Chloris truncata	1	0.51	0.48	0.95	88.3
	Eragrostis lacunaria	1	0.56	0.69	1.04	87.35
	Austrostipa verticillata	1.83	0.69	0.65	1.29	82.78
	Enteropogon acicularis	1.33	0.78	0.79	1.46	81.49
	Microlaena stipoides var. *stipoides*	1.67	0.84	0.78	1.57	78.49
	Paspalidium aversum	1.5	0.89	0.78	1.66	75.3
	Cymbopogon refractus	1.67	1.47	1.34	2.72	54.71
	Dichanthium sericeum subsp. *sericeum*	2.17	1.58	1.31	2.93	46.17
	Eriochloa pseudoacrotricha	2	1.58	1.3	2.93	49.11
	Panicum queenslandicum var. *queenslandicum*	2.17	1.61	1.25	2.98	43.24
	Bothriochloa decipiens var. *decipiens*	2.5	1.81	1.28	3.36	36.91
	Panicum effusum	2.5	2.37	6.65	4.39	18.62
	Digitaria brownii	2.67	2.4	4.29	4.45	14.23
	Aristida ramosa	2.83	2.59	4.72	4.81	9.78
	Digitaria divaricatissima	3	2.67	3.71	4.96	4.96
Fern	*Cheilanthes sieberi* subsp. *sieberi*	2	1.85	2.8	3.43	30.12
Other	*Convolvulus graminetinus*	1.33	0.94	0.78	1.74	68.55
	Glycine tabacina	2	2.17	8.61	4.04	26.7
Weed	*Plantago lanceolata*	1.17	0.59	0.75	1.1	86.32
	Glandularia aristigera	1.17	0.64	0.7	1.19	85.22
	Lysimachia arvensis	1.33	0.84	0.78	1.55	80.04
	Cynodon dactylon	1.5	0.91	0.78	1.68	73.64
	Medicago sp.	1.83	1.8	3.3	3.34	40.26
	Sida rhombifolia	2.17	2.17	8.61	4.04	22.66
HTE	*Bidens subalternans*	1	0.49	0.75	0.92	89.22
	Galenia pubescens	1.67	1.39	1.35	2.58	60.01
	Carthamus lanatus	2	1.55	1.27	2.88	51.98

8a. Derived Native Grassland (PCT1655)





Plant Community Type

PCT 1655 Grey Box - Slaty Box shrub-grass woodland on sandstone slopes of the upper Hunter and Sydney Basin

Status

Not a TEC

General Description

This community was characterised by widely scattered Slaty Box (*Eucalyptus dawsonii*) paddock trees and made up approximately 0.3% of the mapped derived native grasslands; there was no Slaty Box woodland in the Study Area. The ground cover consisted mainly of forbs (15 species) and grasses (21 species).

Species Richness

Native species 45; Weeds 28 including High Threat Weeds 7
Plots: 4
Mean species/plot 39±6.0SD

Key Diagnostic Species

Average similarity: 59.97						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
Shrub	*Solanum cinereum*	1.5	1.6	3.28	2.66	71.82
Forb	*Chrysocephalum apiculatum*	1.5	1	0.82	1.67	89.97
	Brunoniella australis	1.5	1.33	0.91	2.22	88.3
	Einadia polygonoides	1.5	1.4	0.9	2.33	81.45
	Wahlenbergia communis	1.5	1.58	3.81	2.64	74.46
	Oxalis perennans	2	2.77	9.34	4.61	62.3
Grass	*Cymbopogon refractus*	1.5	1.4	0.9	2.33	79.12
	Sporobolus creber	1.5	1.4	0.9	2.33	83.78
	Digitaria divaricatissima	1.75	2.03	3.15	3.39	69.16
	Dichanthium sericeum subsp. *sericeum*	2.25	2.77	9.34	4.61	53.08
	Enteropogon acicularis	2.25	2.77	9.34	4.61	57.69
	Eriochloa pseudoacrotricha	2.5	2.99	5.4	4.98	39.24
	Chloris ventricosa	2.75	3	4.34	5.01	29.26

Average similarity: 59.97						
BAM Growth Form Group	**Scientific Name**	**Av. Abund**	**Av. Sim**	**Sim/ SD**	**Contrib %**	**Cum. %**
	Eragrostis lacunaria	2.75	3	4.34	5.01	34.27
	Aristida ramosa	3	3.46	3.92	5.78	18.47
	Panicum effusum	2.75	3.46	3.92	5.78	24.25
	Bothriochloa decipiens var. *decipiens*	3.25	4.15	9.34	6.92	6.92
Fern	*Cheilanthes sieberi* subsp. *sieberi*	2	2.77	9.34	4.61	48.47
Other	*Glycine tabacina*	1.25	0.85	0.84	1.42	91.39
Weed	*Sida rhombifolia*	1.25	1.38	9.34	2.31	86.08
	Cynodon dactylon	1.5	1.4	0.9	2.33	76.79
	Setaria parviflora	2	2.08	2.55	3.47	65.77
	Lysimachia arvensis	2	2.77	9.34	4.61	43.85
HTE	*Carthamus lanatus*	3	3.46	3.92	5.78	12.69

APPENDIX 3 PLOT FIELD DATA

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
**Alternanthera pungens*																	0.1												
**Bidens pilosa*															0.1													0.1	
**Bidens subalternans*	0.1	0.1			0.1	0.1	0.1			2					0.1		0.1		0.1	0.1	0.1		0.1		0.1			0.1	
**Carrichtera annua*																													
**Carthamus lanatus*	0.1			0.1		0.1	1						0.1					0.1			0.1	6		40	0.1		0.1		
**Cenchrus clandestinus*		0.1																											
**Cenchrus longisetus*																	0.1			0.1	1								
**Galenia pubescens*		1				0.1		0.1		0.1			0.1	0.1		6	1	0.1	0.1	0.1	0.1	0.1	1		0.1	0.1	0.1	0.1	7
**Hyparrhenia hirta*																													
**Hypericum perforatum*				0.1																									
**Lycium ferocissimum*	0.1	65	0.1														1						0.1					0.1	
**Opuntia aurantiaca*																0.1													
**Opuntia humifusa*												0.1				0.1		0.1										0.1	0.1
**Opuntia stricta var. stricta*				0.1	0.1	0.1	0.1					0.1				0.1		0.1	0.1				0.1			0.1			
**Paspalum dilatatum*		0.1													0.1	0.1	0.1			0.1	0.1					0.1			
**Senecio madagascariensis*	0.1	0.1					0.1				0.1			0.1	0.1	0.1				0.1						0.1			
**Xanthium occidentale*																	0.1												
**Xanthium spinosum*																	0.1												
Amaranthus powellii										0.1							2												
Argemone ochroleuca subsp. ochroleuca																			0.1										
Asphodelus fistulosus	0.1									0.1									0.1										
Capsella bursa-pastoris																													
Cerastium glomeratum																													
Cirsium vulgare	0.1																					0.1			0.1				
Citrullus amarus																	0.1												
Conyza bonariensis																													
Conyza sp.	0.1																												
Cucumis myriocarpus subsp. leptodermis																						0.1							
Cyanthillium cinereum var. cinereum											0.1																		
Cynodon dactylon										80							10												40
Cyperus rotundus																					0.1								

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
**Datura ferox*																													
**Echium plantagineum*																													
**Eleusine tristachya*																	0.1												
**Erodium cicutarium*																													
**Erodium moschatum*																													
**Glandularia aristigera*											0.1		0.1	0.1								3	0.1	0.1	0.1	0.1	0.1		
**Gomphocarpus fruticosus*	0.1					0.1	0.1															0.1							
**Gomphrena celosioides*				0.1												0.1		0.1											
**Hirschfeldia incana*																					0.1								
**Hypochaeris albiflora*		0.1						0.1	0.1			0.1			0.1	0.1				0.1						0.1	0.1	0.1	
**Kickxia elatine subsp. crinita*						0.1													0.1										
**Lactuca serriola*	1		0.1	0.1		0.1	0.1																						
**Lamium amplexicaule*																			0.1	0.1									
**Leontodon rhagadioloides subsp. cretica*																													
**Lepidium africanum*		0.1											0.1					0.1				0.1	0.1	0.1					
**Linum trigynum*																													
**Lysimachia arvensis*	0.1		0.1			0.1	0.1					0.1	0.1		0.1				0.1			0.1	0.1	0.1	0.1	0.1	0.1		
**Malva parviflora*						0.1				0.1			0.1				0.1		0.1										
**Marrubium vulgare*																	0.1												
**Medicago sativa*																													
**Medicago sp.*															0.1		0.1	0.1	0.1		0.1	0.1	0.1		0.1		0.1		
**Modiola caroliniana*		0.1								0.1								0.1											
**Nothoscordum gracile*																			0.1										
**Paronychia brasiliana*																0.1							0.1						
**Plantago lanceolata*		0.1	0.1	0.1			0.1			0.1			0.1		0.1	0.1	0.1		0.1	0.1	0.1		0.1						
**Prunella vulgaris*																													
**Rapistrum rugosum*	0.1		1				0.1			2						0.1	0.1		0.1		0.1								
**Richardia stellaris*								0.1				0.1								0.1						0.1			
**Salvia reflexa*			0.1														0.1												
**Salvia verbenaca*															0.1														
**Schkuhria pinnata*	0.1			0.1						0.1			0.1			0.1	0.1	0.1	0.1										
**Setaria parviflora*	0.1					0.1																0.1							
**Sherardia arvensis*																			0.1										
**Sida rhombifolia*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1	1		0.1	0.1		0.1	0.1		0.1	0.1		0.1	0.1

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
**Sida spinosa*			0.1		0.1	1	0.1	0.1			0.1	0.1	0.1	0.1		0.1	0.1	0.1	6	0.1	6	3		1	0.1		0.1	0.1	
**Solanum nigrum*		0.1					0.1								0.1	0.1							0.1				0.1	0.1	
**Solanum rostratum*										0.1																			
**Soliva sessilis*																													
**Sonchus asper*					0.1	0.1				0.1							0.1												
**Sonchus oleraceus*	0.1	0.1	0.1	0.1								0.1			0.1	0.1			0.1		0.1	0.1	0.1	0.1		0.1	0.1		
**Stachys arvensis*																						0.1			0.1		0.1		
**Tagetes minuta*																													
**Trifolium glomeratum*																													
**Trifolium sp.*																													
**Urochloa panicoides*									0.1	7						0.1	40	0.1	0.1		0.1	0.1					0.1		
**Verbena bonariensis*	0.1					0.1	0.1									0.1		0.1											
**Verbena rigida var. rigida*				0.1		0.1										0.1				0.1							0.1		
Abutilon oxycarpum															0.1													0.1	0.1
Acacia decora																													
Acacia paradoxa											0.1			0.1											0.1	0.1		
Acacia salicina																			0.1										
Acaena sp.																													
Allocasuarina gymnanthera											0.1																		
Allocasuarina luehmannii											0.1			0.1		2													
Alternanthera nana		0.1																											
Amyema miquelii																							0.1						
Angophora floribunda		10					3										35												
Anthosachne scabra												0.1										0.1							
Aristida leichhardtiana			0.1																										
Aristida ramosa	1		2	2	10	1	1	1	10	1	1	1	10	10	0.1	1	0.1	10	6	15	1	8	0.1	10	10	0.1	15	0.1	
Arthropodium milleflorum															0.1													0.1	
Arthropodium species B sensu Harden (1993)																													
Asperula conferta				0.1			0.1					0.1		0.1	0.1						0.1			0.1			0.1	0.1	
Atriplex semibaccata										0.1																			
Austrostipa aristiglumis															0.1				0.1										
Austrostipa scabra subsp. falcata																			0.1						0.1	0.1	0.1	0.1	
Austrostipa scabra subsp. scabra					0.1							0.1											0.1						0.1
Austrostipa verticillata	0.1	10				0.1		0.1		30	0.1			0.1	20		10		1	0.1	0.1	1	0.1					6	50

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
Boerhavia dominii		0.1		0.1		0.1	0.1							0.1	0.1			0.1	0.1										
Bothriochloa decipiens var. decipiens	20		1	8	15	2	1	7	15	1	7	1	10	10	1	10	0.1	1		15	0.1	15	0.1	2	50	0.1	50	1	
Bothriochloa macra																	0.1												
Brachychiton populneus subsp. populneus								0.1			0.1	0.1		0.1	0.1								0.1		0.1	0.1		0.1	
Brachyscome ciliaris																													
Brunoniella australis	0.1		0.1		0.1	0.1	0.1	0.1	2		0.1	0.1	0.1		0.1			0.1		0.1			0.1	0.1	0.1	0.1	0.1	0.1	
Bursaria spinosa											0.1	0.1		0.1								0.1	0.1	0.1		10	0.1		
Calotis lappulacea		0.1			0.1			0.1	0.1		0.1	0.1		0.1	0.1	0.1	0.1			0.1		0.1	0.1			0.1		10	10
Carex inversa		0.1				0.1	0.1																					0.1	0.1
Cassinia sifton																							0.1						
Cassinia uncata																													
Casuarina cunninghamiana subsp. cunninghamiana																			0.1										
Casuarina glauca																													
Chamaesyce drummondii	0.1		0.1			0.1	0.1		0.1		0.1			0.1				0.1		0.1				0.1	0.1			0.1	
Cheilanthes distans											0.1			0.1									0.1					0.1	
Cheilanthes sieberi subsp. sieberi	0.1		0.1		0.1	0.1	0.1				0.1		0.1		0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1	0.1	0.1	0.1	
Chloris truncata	0.1			0.1														10		10		10		6	10		0.1		
Chloris ventricosa	0.1		7		0.1	0.1	0.1	0.1	0.1		0.1	0.1	1	4	65		0.1		6	0.1		0.1	0.1	0.1	0.1		0.1	20	0.1
Chrysocephalum apiculatum	0.1		0.1	0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	
Commelina cyanea																0.1													
Convolvulus graminetinus	0.1		0.1	0.1	0.1		0.1		0.1		0.1	0.1	0.1		0.1			0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1		
Corymbia maculata											20															40			
Cullen tenax																													
Cymbonotus lawsonianus																													
Cymbopogon refractus	0.1		10	0.1	10	10	8	0.1	0.1		1	0.1		0.1	1	0.1			0.1	0.1				0.1	0.1	0.1	0.1	0.1	
Cyperus gracilis					0.1			0.1			0.1	0.1		0.1	0.1	0.1				0.1			0.1			0.1		0.1	0.1
Daucus glochidiatus																													
Denhamia silvestris																													
Desmodium gunnii																								0.1					
Desmodium varians					0.1				0.1		0.1	0.1		0.1									0.1			0.1		0.1	
Dianella longifolia var. longifolia															0.1											0.1			
Dianella revoluta var. revoluta											0.1				0.1								0.1						
Dichanthium sericeum subsp. sericeum	30		30	40	0.1	10	10	0.1	0.1	0.1	0.1	0.1	30		1		0.1	10	10	15	20	20		65	15		20		
Dichelachne micrantha															0.1														

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
Dichondra repens		0.1	0.1	0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Dichondra sp. Inglewood (J.M.Dalby 86/93) Qld Herbarium											0.1	0.1																	
Digitaria brownii	1		0.1		0.1	10					0.1		0.1		0.1	0.1	0.1		0.1	0.1	0.1	10			0.1		0.1		
Digitaria diffusa																													
Digitaria divaricatissima	30		30	10		15	1			6						10	10	10	0.1	0.1	6			0.1	1				0.1
Dysphania carinata		0.1										0.1	0.1			0.1	0.1	0.1				0.1	0.1	0.1	0.1	0.1		0.1	
Eclipta platyglossa		0.1																											
Einadia hastata		0.1													0.1	0.1	0.1						0.1					0.1	10
Einadia nutans subsp. linifolia																										0.1		0.1	
Einadia polygonoides	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	1		0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1		0.1	0.1		0.1	0.1		0.1
Enchylaena tomentosa								0.1								0.1		0.1		0.1									
Enteropogon acicularis	20		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	35	0.1	0.1	1	0.1	5	7	0.1		0.1	0.1	0.1	1	0.1		0.1	
Eragrostis brownii																							0.1						
Eragrostis lacunaria	20		1	1				0.1	0.1			0.1		0.1	0.1	0.1			0.1	0.1		0.1		0.1	0.1		0.1		
Eragrostis leptostachya					0.1			0.1			0.1	0.1		0.1		0.1				0.1			0.1		0.1	0.1	0.1	0.1	0.1
Eragrostis sororia																	0.1												
Eremophila debilis			0.1	0.1	0.1	0.1		1	0.1		0.1	0.1		0.1	0.1	0.1			0.1	0.1			0.1			0.1	0.1	0.1	0.1
Eriochloa pseudoacrotricha	20	0.1	7	10		10	1		0.1	6		0.1	10		0.1	1	20	15		0.1	0.1	15	0.1	10	8	0.1	10	20	0.1
Erodium crinitum							0.1								0.1				0.1		0.1	0.1		0.1	0.1		0.1		
Eucalyptus albens																													
Eucalyptus albens x moluccana					15				20					10	35							0.1							
Eucalyptus blakelyi																35													
Eucalyptus conica																													
Eucalyptus crebra								40			5	35		6					6				10			0.1		35	25
Eucalyptus dawsonii																													
Eucalyptus melliodora																				35									
Eucalyptus microcarpa																			10										
Eucalyptus moluccana												6		15									7						
Eucalyptus sideroxylon																													
Eucalyptus tereticornis		30																											
Eulalia aurea																					0.1								
Evolvulus alsinoides var. decumbens																													
Fimbristylis dichotoma	0.1				0.1	0.1		0.1	0.1		0.1		0.1			0.1		0.1				0.1	0.1			0.1			
Galium leiocarpum																													

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
Geranium solanderi var. solanderi																													
Glossocardia bidens			0.1		0.1	0.1		0.1	0.1		0.1	0.1													0.1				
Glycine clandestina		0.1	0.1	0.1								0.1		0.1			0.1			0.1	0.1			0.1	0.1	0.1	0.1		0.1
Glycine tabacina	0.1	0.1	0.1	1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Goodenia pinnatifida			0.1	0.1					0.1			0.1	0.1		0.1					0.1									
Hackelia suaveolens														0.1															
Hydrocotyle laxiflora														0.1											0.1				
Hypoxis pratensis var. pratensis							0.1						0.1													0.1			
Lagenophora stipitata														0.1															
Leiocarpa panaetioides																		0.1											
Linum marginale			0.1																										
Lobelia purpurascens											0.1																		
Lomandra confertifolia subsp. pallida					10	0.1	0.1	7	0.1		0.1	0.1		0.1	0.1	0.1				0.1	0.1	0.1	0.1		0.1	0.1		0.1	
Lomandra filiformis subsp. coriacea																													
Lomandra glauca	0.1							0.1			0.1			0.1		0.1							0.1						
Lomandra multiflora subsp. multiflora					0.1						0.1	0.1		0.1		0.1							0.1		0.1	0.1		0.1	
Maireana enchylaenoides																													
Maireana microphylla		1											0.1	0.1									0.1			0.1	0.1	6	0.1
Marsdenia viridiflora subsp. viridiflora																													
Melia azedarach																													
Mentha satureioides			0.1	0.1			0.1				0.1	0.1		0.1							0.1			0.1		0.1		
Microlaena stipoides var. stipoides		1			7		7	0.1			1	6	1	10		10	0.1		1	0.1		0.1	0.1			10	1	20	0.1
Mimulus gracilis							0.1																						
Minuria leptophylla				0.1																0.1									
Myoporum montanum																									3				
Neptunia gracilis f. gracilis			1						0.1									0.1	0.1		0.1				0.1				
Notelaea microcarpa var. microcarpa												0.1			0.1														
Oxalis perennans	0.1	0.1		0.1		0.1	0.1				0.1		0.1		0.1		0.1		0.1	0.1		0.1	0.1		0.1	0.1	0.1	0.1	
Oxytes brachypoda																													
Ozothamnus diosmifolius																0.1													
Panicum buncei			10																			1							
Panicum effusum			0.1		0.1	1					0.1		0.1			0.1	0.1	0.1	0.1	0.1		0.1	0.1			0.1	0.1		
Panicum queenslandicum var. queenslandicum	30		30	25	0.1	50	85		0.1	10		0.1	0.1		7	0.1	0.1		0.1	0.1	70		0.1	0.1	0.1		0.1		
Panicum simile																			0.1			0.1							

Species \ Plots	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
Parsonsia lanceolata																													
Paspalidium aversum	1	0.1	7	1	0.1					6			1			0.1	0.1				1	8							
Paspalidium criniforme					0.1						0.1	0.1		0.1															
Paspalidium distans														0.1	2	0.1			0.1	0.1					0.1		0.1	0.1	
Phyllanthus virgatus	0.1			0.1	0.1			0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1			0.1	0.1	0.1	0.1	0.1	0.1	
Pimelea curviflora var. sericea											0.1	0.1		0.1	0.1								0.1	0.1	0.1	0.1	0.1		
Plantago debilis												0.1		0.1	0.1														
Poa sieberiana var. hirtella																													
Portulaca oleracea																0.1	0.1	0.1	0.1						0.1		0.1	0.1	
Psydrax odorata																													
Rhynchosia minima																													
Rostellularia adscendens var. adscendens					0.1			0.1			0.1	0.1		0.1	0.1								0.1					0.1	
Rumex brownii		0.1			0.1														0.1									0.1	
Rytidosperma caespitosum																						0.1				0.1	0.1	0.1	
Rytidosperma fulvum																1					0.1		0.1						
Rytidosperma longifolium									1		0.1	1	0.1	0.1					0.1	0.1				0.1					
Rytidosperma racemosum var. racemosum											0.1	0.1																	0.1
Rytidosperma setaceum																													
Rytidosperma tenuius	1	0.1	0.1	8						0.1																			
Scleria mackaviensis																													
Sclerolaena muricata var. muricata																									0.1				
Sida corrugata		0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1		0.1	0.1	0.1		0.1		0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sida hackettiana					0.1																							0.1	0.1
Solanum brownii																													
Solanum campanulatum																							0.1						
Solanum cinereum				0.1						0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Solanum prinophyllum																										0.1			
Solenogyne bellioides									0.1											0.1									
Sorghum leiocladum																													
Sporobolus caroli																		0.1											
Sporobolus creber	3		1	0.1		0.1			0.1			0.1	0.1		0.1	0.1				0.1	0.1	0.1	0.1	1	0.1		0.1	0.1	
Stackhousia muricata								0.1			0.1	0.1												0.1		0.1			
Swainsona galegifolia																													
Templetonia stenophylla																0.1							0.1			0.1			

Plots / Species	200323P1	200323P2	200323P3	200323P4	200324P3	200324P4	200324P5	200324P6	200324P7	200324P8	200325P1	200325P2	200325P3	200325P4	200327P1	200327P2	200327P3	200327P4	200327P5	200327P6	200327P7	200331P1	200331P2	200331P3	200331P4	200331P5	200331P6	200331P7	200331P8
Themeda avenacea																													
Tragus australianus																		1											
Tribulus micrococcus															0.1														
Verbena gaudichaudii																													
Veronica plebeia								0.1																					
Viola betonicifolia subsp. betonicifolia																													
Vittadinia cervicularis var. subcervicularis																													
Vittadinia cuneata var. cuneata																													
Vittadinia cuneata var. hirsuta							0.1							0.1								0.1							
Vittadinia gracilis																													
Vittadinia muelleri	0.1		0.1	0.1		0.1	0.1		0.1				0.1					0.1		0.1				0.1	0.1		0.1		
Vittadinia pterochaeta				0.1																				0.1					
Vittadinia pustulata			0.1						0.1				0.1		0.1					0.1	0.1		0.1		0.1	0.1	0.1		
Vittadinia sulcata		0.1						0.1		0.1		0.1		0.1				0.1										0.1	0.1
Wahlenbergia communis			0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1			0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	
Wahlenbergia luteola																													
Walwhalleya subxerophila	3																												
Zornia dyctiocarpa var. dyctiocarpa																0.1													

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
**Alternanthera pungens																												
**Bidens pilosa	0.1	0.1		0.1	0.1	30			0.1		0.1		0.1	0.1		0.1					0.1	0.1	0.1		0.1			
**Bidens subalternans	0.1	0.1		0.1	0.1	30		0.1		0.1	0.1			0.1				0.1	0.1		0.1	0.1	0.1		2			0.1
**Carrichtera annua																												
**Carthamus lanatus		0.1	0.1		0.1		0.1	10	0.1	0.1		70	50		60		30				0.1	10	0.1	25	0.1	35	6	0.1
**Cenchrus clandestinus																												
**Cenchrus longisetus																												
**Galenia pubescens				0.1	0.1		0.1	0.1	0.1	0.1	0.1			0.1			0.1	0.1	0.1	0.1		0.1			0.1			0.1
**Hyparrhenia hirta																												
**Hypericum perforatum																												
**Lycium ferocissimum				0.1		0.1				0.1																		
**Opuntia aurantiaca																												
**Opuntia humifusa				0.1								0.1		0.1		0.1	0.1								0.1			
**Opuntia stricta var. stricta	0.1			0.1					0.1	0.1		0.1	0.1	0.1						0.1							0.1	
**Paspalum dilatatum							0.1																1					
**Senecio madagascariensis	0.1					0.1	0.1		0.1	0.1	0.1			0.1		0.1				0.1					0.1			
**Xanthium occidentale																												
**Xanthium spinosum																												
*Amaranthus powellii																												
*Argemone ochroleuca subsp. ochroleuca		0.1																										
*Asphodelus fistulosus			0.1		0.1	0.1															0.1	0.1	0.1		0.1		0.1	
*Capsella bursa-pastoris																												
*Cerastium glomeratum																												
*Cirsium vulgare				0.1																								
*Citrullus amarus																												
*Conyza bonariensis																												
*Conyza sp.																												

Species \ Plots	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
**Cucumis myriocarpus subsp. leptodermis*																												
**Cyanthillium cinereum var. cinereum*				0.1												0.1												
**Cynodon dactylon*				0.1			0.1																					
**Cyperus rotundus*																												
**Datura ferox*																												
**Echium plantagineum*													0.1				0.1										0.1	
**Eleusine tristachya*																												
**Erodium cicutarium*																												
**Erodium moschatum*																												
**Glandularia aristigera*							0.1	0.1	0.1	0.1		0.1	0.1		0.1		0.1		0.1	0.1								
**Gomphocarpus fruticosus*			0.1				0.1		0.1				0.1				0.1				0.1	0.1	0.1					
**Gomphrena celosioides*										0.1									0.1									
**Hirschfeldia incana*																												
**Hypochaeris albiflora*											0.1			0.1						0.1	0.1				0.1			
**Kickxia elatine subsp. crinita*								0.1												0.1				0.1				
**Lactuca serriola*																												
**Lamium amplexicaule*							0.1														0.1		0.1				0.1	
**Leontodon rhagadioloides subsp. cretica*																												
**Lepidium africanum*	0.1			0.1		0.1			0.1	0.1		0.1	0.1	0.1				0.1	0.1	0.1								0.1
**Linum trigynum*																												
**Lysimachia arvensis*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
**Malva parviflora*														0.1									0.1		0.1			
**Marrubium vulgare*																												
**Medicago sativa*																								0.1			0.1	
**Medicago sp.*			0.1		0.1		0.1	0.1				0.1		0.1			0.1	0.1		0.1	0.1		0.1		0.1		0.1	0.1
**Modiola caroliniana*									0.1																			
**Nothoscordum gracile*																												

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
**Paronychia brasiliana*										0.1										0.1								
**Plantago lanceolata*	0.1					0.1	0.1		0.1	0.1	0.1			0.1						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
**Prunella vulgaris*																												
**Rapistrum rugosum*					2							0.1										0.1	0.1	0.1	0.1	0.1	0.1	
**Richardia stellaris*							0.1																		0.1			
**Salvia reflexa*																								0.1		0.1	0.1	
**Salvia verbenaca*																												
**Schkuhria pinnata*						0.1			0.1				0.1				0.1									0.1		
**Setaria parviflora*																												
**Sherardia arvensis*																												
**Sida rhombifolia*			0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				0.1	0.1		0.1	0.1	1		0.1			0.1
**Sida spinosa*		0.1	0.1		0.1			0.1				0.1	0.1		0.1		0.1		0.1			0.1			0.1			
**Solanum nigrum*	0.1						0.1	0.1	0.1		0.1		0.1		0.1		0.1			0.1					0.1			
**Solanum rostratum*																												
**Soliva sessilis*										0.1										0.1								
**Sonchus asper*																												
**Sonchus oleraceus*	0.1			0.1	0.1	0.1				0.1	0.1	0.1		0.1		0.1		0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1
**Stachys arvensis*					0.1		0.1	0.1	0.1			0.1					0.1				0.1	0.1	0.1	0.1	0.1	0.1		0.1
**Tagetes minuta*													0.1															
**Trifolium glomeratum*											0.1																	
**Trifolium sp.*	0.1				0.1	0.1																	0.1	0.1				
**Urochloa panicoides*				0.1					0.1								0.1			0.1	0.1		0.1	0.1		0.1	0.1	0.1
**Verbena bonariensis*									0.1	0.1											0.1	0.1						
**Verbena rigida var. rigida*																												
Abutilon oxycarpum						0.1																						
Acacia decora																												
Acacia paradoxa																0.1												
Acacia salicina																												
Acaena sp.																				0.1								
Allocasuarina gymnanthera																												
Allocasuarina luehmannii																												
Alternanthera nana	0.1					0.1																						

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Amyema miquelii																												
Angophora floribunda							10		1																			
Anthosachne scabra																												
Aristida leichhardtiana																							0.1				0.1	
Aristida ramosa	40	0.1	0.1	0.1	10	0.1	10	8	15	1	30	1	6	0.1	0.1	1	10	0.1	3	10	0.1	0.1	0.1		0.1	0.2		0.1
Arthropodium milleflorum																												
Arthropodium species B sensu Harden (1993)	0.1			0.1						0.1				0.1		0.1	0.1	0.1		0.1								
Asperula conferta	0.1		0.1	0.1	0.1	0.1	0.1				0.1			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1		
Atriplex semibaccata																										0.1		
Austrostipa aristiglumis																											10	
Austrostipa scabra subsp. falcata			0.1	0.1			0.1			50	0.1	0.1		1		0.1	0.1	0.1	0.1	10					0.1			
Austrostipa scabra subsp. scabra																												
Austrostipa verticillata	0.1			0.1	0.1	6	0.1			3			0.1	2				0.1							0.1			
Boerhavia dominii	0.1		0.1	0.1		0.1	0.1		0.1	0.1			0.1	0.1			0.1	0.1		0.1					0.1			
Bothriochloa decipiens var. decipiens	0.1	1	15	10	10		40	20	20	1	10	1	20	0.1	10	0.1	15	0.1	10	0.1	6	0.1	0.1	1	0.1	1	0.1	
Bothriochloa macra																				0.1								
Brachychiton populneus subsp. populneus	7					0.1										0.1		0.1							0.1			
Brachyscome ciliaris																			0.1									0.1
Brunoniella australis	0.1	0.1	0.1	0.1		0.1			0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1			0.1
Bursaria spinosa																0.1												
Calotis lappulacea	0.1			0.1	0.1		0.1	0.1	0.1	20	0.1		0.1	0.1		0.1	0.1		0.1	0.1			0.1	0.1	0.1	0.1		0.1
Carex inversa	0.1				0.1	0.1				0.1				0.1				0.1		0.1								
Cassinia sifton																												
Cassinia uncata																									0.1			
Casuarina cunninghamiana subsp. cunninghamiana																												
Casuarina glauca																												

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Chamaesyce drummondii	0.1	0.1	0.1	0.1			0.1			0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	
Cheilanthes distans	0.1	0.1		0.1			0.1		0.1		0.1								0.1									
Cheilanthes sieberi subsp. sieberi	0.1	0.1	0.1	0.1			6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1			0.1		0.1
Chloris truncata		0.1	0.1		0.1			0.1	0.1		0.1	60	10		50		15		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1
Chloris ventricosa	30	0.1	0.1	6	1	0.1	0.1	0.1	0.1		2	0.1	0.1	0.1	0.1	0.1	1	0.1	1	0.1		0.1			0.1			70
Chrysocephalum apiculatum	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	1	0.1		0.1
Commelina cyanea																												
Convolvulus graminetinus	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1
Corymbia maculata	10					40										25			10									
Cullen tenax																					0.1	0.1	0.1					
Cymbonotus lawsonianus																												
Cymbopogon refractus	0.1	10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2	1	6	0.1	6	0.1	3	0.1	2	0.1	30	25	25	6	3	1	0.1	
Cyperus gracilis	0.1			0.1		0.1				0.1	0.1			0.1		0.1		0.1	0.1	0.1								
Daucus glochidiatus																												
Denhamia silvestris																												
Desmodium gunnii																												
Desmodium varians	0.1								0.1		0.1			0.1		0.1					0.1							
Dianella longifolia var. longifolia						0.1			0.1																			
Dianella revoluta var. revoluta																												
Dichanthium sericeum subsp. sericeum		50	70		60	1	10	10	15		0.1	10	40	0.1	15	0.1	3	0.1	0.1		15	8	10	80	60	25	25	10
Dichelachne micrantha																												
Dichondra repens	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1			0.1		0.1		0.1	0.1		0.1	0.1			0.1	0.1	0.1	
Dichondra sp. Inglewood (J.M.Dalby 86/93) Qld Herbarium																												
Digitaria brownii		0.1					6	10	0.1	0.1	0.1		7													0.1		0.1
Digitaria diffusa																												
Digitaria divaricatissima	0.1	0.1			0.1		0.1	10	0.1	0.1		0.1			0.1		10		0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1
Dysphania carinata		0.1	0.1	0.1			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1			0.1			0.1
Eclipta platyglossa																												

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Einadia hastata	0.1									0.1	0.1	0.1	0.1	0.1						0.1								0.1
Einadia nutans subsp. linifolia						0.1																						
Einadia polygonoides	0.1	0.1	0.1	0.1	0.1		0.1	0.1			0.1	6	0.1	0.1	0.1	0.1		0.1	0.1	1		0.1	0.1		0.1	0.1		0.1
Enchylaena tomentosa										0.1								0.1										
Enteropogon acicularis		10	2				1	0.1	0.1				1	0.1	0.1			0.1		0.1				0.1				
Eragrostis brownii																												
Eragrostis lacunaria	0.1						0.1	0.1	0.1	0.1	1	0.1		0.1			0.1	0.1	0.1	8		0.1			0.1	0.1		0.1
Eragrostis leptostachya																		0.1										
Eragrostis sororia																												
Eremophila debilis	0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1			0.1			0.1
Eriochloa pseudoacrotricha		15	0.1	0.1	10	0.1		0.1		0.1	0.1	0.1		0.1	0.1		1	0.1	0.1	0.1		0.1		0.1	2	60	15	0.1
Erodium crinitum		0.1			0.1		1	0.1	0.1	0.1	0.1						0.1	0.1				0.1	0.1			0.1		0.1
Eucalyptus albens																												
Eucalyptus albens x moluccana	15			40							0.1			40		15		35	25	35	10		3		10			
Eucalyptus blakelyi																												
Eucalyptus conica									0.1																			
Eucalyptus crebra									3	15	40																	
Eucalyptus dawsonii																												
Eucalyptus melliodora																												
Eucalyptus microcarpa																												
Eucalyptus moluccana																												
Eucalyptus sideroxylon																												
Eucalyptus tereticornis																												
Eulalia aurea									0.1																			
Evolvulus alsinoides var. decumbens																												
Fimbristylis dichotoma							0.1	0.1	0.1		0.1						0.1		0.1									
Galium leiocarpum																												
Geranium solanderi var. solanderi	0.1						0.1		0.1												0.1							

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Glossocardia bidens			0.1	0.1				0.1			0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1					0.1			
Glycine clandestina			0.1			0.1									0.1						0.1	0.1						0.1
Glycine tabacina	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Goodenia pinnatifida																			0.1				0.1		0.1			0.1
Hackelia suaveolens				0.1			0.1									0.1				0.1				0.1				
Hydrocotyle laxiflora				0.1																								
Hypoxis pratensis var. pratensis																												
Lagenophora stipitata																												
Leiocarpa panaetioides																							0.1					
Linum marginale																												
Lobelia purpurascens				0.1		0.1								0.1		0.1												
Lomandra confertifolia subsp. pallida	0.1		0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1	2	0.1	1		0.1	6	2	1	0.1	0.1					
Lomandra filiformis subsp. coriacea										0.1																		
Lomandra glauca																				0.1								
Lomandra multiflora subsp. multiflora			0.1				0.1		0.1		0.1					0.1			0.1									
Maireana enchylaenoides																												
Maireana microphylla		0.1			0.1	0.1	0.1		0.1					0.1			0.1	0.1	0.1									
Marsdenia viridiflora subsp. viridiflora																	0.1											
Melia azedarach						0.1																						
Mentha satureioides	0.1	0.1			0.1						0.1	0.1		0.1	0.1	0.1			0.1	0.1	0.1		0.1		0.1			
Microlaena stipoides var. stipoides	10			0.1		0.1	6	0.1	0.1	1	10			0.1		0.1			0.1						0.1			
Mimulus gracilis																												
Minuria leptophylla																												
Myoporum montanum	0.1			0.1																								
Neptunia gracilis f. gracilis																					0.1		0.1					
Notelaea microcarpa var. microcarpa	0.1			0.1		1										0.1												
Oxalis perennans	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Oxytes brachypoda																			0.1									

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Ozothamnus diosmifolius																												
Panicum buncei																									0.1			
Panicum effusum		0.1					15	10	10	0.1	0.1	0.1						0.1										0.1
Panicum queenslandicum var. queenslandicum	0.1	6	0.1	0.1	6	0.1	1	15	1		0.1	2	10	0.1	1	0.1	1			2	40	60	50	10	10	80	50	0.1
Panicum simile																												
Parsonsia lanceolata				0.1																0.1								
Paspalidium aversum										0.1													0.1					0.1
Paspalidium criniforme	0.1			15		0.1				0.1				0.1		0.1		0.1	0.1	0.1					1			
Paspalidium distans			0.1		1				0.1							0.1			0.1				0.1					
Phyllanthus virgatus		0.1	0.1	0.1					0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1			
Pimelea curviflora var. sericea	0.1	0.1	0.1	0.1	0.1	0.1	0.1						0.1	0.1	0.1	0.1			0.1		0.1	0.1	0.1		0.1			
Plantago debilis	0.1			0.1																0.1								
Poa sieberiana var. hirtella																												
Portulaca oleracea										0.1		0.1	0.1				0.1		0.1									0.1
Psydrax odorata																0.1												
Rhynchosia minima									0.1				0.1				0.1		0.1		1	0.1	0.1	0.1	0.1			
Rostellularia adscendens var. adscendens			0.1	0.1		0.1	0.1		0.1	0.1	0.1					0.1	0.1	0.1	0.1	1	0.1		0.1					
Rumex brownii						0.1																			0.1			
Rytidosperma caespitosum		0.1		40	0.1																0.1	0.1		0.1	1	0.1	1	0.1
Rytidosperma fulvum																							0.1					
Rytidosperma longifolium						6																						
Rytidosperma racemosum var. racemosum																												
Rytidosperma setaceum																												
Rytidosperma tenuius									0.1	0.1	25	0.1		1	0.1	0.1		0.1	0.1	15								
Scleria mackaviensis				0.1															0.1		0.1							
Sclerolaena muricata var. muricata																								0.1				
Sida corrugata	0.1	0.1	0.1	0.1		0.1			0.1		0.1	0.1		0.1	0.1	0.1		0.1					0.1		0.1	0.1		

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Sida hackettiana								0.1		0.1				0.1				0.1	0.1		0.1			0.1	0.1			
Solanum brownii	0.1												0.1															
Solanum campanulatum																												
Solanum cinereum			0.1	0.1			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1	0.1				0.1			0.1
Solanum prinophyllum																												
Solenogyne bellioides														0.1		0.1												
Sorghum leiocladum																							10					
Sporobolus caroli																												
Sporobolus creber	0.1	0.1	0.1	0.1			1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1						0.1	0.1	0.1		0.1
Stackhousia muricata	0.1		0.1				0.1		0.1		0.1				0.1				0.1		0.1							
Swainsona galegifolia																												
Templetonia stenophylla									0.1							0.1												
Themeda avenacea																												
Tragus australianus			0.1																									
Tribulus micrococcus					0.1												6		0.1									
Verbena gaudichaudii																							0.1	0.1				
Veronica plebeia										0.1										0.1								
Viola betonicifolia subsp. betonicifolia	0.1																											
Vittadinia cervicularis var. subcervicularis																											0.1	
Vittadinia cuneata var. cuneata																0.1												
Vittadinia cuneata var. hirsuta				0.1						0.1			0.1	0.1				0.1										
Vittadinia gracilis																								0.1				0.1
Vittadinia muelleri		0.1	0.1				0.1	0.1	0.1		0.1	0.1	0.1		0.1		0.1					0.1	0.1		0.1	0.1	0.1	0.1
Vittadinia pterochaeta		0.1																			0.1	0.1			0.1		0.1	
Vittadinia pustulata			0.1		0.1		0.1	0.1			0.1	0.1	0.1	0.1	0.1				0.1	0.1			0.1			0.1		
Vittadinia sulcata	0.1				0.1	0.1																						
Wahlenbergia communis	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1
Wahlenbergia luteola						0.1																						
Walwhalleya subxerophila																												

Plots / Species	200402P1	200402P2	200402P3	200402P4	200402P5	200402P6	200406P1	200406P2	200406P3	200406P5	200406P8	200407P1	200407P2	200407P3	200407P4	200407P5	200407P6	200407P7	200407P8	200407P9	200408P1	200408P2	200408P3	200408P4	200408P5	200408P6	200408P7	200420P1
Zornia dyctiocarpa var. dyctiocarpa							0.1		0.1																			

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
**Alternanthera pungens*																																
**Bidens pilosa*											0.1				0.1														0.1			
**Bidens subalternans*							0.1	0.1		0.1	0.1				0.1	0.1		0.1	0.1					0.1	0.1	0.1				0.1		
**Carrichtera annua*							1																									
**Carthamus lanatus*		0.1	0.1	0.1	20				15	40		0.1	10	0.1	0.1	0.1	10		0.1		10	0.1	25	10	1	15	30	40		0.1		7
**Cenchrus clandestinus*																																
**Cenchrus longisetus*																0.1																
**Galenia pubescens*	0.1	0.1	0.1	10	0.1	30	0.1	60			0.1						0.1	0.1		1	0.1			0.1		0.1	0.1	0.1	0.1	25	80	
**Hyparrhenia hirta*					0.1																											
**Hypericum perforatum*																																
**Lycium ferocissimum*	1		0.1			0.1	0.1	0.1					0.1		0.1									0.1	0.1	0.1			0.1	0.1		
**Opuntia aurantiaca*																																
**Opuntia humifusa*																		0.1						0.1			0.1		0.1	0.1		
**Opuntia stricta var. stricta*			0.1			0.1	0.1	0.1	0.1		0.1	0.1	0.1		0.1			0.1						0.1			0.1					
**Paspalum dilatatum*																							0.1	0.1								0.1
**Senecio madagascariensis*	0.1								0.1	0.1	0.1	0.1	0.1					0.1			0.1			0.1	0.1	0.1			0.1	0.1	0.1	
**Xanthium occidentale*																																
**Xanthium spinosum*																																
Amaranthus powellii				0.1																												
Argemone ochroleuca subsp. ochroleuca																							0.1				0.1					
Asphodelus fistulosus														0.1	0.1							0.1										
Capsella bursa-pastoris											0.1																					
Cerastium glomeratum																														0.1		
Cirsium vulgare										0.1	0.1							0.1														
Citrullus amarus																																

Plots / Species	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
*Conyza bonariensis																															0.1	
*Conyza sp.																																
*Cucumis myriocarpus subsp. leptodermis																																
*Cyanthillium cinereum var. cinereum																								0.1		0.1			0.1			
*Cynodon dactylon	1		1				10								25					1					1	0.1					30	0.1
*Cyperus rotundus																																
*Datura ferox											0.1																					
*Echium plantagineum																																
*Eleusine tristachya	0.1																0.1															
*Erodium cicutarium	0.1			0.1				0.1																						0.1		
*Erodium moschatum			0.1																													
*Glandularia aristigera									1			30	0.1	10			0.1															
*Gomphocarpus fruticosus									0.1	0.1		0.1											0.1					0.1		0.1		
*Gomphrena celosioides					0.1																0.1											0.1
*Hirschfeldia incana																																
*Hypochaeris albiflora										0.1	0.1						0.1									0.1			0.1		
*Kickxia elatine subsp. crinita																																
*Lactuca serriola																																
*Lamium amplexicaule																																
*Leontodon rhagadioloides subsp. cretica																																0.1
*Lepidium africanum	0.1	0.1	0.1		0.1								0.1		0.1						0.1		0.1							0.1	0.1	
*Linum trigynum												0.1									0.1											
*Lysimachia arvensis		0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1
*Malva parviflora	0.1																													0.1		
*Marrubium vulgare																								0.1								

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
**Medicago sativa*																																
**Medicago sp.*	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1			0.1	0.1		0.1		
**Modiola caroliniana*																																
**Nothoscordum gracile*																																
**Paronychia brasiliana*											0.1																					
**Plantago lanceolata*				0.1				0.1		0.1				0.1																		0.1
**Prunella vulgaris*																							0.1	0.1								
**Rapistrum rugosum*			0.1		0.1	0.1	0.1								0.1																	
**Richardia stellaris*																																
**Salvia reflexa*																																
**Salvia verbenaca*																																
**Schkuhria pinnata*	0.1						0.1	0.1									0.1				0.1											
**Setaria parviflora*					0.1												0.1															0.1
**Sherardia arvensis*																																
**Sida rhombifolia*	0.1	0.1		1	2		0.1		0.1		0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	1		0.1		0.1	1	0.1	0.1	0.1	1	1	0.1
**Sida spinosa*									0.1					60			0.1		0.1	0.1	0.1	0.1	35	80	25		2	7		0.1		
**Solanum nigrum*	0.1		0.1	0.1			0.1	0.1	0.1	0.1	0.1		0.1		0.1			0.1					0.1	0.1		0.1			0.1	0.1	0.1	
**Solanum rostratum*																																
**Soliva sessilis*																																
**Sonchus asper*																																
**Sonchus oleraceus*	0.1	0.1		0.1			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1							0.1	0.1	
**Stachys arvensis*									0.1		0.1	0.1	0.1	0.1		0.1	1		0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1		
**Tagetes minuta*												0.1																				
**Trifolium glomeratum*																																
**Trifolium sp.*																																
**Urochloa panicoides*	0.1						0.1	0.1		0.1	0.1					0.1					0.1		0.1									
**Verbena bonariensis*																																
**Verbena rigida var. rigida*																																0.1
Abutilon oxycarpum																			0.1					0.1	0.1	0.1	0.1		0.1	0.1		

Plots / Species	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Acacia decora								0.1																								
Acacia paradoxa																																
Acacia salicina						1																										
Acaena sp.																																
Allocasuarina gymnanthera																																
Allocasuarina luehmannii																																
Alternanthera nana																										0.1						
Amyema miquelii																																
Angophora floribunda						1																										
Anthosachne scabra																																
Aristida leichhardtiana																																
Aristida ramosa	0.1	0.1	10	20	1	1	0.1	0.1	0.1	30	0.1	1	0.1	0.1		50	10	0.1	1	1	20	0.1	15	20	0.1	0.1	1	0.1	0.1	0.1	0.1	20
Arthropodium milleflorum																																
Arthropodium species B sensu Harden (1993)											0.1		0.1					0.1								0.1			0.1			
Asperula conferta							0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1			0.1						0.1	0.1		0.1		
Atriplex semibaccata	0.1		0.1																													
Austrostipa aristiglumis							0.1																									
Austrostipa scabra subsp. falcata	0.1	0.1	0.1			1						0.1	0.1	0.1	0.1			0.1	0.1	0.1				7			0.1		0.1		2	
Austrostipa scabra subsp. scabra																																
Austrostipa verticillata	6		6				0.1	20	0.1	0.1	0.1		0.1	0.1	0.1			0.1	0.1	0.1			7		0.1	0.1	3		0.1	70	0.1	
Boerhavia dominii							0.1	0.1		0.1					0.1																	
Bothriochloa decipiens var. decipiens	0.1	0.1	0.1	2	1	0.1	0.1	6	1	30	30	10	20	10	10	20	15	20	0.1	10	20	30	30	20	60	0.1	30	40	30	1	0.1	25
Bothriochloa macra																																
Brachychiton populneus subsp. populneus							0.1			0.1	0.1		0.1					0.1								0.1					
Brachyscome ciliaris					0.1	0.1	0.1																	0.1								
Brunoniella australis				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1		0.1	0.1		0.1		0.1	0.1		0.1	0.1		0.1

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Bursaria spinosa										0.1																						
Calotis lappulacea	0.1	0.1	0.1			0.1	0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Carex inversa	0.1		0.1								0.1				0.1			0.1														
Cassinia sifton																																
Cassinia uncata																																
Casuarina cunninghamiana subsp. cunninghamiana																																
Casuarina glauca						6	1	1																								
Chamaesyce drummondii								0.1	0.1	0.1	0.1		0.1		0.1	0.1	0.1	0.1			0.1		0.1	0.1			0.1					
Cheilanthes distans							0.1		0.1						0.1																	
Cheilanthes sieberi subsp. sieberi		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1	0.1	0.1	0.1				0.1
Chloris truncata	30	25	0.1	1	0.1				0.1			0.1				1	0.1		1		40	10	6				7	15		0.1		
Chloris ventricosa		1	0.1	30	2		20	0.1	10	1	0.1	10	15	0.1	10	40	10	20	20		2	10	10	0.1	30	0.1	1	1	0.1	1		1
Chrysocephalum apiculatum	0.1	0.1			0.1	0.1	0.1		0.1	0.1	0.1	15	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Commelina cyanea																										0.1				0.1		
Convolvulus graminetinus		0.1		0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1		0.1	0.1	0.1		0.1		0.1
Corymbia maculata							20	3																		4						
Cullen tenax																																
Cymbonotus lawsonianus												0.1																				
Cymbopogon refractus	7	0.1	0.1			0.1	0.1	0.1	0.1	15	0.1	0.1	0.1	0.1		1	0.1	0.1	0.1		0.1	0.1	0.1	1	0.1	0.1	10	0.1	0.1	0.1		0.1
Cyperus gracilis									0.1	0.1	0.1		0.1					0.1						0.1	0.1	0.1			0.1	0.1		
Daucus glochidiatus										0.1	0.1		0.1		0.1			0.1														
Denhamia silvestris																										0.1						
Desmodium gunnii											0.1																					
Desmodium varians								0.1	0.1				0.1					0.1								0.1				0.1		
Dianella longifolia var. longifolia							0.1	0.1	0.1	0.1	0.1							0.1				0.1				0.1						
Dianella revoluta var. revoluta																																
Dichanthium sericeum subsp. sericeum	0.1	20	0.1	0.1	2	0.1	0.1	1	0.1	0.1	0.1	10	0.1	0.1	40	1	30	15	30		0.1	1	10	40			25	30		0.1		1

Plots / Species	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Dichelachne micrantha																																
Dichondra repens				0.1			0.1		0.1	0.1	0.1		0.1		0.1		0.1	0.1				0.1	0.1	0.1		0.1	0.1			0.1		0.1
Dichondra sp. Inglewood (J.M.Dalby 86/93) Qld Herbarium																																
Digitaria brownii	0.1	2	7	0.1	7		0.1		25			0.1		0.1					6	0.1		25	0.1	0.1	6			0.1				
Digitaria diffusa																										1			1			
Digitaria divaricatissima	0.1	0.1	0.1	0.1	10	0.1	20	1	6			0.1	0.1	0.1	0.1	0.1	0.1	0.1	10	1	0.1	0.1	0.1	0.1	0.1	10	10	6			0.1	0.1
Dysphania carinata							0.1				0.1	0.1					0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	10	0.1		0.1	0.1	0.1	
Eclipta platyglossa																																
Einadia hastata											0.1						0.1									0.1			0.1	0.1	0.1	
Einadia nutans subsp. linifolia								0.1			0.1							0.1														
Einadia polygonoides	0.1	0.1	0.1	0.1			1	0.1	0.1		0.1		0.1	0.1	0.1	0.1			0.1								0.1	0.1		0.1		0.1
Enchylaena tomentosa			0.1	0.1			0.1	0.1																								
Enteropogon acicularis	0.1	0.1	0.1		0.1	0.1	0.1	0.1				0.1		0.1	0.1		0.1	0.1						0.1	0.1				0.1	0.1	0.1	20
Eragrostis brownii																										0.1						
Eragrostis lacunaria	0.1	0.1	1	0.1	0.1	50	1	40	1		2		30	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
Eragrostis leptostachya							0.1													0.1						0.1			0.1		0.1	
Eragrostis sororia																																
Eremophila debilis	0.1	0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1			0.1
Eriochloa pseudoacrotricha	0.1	0.1	20	0.1	6	10	6	6				6	1	0.1	10	0.1	0.1	0.1	1	30	30	0.1	0.1	10	0.1		6	2	6	0.1	0.1	20
Erodium crinitum	0.1	0.1	0.1	1			0.1	0.1	0.1			0.1		0.1			0.1		0.1	0.1	20	0.1	45	0.1	0.1			0.1	0.1	0.1		
Eucalyptus albens								10																								
Eucalyptus albens x moluccana			25		10	25	0.1	1		10			3		25			40						20			35			30		
Eucalyptus blakelyi						1	1	1																								
Eucalyptus conica																																
Eucalyptus crebra	20				10		35										15			0.1					3	0.1			0.1		30	
Eucalyptus dawsonii						1																										
Eucalyptus melliodora						10																										

Plots / Species	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Eucalyptus microcarpa																																
Eucalyptus moluccana										2	40																					
Eucalyptus sideroxylon						20	10	3																								
Eucalyptus tereticornis																																
Eulalia aurea												0.1																				
Evolvulus alsinoides var. decumbens																									0.1	0.1						
Fimbristylis dichotoma		0.1			0.1	0.1							0.1												0.1	0.1					0.1	
Galium leiocarpum										0.1																						
Geranium solanderi var. solanderi									0.1			0.1		0.1																		
Glossocardia bidens									0.1	0.1			0.1				0.1	0.1						0.1		0.1	0.1					
Glycine clandestina				0.1		0.1			0.1	0.1			0.1		0.1		0.1				0.1	0.1		0.1				0.1	0.1	0.1		
Glycine tabacina	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Goodenia pinnatifida					0.1	0.1																							0.1			
Hackelia suaveolens									0.1	0.1	0.1	0.1	0.1	0.1				0.1						0.1			0.1					
Hydrocotyle laxiflora										0.1	0.1		0.1																			
Hypoxis pratensis var. pratensis																																
Lagenophora stipitata																																
Leiocarpa panaetioides																																
Linum marginale																																
Lobelia purpurascens										0.1	0.1							0.1														
Lomandra confertifolia subsp. pallida						0.1	0.1	0.1	0.1	0.1	0.1	1	15	0.1			0.1	0.1				0.1		2		0.1	0.1	1	0.1		0.1	
Lomandra filiformis subsp. coriacea																																
Lomandra glauca						0.1		0.1			0.1		0.1													0.1	0.1					
Lomandra multiflora subsp. multiflora						0.1		0.1	0.1	0.1		0.1						0.1							0.1	0.1			0.1			

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Maireana enchylaenoides						0.1												0.1								0.1				0.1	0.1	
Maireana microphylla			0.1								0.1				0.1	0.1		15	0.1	0.1	1	0.1		0.1	0.1	0.1	0.1		0.1	1		0.1
Marsdenia viridiflora subsp. viridiflora										0.1								0.1						0.1								
Melia azedarach																																
Mentha satureioides									0.1	0.1		0.1	0.1	0.1			0.1				0.1	0.1					0.1			0.1		
Microlaena stipoides var. stipoides									1	3	1		0.1					0.1							0.1	0.1			0.1		1	
Mimulus gracilis																																
Minuria leptophylla																																
Myoporum montanum																																
Neptunia gracilis f. gracilis																								0.1								
Notelaea microcarpa var. microcarpa										3	0.1		0.1																	0.1		
Oxalis perennans			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1		0.1	0.1			0.1		0.1
Oxytes brachypoda																		0.1														
Ozothamnus diosmifolius																																
Panicum buncei																		0.1	1					0.1			0.1					
Panicum effusum	0.1				0.1	1	0.1	1						0.1			0.1			0.1		0.1	1		0.1	0.1		0.1			0.1	20
Panicum queenslandicum var. queenslandicum		0.1	1	0.1	10	0.1	6	10	0.1	0.1	0.1	6	0.1	0.1	1	0.1	0.1	0.1	10		0.1	0.1		1			0.1	1		0.1		
Panicum simile																																
Parsonsia lanceolata																																
Paspalidium aversum				0.1																												
Paspalidium criniforme			10				0.1			0.1	0.1		0.1	0.1	0.1			0.1						0.1		15	0.1					
Paspalidium distans			0.1		0.1		0.1		0.1						0.1			0.1		0.1												
Phyllanthus virgatus							0.1			0.1	0.1		0.1					0.1									0.1					
Pimelea curviflora var. sericea										0.1	0.1	0.1	0.1					0.1														
Plantago debilis										0.1	0.1		0.1		0.1			0.1												0.1		

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Poa sieberiana var. hirtella													0.1																			
Portulaca oleracea			0.1	0.1	0.1		0.1		0.1		0.1				0.1										0.1	0.1					0.1	
Psydrax odorata										1																						
Rhynchosia minima												0.1																				
Rostellularia adscendens var. adscendens								0.1	0.1	0.1	0.1	0.1	0.1	0.1				0.1				0.1		0.1			0.1		0.1			
Rumex brownii											0.1																					
Rytidosperma caespitosum		0.1	0.1	0.1	0.1	0.1	6		0.1			1	10		25	0.1	0.1	20	2				1	0.1			1	0.1	0.1			
Rytidosperma fulvum																																
Rytidosperma longifolium																																
Rytidosperma racemosum var. racemosum										0.1	0.1							0.1														
Rytidosperma setaceum																							0.1									
Rytidosperma tenuius	4							2		3	10																			0.1	0.1	
Scleria mackaviensis										0.1	0.1																					
Sclerolaena muricata var. muricata																																
Sida corrugata	0.1				0.1	0.1		0.1		0.1		0.1	0.1													0.1	0.1	0.1	0.1	0.1		
Sida hackettiana																	20	1	0.1	0.1		20	0.1		0.1	0.1	6	0.1	0.1	0.1		
Solanum brownii										0.1	0.1			1																		
Solanum campanulatum																																
Solanum cinereum	0.1	0.1	0.1		1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	7	0.1	1	0.1	0.1	0.1	0.1	0.1
Solanum prinophyllum																																
Solenogyne bellioides										0.1	0.1																0.1					
Sorghum leiocladum																																
Sporobolus caroli																																
Sporobolus creber	0.1	0.1	0.1	0.1		0.1	0.1		0.1	0.1			0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1	0.1	0.1		0.1	0.1		0.1		0.1
Stackhousia muricata									0.1	0.1	0.1	0.1						0.1								0.1						
Swainsona galegifolia										0.1	0.1		0.1																			

Species \ Plots	200420P4	200420P5	200420P6	200420P7	200420P8	200420P9	200421P1	200421P2	200421P5	200421P6	200421P7	200423P1	200423P2	200423P3	200423P4	200424P1	200424P2	200424P3	200424P4	200424P5	200424P6	200424P7	200424P8	200429P1	200429P2	200429P3	200429P4	200429P5	200429P6	200513P1	200514P2	200515P2
Templetonia stenophylla										0.1								0.1														
Themeda avenacea		0.1																														
Tragus australianus		0.1																														
Tribulus micrococcus			0.1	0.1			0.1								0.1									0.1								
Verbena gaudichaudii											0.1		0.1				0.1															
Veronica plebeia																																
Viola betonicifolia subsp. betonicifolia																																
Vittadinia cervicularis var. subcervicularis																																
Vittadinia cuneata var. cuneata																																
Vittadinia cuneata var. hirsuta	0.1						0.1	0.1		0.1			0.1		0.1			0.1									0.1	0.1	0.1	0.1		
Vittadinia gracilis				0.1																												
Vittadinia muelleri					0.1				0.1			0.1				0.1	0.1				0.1	0.1	0.1	0.1			0.1	0.1				
Vittadinia pterochaeta											0.1																					
Vittadinia pustulata						0.1			0.1			0.1					0.1	0.1	0.1		0.1	0.1	0.1	0.1				0.1		0.1		
Vittadinia sulcata																										0.1						
Wahlenbergia communis		0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1				0.1
Wahlenbergia luteola																																
Walwhalleya subxerophila																																
Zornia dyctiocarpa var. dyctiocarpa																																

APPENDIX 4 VEGETATION INTEGRITY DATA

Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	Composition						Structure						Function										
									Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	LargeTrees	HollowTrees	LitterCover	LenFallenLogs	TreeStem5to10	TreeStem10to20	TreeStem20to30	TreeStem30to50	TreeStem50to80	TreeRegen	HighThreatExotic
200323P3	483	671.3	101	DNG	56	296192	6433997	88	0	1	17	13	1	3	0	0.1	136.5	2.2	0.1	0.3	0	0	12	0	0	0	0	0	0	0	0.1
200323P4	483	671.3	101	DNG	56	296411	6433760	210	0	2	13	14	0	3	0	0.2	105.4	1.4	0	1.2	0	0	6	0	0	0	0	0	0	0	0.3
200324P8	483	671.3	101	DNG	56	295838	6434694	65	0	2	10	2	0	0	0	0.2	60.3	1.1	0	0	0	0	3	0	0	0	0	0	0	0	2.1
200331P3	483	671.3	101	DNG	56	292805	6430470	6	0	2	13	17	0	3	0	0.2	94.7	1.7	0	0.3	0	0	2	0	0	0	0	0	0	0	40
200407P1	483	671.3	101	DNG	56	295132	6432976	20	0	2	15	11	1	2	0	0.2	75.9	7	0.1	0.2	0	0	2	0	0	0	0	0	0	0	70.2
200407P4	483	671.3	101	DNG	56	294850	6432225	134	0	2	13	16	1	3	0	0.2	82.8	1.6	0.1	1.2	0	0	4	0	0	0	0	0	0	0	60
200407P6	483	671.3	101	DNG	56	295571	6431546	124	0	2	13	15	1	4	0	0.2	59.4	7.4	0.1	1.3	0	0	3	0	0	0	0	0	0	0	30.2
200408P2	483	671.3	101	DNG	56	294587	6433853	215	0	1	12	12	1	4	0	0.1	93.9	1.2	0.1	0.4	0	0	8	0	0	0	0	0	0	0	10.3
200408P4	483	671.3	101	DNG	56	294994	6433653	308	0	1	9	9	0	3	0	0.1	97.5	0.9	0	0.3	0	0	7	0	0	0	0	0	0	0	25
200408P6	483	671.3	101	DNG	56	295526	6434347	252	0	1	11	11	1	1	0	0.1	167.7	1.1	0.1	0.1	0	0	7	0	0	0	0	0	0	0	35
200408P7	483	671.3	101	DNG	56	295482	6434603	49	0	0	10	7	0	2	0	0	101.5	0.7	0	0.2	0	0	13	0	0	0	0	0	0	0	6.1
200420P7	483	671.3	101	DNG	56	298957	6433439	186	0	1	13	9	1	3	0	0.1	105.6	0.9	0.1	0.3	0	0	4	0	0	0	0	0	0	0	10.1
200423P3	483	671.3	101	DNG	56	292662	6432005	325	0	2	17	9	1	1	0	2	99	20.8	0.1	0.1	0	0	7	2	0	0	0	0	0	0	10
200424P1	483	671.3	101	DNG	56	294826	6434564	234	0	1	12	6	1	2	0	0.1	112.5	0.6	0.1	0.2	0	0	4	0	0	0	0	0	0	0	25.2
200424P4	483	671.3	101	DNG	56	296205	6431133	118	0	4	15	9	0	2	0	7.3	92	45.8	0	0.2	0	0	3	0	0	0	0	0	0	0	1.1
200429P5	483	671.3	101	DNG	56	295661	6430774	87	0	2	15	11	1	3	0	1.1	96.7	1.1	0.1	0.3	0	0	2	0	0	0	0	0	0	0	20.1
200402P2	483	128.8	101	DNG_SG	56	294347	6433557	84	0	2	14	15	2	2	0	0.2	92.8	1.5	0.2	0.2	0	0	6	0	0	0	0	0	0	0	0.3
200402P3	483	128.8	101	DNG_SG	56	294216	6432947	347	0	2	15	17	1	3	0	0.2	88.2	1.7	0.1	0.3	0	0	5	0	0	0	0	0	0	0	0.1
200402P5	483	128.8	101	DNG_SG	56	294102	6434100	26	0	1	13	13	0	2	0	0.1	98.6	1.3	0	0.2	0	0	6	0	0	0	0	0	0	0	0.4
200407P2	483	128.8	101	DNG_SG	56	294698	6432849	256	0	3	12	16	1	3	0	0.3	100.4	1.6	0.1	0.3	0	0	3	0	0	0	0	0	0	0	50.2
200421P5	483	128.8	101	DNG_SG	56	293908	6431791	92	0	2	18	20	2	4	0	0.2	95	2	0.2	0.4	0	0	5	16	1	0	0	1	0	1	0.3
200423P1	483	128.8	101	DNG_SG	56	293267	6431998	250	0	2	16	16	1	3	0	0.2	83.1	1.6	0.1	0.3	0	0	2	0	0	0	0	0	0	0	10.2
200424P6	483	128.8	101	DNG_SG	56	296070	6431643	98	0	3	11	12	0	3	0	1.2	104.3	1.2	0	0.3	0	0	3	0	0	0	0	0	0	0	15.2

Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	Composition						Structure						Function										
									Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	LargeTrees	HollowTrees	LitterCover	LenFallenLogs	TreeStem5to10	TreeStem10to20	TreeStem20to30	TreeStem30to50	TreeStem50to80	TreeRegen	HighThreatExotic
200424P7	483	128.8	101	DNG_SG	56	296154	6431812	154	0	3	14	14	1	3	0	0.3	92.6	1.4	0.1	0.3	0	0	3	0	0	0	0	0	0	0	30
200324P3	483	142.5	101	Woodland	56	295834	6433169	206	1	1	17	11	1	3	15	0.1	53.2	1.1	0.1	0.3	0	0	21	14	1	1	1	0	0	1	0.2
200324P7	483	142.5	101	Woodland	56	295964	6433822	305	1	1	13	15	0	3	20	0.1	27	3.4	0	0.3	0	0	24	4	1	1	1	0	0	1	0
200327P1	483	142.5	101	Woodland	56	295214	6434661	81	3	3	17	20	1	2	35.2	0.3	98	2	0.1	0.2	0	0	11	12	1	1	1	1	0	1	0.4
200407P3	483	142.5	101	Woodland	56	295162	6432445	100	1	3	17	23	1	3	40	0.3	7.3	2.3	0.1	1.2	0	0	32	0	1	1	1	1	0	1	0.6
200407P9	483	142.5	101	Woodland	56	295621	6432273	352	1	2	18	20	1	3	35	1.1	48.2	3.8	0.1	0.3	1	1	30	1	0	1	1	1	1	0	0.3
200408P5	483	142.5	101	Woodland	56	295160	6433993	63	2	3	17	21	0	3	10.1	0.3	78.1	3	0	0.3	0	0	15	14	0	1	1	0	0	1	2.5
200420P6	483	142.5	101	Woodland	56	299038	6433587	80	1	4	19	6	1	1	25	0.4	17.3	1.5	0.1	0.1	1	1	6	3	0	0	0	0	1	0	60.3
200424P3	483	142.5	101	Woodland	56	295421	6431181	282	2	3	23	27	1	4	35.1	0.3	81.6	2.7	0.1	0.4	2	2	48	47	1	1	1	1	1	1	0.5
200429P1	483	142.5	101	Woodland	56	296744	6431490	54	1	4	18	17	0	4	25	0.4	98.4	1.7	0	0.4	1	1	17	9	0	0	0	0	1	1	1.7
200429P4	483	142.5	101	Woodland	56	295388	6430867	55	1	4	18	20	1	2	10	0.4	45.3	2	0.1	0.2	0	0	10	4	1	1	0	0	0	1	0.4
200513P1	483	142.5	101	Woodland	56	296179	6430686	182	2	3	14	18	0	4	30.1	1.2	73.1	1.8	0	0.4	2	3	34	25	1	0	0	1	1	1	25.5
200402P1	483	238.5	101	Woodland_SG	56	294049	6433372	187	4	3	14	21	2	3	32.1	0.3	81.1	2.1	0.2	0.3	0	1	48	34	1	0	1	1	1	1	0.4
200402P4	483	238.5	101	Woodland_SG	56	294348	6432700	108	2	3	15	22	2	3	40.1	0.3	72.1	2.2	0.2	0.3	1	1	42	26	1	1	1	0	0	1	0.6
200402P6	483	238.5	101	Woodland_SG	56	294395	6434221	98	4	3	13	16	0	3	41.2	0.3	14	1.6	0	0.3	3	1	46	15	1	0	0	0	0	1	60.2
200407P5	483	238.5	101	Woodland_SG	56	294989	6431882	320	4	4	14	20	1	3	40.2	0.4	3.2	2	0.1	0.3	1	0	72	55	1	1	1	1	1	1	0.3
200407P7	483	238.5	101	Woodland_SG	56	295443	6431810	119	2	4	18	17	1	2	35.1	0.4	1.8	1.7	0.1	0.2	0	0	44	10	1	1	1	1	0	1	0.2
200407P8	483	238.5	101	Woodland_SG	56	295590	6431999	113	2	3	19	23	2	3	35	0.3	23.4	2.3	0.2	0.3	0	0	26	0	0	1	1	1	0	1	0.2
200408P1	483	238.5	101	Woodland_SG	56	294474	6434015	64	1	2	9	18	0	5	10	0.2	92.4	1.8	0	1.4	0	0	7	0	1	1	0	0	0	0	0.3
200408P3	483	238.5	101	Woodland_SG	56	294943	6433877	98	1	0	13	20	1	3	3	0	95.9	2	0.1	0.3	0	0	10	9	1	1	0	0	0	1	1.3
200421P6	483	238.5	101	Woodland_SG	56	293704	6431913	228	4	5	16	27	1	4	30.1	1.4	74.2	2.7	0.1	0.4	1	0	40	8	1	1	0	0	0	1	0.3
200421P7	483	238.5	101	Woodland_SG	56	293857	6431929	190	3	4	17	29	0	1	40.2	0.4	36.4	2.9	0	0.1	0	0	66	9	1	1	1	0	0	1	0.5
200423P2	483	238.5	101	Woodland_SG	56	293215	6432136	324	3	2	20	21	0	4	40.2	0.2	45.5	2.1	0	0.4	0	0	38	2	0	0	0	0	0	0	0.4
200423P4	483	238.5	101	Woodland_SG	56	293899	6434076	298	1	3	15	14	2	3	20	1.2	100.7	1.4	0.2	0.3	1	2	17	15	0	0	0	1	1	1	0.5

Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	Composition						Structure						Function										
									Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	LargeTrees	HollowTrees	LitterCover	LenFallenLogs	TreeStem5to10	TreeStem10to20	TreeStem20to30	TreeStem30to50	TreeStem50to80	TreeRegen	HighThreatExotic
200323P1	618	7.3	101	DNG	56	296160	6434306	72	0	0	19	7	1	2	0	0	180.6	0.7	0.1	0.2	0	0	8	0	0	0	0	0	0	0	0.4
200324P5	618	7.3	101	DNG	56	295577	6433744	230	1	0	12	15	1	2	3	0	114.4	1.5	0.1	0.2	0	0	8	7	1	1	0	0	0	1	1.3
200327P7	618	7.3	101	DNG	56	296630	6434310	235	0	0	13	9	0	3	0	0	98.8	0.9	0	0.3	0	0	9	0	0	0	0	0	0	0	1.4
200323P2	618	3	101	Woodland	56	296026	6434212	356	2	1	6	12	0	2	40	1	11.4	1.2	0	0.2	4	2	64	28	0	0	0	0	1	1	66.4
200327P6	618	3	101	Woodland	56	296785	6434525	35	1	2	21	14	1	3	35	0.2	56.7	1.4	0.1	0.3	3	2	84	0	1	1	1	0	0	1	0.5
200325P1	1602	22.1	101	Woodland	56	292225	6429479	260	4	5	19	17	2	3	25.2	0.5	11.5	1.7	0.2	0.3	0	0	84	0	1	1	1	1	0	1	0.1
200331P5	1602	22.1	101	Woodland	56	293157	6430052	75	3	6	14	19	1	4	40.2	13.4	11.3	1.9	0.1	0.4	1	0	43	0	1	1	1	1	0	1	0.4
200429P3	1602	22.1	101	Woodland	56	296443	6431675	258	3	5	18	19	1	3	30.1	0.5	11.5	2.8	0.1	0.3	2	0	48	18	0	1	0	0	1	1	0.5
200324P4	1605	241.3	101	DNG	56	295598	6433579	320	0	1	16	9	1	0	0	0.1	109.7	0.9	0.1	0	0	0	5	0	0	0	0	0	0	0	0.4
200327P4	1605	241.3	101	DNG	56	297585	6434601	58	0	2	11	14	1	2	0	0.2	62.3	1.4	0.1	0.2	0	0	3	0	0	0	0	0	0	0	0.4
200331P1	1605	241.3	101	DNG	56	292346	6430067	196	1	2	20	8	1	1	0.1	0.2	89.1	0.8	0.1	0.1	0	0	2	0	0	0	0	0	0	0	6.1
200331P4	1605	241.3	101	DNG	56	293054	6429987	64	1	2	18	15	1	2	0.1	0.2	96.1	1.5	0.1	0.2	0	0	7	0	0	0	0	0	0	0	0.3
200331P6	1605	241.3	101	DNG	56	293050	6430118	250	0	5	17	16	1	3	0	0.5	97.2	1.6	0.1	0.3	0	0	10	0	0	0	0	0	0	0	0.2
200406P6	1605	241.3	101	DNG	56	295861	6432836	330	1	1	11	9	1	1	0.1	0.1	82.6	0.9	0.1	0.1	0	0	5	0	0	0	0	0	0	1	0.5
200420P1	1605	241.3	101	DNG	56	298950	6434349	258	0	2	13	14	1	3	0	0.2	100.6	2.3	0.1	0.3	0	0	3	0	0	0	0	0	0	0	15.2
200420P5	1605	241.3	101	DNG	56	298680	6433192	130	0	2	18	5	1	2	0	0.2	117.8	0.5	0.1	0.2	0	0	11	0	0	0	0	0	0	0	40.1
200424P2	1605	241.3	101	DNG	56	295718	6432553	136	1	2	15	16	1	3	0.1	0.2	88.9	1.6	0.1	0.3	0	0	2	0	0	0	0	0	0	1	10.1
200424P5	1605	241.3	101	DNG	56	296363	6431232	130	1	2	10	5	1	1	0.1	0.2	3.9	16.3	0.1	0.1	0	0	3	0	0	0	0	0	0	0	0.1
200424P8	1605	241.3	101	DNG	56	296126	6431594	168	0	2	15	9	1	1	0	0.2	88	0.9	0.1	0.1	0	0	2	0	0	0	0	0	0	0	40.1
200327P5	1605	22.5	101	Plantation	56	297855	6434623	92	4	1	17	7	0	2	16.2	0.1	32.1	0.7	0	0.2	0	0	32	0	0	1	1	0	0	0	0.3
200420P9	1605	22.5	101	Plantation	56	299118	6432759	173	8	1	17	10	1	3	41	0.1	22.4	1	0.1	0.3	0	0	54	0	1	1	1	0	0	1	0.3
200421P1	1605	22.5	101	Plantation	56	298856	6432865	276	7	3	20	17	2	2	28.1	0.3	72.5	1.7	0.2	0.2	0	0	56	0	1	1	1	0	0	1	2.3
200421P2	1605	22.5	101	Plantation	56	298730	6432801	250	6	4	16	14	1	3	22	0.4	28.3	1.4	0.1	0.3	0	0	76	0	1	1	1	0	0	1	0.4
200324P2	1605	110.9	101	Woodland	56	296085	6433278	20	2	2	17	15	0	3	30.1	2	17.2	1.5	0	0.3	1	0	52	6	1	1	1	0	0	1	0.3

Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	Composition						Structure						Function										
									Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	LargeTrees	HollowTrees	LitterCover	LenFallenLogs	TreeStem5to10	TreeStem10to20	TreeStem20to30	TreeStem30to50	TreeStem50to80	TreeRegen	HighThreatExotic
200324P6	1605	110.9	101	Woodland	56	295765	6433710	340	2	2	14	13	0	1	40.1	1.1	16.1	1.3	0	0.1	0	0	27	0	1	1	1	0	0	1	0.1
200331P7	1605	110.9	101	Woodland	56	296094	6430958	211	2	4	17	19	2	2	35.1	6.3	68.2	11.8	0.2	0.2	0	0	44	2	1	0	0	1	0	1	0.5
200331P8	1605	110.9	101	Woodland	56	295648	6431004	218	1	4	10	7	0	2	25	0.4	50.9	20.5	0	0.2	0	0	58	2	0	0	1	1	0	5	7.1
200406P5	1605	110.9	101	Woodland	56	295878	6432696	40	1	3	18	16	1	2	15	0.3	57.3	21.5	0.1	0.2	4	0	44	7	1	0	0	0	1	1	0.6
200406P8	1605	110.9	101	Woodland	56	295488	6432613	268	2	2	19	20	2	3	40.1	0.2	81.2	2	0.2	0.3	1	0	48	0	1	1	1	1	1	1	0.4
200420P4	1605	110.9	101	Woodland	56	298654	6433401	12	1	3	16	6	0	1	15	0.3	17.2	0.6	0	0.1	2	1	4	0	0	0	0	0	1	0	30.2
200429P2	1605	110.9	101	Woodland	56	296532	6431519	137	1	3	16	8	1	1	20	0.3	9.3	20.7	0.1	0.1	1	0	18	2	1	2	0	0	1	1	0.4
200429P6	1605	110.9	101	Woodland	56	295813	6430641	123	1	4	16	12	0	2	35	15.3	44.1	21.1	0	0.2	0	0	42	21	1	0	1	1	0	1	10.4
200514P2	1605	110.9	101	Woodland	56	298902	6433166	350	1	1	14	6	0	0	30	0.1	4.2	0.6	0	0	3	3	32	6	0	0	0	0	1	1	80.1
200324P1	1606	12.8	101	DNG	56	296125	6433212	42	0	0	19	17	1	3	0	0	128.7	1.7	0.1	0.3	0	0	5	0	0	0	0	0	0	0	2.4
200327P3	1606	12.8	101	DNG	56	297318	6434652	52	1	1	15	9	1	2	35	0.1	41.2	0.9	0.1	0.2	1	0	2	6	0	0	0	0	0	0	2.6
200406P1	1606	12.8	101	DNG	56	295491	6432732	220	1	3	18	19	2	2	10	0.3	90.9	2.8	6.1	0.2	0	0	25	10	1	1	1	0	0	0	0.4
200406P2	1606	12.8	101	DNG	56	295609	6432771	115	0	1	17	11	1	2	0	0.1	84	1.1	0.1	0.2	0	0	15	7	0	0	0	0	0	0	10.2
200406P7	1606	12.8	101	DNG	56	295890	6432988	85	0	1	12	7	1	2	0	0.1	92.7	10.6	0.1	0.2	0	0	5	0	0	0	0	0	0	0	0.5
200327P2	1606	3.2	101	Woodland	56	296904	6434607	80	2	4	21	12	1	1	37	0.4	35.4	1.2	0.1	0.1	0	0	32	3	0	1	1	1	1	1	6.5
200406P3	1606	3.2	101	Woodland	56	295720	6432811	23	3	3	20	17	2	4	4.1	0.3	62.5	1.7	0.2	0.4	0	0	15	4	1	1	1	0	0	1	0.5
200420P8	1655	2.4	101	DNG	56	299046	6432646	268	2	1	15	9	1	1	0.2	0.1	84.7	15.8	0.1	0.1	0	0	2	0	0	0	0	0	0	0	0.3
200515P2	1655	2.4	101	DNG	56	299069	6432327	0	0	3	11	6	1	1	0	0.3	109.3	0.6	0.1	0.1	0	0	6	0	0	0	0	0	0	0	7.1
200325P3	1691	0.8	101	DNG	56	292172	6429823	38	0	2	14	12	1	2	0	1.1	98.6	1.2	0.1	0.2	0	0	3	0	0	0	0	0	0	0	0.2
200325P2	1691	23.2	101	Woodland	56	292320	6429727	32	4	3	20	19	0	4	41.2	0.3	10.6	1.9	0	0.4	0	0	52	7	1	1	1	1	0	1	0.2
200325P4	1691	23.2	101	Woodland	56	292162	6429946	100	5	5	16	17	1	3	31.2	0.5	35.2	1.7	0.1	0.3	0	0	33	3	1	1	1	0	0	1	0.2
200331P2	1691	23.2	101	Woodland	56	292595	6430320	76	3	6	19	15	2	4	17.1	0.6	1.9	1.5	0.2	0.4	1	1	74	28	1	1	1	1	0	1	1.3
200406P4	1602	0.2	101	Woodland	56	295834	6432412	178	3	4	15	29	1	2	35.1	0.4	17.3	2.9	0.1	0.2	1	1	20	6	1	1	1	1	1	1	0.5
200423P5	483	4.3	101	DNG_SG	56	293739	6434149	275	0	2	13	5	0	1	0	0.2	111.8	0.5	0	0.1	0	0	6	0	0	0	0	0	0	0	40.2

Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	Composition						Structure						Function										
									Tree	Shrub	Grass	Forb	Fern	Other	Tree	Shrub	Grass	Forb	Fern	Other	LargeTrees	HollowTrees	LitterCover	LenFallenLogs	TreeStem5to10	TreeStem10to20	TreeStem20to30	TreeStem30to50	TreeStem50to80	TreeRegen	HighThreatExotic
200409P7	1605	0.5	101	DNG	56	297644	6434572	260	0	1	15	7	1	2	0	0.1	99.1	0.7	6	0.2	0	0	30	0	0	0	0	0	0	0	0.4

ATTACHMENT B
MOUNT PLEASANT OPTIMISATION PROJECT BASELINE FAUNA SURVEY REPORT



MOUNT PLEASANT OPTIMISATION PROJECT
BASELINE FAUNA SURVEY REPORT

Prepared for MACH Energy Australia

December 2020

PROJECT NAME	Mount Pleasant Optimisation Project Baseline Fauna Survey Report		
PROJECT ADDRESS	Muswellbrook NSW		
PREPARED FOR	MACH Energy Australia		
AUTHOR/S	Garon Staines		
VERSION	**Version**	**Draft/Final**	**Date to client**
	1.0	Draft V1	18-03-2020
		Draft V1A	08-05-2020
		Draft V1B	10-08-2020
		Draft V1C	29-10-2020
		Draft V1D	11-12-2020

This report should be cited as: '*Future Ecology (2020) Mount Pleasant Optimisation Project Baseline Fauna Survey Report. Prepared for MACH Energy Australia Pty Ltd*.'

Disclaimer

This report has been prepared by Future Ecology for MACH Energy Australia Pty Ltd and may only be used for the purpose agreed between these parties, as described in this report. The opinions, conclusions and recommendations set out in this report are limited to those set out in the scope of works and agreed between these parties. Future Ecology accepts no responsibility or obligation for any third party that may use this information or for conclusions drawn from this report that are not provided in the scope of works or following changes occurring subsequent to the date that the report was prepared.

The recommendations provided in this report are based on the results from currently accepted and naturally limited ecological survey techniques. Every effort is made and reasonable care taken to detect all threatened species that may have potential to occur in the locality.

Any representation, statement, opinion or advice expressed or implied in this report is made in good faith on the basis that Future Ecology Pty Ltd, its agents and employees are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Contents

Executive Summary ES-1
1 Introduction and Project Description 1
1.1 Purpose of Report 5
1.2 Site Description 5
1.2.1 Study Area 5
1.2.2 Land Use 5
1.2.3 Regional Setting 6
1.2.4 Landform and Hydrology 6
1.2.5 Vegetation 6
1.2.6 Summary of Previous Threatened Species Recorded in the Study Area 6
2 Methods 12
2.1 Nomenclature 12
2.2 Literature and Database Review 12
2.3 Relevant Survey Guidelines 15
2.4 Field Survey 16
2.4.1 Weather, Climate and Astronomical Conditions 16
2.4.2 Techniques 18
2.4.3 Survey Effort 38
2.4.4 Limitations 38
2.4.5 Targeted Searches for Threatened Fauna 41
2.4.6 Species Credit Species Habitat Polygon Mapping 41
3 Survey Results 51
3.1 Fauna Habitat Types 51
3.2 Fauna Species 55
3.3 Threatened Fauna Species Listed under the BC Act 55
3.3.1 Threatened Fauna Species Recorded During the Surveys 55
3.3.2 Other Threatened Fauna Species Previously Recorded within the Study Area 72
3.3.3 Other Threatened Fauna Species Not Recorded in the Study Area 77
3.4 Threatened Fauna Species Listed under the EPBC Act 77
4 Conclusion 85
5 References and Bibliography 86
Appendix A Fauna Species Detected 90
Appendix B Fauna Survey Site Descriptions 102
Appendix C BioNet Threatened Biodiversity Data Collection Species PCT Associations Sydney Basin – Hunter IBRA Subregion 126

Figures

Figure 1 Regional Location
Figure 2a Project General Arrangement
Figure 2b Project General Arrangement Inset
Figure 3a Vegetation Mapping
Figure 3b Vegetation Mapping Inset
Figure 4a Fauna Survey Sites
Figure 4b Fauna Survey Sites
Figure 4c Fauna Survey Sites
Figure 5 Broad Fauna Habitat Types
Figure 6 Threatened Reptiles
Figure 7 Threatened Birds
Figure 8 Threatened Mammals
Figure 9 Species Credit Species Relevant to the Study Area
Figure 10 Threatened Species Listed Under the EPBC Act
Figure 11 Striped Legless Lizard Species Polygon
Figure 12 Squirrel Glider Species Polygon
Figure 13 Grey-headed Flying-fox Potential Habitat
Figure 14 Koala Potential Habitat

Tables

Table 1: Threatened Fauna Species Known or Predicted to occur in the Wider Locality 9
Table 2: Weather and Astronomical Conditions during Survey Periods 17
Table 3: Fauna Survey Sites for the Study Area 18
Table 4: Habitat Constraints Identified in the *BioNet Threatened Biodiversity Data Collection* 23
Table 5: Bird Survey Effort for August 2018 Survey Period 25
Table 6: Bird Survey Effort for December 2018 Survey Period 25
Table 7: Bird Survey Effort for July 2019 Survey Period 26
Table 8: Targeted Searches for Conservation Significant Bat Species 32
Table 9: Summary of Survey Techniques and Effort Used at Each Site within the Study Area 39
Table 10: Targeted Searches for Conservation Significant Fauna Species 42
Table 11: Threatened Fauna Species Recorded During this Study 55
Table 12: Other Threatened Species Previously Recorded within the Study Area 72
Table 13: Other Threatened Fauna Species Not Recorded in the Study Area 78
Table 14: Threatened Fauna Species Listed Under the EPBC Act 83

Executive Summary

MACH Energy Australia Pty Ltd is seeking consent for the Mount Pleasant Optimisation Project (the Project) to increase open cut coal extraction and related activities. The Project is in the Upper Hunter Valley of New South Wales (NSW), northwest 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 1997. 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 August 2018, December 2018, July 2019 and November 2019 using a team of up to five ecologists including specialists in amphibians, reptiles, birds and mammals. Some incidental fauna observations were also made in October 2019.

A number of sites were surveyed throughout the habitats 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.

Eight broad fauna habitat types were observed within the study area, comprising two natural habitats (i.e. Dry Sclerophyll Forest and Grassy Woodlands) and six secondary habitats (i.e. Derived Native Grassland, Cropping/Grazing, Cultivation, Disturbed/Exotic, Infrastructure/Cleared Land and Dam/Waterbody). Most woodland/forest patches showed evidence of historic and ongoing disturbance from grazing. Most woodland/forest patches were small to medium size (< 150 hectares), fragmented and lacked structural diversity in terms of subcanopy and understorey layers. Connectivity between woodland/forest patches was generally poor across the study area. However, some fauna habitat features such as hollow bearing trees, hollow logs and fallen timber were present at most survey sites.

A total of 176 fauna species were recorded in the study area during the 2018 to 2019 surveys including six amphibian, 17 reptile, 111 bird, and 42 mammal species. A total of 13 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in, or immediately adjacent to, the study area during the current surveys.

Two of the threatened fauna species listed under the BC Act which were recorded are considered relevant ‘species credit species’ under the NSW Biodiversity Offsets Scheme, namely, the Striped Legless Lizard (*Delma impar*) and Squirrel Glider (*Petaurus norfolcensis*). Two of the threatened fauna species recorded are listed under the EPBC Act, namely, the Striped Legless Lizard and Grey-headed Flying-fox (*Pteropus poliocephalus*).

1 Introduction and Project Description

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal & Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd now manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95 percent [%] owner) and J.C.D. Australia Pty Ltd (5% owner)[1].

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (Figures 1, 2a and 2b).

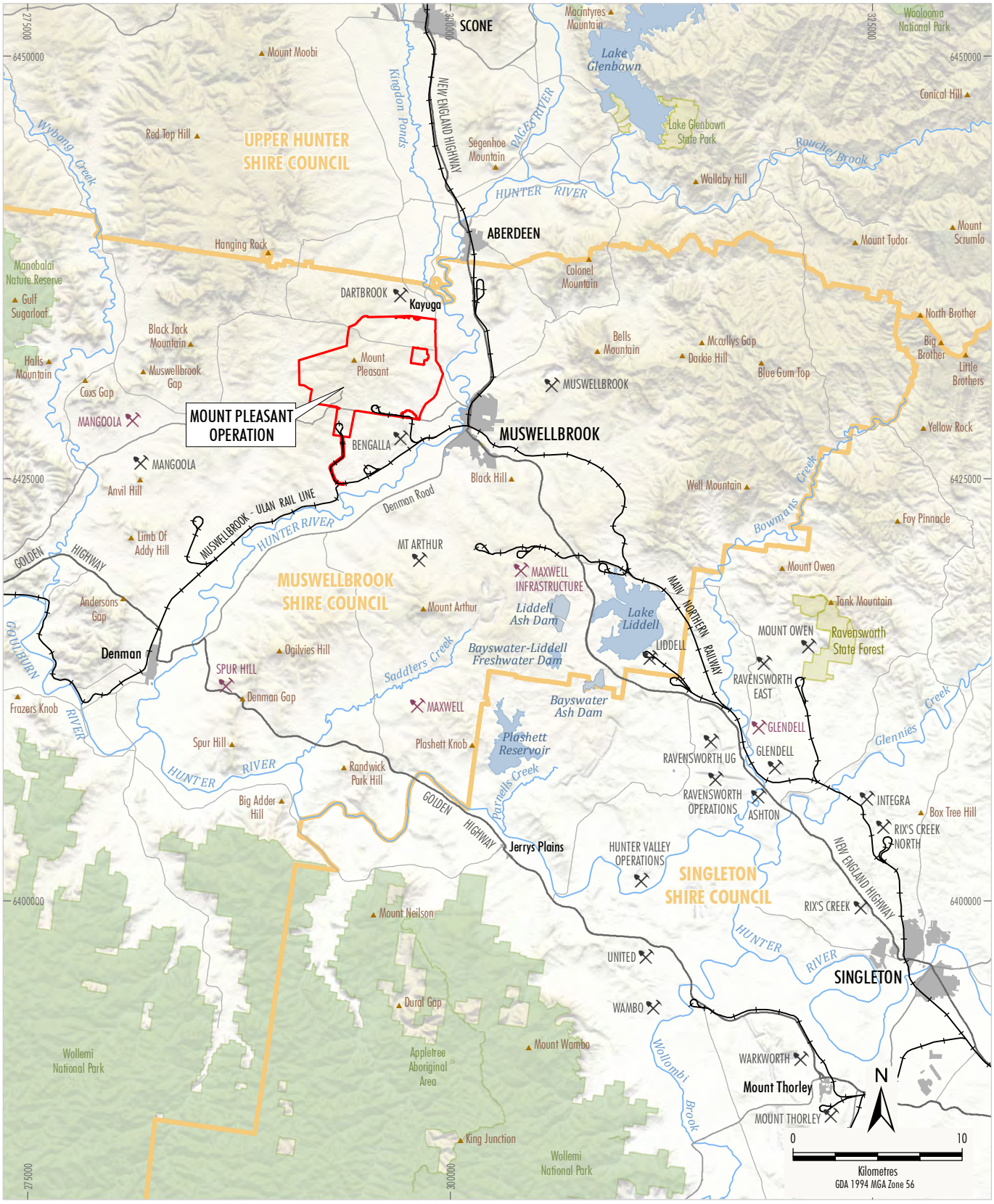
The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately 9 trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export or to domestic customers for use in electricity generation.

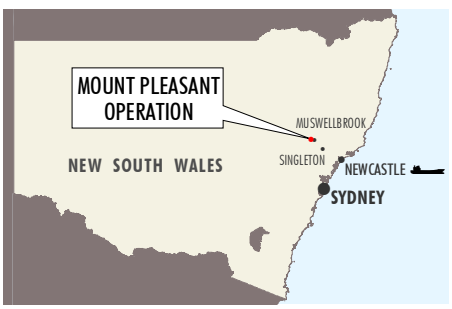
Overview of the Project

The Mount Pleasant Optimisation Project (the Project) would include the following development:

- increased open cut coal extraction within Mount Pleasant Operation Mining Leases by mining of additional coal reserves, including lower coal seams in North Pit;
- staged increase in extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life);
- staged upgrades to the existing Coal Handling and Preparation Plant (CHPP) and coal handling infrastructure to facilitate the handling and processing of additional coal;
- rail transport of up to approximately 17 Mtpa of product coal to domestic and export customers;
- upgrades to workshops, electricity distribution and other ancillary infrastructure;
- existing infrastructure relocations to facilitate mining extensions (e.g. local roads, powerlines and water pipelines);
- construction and operation of new water management and water storage infrastructure in support of the mine;
- additional reject dewatering facilities to allow co-disposal of fine rejects with waste rock as part of ROM waste rock operations;

[1] Throughout this report, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.





LEGEND

- Mining Operation
- Proposed Mining Operation (Application Lodged)
- Railway
- Local Government Boundary
- State Forest/Reserve
- National Parks and Wildlife Estate
- Mining Lease Boundary (Mount Pleasant Operation)

Source: NSW Spatial Services (2020)

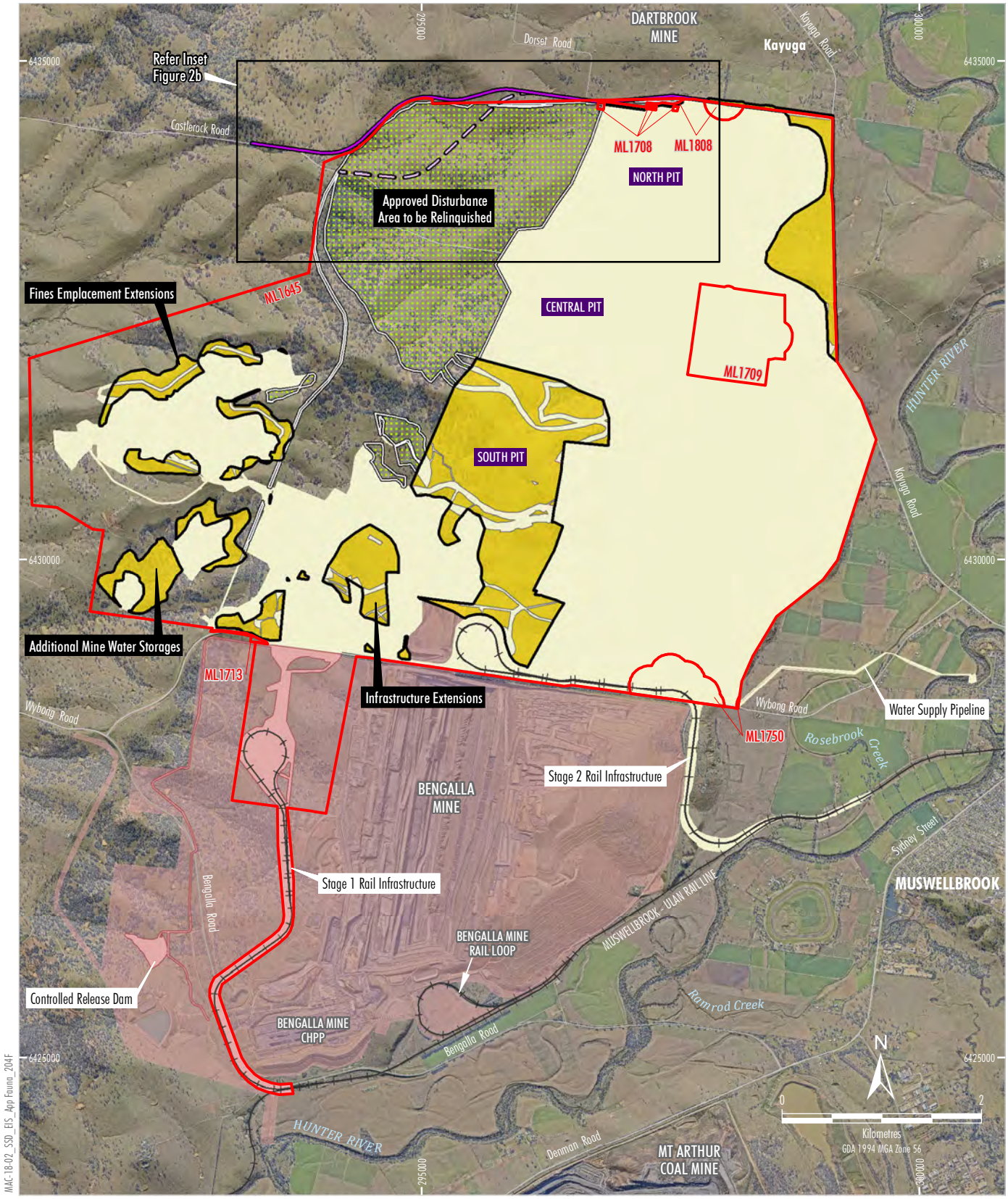
MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Regional Location

Figure 1

MAC-18-02_SSD_EIS_App Fauna_200B



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170) [1]
- Development Footprint 1 - General Extension Areas [1]
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

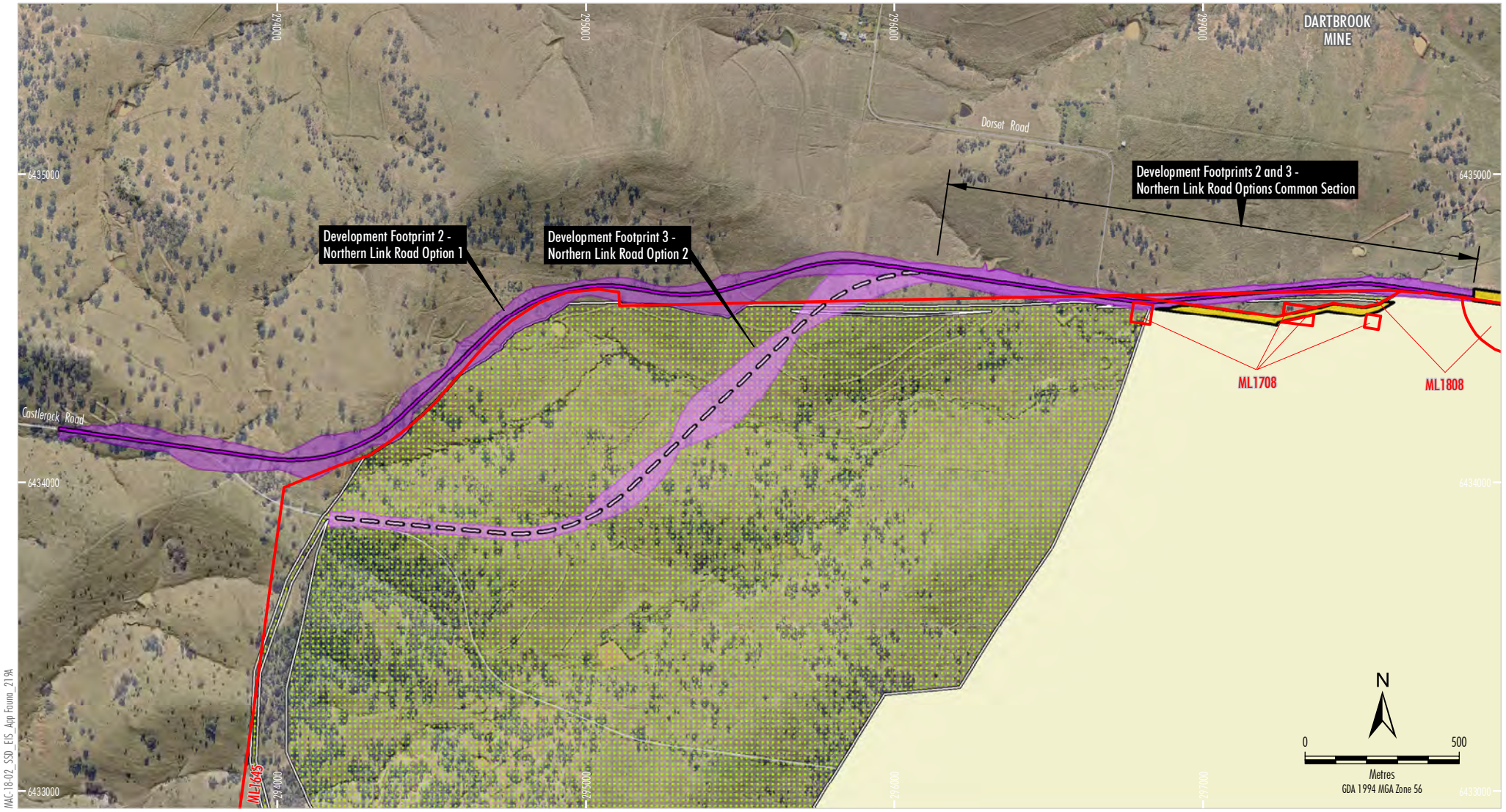
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement

Figure 2a



MAC 18-02_SSD_EIS_App Fauna_219A

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97) [1]
- Development Footprint 1 - General Extension Areas [1]
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area [2]
- Northern Link Road Option 1 Centreline [3]
- Northern Link Road Option 2 Centreline

NOTES

1. Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.
2. Subject to detailed design of Northern Link Road alignment.
3. Preferred alignment subject to landholder access.

Source: MACH (2020); NSW Spatial Services (2020)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Project General Arrangement Inset

Figure 2b

- development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability, and varying topographic relief to be more natural in exterior appearance;
- construction and operation of new ancillary infrastructure in support of mining;
- extension to the time limit on mining operations to 22 December 2048;
- an average operational workforce of approximately 600 people, with a peak of approximately 830 people;
- ongoing exploration activities; and
- other associated infrastructure, plant, equipment and activities.

1.1 Purpose of Report

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*.

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 EPBC Act in accordance with the relevant survey guidelines;
- survey and document threatened fauna species according to the *Biodiversity Assessment Method* (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 approximately 2,300 hectares (ha) in size. The southern part of the study area is mostly infrastructure, with some woodland and open grazing areas. Immediately to the east of the study area is the currently approved open cut mine. The northern area consists of a mosaic of cleared grazing land and woodland as well as Castlerock and Dorset roads.

1.2.2 Land Use

Land within the northern part of the study area is primarily cleared, open paddock grazing land, with some areas of remnant forest and open woodland and is mainly used for cattle grazing.

Infrastructure areas and clearing associated with existing and approved open cut mining operations are mostly located in the southern part of the study area. The agricultural activities are supported by farm dams, unsealed tracks, land contouring, cattle yards and fencing.

Land immediately to the south of the study area is associated with active open cut coal mining activities of the Bengalla Mine.

Wybong Road is located to the south, Kayuga Road to the east and Dorset Road to the north of the study area. Castlerock Road crosses through the northern section of the study area.

1.2.3 Regional Setting

The study area is located in the following regional setting:

- Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and Hunter IBRA subregion; and
- the Muswellbrook Local Government Area (LGA).

1.2.4 Landform and Hydrology

The landform in the study area consists of undulating low hills and undulating hills with elevations of 80 – 370 metres (m) over open paddock grazing land (OEH, 2019), with some areas of remnant forest and open woodland together with disturbed land from open cut mining activities and associated infrastructure. Surface elevations vary from a low point of approximately 170 metres above Australian Height Datum (m AHD) to a high point of approximately 368 m AHD (at the Mount Pleasant trig station) along a northeast to southwest trending ridgeline with associated spurs (NSW Spatial Services, 2020).

The study area is located in the Hunter River catchment, with the Hunter River approximately 2.7 km southeast of the study area, at its closest point.

The following streams (all intermittent) occur in the study area and drain to the Hunter River:

- Rosebrook Creek drains the extreme eastern part of the study area and is a 3rd order stream downstream of Kayuga and Wybong Roads;
- An un-named stream drains to the northeast of Mount Pleasant across Castlerock and Dorset Roads and is a 4th order stream downstream of Dorset and Kayuga Roads;
- An un-named stream (commonly referred to as Dry Creek) formerly drained to the south of Mount Pleasant but is now captured and diverted as part of the Bengalla Mine Dry Creek Project; and
- Sandy Creek drains to the west and southwest of Mount Pleasant and is a 5th order stream downstream of Wybong Road.

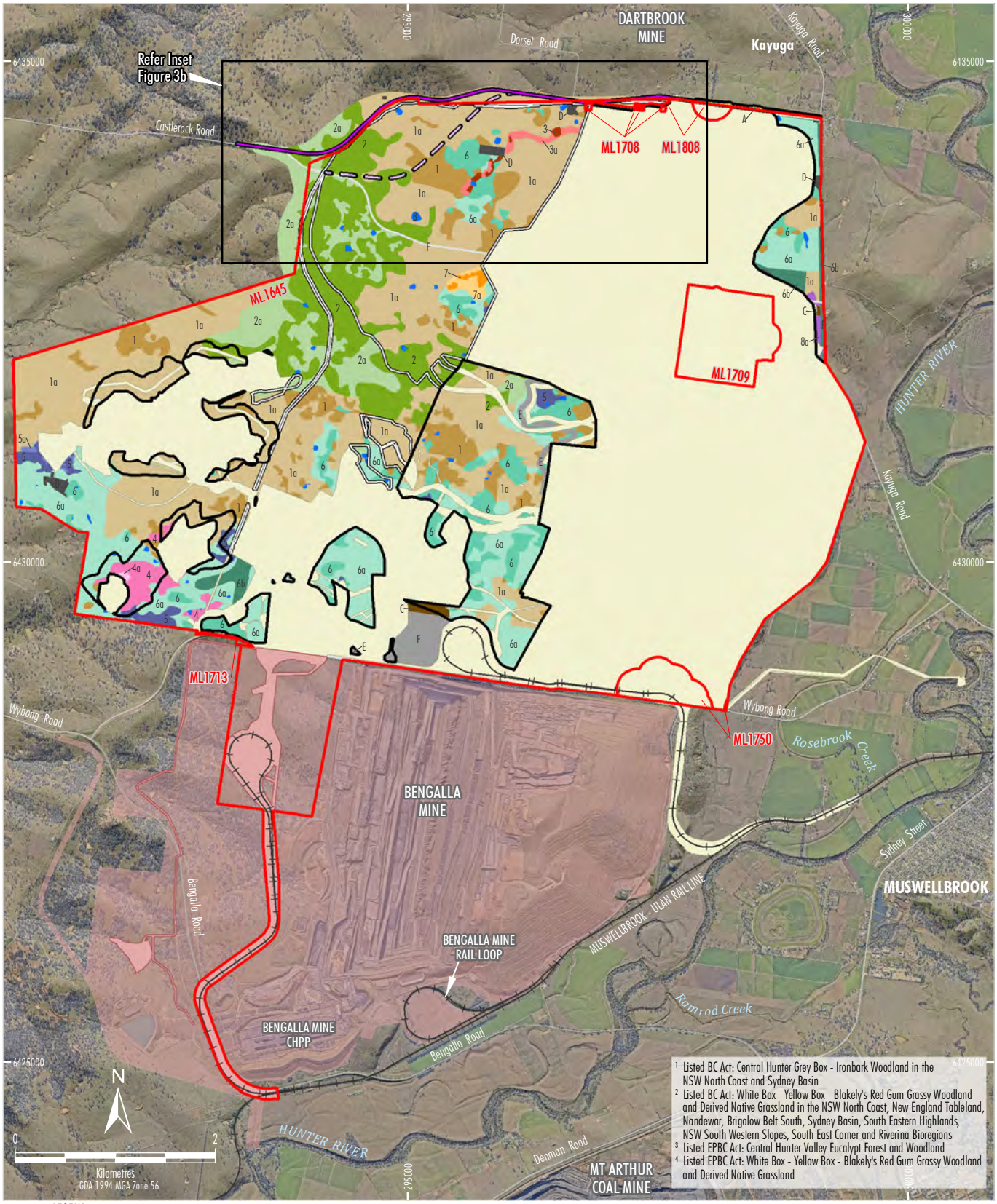
All of these streams are fed by several small ephemeral creeks and drainage lines that originate in the Mount Pleasant ridgeline and spur complex. Dry for much of the year, these watercourses commonly only flow after large rain events.

1.2.5 Vegetation

Hunter Eco (2020) has undertaken flora surveys across the study area. Seven native vegetation communities were identified and several of these occur in woodland and 'Derived Native Grassland' (DNG) form (Figures 3a and 3b). The majority of the study area comprises Grey Box x White Box Grassy Woodland (Plant Community Type [PCT] 483) in woodland and DNG (approximately 1,589 ha).

1.2.6 Summary of Previous Threatened Species Recorded in the Study Area

As detailed in Section 2.2, 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 wider locality.



MAC-18-02_SSD_EIS_App Fauna_203H

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Approximate Extent of Existing/Approved Surface Development
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 5a Derived Native Grassland (PCT1602)
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Dry Sclerophyll Forests (Shrubby sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- A Cropping/Grazing
- B Dam
- C Disturbed
- D Dwellings
- E Infrastructure
- F Local Roads

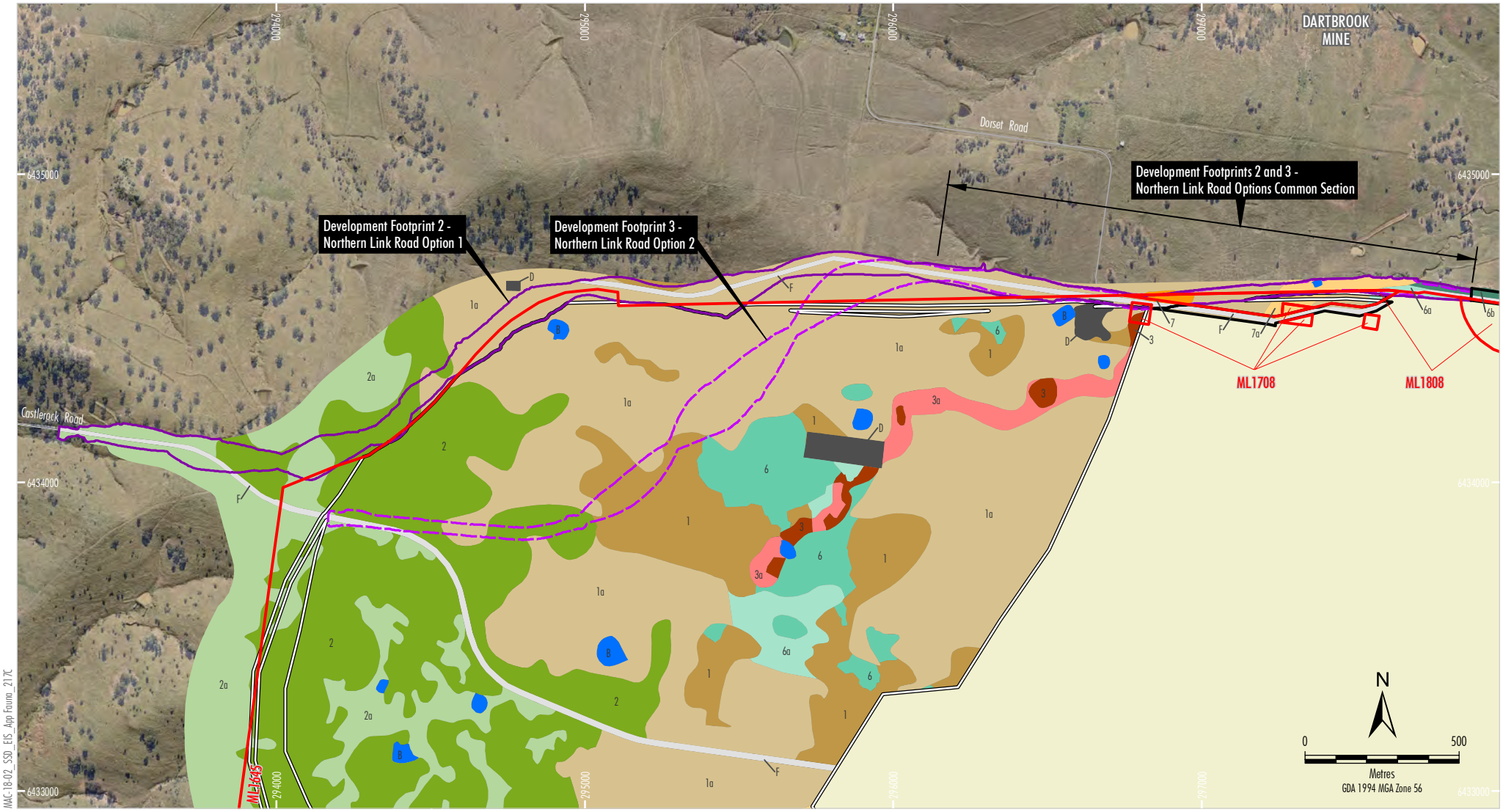
Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Mapping

Figure 3a



MAC 18-02_SSD_EIS_App Fauna_217C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Development Footprint 1 - General Extension Areas
- Development Footprint 2 - Northern Link Road Option 1
- Development Footprint 3 - Northern Link Road Option 2
- Relinquishment Area

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2,4]
- 1a Derived Native Grassland (PCT483) [2,4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2,4]
- 2a Derived Native Grassland (PCT483) [2,4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2,4]
- 3a Derived Native Grassland (PCT618) [2,4]

Dry Sclerophyll Forests (Shrub/grass sub-formation)

- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2,4]
- 7a Derived Native Grassland (PCT1606) [2,4]

Other

- B Dam
- D Dwellings
- F Local Roads

[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Vegetation Mapping Inset

Figure 3b

Table 1: Threatened Fauna Species Known or Predicted to occur in the Wider Locality

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Database Records				Recorded in Previous Studies[8]
		BC Act[1]	EPBC Act[2]		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*	E	V	S	Yes	-	-	-	-
Green-thighed Frog	*Litoria brevipalmata*	V	-	S	Yes	-	-	-	-
Reptiles									
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	Yes	Predicted	-	-	-
Striped Legless Lizard	*Delma impar*	V	V	S	Yes	Predicted	Yes	Yes	-
Western Blue-tongued Lizard	*Tiliqua occipitalis*	V	-	E	No	-	-	Yes	-
Pale-headed Snake	*Hoplocephalus bitorquatus*	V	-	S	Yes	-	-	-	-
Birds									
Magpie Goose	*Anseranas semipalmata*	V	-	E	No	-	Yes	Yes	-
Freckled Duck	*Stictonetta naevosa*	V	-	E	No	-	-	Yes	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	E	-	E	No	-	Yes	Yes	-
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	No	Predicted	-	Yes	-
Grey Falcon	*Falco hypoleucos*	E	-	E	No	Predicted	-	Yes	-
Black Falcon	*Falco subniger*	V	-	E	No	-	Yes	Yes	A
Square-tailed Kite	*Lophoictinia isura*	V	-	S/E	Yes	-	-	Yes	-
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	-	S/E	Yes	Predicted	Yes	Yes	-
Spotted Harrier	*Circus assimilis*	V	-	E	No	-	Yes	Yes	-
Red Goshawk	*Erythrotriorchis radiatus*	CE	V	S	No	Predicted	-	-	-
Little Eagle	*Hieraaetus morphnoides*	V	-	S/E	Yes	-	Yes	Yes	-
Red-backed Button-quail	*Turnix maculosus*	V	-	S	No	-	-	Yes	-
Bush Stone-curlew	*Burhinus grallarius*	E	-	S	Yes	-	-	Yes	-
Australian Painted Snipe	*Rostratula australis*	E	E	E	No	Predicted	-	Yes	-
Eastern Curlew	*Numenius madagascariensis*	-	CE	S/E	No	Predicted	-	-	-
Curlew Sandpiper	*Calidris ferruginea*	E	CE	S/E	No	Predicted	-	-	-
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	S/E	Yes	-	Yes	Yes	-
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	-	S/E	Yes	-	-	-	-
Little Lorikeet	*Glossopsitta pusilla*	V	-	E	Yes	-	Yes	Yes	-

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Database Records				Recorded in Previous Studies[8]
		BC Act[1]	EPBC Act[2]		Potentially Associated with PCTs in the Study Area[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Turquoise Parrot	*Neophema pulchella*	V	-	E	Yes	-	Yes	Yes	-
Swift Parrot	*Lathamus discolor*	E	CE	S/E	Yes	Predicted	-	Yes	-
Eastern Ground Parrot	*Pezoporus wallicus wallicus*	V	-	S	No	-	-	Yes	-
Masked Owl	*Tyto novaehollandiae*	V	-	S/E	Yes	-	Yes	Yes	-
Powerful Owl	*Ninox strenua*	V	-	S/E	Yes	-	Yes	Yes	-
Barking Owl	*Ninox connivens*	V	-	S/E	Yes	-	Yes	Yes	-
White-throated Needletail	*Hirundapus caudacutus*	-	V	S	No	Predicted	-	Yes	C
Collared Kingfisher	*Todiramphus chloris*	V	-	S	No	-	-	Yes	-
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	E	Yes	-	Yes	Yes	A
Speckled Warbler	*Chthonicola sagittata*	V	-	E	Yes	-	Yes	Yes	A, B, C
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	-	E	Yes	-	Yes	Yes	A
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E	Yes	Predicted	Yes	Yes	-
Painted Honeyeater	*Grantiella picta*	V	V	E	Yes	Predicted	-	Yes	-
White-fronted Chat	*Epthianura albifrons*	V	-	E	No	-	-	Yes	-
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	-	E	Yes	-	-	-	-
Flame Robin	*Petroica phoenicea*	V	-	E	Yes	-	Yes	Yes	-
Scarlet Robin	*Petroica boodang*	V	-	E	Yes	-	-	Yes	-
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V	-	E	Yes	-	Yes	Yes	A
Varied Sittella	*Daphoenositta chrysoptera*	V	-	E	Yes	-	Yes	Yes	A
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	E	No	-	Yes	Yes	A
Diamond Firetail	*Stagonopleura guttata*	V	-	E	Yes	-	Yes	Yes	A
Mammals									
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	E	Yes	Predicted	Yes	Yes	-
Brush-tailed Phascogale	*Phascogale tapoatafa*	V	-	S	Yes	-	Yes	Yes	-
Common Planigale	*Planigale maculata*	V	-	S	Yes	-	-	-	-
Koala	*Phascolarctos cinereus*	V	V	S/E	Yes	Predicted	Yes	Yes	-

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Database Records				Recorded in Previous Studies[8]
		BC Act[1]	EPBC Act[2]		Potentially Associated with PCTs in the Study Area[4]	EPBC Act Protected Matters Search[5]	BioNet Atlas[6]	ALA[7]	
Eastern Pygmy-possum	*Cercartetus nanus*	V	-	S	Yes	-	-	-	-
Yellow-bellied Glider	*Petaurus australis*	V	-	E	Yes	-	Yes	Yes	-
Squirrel Glider	*Petaurus norfolcensis*	V	-	S	Yes	-	Yes	Yes	A, C
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E	V	S	Yes	Predicted	-	-	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	S/E	Yes	Predicted	Yes	Yes	A
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	E	Yes	-	Yes	Yes	A, B, C^{Po}
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V	-	E	Yes	-	Yes	Yes	A, B
Little Bent-winged Bat	*Miniopterus australis*	V	-	S/E	No	-	Yes	Yes	-
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V	-	S/E	Yes	-	Yes	Yes	A, B
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E	Yes	Predicted	-	-	-
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S	Yes	Predicted	Yes	Yes	-
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	E	Yes	-	Yes	Yes	A^{Po},B^{Po},C^{Po}
Southern Myotis	*Myotis macropus*	V	-	S	Yes	-	Yes	Yes	A
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	E	Yes	-	Yes	Yes	A^{Po},B^{Po}, C^{Po}
Eastern Cave Bat	*Vespadelus troughtoni*	V	-	S	Yes	-	Yes	Yes	C

Highlighted species are species previously recorded in the study area.

1 Conservation status under the BC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

2 Conservation status under the EPBC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

3 Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (Department of Planning, Industry and Environment [DPIE], 2020b) (current as at December 2020). E = Ecosystem, S = Species.

4 DPIE (2020b).

5 Department of Agriculture, Water and the Environment (DAWE) (2020b).

6 DPIE (2020a).

7 Atlas of Living Australia (ALA) (2020).

8 A – Cumberland Ecology (2010).
B – Eco Logical Australia (2017a).
C – Eco Logical Australia (2017b).

^{Pr} = probable record

^{Po} = possible record

2 Methods

2.1 Nomenclature

Primary sources of literature accessed for nomenclature includes:

- *CSIRO List of Australian Vertebrates* (Clayton *et al.,* 2006);
- Amphibians/Reptiles - *Reptiles and Amphibians of Australia, Seventh Edition* (Cogger, 2018);
- Birds - *Systematics and Taxonomy of Australian Birds* (Christidis and Boles, 2008);
- Mammals - *The Mammals of Australia, Third Edition* (Van Dyck and Strahan, 2008); and
- Bats - *Australian Bats, Second Edition* (Churchill, 2009) and *A Current Taxonomic List of Australian Chiropteran* (Reardon *et al.*, 2015).

2.2 Literature and Database Review

A review of relevant literature and databases was undertaken prior to undertaking the field surveys (Section 2.4) to identify known or potentially occurring threatened fauna species or their habitats.

The following databases were reviewed:

- *Birdlife Australia Atlas Database* (Birdlife Australia, 2020);
- *BioNet Atlas* (DPIE, 2020a);
- *Protected Matters Search Tool* (DAWE, 2020b); and
- *Atlas of Living Australia* (ALA, 2020).

The following mapping sources were reviewed:

- *Mount Pleasant Optimisation Project Baseline Flora Report* (Hunter Eco, 2020);
- *SIX Maps* (NSW Spatial Services, 2020); and
- *Google Earth Pro* (Google, 2020).

The following local survey reports were also reviewed:

- *Mount Pleasant Project Modification Ecological Assessment* (Cumberland Ecology, 2010);
- *Mount Pleasant Operation Rail Modification – Terrestrial Fauna Survey Report* (Eco Logical Australia, 2017a); and
- *Mount Pleasant Operation Rail Modification – Portion of South West Out of Pit Emplacement – Terrestrial Fauna Survey Report* (Eco Logical Australia, 2017b).

Results for each of the surveys are summarised below.

Mount Pleasant Project Modification Ecological Assessment (Cumberland Ecology, 2010)

Cumberland Ecology (2010) undertook ecological surveys as part of an ecological assessment for the Mount Pleasant Project conveyor/service corridor envelope immediately south of Wybong Road. The report refers to previous targeted fauna surveys conducted within the area as part of the Mount Pleasant Mine EIS (ERM Mitchell McCotter Pty Ltd, 1997) and subsequent targeted fauna surveys completed in 2007 and 2009. It also refers to an avifauna and fauna habitat assessment completed in 2010. Fauna surveys included targeted amphibian and reptile habitat day and night active searches, call-playback for Green and Golden Bell Frog (*Litoria aurea*), tadpole catch and identification, pitfall traps with drift nets, bird point counts and area searches, spotlighting, call-playback (including targeted Squirrel Glider [*Petaurus norfolcensis*] calls), cage and terrestrial and arboreal Elliott trapping, terrestrial and arboreal hair tubes, wildlife camera trapping, searches for scats and signs, bat ultrasonic call recording and harp and tripline bat surveys. Survey months included February, July and November and were carried out over several years, during drought and following heavy rains.

During surveys the following threatened species were recorded: Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Speckled Warbler (*Chthonicola sagittata*), Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*), Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), Varied Sittella (*Daphoenositta chrysoptera*), Dusky Woodswallow (*Artamus cyanopterus cyanopterus*), Diamond Firetail (*Stagonopleura guttata*), Squirrel Glider, Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*), Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Southern Myotis (*Myotis macropus*). The following bat species were possibly recorded: Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*). No habitat for cave-dwelling bats was recorded.

The following survey techniques were conducted by Cumberland Ecology (2010) which are also suitable for Koala (*Phascolarctos cinereus*) detection:

- Spotlighting on foot for 20 hours (10 x 2 hours per night on 10 separate nights) and an unspecified number of hours over an additional 3 nights;
- Spotlighting from vehicle for 5 hours (5 x 1 hours per night);
- Call-playback for 9 nights
- Search for scats and signs for 3 hours;
- IR cameras - 12 survey nights; and
- Collection of scats (predator) throughout survey period.

No Koalas (or evidence of the Koala) were recorded at the Mount Pleasant Mine, despite the surveys from 1997 to 2010.

Mount Pleasant Operation Rail Modification (MOD4) - Terrestrial Fauna Survey Report (Eco Logical Australia, 2017a).

Eco Logical Australia (2017a) undertook targeted threatened fauna survey for a proposed modification at the Mount Pleasant Operation in 2017. The modification included duplication of approved rail and conveyor facilities and Hunter River water supply infrastructure to the southeast of Mount Pleasant and then demolition of redundant infrastructure once the new infrastructure has been commissioned.

Field surveys were undertaken in November 2017 and targeted 'species credit species' and their habitat. The survey consisted of fauna habitat mapping and recording of habitat values (including hollow-bearing trees), a Koala habitat assessment, diurnal bird surveys using 20-minute point counts, microbat call recording, remote camera traps, nocturnal mammal and reptile surveys (stagwatching, call-playback, spotlighting, active searches), diurnal reptile searches and opportunistic sightings. Recorded microbat calls were analysed by expert Dr Greg Richards.

During surveys by Eco Logical Australia (2017a) the following threatened species were recorded: Speckled Warbler and Large Bent-winged Bat. The following bat species were possibly recorded: Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle, and Greater Broad-nosed Bat. No habitat for cave-dwelling bats was recorded.

Koalas were target surveyed by an hour of spotlighting on each of two separate nights in November 2017 by two ecologists (total effort of four person hours). During spotlighting, areas of potential habitat for the Koala were inspected for signs of Koala such as scats and scratch marks on tree trunks. In addition, the four wildlife cameras set for five nights at bait stations for the Spotted-tailed Quoll (*Dasyurus maculatus*) in same period would have also potentially detected Koala if it was moving along the ground in front of these cameras. The 13 hours of diurnal bird surveys completed at five locations over 3 days in November 2017 would also have sampled the Koala if it was present in observed trees during those days. No Koalas (or evidence of the Koala) were recorded at the Mount Pleasant Mine, despite the surveys by Eco Logical Australia (2017a).

Mount Pleasant Operation Rail Modification – Portion of South West Out of Pit Emplacement – Terrestrial Fauna Survey Report (Eco Logical Australia, 2017b).

Eco Logical Australia (2017b) undertook a second targeted threatened fauna and habitat survey for a proposed modification at the Mount Pleasant Operation in 2017. This modification included relinquishment of part of an approved but yet to be constructed infrastructure area as part of the Rail Modification. The study area was approximately 35 ha.

Field surveys were undertaken in December 2017 and targeted relevant 'species credit species' and their habitat likely to occur within the modification study area and those threatened fauna species previously detected within the Rail Modification area in November 2017 (Eco Logical Australia, 2017a). The survey consisted of fauna habitat mapping and recording of habitat values (including hollow-bearing trees), a Koala habitat assessment, diurnal bird surveys using 20-minute point counts, microbat call recording and harp trapping, remote camera traps, nocturnal mammal surveys (stagwatching, call-playback, spotlighting), and opportunistic sightings. Recorded microbat calls were analysed by expert Dr Greg Richards.

During surveys the following threatened species were recorded: Speckled Warbler, Squirrel Glider, Yellow-bellied Sheathtail-bat, and Eastern Cave Bat (*Vespadelus troughtoni*). The following bat species were possibly recorded: Eastern False Pipistrelle, and Greater Broad-nosed Bat. No habitat for cave-dwelling bats was recorded. The White-throated Needletail (*Hirundapus caudacutus*) was recorded flying over the study area.

Koalas were target surveyed by an hour of spotlighting on each of two separate nights in December 2017 by two ecologists (total effort of four person hours). During spotlighting areas of potential habitat for the Koala were inspected for signs of Koala such as scats and scratch marks on tree trunks. In addition, the six wildlife cameras set for six nights at bait stations for the Spotted-tail Quoll (three cameras on ground) and Squirrel Glider (three cameras in trees) in same period would have also potentially detected Koala if it was moving in front of these cameras. The 13 hours of diurnal bird surveys completed at five locations over 3 days in December 2017 would also have sampled the Koala if it was present foraging in observed trees during those days. No Koalas (or evidence of the Koala) were recorded at the Mount Pleasant Mine, despite the surveys by Eco Logical Australia (2017b).

2.3 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 [DotE], 2014);
- *Species Profile and Threats Database* of relevant Commonwealth listed threatened and/or migratory fauna species (DAWE, 2020c);
- BAM (OEH, 2017); and
- *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b)

2.4 Field Survey

2.4.1 Weather, Climate and Astronomical Conditions

Fauna surveys took place over several separate periods:

1. 20 to 25 August 2018;
2. 10 to 14 December 2018;
3. 1 to 7 July 2019;
4. 4 to 9 November 2019; and
5. 20 to 25 November 2019.

Weather records during the surveys were taken from the Mount Pleasant Automatic Weather Station (AWS), within the study area. Astronomical records were taken from the Geoscience Australia website (2020a; 2020b), the Museum of Applied Arts and Sciences – Sydney Observatory website (2020) and the Timeanddate website (2020).

2018 was the warmest on record for NSW at that time for both mean temperature and mean maximum temperature and it was a very dry year as a whole with rainfall 40% below average, the sixth-driest year on record and the driest since 2002 (Bureau of Meteorology [BoM], 2020a).

2019 was the driest and warmest year on record for NSW at that time with total rainfall the lowest on record, at 55% below average well below the previous driest year of 1944 (BoM, 2020b). It was the warmest year on record for NSW as a whole, with the mean temperature 1.95 degrees Celsius (°C) above average and 0.27°C warmer than the previous warmest, 2018 (BoM, 2020b).

Weather conditions during the August 2018 survey period were cold to cool, with a maximum and minimum temperature of 19°C and 0.8°C recorded, respectively. A total of 0.2 millimetres (mm) of rainfall was recorded during the survey period.

Weather conditions during the December 2018 survey periods were mild to warm, with temperatures ranging from 17.1°C to 33°C. A total of 32.6 mm of rainfall was recorded during the survey period.

Weather conditions during the July 2019 survey period were cold to mild with temperatures ranging from -0.5°C to 21.4°C. A total of 4.8 mm of rainfall was recorded during the survey period.

Weather conditions during the first November 2019 survey period were cold to warm, with temperatures ranging from 8°C to 31.6°C. 0.8 mm of rainfall was recorded during the survey period. Weather conditions during the second November 2019 survey period were cool to hot, with temperatures ranging from 13.8°C to 38.9°C. A total of 4 mm of rainfall was recorded during the survey period.

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 Conditions during Survey Periods

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Sunrise	Sunset	Moonrise	Moonset	Moonphase
August 2018								
20/08/2018	3.8	15.4	0	0628	1732	1219	0135	Waxing Gibbous
21/08/2018	6.1	15.9	0	-	-	-	-	-
22/08/2018	5.2	17	0	-	-	-	-	-
23/08/2018	0.8	17.4	0	-	-	-	-	-
24/08/2018	4.1	19	0	-	-	-	-	-
25/08/2018	5.4	18.3	0.2	0622	1735	1625	0533	Waxing Gibbous
December 2018								
10/12/2018	18.9	33	0.2	0543	1955	0757	2218	Waxing Crescent
11/12/2018	17.6	21.6	9.2	-	-	-	-	-
12/12/2018	17.1	24.4	1.2	-	-	-	-	-
13/12/2018	18.4	31.7	6.1	-	-	-	-	-
14/12/2018	19.8	27	15.9	0544	1958	1130	0017	Waxing Crescent
July 2019								
01/07/2019	-0.5	17.6	0	0658	1702	0459	1536	Waning Crescent
02/07/2019	0.6	21.4	0	-	-	-	-	-
03/07/2019	-0.4	19.2	0.2	-	-	0706	1729	New Moon
04/07/2019	11.8	16.1	4.4	-	-	-	-	-
05/07/2019	10.2	18	0.2	-	-	-	-	-
06/07/2019	10.8	17.6	0	-	-	-	-	-
07/07/2019	8.5	18.1	0	0658	1705	1027	2201	Waxing Crescent
November 2019								
04/11/2019	16.3	27.1	0.2	0556	1924	1149	0120	First Quarter
05/11/2019	11.1	22.9	2	-	-	-	-	-
06/11/2019	8	27.9	0	-	-	-	-	-
07/11/2019	18	31.6	0	-	-	-	-	-
08/11/2019	14.3	30.4	0	-	-	-	-	-
09/11/2019	11.4	22.6	0	0552	1928	1622	0413	Waxing Gibbous
November 2019								
20/11/2019	18	30.8	0	0546	1938	0136	1234	Last Quarter
21/11/2019	13.8	36.3	0	-	-	-	-	-
22/11/2019	18.4	38.9	3.8	-	-	-	-	-
23/11/2019	19.8	31.9	0.2	-	-	-	-	-
24/11/2019	18.6	24.6	0	-	-	-	-	-
25/11/2019	17.4	32.6	0	0544	1943	0444	1807	Waning Crescent

Sources: Geoscience Australia (2020a, 2020b), Museum of Applied Arts and Sciences - Sydney Observatory (2020), Timeanddate.com (2020), MACH Mount Pleasant AWS.

2.4.2 Techniques

Stratification of the study area and site selection

The study area was initially assessed through interpretation of digital aerial imagery and from advice received from preliminary vegetation work carried out by Hunter Eco. The landscape is mostly cleared agricultural lands and therefore remnant patches of treed vegetation within the study area and a preliminary delineation of vegetation communities based on canopy species were used as a basis for the initial stratification. Further stratification considered previous threatened and/or protected migratory fauna records within the study area, various reiterations of the study area boundary, and the spacing between survey sites.

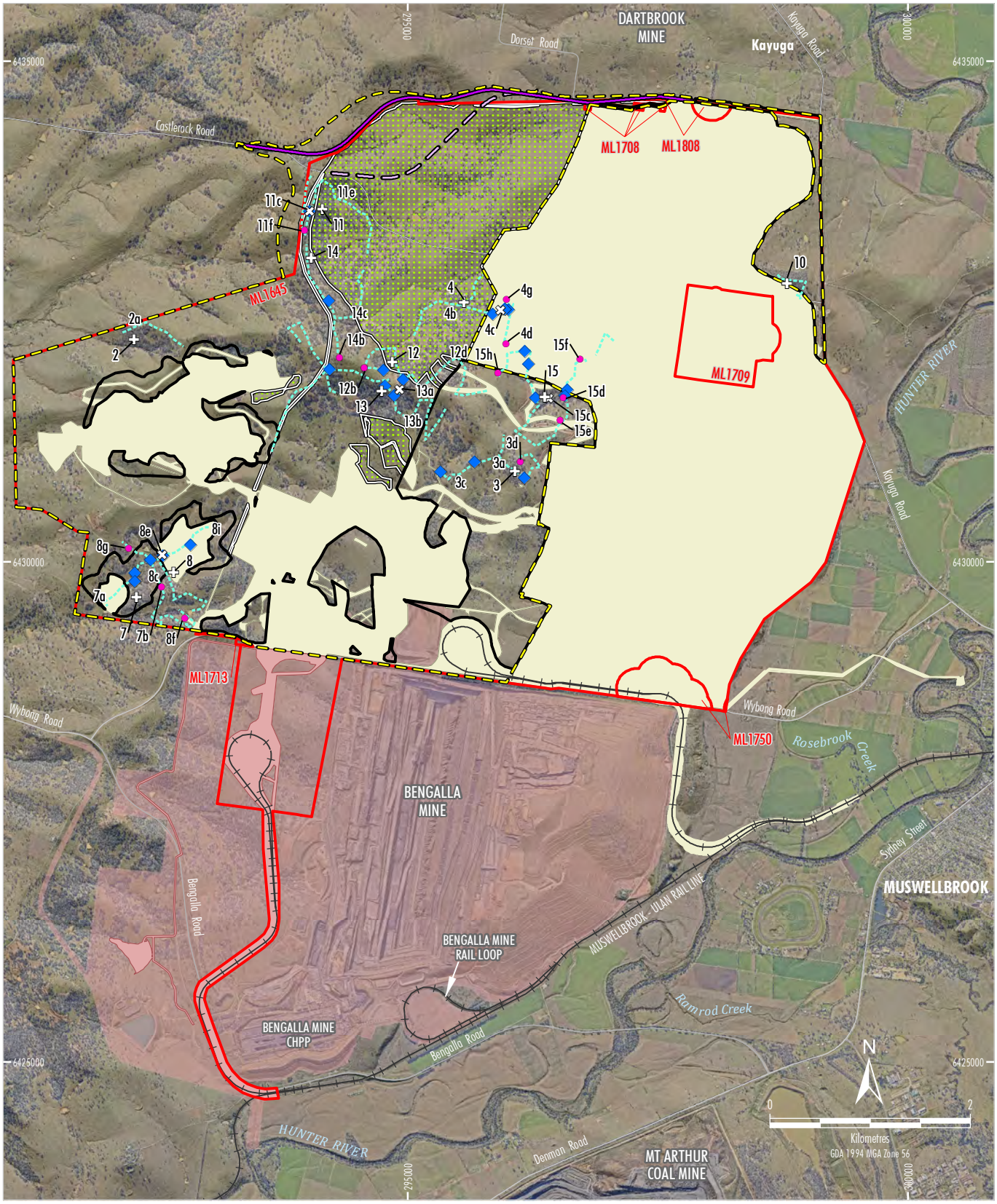
Eleven general survey sites were initially selected for the August 2018 survey period with a further thirteen additional habitat assessment sites added to the November 2019 survey period. Some of the survey sites (Site 11 and 13) had been previously surveyed (or partly surveyed) by Cumberland Ecology (2010) and/or Eco Logical Australia (2017b). Some subsites were created at locations within general survey sites to allow for specific survey techniques to be undertaken.

General fauna and mammal survey sites are listed in Table 3 and shown on Figure 4a. Reptile survey sites are shown on Figure 4b and bat survey sites are shown on Figure 4c. Additional habitat assessment sites are listed in Table 3 and shown on Figure 4b.

Table 3: Fauna Survey Sites for the Study Area

Detailed Site	Location (Lat/Long GDA)		Site Type	Figure
2	-32.23	150.80	General Fauna Survey Site	4a
2a	-32.23	150.80	Camera and Hair Tube Transect	4a
3	-32.24	150.84	General Fauna Survey Site	4a
3a	-32.24	150.84	Camera and Hair Tube Transect	4a
3b	-32.24	150.84	Artificial Shelter Habitat (Tile Grid)	4b
3c	-32.24	150.83	Camera and Hair Tube Transect	4a
3d	-32.24	150.84	Call-playback Location	4a
4	-32.22	150.83	General Fauna Survey Site	4a
4a	-32.22	150.83	Pitfall and Funnel Trap Transect	4b
4b	-32.23	150.83	Camera and Hair Tube Transect	4a
4c	-32.23	150.83	Mammal Survey Site (Elliotts, cages, camera traps)	4a
4d	-32.23	150.83	Call-playback Location	4a
4e	-32.22	150.84	Acoustic Bat Recorder Site	4c
4f	-32.22	150.84	Acoustic Bat Recorder Site	4c
4g	-32.22	150.84	Call-playback Location	4a
7	-32.25	150.80	General Fauna Survey Site	4a
7a	-32.25	150.79	Camera and Hair Tube Transect	4a
7b	-32.25	150.80	Call-playback Location	4a
7c	-32.25	150.80	Reptile Active Search Site	4b
8	-32.25	150.80	General Fauna Survey Site	4a
8a	-32.25	150.80	Bat Survey Site (Harp traps, acoustic recorders)	4c
8b	-32.25	150.80	Pitfall and Funnel Trap Transect	4b
8c	-32.25	150.80	Camera and Hair Tube Transect	4a
8d	-32.25	150.80	Artificial Shelter Habitat (Tile Grid)	4b
8e	-32.25	150.80	Mammal Survey Site (Elliotts, cages, camera traps)	4a
8f	-32.25	150.80	Call-playback Location	4a
8g	-32.25	150.79	Call-playback Location	4a
8h	-32.25	150.80	Acoustic Bat Recorder Site	4c
8i	-32.24	150.80	Camera and Hair Tube Transect	4a

Detailed Site	Location (Lat/Long GDA)		Site Type	Figure
8j	-32.24	150.80	Reptile Active Search Site	4b
10	-32.22	150.86	General Fauna Survey Site	4a
11	-32.22	150.82	General Fauna Survey Site	4a
11a	-32.22	150.81	Pitfall and Funnel Trap Transect	4b
11b	-32.22	150.81	Artificial Shelter Habitat (Tile Grid)	4b
11c	-32.22	150.81	Mammal Survey Site (Elliotts, cages, camera traps)	4a
11d	-32.21	150.81	Acoustic Bat Recorder Site	4c
11e	-32.21	150.82	Camera and Hair Tube Transect	4a
11f	-32.22	150.81	Call-playback Location	4a
11g	-32.22	150.81	Acoustic Bat Recorder Site	4c
12	-32.23	150.82	General Fauna Survey Site	4a
12a	-32.23	150.82	Pitfall and Funnel Trap Transect	4b
12b	-32.23	150.82	Call-playback Location	4a
12c	-32.23	150.82	Acoustic Bat Recorder Site	4c
12d	-32.23	150.83	Camera and Hair Tube Transect	4a
12e	-32.23	150.82	Reptile Active Search Site	4b
13	-32.23	150.82	General Fauna Survey Site	4a
13a	-32.23	150.82	Mammal Survey Site (Elliotts, cages, camera traps)	4a
13b	-32.24	150.82	Camera and Hair Tube Transect	4a
14	-32.22	150.81	General Fauna Survey Site	4a
14a	-32.22	150.82	Artificial Shelter Habitat (Tile Grid)	4b
14b	-32.23	150.82	Call-playback Location	4a
14c	-32.23	150.82	Camera and Hair Tube Transect	4a
14d	-32.22	150.82	Acoustic Bat Recorder Site	4c
15	-32.23	150.84	General Fauna Survey Site	4a
15a	-32.23	150.84	Bat Survey Site – Nov 2019 (Harp traps, acoustic recorders)	4c
15b	-32.23	150.84	Artificial Shelter Habitat (Tile Grid)	4b
15c	-32.23	150.84	Mammal Survey Site (Elliotts, cages, camera traps)	4a
15d	-32.23	150.84	Call-playback Location	4a
15e	-32.24	150.84	Call-playback Location	4a
15f	-32.23	150.84	Call-playback Location	4a
15g	-32.23	150.84	Acoustic Bat Recorder Site	4c
15h	-32.23	150.83	Call-playback Location	4a
A	-32.21	150.85	Additional Habitat Assessment	4b
B	-32.21	150.85	Additional Habitat Assessment	4b
C	-32.212	150.83	Additional Habitat Assessment	4b
D	-32.21	150.83	Additional Habitat Assessment	4b
E	-32.21	150.83	Additional Habitat Assessment	4b
F	-32.21	150.82	Additional Habitat Assessment	4b
G	-32.21	150.81	Additional Habitat Assessment	4b
H	-32.21	150.81	Additional Habitat Assessment	4b
I	-32.22	150.82	Additional Habitat Assessment	4b
J	-32.23	150.81	Additional Habitat Assessment	4b
K	-32.25	150.80	Additional Habitat Assessment	4b
L	-32.25	150.82	Additional Habitat Assessment	4b
M	-32.25	150.83	Additional Habitat Assessment	4b



MAC-18-02_SSD_EIS_App Fauna_202K

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Fauna Survey Sites

- General Fauna Survey Site
- Mammal Survey Site
- Nest Box
- Call-Playback Location
- Camera and Hair Tube Transect

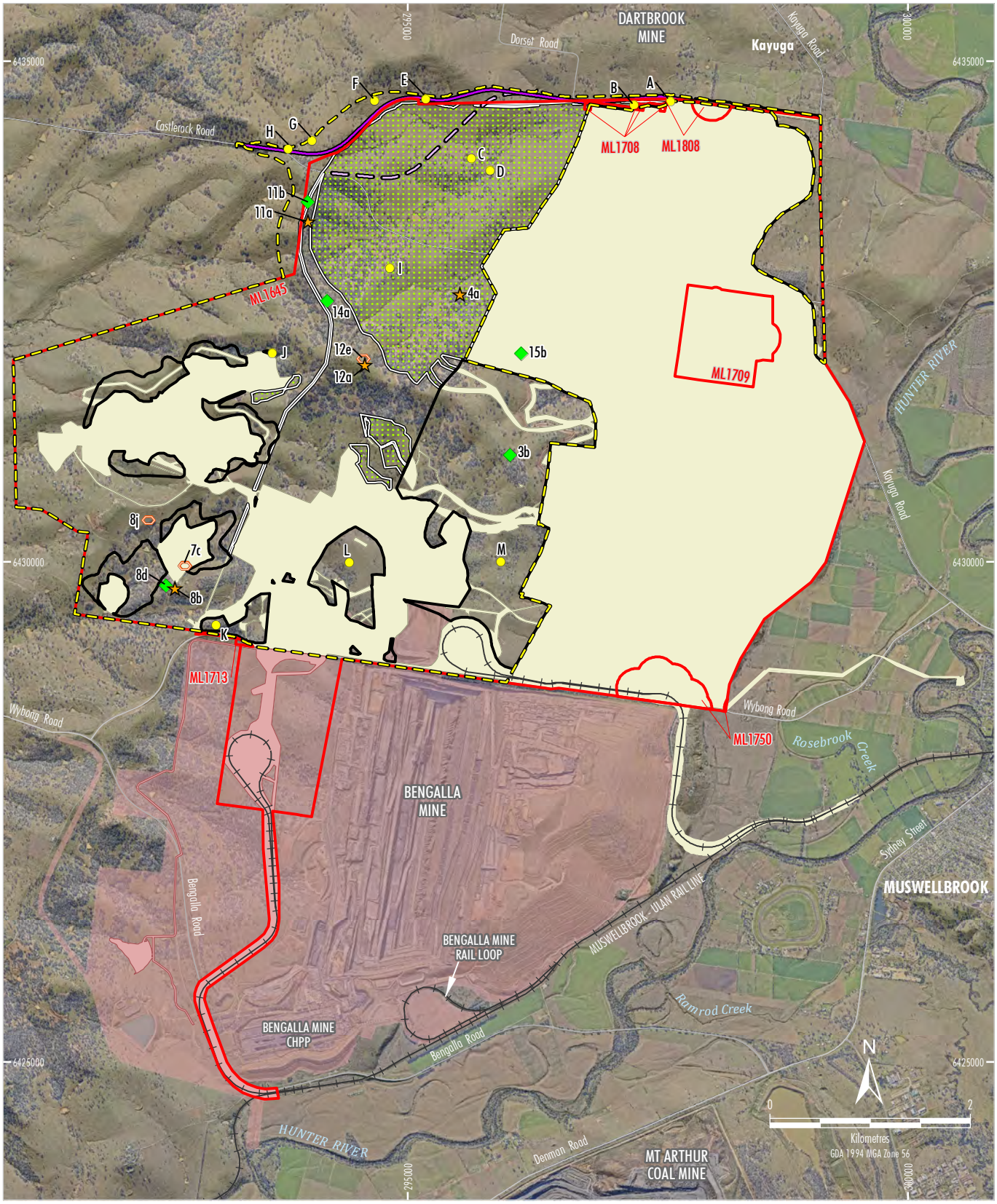
Source: MACH (2020); Future Ecology (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Fauna Survey Sites

Figure 4a



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Fauna Survey Sites

- Reptile Active Search Site
- Artificial Shelter Habitat (Tile Grid)
- Additional Habitat Assessment Site
- Pitfall and Funnel Trap Transect

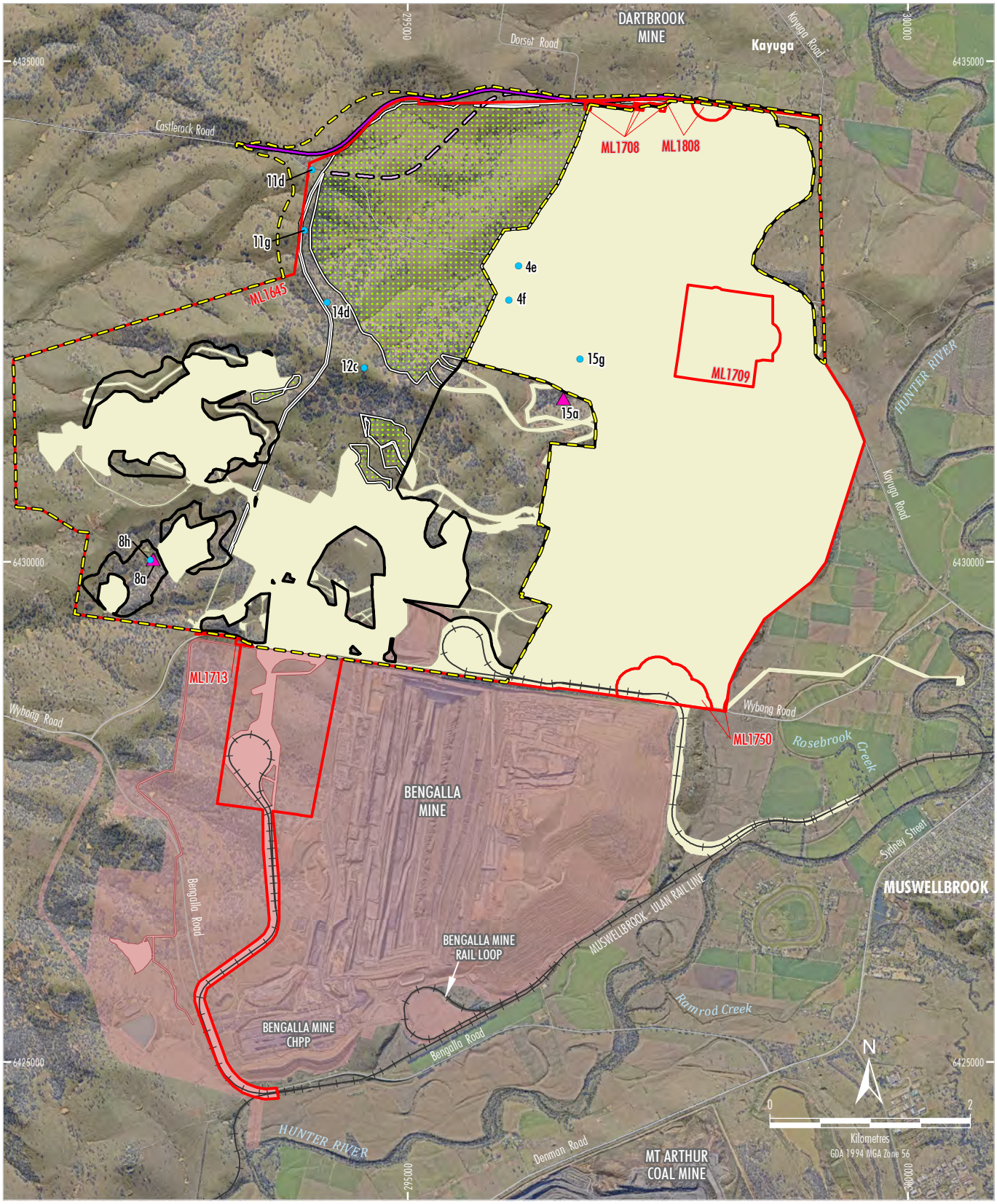
Source: MACH (2020); Future Ecology (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Fauna Survey Sites

Figure 4b



MAC-18-02_SSD_EIS_App Fauna_212F

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Fauna Survey Sites

- Harp Trap / Mist Net
- Acoustic Bat Recorder Site

Source: MACH (2020); Future Ecology (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Fauna Survey Sites

Figure 4c

The following general survey techniques were used: habitat assessment, diurnal and nocturnal bird, reptile, amphibian and reptile surveys, microbat surveys and mammal surveys via observation, listening, spotlighting, call-playback, trapping, acoustic recording and deployment of artificial shelter habitats. These techniques are described in more detail below.

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 three ecologists in August 2018, five ecologists in December 2018, four ecologists in July 2019, and four ecologists in July 2019, total survey effort would be in the order of at least two times what is described below for the specialist avifauna and herpetofauna surveys.

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 sp*., *Allocasuarina sp*. 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. The structure of the canopy, shrub cover and ground cover were 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 (2020).

Consideration was also given to the occurrence of habitat constraints in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (Table 4).

Table 4: Habitat Constraints Identified in the *BioNet Threatened Biodiversity Data Collection*

Common Name	Scientific Name	Credit Class[1]	Habitat Constraints identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b)
Reptiles			
Pink-tailed Legless Lizard	*Aprasia parapulchella*	Species	*Rocky areas or within 50 m of rocky areas.*
Birds			
Square-tailed Kite	*Lophoictinia isura*	Species/Ecosystem	*Breeding constraint: Other (Nest trees).* *Foraging constraint: None.*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Species/Ecosystem	*Breeding constraint: Other (Living or dead mature trees within suitable vegetation within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines).* *Foraging constraint: Waterbodies (Within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines).*
Little Eagle	*Hieraaetus morphnoides*	Species/Ecosystem	*Breeding constraint: Other (Nest trees - live (occasionally dead) large old trees within vegetation).* *Foraging constraint: None.*
Bush Stone-curlew	*Burhinus grallarius*	Species	*Fallen/standing dead timber including logs.*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	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).*

Common Name	Scientific Name	Credit Class[1]	Habitat Constraints identified in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b)
			Foraging constraint: Other (Presence of Allocasuarina and Casuarina species).
Swift Parrot	*Lathamus discolor*	Species/Ecosystem	*Breeding constraint: Other (As per mapped areas).* *Foraging constraint: None.*
Masked Owl	*Tyto novaehollandiae*	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Living or dead trees with hollows greater than 20 cm diameter).* *Foraging constraint: None.*
Powerful Owl	*Ninox strenua*	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Living or dead trees with hollows greater than 20 cm diameter).* *Foraging constraint: None.*
Barking Owl	*Ninox connivens*	Species/Ecosystem	*Breeding constraint: Hollow-bearing trees (Living or dead trees with hollows greater than 20 cm diameter and greater than 4 m above the ground).* *Foraging constraint: None.*
Regent Honeyeater	*Anthochaera phrygia*	Species/Ecosystem	*Breeding constraint: Other (As per mapped areas).* *Foraging constraint: None.*
Mammals			
Koala	*Phascolarctos cinereus*	Species/Ecosystem	*Breeding constraint: Other (Areas identified via survey as important habitat [see comments].* *Foraging constraint: None.*
Brush-tailed Rock-wallaby	*Petrogale penicillata*	Species	*Other (Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliffflines).*
Grey-headed Flying-fox	*Pteropus poliocephalus*	Species/Ecosystem	*Breeding constraint: Other (Breeding camps).* *Foraging constraint: None.*
Little Bent-winged Bat	*Miniopterus australis*	Species/Ecosystem	*Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature).* *Foraging constraint: None.*
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	Species/Ecosystem	*Breeding constraint: Caves (Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;" with numbers of individuals >500).* *Foraging constraint: None.*
Large-eared Pied Bat	*Chalinolobus dwyeri*	Species	*Cliffs (Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within 2 km of old mines or tunnels).*
Southern Myotis	*Myotis macropus*	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	*Vespadelus troughtoni*	Species	*Caves (Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within 2 km of old mines, tunnels, old buildings or sheds).*

[1] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at **December** 2020).

Diurnal 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 7 is provided by the dedicated avifauna specialist (Dr Tony Saunders) on the ecological team.

Specialist diurnal bird surveys were conducted in August 2018, December 2018 and July 2019 to cover seasonality and detection requirements of several species. A 500 m radius area search was conducted at each site and all species seen and/or heard were recorded. All observations were recorded within the 'Sightings' App on an iPhone and converted to an Excel file.

When threatened species were detected a count of the number of individuals of that species was also recorded. 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.

August 2018

Eleven sites were visited 20-25 August 2018 with 31 hours of diurnal surveys completed. Each site was visited for a minimum of 1.5 hours and up to 4 hours if a site was structurally more complex, contained a greater variety of birds and if there was a high likelihood of threatened species being present. Such sites were surveyed more than once between dawn and mid-morning, as this is the optimal observation period. The survey effort for each site and sampling period are shown in Table 5:

Table 5: Bird Survey Effort for August 2018 Survey Period

Timing	Site (hours)											Totals (hours)
	2	3	4	7	8	10	11	12	13	14	15	
Dawn to mid-morning	0	0	0	2	1	3	3.5	1.5	1.5	2.5	0	15
Mid-morning to early afternoon	1.5	0	1	0	1	0	0	2	1	0	1	7.5
Afternoon	0	2	3	0	0	0.5	0.5	0	1	0.5	1	8.5
Totals (hours)	**1.5**	**2**	**4**	**2**	**2**	**3.5**	**4**	**3.5**	**3.5**	**3**	**2**	**31**

December 2018

Ten sites were visited 10-14 December 2018 with 39.75 hours of diurnal surveys (including 7 hours of incidental surveys between sites) completed. Ten sites were visited for a minimum of 1 hour and up to 6.5 hours if a site was structurally more complex, contained a greater variety of birds and if there was a high likelihood of threatened species being present. Such sites were surveyed between dawn and mid-morning, as this is the optimal observation period. The survey effort for each site and sampling period are shown in Table 6:

Table 6: Bird Survey Effort for December 2018 Survey Period

Timing	Site (hours)												Totals (hours)
	2*	3	4	7	8	10	11	12	13	14	15	Inc^	
Dawn to mid-morning	0	1.5	2.5	6.5	6.5	1	5.5	2	2	2.25	3	7	39.75
Totals (hours)	**0**	**1.5**	**2.5**	**6.5**	**6.5**	**1**	**5.5**	**2**	**2**	**2.25**	**3**	**7**	**39.75**

* Site 2 was not sampled due to poor habitat quality

^ Inc = incidental observation time between sites

July 2019

Ten sites were visited 1-6 July 2019 with 46.5 hours of diurnal surveys completed between 0700 hours and 1700 hours (including 9 hours of incidental surveys between sites).

Each site was visited for a minimum of half an hour and up to 6.5 hours if a site was structurally more complex, contained a greater variety of birds and if there was a high likelihood of threatened species being present. Sites 7, 8, 10, 11, 12, 13 and 14 were found to have a greater variety of birds and a higher likelihood of threatened bird species. Such sites were surveyed both early morning and late afternoon to capture the most active periods of bird behaviour. Sites 3 and 15 were structurally very simple and were

dominated by large numbers of Noisy Miners (*Manorina melanocephala*) and a few other large bird species. The high presence of Noisy Miners on these sites meant that very few other bird species were present as they often exclude most other smaller bird species. Despite the presence of flowering eucalypts on these sites no other nectivorous species were detected as they are aggressively excluded by Noisy Miners from these sites. These latter sites were much less likely to contain any threatened bird species. Extended surveys of these sites were considered to be less productive and more effort could then be spent on the more productive sites where Noisy Miners were far less common and many other bird species were present. Site 2 was investigated during a previous sampling period and was found to be a small very isolated habitat area which was dominated by Noisy Miners and with very low bird species diversity. For avifaunal census this site was not considered to be worth any further survey effort.

The survey effort for each site and sampling period are shown in Table 7:

Table 7: Bird Survey Effort for July 2019 Survey Period

Timing	Site (hours)												Totals (hours)
	2*	3	4	7	8	10	11	12	13	14	15	Inc^	
Dawn to mid-morning	0	0	0	2	3	1	1.5	2.5	1.5	1	1.5	4.5	18.5
Afternoon	0	0.5	2	3	3.5	0.5	4	3	3.5	1.5	2	4.5	28
Totals (hours)	**0**	**0.5**	**2**	**5**	**6.5**	**1.5**	**5.5**	**5.5**	**5**	**2.5**	**3.5**	**9**	**46.5**

* Site 2 was not sampled due to poor habitat quality

^ Inc = incidental observation time between sites

As part of the overall avifauna survey effort summarised above, several sessions were conducted targeting raptor species such as the Square-tailed Kite (*Lophoictinia isura*), White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and Little Eagle (*Hieraaetus morphnoides*). For each of these surveys several high vantage points were selected to ensure that the majority of the study area 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 addition, whenever a raptor nest was observed it was checked for signs of occupation including identification of species if actual birds were observed in nests and/or and indication of current use via presence of recent prey items and faecal whitewash below nest or nest tree. All raptor nest locations and additional information as above were recorded in the 'Sightings' App.

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).

Nocturnal Bird Surveys

Nocturnal surveys consisted of listening for calls from dusk, conducting call-playback of several target species and spot lighting. Calls of Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Barking Owl (*Ninox connivens*) and Bush Stone-curlew (*Burhinus grallarius*) were played via digital mp3 players coupled to a 15-watt Toa megaphone with a potential coverage of 2-3 km on nights with little to no wind.

The call-playback and spotlighting sections below provide details as to what sites within the study area were covered by these techniques.

Ground Elliott Trapping

Ground trap transects consisting of a mix of "A", "B" and "E" type Elliott traps targeting small to medium sized ground-dwelling mammals were deployed on the ground at several sites in July 2019 as follows:

- Site 4c: 22 traps (consisting of nine “A”, six “B” and seven “E”) for three consecutive nights from 1-4 July 2019;
- Site 8e: 24 traps (consisting of eight “A”, eight “B” and eight “E”) for three consecutive nights from 4-7 July 2019;
- Site 11c: 23 traps (consisting of six “A”, five “B” and nine “E”) for three consecutive nights from 1-4 July 2019 (a further three “A” traps were deployed for three consecutive nights from 2-4 July);
- Site 13a: 23 traps (consisting of eight “A”, seven “B” and eight “E”) for three consecutive nights from 1-4 July 2019; and
- Site 15c: 14 traps (consisting of seven “A” and seven “E”) for two consecutive nights from 5-7 July 2019. (Note that access issues due to rain on 4 July preventing traps from being deployed here for three consecutive nights).

Figure 4a shows the location of the mammal survey (trapping sites), which included ground Elliott traps.

Trap lines typically traversed areas of diverse vegetation or habitat features likely to support the target mammals including areas of denser groundcovers, fallen timber, hollow logs or shrubs where available. 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.

Arboreal Elliott Trapping

Arboreal trap transects consisting of ten “B” Elliott traps (15 centimetres [cm] x 15 cm x 56 cm) were deployed at several sites in July 2019. The traps were placed 2-3 m off the ground on platforms fixed to tree trunks at approximately 30-50 m spacing. Transects were placed in woodland areas typically with hollow trees and/or flowering canopy species with the aim of targeting Squirrel Glider and Brush-tailed Phascogale (*Phascogale tapoatafa*). Arboreal trap transects were located in the vicinity of ground trap transects.

Figure 4a shows the location of the mammal survey (trapping sites), which included arboreal Elliott traps.

Each trap was baited with a bait mix of peanut butter, honey, molasses, rolled oats, vanilla essence, almond essence and fish sauce. The trunks of trees containing traps were sprayed with a solution of molasses, honey, 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.

Arboreal traps were deployed as follows:

- Site 4c: ten “B” traps for three consecutive nights from 1-4 July 2019;
- Site 8e: ten “B” traps for three consecutive nights from 4-7 July 2019;
- Site 11c: ten “B” traps for three consecutive nights from 1-4 July 2019;
- Site 13a: ten “B” traps for three consecutive nights from 1-4 July 2019; and
- Site 15c: ten “B” traps for two consecutive nights from 5-7 July 2019. (Note that access issues due to rain on 4 July 2019 preventing traps from being deployed here for three consecutive nights).

Cage Trapping

Cage traps targeting medium mammals were deployed at several sites in July 2019.

Cages were Mascot Wire Works steel traps including a medium "bandicoot" sized cage measuring 20 cm x 20 cm x 56 cm with a 12.5 x 50 mm mesh and a larger "dog" sized trap.

Cages were placed on the ground as part of arboreal and ground trapping transects, baited with sardines and covered in hessian bags or plastic sheets. Traps were checked early each morning for captures, with any captured animals identified and immediately released.

Figure 4a shows the location of the mammal survey (trapping) sites, which included cage traps.

Cages were deployed as follows:

- Site 4c: one "bandicoot" cage for three consecutive nights from 1-4 July 2019;
- Site 8e: one "bandicoot" cage for three consecutive nights from 4-7 July 2019;
- Site 11c: one "dog" cage for three consecutive nights from 1-4 July 2019;
- Site 13a: one "bandicoot" cage for three consecutive nights from 1-4 July 2019; and
- Site 15c: one "dog" cage for two consecutive nights from 5-7 July 2019. (Note that access issues due to rain on 4 July 2019 prevented traps from being deployed here for three consecutive nights).

Hair Tubes

Two hair tube surveys, targeting small to medium-sized arboreal and terrestrial mammals, were carried out. The first survey in August 2018 used 220 Faunatech hairfunnels to specifically target Spotted-tailed Quoll. Funnels were deployed in late August 2018 and collected in mid December 2018 (approximately 110 days/nights). They were baited with a mix of flour, sardines, fish sauce and tuna oil. Faunatech sticky wafers were placed inside the funnels on their upper sides to collect hairs of mammals attracted to the bait. Hairfunnels were placed at least 100 m apart on the ground, on fallen timber or on hollow logs in woodland and below scattered trees in grasslands forming a disjunct series of transects of several km in length and which traversed a variety of sites.

In August 2018 hair tube effort was as follows:

- Site 2a: 1,110 trap-nights;
- Sites 3a and 3c: 2,553 trap-nights;
- Site 4b: 330 trap-nights;
- Site 7a: 2,352 trap-nights;
- Site 8c and 8i: 2,128 trap-nights;
- Site 10: 555 trap-nights;
- Site 11e: 2,553 trap-nights;
- Site 12d: 2,310 trap-nights;
- Site 13b: 2,970 trap-nights;
- Site 14c: 1,887 trap-nights; and
- Site 15: 2,825 trap-nights.

Figure 4a shows the location of the Faunatech hairfunnel transects deployed in August 2018.

The second hair tube survey was carried out in November 2019. In this survey hair tubes were single-sided and five sizes 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.

Hair tubes were set on the ground, in shrub/tree bases, on fallen timber and hollow logs and in trees at a height approximately 1-1.5 m above the ground.

Figure 4a shows the location of the hair tube transects deployed in November 2019.

In November 2019 hair tubes were deployed as follows:

- Site 3c: 30 tubes over 16 nights (7-23 November 2019), giving 480 trap-nights;
- Site 4b: 30 tubes over 19 nights (6-25 November 2019), giving 570 trap-nights; and
- Site 8c: 30 tubes over 15 nights (7-22 November 2019), giving 450 trap-nights.

Any hairs collected were sent to experts in hair analysis (Barbara Triggs [Genoa, Victoria] and Georgeanna Story [Majors Creek, NSW]) for analysis.

In total 23,073 hair tube/funnel trap-nights were undertaken within the study area from August 2018 to November 2019.

Camera Trapping

Wildlife cameras were deployed as part of live trapping, hairfunnel and hair tube transects at several sites in areas of suitable habitat. Several types of cameras were used including Scout Guard SG562C White Flash, Scout Guard SG550V, Reconyx PC900 and Swift 3C.

Cameras were pointed at bait stations consisting of a can of sardines pegged through can into ground, 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. Most camera bait stations were sprayed with a solution of molasses, honey, vanilla essence, almond essence and fish sauce.

All cameras were set to take still photos only.

Figure 4a shows the location of the mammal survey (trapping) sites in July 2019, which included wildlife cameras, as well as wildlife camera locations as part of hairfunnel transects in August 2018 and hair tube transects in November 2019.

Cameras were deployed as follows:

- Site 2a: one camera for 107 days/nights from 24/8/2018 to 9/12/2018;
- Site 3c: one camera for 111 days/nights from 23/8/2018 to 12/12/2018;
- Site 7a: one camera for 112 days/nights from 23/8/2018 to 13/12/2018;
- Site 8i: one camera for 110 days/nights from 23/8/2018 to 11/12/2018;
- Site 11e: one camera for 111 days/nights from 21/8/2018 to 10/12/2018;
- Site 12d: one camera for 110 days/nights from 24/8/2018 to 12/12/2018;
- Site 13b: one camera for 110 days/nights from 24/8/2018 to 12/12/2018;

- Site 14c: one camera for 111 days/nights from 21/8/2018 to 10/12/2018;
- Site 4c: one camera for three nights from 1-4 July 2019;
- Site 8e: one camera for three nights from 4-7 July 2019;
- Site 11c: one camera for three nights from 1-4 July 2019;
- Site 13a: one camera for three nights from 1-4 July 2019;
- Site 15c: one camera for two nights from 5-7 July 2019;
- Site 3a: two cameras over 16 nights from 7-23 November 2019;
- Site 4b: two cameras over 19 nights from 6-25 November 2019; and
- Site 8c: two cameras over 15 nights from 7-22 November 2019.

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

A total of 23 nest boxes were deployed at several sites throughout the study from late August 2018 to late November 2019 (approximately 450 days/nights). They were made from natural recycled hollows and/or marine plyboard. Boxes either had an entrance diameter around 40 mm suitable for Squirrel Glider and Brush-tailed Phascogale or less than 20 mm suitable for Eastern Pygmy-possum (*Cercartetus nanus*) and microbats.

They were checked for fauna occupation in December 2018, July 2019 and November 2019.

Nest boxes were deployed at the following sites:

- Site 3: three Squirrel Glider boxes;
- Site 4: two Eastern Pygmy-possum boxes and one Squirrel Glider box;
- Site 7: one Eastern Pygmy-possum box and one Squirrel Glider box;
- Site 8: three Squirrel Glider boxes;
- Site 11: one Squirrel Glider box;
- Site 12: two Squirrel Glider boxes;
- Site 13: two Eastern Pygmy-possum boxes and one Squirrel Glider box;
- Site 14: one Squirrel Glider box; and
- Site 15: two Eastern Pygmy-possum boxes and three Squirrel Glider boxes.

Bat Surveys

Bats were surveyed 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., Henry Cook B.Sc. and Garon Staines B.App.Sc. Bat call identification was undertaken by Adam Greenhalgh. These surveyors each have over ten years of experience surveying and identifying bats in NSW.

All bat species in Table 1 were targeted during the surveys, however species in Table 8 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 8.

Some preliminary acoustic based bat surveys were undertaken in August 2018 and December 2018 together with inspection of a derelict house off Castlerock Road at Site 4 in July 2019 for signs of roosting bats.

Live trapping surveys using harp traps and mist nets together with acoustic detection were undertaken over four nights in November 2019 during suitable weather conditions (Section 2.4.1), to ensure compliance with *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018) and the species targeted as per Table 8.

The bat surveys for the Grey-headed Flying-fox, Corben's Long-eared Bat (*Nyctophilus corbeni*) and Large-eared Pied Bat (*Chalinolobus dwyeri*) 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 used and total survey effort for bats.

Harp Trapping and Mist Netting

Harp trapping was carried out at dams at Sites 8a and 15a which contained water to a width of at least 3 m to meet Southern Myotis potential foraging habitat requirements (OEH, 2018). Mist netting was also used in conjunction with harp traps at the Site 15a dam.

Harp traps were the standard Faunatech two-bank design. Mist nets were two ultrafine monofilament nets being 12 m long and 3 m in height erected on extendable poles.

- Site 8a: four harp traps placed for four consecutive nights (20-24 November 2019);
- Site 15a: two harp traps placed for four consecutive nights (20-24 November 2019); and
- Site 15a: two mist nets placed for four consecutive nights (21-24 November 2019).

Harp traps were set and left all night 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 at dawn and then disarmed for the day. Any captures were held during the day in cotton bags back at the accommodation, identified to species level, and then released back at the same site that night. Harp traps were moved to a different location within the same site each evening.

Mist nets were armed at dusk and then monitored for 3 hours before disarming. Any captures were identified to species level and then immediately released.

Harp traps and mist nets were moved to a different location within the same site each evening. Harp traps were placed at least 20 m apart.

Figure 4c shows the bat survey sites.

Table 8: Targeted Searches for Conservation Significant Bat Species

Species	Credit Type[1]	Potential Habitat[#]	Survey Method	Survey Period	Required Survey Effort (hours)[#]	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 (2 per day)	3 (one per month)	No camps are known to occur in the study area (DAWE, 2020a). Numerous daytime searches were conducted throughout the study area. No camps were found and therefore the survey effort is not applicable.
Little Bent-winged 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* (DPIE, 2020a) 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. Harp trapping was carried out at Sites 8a and 15a in late November 2019 using six harp traps and two mist nets over four nights but was not repeated two weeks later due to lack of any potential maternity roost habitat in the study area. In addition, some acoustic recording was also carried out at these same sites in November 2019 as well as in December 2018 (and August 2018) at several other sites within the study area.
Large Bent-winged Bat *Miniopterus orianae 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 BioNet Threatened Biodiversity Data Collection [DPIE, 2020b]) within 100 m 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 rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings occur in the study area. The study area does not appear to provide the deep sandstone overhang with domed roof habitat required by this species for maternity roosts (the study area does not provide any rock escarpment or other potential roosting habitat for this species). Harp trapping was carried out at Sites 8a and 15a in late November 2019 using six harp traps and two mist nets over four nights. In addition, acoustic recording was also carried out in November 2019 at these same sites as well as in December 2018 (and August 2018) at several other sites within the study area.
			Acoustic detection	Mid Nov – end Jan	16	4	

Species	Credit Type[1]	Potential Habitat[#]	Survey Method	Survey Period	Required Survey Effort (hours)[#]	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 BioNet Threatened Biodiversity Data Collection [DPIE, 2020b]) within 200 m of any medium to large permanent creeks, rivers, lakes or other waterways (i.e. with pools/ stretches 3 m or wider).*	Harp trap or mist net	Oct – Mar	16	4	No bridges, tunnels, culverts or other structures identified as potential breeding habitat occur in the study area apart from numerous hollow-bearing trees. Some derelict buildings do occur. One derelict building at Site 4 was checked for bat roosts but none (of any species) were found. Kayuga Bridge at Muswellbrook (outside study area) was checked but no bat roosts (of any species) were detected. No permanent creeks, rivers or lakes occur in the study area. The study area does contain a number of farm 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 at dams containing water at Sites 8a and 15a in November 2019 using six harp traps and two mist nets over four nights. In addition, acoustic recording was also carried out in November 2019 at these same sites as well as in December 2018 (and August 2018) at several other sites within the study area.
			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 BioNet Threatened Biodiversity Data Collection [DPIE, 2020b]) within 100 m 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 rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, occur in the study area. Some old buildings and sheds do occur. One derelict building at Site 4 was checked for bat roosts but none (of any species) were found. The study area does not provide any rock escarpment habitat or old mines or tunnels for this species. Harp trapping was carried out at Sites 8a and 15a in late November 2019 using six harp traps and two mist nets over four nights. In addition, acoustic recording was also carried out in November 2019 at these same sites as well as in December 2018 (and August 2018) at several other sites within 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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at December 2020).

[#] '*Species Credit*' *Threatened Bats and Their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

Ultrasonic Bat Detection

Electronic detectors were used to collect ultrasonic calls of microbat species. Detectors used included: Anabat SD1, Express and Scout detectors (Titley Scientific, Brisbane QLD), and an SMBAT2+ Songmeter (Wildlife Acoustics, Maynard, MA, USA).

Detectors were used statically (i.e. set and left in one location for several hours or overnight) and were placed at least 50 m apart within each relevant site at ground level or off the ground aiming along potential microbat flyways that microbats could use to forage and navigate.

Detectors were deployed follows:

- Site 4f: one detector for 1.5 hours on 20 August 2018;
- Site 11g: one detector for 1.25 hours on 24 August 2018;
- Site 12c: one detector for 2 hours on 23 August 2018;
- Site 15g: one detector for 1.25 hours on 22 August 2018;
- Site 4e: one detector for one night on 12 December 2018;
- Site 4f: one detector for one night on 13 December 2018;
- Site 8h: one detector for one night on 11 December 2018;
- Site 11d: one detector for one night on 12 December 2018;
- Site 14d: one detector for one night on 10 December 2018;
- Site 8a: four detectors on four consecutive nights (20-24 November 2019); and
- Site 15a: four detectors on four consecutive nights (concurrently with harp trapping and mist netting) (20-24 November 2019).

Figure 4c shows the bat survey sites.

Microbat Habitat Searches

Potential microbat roost habitats were visually inspected during the day for roosting bats as follows:

- A derelict house at Site 4 for 1.5 hours in July 2019; and
- Kayuga Bridge over Hunter River at Muswellbrook (outside study area) for 1 hour in November 2019.

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, Masked Owl, Barking Owl and Bush Stone-curlew. Any fauna responding were identified either by characteristic call or direct observation using spotlights.

Note that on nights with little to no wind that call-playback sound can travel 2-3 km and therefore cover more than one site. During windy nights the reverse is often true and sound may only cover the site from which the call-playback is being played. This has been taken into account with the following information.

Figure 4a shows the call-playback locations.

Call-playback was carried out as follows:

- Site 4g: 20 August 2018;
- Site 11f: 24 August 2018 (also covered Site 14);
- Site 12b: 23 August 2018 (also covered Site 13 and 14);
- Site 15f: 22 August 2018 (also covered Site 4);
- Site 7b: 11 December 2018 (also covered Site 8);
- Site 11f: 12 December 2018 (also covered Site 14);
- Site 12b: 12 December 2018 (also covered Site 13 and 14);
- Site 14b: 10 December 2018 (also covered Site 11, 12 and 13);
- Site 4d: 1 July 2019;
- Site 8g: 3 July 2019 (also covered Site 7);
- Site 8f: 4 July 2019 (also covered Site 7);
- Site 11f: 1 July 2019;
- Site 11f: 2 July 2019;
- Site 12b: 2 July 2019 (also covered Site 13);
- Site 14b: 1 July 2019 (also covered Sites 3, 4, 12, 13);
- Site 15h: 2 July 2019 (also covered Sites 3, 12, 13, 14);
- Site 15f: 3 July 2019;
- Site 15e: 5 July 2019 (also covered Site 3);
- Site 3d: 23 November 2019 (also covered Sites 4, 12, 13 and 15);
- Site 15d: 20 November 2019 (also covered Site 3);
- Site 15d: 21 November 2019 (also covered Site 3); and
- Site 15d: 22 November 2019 (also covered Site 3).

Spotlighting

Spotlighting was conducted on foot by using powerful LED hand-held torches and/or headlamps. It was typically carried out by two or more ecologists for a minimum of one hour each. 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 4: 3 hours on 20 August 2018;
- Site 10: 3.75 hours on 21 August 2018;
- Site 11 and 14: 1.5 hours each on 24 August 2018;
- Site 12 and 13: 1.5 hours each on 23 August 2018;
- Site 15: 2.5 hours on 22 August 2018;
- Site 7 and 8: 3 hours each on 11 December 2018;

- Site 11: 3 hours on 12 December 2018;
- Site 14: 1.5 hours on 12 December 2018;
- Site 12: 3 hours on 12 December 2018;
- Site 13: 1.5 hours on 12 December 2018;
- Site 13 and 14: 1.5 hours each site on 10 December 2018;
- Site 4: 1.5 hours on 1 July 2019;
- Site 4 and 15: 1.5 hours each site on 2 July 2019;
- Site 7 and 8: 2 hours each site on 3 July 2019;
- Site 7: 2.25 hours on 4 July 2019;
- Site 8: 2 hours on 4 July 2019;
- Site 11 and 14: 1 hour each site on 1 July 2019;
- Site 11 and 14: 1 hour each site on 2 July 2019;
- Site 12 and 13: 1 hour each site on 2 July 2019;
- Site 13 and 14: 1 hour each site on 1 July 2019;
- Site 15: 2.5 hours on 3 July 2019;
- Site 15: 2.75 hours on 5 July 2019;
- Site 3: 2 hours on 23 November 2019;
- Site 15: 4.5 hours on 20 November 2019;
- Site 15: 5.75 hours on 21 November 2019;
- Site 15: 4.5 hours on 22 November 2019;
- Site 15: 4.5 hours on 23 November 2019;
- Site A: 2 hours on 22 November 2019; and
- Site B: 2 hours on 22 November 2019.

Figure 4a shows the call-playback locations which includes spotlighting.

Koala Scat Searches

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 targeted. Inspected habitat features included ground logs/timber, lightly imbedded surface rock, cow pats, decorticating bark, mature/old growth trees and stags with accessible crevices/fissures/hollows, dams, riparian zones, 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 or night.

Surveys for amphibians were undertaken in accordance with the *Hygiene Protocol for the Control of Disease in Frogs* (DECC, 2008).

Initial habitat surveys were carried out for the threatened Green and Golden Bell Frog on at least 10 dams/ponds/drainage lines within the study area 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 for Green and Golden Bell Frog and one other threatened amphibian species Green-thighed Frog (*Litoria brevipalmata*) were not carried out as the study area lacked suitable habitat for these species.

Diurnal surveys were generally conducted between dawn and midday or until conditions became too hot. Nocturnal surveys were generally run between dusk and 2200-2300 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*).

Lightly imbedded rock areas were identified at Sites 7c, 8j and 12e and several searches were undertaken at these locations. Typically, 200 rocks were carefully lifted up and searched under per ecologist per session. In addition, searches were undertaken by looking under cow pats (dung) at several locations given that Striped Legless Lizard is known to use this microhabitat feature (author pers. obs.).

A total of 99.5 hours of nocturnal searches were undertaken consisting of 54 hours of warm season surveys (December 2018 and November 2019) with the balance undertaken during cooler seasons (August 2018 and July 2019).

A total of 239.25 hours of diurnal searches were undertaken consisting of 78 hours of warm season surveys (December 2018 and November 2019) with the balance undertaken during cooler seasons (August 2018 and July 2019).

Pitfall and funnel trap transects

Pitfall trap transects consisting of six 150 mm diameter, 600 mm deep end capped PVC pipes with 300 mm high 30 m long drift fencing and two reptile funnels were deployed at Sites 4a, 8b, 11a and 12a for four days/nights from 5-9 November 2019 (see Figure 4b for locations). Pits were 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 pit was capped. Pitfalls and funnels were typically checked at dawn, in the afternoon and after sunset and any animals identified and released.

A total of 24 trap-nights was completed at each of Sites 4a, 8b, 11a and 12a in November 2019.

Artificial shelter habitat

In August 2018, artificial shelter habitat consisting of grids of second-hand terracotta roofing tiles (approximately 40 cm x 30 cm) were deployed at Sites 3b, 8d, 11b, 14a and 15b to specifically target Striped Legless Lizard as per SEWPaC (2011c) (see Figure 4b for locations). Each grid consisted of 50 tiles, at 5 m spacing between tiles, arranged in rows of 10 tiles by five tiles. Where possible grids were located on north facing slopes in areas of DNG with denser groundcover. Grids were checked in December 2018, July 2019 and November 2019 (twice) for reptiles and small mammals.

Approximately 22,850 trap-nights were completed at each of Sites 3b, 8d, 11b, 14a and 15b.

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).

2.4.3 Survey Effort

Table 9 provides a summary of the survey techniques and effort employed at each of the survey sites.

2.4.4 Limitations

Despite below average rainfall conditions (Section 2.4.1), a number of fauna surveys have been carried in the study area since the mid 2000s and therefore it is likely that the fauna and habitats present (or potentially present) are well understood.

Table 9: Summary of Survey Techniques and Effort Used at Each Site within the Study Area

Site	Habitat Assessment (hours)	Diurnal Bird Survey (hours)			Incidental (diurnal) (hours)	Nocturnal Bird Surveys (hours)				A Elliott Ground Trapping (trap-nights)	B Elliott Ground Trapping (trap-nights)	E Elliott Ground Trapping (trap-nights)	B Elliott Arboreal Trapping (trap-nights)	Cage Trapping (trap-nights)	Hair Funnels (trap-nights) (Aug-Dec 2018)	Hair Tubes (trap-nights) (Nov 2019)	Cameras (trap-nights) (Aug-Dec 2018)	Cameras (trap-nights) (July 2019)	Cameras (trap-nights) (Nov 2019)	Nest Boxes (trap-nights)	Harp / Mist Net Trapping (trap-nights)	Bat Acoustic – (hours) (Aug 2018)	Bat Acoustic – (nights) (Dec 2018)	Bat Acoustic – (nights) (Nov 2019)	Habitat Searches – Caves (hours)
		Aug 2018	Dec 2018	Jul 2019		Aug 2018	Dec 2018	Jul 2019	Nov 2019																
2	0.5	1.5	-	-	13	-	-	-	-	-	-	-	-	-	1110	-	107	-	-	-	-	-	-	-	-
3	0.5	2	1.5	0.5	27.25	-	-	-	2	-	-	-	-	-	2553	480	111	-	32	1350	-	-	-	-	-
4	0.5	4	2.5	2	43.5	4.5	7	1	-	27	18	21	30	3	330	570	-	3	38	1350	-	1.5	2	-	1.5
7	0.5	2	6.5	5	23.25	-	3	4.25	0.75	-	-	-	-	-	2352	-	112	-	-	900	-	-	-	-	-
8	0.5	2	6.5	6.5	40.75	-	3.5	4	1.75	24	24	24	30	3	2128	450	110	3	30	1350	16	-	1	16	-
10	0.5	3.5	1	1.5	4.5	4	-	-	-	-	-	-	-	-	555	-	-	-	-	-	-	-	-	-	-
11	0.5	4	5.5	5.5	40	1	-	3	-	27	15	27	30	3	2553	-	111	3	-	450	-	1.25	1	-	-
12	0.5	3.5	2	5.5	29	2	1.5	1	-	-	-	-	-	-	2310	-	110	-	-	900	-	2	-	-	-
13	0.5	3.5	2	5	26.25	2	3.5	1	-	24	21	24	30	3	2970	-	111	3	-	1350	-	-	-	-	-
14	0.5	3	2.25	2.5	16	0.5	2.5	3	-	-	-	-	-	-	1887	-	111	-	-	450	-	-	1	-	-
15	0.5	2	3	3.5	46.75	1.25	2	8.5	36.75	14	-	14	20	2	2825	-	-	2	-	2250	16	1.25	-	16	-
Incidental between sites	-	-	7	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
A	0.5	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	0.5	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
J	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
K	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L	0.75	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M	0.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	**12.75**	**31**	**39.75**	**46.5**	**324.75**	**15.25**	**23**	**25.75**	**45.25**	**116**	**78**	**110**	**140**	**14**	**21573**	**1500**	**883**	**14**	**100**	**10350**	**32**	**6**	**5**	**32**	**2.5**

Continued Table 9: Summary of survey techniques and Effort used at each site within the Study Area

Site	Call-Playback (sessions) (Aug 2018)	Call-Playback (sessions) (Dec 2018)	Call-Playback (sessions) (July 2019)	Call-Playback (sessions) (Nov 2019)	Spotlighting (hours) (Aug 2018)	Spotlighting (hours) (Dec 2018)	Spotlighting (hours) (July 2019)	Spotlighting (hours) (Nov 2019)	Nocturnal Herp Searches (hours) - Cool Season (Aug 2018 + July 2019)	Nocturnal Herp Searches (hours) - Warm Season (Dec 2018 + Nov 2019)	Diurnal Herp Searches (hours) - Cool Season (Aug 2018 + July 2019)	Diurnal Herp Searches (hours) - Warm Season (Dec 2018 + Nov 2019)	Pitfall Trapping (trap-nights)	Artificial Reptile Shelters (trap-nights)
2	-	-	-	-	-	-	-	-	-	-	9.5	3.5	-	-
3	-	-	3	4	-	-	-	2	0	2	14	8.25	-	22850
4	2	-	2	1	3	-	3	-	7	3	21.75	8.25	24	-
7	-	1	2	-	-	3	4.25	-	5.25	2	11	7.25	-	-
8	-	1	2	-	-	3	4	-	5.25	2.25	14.5	10.25	24	22850
10	-	-	-	-	3.75	-	-	-	4	0	3.5	0.5	-	-
11	1	2	2	-	1.5	3	2	-	5.25	1	24.75	2.75	24	22850
12	1	2	3	1	1.5	3	1	-	1.5	2	11.5	10.5	24	-
13	1	2	3	1	1.5	3	2	-	4	2	22.25	2	-	-
14	2	3	2	-	1.5	3	3	-	6.75	1	13.75	2.5	-	22850
15	1	-	3	4	2.5	-	6.75	19.25	6.5	34.75	14.75	12	-	22850
Incidental between sites	-	-	-	-	-	-	-	-	-	0	-	3	-	-
A	-	-	-	-	-	-	-	2	-	2	-	0.5	-	-
B	-	-	-	-	-	-	-	2	-	2	-	0.5	-	-
C	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
D	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
E	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
F	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
G	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
H	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
I	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
J	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
K	-	-	-	-	-	-	-	-	-	-	-	1	-	-
L	-	-	-	-	-	-	-	-	-	-	-	0.75	-	-
M	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
Totals	**8**	**11**	**22**	**11**	**15.25**	**18**	**26**	**25.25**	**45.5**	**54**	**161.25**	**78**	**96**	**114250**

2.4.5 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 10). Threatened fauna species were targeted in accordance with the survey timing, techniques and effort described within the relevant survey guidelines listed in Section 2.3.

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 (threatened fauna species predicted to occur in the wider locality) did not have any potential habitat in the study area and are therefore not included in Table 10: Green and Golden Bell Frog, Green-thighed Frog, Western Blue-tongued Lizard (*Tiliqua occipitalis*), Magpie Goose (*Anseranas semipalmata*), Freckled Duck (*Stictonetta naevosa*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Australasian Bittern (*Botaurus poiciloptilus*), Eastern Curlew (*Numenius madagascariensis*), Curlew Sandpiper (*Calidris ferruginea*), Eastern Ground Parrot (*Pezoporus wallicus wallicus*), Collared Kingfisher (*Todiramphus chloris*), White-fronted Chat (*Epthianura albifrons*), and Brush-tailed Rock-wallaby (*Petrogale penicillata*).

2.4.6 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 Striped Legless Lizard and Squirrel Glider 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 (2020) 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 (2020) notes that this was a conservative approach as a limitation 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 10: Targeted Searches for Conservation Significant Fauna Species

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
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). Survey in spring, avoiding hot days in November (DPIE, 2020b).	September, October and November	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Active diurnal reptile searches were undertaken at several sites in November 2019. This also included searching of lightly imbedded rock areas identified at Sites 7c, 8j and 12e in November 2019 (Reptile Active Search Sites in Figure 4b). In addition to the above, pitfall trapping at four sites in November 2019 and placement of artificial shelter habitat (tile grids) at five sites from August 2018 to November 2019 (Figure 4b), could have also detected this species. Further, although outside the survey timing by DPIE (2020b), diurnal habitat searches (which included the overturning of rocks) were also undertaken in August 2018, December 2018 and July 2019.
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 2011b; 2011c): 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. Pitfall trapping: at least 50 pitfall configurations should be used for sites >25 ha, using 2-5 pitfalls, 5 m fence per configuration. Survey timing: September to May (SEWPaC, 2011b)	September, October, November and December	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** This species was surveyed via multiple methods, namely pitfall trapping, artificial shelter sites and active searching (including searching under lightly imbedded rock areas at Sites 7c, 8j and 12e and searching under cow pats throughout the study area). Active searching was undertaken in December 2018 and November 2019 within the required NSW survey period. Pitfall trapping was undertaken over 24 trap-nights, using six traps for four consecutive nights, at Sites 4a, 8d, 11a and 12a in November 2019 (Figure 4b). In addition, five tile grids of 50 artificial shelter sites (total of 250) were installed at Sites 3b, 8d, 11b, 14a and 15b, from August 2018 to November 2019 and checked several times in that period (Figure 4b). Further, although outside the survey timing by DPIE (2020b), diurnal habitat searches (which included the overturning of rocks) was also undertaken in August 2018 and July 2019.

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
Pale-headed Snake	*Hoplocephalus bitorquatus*	V	-	S	NSW guidelines (DEC, 2004a): Nocturnal spotlighting, 30-minute searches on 2 separate nights should be undertaken per stratification unit. Survey should be undertaken 1-2 days after rainfall and on humid nights (DPIE, 2020b).	January, February, March, November and December	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous nocturnal surveys were carried out at various sites at various times of the year.
Birds							
Grey Falcon	*Falco hypoleucos*	E	-	E	No species-specific requirement defined (DEC, 2004a). Diurnal bird surveys would be appropriate for these species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** A total of 117.25 hours of dedicated diurnal bird surveys by an ornithologist and a further 324.75 hours of incidental diurnal bird surveys by other ecologists were undertaken. Surveys were carried out in August 2018, December 2018, July 2019 and November 2019 and exceeded 80 hours over 10 days. Diurnal surveys included surveys from high points in study area searching for raptors. Particular attention was given to searches for and inspection of raptor nests to determine use and what species were using them. In accordance with BAM requirements (DPIE, 2020b), seasonal surveys for Square-tailed Kite were undertaken in December 2018 and November 2019, White-bellied Sea-Eagle and Red Goshawk in August 2018, December 2018, July 2019 and November 2019, and Little Eagle in August 2018.
Black Falcon	*Falco subniger*	V	-	E		None	
Square-tailed Kite	*Lophoictinia isura*	V	-	S/E	Breeding habitat is live large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy (DPIE, 2020b).	January, September, October, November and December	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	-	S/E	Breeding habitat is live large old trees within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines AND the presence of a large stick nest within tree canopy; or an adult with nest material; or adults observed duetting within breeding period. Due to the similarities in nest structure and use of the same nests by White-belled Sea-Eagles and Wedge-tailed Eagles, where a nest is observed without a bird present, searches for prey remains/feathers below the structure should be undertaken. The differing diets of both species and distinctive adult feathers should provide evidence of nest use, however; where prey items/feathers are absent, repeat visists to the nest until a bird is observed should be undertaken (DPIE, 2020b).	July, August, September, October, November and December	
Spotted Harrier	*Circus assimilis*	V	-	E	No species-specific requirement defined (DEC, 2004a). Diurnal bird surveys would be appropriate for these species.	None	
Red Goshawk	*Erythrotriorchis radiatus*	CE	V	S	Searches for its distinctive nest and area searches (80 hours over 10 days) is recommended (DEWHA, 2010c).	All year	

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
Little Eagle	*Hieraaetus morphnoides*	V	-	S/E	Breeding habitat is live (occasionally dead) large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy (DPIE, 2020b).	August, September and October	
Red-backed Button-quail	*Turnix maculosus*	V	-	S	Nocturnal surveys to flush birds from habitat should be used however identification is difficult and may require photos or handling individuals to distinguish from other more common species. Also important to note that call surveys including playback and songmeters not known to be effective as not known whether it responds, in what month it mostly calls or how to identify from other button-quail species (DPIE, 2020b).	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous nocturnal surveys incorporating spotlighting to flush this species were carried out at various sites at various times of the year.
Bush Stone-curlew	*Burhinus grallarius*	E	-	S	NSW guidelines (DEC, 2004a): Call-playback should consist of playing calls for 30 seconds, followed by 4.5 minutes of listening, repeated up to three times. Sites for this species should be 2-4 km apart and conducted during the breeding season. Spotlighting should be done by foot or from a slow-moving vehicle.	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Nocturnal surveys incorporating quiet listening, call-playback and spotlighting were carried out at numerous sites during the survey period. 55 call-playback sessions in total were carried out during the survey period.
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). This species can only be surveyed for if there is water in the wetland and even then, only when suitable conditions exist (i.e. muddy flats) (DPIE, 2020b).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Wetland habitat was not present in study area however some farm dams (which still contained water despite drought) may have provided potential but marginal habitat. Diurnal and nocturnal surveys undertaken at or near dams in study area would have covered this species. Targeted stationary observations were generally not undertaken due to lack of quality habitat for this species (e.g. wetlands, lakes, swamps and clay pans) within the study area.
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	S/E	No species-specific requirement defined (DEC, 2004a) prior to and during the survey work. DEWHA (2010c) has some recommended survey techniques for Glossy Black-Cockatoo (which is listed as nationally endangered in South Australia)	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 within the required seasonal survey periods for Glossy Black-Cockatoo (August 2018 and July 2019).

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
					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). 1. Assessors should look for SIGNS OF BREEDING on site as follows; (a) begging birds of any age or sex; or (b) lone adult males identified during the breeding season (April to August); or (c) an occupied nest. 2. Where signs of breeding on site are present POTENTIAL NEST TREES should be identified. Potential nest trees contain hollows that are; (i) at least 8 m above the ground; and (ii) in stems with a diameter of at least 30 cm; and (iii) hollow diameter is at least 15 cm; and (iv) stem angle is at least 45 degrees, and may be near-vertical or vertical. 3. Where potential nest trees are identified on site, monitor for this species during the breeding season (Apr – Aug) to confirm the presence of any ACTUAL NEST TREES on site. DPIE is currently developing survey guidance for threatened bird species. In the interim, assessors must undertake a species survey using best practice method that can be replicated for repeat surveys (as per the BAM threatened species survey requirements) (DPIE, 2020b).		Chewed cones were searched for under casuarina trees whenever encountered. Wherever hollows suitable for nesting by Glossy Black-Cockatoo were detected (i.e. very large hollows) they were searched (from the ground) for signs of nesting, feathers etc. The above survey techniques are considered to be in accordance with the methodology specified in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) as identification of breeding requires bird surveys and searches of breeding habitat constraints.
Little Lorikeet	*Glossopsitta pusilla*	V	-	E	No species-specific requirement defined (DEC, 2004a).	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 August 2018 to November 2019.
Turquoise Parrot	*Neophema pulchella*	V	-	E	Diurnal surveys for all species would be appropriate (DEWHA, 2010c).	None	
Swift Parrot	*Lathamus discolor*	E	CE	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,	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Specific diurnal surveys for this species were carried out in August 2018 and July 2019 targeting any patches of flowering Eucalypt trees at that time. 31 hours were

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
					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).		spent on dedicated diurnal bird surveys over 5 days In August 2018. 46.5 hours was spent over 6 days in July 2019. (i.e. a total of 77.5 hours over 11 days).
Masked Owl	*Tyto novaehollandiae*	V	-	S/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. For Powerful Owl and Barking Owl where there are no known nest trees on site, assessors should apply the following process: 1. Look for SIGNS OF BREEDING on site as follows; suitable habitat AND (a) presence of male and female OR (b) calling to each other (duetting) OR (c) find nest. Note that Powerful Owl does not respond as well to call-play-back and could require stagwatching and other evidence of nesting. 2. Where signs of breeding on site are present, POTENTIAL NEST TREES should be identified. Potential nest trees are living or dead trees with hollows greater than 20 cm diameter. 3. Where potential nest trees are identified on site, night monitoring at the identified potential nest locations for a minimum of 2 nights should be undertaken to detect the presence of any owl of this species using a potential nest tree or demonstrating behaviour focussed on a potential nest tree (e.g. investigating the hollow or roosting within 10 m). DPIE is currently developing survey guidance for threatened bird species. In the interim, assessors must undertake species surveys using best practice methods that can be replicated for repeat surveys (as per the BAM threatened species survey requirements) (DPIE, 2020b).	May, June, July and August	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Nocturnal surveys incorporating quiet listening, call-playback and spotlighting were carried out at numerous sites during the survey period. 55 call-playback sessions in total were carried out during the survey period which covered the required survey timing period for Barking Owl (DPIE, 2020b), and included 32 sessions in August 2018 and July 2019 during the required survey timing period for the Masked Owl and Powerful Owl. Wherever hollows suitable for nesting (very large hollows) were detected they were searched (from the ground) for signs of nesting, feathers, pellets, remains of prey etc. At least one stag watching session was carried out from dusk at a Spotted Gum with very large hollows at Site 13 in August 2018.
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	

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
White-throated Needletail	*Hirundapus caudacutus*	-	V	S	No species-specific requirement defined. Diurnal bird surveys would be appropriate for these species.	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Numerous dedicated diurnal bird surveys were carried out throughout the study area over several days in different seasons during the survey period by an ornithologist as well as incidental surveys by other ecologists.
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	E		None	
Speckled Warbler	*Chthonicola sagittata*	V	-	E		None	
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	-	E		None	
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 for 20 hours over five days 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 49.5 hours of diurnal surveys within the study area were carried out over 12 days in November 2019. In addition, 31 hours were spent on dedicated bird surveys over five days In August 2018, 39.75 hours over five days in December 2018, and 46.5 hours spent over 6 days in July 2019. All sites except Sites 2 and 10 received at least 20 hours of diurnal survey (including incidental diurnal survey) during the survey period. Site 10 was a plantation site with relatively young trees and Site 2 was an isolated poor habitat area.
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 dedicated diurnal bird surveys were carried out throughout the study area over several days in different seasons during the survey period by an ornithologist as well as incidental surveys by other ecologists.
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	

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
Varied Sittella	*Daphoenositta chrysoptera*	V	-	E		None	
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	E		None	
Diamond Firetail	*Stagonopleura guttata*	V	-	E		None	
Mammals							
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	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). Whilst survey is not required for this species IF survey is undertaken cameras can be used throughout the year, however trapping should be limited to Dec to Oct, post breeding months (Sept to Nov) where females have dependent young should be avoided (DPIE, 2020b).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** A total of 21,573 (Faunatech) hair funnel trap-nights and 558 camera trap-nights were completed over the study area from August to December 2018. An additional 14 camera trap-nights and 14 cage trap-nights were completed in July 2019. An additional 1,500 hair tube trap-nights (not Faunatech funnels) and 100 camera trap-nights were completed in November 2019. 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 prior to and during the survey work. Nocturnal spotlighting surveys, wildlife cameras, nest boxes, hair tubes and arboreal Elliott trapping would all be appropriate for this species. Survey must be undertaken using baited cameras. The bait type used must remain as an effective attractant until replaced. Cameras must remain in place for a minimum of 4 weeks with cameras checked and baits replaced after 2 weeks. Modified camera approach for sites over 10 ha (DPIE, 2020b).	January, February, March, April, May, June and December	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** The survey techniques and effort discussed above for Spotted-tailed Quoll and below for Squirrel Glider would also have covered this species. Recommended survey months for the Brush-tailed Phascogale were changed in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) after survey commission (i.e. previous data recommended the species could be surveyed all year). However, the species is capable of being detected throughout the year, and considerable camera trapping and hair tube survey effort was undertaken in the study area.
Common Planigale	*Planigale maculata*	V	-	S	No species-specific requirement defined prior to and during the survey work. Pitfall trapping, artificial shelter habitat, nocturnal spotlighting	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.**

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
					surveys, wildlife cameras, hair tubes and Elliott trapping would all be appropriate for this species. Survey must be undertaken using pitfall traps where the substrate allows. Elliott traps should be used to detect whether the Yellow-footed Antechinus (*Antechinus flavipes*) is present (general indicator of Common Planigale presence). Modifiied survey approach for potential habitat greater than 10 ha (DPIE, 2020b).		The survey techniques and effort discussed above for Spotted-tailed Quoll and Striped Legless Lizard would also have covered this species. In addition, a total of 250 terrestrial trap-nights were conducted in July 2019 using a mix of Elliott A, B and E sized traps. The above survey techniques are considered to be in accordance with the methodology specified in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) as considerable pitfall trapping and Elliott trapping survey effort was undertaken in the study area.
Koala	*Phascolarctos cinereus*	V	V	S/E	Federal guidelines (DotE, 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 (DotE, 2014). Call-playback only during peak breeding season (September to November) (DPIE, 2020c).	All year	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** Nocturnal surveys incorporating quiet listening, call-playback and spotlighting were carried out at numerous sites during the survey period. 55 call-playback sessions in total were carried out during the survey period and included 32 sessions in August 2018, December 2018 and November 2019 during the recommended August to January period (DotE, 2014) and 11 sessions during the recommended September to November period (DPIE, 2020c). A total of 672 camera trap-nights were completed over the study area during the survey period which would also have covered this species. Searches for scratchings on tree trunks and scats below Eucalypt trees (particularly published feed tree species) were undertaken as part of general ecological surveys on a daily basis.
Eastern Pygmy-possum	*Cercartetus nanus*	V	-	S	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.	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-tailed Quoll would also have partly covered these species. In addition, 140 Elliott B arboreal trap-nights were completed in total (Sites 4c, 7/8e, 11c, 13a and 15c) in July 2019. In addition, the numerous call-playback sessions (including quiet listening and spotlighting) conducted across the study area over the survey period as
Yellow-bellied Glider	*Petaurus australis*	V	-	E		None	
Squirrel Glider	*Petaurus norfolcensis*	V	-	S		All year	
						All year	

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Guideline Requirements	Survey Timing (DPIE, 2020b)	Survey Techniques and Effort undertaken by Future Ecology
		BC Act[1]	EPBC Act[2]				
							discussed above for Koala also covered Squirrel Glider and Yellow-bellied Glider.
Grey-headed Flying-fox, Little Bent-winged Bat, Large Bent-winged Bat, Large-eared Pied Bat, Southern Myotis, Eastern Cave Bat	-	-	-	-	Refer to Table 8.	-	Refer to Table 8.
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	E	Harp trapping / mist netting and ultrasonic bat detection (Anabat) (DEC, 2004a; DEWHA, 2010b). October to March (DEC, 2004a). October to April (Corben's Long-eared Bat) (DEWHA, 2010b).	None	**The survey guideline requirements were met and surveys undertaken at an appropriate time.** A total of 32 harp trap / mist net nights and 37.5 Anabat detection nights were undertaken within the recommended October to March (April) survey timing period for these microbat species.
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V	-	E			
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E			
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	E			
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	E			

[1] Threatened species status under the BC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

[2] Threatened species status under the EPBC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

[3] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at December 2020), E = Ecosystem, S = Species.

3 Survey Results

3.1 Fauna Habitat Types

Vegetation within the study area was described and mapped by Hunter Eco (2020). Broad fauna habitat types in the study area are mapped on Figure 5 and described below based on the vegetation mapping by Hunter Eco (2020). The broad fauna habitat types are:

- Dry Sclerophyll Forest;
- Grassy Woodland;
- Derived Native Grassland;
- Cropping/Grazing;
- Cultivation;
- Disturbed/Exotic;
- Infrastructure/Cleared Land; and
- Dam/Waterbody.

The broad fauna habitat types are described below while a summary of habitat features and condition observed at each survey site is presented in **Appendix B**.

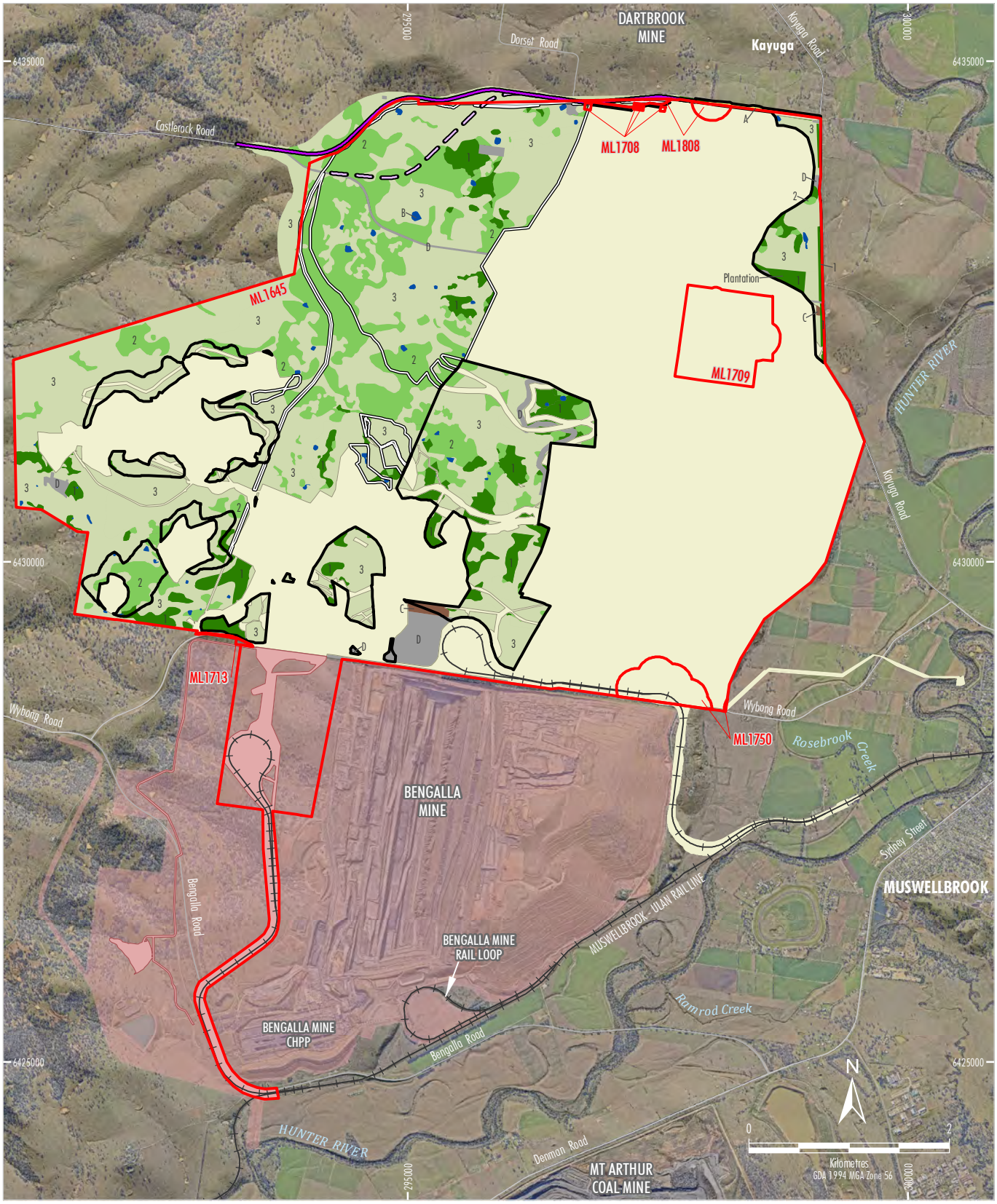
Most woodland/forest patches showed evidence of historic and ongoing disturbance from grazing. Livestock grazing and prolonged drought has effectively removed the shrub layer from parts of the study area and suppressed the ground-cover layer. Most woodland/forest patches were small to medium size (< 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.

Some relatively small areas of scattered lightly imbedded surface rock was observed in only a few parts of the study area and particularly at Sites 8 and 12 (Figure 4b). Observed surface rock was generally small (<50 cm diameter) and rocks were mostly located directly on soil rather than rock on rock. Rock escarpment and rock on rock features were absent.

Dry Sclerophyll Forest

The dry sclerophyll forest in the study area is shown on Figure 5 and comprised (Hunter Eco, 2020):

- White Box – Narrow-leaved Ironbark – Blakely's Red Gum (PCT 1606);
- Narrow-leaved Ironbark Shrubby Forest (PCT 1605);
- Plantation; and
- Forest Red Gum Grassy Open Forest (PCT 618).



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Fauna Habitat Types

- 1 Dry Sclerophyll Forest
- 2 Grassy Woodland
- 3 Derived Native Grassland
- A Cropping/Grazing
- B Dam/Waterbody
- C Disturbed/Exotic
- D Infrastructure/Cleared Land

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Broad Fauna Habitat Types

Figure 5

This habitat type consisted of remnant patches of native dominated vegetation containing a Eucalypt dominated canopy. If a sub-canopy was present it was generally patchy with Kurrajong (*Brachychiton populneus*).

Where a shrub layer was present it was generally very sparse with common species including Blackthorn (*Bursaria spinosa*) and the weed species African Boxthorn (*Lycium ferocissimum*).

The groundcover layer was sparse as a consequence of the prevailing dry conditions. 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*), Three-awned Grass (*Aristida sp.*) and Lomandra (*Lomandra sp.*).

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.

The plantation consisted of a number of tree species that had been planted in previously cleared areas several years ago. The canopy generally consisted of Eucalypt species, many not from the immediate region and several from other States. There were also a number of *Acacia*, *Allocasuarina*, *Casuarina* and *Melaleuca* species.

Grassy Woodland

The grassy woodland in the study area comprised (Hunter Eco, 2020):

- Narrow-leaved Ironbark – Grey Box Grassy Woodland (PCT 1691);
- Spotted Gum – Narrow-leaved Ironbark Woodland (PCT 1602);
- Grey Box x White Box – Spotted Gum Grassy Woodland (PCT 483); and
- Grey Box x White Box Grassy Woodland (PCT 483).

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, Grey Box x White Box, Spotted Gum and Slaty Box (*Eucalyptus dawsonii*). If a sub-canopy was present it was generally patchy and dominated by Kurrajong.

Where a shrub layer was present it was generally very sparse with common species including Blackthorn, Wilga (*Geijera parviflora*) and the weed species African Boxthorn.

The groundcover layer was sparse as a consequence of the prevailing dry conditions. It was typically co-dominated by a variety of grass and forb species depending on the site. Common species included Slender Bamboo Grass, Three-awned Grass, *Solanum sp*., *Sida sp*. and Lomandra.

Similar to the dry sclerophyll forest, 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 and included DNG versions of the above PCTs. Cover was sparse to moderately dense as a consequence of the prevailing dry conditions. Typical species included Slender Bamboo Grass, Three-awned Grass, Small-leaf Bluebush (*Maireana microphylla*) and the weed species Slender Thistle (*Carduus tenuiflorus*).

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.

Cropping/Grazing

Areas of cropping/grazing occur immediately adjacent to southeast and northeast sections of the study area off Wybong Road, Kayuga Road and Dorset Road. It has only occasional remnant native trees (paddock trees) and has been heavily impacted by more intense agricultural practices. Fauna habitat value was low due to low numbers of native trees and shrubs, tree hollows, dead standing tree and fallen timber.

Cultivation

Two cultivated areas occur immediately adjacent to the southeast and northeast sections of the study area off Wybong and Kayuga Road. They are totally devoid of native trees and had been heavily impacted by more intense agricultural practices. Fauna habitat value was very low due to lack of native trees and shrubs, tree hollows, dead standing tree and fallen timber.

Disturbed/Exotic

A relatively small area of this broad fauna habitat type occurs in the south of study area off Wybong Road. It appears to be associated with recent disturbance from approved mining infrastructure. It has very low fauna habitat value.

Infrastructure/Cleared Land

Cleared land and infrastructure areas associated with the mine and previous agricultural homesteads/sheds etc. are shown in Figure 5. They generally provide very low fauna habitat value apart from the large infrastructure dams which over time may provide habitat for aquatic species and water birds.

Waterbody/Dam

There were approximately 45 waterbodies/dams within the study area with most being relatively small farm dams associated with grazing activity (Figure 5). Only very few farms still contained any water towards the end of the survey period due to the prolonged drought. The study area did not have any permanent creeks and no ponded water was observed within intermittent drainage lines during the survey period.

All observed dams lacked aquatic vegetation and/or dense fringing vegetation of sedges and rushes probably due to grazing pressure and the prolonged drought during the survey period. As such most dams provided low quality habitat for aquatic and amphibian species.

3.2 Fauna Species

A total of 176 fauna species were recorded in the study area during the 2018 to 2019 surveys including 6 amphibian, 17 reptile, 111 bird, and 42 mammal species. A total of 13 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 13 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in or immediately adjacent to the study area during the current surveys (Table 11). Two of the species recorded are listed under the EPBC Act (both listed as vulnerable) (Table 11).

Table 11: Threatened Fauna Species Recorded During this Study

Common Name	Scientific Name	Conservation Status		Credit Class[3]
		BC Act[1]	EPBC Act[2]	
Reptiles				
Striped Legless Lizard	*Delma impar*	V	V	S
Birds				
Spotted Harrier	*Circus assimilis*	V	-	E
Little Lorikeet	*Glossopsitta pusilla*	V	-	E
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	-	E
Speckled Warbler	*Chthonicola sagittata*	V	-	E
Flame Robin	*Petroica phoenicea*	V	-	E
Scarlet Robin	*Petroica boodang*	V	-	E
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	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
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V	-	E*

1 Conservation status under the BC Act (current as at December 2020). V = Vulnerable.

2 Conservation status under the EPBC Act (current as at December 2020). V = Vulnerable.

3 Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at December 2020). 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.

Figures 6 to 10 show the locations of threatened fauna species records. Two of the species recorded are considered 'species credit species' in the study area (Figure 9), namely:

- Striped Legless Lizard; and
- Squirrel Glider.

Figure 10 shows the locations of threatened fauna species listed under the EPBC Act. All of the species in Table 11 are discussed below.

Striped Legless Lizard (*Delma impar*)

This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'species credit species' in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

In NSW, the Striped Legless Lizard mostly occurs in the Southern Tablelands and the South West Slopes regions. It also occurs in the Australian Capital Territory (ACT), Victoria and south-eastern South Australia (DPIE, 2020c). 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 triandra*), spear-grasses *Austrostipa sp*. and poa tussocks *Poa sp*., and occasionally wallaby grasses *Rytidosperma sp*., 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, 2017; DPIE, 2020c). It is sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter (DPIE, 2020c).

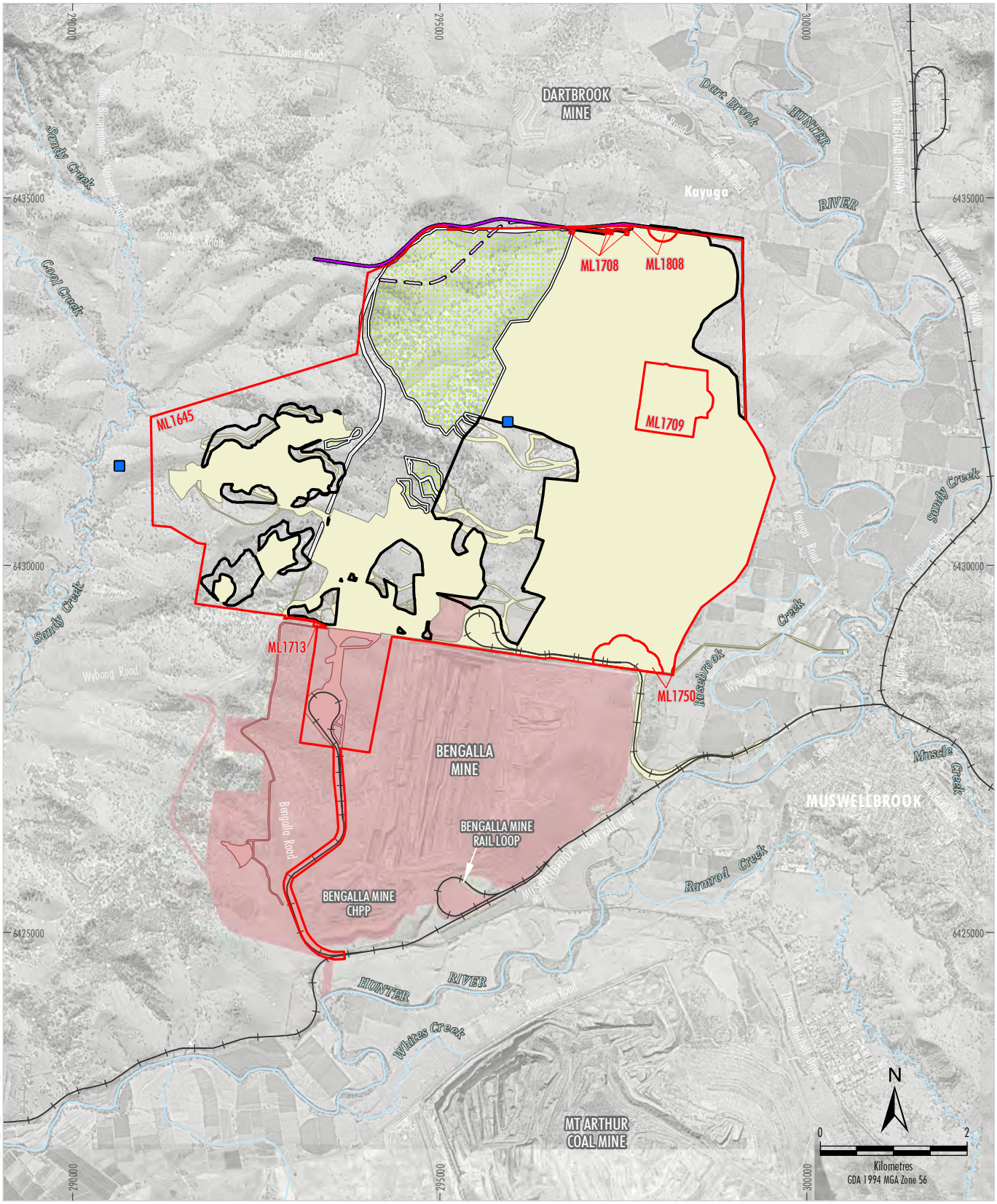
This species was recorded (caught in the hand) during the 2018 to 2019 survey period (Figure 6) as follows:

- 35 m north of the study area boundary at Site 15 (one individual), in December 2018; and
- 440 m west of the study area boundary between Sites 7/8 and 2 (one individual), in December 2018.

Observations just outside the study area were made under a cow pat (dung) in an open grassy area with scattered White Box (*Eucalyptus albens*) (at Site 15) and the latter observation was made under a lightly imbedded rock in a grassy open hillside with no trees on a farm track between Sites 7/8 and Site 2.

The vegetation where this species was observed at Site 15 was PCT 483. The vegetation where this species was found west of the study area between Sites 7/8 and Site 2 was outside of the flora survey area.

The Upper Hunter population appears to be disjunct from other recorded populations which occur greater than 200 km to the south. Before 2018, there were only seven previous records of this species from the Upper Hunter area, all from near Muswellbrook Common (approximately 5 km east of the study area) and dated from the years 2013 and 2015 (ALA, 2020; DPIE, 2020a). In 2018, this species was recorded by Future Ecology on another site near Jerrys Plains approximately 15 km southeast of the study area (Future Ecology, 2019). In that site, 26 observations of this species were made with the majority found under cow pats in open grassy areas with a good cover of native grasses and herbs (Future Ecology, 2019). There was one observation within a pitfall trap and two observations beneath artificial shelter habitat (Future Ecology, 2019).



MAC-18-02_SSD_EIS_App Fauna_2060

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey — Threatened Species

- Striped Legless Lizard

Survey Record Source: Future Ecology (2020a)

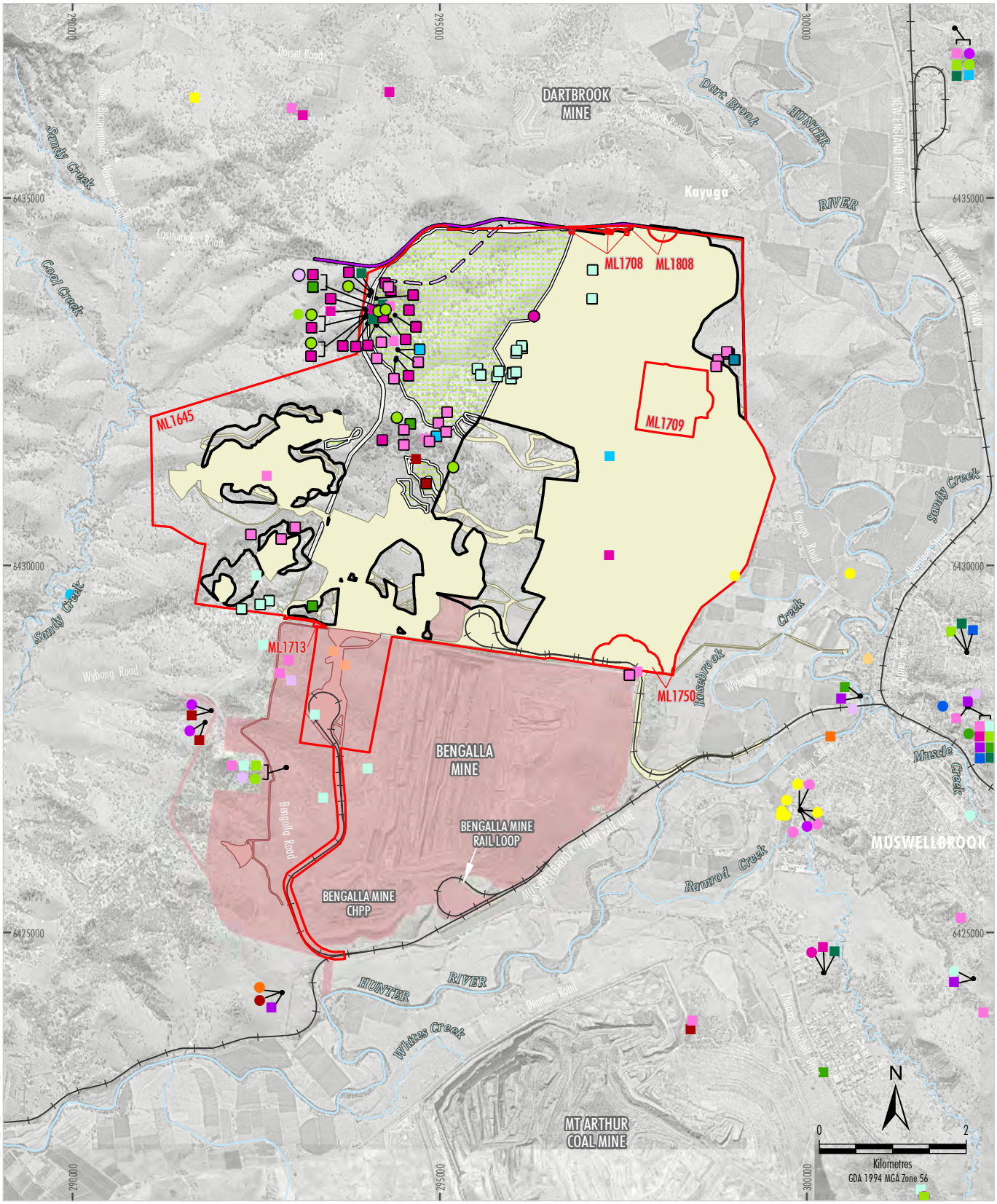
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Reptiles

Figure 6



MAC-18-02_SSD_EIS_App Fauna_210E

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey	Database	Threatened Birds
		Freckled Duck
		Black-necked Stork
		Australasian Bittern
		Grey Falcon
		Black Falcon
		White-bellied Sea-Eagle
		Spotted Harrier

Survey	Database	
		Little Eagle
		Red-backed Button-quail
		Australian Painted Snipe
		Glossy Black-Cockatoo
		Little Lorikeet
		Turquoise Parrot
		Masked Owl

Survey	Database	
		Powerful Owl
		Barking Owl
		White-throated Needletail
		Brown Treecreeper (eastern subspecies)
		Speckled Warbler
		Black-chinned Honeyeater (eastern subspecies)
		Regent Honeyeater
		White-fronted Chat
		Flame Robin
		Scarlet Robin
		Grey-crowned Babbler (eastern subspecies)
		Varied Sittella
		Dusky Woodswallow
		Diamond Firetail

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017a, 2017b)
Database Record Sources: ALA (2020); Birdlife Australia (2020); DPIE (2020)

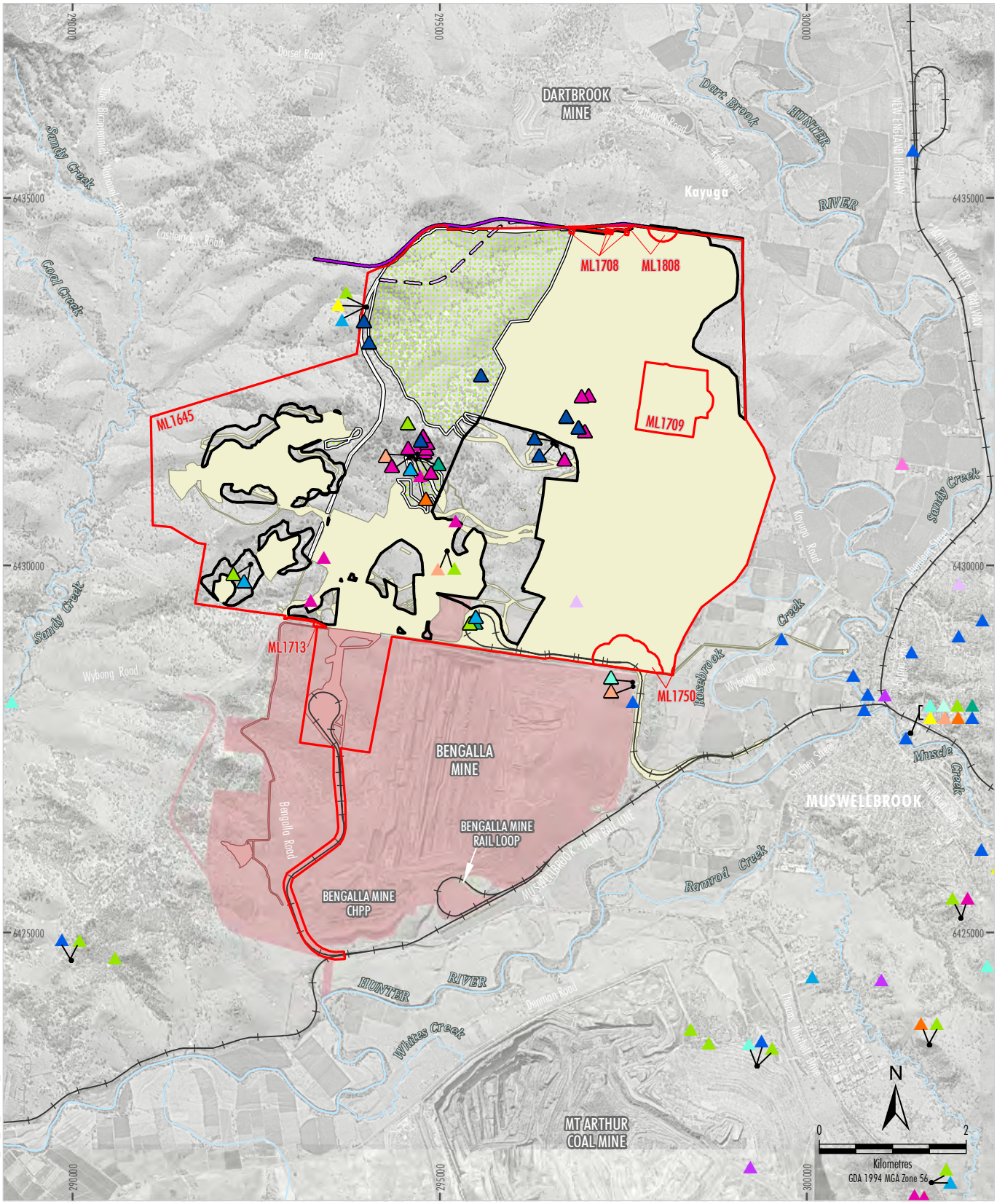
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Birds

Figure 7



MAC-18-02_SSD_EIS_App Fauna_213F

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey	Database	Threatened Mammals
		Spotted-tailed Quoll
		Brush-tailed Phascogale
		Koala
		Squirrel Glider
		Grey-headed Flying-fox
		Yellow-bellied Sheathtail-bat
		Eastern Coastal Free-tailed Bat
		Little Bent-winged Bat
		Large Bent-winged Bat
		Eastern False Pipistrelle
		Southern Myotis
		Greater Broad-nosed Bat
		Eastern Cave Bat

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017a, 2017b)
Database Record Sources: ALA (2020); DPIE (2020)

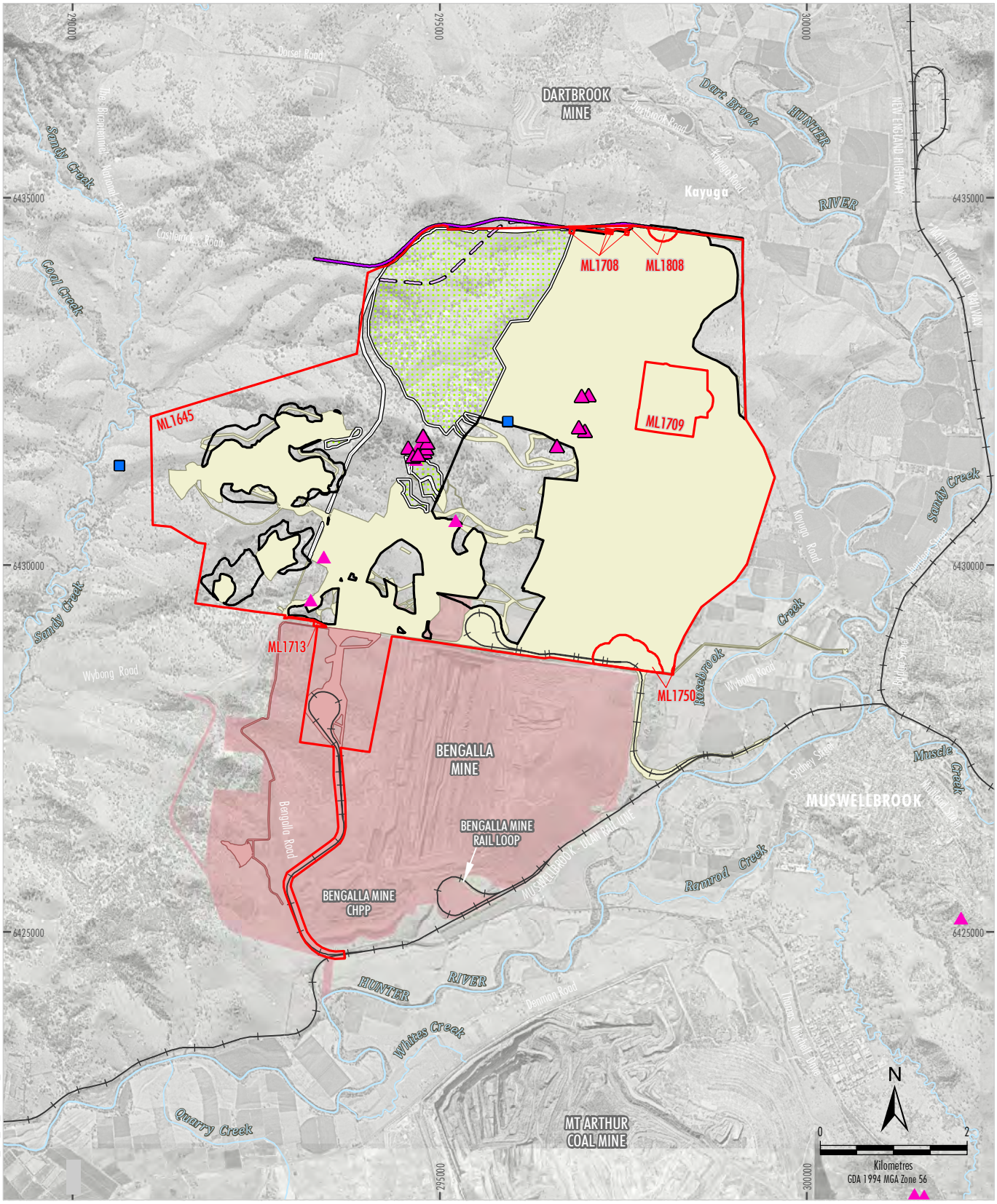
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Mammals

Figure 8



MAC-18-02_SSD_EIS_App Fauna_2140

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey / Database — Threatened Species

- Striped Legless Lizard
- Squirrel Glider

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017b)
Database Record Sources: ALA (2020); DPIE (2020)

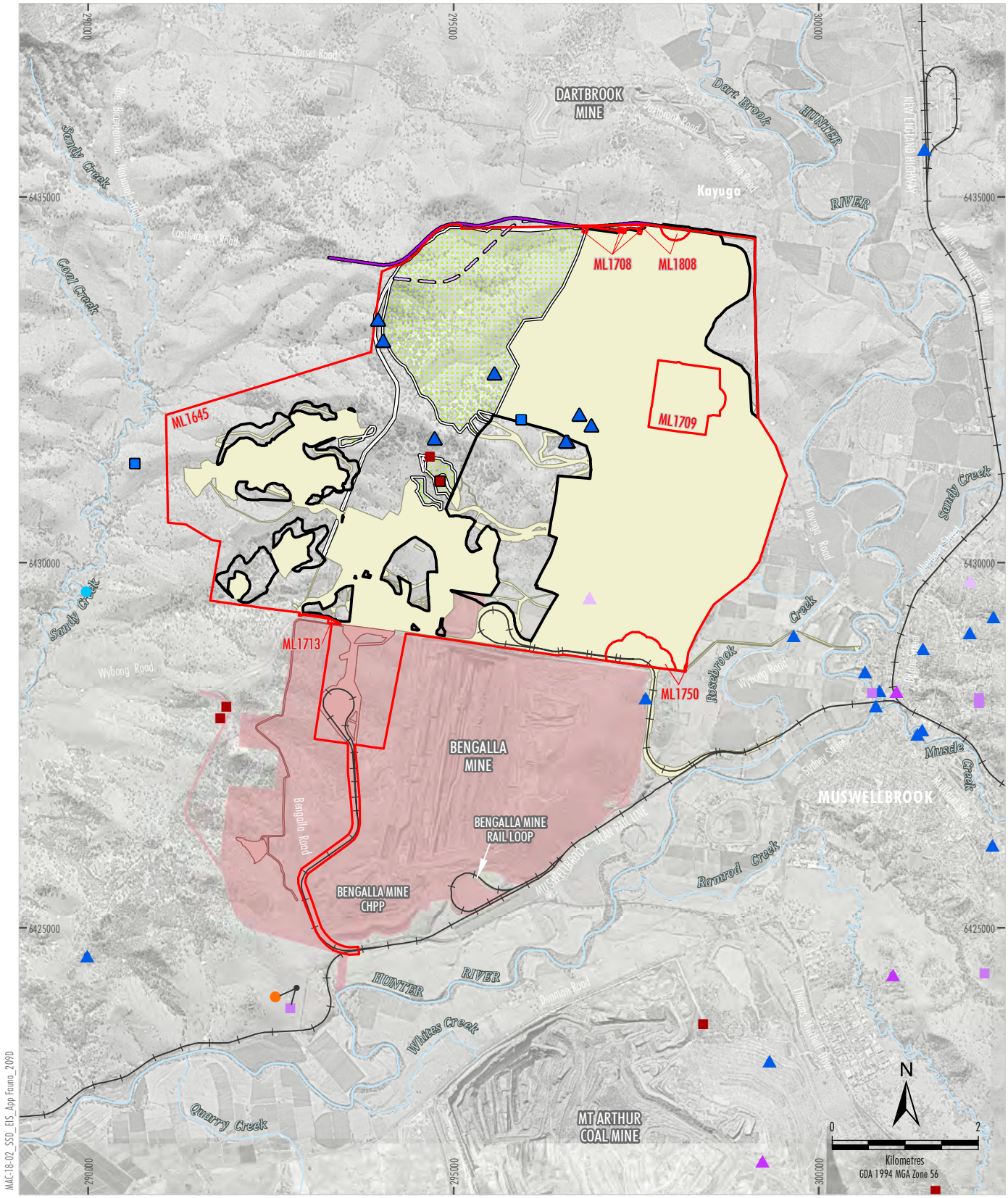
Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Species Credit Species Relevant to the Project

Figure 9



MAC-18-02_SSD_EIS_App Fauna_2090

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline

Survey	Database	Threatened Species
■		Striped Legless Lizard
●		Australasian Bittern
●		Australian Painted Snipe
■	■	White-throated Needletail
	■	Regent Honeyeater
	▲	Spotted-tailed Quoll
	▲	Koala
▲	▲	Grey-headed Flying-fox

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017b)
Database Record Sources: ALA (2020); Birdlife Australia (2020); DPIE (2020)

Source: MACH (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016) Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Threatened Species Listed Under the EPBC Act

Figure 10

The density of native grass and forbs across the current study area would fluctuate over time due to rainfall and grazing pressure. 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, 2017).

No further observations of Striped Legless Lizard were made in the study area (or immediately adjacent to the study area) during additional surveys in July and November 2019 but this may have been due to a range of factors at those times including prolonged drought, grazing pressure or even naturally low densities of this species.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat (Appendix C) and include the PCTs in which it was observed within and immediately adjacent to the study area. Some relatively small areas of scattered lightly imbedded surface rock was observed in only a few parts of the study area and particularly at Sites 7c, 8j and 12e (Figure 4b). Observed surface rock was generally small (< 50 cm diameter) and rocks were mostly located directly on soil rather than rock on rock.

Figure 11 shows the species polygon (extent of habitat) for the Striped Legless Lizard in study area.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

This species was recorded within the study area at Site 11 (one individual) in July 2019 (Figure 7). The mapped PCT in which it was observed was PCT 483. This species has not been previously recorded in the study area by others.

Several raptor nests were detected across the study area during current surveys and if occupied the only occupants observed were Wedge-tailed Eagles (*Aquila audax*) and Grey Goshawks (*Accipiter novaehollandiae*).

None of the PCTs in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) associated with this highly mobile species have been mapped in the study area (Appendix C). It was however observed in one non-associated PCT within the study area, namely PCT 483.

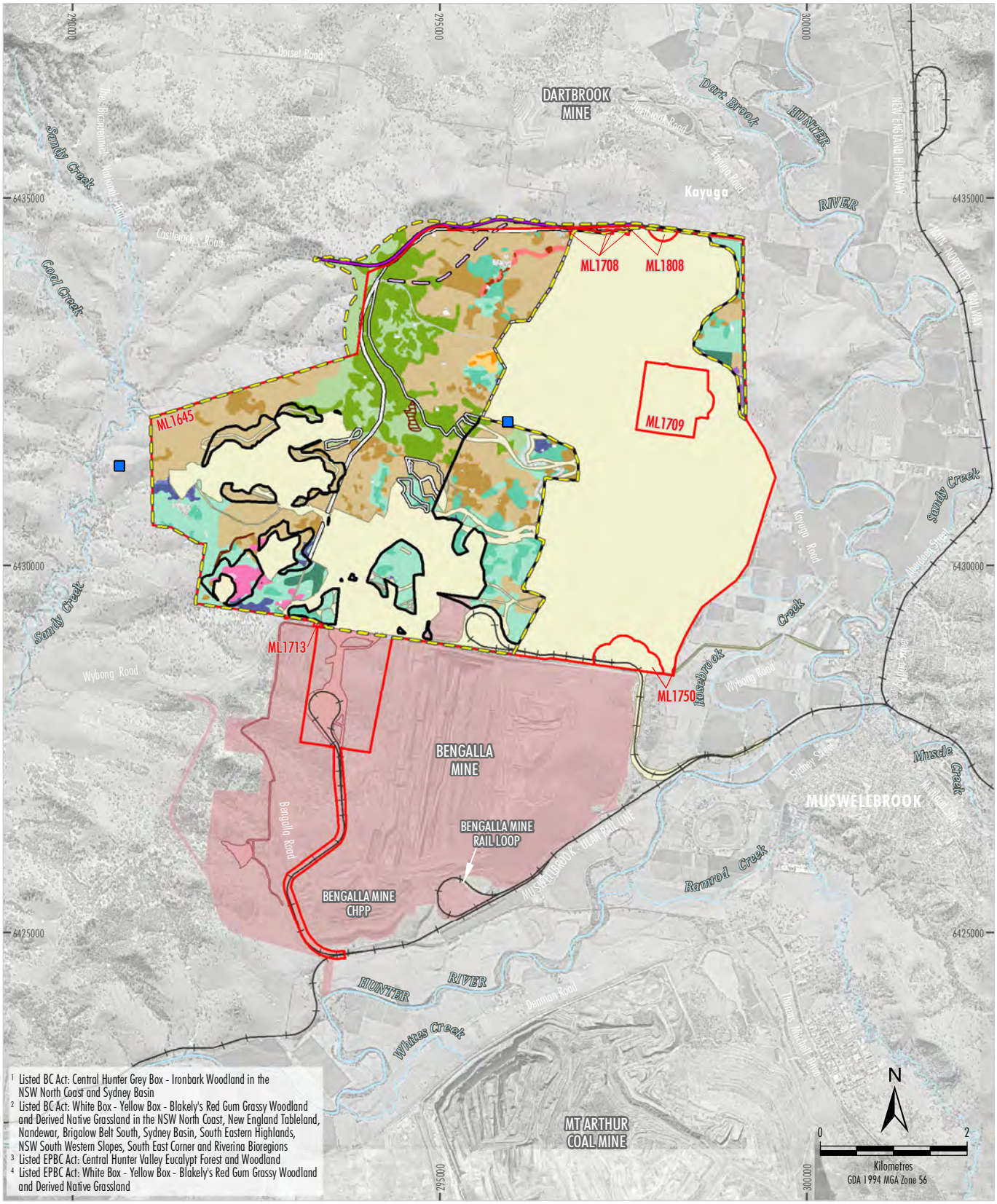
Little Lorikeet (*Glossopsitta pusilla*)

This species is listed as 'vulnerable' in NSW and it is not nationally listed. It is classified as an 'ecosystem credit species' in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

This species was recorded within the study area during the 2018 to 2019 survey period (Figure 7) as follows:

- Site 13 (2 individuals) in August 2018;
- Site 11/14 (1 to 10 individuals) in August 2018, July 2019, October 2019 and November 2019; and
- Site 12 (10 individuals) in July 2019.

The mapped PCT in which it was observed was PCT 483. This species has not been previously recorded in the study area by others. The PCTs in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) associated with this highly mobile species which have been mapped in the study area would provide potential habitat (Appendix C).



[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

MAC-18-02_SSD_EIS_App Fauna_2070

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area
- Survey
- Threatened Species
- Striped Legless Lizard
- SPECIES POLYGON MAPPING

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 1a Derived Native Grassland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 2a Derived Native Grassland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 3a Derived Native Grassland (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]
- 4a Derived Native Grassland (PCT1691)

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 5a Derived Native Grassland (PCT1602)
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6a Derived Native Grassland (PCT1605)
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]
- 7a Derived Native Grassland (PCT1606) [2, 4]

Dry Sclerophyll Forests (Shrubby Sub-formation)

- 8a Derived Native Grassland (PCT1655)

Other

- Lightly Imbedded Rock Area

Survey Record Source: Future Ecology (2020a)

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Striped Legless Lizard Species Polygon

Figure 11

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during surveys as follows (Figure 7):

- Site 11 (one to four individuals) in August 2018, December 2018, October 2019 and November 2019;
- Site 13 (one individual) in December 2018; and
- Site 14 (two individuals) in December 2018, July 2019 and October 2019.

The mapped PCTs in which it was observed were PCT 483 and PCT 483 DNG. The mapped PCT at previous observations of this species by others within the study area was PCT 483 (DPIE, 2020a). The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during the 2018 to 2019 survey period as follows (Figure 7):

- Site 8 (three to four individuals) in August 2018, December 2018 and July 2019;
- Site 10 (two to three individuals) in August 2018, December 2018 and July 2019;
- Site 11 (four individuals) in July 2019;
- Site 12 (two to three individuals) in December 2018 and July 2019;
- Site13 (two to four individuals) in December 2018 and July 2019; and
- Site 14 (two to four individuals) in August 2018, December 2018 and July 2019.

The mapped PCTs in which it was observed include:

- PCT 483 and PCT 483 DNG;
- PCT 1605 DNG; and
- PCT 1605 Plantation.

It has been previously observed within the study area by others (Figure 7). Mapped PCTs at previous observations of this species by others within the study area include:

- PCT 483 (Eco Logical Australia, 2017a; DPIE 2020a); and
- PCT 483 DNG (DPIE, 2020a).

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected by Future Ecology during the 2018 to 2019 survey period but it was detected by Hunter Eco (Colin Driscoll, pers. obs.) within the study area during vegetation surveys in 2018 (Figure 7). One individual female was detected immediately to the east of Site 10 within a paddock area with scattered trees.

The mapped PCT at the recorded location of this species within the study area is PCT 483 DNG. It was not detected within the study area during previous surveys and there are no additional records of this species from the study area.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483 DNG.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected during the 2018 to 2019 survey period (Figure 7) as follows:

- Site 13 (one individual) in July 2019; and
- Site 14 (two individuals) in July 2019.

The mapped PCT in which it was observed was PCT 483. It has not been previously observed within the study area by others.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483 (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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during the 2018 to 2019 survey period (Figure 7) as follows:

- Site 4 (1 to 10 individuals) in August and December 2018 and July, October and November 2019; and
- Site 7 (3 to 4 individuals) in August 2018 and July 2019.

The mapped PCTs in which it was observed were PCT 1602 and PCT 1605 DNG.

It has been previously observed within the study area by others with records from what is now Site 7/8 (DPIE, 2020a), and from south of the study area within the current rail spur and services corridor south of Wybong Road (Cumberland Ecology, 2010; DPIE, 2020a).

Mapped PCTs at previous observations of this species by others within the study area include PCT 1691 (DPIE, 2020a). The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 1602.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during the current survey period (Figure 7) as follows:

- Site 11 (1 individual) in August 2018;
- Site 13 (2 individuals) in November 2019; and
- Additional Habitat Assessment Site K (approximately 25 individuals recorded) in November 2019.

The mapped PCTs in which it was observed were PCT 483, PCT 483 DNG and PCT 1605.

This species has been previously recorded in the study area in 2006 and 2009 (Cumberland Ecology, 2010) but no location information was provided.

There are no PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area (Appendix C). There are however a number of additional non-associated PCTs in which it was observed to occur within the study area, namely: PCT 483, PCT 483 DNG and PCT 1605.

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 a 'species credit species' in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during the 2018 survey period (Figure 8) as follows:

- Site 13 (one to two individuals recorded in nest boxes and via spotlighting) in December 2018 and July 2019; and
- Site 15 (one individual recorded via spotlighting) in November 2019.

The mapped PCTs in which it was observed were PCT 483, PCT 483 DNG and PCT 1605.

It has been previously observed within the study area by others with records from what is now Site 13 (Eco Logical Australia, 2017a; DPIE, 2020a), about 250 m east of what is now Site 8 (DPIE, 2020a), about 250 m southwest of what is now Site 3 (Figure 8), and from 'within the Mount Pleasant Project Area' but no exact location is given (Cumberland Ecology, 2010).

The number of Squirrel Gliders recorded by each source is listed below:

- Cumberland Ecology (2010) states that two Squirrel Gliders were observed feeding in Spotted Gum in 2009 from 'within the Mount Pleasant Project Area';
- Eco Logical Australia (2017a) do not state how many individual Squirrel Gliders were recorded but it was recorded at five different locations from what is now Site 13;

- DPIE (2020a) states that two individuals were recorded from what is now Site 13; three individuals were recorded during tree clearing works for previously approved infrastructure from immediately east of what is now Site 8 and another three individuals during tree clearing works from immediately southwest of what is now Site 3.

This species is likely to occur in low numbers throughout the study area in DPIE (2020b) associated PCTs (1606, 1655). It was also recorded in the study area in the non-associated PCT 483, PCT 483 DNG, PCT 1605 and within 10 m of PCT 1602. 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 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 12 shows the species polygon (extent of habitat) for the Squirrel Glider in the study area.

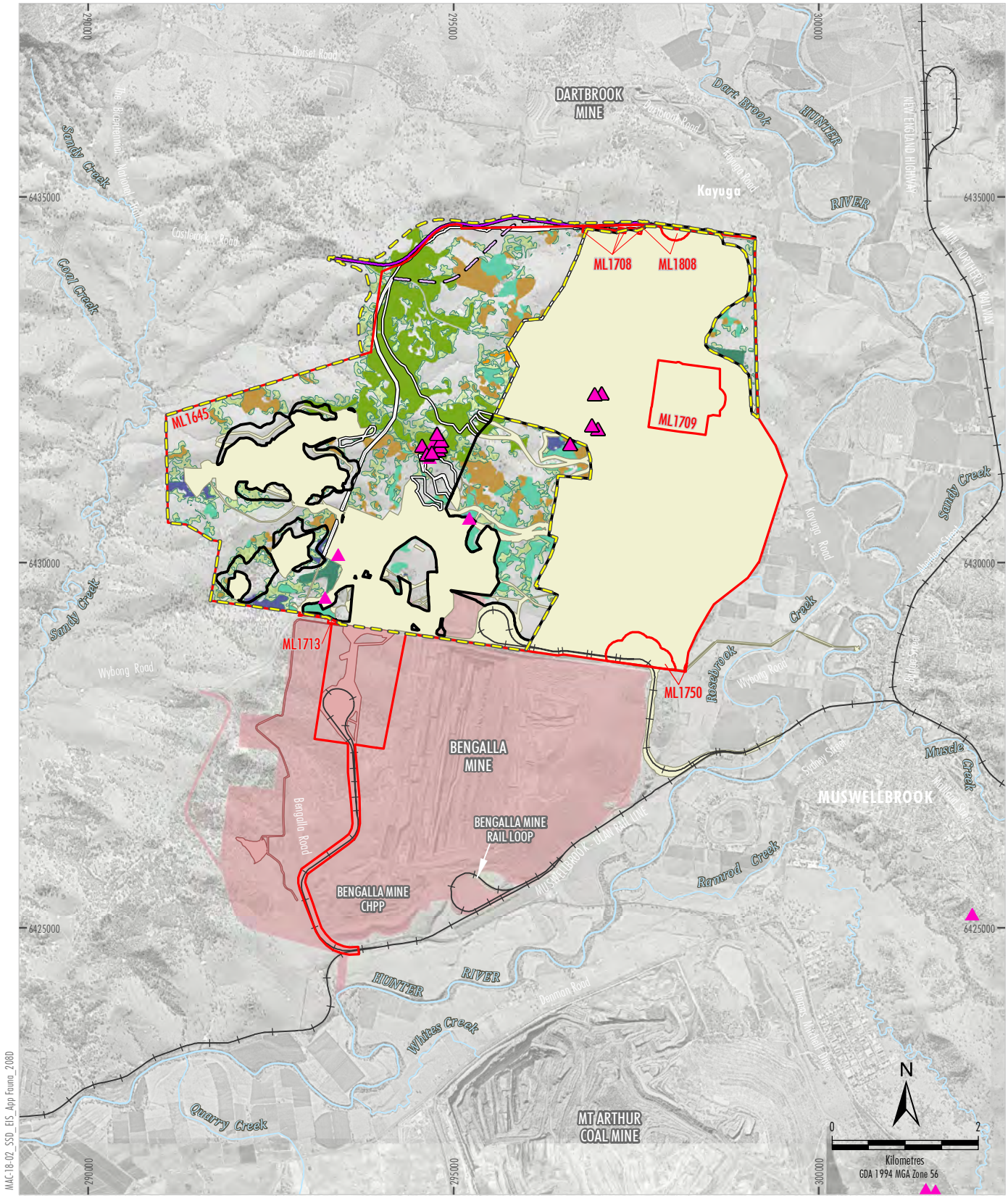
Grey-headed Flying-fox (*Pteropus poliocephalus*)

This species is listed as 'vulnerable' under the BC Act and EPBC Act. It is classified as a 'species/ecosystem credit species' in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected foraging within or immediately adjacent to the study area during the 2018 and 2019 survey (Figure 8) period as follows:

- Site 4 (10 individuals recorded) in August 2018;
- Site 11 (six individuals recorded) in August 2018;
- Site 13 (two individuals recorded) in August 2018;
- Site 14 (seven individuals recorded) in August 2018; and
- Site 15 (one to two individuals recorded) in November 2019.

The mapped PCT in which it was observed during 2018 to 2019 was PCT 483.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Survey / Database

Threatened Species

- Squirrel Glider

Survey Record Sources: Future Ecology (2020a, 2020b); Eco Logical Australia (2017b)
Database Record Sources: ALA (2020); DPIE (2020)

SPECIES POLYGON MAPPING

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]

Other

- Paddock Tree

[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Squirrel Glider Species Polygon

Figure 12

This species has been previously recorded flying adjacent to the study area in 2009 by Cumberland Ecology (2010) and is probably the same record as DPIE (2020a) on Wybong Road southeast of the study area (Table 1).

This species was only ever observed to be foraging in the study area (i.e. at night) and not roosting. A known camp of this species has been recorded from the Hunter River in Muswellbrook township (DAWE, 2020a) and observed along Muscle Creek in Muswellbrook township in 2019 (author, pers. obs.).

Given that no camps of this species occur within the study area it will be considered as an 'ecosystem credit species' under the BAM (OEH, 2017). The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat together with an additional PCT being PCT 483 (Appendix C).

Figure 13 shows the potential foraging habitat for the Grey-headed Flying-fox in the study area.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at one location within the study area during the 2018 to 2019 survey period via acoustic recording with a 'definite' confidence level (Figure 8) at Site 8h in November 2019. The mapped PCT in which it was recorded was PCT 1605.

It has been previously recorded within the study area from:

- 'within the Mount Pleasant Project Area' in 2009 (Cumberland Ecology, 2010), but no details are given as to the exact location or method of detection;
- two locations from what is now Site 13 via acoustic call recording with a definite confidence level (Eco Logical Australia, 2017a); and
- what is the approved new rail spur site (Eco Logical Australia, 2017b) approximately 400 m north of Wybong Road and 800 m southwest of Additional Habitat Assessment Site M.

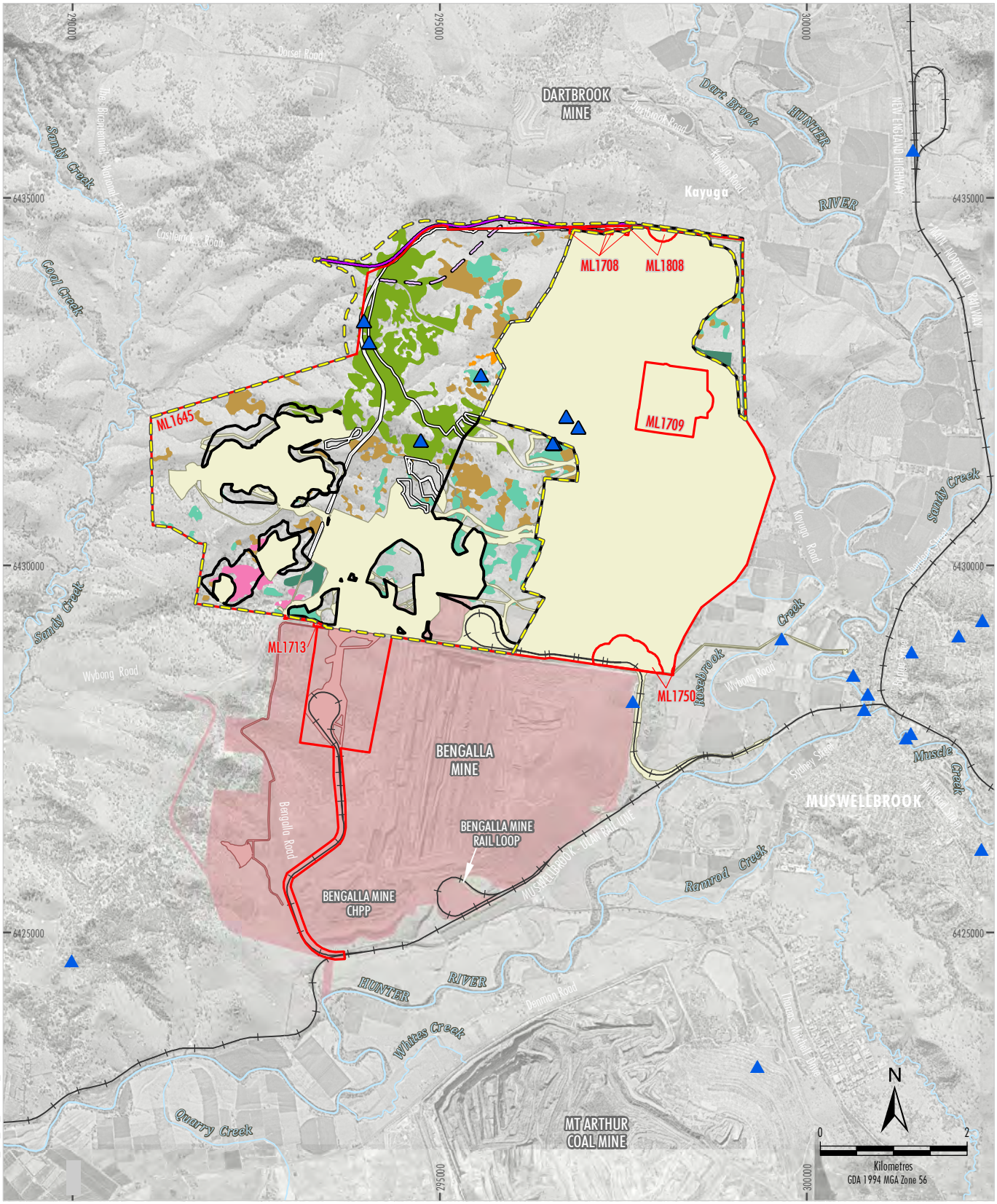
The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat (Appendix C), together with an additional non-associated PCT in which it was also observed to occur within the study area, namely: PCT 483.

Large Bent-winged Bat (*Miniopterus orianae 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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at several locations within the study area during the 2018 to 2019 survey period via acoustic recording with a 'definite' confidence level (Figure 8) as follows:

- Site 8h in November 2019;
- Site 12c in August 2018; and
- Site 15g in November 2019.



MAC-18-02_SSD_EIS_App Fauna_215C

LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Survey / Database

Threatened Species

- Grey-headed Flying-fox

Survey Record Sources: Future Ecology (2020a, 2020b)
Database Record Sources: ALA (2020); DPIE (2020)

POTENTIAL FORAGING HABITAT

Grassy Woodlands

- 1 Grey Box x White Box Grassy Woodland (PCT483) [2, 4]
- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 6b Plantation (PCT1605)
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]

[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Grey-headed Flying-fox Potential Foraging Habitat

Figure 13

The mapped PCTs in which it was recorded were:

- PCT 483;
- PCT 483 DNG;
- PCT 1602; and
- PCT 1605.

It has been previously observed within the study area from:

- two records in the locality from years 2006 and 2009 (Cumberland Ecology, 2010) but an exact location not given;
- a location near what is now Site 11 (DPIE, 2020a);
- a location near what is now an infrastructure area approximately halfway between Additional Habitat Assessment Sites L and M (DPIE, 2020a), (note that both DPIE records could be the Cumberland Ecology records referred to above as the years match); and
- a location near what is the approved new rail spur site (Eco Logical Australia, 2017a) approximately 300 m north of Wybong Road and 1 km southwest of Additional Habitat Assessment Site M (note that the Cumberland Ecology and Eco Logical Australia records are both via acoustic detection and all have a definite confidence level for identification).

Mapped PCTs at previous recordings of this species by others within the study area include:

- PCT 483 (DPIE, 2020a); and
- the other locations where it was known to be recorded in the study area are open cleared areas which have not been mapped as any PCT.

There are additional records of this species outside the study area (DPIE, 2020a) 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 Coal Mine.

It is known to breed in 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 Little Bent-winged Bat (National Parks and Wildlife Service, 2019).

The study area provides no 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.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483 and PCT 1602.

3.3.2 Other Threatened Fauna Species Previously Recorded within the Study Area

Some additional threatened species, which were not detected by Future Ecology with a 'definite' confidence level during current surveys, or have been previously detected within the study area by others (Cumberland Ecology, 2010; Eco Logical Australia, 2017a; 2017b) are listed in Table 12 and discussed below.

Figures 7 and 8 show the locations of other threatened fauna species records within the study area and surrounds by others (where the co-ordinates were available).

Table 12: Other Threatened Species Previously Recorded within the Study Area

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Previous Studies[4]
		BC Act[1]	EPBC Act[2]		
Birds					
Black Falcon	*Falco subniger*	V	-	E	A
White-throated Needletail	*Hirundapus caudacutus*	-	V	S	C
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V	-	E	A
Varied Sittella	*Daphoenositta chrysoptera*	V	-	E	A
Diamond Firetail	*Stagonopleura guttata*	V	-	E	A
Mammals					
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V	-	E	A, B
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	E	A^{Po},B^{Po},C^{Po}
Southern Myotis	*Myotis macropus*	V	-	S	A, C
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	E	A^{P},B^{P},C^{P}
Eastern Cave Bat	*Vespadelus troughtoni*	V	-	S^	C

1 Conservation status under the BC Act (current as at December 2020). V = Vulnerable.

2 Conservation status under the EPBC Act (current as at December 2020). V = Vulnerable.

3 Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at December 2020). E = Ecosystem; S = Species.

^ This species is a 'species credit species'; however, no breeding habitat was recorded.

4 Study area previous survey references:
A – Cumberland Ecology (2010).
B – Eco Logical Australia (2017a).
C – Eco Logical Australia (2017b).
^{Pr} = probable record.
^{Po} = possible record.

Black Falcon (*Falco subniger*)

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected in the study area during current surveys, but a single individual was detected to the east of the study area between Castlerock and Dorset Road in October 2019 (Figure 7), during vegetation surveys by Future Ecology and Hunter Eco within the area approved for mining. This area has been mapped by Hunter Eco (2019) as PCT 1606.

There is a previous record of this species from the locality dated 2009 (Cumberland Ecology, 2010) but no details are provided of the exact location. There are no PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* for the Sydney Basin – Hunter IBRA subregion (DPIE, 2020b).

White-throated Needletail (*Hirundapus caudacutus*)

This is a Commonwealth listed vulnerable species and it is not listed as threatened in NSW. It is classified as a 'species credit species' in the *BioNet Threatened Biodiversity Data Collection*, however there is no associated vegetation for this species (DPIE, 2020b).

White-throated Needletails are non-breeding migrants in Australia from around October to May (DAWE, 2020c). Breeding takes place in northern Asia. The species is likely to occasionally forage over the study area or use it as an overfly area.

Not recorded during current surveys but was recorded within the study area in 2017 (Eco Logical Australia, 2017b). Exact location and numbers were not provided. This species is not considered to be a relevant 'species credit species' in the study area as it would not be associated with the vegetation.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected during Future Ecology current surveys. There is a *BioNet Atlas* record of this species just outside the study area south of Wybong Road near the approved rail spur and coal loading area about 900 m south of what is now Site 8 (DPIE, 2020a) (Figure 7). This could be the same observation recorded by Cumberland Ecology (2010) in February 2010 where a group of approximately six to eight Black-chinned Honeyeaters were recorded feeding on flowering mistletoe within the then proposed conveyor/services corridor south of Wybong Road within the Bengalla Mine owned lands.

The PCT in which this species was observed is unknown. The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat (Appendix C).

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected within the study area during the 2018 to 2019 survey period but it has been previously recorded 'within the Mount Pleasant Project Area' in 2006 (Cumberland Ecology, 2010), but no details are given as to exact location or numbers of individuals observed. As such it may or may not have been recorded in the current study area.

The mapped PCT(s) in which it was observed are not known. The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat (Appendix C).

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected during Future Ecology surveys in 2018 and 2019. It has been previously recorded by others within the study area as follows (Figure 7):

- At what is now Site 11 (DPIE, 2020a) – two observations of up to two individuals were detected in 2009 (this could possibly be the same record stated in Cumberland Ecology (2010) but no specific location is given).

The mapped PCTs in which it was previously recorded (DPIE, 2020a) include:

- PCT 483; and
- PCT 483 DNG.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483 and PCT 483 DNG.

Eastern Coastal Free-tailed Bat (*Micronomus 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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It has been previously recorded within or immediately adjacent to the study area by others as follows:

- 'from the Mount Pleasant Project Area' in 2006 but no detail is given as to exact location, method of detection or confidence level (Cumberland Ecology, 2010); and
- via acoustic call analysis with a 'Definite' confidence level from the approved rail spur just south of Wybong Road (Eco Logical Australia, 2017a), about 1.65 km east southeast of the study area (Figure 8).

No PCT vegetation has been mapped at the known location (Eco Logical Australia, 2017a). Previously mapped vegetation at this location includes cleared agricultural land and planted trees (Hunter Eco, 2017).

It was detected at one location within the study area during the 2018-2019 survey period via call recording but only with a 'Possible' confidence level at Site 11d in December 2018. The mapped PCT in which it was possibly recorded is PCT 483 DNG.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) which have been mapped in the study area would provide potential habitat (Appendix C), namely: PCT 1605 and 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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected with a 'Probable' confidence level at one location within the study area during the 2018-2019 survey period via call recording at Site 8h in November 2018. The mapped PCT in which it was probably recorded is PCT 1605 DNG.

It has been previously observed within the study area by others with records from what is now Site 13 (Eco Logical Australia, 2017b) and from the southeast corner of the study area about 900 m south southwest of Additional Habitat Assessment Site M (Eco Logical Australia, 2017a) (Figure 8). There is an additional record from 2009 but the location is not specified (Cumberland Ecology, 2010). All of these records are from call analysis and were only identified at a 'possible' confidence level.

Mapped PCTs at previous observations of this species by others within the study area include PCT 483 (Eco Logical Australia, 2017b). The second known location record (Eco Logical Australia, 2017a) is in an area which has not been mapped for PCTs but appears to be cleared land with scattered trees nearby.

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483.

Southern Myotis (*Myotis macropus*)

This species is listed as 'vulnerable' under the BC Act but is not listed under the EPBC Act. It is classified as a 'species credit species' in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was recorded with a 'Possible' confidence level at Site 15g in November 2019 via acoustic recording. However, it was not caught in any harp traps or mist nets placed around dams at Site 8a and Site 15a in November 2019 and was not observed foraging over any dam during spotlighting surveys.

There is a database record on Figure 8 from DPIE (2020a). This record was obtained via call analysis in 2009 from 'Properties surrounding Mount Pleasant; approximately 8 km west of Muswellbrook' (DPIE, 2020a) but the accuracy is listed as 10 km. Based on a review of previous surveys, this species has been previously observed within the study area by Cumberland Ecology (2010) in 2009 and this could be the same record as DPIE (2020a) as exact locations and information regarding recording method and confidence level were not provided by Cumberland (2010).

It was reportly recorded by Eco Logical Australia (2017a) from the approved rail spur and corridor area (outside of the current study area). There are additional records of this species outside the study area (DPIE, 2020a) where it appears to have been recorded in native vegetation, disturbed native vegetation, an urban area (Muswellbrook) and along the Hunter River and Muscle Creek.

Potential breeding habitat for this species is defined as: "The range of PCTs associated with the species (as per the *BioNet Threatened Biodiversity Data Collection* [DPIE, 2020b]) 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 no permanently flowing creeks. Many dams within the study area were dry due to drought during November 2019.

There were no bridges or other such features in the study area that could be used for roosting and/or breeding by this species. The Kayuga Bridge over the Hunter River at Muswellbrook which is outside the study area, was checked for roosting Southern Myotis in November 2019 but no bats of any species were observed roosting. It appears to have been recently refurbished with marine plyboard underneath and as such the bridge lacks the necessary 'nooks and crannies' to allow this (or any bat) species to roost (author pers. obs.). The only potential breeding habitat in the study area would be hollow-bearing trees.

Given no Southern Myotis were definitively recorded within 200 m of dams within associated PCTs mapped for the study area, this species is not considered to be a relevant 'species credit species' in the study area.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was detected at two locations within the study area during the 2018-2019 survey period via call recording but only with a 'Probable' and 'Possible' confidence level as follows:

- On Castlerock Road near Site 4e in December 2018 ('Probable'); and
- At Site 15g in November 2019 ('Possible').

The mapped PCT immediately adjacent to where it was probably recorded on Castlerock Road is PCT 1606 DNG. The mapped PCT in which it was possibly recorded is PCT 1605.

It has been previously observed within the study area by others with records from what is now Site 13 (Eco Logical Australia, 2017a) and from the approved rail spur just south of Wyong Road (Eco Logical Australia, 2017b), about 1.65 km east southeast of the study area (Figure 8). There is an additional record from the locality dated 2009 but the location is not specified (Cumberland Ecology, 2010). It is noted that all of these previous records from the study area are from call analysis and were only identified at a 'possible' confidence level.

Mapped PCTs at previous observations of this species by others within the study area include PCT 483 at what is now Site 13 (Eco Logical Australia, 2017a). No PCT vegetation has been mapped at the approved rail spur location (Eco Logical Australia, 2017b). Previously mapped vegetation at this location includes cleared agricultural land and planted trees (Hunter Eco, 2017).

The PCTs assigned to this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) 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 483.

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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b).

It was not detected within the study area during the 2018 to 2019 survey period. It has been previously recorded within the study area by others with calls recorded from a location within the South West Out of Pit Emplacement area (Eco Logical Australia, 2017b) (Figure 8), which is about 500 m west of what is now Site 3 and about 550 m south of what is now Site 13 in this current report. This species was identified via call analysis with a 'Definite' confidence level (Eco Logical Australia, 2017b).

The mapped PCT at the previous record of this species by others within the study area is PCT 483. There are additional records of this species outside the study area (DPIE, 2020a) where it appears to have been recorded in native vegetation, disturbed native vegetation, urban areas of Muswellbrook and cleared agricultural land.

Potential breeding habitat for this species is defined as: "The PCTs associated with the species (as per the *BioNet Threatened Biodiversity Data Collection* [DPIE, 2020b]) within 100 m 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 no rocky areas, caves or overhangs but it does contain several old abandoned farmhouses and sheds. There are no records of this species from within or adjacent to these structures.

In accordance with *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018) this species is not considered to be a relevant 'species credit species' in the study area because no breeding individuals of the target species were observed. Clearance of foraging habitat is not a potential 'serious and irreversible impact' (OEH, 2018).

3.3.3 Other Threatened Fauna Species Not Recorded in the Study Area

A number of threatened fauna predicted to occur in the locality (Table 1) but not recorded in the study area during past or present surveys are discussed in Table 13.

3.4 Threatened Fauna Species Listed under the EPBC Act

Two threatened fauna species listed under the EPBC Act were recorded during the surveys, namely, Striped Legless Lizard and Grey-headed Flying-fox. Records of threatened fauna species listed under the EPBC Act are shown on Figure 10. One additional threatened fauna species listed under the EPBC Act was previously recorded in the study area during other surveys, namely, White-throated Needletail.

The threatened species under the EPBC Act shown on Figure 10 are discussed in Table 14.

Table 13: 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	No potential habitat as preferred habitat of marshes, dams and stream-sides, particularly those containing Cumbungi or spikerushes (*Eleocharis sp*.) (DPIE, 2020c) is not present within the study area. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records.
Green-thighed Frog	*Litoria brevipalmata*	V	-	S	No potential habitat as preferred habitat of rainforest and moist eucalypt forest in the south of its range (DPIE, 2020c) is not present within the study area. There is one PCT in the study area which is recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records.
Reptiles					
Pink-tailed Legless Lizard	*Aprasia parapulchella*	V	V	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 6).
Pale-headed Snake	*Hoplocephalus bitorquatus*	V	-	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 6).
Birds					
Magpie Goose	*Anseranas semipalmata*	V	-	E	Not recorded, despite targeted surveys. Preferred habitat of shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges (DPIE, 2020c) absent. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Freckled Duck	*Stictonetta naevosa*	V	-	E	Not recorded, despite targeted surveys. Preferred permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum (*Duma florulenta*) or Tea-tree (*Melaleuca alternifolia*) (DPIE, 2020c) not present. Only marginal habitat in the form of ephemeral farm dams present. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at several locations outside of the study area in habitat associated with the Hunter River and nearby watercourses (Figure 7).
Black-necked Stork	*Ephippiorhynchus asiaticus*	E	-	E	Not recorded, despite targeted surveys. Prime habitat of floodplain wetlands (swamps, billabongs, watercourses and dams) of major coastal rivers (DPIE, 2020c) absent. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area in habitat associated with the Hunter River (Figure 7).
Australasian Bittern	*Botaurus poiciloptilus*	E	E	E	Some marginal habitat present (e.g. farm dams) but large permanent freshwater wetlands with tall, dense vegetation, particularly Cumbungi and spikerushes (DPIE, 2020c) are absent. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area in habitat associated with the Hunter River (Figure 7).

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Grey Falcon	*Falco hypoleucos*	E	-	E	Not recorded. The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range (DPIE, 2020c). The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area south of Bengalla Mine (Figure 7).
Square-tailed Kite	*Lophoictinia isura*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at two locations outside of the study area in habitat associated with the Hunter River and nearby watercourses (Figure 7).
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 *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Little Eagle	*Hieraaetus morphnoides*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at three locations outside of the study area to the north and south (Figure 7).
Red-backed Button-quail	*Turnix maculosus*	V	-	S	Not recorded, despite targeted surveys. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location (dated 1963) outside of the study area in habitat associated with the Hunter River and nearby watercourses (Figure 7).
Bush Stone-curlew	*Burhinus grallarius*	E	-	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Australian Painted Snipe	*Rostratula australis*	E	E	E	Only marginal habitat is present within the study area (ephemeral farm dams lacking dense fringing cover), and not previously recorded in broader locality. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area in habitat associated with Sandy Creek (Figure 7).
Eastern Curlew	*Numenius madagascariensis*	-	CE	S/E	No potential habitat, as preferred estuarine intertidal mudflat habitat (DPIE, 2020c) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Curlew Sandpiper	*Calidris ferruginea*	E	CE	S/E	No potential habitat, as preferred estuarine intertidal mudflat habitat (DPIE, 2020c) is not present in study area. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at two locations outside of the study area near and to the south of Muswellbrook (Figure 7).
Turquoise Parrot	*Neophema pulchella*	V	-	E	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area near Muswellbrook (Figure 7).
Swift Parrot	*Lathamus discolor*	E	CE	S/E*	Not recorded, despite targeted surveys. No important habitat mapping within the study area by DPIE. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Masked Owl	*Tyto novaehollandiae*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area to the north-west (Figure 7).
Powerful Owl	*Ninox strenua*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at two locations outside of the study area where there is now Mount Pleasant Operation infrastructure (Figure 7).
Barking Owl	*Ninox connivens*	V	-	S/E[#]	Not recorded, despite targeted surveys. No sign of breeding onsite and therefore the study area is regarded as potential foraging habitat only. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area in habitat associated with the Hunter River (Figure 7).
Collared Kingfisher	*Todiramphus chloris*	V	-	S	Not recorded. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	S/E*	Not recorded, despite targeted surveys. Regent Honeyeaters in the area are classed as 'ecosystem credit species' based on no important habitat mapping within the study area by DPIE. This species has previously been recorded at several locations outside of the study area to the south of Bengalla Mine and near Muswellbrook (Figure 7).
Painted Honeyeater	*Grantiella picta*	V	V	E	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
White-fronted Chat	*Epthianura albifrons*	V	-	E	Not recorded. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at two locations outside of the study area in habitat associated with the Hunter River and nearby watercourses (Figure 7).

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	-	E	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 7).
Mammals					
Spotted-tailed Quoll	*Dasyurus maculatus maculatus*	V	E	E	Not recorded during current and previous surveys, despite targeted surveys. There is a record from Mount Pleasant but outside the study area dated 2006-2008 (DPIE, 2020a). There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at two locations outside of the study area to the east (Figure 8).
Brush-tailed Phascogale	*Phascogale tapoatafa*	V	-	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area in habitat associated with the Hunter River (Figure 8).
Common Planigale	*Planigale maculata*	V	-	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 8).
Koala	*Phascolarctos cinereus*	V	V	S/E^	Not recorded, despite targeted surveys (i.e no core Koala habitat occurs in the Study Area in consideration of the *State Environmental Planning Policy [Koala Habitat Protection] 2020*). Not recorded in any previous surveys in the study area (Cumberland Ecology, 2010; Eco Logical Australia, 2017a; 2017b). Potential habitat was identified by Hunter Eco (2020) in woodland forms of PCT 483, 618, 1691, 1602, 1605 and 1606 (Figure 14). This species has previously been recorded at three locations outside of the study area near Muswellbrook to the east and Mt Arthur Coal Mine to the south (Figure 8).
Eastern Pygmy-possum	*Cercartetus nanus*	V	-	S	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 8).
Yellow-bellied Glider	*Petaurus australis*	V	-	E	Not recorded, despite targeted surveys. There is one PCT in the study area which is recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 8).
Brush-tailed Rock-wallaby	*Petrogale penicillata*	E	V	S	Not recorded. No potential habitat as rocky escarpment habitat is absent from the study area. No nearby records (Figure 8).
Little Bent-winged Bat	*Miniopterus australis*	V	-	S/E#	Not recorded, despite targeted surveys. No breeding habitat present. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). This species has previously been recorded at one location outside of the study area to the east near Muswellbrook (Figure 8).
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	E	Not recorded, despite targeted surveys. There are several PCTs in the study area which are recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). No nearby records (Figure 8).

Common Name	Scientific Name	Conservation Status		Credit Class[3]	Survey Result
		BC Act[1]	EPBC Act[2]		
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	S[$]	Calls were recorded with a 'probable' confidence level during current surveys via acoustic recording at Sites 4 and 8. It was not trapped. Potential breeding habitat for this species is defined as: "The PCTs associated with the species (as per the *BioNet Threatened Biodiversity Data Collection* [DPIE, 2020b]) 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' Threatened Bats and Their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018). No such features were observed and potential breeding habitat is absent from the study area. No nearby records (Figure 8).

[1] Conservation status under the BC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

[2] Conservation status under the EPBC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

[3] Biodiversity credit class under the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b) (current as at December 2020). 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 DPIE.

^ 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.

This species is a duel credit species; however, no breeding habitat is present therefore it is considered an 'ecosystem credit species' in the study area.

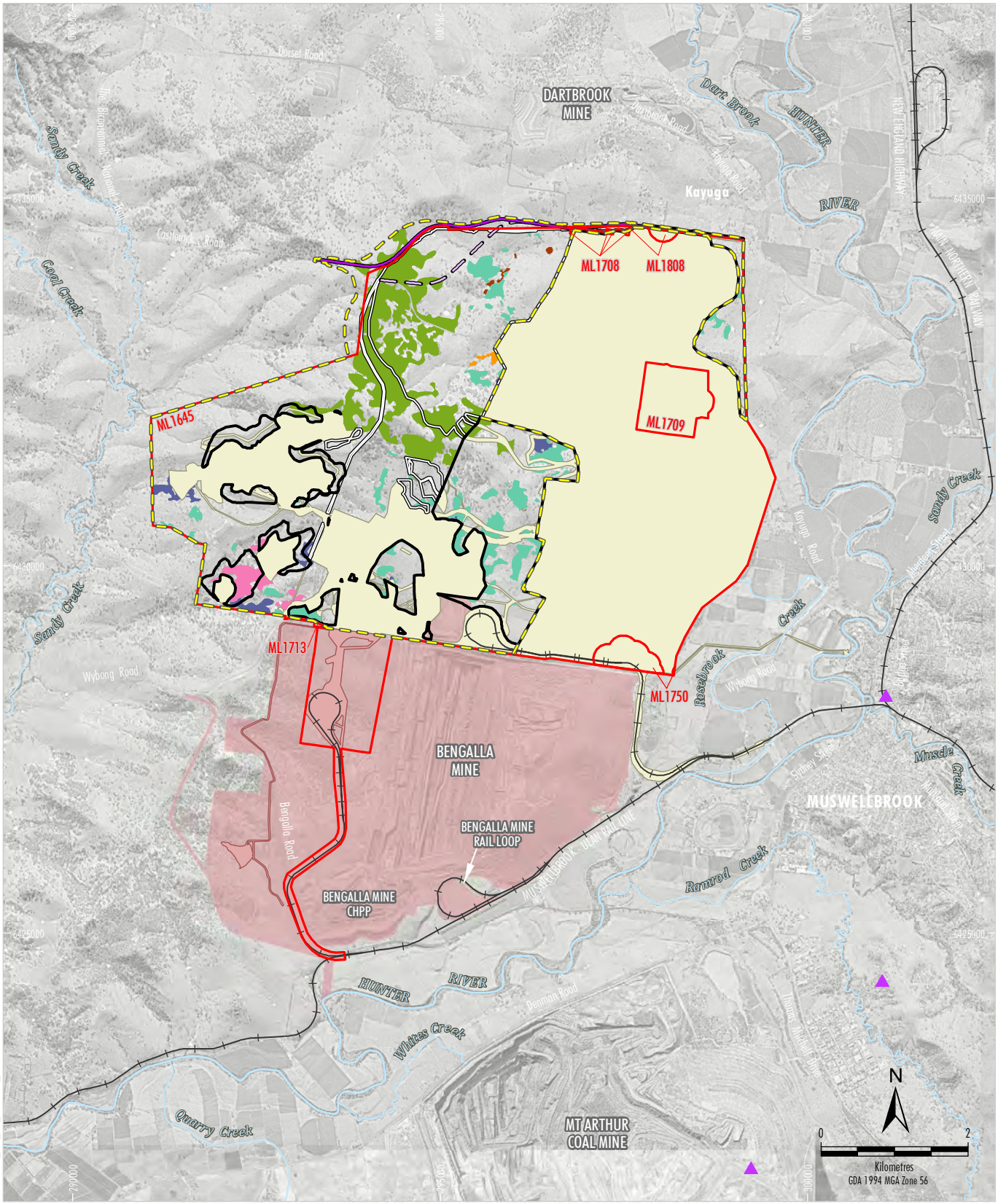
$ This species is a 'species credit species'; however, no breeding habitat was recorded and therefore no species credits would be generated from the study area.

Table 14: Threatened Fauna Species Listed Under the EPBC Act

Common Name	Scientific Name	Conservation Status		Survey Result
		BC Act[1]	EPBC Act[2]	
Reptiles				
Striped Legless Lizard	*Delma impar*	V	V	Recorded during this survey (Section 3.3.1; Figure 10).
Birds				
Australasian Bittern	*Botaurus poiciloptilus*	E	E	Some marginal potential habitat present (e.g. farm dams) but large permanent freshwater wetlands with tall, dense vegetation, particularly Cumbungi and spikerushes (DPIE, 2020c) are absent. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). There is a database record outside the study area to the south within habitat associated with the Hunter River (Figure 10).
Australian Painted Snipe	*Rostratula australis*	E	E	Only marginal potential habitat is present within the study area (ephemeral farm dams lacking dense fringing cover), and not previously recorded in broader locality. The PCTs in the study area are not recognised as potential habitat for this species in the *BioNet Threatened Biodiversity Data Collection* (DPIE, 2020b). There is a database record outside of the study area to the west within habitat associated with Sandy Creek (Figure 10).
Swift Parrot	*Lathamus discolor*	E	CE	Not recorded, despite targeted surveys. No important habitat mapping within the study area by DPIE.
White-throated Needletail	*Hirundapus caudacutus*	-	V	Not recorded during current surveys but was recorded within the study area in 2017 (Eco Logical Australia, 2017b) (Figue 10). Likely to occasionally forage over the study area or use as an overfly area.
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	Not recorded, despite targeted surveys. Regent Honeyeater is classed as ecosystem credit species in the area based on no important habitat mapping within the study area by DPIE. There are several database records outside of the study area south of Bengalla Mine and near Muswellbrook (Figure 10).
Mammals				
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	Not recorded, despite targeted surveys. There is a database record approximately 360 m east of the study area from 2018 with a 30 m accuracy (DPIE, 2020a) (Figure 10).
Koala	*Phascolarctos cinereus*	V	V	Not recorded despite targeted surveys. There are database records at three locations outside of the study area near Muswellbrook to the east and Mt Arthur Coal Mine to the south (Figure 10).
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Recorded during this survey (Section 3.3.1; Figure 10).

[1] Threatened species status under the BC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.

[2] Threatened species status under the EPBC Act (current as at December 2020). CE = Critically Endangered, E = Endangered, V = Vulnerable.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Project Continuation of Existing/Approved Surface Development (DA92/97)
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Existing/Approved Mount Pleasant Operation Infrastructure within Bengalla Mine Approved Disturbance Boundary (SSD-5170)
- Development Footprint 1 - General Extension Areas
- Relinquishment Area
- Northern Link Road Option 1 Centreline
- Northern Link Road Option 2 Centreline
- Ecology Study Area

Database

Threatened Species

- Koala

POTENTIAL FORAGING HABITAT

Grassy Woodlands

- 2 Grey Box x White Box - Spotted Gum Grassy Woodland (PCT483) [2, 4]
- 3 Forest Red Gum Grassy Open Forest (PCT618) [2, 4]
- 4 Narrow-leaved Ironbark - Grey Box Grassy Woodland (PCT1691) [1, 3]

Dry Sclerophyll Forests (Shrub/grass Sub-formation)

- 5 Spotted Gum - Narrow-leaved Ironbark Woodland (PCT1602) [3]
- 6 Narrow-leaved Ironbark Shrubby Forest (PCT1605) [3]
- 7 White Box - Narrow-leaved Ironbark - Blakely's Red Gum (PCT1606) [2, 4]

[1] Listed BC Act: Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin
[2] Listed 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
[3] Listed EPBC Act: Central Hunter Valley Eucalypt Forest and Woodland
[4] Listed EPBC Act: White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Database Record Sources: ALA (2020); DPIE (2020)

Source: MACH (2020); Hunter Eco (2020); NSW Spatial Services (2020); Department of Planning and Environment (2016)
Orthophoto: MACH (July 2020)

MACHEnergy

MOUNT PLEASANT OPTIMISATION PROJECT

Koala
Potential Foraging Habitat

Figure 14

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 1997, and then undertook additional comprehensive fauna surveys in 2018 and 2019.

Eight broad fauna habitat types were observed within the study area, comprising two natural habitats (i.e. Dry Sclerophyll Forest and Grassy Woodlands) and six secondary habitats (i.e. Derived Native Grassland, Cropping/Grazing, Cultivation, Disturbed/Exotic, Infrastructure/Cleared Land and Dam/Waterbody). 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. 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 176 fauna species were recorded in the study area during the 2018 to 2019 surveys including 6 amphibian, 17 reptile, 111 bird, and 42 mammal species. A total of 13 threatened fauna species listed under the BC Act (all listed as vulnerable) were recorded by Future Ecology in or immediately adjacent to the study area during the current surveys.

Two of the threatened fauna species recorded are considered relevant ‘species credit species’ under the NSW Biodiversity Offsets Scheme, namely, Striped Legless Lizard and Squirrel Glider.

Two threatened fauna species listed under the EPBC Act were recorded during the surveys, namely, the Striped Legless Lizard and Grey-headed Flying-fox. One additional threatened fauna species listed under the EPBC Act was previously recorded in the study area during other surveys, namely, White-throated Needletail.

5 References and Bibliography

Atlas of Living Australia (2020) **Atlas of Living Australia Database with Search Co-ordinates -32.23755 150.94161, -32.23697 150.94092, -32.34377 150.94092, -32.35247 150.71433, -32.13178 150.70884, -32.12946 150.93955**. Website: http://www.ala.org.au. Accessed July 2020.

Australian Capital Territory Government (2017) **Action Plan, Striped Legless Lizard *Delma impar***, Australian Capital Territory Government Canberra.

Beyer, G.L., Goldingay, R.L. and Sharpe, D.J. (2008) **The characteristics of squirrel glider (*Petaurus norfolcensis*) den trees in subtropical Australia**. *Australian Journal of Zoology* 56(1) 13-21.

BirdLife Australia (2020) **BirdLife Australia Atlas Database with Search Co-ordinates -32.23755 150.941609, -32.23697 150.940923, -32.343774 150.940923, -32.352475 150.71433, -32.131784 150.708837, -32.129458 150.939549.** Website: https://birdlife.org.au/. Accessed July 2020.

Bureau of Meteorology (2020a) **New South Wales in 2018: warmest year on record, very dry. Annual Climate Summary for New South Wales** - Product code IDCKGC55R0 dated 10 January 2019. Viewed on 09/03/2020. Website: http://www.bom.gov.au/climate/current/annual/nsw/archive/2018.summary.shtml

Bureau of Meteorology (2020b) **New South Wales in 2019: record warm and record dry. Annual Climate Summary for New South Wales** - Product code IDCKGC55R0 dated 9 January 2020. Viewed on 09/03/2020. Website: http://www.bom.gov.au/climate/current/annual/nsw/summary.shtml

Christidis, L. and Boles, W. (2008) **Systematics and Taxonomy of Australian Birds**, CSIRO Publishing, Clayton, Victoria. ISBN: 9780643065116.

Churchill, S. (2009) **Australian Bats**, 2nd Edition, Jacana Books Allen and Unwin, Crows Nest New South Wales.

Clayton, M, Wombey, J.C, Mason, I.J, Chesser, R.T, and Wells, A. (2006) **CSIRO List of Australian Vertebrates.**

Cogger, H. (2018) **Reptiles and Amphibians of Australia, updated 7th edition**, CSIRO Publishing, Clayton Victoria, ISBN: 978064309696, October 2018.

Crane, M.J., Lindenmayer, D.B. and Cunningham, R.B. (2013) **Use and characteristics of nocturnal habitats of the squirrel glider (*Petaurus norfolcensis*) in Australian temperate woodlands**. *Australian Journal of Zoology* 60(5) 320-329.

Cumberland Ecology (2010) **Mount Pleasant Project Modification Ecological Assessment**. Prepared for Coal & Allied Operations Pty Ltd. Final Report. September 2010.

Department of Agriculture, Water and Environment (2020a) **National Flying-fox monitoring viewer**. Australian government Department of Agriculture, Water and the Environment. Viewed on 10/2/2020. Website: http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf

Department of Agriculture, Water and the Environment (2020b) **Protected Matters Search with Search Co-ordinates -32.23755 150.94161, -32.23697 150.94092, -32.34377 150.94092, -32.35247 150.71433, -32.13178 150.70884, -32.12946 150.93955**. Report created: 10/07/2020.

Department of Agriculture, Water and the Environment (2020c) **Species Profile and Threats Database of relevant Commonwealth listed threatened and/or migratory fauna species**. Australian Government Department of Agriculture, Water and the Environment. Website: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Department of Environment and Climate Change (2008) **Hygiene protocol for the control of disease in frogs**. Information Circular Number 6. Department of Environment and Climate Change (New South Wales), Sydney South.

Department of Environment and Climate Change (2009) **Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians**. Sydney South, Department of Environment and Climate Change 2009/213.

Department of Environment and Conservation (2004a) **Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)**, Biodiversity Conservation Unit, Department of Environment and Conservation, Sydney South New South Wales, November 2004.

Department of Environment, Water, Heritage and Arts (2010a) **Survey guidelines for Australia's threatened frogs.** Guidelines for detecting frogs listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999, Australian Government Barton, Australian Capital Territory. Website: https://www.environment.gov.au/resource/survey-guidelines-australias-threatened-frogs-guidelines-detecting-frogs-listed-threatened

Department of Environment, Water, Heritage and Arts (2010b) **Survey guidelines for Australia's threatened bats.** Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999, Australian Government Barton, Australian Capital Territory. Website: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-bats-guidelines-detecting-bats-listed-threatened

Department of Environment, Water, Heritage and Arts (2010c) **Survey guidelines for Australia's threatened birds.** listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999, Australian Government Barton, Australian Capital Territory. Website: https://www.environment.gov.au/resource/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened

Department of Planning, Industry and Environment (2020a). **BioNet Atlas records for Mount Pleasant Project study area and general locality. N: -32.12, W: 150.71, E: 150.94, S: -32.35**. Website: https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx?who=814a040b-7824-4e42-9398-2cda9a74c213. Accessed July 2020.

Department of Planning, Industry and Environment (2020b) **BioNet Threatened Biodiversity Data Collection**. Website: https://www.environment.nsw.gov.au/AtlasApp/UI_Modules/TSM_/Default.aspx?a=1

Department of Planning, Industry and Environment (2020c). **Threatened Species Profile Database**. Viewed in March 2020. Website: https://www.environment.nsw.gov.au/threatenedSpeciesApp/

Department of Sustainability, Environment, Water, Population and Communities (2011a) **Survey guidelines for Australia's threatened mammals.** Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Australian Government Barton, Australian Capital Territory. Website: https://www.environment.gov.au/resource/survey-guidelines-australias-threatened-mammals-guidelines-detecting-mammals-listed

Department of Sustainability, Environment, Water, Population and Communities (2011b) **Survey guidelines for Australia's threatened reptiles.** Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Australian Government Barton, Australian Capital Territory. Website: https://www.environment.gov.au/resource/survey-guidelines-australias-threatened-reptiles-guidelines-detecting-reptiles-listed

Department of Sustainability, Environment, Water, Population and Communities (2011c) **Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable striped legless lizard, Delma impar**.

Department of the Environment (2014) **EPBC Act Referral Guidelines for the Vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)**, Australian Government, Department of the Environment, Canberra.

Eco Logical Australia (2017a) **Mount Pleasant Operation Rail Modification – Terrestrial Fauna Survey Report.** Prepared for MACH Energy Australia Pty Ltd. 12 December 2017.

Eco Logical Australia (2017b) **Mount Pleasant Operation Rail Modification – Portion of South West Out of Pit Emplacement Terrestrial Fauna Survey Report.** Prepared for MACH Energy Australia Pty Ltd. 18 December 2017.

ERM Mitchell McCotter Pty Ltd (1997) **Mount Pleasant Mine Environmental Impact Statement.** Prepared for Coal & Allied Operations Pty Ltd.

Future Ecology (2019) **Maxwell Project Baseline Fauna Survey Report**. Prepared for Malabar Coal Limited.

Geoscience Australia (2020a) **Compute Sunrise, Sunset & Twilight Times**, online information at Geoscience Australia. Website: http://www.ga.gov.au/geodesy/astro/sunrise.jsp

Geoscience Australia (2020b) **Compute Moonrise & Moonset Times**, online information at Geoscience Australia. Website: http://www.ga.gov.au/geodesy/astro/moonrise.jsp

Google Inc. (2020) **Google Earth Pro**. Website: https://www.google.com/earth/download/gep/agree.html

Hunter Eco (2020) **Mount Pleasant Optimisation Project Baseline Flora Survey Report.** Prepared for MACH Energy Australia Pty Ltd.

Museum of Applied Arts and Sciences – Sydney Observatory (2020) **Moon Phase Calendar for 2019.** Website viewed on 09/03/2020 at: https://maas.museum/sydney-observatory/astronomy-resources/moon-phase-calendar/

National Parks and Wildlife Service, New South Wales (2019) **Eastern bentwing-bat**. Viewed on 18/2/2019. Website: https://www.nationalparks.nsw.gov.au/plants-and-animals/eastern-bentwing-bat

New South Wales Scientific Committee (2008) **Squirrel Glider *Petaurus norfolcensis*. Review of current information in NSW**. August 2008. Unpublished report arising from the Review of the Schedules of the Threatened Species Conservation Act 1995. New South Wales Scientific Committee, Hurstville.

New South Wales Spatial Services (2020) **Six Maps**. Accessed: February and March 2020. Website: https://maps.six.nsw.gov.au/

Office of Environment and Heritage (2017) **Biodiversity Assessment Method**, New South Wales Government Office of Environment and Heritage, Sydney, August 2017.

Office of Environment and Heritage (2018) **'Species Credit' Threatened Bats and Their Habitats: NSW Survey Guide for the Biodiversity Assessment Method**, Office of Environment and Heritage, Sydney. September 2018.

Office of Environment and Heritage (2019) **Soil Landscapes of Central and Eastern NSW - v2**, New South Wales Office of Environment and Heritage, Sydney.

Phillips, S. and Callaghan, J. (2011) **The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus***. Australian Zoologist volume 35(3).

Reardon, T.B., Armstrong, K.N. and Jackson, S.M. (2015) **A current taxonomic list of Australian Chiroptera**. Australasian Bat Society. Version 2015-05-15. Website: http://ausbats.org.au/taxonomic-list/4589345107

Smith, A.P. (2002) **Squirrel Glider (*Petaurus norfolcensis*) Conservation Management Plan: Wyong Shire**, unpublished report prepared for Wyong Shire Council, August 2002.

Smith, A.P. and Murray, M. (2003) **Habitat requirements of the squirrel glider (*Petaurus norfolcensis*) and associated possums and gliders on the NSW Central Coast**. *Wildlife Research 30(3).*

Smith, W.J.S. and Robertson, P. (1999) **National Recovery Plan for the Striped Legless Lizard (*Delma impar*) 1999-2003**, New South Wales National Parks and Wildlife Service and Wildlife Profiles Pty Ltd, June 1999.

Timeanddate.com (2020). **Moon Phases 2018 – Lunar Calendar for Sydney, Australia**. Website viewed on 09/03/2020 at: https://www.timeanddate.com/moon/phases/?year=2018

Van Dyck, S. and Strahan, R. (2008) **The Mammals of Australia**, **3rd ed**. Edited by Steve van Dyck and Ronald Strahan. New Holland Publishers, Sydney New South Wales.

Wilson, S. and Swan, G. (2017) **A complete guide to reptiles of Australia**, Fifth Edition, New Holland, August 2017.

Appendix A Fauna Species Detected

Sites 2, 3, 4, 7, 8 ,10 and 11

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level	Site 8	Observation Type	Confidence Level	Site 10	Observation Type	Confidence Level	Site 11	Observation Type	Confidence Level
Amphibians	Common Eastern Froglet	*Crinia signifera*																X	W							
Amphibians	Fletcher's Frog	*Lechriodus fletcheri*																								
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*							X	O								X	O							
Amphibians	Green Tree Frog	*Litoria caerulea*							X	O		X	O					X	O							
Amphibians	Broad-palmed Frog	*Litoria latopalmata*																X	O							
Amphibians	Peron's Tree Frog	*Litoria peronii*																								
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*																X	O							
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*																X	O							
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*							X	O		X	O		X	O		X	O					X	T	
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**																					
Reptiles	Leaden Delma	*Delma plebeia*																X	O							
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*				X	O											X	T					X	T	
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*																								
Reptiles	Robust Ctenotus	*Ctenotus robustus*				X	O								X	O		X	O		X	O		X	T	
Reptiles	Tree Skink	*Egernia striolata*				X	O					X	O		X	O		X	T							
Reptiles	Dark-flecked Garden Sunskink	*Lampropholis delicata*																								
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*							X	O																
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*																								
Reptiles	Eastern Bearded Dragon	*Pogona barbata*										X	O											X	O	
Reptiles	Lace Monitor	*Varanus varius*				X	Q											X	Q					X	O	
Reptiles	Red-naped Snake	*Furina diadema*																								
Reptiles	Spotted Black Snake	*Pseudechis guttatus*																								
Reptiles	Bandy-bandy	*Vermicella annulata*																								
Birds	Brown Quail	*Coturnix ypsilophora*																X	O							
Birds	Australian Wood Duck	*Chenonetta jubata*							X	O		X	O		X	O		X	O							
Birds	Pacific Black Duck	*Anas superciliosa*																								
Birds	Australasian Shoveler	*Anas rhynchotis*																								
Birds	Grey Teal	*Anas gracilis*																X	O							
Birds	Hardhead Duck	*Aythya australis*																								
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*																								
Birds	White-necked Heron	*Ardea pacifica*																								
Birds	White-faced Heron	*Egretta novaehollandiae*																								
Birds	Australasian Darter	*Anhinga novaehollandiae*																								
Birds	Nankeen Kestrel	*Falco cenchroides*																X	O		X	O				
Birds	Australian Hobby	*Falco longipennis*													X	O										
Birds	Brown Falcon	*Falco berigora*				X	O					X	O					X	O		X	O				
Birds	**Black Falcon**	***Falco subniger***		**V**																						
Birds	Peregrine Falcon	*Falco peregrinus*							X	O		X	O		X	O								X	O	
Birds	Black-shouldered Kite	*Elanus axillaris*																X	O					X	O	
Birds	Black Kite	*Milvus migrans*																			X	O				
Birds	Whistling Kite	*Haliastur sphenurus*													X	O		X	O							
Birds	**Spotted Harrier**	***Circus assimilis***		**V**																				**X**	**O**	
Birds	Brown Goshawk	*Accipiter fasciatus*																			X	O				
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*																X	O							

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level	Site 8	Observation Type	Confidence Level	Site 10	Observation Type	Confidence Level	Site 11	Observation Type	Confidence Level
Birds	Wedge-tailed Eagle	*Aquila audax*				X	O		X	O								X	O					X	O	
Birds	Painted Button-quail	*Phileмon citreogularis*																						X	O	
Birds	Black-winged Stilt	*Himantopus himantopus*																								
Birds	Masked Lapwing	*Vanellus miles*				X	O								X	O		X	O							
Birds	Common Bronzewing	*Phaps chalcoptera*										X	O													
Birds	Crested Pigeon	*Ocyphaps lophotes*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Galah	*Eolophus roseicapillus*							X	O		X	O		X	O		X	O		X	O		X	OW	
Birds	Little Corella	*Cacatua sanguinea*										X	O		X	O		X	O		X	O		X	OW	
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*													X	O		X	O		X	O		X	OW	
Birds	Musk Lorikeet	*Glossopsitta concinna*				X	O		X	O		X	O		X	O					X	O		X	OW	
Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**					**X**	**O**														**X**	**OW**	
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	Red-rumped Parrot	*Psephotus haematonotus*										X	O								X	O				
Birds	Australian King-Parrot	*Alisterus scapularis*																X	O		X	O		X	OW	
Birds	Pallid Cuckoo	*Cacomantis pallidus*																								
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*																						X	OW	
Birds	Eastern Koel	*Eudynamys orientalis*										X	O		X	O		X	O					X	OW	
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*													X	O					X	O				
Birds	Eastern Barn Owl	*Tyto javanica*																								
Birds	Southern Boobook	*Ninox novaeseelandiae*																						X	W	
Birds	Tawny Frogmouth	*Podargus strigoides*													X	O										
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*							X	O		X	O		X	O		X	O					X	OW	
Birds	Laughing Kookaburra	*Dacelo novaeguineae*							X	O		X	O		X	O		X	O					X	OW	
Birds	Sacred Kingfisher	*Todiramphus sanctus*													X	O								X	OW	
Birds	White-throated Treecreeper	*Cormobates leucophaea*													X	O		X	O					X	OW	
Birds	**Brown Treecreeper**	***Climacteris picumnus***		**V**																				**X**	**OW**	
Birds	Superb Fairy-wren	*Malurus cyaneus*													X	O		X	O		X	O				
Birds	Spotted Pardalote	*Pardalotus punctatus*																						X	OW	
Birds	Striated Pardalote	*Pardalotus striatus*				X	O		X	O		X	O		X	O		X	O		X	O		X	OW	
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**														**X**	**O**		**X**	**O**		**X**	**O**	
Birds	Weebill	*Smicrornis brevirostris*													X	O		X	O		X	O		X	OW	
Birds	Western Gerygone	*Gerygone fusca*													X	O		X	OW		X	O		X	OW	
Birds	White-throated Gerygone	*Gerygone olivacea*													X	O		X	W					X	OW	
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*																			X	O		X	OW	
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*										X	O		X	0		X	O		X	O		X	OW	
Birds	Yellow Thornbill	*Acanthiza nana*																X	O		X	O		X	OW	
Birds	Striated Thornbill	*Acanthiza lineata*																								
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*													X	O		X	O		X	O		X	O	
Birds	Fuscous Honeyeater	*Ptilotula fuscus*																						X	O	
Birds	White-plumed Honeyeater	*Ptilotula penicillatus*													X	O								X	O	
Birds	Noisy Miner	*Manorina melanocephala*							X	O		X	O		X	O		X	0		X	O		X	O	
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*										X	O		X	O		X	O							
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*																						X	OW	
Birds	White-naped Honeyeater	*Melithreptus lunatus*																X	O					X	OW	
Birds	Little Friarbird	*Philemon citreogularis*																						X	OW	
Birds	Noisy Friarbird	*Philemon corniculatus*				X	O		X	O		X	O		X	O		X	O		X	O		X	OW	
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*										X	O								X	O		X	OW	
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*										X	O											X	OW	
Birds	Red Wattlebird	*Anthochaera carunculata*																			X	O		X	OW	

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level	Site 8	Observation Type	Confidence Level	Site 10	Observation Type	Confidence Level	Site 11	Observation Type	Confidence Level
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*																			X	O		X	OW	
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*																								
Birds	Eastern Yellow Robin	*Eopsaltria australis*																						X	O	
Birds	Jacky Winter	*Microeca fascinans*																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							
Birds	**Grey-crowned Babbler**	***Pomatostomus temporalis temporalis***		**V**								**X**	**O**		**X**	**O**										
Birds	Golden Whistler	*Pachycephala pectoralis*													X	O		X	O		X	O		X	OW	
Birds	Rufous Whistler	*Pachycephala rufiventris*										X	O		X	O		X	OW					X	OW	
Birds	Grey Fantail	*Rhipidura albiscapa*													X	O		X	O		X	O		X	O	
Birds	Willie Wagtail	*Rhipidura leucophrys*													X	O		X	O		X	O		X	O	
Birds	Magpie-lark	*Grallina cyanoleuca*							X	O		X	O		X	O		X	O		X	O		X	O	
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M/MI**										**X**	**O**										
Birds	**Satin Flycatcher**	***Myiagra cyanoleuca***			**M**																					
Birds	Grey Butcherbird	*Cracticus torquatus*							X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Pied Butcherbird	*Cracticus nigrogularis*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Birds	Australian Magpie	*Cracticus tibicen*				X	O		X	O		X	O		X	O		X	OW		X	O		X	O	
Birds	Pied Currawong	*Strepera graculina*				X	O		X	O		X	O		X	O					X	O		X	O	
Birds	White-browed Woodswallow	*Artamus superciliosus*																						X	O	
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**																				**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	
Birds	Ground Cuckoo-shrike	*Coracina maxima*																X	O							
Birds	White-winged Triller	*Lalage sueurii*										X	O					X	O							
Birds	Olive-backed Oriole	*Oriolus sagittatus*										X	O													
Birds	Little Raven	*Corvus mellori*																			X	O				
Birds	Australian Raven	*Corvus coronoides*				X	O		X	O		X	O		X	O		X	O		X	O		X	OW	
Birds	White-winged Chough	*Corcorax melanorhamphos*							X	O		X	O		X	O		X	O		X	O		X	OW	
Birds	Common Starling	*Sturnus vulgaris*	X												X	O					X	O				
Birds	Common Myna	*Sturnus tristis*	X									X	O													
Birds	Welcome Swallow	*Hirundo neoxena*										X	O											X	O	
Birds	Tree Martin	*Petrochelidon nigricans*										X	O											X	O	
Birds	Silvereye	*Zosterops lateralis*																X	O					X	O	
Birds	Rufous Songlark	*Cincloramphus mathewsi*																						X	OW	
Birds	Brown Songlark	*Cincloramphus cruralis*				X	W																			
Birds	Horsfield's Bushlark	*Mirafra javanica*																						X	O	
Birds	Mistletoebird	*Dicaeum hirundinaceum*													X	O		X	O							
Birds	House Sparrow	*Passer domesticus*	X									X	O													
Birds	Double-barred Finch	*Taeniopygia bichenovii*													X	O										
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*				X	Q					X	O		X	Q		X	Q					X	Q	
Mammals	Common Dunnart	*Sminthopsis murina*							X	Q		X	Q													
Mammals	Common Wombat	*Vombatus ursinus*																						X	Q	
Mammals	Sugar Glider	*Petaurus breviceps*										X	O													
Mammals	**Squirrel Glider**	***Petaurus norfolcensis***		**V**																						
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*																								
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*							X	Q		X	O		X	O		X	O					X	O	
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*				X	O		X	O		X	O		X	O		X	O		X	O		X	O	
Mammals	Eastern Wallaroo	*Macropus robustus*							X	O					X	O		X	Q					X	O	
Mammals	Red-necked Wallaby	*Macropus rufogriseus*							X	O		X	O		X	O		X	O		X	O		X	O	

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 2	Observation Type	Confidence Level	Site 3	Observation Type	Confidence Level	Site 4	Observation Type	Confidence Level	Site 7	Observation Type	Confidence Level	Site 8	Observation Type	Confidence Level	Site 10	Observation Type	Confidence Level	Site 11	Observation Type	Confidence Level
Mammals	Swamp Wallaby	*Wallabia bicolor*										X	H	PR	X	O		X	H	PR				X	Q	
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**							**X**	**O**											**X**	**OW**	
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**								**X**	**U**	**PR**				**X**	**U**	**D**						
Mammals	**Eastern Coastal Free-tailed Bat**	***Mormopterus norfolkensis***		**V**																				**X**	**U**	**PO**
Mammals	Little Mastiff-bat	*Mormopterus planiceps*										X	U	PR				X	U	PR						
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*																X	U	D						
Mammals	White-striped Freetail-bat	*Austronomus australis*										X	U	D				X	U	D	X	U	D	X	U	D
Mammals	**Large Bent-winged Bat**	***Miniopterus orianae oceanensis***		**V**														**X**	**U**	**D**	**X**	**U**	**PR**			
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*																X	T							
Mammals	Gould's Long-eared Bat	*Nyctophilus gouldi*																X	T							
Mammals	Long-eared Bat	*Nyctophilus sp.*										X	U	D				X	U	D	X	U	D			
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**							**X**	**U**	**PR**				**X**	**U**	**PR**						
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*										X	U	D				X	T		X	U	D	X	U	D
Mammals	Chocolate Wattled Bat	*Chalinolobus morio*										X	U	D				X	U	PR	X	U	D	X	U	D
Mammals	**Eastern False Pipistrelle**	***Falsistrellus tasmaniensis***		**V**														**X**	**U**	**PR**						
Mammals	**Southern Myotis**	***Myotis macropus***		**V**																						
Mammals	**Greater Broad-nosed Bat**	***Scoteanax rueppellii***		**V**																	**X**	**U**	**PR**			
Mammals	Inland Broad-nosed Bat	*Scotorepens balstoni*										X	U	PO				X	U	PR	X	U	PO	X	U	PR
Mammals	Little Broad-nosed Bat	*Scotorepens greyii*																								
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*																								
Mammals	Southern Forest Bat	*Vespadelus regulus*										X	U	PR				X	U	PR	X	U	PR			
Mammals	Little Forest Bat	*Vespadelus vulturnus*										X	U	D				X	T		X	U	D	X	U	D
Mammals	House Mouse	*Mus musculus*	X																							
Mammals	Black Rat	*Rattus rattus*	X			X	Q					X	H	D				X	Q							
Mammals	Dog	*Canis lupus familiaris*	X																					X	Q	
Mammals	Fox	*Vulpes vulpes*	X			X	O		X	O		X	O		X	Q										
Mammals	Cat	*Felis catus*	X			X	Q								X	Q		X	Q					X	Q	
Mammals	Brown Hare	*Lepus capensis*	X												X	Q					X	O				
Mammals	Rabbit	*Oryctolagus cuniculus*	X									X	O		X	O		X	O		X	O				
Mammals	Pig	*Sus scrofa*	X												X	Q										
Mammals	European Cattle	*Bos taurus*	X																							
Mammals	Fallow Deer	*Dama dama*	X																							

Sites 12, 13, 14, 15, AHA-A, AHA-B and AHA-C

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 12	Observation Type	Confidence Level	Site 13	Observation Type	Confidence Type	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	AHA-A	Observation Type	Confidence Type	AHA-B	Observation Type	Confidence Type	AHA-C	Observation Type	Confidence Type
Amphibians	Common Eastern Froglet	*Crinia signifera*																								
Amphibians	Fletcher's Frog	*Lechriodus fletcheri*													X	OW										
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*				X	W		X	W		X	O		X	OW					X	O				
Amphibians	Green Tree Frog	*Litoria caerulea*				X	O								X	OW										
Amphibians	Broad-palmed Frog	*Litoria latopalmata*													X	OW										
Amphibians	Peron's Tree Frog	*Litoria peronii*													X	OW										
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*													X	O										
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*				X	O					X	O													
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*				X	O								X	O					X	O				
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**										**X**	**O**										
Reptiles	Leaden Delma	*Delma plebeia*																								
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*										X	O		X	O								X	O	
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*													X	O										
Reptiles	Robust Ctenotus	*Ctenotus robustus*				X	O								X	O										
Reptiles	Tree Skink	*Egernia striolata*				X	O					X	O													
Reptiles	Dark-flecked Garden Sunskink	*Lampropholis delicata*													X	O										
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*													X	O										
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*																								
Reptiles	Eastern Bearded Dragon	*Pogona barbata*				X	O																			
Reptiles	Lace Monitor	*Varanus varius*										X	Q													
Reptiles	Red-naped Snake	*Furina diadema*													X	O										
Reptiles	Spotted Black Snake	*Pseudechis guttatus*							X	Q																
Reptiles	Bandy-bandy	*Vermicella annulata*																			X	O				
Birds	Brown Quail	*Coturnix ypsilophora*																								
Birds	Australian Wood Duck	*Chenonetta jubata*				X	O					X	OW		X	OW										
Birds	Pacific Black Duck	*Anas superciliosa*													X	O										
Birds	Australasian Shoveler	*Anas rhynchotis*													X	O										
Birds	Grey Teal	*Anas gracilis*				X	O								X	O										
Birds	Hardhead Duck	*Aythya australis*																								
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*													X	O										
Birds	White-necked Heron	*Ardea pacifica*													X	O										
Birds	White-faced Heron	*Egretta novaehollandiae*													X	O										
Birds	Australasian Darter	*Anhinga novaehollandiae*													X	O										
Birds	Nankeen Kestrel	*Falco cenchroides*																			X	O				
Birds	Australian Hobby	*Falco longipennis*													X	O										
Birds	Brown Falcon	*Falco berigora*																								
Birds	**Black Falcon**	***Falco subniger***		**V**																						
Birds	Peregrine Falcon	*Falco peregrinus*													X	O										
Birds	Black-shouldered Kite	*Elanus axillaris*																								
Birds	Black Kite	*Milvus migrans*																								
Birds	Whistling Kite	*Haliastur sphenurus*													X	O										
Birds	**Spotted Harrier**	***Circus assimilis***		**V**																						
Birds	Brown Goshawk	*Accipiter fasciatus*							X	O					X	O										
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*													X	O										
Birds	Wedge-tailed Eagle	*Aquila audax*							X	O		X	O		X	O										
Birds	Painted Button-quail	*Philemon citreogularis*																								
Birds	Black-winged Stilt	*Himantopus himantopus*				X	W																			
Birds	Masked Lapwing	*Vanellus miles*							X	OW																

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 12	Observation Type	Confidence Level	Site 13	Observation Type	Confidence Type	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	AHA-A	Observation Type	Confidence Type	AHA-B	Observation Type	Confidence Type	AHA-C	Observation Type	Confidence Type
Birds	Common Bronzewing	*Phaps chalcoptera*				X	O		X	O		X	O													
Birds	Crested Pigeon	*Ocyphaps lophotes*													X	OW								X	O	
Birds	Galah	*Eolophus roseicapillus*				X	OW		X	OW		X	OW		X	OW					X	O		X	O	
Birds	Little Corella	*Cacatua sanguinea*							X	OW		X	OW		X	OW										
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*				X	OW		X	OW		X	OW		X	O										
Birds	Musk Lorikeet	*Glossopsitta concinna*				X	OW		X	OW		X	OW		X	W										
Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**		X	OW					X	OW													
Birds	Crimson Rosella	*Platycercus elegans*																								
Birds	Eastern Rosella	*Platycercus eximius*				X	O		X	O		X	O		X	OW								X	O	
Birds	Red-rumped Parrot	*Psephotus haematonotus*																			X	O				
Birds	Australian King-Parrot	*Alisterus scapularis*				X	OW					X	W		X	W										
Birds	Pallid Cuckoo	*Cacomantis pallidus*													X	OW										
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*																								
Birds	Eastern Koel	*Eudynamys orientalis*										X	W		X	W										
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*				X	OW								X	OW										
Birds	Eastern Barn Owl	*Tyto javanica*													X	W										
Birds	Southern Boobook	*Ninox novaeseelandiae*																								
Birds	Tawny Frogmouth	*Podargus strigoides*				X	O														X	OW				
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*				X	W		X	O					X	OW					X	OW				
Birds	Laughing Kookaburra	*Dacelo novaeguineae*				X	OW		X	O		X	O		X	OW										
Birds	Sacred Kingfisher	*Todiramphus sanctus*				X	OW					X	OW		X	OW										
Birds	White-throated Treecreeper	*Cormobates leucophaea*				X	OW		X	OW		X	OW		X	OW										
Birds	**Brown Treecreeper**	***Climacteris picumnus***		**V**					X	OW		X	OW													
Birds	Superb Fairy-wren	*Malurus cyaneus*				X	O		X	O														X	O	
Birds	Spotted Pardalote	*Pardalotus punctatus*				X	OW		X	OW		X	OW													
Birds	Striated Pardalote	*Pardalotus striatus*				X	OW		X	OW		X	OW		X	W										
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**		X	O		X	O		X	O													
Birds	Weebill	*Smicrornis brevirostris*				X	OW					X	OW													
Birds	Western Gerygone	*Gerygone fusca*										X	OW													
Birds	White-throated Gerygone	*Gerygone olivacea*				X	OW		X	OW																
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*				X	OW		X	OW		X	OW													
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*				X	OW		X	OW		X	W					X	O							
Birds	Yellow Thornbill	*Acanthiza nana*				X	OW																			
Birds	Striated Thornbill	*Acanthiza lineata*										X	OW													
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*				X	OW		X	OW		X	OW													
Birds	Fuscous Honeyeater	*Ptilotula fuscus*				X	OW		X	OW		X	OW													
Birds	White-plumed Honeyeater	*Ptilotula penicillatus*				X	OW		X	OW		X	OW													
Birds	Noisy Miner	*Manorina melanocephala*				X	OW		X	OW		X	OW		X	OW										
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*																								
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*				X	OW		X	OW		X	OW													
Birds	White-naped Honeyeater	*Melithreptus lunatus*				X	OW		X	OW		X	OW													
Birds	Little Friarbird	*Philemon citreogularis*										X	W													
Birds	Noisy Friarbird	*Philemon corniculatus*				X	OW		X	OW		X	OW		X	W										
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*										X	W													
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*										X	W											X	O	
Birds	Red Wattlebird	*Anthochaera carunculata*							X	OW		X	OW													
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*				X	OW		X	OW		X	OW													
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*										X	O													
Birds	Eastern Yellow Robin	*Eopsaltria australis*										X	W													
Birds	Jacky Winter	*Microeca fascinans*				X	O		X	O		X	O													

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 12	Observation Type	Confidence Level	Site 13	Observation Type	Confidence Type	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	AHA-A	Observation Type	Confidence Type	AHA-B	Observation Type	Confidence Type	AHA-C	Observation Type	Confidence Type
Birds	**Flame Robin**	***Petroica phoenicea***		**V**																						
Birds	**Scarlet Robin**	***Petroica boodang***		**V**					X	O		X	O													
Birds	Red-capped Robin	*Petroica goodenovii*																								
Birds	**Grey-crowned Babbler**	***Pomatostomus temporalis temporalis***		**V**																						
Birds	Golden Whistler	*Pachycephala pectoralis*				X	O		X	OW		X	O													
Birds	Rufous Whistler	*Pachycephala rufiventris*				X	OW		X	OW		X	OW													
Birds	Grey Fantail	*Rhipidura albiscapa*				X	OW		X	OW		X	OW													
Birds	Willie Wagtail	*Rhipidura leucophrys*				X	OW					X	OW		X	OW								X	O	
Birds	Magpie-lark	*Grallina cyanoleuca*													X	OW										
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M/MI**				**X**	**O**																
Birds	**Satin Flycatcher**	***Myiagra cyanoleuca***			**M**				X	O																
Birds	Grey Butcherbird	*Cracticus torquatus*				X	OW		X	OW		X	OW		X	W								X	O	
Birds	Pied Butcherbird	*Cracticus nigrogularis*				X	OW		X	OW		X	OW		X	W										
Birds	Australian Magpie	*Cracticus tibicen*				X	OW		X	OW		X	OW		X	W		X	O							
Birds	Pied Currawong	*Strepera graculina*				X	OW		X	OW		X	OW		X	OW										
Birds	White-browed Woodswallow	*Artamus superciliosus*				X	O																			
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**					X	O																
Birds	Cicadabird	*Coracina tenuirostris*																								
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				X	O		X	O		X	O		X	OW										
Birds	Ground Cuckoo-shrike	*Coracina maxima*																								
Birds	White-winged Triller	*Lalage sueurii*				X	OW					X	OW		X	OW										
Birds	Olive-backed Oriole	*Oriolus sagittatus*				X	OW		X	OW		X	OW		X	OW										
Birds	Little Raven	*Corvus mellori*																								
Birds	Australian Raven	*Corvus coronoides*				X	OW		X	OW		X	OW		X	OW										
Birds	White-winged Chough	*Corcorax melanorhamphos*				X	OW		X	OW					X	OW										
Birds	Common Starling	*Sturnus vulgaris*	X												X	O										
Birds	Common Myna	*Sturnus tristis*	X																							
Birds	Welcome Swallow	*Hirundo neoxena*										X	O													
Birds	Tree Martin	*Petrochelidon nigricans*										X	O													
Birds	Silvereye	*Zosterops lateralis*				X	O																			
Birds	Rufous Songlark	*Cincloramphus mathewsi*																								
Birds	Brown Songlark	*Cincloramphus cruralis*																								
Birds	Horsfield's Bushlark	*Mirafra javanica*																								
Birds	Mistletoebird	*Dicaeum hirundinaceum*				X	OW		X	OW		X	OW													
Birds	House Sparrow	*Passer domesticus*	X																							
Birds	Double-barred Finch	*Taeniopygia bichenovii*																								
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*				X	Q		X	Q		X	Q		X	P										
Mammals	Common Dunnart	*Sminthopsis murina*				X	Q					X	Q													
Mammals	Common Wombat	*Vombatus ursinus*				X	FB		X	Q					X	P								X	P	
Mammals	Sugar Glider	*Petaurus breviceps*													X	O										
Mammals	**Squirrel Glider**	***Petaurus norfolcensis***		**V**					**X**	**O**					**X**	**O**										
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*				X	O																			
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*				X	O		X	O		X	O		X	O					X	O				
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*				X	O		X	O		X	O		X	O										
Mammals	Eastern Wallaroo	*Macropus robustus*				X	O		X	O		X	O		X	O										
Mammals	Red-necked Wallaby	*Macropus rufogriseus*				X	O		X	O		X	O		X	O					X	O				
Mammals	Swamp Wallaby	*Wallabia bicolor*										X	O													
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**				X	OW		X	OW		X	OW										
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**																						
Mammals	**Eastern Coastal Free-tailed Bat**	***Mormopterus norfolkensis***		**V**																						

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	Site 12	Observation Type	Confidence Level	Site 13	Observation Type	Confidence Type	Site 14	Observation Type	Confidence Type	Site 15	Observation Type	Confidence Type	AHA-A	Observation Type	Confidence Type	AHA-B	Observation Type	Confidence Type	AHA-C	Observation Type	Confidence Type
Mammals	Little Mastiff-bat	*Mormopterus planiceps*													X	U	PR									
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*																								
Mammals	White-striped Freetail-bat	*Austronomus australis*										X	U	D	X	U	D				X	W				
Mammals	**Large Bent-winged Bat**	***Miniopterus orianae oceansis***		**V**		X	U	D							X	U	D									
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*													X	U	T									
Mammals	Gould's Long-eared Bat	*Nyctophilus gouldi*																								
Mammals	Long-eared Bat	*Nyctophilus sp.*				X	U	D							X	U	D									
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**																					
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*				X	U	D				X	U	D	X	U	D									
Mammals	Chocolate Wattled Bat	*Chalinolobus morio*				X	U	PR							X	U	D									
Mammals	**Eastern False Pipistrelle**	***Falsistrellus tasmaniensis***		**V**																						
Mammals	**Southern Myotis**	***Myotis macropus***		**V**											X	U	PO									
Mammals	**Greater Broad-nosed Bat**	***Scoteanax rueppellii***		**V**											X	U	PO									
Mammals	Inland Broad-nosed Bat	*Scotorepens balstoni*										X	U	PO	X	U	D									
Mammals	Little Broad-nosed Bat	*Scotorepens greyii*													X	T										
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*													X	U	PR									
Mammals	Southern Forest Bat	*Vespadelus regulus*													X	U	D									
Mammals	Little Forest Bat	*Vespadelus vulturnus*										X	U	PR	X	T										
Mammals	House Mouse	*Mus musculus*	X																		X	O		X	O	
Mammals	Black Rat	*Rattus rattus*	X																							
Mammals	Dog	*Canis lupus familiaris*	X																							
Mammals	Fox	*Vulpes vulpes*	X			X	O		X	Q					X	O										
Mammals	Cat	*Felis catus*	X						X	O		X	Q													
Mammals	Brown Hare	*Lepus capensis*	X												X	O										
Mammals	Rabbit	*Oryctolagus cuniculus*	X						X	Q					X	O					X	O				
Mammals	Pig	*Sus scrofa*	X						X	O																
Mammals	European Cattle	*Bos taurus*	X			X	Q		X	Q																
Mammals	Fallow Deer	*Dama dama*	X			X	O								X	O										

Sites AHA-E, AHA-F, AHA-K, AHA-L, AHA-M and Incidental

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	AHA-E	Observation Type	Confidence Type	AHA-F	Observation Type	Confidence Type	AHA-K	Observation Type	Confidence Type	AHA-L	Observation Type	Confidence Type	AHA-M	Observation Type	Confidence Type	Incidental	Observation Type
Amphibians	Common Eastern Froglet	*Crinia signifera*																				
Amphibians	Fletcher's Frog	*Lechriodus fletcheri*																				
Amphibians	Spotted Grass Frog	*Limnodynastes tasmaniensis*																			X	O
Amphibians	Green Tree Frog	*Litoria caerulea*																			X	O
Amphibians	Broad-palmed Frog	*Litoria latopalmata*																			X	OW
Amphibians	Peron's Tree Frog	*Litoria peronii*																			X	W
Reptiles	Eastern Snake-necked Turtle	*Chelodina longicollis*																				
Reptiles	Eastern Stone Gecko	*Diplodactylus vittatus*																				
Reptiles	Robust Velvet Gecko	*Nebulifera robusta*																			X	O
Reptiles	**Striped Legless Lizard**	***Delma impar***		**V**	**V**																**X**	**O**
Reptiles	Leaden Delma	*Delma plebeia*																			X	O
Reptiles	Two-clawed Worm-skink	*Anomalopus leuckartii*																			X	O
Reptiles	Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*																				
Reptiles	Robust Ctenotus	*Ctenotus robustus*																			X	O
Reptiles	Tree Skink	*Egernia striolata*				X	O														X	O
Reptiles	Dark-flecked Garden Sunskink	*Lampropholis delicata*																				
Reptiles	South-eastern Morethia Skink	*Morethia boulengeri*																			X	O
Reptiles	Eastern Blue-tongue	*Tiliqua scincoides*																X	O		X	O
Reptiles	Eastern Bearded Dragon	*Pogona barbata*																			X	O
Reptiles	Lace Monitor	*Varanus varius*																			X	O
Reptiles	Red-naped Snake	*Furina diadema*																				
Reptiles	Spotted Black Snake	*Pseudechis guttatus*																				
Reptiles	Bandy-bandy	*Vermicella annulata*																			X	O
Birds	Brown Quail	*Coturnix ypsilophora*																				
Birds	Australian Wood Duck	*Chenonetta jubata*							X	O												
Birds	Pacific Black Duck	*Anas superciliosa*																				
Birds	Australasian Shoveler	*Anas rhynchotis*																				
Birds	Grey Teal	*Anas gracilis*							X	O												
Birds	Hardhead Duck	*Aythya australis*																			X	O
Birds	Australasian Grebe	*Tachybaptus novaehollandiae*							X	O											X	O
Birds	White-necked Heron	*Ardea pacifica*																				
Birds	White-faced Heron	*Egretta novaehollandiae*																				
Birds	Australasian Darter	*Anhinga novaehollandiae*																				
Birds	Nankeen Kestrel	*Falco cenchroides*																				
Birds	Australian Hobby	*Falco longipennis*																				
Birds	Brown Falcon	*Falco berigora*																				
Birds	**Black Falcon**	***Falco subniger***		**V**																	**X**	
Birds	Peregrine Falcon	*Falco peregrinus*																				
Birds	Black-shouldered Kite	*Elanus axillaris*																				
Birds	Black Kite	*Milvus migrans*																			X	O
Birds	Whistling Kite	*Haliastur sphenurus*																			X	O
Birds	**Spotted Harrier**	***Circus assimilis***		**V**																		
Birds	Brown Goshawk	*Accipiter fasciatus*																				
Birds	Collared Sparrowhawk	*Accipiter cirrocephalus*																				
Birds	Wedge-tailed Eagle	*Aquila audax*																X	O			
Birds	Painted Button-quail	*Philemon citreogularis*																				
Birds	Black-winged Stilt	*Himantopus himantopus*																				
Birds	Masked Lapwing	*Vanellus miles*																				

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	AHA-E	Observation Type	Confidence Type	AHA-F	Observation Type	Confidence Type	AHA-K	Observation Type	Confidence Type	AHA-L	Observation Type	Confidence Type	AHA-M	Observation Type	Confidence Type	Incidental	Observation Type
Birds	Common Bronzewing	*Phaps chalcoptera*																				
Birds	Crested Pigeon	*Ocyphaps lophotes*																			X	O
Birds	Galah	*Eolophus roseicapillus*				X	O														X	O
Birds	Little Corella	*Cacatua sanguinea*																				
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*																				
Birds	Musk Lorikeet	*Glossopsitta concinna*																				
Birds	**Little Lorikeet**	***Glossopsitta pusilla***		**V**																		
Birds	Crimson Rosella	*Platycercus elegans*																			X	R
Birds	Eastern Rosella	*Platycercus eximius*				X	O														X	O
Birds	Red-rumped Parrot	*Psephotus haematonotus*																			X	O
Birds	Australian King-Parrot	*Alisterus scapularis*																			X	OW
Birds	Pallid Cuckoo	*Cacomantis pallidus*																				
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*																				
Birds	Eastern Koel	*Eudynamys orientalis*																				
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*																				
Birds	Eastern Barn Owl	*Tyto javanica*																				
Birds	Southern Boobook	*Ninox novaeseelandiae*																			X	W
Birds	Tawny Frogmouth	*Podargus strigoides*																				
Birds	Australian Owlet-nightjar	*Aegotheles cristatus*																			X	W
Birds	Laughing Kookaburra	*Dacelo novaeguineae*																				
Birds	Sacred Kingfisher	*Todiramphus sanctus*																				
Birds	White-throated Treecreeper	*Cormobates leucophaea*																				
Birds	**Brown Treecreeper**	***Climacteris picumnus***		**V**																		
Birds	Superb Fairy-wren	*Malurus cyaneus*							X	O		X	O									
Birds	Spotted Pardalote	*Pardalotus punctatus*																				
Birds	Striated Pardalote	*Pardalotus striatus*										X	O								X	O
Birds	**Speckled Warbler**	***Chthonicola sagittata***		**V**																		
Birds	Weebill	*Smicrornis brevirostris*																				
Birds	Western Gerygone	*Gerygone fusca*																				
Birds	White-throated Gerygone	*Gerygone olivacea*																				
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*																				
Birds	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*										X	O								X	O
Birds	Yellow Thornbill	*Acanthiza nana*																				
Birds	Striated Thornbill	*Acanthiza lineata*																				
Birds	Yellow-faced Honeyeater	*Caligavis chrysops*																				
Birds	Fuscous Honeyeater	*Ptilotula fuscus*																				
Birds	White-plumed Honeyeater	*Ptilotula penicillatus*																				
Birds	Noisy Miner	*Manorina melanocephala*				X	O											X	W			
Birds	Blue-faced Honeyeater	*Entomyzon cyanotis*																				
Birds	Brown-headed Honeyeater	*Melithreptus brevirostris*																				
Birds	White-naped Honeyeater	*Melithreptus lunatus*																				
Birds	Little Friarbird	*Philemon citreogularis*																				
Birds	Noisy Friarbird	*Philemon corniculatus*										X	O									
Birds	Striped Honeyeater	*Plectorhyncha lanceolata*																				
Birds	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*																				
Birds	Red Wattlebird	*Anthochaera carunculata*																				
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*																				
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*																				
Birds	Eastern Yellow Robin	*Eopsaltria australis*																				
Birds	Jacky Winter	*Microeca fascinans*																				

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	AHA-E	Observation Type	Confidence Type	AHA-F	Observation Type	Confidence Type	AHA-K	Observation Type	Confidence Type	AHA-L	Observation Type	Confidence Type	AHA-M	Observation Type	Confidence Type	Incidental	Observation Type
Birds	**Flame Robin**	***Petroica phoenicea***		**V**																		
Birds	**Scarlet Robin**	***Petroica boodang***		**V**																		
Birds	Red-capped Robin	*Petroica goodenovii*																				
Birds	**Grey-crowned Babbler**	***Pomatostomus temporalis temporalis***		**V**																	**X**	**O**
Birds	Golden Whistler	*Pachycephala pectoralis*																				
Birds	Rufous Whistler	*Pachycephala rufiventris*																				
Birds	Grey Fantail	*Rhipidura albiscapa*																				
Birds	Willie Wagtail	*Rhipidura leucophrys*																			X	O
Birds	Magpie-lark	*Grallina cyanoleuca*																				
Birds	**Leaden Flycatcher**	***Myiagra rubecula***			**M/MI**																	
Birds	**Satin Flycatcher**	***Myiagra cyanoleuca***			**M**																	
Birds	Grey Butcherbird	*Cracticus torquatus*																				
Birds	Pied Butcherbird	*Cracticus nigrogularis*													X	O		X	O			
Birds	Australian Magpie	*Cracticus tibicen*																X	O			
Birds	Pied Currawong	*Strepera graculina*																				
Birds	White-browed Woodswallow	*Artamus superciliosus*																				
Birds	**Dusky Woodswallow**	***Artamus cyanopterus***		**V**								**X**	**O**									
Birds	Cicadabird	*Coracina tenuirostris*																				
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*																				
Birds	Ground Cuckoo-shrike	*Coracina maxima*																				
Birds	White-winged Triller	*Lalage sueurii*				X	O															
Birds	Olive-backed Oriole	*Oriolus sagittatus*																				
Birds	Little Raven	*Corvus mellori*																				
Birds	Australian Raven	*Corvus coronoides*										X	W									
Birds	White-winged Chough	*Corcorax melanorhamphos*				X	O					X	O									
Birds	Common Starling	*Sturnus vulgaris*	X																			
Birds	Common Myna	*Sturnus tristis*	X																			
Birds	Welcome Swallow	*Hirundo neoxena*													X	O						
Birds	Tree Martin	*Petrochelidon nigricans*																				
Birds	Silvereye	*Zosterops lateralis*																				
Birds	Rufous Songlark	*Cincloramphus mathewsi*																			X	W
Birds	Brown Songlark	*Cincloramphus cruralis*																			X	O
Birds	Horsfield's Bushlark	*Mirafra javanica*																			X	O
Birds	Mistletoebird	*Dicaeum hirundinaceum*																				
Birds	House Sparrow	*Passer domesticus*	X																			
Birds	Double-barred Finch	*Taeniopygia bichenovii*										X	O									
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*																			X	O
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*																				
Mammals	Common Brushtail Possum	*Trichosurus vulpecula*																X	P		X	O
Mammals	Eastern Grey Kangaroo	*Macropus giganteus*										X	O		X	O		X	O			
Mammals	Eastern Wallaroo	*Macropus robustus*																				
Mammals	Red-necked Wallaby	*Macropus rufogriseus*																				
Mammals	Swamp Wallaby	*Wallabia bicolor*																				
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		**V**	**V**																	
Mammals	**Yellow-bellied Sheathtail-bat**	***Saccolaimus flaviventris***		**V**																		
Mammals	**Eastern Coastal Free-tailed Bat**	***Mormopterus norfolkensis***		**V**																		

Fauna Group	Common Name	*Scientific Name*	Introduced	NSW Status	Federal Status	AHA-E	Observation Type	Confidence Type	AHA-F	Observation Type	Confidence Type	AHA-K	Observation Type	Confidence Type	AHA-L	Observation Type	Confidence Type	AHA-M	Observation Type	Confidence Type	Incidental	Observation Type
Mammals	Little Mastiff-bat	*Mormopterus planiceps*																				
Mammals	Eastern Free-tailed Bat	*Mormopterus ridei*																				
Mammals	White-striped Freetail-bat	*Austronomus australis*																				
Mammals	**Large Bent-winged Bat**	***Miniopterus orianae oceansis***		**V**																		
Mammals	Lesser Long-eared Bat	*Nyctophilus geoffroyi*																				
Mammals	Gould's Long-eared Bat	*Nyctophilus gouldi*																				
Mammals	Long-eared Bat	*Nyctophilus sp.*																				
Mammals	**Large-eared Pied Bat**	***Chalinolobus dwyeri***		**V**	**V**																	
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*																				
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*																				
Mammals	Little Broad-nosed Bat	*Scotorepens greyii*																				
Mammals	Eastern Broad-nosed Bat	*Scotorepens orion*																				
Mammals	Southern Forest Bat	*Vespadelus regulus*																				
Mammals	Little Forest Bat	*Vespadelus vulturnus*																				
Mammals	House Mouse	*Mus musculus*	X																			
Mammals	Black Rat	*Rattus rattus*	X																			
Mammals	Dog	*Canis lupus familiaris*	X																			
Mammals	Fox	*Vulpes vulpes*	X																			
Mammals	Cat	*Felis catus*	X																			
Mammals	Brown Hare	*Lepus capensis*	X																			
Mammals	Rabbit	*Oryctolagus cuniculus*	X																			
Mammals	Pig	*Sus scrofa*	X												X	P					X	O
Mammals	European Cattle	*Bos taurus*	X																			
Mammals	Fallow Deer	*Dama dama*	X																			

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
P: scat
FB: burrow
R: road kill

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: 2

Site Description: Small patch of regrowth Ironbark and White Box with some older trees on exposed eroded western slope in remote part of study area.

Habitat Condition: Poor

Site Disturbance Level and Type: Moderate. Historic clearing, current grazing, sheet and gully erosion, fencing, tracks, weeds.

Connectivity: Poor. Isolated patch surrounded by cleared paddocks and sparse paddock trees.

Site Location: -32.227447, 150.795498

Patch Size: 14 ha

Topography, Slope and Aspect: Undulating hills. Moderate slope to west 5 to 10°.

Soil Type: Pale orange brown clay loam.

Canopy Height: 15 m



DBH Canopy Trees: 0.4 to 0.5 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 *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)

Site Number: 3

Site Description: Small hilltop with mostly young Ironbark regrowth with few shrubs and open understorey. Occasional older White Box and Slaty Gum specimens. Slopes to west and north with scattered trees and cleared open grassy sections. Thicker groundcovers due to lack of recent grazing. Older trees along drainage line at bottom of slope to west. Hill contains communication tower and ruins of old shed.

Habitat Condition: Poor



Site Disturbance Level and Type: High. Infrastructure, historic clearing and shed ruins, recent clearing for mine in western gully, current cattle grazing, weeds, drought, dams, gully erosion, old farm fencing, new mine fencing.

Connectivity: Poor connectivity to other vegetation.

Site Location: -32.240001, 150.835605

Patch Size: 20 ha

Topography, Slope and Aspect: Hilltop with gentle slopes on all sides and connected to ridgetop running to northwest. Slopes less than 5°.

Soil Type: Pale orange clay.

Canopy Height: 15 m

DBH Canopy Trees: 0.3 to 0.5 m

DBH Sub-canopy Trees: N/A

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - DNG (PCT 1605)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: 4

Site Description: Patches of relatively young Ironbark woodland regrowth with a few older White Box and Narrow-leaved Ironbark trees, open understorey with few shrubs and patchy groundcovers, interspersed with patches of cleared grassy section some with a heavy cover of weedy thistle.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Historic clearing, current cattle grazing, weeds, drought, dams, gully erosion and fencing. Few mature trees.

Connectivity: Poor to moderate connectivity to vegetation associated with Site 12 to the southwest and Site 15 to the southeast.

Site Location: -32.224701, 150.830543

Patch Size: 30 ha

Topography, Slope and Aspect: Gently undulating lower slopes and flatter areas along drainage lines. Slopes up to 5° and aspect north to northeast.

Soil Type: Pale orange-brown clay.

Canopy Height: 12-15 m

DBH Canopy Trees: 0.3 to 0.7 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: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - DNG (PCT 1605)
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter – DNG (PCT 1606)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: 7

Site Description: On western side of access road to old abandoned Broomfield homestead. Patches of young regrowth Ironbark with some scattered older specimens of White Box, Ironbark and Kurrajong interspersed with cleared grassy grazing areas. Generally open understorey but occasional Black Thorn with patchy groundcovers. Deeply eroded gullies.



Habitat Condition: Poor to Moderate. Some better condition patches of remnant trees, some with hollows.

Site Disturbance Level and Type: Moderate. Historic clearing, current grazing, access road, tracks, fencing, dams, weeds, erosion.

Connectivity: Moderate to good connectivity to extension of same vegetation patch into Site 8 to east but poor connectivity with vegetation outside this area.

Site Location: -32.250665, 150.795216

Patch Size: 31 ha but part of larger patch of vegetation associated with Site 8 (35 ha) so total patch size around 66 ha.

Topography, Slope and Aspect: Undulating low hills and slopes into eroded drainage lines. Slopes up to 5 to 10° but some flatter areas next to drainage lines. Aspects mostly west, south and north.

Soil Type: Very pale orange heavy clay stony soils with some small areas of exposed and imbedded rock on higher ground.

Canopy Height: 18 m

DBH Canopy Trees: 0.35 to 0.8 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: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Spotted Gum - Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter (PCT 1602)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter – DNG (PCT 1605)
- 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)

Site Number: 8

Site Description: On eastern side of access road to old abandoned Broomfield homestead. Patches of young regrowth Ironbark with some scattered older specimens of White Box, Ironbark and Kurrajong interspersed with cleared grassy grazing areas. Generally open understorey but occasional Black Thorn with patchy groundcovers. Deeply eroded gullies.

Habitat Condition: Poor to Moderate. Some better condition patches of remnant trees, some with hollows.

Site Disturbance Level and Type: Moderate. Historic clearing, current grazing, access road, tracks, fencing, dams, weeds, erosion.

Connectivity: Moderate to good connectivity to extension of same vegetation patch into Site 8 to east but poor connectivity with vegetation outside this area.

Site Location: -32.248537, 150.799221

Patch Size: 35 ha but part of larger patch of vegetation associated with Site 7 (31 ha) so total patch size around 66 ha.

Topography, Slope and Aspect: Undulating low hills and slopes into eroded drainage lines. Slopes up to 5 to 10° but some flatter areas next to drainage lines. Aspects mostly west, south and north.

Soil Type: Very pale orange heavy clay stony soils with some small areas of exposed and imbedded rock on higher ground.

Canopy Height: 18 m



DBH Canopy Trees: 0.35 to 0.8 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: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter (PCT 1602)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter – DNG (PCT 1605)
- 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)

Site Number: 10

Site Description: Plantation eucalypts on a gentle slope near corner of Castlerock and Kayuga Roads.

Habitat Condition: Poor



Site Disturbance Level and Type: High. Historic clearing, dam, driveway, house, road, young planted eucalypts, no hollows, sparse shrubs.

Connectivity: Moderate as extends to patch regrowth to west of site (off study area) but poor connectivity to any other vegetation.

Site Location: -32.223597, 150.864823

Patch Size: 31 ha (including extension into plantation and regrowth vegetation west of site)

Topography, Slope and Aspect: Gentle slope 5° northeast.

Soil Type: Brown sandy clay loam.

Canopy Height: 8-10 m

DBH Canopy Trees: 0.1 to 0.2 m

DBH Sub-canopy Trees: N/A

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Plantation (PCT 1605)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: 11

Site Description: Long north-south ridge with track out to old Mount Pleasant trig station. Mix of woodland on ridgetop and upper slopes and grassy paddocks on bottom slopes. Few shrubs, moderate groundcover and lots of old hollow-bearing trees.



Habitat Condition: Moderate on ridge and upper slopes. Poorer on lower slopes.

Site Disturbance Level and Type: Moderate. Current grazing, weeds, historic clearing, track, fencing, dams.

Connectivity: Good connectivity to vegetation associated with Site 14 to south.

Site Location: -32.216028, 150.815734

Patch Size: 35 ha

Topography, Slope and Aspect: Ridgetop and 10° slopes to east and southeast.

Soil Type: Chocolate to pale orange loamy clay.

Canopy Height: 20 to 25 m

DBH Canopy Trees: 0.7 to 0.9 m

DBH Sub-canopy Trees: 0.12 to 0.2 m

Tree Hollow Density: High

Fallen Log Density: Moderate

Standing Dead Tree Density: Moderate

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG (PCT 483)

Site Number: 12

Site Description: A cleared ridgetop sloping to the northeast into patches of woodland with some scattered older trees.



Habitat Condition: Poor on cleared ridgetop with grazing pressure and weeds. Better habitat conditions downslope.

Site Disturbance Level and Type: Moderate. Current grazing, weeds, historic clearing, track, fencing, dams.

Connectivity: Low to moderate connectivity to vegetation associated with Site 13 to south and Site 4 to northeast.

Site Location: -32.229927, 150.822853

Patch Size: 40 ha

Topography, Slope and Aspect: Ridgetop, upper, mid and lower slopes – 15° slopes to northeast.

Soil Type: Pale orange-brown clay with patches of lightly imbedded small sandstone rock.

Canopy Height: 15-18 m

DBH Canopy Trees: 0.4 to 1.0 m

DBH Sub-canopy Trees: 0.07 to 0.1 m

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report* (Hunter Eco, 2020) for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG (PCT 483)

Site Number: 13

Site Description: A cleared ridgetop sloping to the southwest into patches of woodland with some scattered older trees.



Habitat Condition: Poor on cleared ridgetop with grazing pressure and weeds. Better habitat conditions downslope.

Site Disturbance Level and Type: Moderate. Current grazing, weeds, historic clearing, track, fencing, dams.

Connectivity: Low to moderate connectivity to vegetation associated with Site 12 to northeast, Site 14 to northwest and Site 3 to southeast.

Site Location: -32.232584, 150.821625

Patch Size: 50 ha

Topography, Slope and Aspect: Ridgetop, upper, mid and lower slopes. Moderate up to 15° slopes to southwest. Some steeper gullies.

Soil Type: Pale orange-brown clay with patches of lightly imbedded small sandstone rock.

Canopy Height: 15-25 m

DBH Canopy Trees: 0.7 to 1.1 m

DBH Sub-canopy Trees: 0.08 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 *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG (PCT 483)

Site Number: 14

Site Description: Long north-south ridge with track out to old Mount Pleasant trig station. Mix of woodland on ridgetop and upper slopes and grassy paddocks on bottom slopes. Few shrubs, moderate groundcover and lots of old hollow-bearing trees.



Habitat Condition: Moderate on ridge and upper slopes. Poorer on lower slopes.

Site Disturbance Level and Type: Moderate. Current grazing, weeds, historic clearing, track, fencing, cattleyards, old caravan, dams.

Connectivity: Good connectivity to vegetation associated with Site 11 to north.

Site Location: -32.220440, 150.814480

Patch Size: 70 ha

Topography, Slope and Aspect: Ridgetop and 10° slopes to east and southeast.

Soil Type: Chocolate to pale orange loamy clay.

Canopy Height: 20 to 25 m

DBH Canopy Trees: 0.7 to 0.9 m

DBH Sub-canopy Trees: 0.12 to 0.2 m

Tree Hollow Density: High

Fallen Log Density: Moderate

Standing Dead Tree Density: Moderate

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG (PCT 483)

Site Number: 15

Site Description: Gentle slopes to west of old farm track which leads through old cattleyards to one of the few dams in the study area still holding water in the drought. Part of larger patch of remnant and regrowth vegetation with stands of older trees including White Box, Spotted Gum and Narrow-leaved Ironbark. Open grassy understorey with few shrubs with patchy but diverse groundcovers.

Habitat Condition: Moderate to good



Site Disturbance Level and Type: Moderate. Current grazing, historic clearing, track, cattleyards, dams, old farm fencing, new mine fencing, deep gully erosion.

Connectivity: Good connectivity to extended vegetation off the study area to northeast.

Site Location: -32.233422, 150.838915

Patch Size: 33 ha (but part of much larger patch to northeast with additional area of approximately 75 ha)

Topography, Slope and Aspect: Gentle slopes to deeply eroded drainage line gully. 4° slopes with south aspect.

Soil Type: Light brown to orange sandy clay loam.

Canopy Height: 20 to 25 m

DBH Canopy Trees: 0.4 to 0.6 m

DBH Sub-canopy Trees: 0.2 to 0.4 m

Tree Hollow Density: Moderate

Fallen Log Density: Moderate

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG (PCT 483)
- Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter (PCT 1602)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter – DNG (PCT 1605)

Site Number: A

Site Description: Grazed paddock off Dorset Road with scattered remnant and regrowth trees along drainage line including Forest Red Gum, Yellow Box and the exotic Peppercorn Tree (*Schinus molle*).

Habitat Condition: Poor

Site Disturbance Level and Type: High. Current grazing, historic clearing, road, fencing, weeds, eroded gully.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.207016, 150.852865

Patch Size: 1 ha

Topography, Slope and Aspect: Gentle 2 to 5° slope to north to drainage line

Soil Type: Pale orange clay.

Canopy Height: 15 m



DBH Canopy Trees: 1 m

DBH Sub-canopy Trees: 0.1 to 0.2 m

Tree Hollow Density: Low

Fallen Log Density: Low to moderate

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter – DNG (PCT 1605)
- Plantation (PCT 1605)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: B

Site Description: Disturbed drainage line off Dorset Road. Mostly grassy paddock with scattered exotic Peppercorn tree, Ironbark and Rough-barked Apple (*Angophora floribunda*).

Habitat Condition: Poor

Site Disturbance Level and Type: High. Current grazing, historic clearing, fencing, weeds, road.

Connectivity: Poor. Mostly cleared but a few scattered paddock trees along drainage line.

Site Location: -32.207260, 150.849001

Patch Size: 0.5 ha

Topography, Slope and Aspect: Drainage line draining north on gentle slope of 1°.

Soil Type: Brown loamy clay possibly alluvial.

Canopy Height: 20 m



DBH Canopy Trees: 0.7 to 1.2 m

DBH Sub-canopy Trees: 0.2 to 0.5 m

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- 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: C

Site Description: Next to 'Athlone' homestead and sheds off Belgrave access road. Small degraded patch of Ironbark regrowth with a few remnant older Yellow Box and Ironbark then extends into scattered paddock trees amongst cleared grassy paddocks.

Habitat Condition: Poor

Site Disturbance Level and Type: Moderate to high. Current grazing, historic clearing, tracks, dams, fencing, abandoned farm house and sheds.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.211765, 150.831669

Patch Size: 3 ha

Topography, Slope and Aspect: Gentle 2° slope to northeast.

Soil Type: Pale orange clay loam.

Canopy Height: 15 m



DBH Canopy Trees: 0.7 to 1 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 *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)

Site Number: D

Site Description: Next to 'Athlone' homestead and sheds off Belgrave access road. Small degraded patch of Ironbark regrowth on deeply eroded drainage line with a few remnant older Yellow Box, Ironbark and Rough-barked Apple. Then extends into scattered paddock trees amongst cleared grassy paddocks.

Habitat Condition: Poor

Site Disturbance Level and Type: High. Farming, current grazing, historic clearing, tracks, dams, fencing, weeds, gully erosion, abandoned farm house and sheds.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.212890, 150.833589

Patch Size: 1.5 ha

Topography, Slope and Aspect: Drainage line flowing northeast within a gentle 2° slope to northeast.

Soil Type: Grey to pale orange sandy clay loam.

Canopy Height: 15 m



DBH Canopy Trees: 0.8 to 1 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 *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley (PCT 618)
- White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley – DNG (PCT 618)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)

Site Number: E

Site Description: On Belgrave access track. Paddocks with some scattered and patches of remnant and regrowth White Box. Open grassy understorey.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Farming, current grazing, historic clearing, track, dams, fencing, cattleyard.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.206354, 150.826972

Patch Size: 2.5 ha

Topography, Slope and Aspect: Gentle to moderate slopes 3 to 10° to south.

Soil Type: Brown to pale orange sandy clay.

Canopy Height: 15 m

DBH Canopy Trees: 0.6 to 0.8 m

DBH Sub-canopy Trees: 0.15 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 *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: F

Site Description: Next to 'Belgrave' homestead off Belgrave access road. Old abandoned homestead in paddock with exotic garden plants like Peppercorn Tree, *Bougainvillea sp.* and Oleander (*Nerium oleander*).

Habitat Condition: Poor

Site Disturbance Level and Type: High. Farming, current grazing, historic clearing, tracks, dams, fencing, weeds/old garden plants, abandoned farm house.

Connectivity: Poor. Mostly scattered old garden plants and trees extending in scattered paddock trees.

Site Location: -32.206387, 150.821519

Patch Size: N/A

Topography, Slope and Aspect: 5° slope to southeast in gently undulating country.

Soil Type: Brown clay.



Canopy Height: 5 m

DBH Canopy Trees: 0.3 to 0.5 m

DBH Sub-canopy Trees: N/A

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: G

Site Description: Paddock with scattered trees off Castlerock Road at the top of the hill opposite the gate and track out to the Mount Pleasant Trig. Some small patches of remnant and regrowth Spotted Gum and White Box. Probably still on the old Belgrave property.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Farming, current grazing, historic clearing, tracks, dams, fencing.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.209912, 150.814818

Patch Size: N/A

Topography, Slope and Aspect: Upper slope. Moderate slopes 6° to northwest.

Soil Type: Pale brown clay loam.

Canopy Height: 12-20 m

DBH Canopy Trees: 0.5 to 0.8 m

DBH Sub-canopy Trees: none

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: H

Site Description: Paddock with patch of remnant and regrowth trees on edge of Castlerock Road at the top of the hill opposite the gate and track out to the Mount Pleasant Trig. Probably still on the old Belgrave property. Closer to the edge of Castlerock Road than Site G.



Habitat Condition: Moderate

Site Disturbance Level and Type: Moderate. Farming, current grazing, historic clearing, erosion, cattleyards, fencing.

Connectivity: Poor. Mostly scattered paddock trees.

Site Location: -32.210617, 150.812282

Patch Size: 2.3 ha

Topography, Slope and Aspect: Upper slope. Moderate slopes 8° to north.

Soil Type: Pale orange clay.

Canopy Height: 15-20 m

DBH Canopy Trees: 0.4 to 0.5 m

DBH Sub-canopy Trees: N/A

Tree Hollow Density: Moderate

Fallen Log Density: Moderate

Standing Dead Tree Density: Moderate

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)

Site Number: I

Site Description: Patch of regrowth and remnant White Box amongst grassy paddocks with open understorey and patchy groundcovers.



Habitat Condition: Moderate

Site Disturbance Level and Type: High. Farming, current grazing, historic clearing, erosion, weeds, exposed soil.

Connectivity: Moderate. Eastern edge of larger patch of vegetation associated with Sites 11 and 14 on ridgetop above.

Site Location: -32.221522, 150.822805

Patch Size: 4 ha but part of a much larger remnant (>100 ha) located upslope on higher ridge of Sites 11 and 14.

Topography, Slope and Aspect: Broad low ridge sloping 3 to 4° to north.

Soil Type: Pale orange brown clay.

Canopy Height: 15-20 m

DBH Canopy Trees: 0.7 to 0.8 m

DBH Sub-canopy Trees: 0.05 to 0.2 m

Tree Hollow Density: Moderate

Fallen Log Density: Moderate

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: J

Site Description: Patch of regrowth and a few old remnant White Box with open understorey and patchy groundcovers.



Habitat Condition: Moderate

Site Disturbance Level and Type: Moderate to high. Sheet erosion, weeds, current grazing, historic clearing, fencing.

Connectivity: Moderate. Patch connections to vegetation associated with Sites 13 and 14.

Site Location: -32.228982, 150.810174

Patch Size: 18 ha

Topography, Slope and Aspect: Midslope with moderate 8° slope to south.

Soil Type: Pale orange clay.

Canopy Height: 12-15 m

DBH Canopy Trees: 0.4 to 0.7 m

DBH Sub-canopy Trees: 0.1 to 0.2 m

Tree Hollow Density: Moderate

Fallen Log Density: Moderate

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley (PCT 483)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Site Number: K

Site Description: Small patch of remnant and regrowth woodland of Ironbark and Forest Red Gum between mine entrance infrastructure, carpark and Wybong Road. Open understorey and patchy groundcovers. Few older trees.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Historic clearing, house, fencing, mining infrastructure, road.

Connectivity: Poor

Site Location: -32.253326, 150.803612

Patch Size: 4 ha

Topography, Slope and Aspect: Midslope with moderate 5 to° slope to south.

Soil Type: Pale orange clay.

Canopy Height: 15 m

DBH Canopy Trees: 0.2 to 0.6 m

DBH Sub-canopy Trees: 0.1 to 0.15 m

Tree Hollow Density: Low

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)

Site Number: L

Site Description: Degraded old paddock area above new mine infrastructure area near CHPP with a few scattered older trees in eroded gully and patches of regrowth ironbark. Open understorey, patchy groundcovers and open grassy areas.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Historic clearing and grazing, recent mine infrastructure clearing, access tracks, weeds, eroded gully, dam.

Connectivity: Poor

Site Location: -32.247958, 150.817837

Patch Size: 4 ha

Topography, Slope and Aspect: Gentle to moderate undulating midslopes. 6° slope to southwest.

Soil Type: Pale orange sandy clay loam.

Canopy Height: 15 to 25 m

DBH Canopy Trees: 0.5 to 0.8 m

DBH Sub-canopy Trees: 0.1 to 0.15 m

Tree Hollow Density: Moderate

Fallen Log Density: Low

Standing Dead Tree Density: Low

Mistletoe Density: Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - DNG (PCT 1605)

Site Number: M

Site Description: Degraded area of scattered old ironbarks with some young regrowth next to new mine dam. Open understorey with patchy weedy groundcovers.



Habitat Condition: Poor

Site Disturbance Level and Type: High. Historic clearing and grazing, recent mine infrastructure clearing, access tracks, weeds.

Connectivity: Poor

Site Location: -32.248171, 150.833936

Patch Size: 7 ha

Topography, Slope and Aspect: Gentle to moderate undulating midslopes. 5° slope to west.

Soil Type: Pale orange clay loam.

Canopy Height: 20 m

DBH Canopy Trees: 0.8 m **DBH Sub-canopy Trees:** 0.1 to 0.7 m

Tree Hollow Density: Low **Fallen Log Density:** Moderate

Standing Dead Tree Density: Low **Mistletoe Density:** Low

Dominant Canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant canopy species present.

Dominant Sub-canopy Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant sub-canopy species present.

Dominant Shrub Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant shrub species present.

Dominant Ground Cover Species: Refer to the *Mount Pleasant Optimisation Project Baseline Flora Report (Hunter Eco, 2020)* for details on the dominant ground cover species present.

Vegetation Community (Hunter Eco, 2020):

- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)
- Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - DNG (PCT 1605)
- Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley – DNG (PCT 483)

Appendix C BioNet Threatened Biodiversity Data Collection Species PCT Associations Sydney Basin – Hunter IBRA Subregion

Table C-1
***BioNet Threatened Biodiversity Data Collection* Species PCT Associations Sydney Basin – Hunter IBRA Sub-region**

Scientific Name	Common Name	PCT (DPIE, 2020b)	Notes
Litoria aurea	Green and Golden Bell Frog	1602, 1606, 1691	Not detected. No potential habitat present.
Litoria brevipalmata	Green-thighed Frog	1602	Not detected. No potential habitat present.
Aprasia parapulchella	Pink-tailed Legless Lizard	483, 618, 1602, 1605, 1606, 1655, 1691	Species not detected but some areas of potential habitat (lightly imbedded rock areas) are present. These PCTs are considered appropriate potential habitat where they intersect with lightly imbedded rock areas.
Delma impar	Striped Legless Lizard	483, 618, 1602, 1605, 1606, 1655, 1691	Species detected just outside study area in PCT 483. These PCTs are considered appropriate potential habitat.
Hoplocephalus bitorquatus	Pale-headed Snake	1605, 1606, 1655, 1691	Not detected but some potential habitat (hollow-bearing trees) along riparian areas present. Cryptic species. These PCTs are considered appropriate potential habitat.
Falco subniger	Black Falcon	None	Previously recorded. Species observed during current surveys in PCT 1606 just outside study area
Lophoictinia isura	Square-tailed Kite	618, 1602, 1605, 1606, 1655, 1691	No foraging detected. No breeding detected. These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Haliaeetus leucogaster	White-bellied Sea-Eagle	1602, 1605, 1691	No foraging detected. No breeding detected. These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Circus assimilis	Spotted Harrier	None	Recorded in PCT 483. PCT 483 is considered potential habitat.
Hieraaetus morphnoides	Little Eagle	1605, 1606, 1655, 1691	No foraging detected. No breeding detected These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Burhinus grallarius	Bush Stone-curlew	1605, 1606, 1655, 1691	Species not detected despite numerous surveys going back to 1997.
Calyptorhynchus lathami	Glossy Black-Cockatoo	1605, 1606, 1655, 1691	No foraging detected. No breeding detected. Less than optimal foraging habitat present due to few Casuarina/Allocasuarina. These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Callocephalon fimbriatum	Gang-gang Cockatoo	1605, 1606, 1655, 1691	No foraging detected. No breeding detected. These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Glossopsitta pusilla	Little Lorikeet	483, 618, 1602, 1605, 1606, 1655, 1691	Recorded in PCT 483. These PCTs are considered appropriate.
Neophema pulchella	Turquoise Parrot	483, 618, 1602, 1605, 1606, 1655, 1691	These PCTs are considered appropriate.
Lathamus discolor	Swift Parrot	1605, 1606, 1655, 1691	These PCTs are considered appropriate potential foraging habitat. No important habitat (as defined by DPIE) is present.
Tyto novaehollandiae	Masked Owl	1605, 1606, 1655, 1691	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Ninox strenua	Powerful Owl	1605, 1606, 1655, 1691	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.
Ninox connivens	Barking Owl	483, 618, 1602, 1605, 1606, 1655, 1691	These PCTs are considered appropriate potential foraging habitat. No breeding habitat is present.

Scientific Name	Common Name	PCT (DPIE, 2020b)	Notes
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	1602, 1605, 1606, 1655, 1691	Detected. PCT 483 is also considered potential habitat.
Chthonicola sagittata	Speckled Warbler	1602, 1605, 1606, 1655, 1691	Detected. PCT 483 is also considered potential habitat.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	1605, 1606, 1655, 1691	Previously recorded. These PCTs are considered appropriate.
Anthochaera phrygia	Regent Honeyeater	483, 618, 1602, 1605, 1606, 1655, 1691	These PCTs are considered appropriate potential foraging habitat. No important habitat (as defined by DPIE) is present.
Grantiella picta	Painted Honeyeater	483, 618, 1605, 1606, 1655, 1691	Not recorded. These PCTs are considered appropriate.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	1602, 1605, 1606, 1655, 1691	Not recorded. These PCTs are considered appropriate.
Petroica phoenicea	Flame Robin	1602, 1605, 1606, 1655, 1691	Detected. PCT 483 is also considered potential habitat.
Petroica boodang	Scarlet Robin	1602, 1605, 1606, 1655, 1691	Detected. PCT 483 is also considered potential habitat.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	1605, 1606, 1655, 1691	Detected during current and previous surveys. PCT 483 and PCT 1602 are also considered potential habitat.
Daphoenositta chrysoptera	Varied Sittella	1602, 1605, 1606, 1655, 1691	Previously recorded. These PCTs are considered appropriate.
Artamus cyanopterus cyanopterus	Dusky Woodswallow	None	Detected during current and previous surveys. PCT 483 and PCT 1605 are considered potential habitat.
Stagonopleura guttata	Diamond Firetail	1606, 1655	Previously recorded. PCT 483 and PCT 483 DNG are also considered potential habitat.
Dasyurus maculatus	Spotted-tailed Quoll	1602, 1605, 1606, 1655, 1691	These PCTs are considered appropriate (in woodland and DNG form).
Phascogale tapoatafa	Brush-tailed Phascogale	1605, 1606, 1691	Not detected during current or previous surveys. These PCTs are considered appropriate.
Planigale maculata	Common Planigale	1605, 1606, 1655, 1691	Not detected during current or previous surveys. Cryptic species. These PCTs are considered appropriate.
Phascolarctos cinereus	Koala	1606, 1655	Not detected during current or previous surveys. Woodland forms of PCTs 483, 618, 1691, 1602, 1605 and 1606 are considered appropriate.
Cercartetus nanus	Eastern Pygmy-possum	1605, 1606, 1655, 1691	Not detected during current or previous surveys. This species is considered unlikely to use habitat in the study area. Species not present.
Petaurus australis	Yellow-bellied Glider	1606	Not detected during current or previous surveys. This species is considered unlikely to use habitat in the study area. Species not present.
Petaurus norfolcensis	Squirrel Glider	1606, 1655	Detected during current and previous surveys. PCT 483, PCT 1602 and PCT 1605 are also considered potential habitat.
Petrogale penicillata	Brush-tailed Rock-wallaby	1605, 1655, 1691	Not detected during current or previous surveys. Suitable habitat not present. This species is considered unlikely to use habitat in the study area. Species not present.
Pteropus poliocephalus	Grey-headed Flying-fox	1605, 1606, 1655, 1691	Recorded as foraging habitat only during current and previous surveys. PCT 483 is also considered potential foraging habitat.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1605, 1606, 1655, 1691	Detected during current and previous surveys. PCT 483 is also considered potential habitat.
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	1605, 1691	Previously recorded. These PCTs are considered appropriate.
Miniopterus australis	Little Bent-winged Bat	None	Not recorded. No relevant PCTs for this species have been mapped in the study area.
Miniopterus orianae oceanensis	Large Bent-winged Bat	1605, 1606, 1655, 1691	Detected during current and previous surveys. PCT 483, PCT 483 DNG and PCT 1602 are also considered potential habitat.
Nyctophilus corbeni	Corben's Long-eared Bat	1606, 1655	Not recorded. These PCTs are considered appropriate.
Chalinolobus dwyeri	Large-eared Pied Bat	1605, 1606, 1655, 1691	Breeding habitat not present. Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018).

Scientific Name	Common Name	PCT (DPIE, 2020b)	Notes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	1605, 1606, 1655, 1691	Previously recorded. PCT 483 is also considered potential habitat.
Myotis macropus	Southern Myotis	1605, 1691	Previously recorded. Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method* (OEH, 2018). PCT 483 is also considered potential habitat.
Scoteanax rueppellii	Greater Broad-nosed Bat	1605, 1606, 1655, 1691	Previously recorded. PCT 483 is also considered potential habitat.
Vespadelus troughtoni	Eastern Cave Bat	1606, 1655	Previously recorded. PCT 483 is also considered potential foraging habitat. Breeding habitat not present. Adopted for use of the *'Species Credit' Threatened Bats and their Habitats: NSW Survey Guide for the Biodiversity Assessment Method'* (OEH, 2018).

ATTACHMENT C
VEGETATION INTEGRITY DATA

Table C1
Vegetation Integrity Score Detail – Development Footprints

Development Footprint	Veg Zone	PCT	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT Condition Class	Percent Cleared (DPIE 2020d)	Sensitivity to Gain*	Patch Size	Composition Condition Score*	Structure Condition Score*	Function Condition Score*	Vegetation Integrity Score*
General Extension Areas (Development Footprint 1)	1	483	Grey Box x White Box Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	67.3	78.3	5.7	31.1
	1a	483	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	84.8	80.1	12.6	44
	2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	79.7	82.3	22.6	53
	2a	483 SG	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	79.5	92.3	27.5	58.7
	3	618	Forest Red Gum Grassy Open Forest[2,4]	Woodland	73 (+/- 50)	High	>100	77	49.6	58.1	60.5
	4	1691	Narrow-leaved Ironbark – Grey Box Grassy Woodland[1,3]	Woodland	77 (+/- 70)	High	>100	83.6	36.5	46.2	52.1
	4a	1691	Derived Native Grassland	DNG	77 (+/- 70)	High	>100	80.5	49.6	23.4	45.4
	5	1602	Spotted Gum – Narrow-leaved Ironbark Woodland[3]	Woodland	54	High	>100	82	17.2	45	39.9
	6	1605	Narrow-leaved Ironbark Shrubby Forest[3]	Woodland	32	High	>100	63.8	36.1	21.5	36.7
	6a	1605	Derived Native Grassland	DNG	32	High	>100	57.7	20.2	0.1	4.7
	6b	1605	Narrow-leaved Ironbark Shrubby Forest	Plantation	32	High	>100	72.9	42.9	43.8	51.5
	7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	Woodland	29	High	>100	63.1	50	41	50.6
	7a	1606	Derived Native Grassland[2,4]	DNG	29	High	>100	54	47.9	10.1	29.7
	8a	1655	Derived Native Grassland	DNG	36	High	>100	46.8	18.8	0	2.2
	1	483	Grey Box x White Box Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	88.2	83.5	39.9	66.5
	1a	483	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	32.9	57.5	0.2	6.7
	2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	71.7	77.7	30.1	55.2

Development Footprint	Veg Zone	PCT	Vegetation Community (Hunter Eco 2020) (Attachment A)	PCT Condition Class	Percent Cleared (DPIE 2020d)	Sensitivity to Gain*	Patch Size	Composition Condition Score*	Structure Condition Score*	Function Condition Score*	Vegetation Integrity Score*
Northern Link Road Option 1 (Development Footprint 2)	2a	483 SG	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	68.7	57.8	0.9	15.2
	3	618	Forest Red Gum Grassy Open Forest[2,4]	Woodland	73 (+/- 50)	High	>100	71.1	71.5	78.8	73.7
	6a	1605	Derived Native Grassland	DNG	32	High	>100	57.7	20.2	0.1	4.7
	6b	1605	Narrow-leaved Ironbark Shrubby Forest	Plantation	32	High	>100	54.9	26.3	21	31.2
	7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	Woodland	29	High	>100	63.1	50	41	50.6
	7a	1606	Derived Native Grassland[2,4]	DNG	29	High	>100	54	47.9	10.1	29.7
Northern Link Road Option 2 (Development Footprint 3)	1	483	Grey Box x White Box Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	71.4	74	42.2	60.6
	1a	483	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	32.9	57.5	0.2	6.7
	2	483 SG	Grey Box x White Box – Spotted Gum Grassy Woodland[2,4]	Woodland	90 (+/- 50)	High	>100	73.3	60.9	11.8	37.5
	2a	483 SG	Derived Native Grassland[2,4]	DNG	90 (+/- 50)	High	>100	68.7	57.8	0.9	15.2
	3	618	Forest Red Gum Grassy Open Forest[2,4]	Woodland	73 (+/- 50)	High	>100	71.1	71.5	78.8	73.7
	6a	1605	Derived Native Grassland	DNG	32	High	>100	57.7	20.2	0.1	4.7
	6b	1605	Narrow-leaved Ironbark Shrubby Forest	Plantation	32	High	>100	54.9	26.3	21	31.2
	7	1606	White Box – Narrow-leaved Ironbark – Blakely's Red Gum[2,4]	Woodland	29	High	>100	63.1	50	41	50.6
	7a	1606	Derived Native Grassland[2,4]	DNG	29	High	>100	54	47.9	10.1	29.7

1 *Central Hunter Grey Box – Ironbark Woodland EEC listed under the BC Act.*

2 *Box-Gum Woodland CEEC listed under the BC Act.*

3 *Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act.*

4 *Box-Gum Woodland CEEC listed under the EPBC Act.*

* BAM Calculator.

Table C2
Vegetation Integrity (Site Condition) Data

Number	Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	compTree	compShrub	compGrass	compForb	compFern	compOther	strucTree	strucShrub	strucGrass	strucForb	strucFern	strucOther	funLargeTrees	funHollowTrees	funLitterCover	funLenFallenLogs	funTreeStem5to10	funTreeStem10to20	funTreeStem20to30	funTreeStem30to50	funTreeStem50to80	funTreeRegen	funHighThreatExotic
1	200323P1	618	7.3	101	DNG	56	296160	6434306	72	0	0	19	7	1	2	0	0	180.6	0.7	0.1	0.2	0	0	8	0	0	0	0	0	0	0	0.4
2	200323P2	618	3	101	Woodland	56	296026	6434212	356	2	1	6	12	0	2	40	1	11.4	1.2	0	0.2	4	2	64	28	0	0	0	0	1	1	66.4
3	200323P3	483	671.3	101	DNG	56	296192	6433997	88	0	1	17	13	1	3	0	0.1	136.5	2.2	0.1	0.3	0	0	12	0	0	0	0	0	0	0	0.1
4	200323P4	483	671.3	101	DNG	56	296411	6433760	210	0	2	13	14	0	3	0	0.2	105.4	1.4	0	1.2	0	0	6	0	0	0	0	0	0	0	0.3
5	200324P1	1606	12.8	101	DNG	56	296125	6433212	42	0	0	19	17	1	3	0	0	128.7	1.7	0.1	0.3	0	0	5	0	0	0	0	0	0	0	2.4
6	200324P2	1605	110.9	101	Woodland	56	296085	6433278	20	2	2	17	15	0	3	30.1	2	17.2	1.5	0	0.3	1	0	52	6	1	1	1	0	0	1	0.3
7	200324P3	483	142.5	101	Woodland	56	295834	6433169	206	1	1	17	11	1	3	15	0.1	53.2	1.1	0.1	0.3	0	0	21	14	1	1	1	0	0	1	0.2
8	200324P4	1605	241.3	101	DNG	56	295598	6433579	320	0	1	16	9	1	0	0	0.1	109.7	0.9	0.1	0	0	0	5	0	0	0	0	0	0	0	0.4
9	200324P5	618	7.3	101	DNG	56	295577	6433744	230	1	0	12	15	1	2	3	0	114.4	1.5	0.1	0.2	0	0	8	7	1	1	0	0	0	1	1.3
10	200324P6	1605	110.9	101	Woodland	56	295765	6433710	340	2	2	14	13	0	1	40.1	1.1	16.1	1.3	0	0.1	0	0	27	0	1	1	1	0	0	1	0.1
11	200324P7	483	142.5	101	Woodland	56	295964	6433822	305	1	1	13	15	0	3	20	0.1	27	3.4	0	0.3	0	0	24	4	1	1	1	0	0	1	0
12	200324P8	483	671.3	101	DNG	56	295838	6434694	65	0	2	10	2	0	0	0	0.2	60.3	1.1	0	0	0	0	3	0	0	0	0	0	0	0	2.1
13	200325P1	1602	22.1	101	Woodland	56	292225	6429479	260	4	5	19	17	2	3	25.2	0.5	11.5	1.7	0.2	0.3	0	0	84	0	1	1	1	1	0	1	0.1
14	200325P2	1691	23.2	101	Woodland	56	292320	6429727	32	4	3	20	19	0	4	41.2	0.3	10.6	1.9	0	0.4	0	0	52	7	1	1	1	1	0	1	0.2
15	200325P3	1691	0.8	101	DNG	56	292172	6429823	38	0	2	14	12	1	2	0	1.1	98.6	1.2	0.1	0.2	0	0	3	0	0	0	0	0	0	0	0.2
16	200325P4	1691	23.2	101	Woodland	56	292162	6429946	100	5	5	16	17	1	3	31.2	0.5	35.2	1.7	0.1	0.3	0	0	33	3	1	1	1	0	0	1	0.2
17	200327P1	483	142.5	101	Woodland	56	295214	6434661	81	3	3	17	20	1	2	35.2	0.3	98	2	0.1	0.2	0	0	11	12	1	1	1	1	0	1	0.4
18	200327P2	1606	3.2	101	Woodland	56	296904	6434607	80	2	4	21	12	1	1	37	0.4	35.4	1.2	0.1	0.1	0	0	32	3	0	1	1	1	1	1	6.5
19	200327P3	1606	12.8	101	DNG	56	297318	6434652	52	1	1	15	9	1	2	35	0.1	41.2	0.9	0.1	0.2	1	0	2	6	0	0	0	0	0	0	2.6
20	200327P4	1605	241.3	101	DNG	56	297585	6434601	58	0	2	11	14	1	2	0	0.2	62.3	1.4	0.1	0.2	0	0	3	0	0	0	0	0	0	0	0.4
21	200327P5	1605	22.5	101	Plantation	56	297855	6434623	92	4	1	17	7	0	2	16.2	0.1	32.1	0.7	0	0.2	0	0	32	0	0	1	1	0	0	0	0.3
22	200327P6	618	3	101	Woodland	56	296785	6434525	35	1	2	21	14	1	3	35	0.2	56.7	1.4	0.1	0.3	3	2	84	0	1	1	1	0	0	1	0.5
23	200327P7	618	7.3	101	DNG	56	296630	6434310	235	0	0	13	9	0	3	0	0	98.8	0.9	0	0.3	0	0	9	0	0	0	0	0	0	0	1.4
24	200331P1	1605	241.3	101	DNG	56	292346	6430067	196	1	2	20	8	1	1	0.1	0.2	89.1	0.8	0.1	0.1	0	0	2	0	0	0	0	0	0	0	6.1
25	200331P2	1691	23.2	101	Woodland	56	292595	6430320	76	3	6	19	15	2	4	17.1	0.6	1.9	1.5	0.2	0.4	1	1	74	28	1	1	1	1	0	1	1.3
26	200331P3	483	671.3	101	DNG	56	292805	6430470	6	0	2	13	17	0	3	0	0.2	94.7	1.7	0	0.3	0	0	2	0	0	0	0	0	0	0	40
27	200331P4	1605	241.3	101	DNG	56	293054	6429987	64	1	2	18	15	1	2	0.1	0.2	96.1	1.5	0.1	0.2	0	0	7	0	0	0	0	0	0	0	0.3
28	200331P5	1602	22.1	101	Woodland	56	293157	6430052	75	3	6	14	19	1	4	40.2	13.4	11.3	1.9	0.1	0.4	1	0	43	0	1	1	1	1	0	1	0.4
29	200331P6	1605	241.3	101	DNG	56	293050	6430118	250	0	5	17	16	1	3	0	0.5	97.2	1.6	0.1	0.3	0	0	10	0	0	0	0	0	0	0	0.2
30	200331P7	1605	110.9	101	Woodland	56	296094	6430958	211	2	4	17	19	2	2	35.1	6.3	68.2	11.8	0.2	0.2	0	0	44	2	1	0	0	1	0	1	0.5
31	200331P8	1605	110.9	101	Woodland	56	295648	6431004	218	1	4	10	7	0	2	25	0.4	50.9	20.5	0	0.2	0	0	58	2	0	0	1	1	0	5	7.1
32	200402P1	483	238.5	101	Woodland_SG	56	294049	6433372	187	4	3	14	21	2	3	32.1	0.3	81.1	2.1	0.2	0.3	0	1	48	34	1	0	1	1	1	1	0.4
33	200402P2	483	128.8	101	DNG_SG	56	294347	6433557	84	0	2	14	15	2	2	0	0.2	92.8	1.5	0.2	0.2	0	0	6	0	0	0	0	0	0	0	0.3
34	200402P3	483	128.8	101	DNG_SG	56	294216	6432947	347	0	2	15	17	1	3	0	0.2	88.2	1.7	0.1	0.3	0	0	5	0	0	0	0	0	0	0	0.1
35	200402P4	483	238.5	101	Woodland_SG	56	294348	6432700	108	2	3	15	22	2	3	40.1	0.3	72.1	2.2	0.2	0.3	1	1	42	26	1	1	1	0	0	1	0.6
36	200402P5	483	128.8	101	DNG_SG	56	294102	6434100	26	0	1	13	13	0	2	0	0.1	98.6	1.3	0	0.2	0	0	6	0	0	0	0	0	0	0	0.4
37	200402P6	483	238.5	101	Woodland_SG	56	294395	6434221	98	4	3	13	16	0	3	41.2	0.3	14	1.6	0	0.3	3	1	46	15	1	0	0	0	0	1	60.2
38	200406P1	1606	12.8	101	DNG	56	295491	6432732	220	1	3	18	19	2	2	10	0.3	90.9	2.8	6.1	0.2	0	0	25	10	1	1	1	0	0	0	0.4
39	200406P2	1606	12.8	101	DNG	56	295609	6432771	115	0	1	17	11	1	2	0	0.1	84	1.1	0.1	0.2	0	0	15	7	0	0	0	0	0	0	10.2
40	200406P3	1606	3.2	101	Woodland	56	295720	6432811	23	3	3	20	17	2	4	4.1	0.3	62.5	1.7	0.2	0.4	0	0	15	4	1	1	1	0	0	1	0.5
41	200406P5	1605	110.9	101	Woodland	56	295878	6432696	40	1	3	18	16	1	2	15	0.3	57.3	21.5	0.1	0.2	4	0	44	7	1	0	0	0	1	1	0.6
42	200406P6	1605	241.3	101	DNG	56	295861	6432836	330	1	1	11	9	1	1	0.1	0.1	82.6	0.9	0.1	0.1	0	0	5	0	0	0	0	0	0	1	0.5
43	200406P7	1606	12.8	101	DNG	56	295890	6432988	85	0	1	12	7	1	2	0	0.1	92.7	10.6	0.1	0.2	0	0	5	0	0	0	0	0	0	0	0.5
44	200406P8	1605	110.9	101	Woodland	56	295488	6432613	268	2	2	19	20	2	3	40.1	0.2	81.2	2	0.2	0.3	1	0	48	0	1	1	1	1	1	1	0.4
45	200407P1	483	671.3	101	DNG	56	295132	6432976	20	0	2	15	11	1	2	0	0.2	75.9	7	0.1	0.2	0	0	2	0	0	0	0	0	0	0	70.2
46	200407P2	483	128.8	101	DNG_SG	56	294698	6432849	256	0	3	12	16	1	3	0	0.3	100.4	1.6	0.1	0.3	0	0	3	0	0	0	0	0	0	0	50.2
47	200407P3	483	142.5	101	Woodland	56	295162	6432445	100	1	3	17	23	1	3	40	0.3	7.3	2.3	0.1	1.2	0	0	32	0	1	1	1	1	0	1	0.6
48	200407P4	483	671.3	101	DNG	56	294850	6432225	134	0	2	13	16	1	3	0	0.2	82.8	1.6	0.1	1.2	0	0	4	0	0	0	0	0	0	0	60
49	200407P5	483	238.5	101	Woodland_SG	56	294989	6431882	320	4	4	14	20	1	3	40.2	0.4	3.2	2	0.1	0.3	1	0	72	55	1	1	1	1	1	1	0.3
50	200407P6	483	671.3	101	DNG	56	295571	6431546	124	0	2	13	15	1	4	0	0.2	59.4	7.4	0.1	1.3	0	0	3	0	0	0	0	0	0	0	30.2

Number	Plot	PCT	Area	Patch Size	Condition Class	Zone	Easting	Northing	Bearing	compTree	compShrub	compGrass	compForb	compFern	compOther	strucTree	strucShrub	strucGrass	strucForb	strucFern	strucOther	funLargeTrees	funHollowTrees	funLitterCover	funLenFallenLogs	funTreeStem5to10	funTreeStem10to20	funTreeStem20to30	funTreeStem30to50	funTreeStem50to80	funTreeRegen	funHighThreatExotic
51	200407P7	483	238.5	101	Woodland_SG	56	295443	6431810	119	2	4	18	17	1	2	35.1	0.4	1.8	1.7	0.1	0.2	0	0	44	10	1	1	1	1	0	1	0.2
52	200407P8	483	238.5	101	Woodland_SG	56	295590	6431999	113	2	3	19	23	2	3	35	0.3	23.4	2.3	0.2	0.3	0	0	26	0	0	1	1	1	0	1	0.2
53	200407P9	483	142.5	101	Woodland	56	295621	6432273	352	1	2	18	20	1	3	35	1.1	48.2	3.8	0.1	0.3	1	1	30	1	0	1	1	1	1	0	0.3
54	200408P1	483	238.5	101	Woodland_SG	56	294474	6434015	64	1	2	9	18	0	5	10	0.2	92.4	1.8	0	1.4	0	0	7	0	1	1	0	0	0	0	0.3
55	200408P2	483	671.3	101	DNG	56	294587	6433853	215	0	1	12	12	1	4	0	0.1	93.9	1.2	0.1	0.4	0	0	8	0	0	0	0	0	0	0	10.3
56	200408P3	483	238.5	101	Woodland_SG	56	294943	6433877	98	1	0	13	20	1	3	3	0	95.9	2	0.1	0.3	0	0	10	9	1	1	0	0	0	1	1.3
57	200408P4	483	671.3	101	DNG	56	294994	6433653	308	0	1	9	9	0	3	0	0.1	97.5	0.9	0	0.3	0	0	7	0	0	0	0	0	0	0	25
58	200408P5	483	142.5	101	Woodland	56	295160	6433993	63	2	3	17	21	0	3	10.1	0.3	78.1	3	0	0.3	0	0	15	14	0	1	1	0	0	1	2.5
59	200408P6	483	671.3	101	DNG	56	295526	6434347	252	0	1	11	11	1	1	0	0.1	167.7	1.1	0.1	0.1	0	0	7	0	0	0	0	0	0	0	35
60	200408P7	483	671.3	101	DNG	56	295482	6434603	49	0	0	10	7	0	2	0	0	101.5	0.7	0	0.2	0	0	13	0	0	0	0	0	0	0	6.1
61	200420P1	1605	241.3	101	DNG	56	298950	6434349	258	0	2	13	14	1	3	0	0.2	100.6	2.3	0.1	0.3	0	0	3	0	0	0	0	0	0	0	15.2
62	200420P4	1605	110.9	101	Woodland	56	298654	6433401	12	1	3	16	6	0	1	15	0.3	17.2	0.6	0	0.1	2	1	4	0	0	0	0	0	1	0	30.2
63	200420P5	1605	241.3	101	DNG	56	298680	6433192	130	0	2	18	5	1	2	0	0.2	117.8	0.5	0.1	0.2	0	0	11	0	0	0	0	0	0	0	40.1
64	200420P6	483	142.5	101	Woodland	56	299038	6433587	80	1	4	19	6	1	1	25	0.4	17.3	1.5	0.1	0.1	1	1	6	3	0	0	0	0	1	0	60.3
65	200420P7	483	671.3	101	DNG	56	298957	6433439	186	0	1	13	9	1	3	0	0.1	105.6	0.9	0.1	0.3	0	0	4	0	0	0	0	0	0	0	10.1
66	200420P8	1655	2.4	101	DNG	56	299046	6432646	268	2	1	15	9	1	1	0.2	0.1	84.7	15.8	0.1	0.1	0	0	2	0	0	0	0	0	0	0	0.3
67	200420P9	1605	22.5	101	Plantation	56	299118	6432759	173	8	1	17	10	1	3	41	0.1	22.4	1	0.1	0.3	0	0	54	0	1	1	1	0	0	1	0.3
68	200421P1	1605	22.5	101	Plantation	56	298856	6432865	276	7	3	20	17	2	2	28.1	0.3	72.5	1.7	0.2	0.2	0	0	56	0	1	1	1	0	0	1	2.3
69	200421P2	1605	22.5	101	Plantation	56	298730	6432801	250	6	4	16	14	1	3	22	0.4	28.3	1.4	0.1	0.3	0	0	76	0	1	1	1	0	0	1	0.4
70	200421P5	483	128.8	101	DNG_SG	56	293908	6431791	92	0	2	18	20	2	4	0	0.2	95	2	0.2	0.4	0	0	5	16	1	0	0	1	0	1	0.3
71	200421P6	483	238.5	101	Woodland_SG	56	293704	6431913	228	4	5	16	27	1	4	30.1	1.4	74.2	2.7	0.1	0.4	1	0	40	8	1	1	0	0	0	1	0.3
72	200421P7	483	238.5	101	Woodland_SG	56	293857	6431929	190	3	4	17	29	0	1	40.2	0.4	36.4	2.9	0	0.1	0	0	66	9	1	1	1	0	0	1	0.5
73	200423P1	483	128.8	101	DNG_SG	56	293267	6431998	250	0	2	16	16	1	3	0	0.2	83.1	1.6	0.1	0.3	0	0	2	0	0	0	0	0	0	0	10.2
74	200423P2	483	238.5	101	Woodland_SG	56	293215	6432136	324	3	2	20	21	0	4	40.2	0.2	45.5	2.1	0	0.4	0	0	38	2	0	0	0	0	0	0	0.4
75	200423P3	483	671.3	101	DNG	56	292662	6432005	325	0	2	17	9	1	1	0	2	99	20.8	0.1	0.1	0	0	7	2	0	0	0	0	0	0	10
76	200423P4	483	238.5	101	Woodland_SG	56	293899	6434076	298	1	3	15	14	2	3	20	1.2	100.7	1.4	0.2	0.3	1	2	17	15	0	0	0	1	1	1	0.5
77	200424P1	483	671.3	101	DNG	56	294826	6434564	234	0	1	12	6	1	2	0	0.1	112.5	0.6	0.1	0.2	0	0	4	0	0	0	0	0	0	0	25.2
78	200424P2	1605	241.3	101	DNG	56	295718	6432553	136	1	2	15	16	1	3	0.1	0.2	88.9	1.6	0.1	0.3	0	0	2	0	0	0	0	0	0	1	10.1
79	200424P3	483	142.5	101	Woodland	56	295421	6431181	282	2	3	23	27	1	4	35.1	0.3	81.6	2.7	0.1	0.4	2	2	48	47	1	1	1	1	1	1	0.5
80	200424P4	483	671.3	101	DNG	56	296205	6431133	118	0	4	15	9	0	2	0	7.3	92	45.8	0	0.2	0	0	3	0	0	0	0	0	0	0	1.1
81	200424P5	1605	241.3	101	DNG	56	296363	6431232	130	1	2	10	5	1	1	0.1	0.2	3.9	16.3	0.1	0.1	0	0	3	0	0	0	0	0	0	0	0.1
82	200424P6	483	128.8	101	DNG_SG	56	296070	6431643	98	0	3	11	12	0	3	0	1.2	104.3	1.2	0	0.3	0	0	3	0	0	0	0	0	0	0	15.2
83	200424P7	483	128.8	101	DNG_SG	56	296154	6431812	154	0	3	14	14	1	3	0	0.3	92.6	1.4	0.1	0.3	0	0	3	0	0	0	0	0	0	0	30
84	200424P8	1605	241.3	101	DNG	56	296126	6431594	168	0	2	15	9	1	1	0	0.2	88	0.9	0.1	0.1	0	0	2	0	0	0	0	0	0	0	40.1
85	200429P1	483	142.5	101	Woodland	56	296744	6431490	54	1	4	18	17	0	4	25	0.4	98.4	1.7	0	0.4	1	1	17	9	0	0	0	0	1	1	1.7
86	200429P2	1605	110.9	101	Woodland	56	296532	6431519	137	1	3	16	8	1	1	20	0.3	9.3	20.7	0.1	0.1	1	0	18	2	1	2	0	0	1	1	0.4
87	200429P3	1602	22.1	101	Woodland	56	296443	6431675	258	3	5	18	19	1	3	30.1	0.5	11.5	2.8	0.1	0.3	2	0	48	18	0	1	0	0	1	1	0.5
88	200429P4	483	142.5	101	Woodland	56	295388	6430867	55	1	4	18	20	1	2	10	0.4	45.3	2	0.1	0.2	0	0	10	4	1	1	0	0	0	1	0.4
89	200429P5	483	671.3	101	DNG	56	295661	6430774	87	0	2	15	11	1	3	0	1.1	96.7	1.1	0.1	0.3	0	0	2	0	0	0	0	0	0	0	20.1
90	200429P6	1605	110.9	101	Woodland	56	295813	6430641	123	1	4	16	12	0	2	35	15.3	44.1	21.1	0	0.2	0	0	42	21	1	0	1	1	0	1	10.4
91	200513P1	483	142.5	101	Woodland	56	296179	6430686	182	2	3	14	18	0	4	30.1	1.2	73.1	1.8	0	0.4	2	3	34	25	1	0	0	1	1	1	25.5
92	200514P2	1605	110.9	101	Woodland	56	298902	6433166	350	1	1	14	6	0	0	30	0.1	4.2	0.6	0	0	3	3	32	6	0	0	0	0	1	1	80.1
93	200515P2	1655	2.4	101	DNG	56	299069	6432327	0	0	3	11	6	1	1	0	0.3	109.3	0.6	0.1	0.1	0	0	6	0	0	0	0	0	0	0	7.1
94	200406P4	1602	0.2	101	Woodland	56	295834	6432412	178	3	4	15	29	1	2	35.1	0.4	17.3	2.9	0.1	0.2	1	1	20	6	1	1	1	1	1	1	0.5
95	200423P5	483	4.3	101	DNG_SG	56	293739	6434149	275	0	2	13	5	0	1	0	0.2	111.8	0.5	0	0.1	0	0	6	0	0	0	0	0	0	0	40.2
96	200409P7	1605	0.5	101	DNG	56	297644	6434572	260	0	1	15	7	1	2	0	0.1	99.1	0.7	6	0.2	0	0	30	0	0	0	0	0	0	0	0.4

ATTACHMENT D
EXPERT REPORT – EXPECTED PRESENCE OF THREATENED TERRESTRIAL ORCHIDS (*DIURIS TRICOLOR, PRASOPHYLLUM PETILUM*, *PTEROSTYLIS CHAETOPHORA*): MOUNT PLEASANT OPTIMISATION PROEJCT

TOC

Expert Report

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

Mount Pleasant Optimisation Project









December 2020

Final Report

MACH Energy Australia Pty Ltd
PO Box 2115
DANGAR NSW 2309

Dr Stephen Bell

Eastcoast Flora Survey
PO Box 216
Kotara Fair NSW 2289

SUMMARY

MACH Mount Pleasant Operations Pty Ltd (MACH Energy) manages the Mount Pleasant Operation on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy Australia Pty Ltd and J.C.D. Australia Pty Ltd. The Mount Pleasant Operation is located wholly in the Muswellbrook local government area within the upper Hunter Valley of New South Wales. Current approvals for the Mount Pleasant Operation include the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure, and it is authorized to produce up to 10.5 million tonnes per annum of run-of-mine coal. If approved, the Mount Pleasant Optimisation Project (the Project) aims to extend the life of the mine until 2048 and employ on average approximately 600 people.

No known records of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* exist for the Subject land, and after analysis of floristic and environmental data I consider there to be very limited evidence in support of populations of *Diuris tricolor* and/or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) that could potentially occur there, and no evidence for *Pterostylis chaetophora*. Historical records of *Pterostylis chaetophora* near Scone and Wybong are erroneous, and there are no other confirmed populations of this species in the upper Hunter Valley. Together with floristic and environmental evidence, the inferred absence or paucity of mycorrhizal fungi (using reported orchid presence and diversity as a surrogate) corroborates this opinion. The habitats present within the Subject land differ sufficiently from those known to support all three target species elsewhere in the Hunter Valley.

During intensive field survey of the Subject land and surrounds over 18 days between March and May 2020 I was able to note clear differences in the floristic composition of habitats there compared to other areas where I have studied the three target orchids. The predominance of woodlands and derived grasslands within Box (*Eucalyptus* '*albemol*' and *Eucalyptus moluccana*) landscapes largely conflicts with my experience elsewhere. Numerical analysis of defined vegetation communities revealed clear differences in habitat from the Subject land relative to elsewhere in the region known to support *Pterostylis chaetophora*, and only limited similarities to some habitats typical of *Diuris tricolor* and *Prasophyllum petilum* (those dominated or co-dominated by *Eucalyptus crebra*). Given this superficial similarity of communities potentially supporting *Diuris tricolor* and *Prasophyllum petilum*, pro-active targeted orchid surveys were undertaken in these communities over two days in early October 2020 (the peak flowering time of both species), but no orchids of any kind were observed during this time.

In further 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, soil type, and (for *Pterostylis chaetophora*) annual rainfall when compared to the Subject land. Of these, soil landscapes are 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 assessing fungi distribution, a review of all terrestrial orchid observation records for the upper Hunter Valley demonstrated a scarcity of orchids in and around the Subject land, suggesting that mycorrhizal fungi were therefore also scarce or localised. This lends further credence to my conclusion that no populations of *Diuris tricolor* or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) are expected across the Subject land.

The combination of differing floristic, geological, soil landscape, soil, and rainfall attributes, together with a largely absent Orchidaceae population (used as a surrogate for mycorrhizal fungi) strongly suggest that *Diuris tricolor, Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) or *Pterostylis chaetophora* are unlikely to be present on the Subject land and therefore no further assessment is required.

Report produced by:

Dr Stephen A.J. Bell
Eastcoast Flora Survey
PO Box 216 Kotara Fair NSW 2289 Australia

Telephone (02) 4953 6523
Email: sajbell@bigpond.com

This document should be cited as:

Bell, S.A.J. (2020) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*): Mount Pleasant Optimisation Project.* Unpublished Report to MACH Energy Australia Pty Ltd. December 2020. Eastcoast Flora Survey.

FINAL Version

© Stephen Bell

This report is copyright. Apart from fair dealing for the purposes of private study, research, criticism or review as permitted under the Copyright Act 1968, no part may be reproduced, copied, transmitted in any form or by any means (electronic, mechanical or graphic) without the prior written permission of the author.

Document cover: View across part of the Mount Pleasant Optimisation Project Area (top), and target orchids (from left) *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora*.

Report produced for:

MACH Energy Australia Pty Ltd
PO Box 2115
DANGAR NSW 2309

Table of Contents

SUMMARY i

Figures v

Tables vi

1. Introduction 1

1.1 Background 1

1.2 Project Overview 1

1.3 Report Criteria & Structure 3

1.4 DPIE Approval to Prepare Expert Report 5

2. Criterion (a) - The Relevant Species 6

2.1 Legal Status 6

2.2 Distribution and Known Populations 6

2.2.1 Diuris tricolor 7
2.2.2 Prasophyllum petilum 8
2.2.3 Pterostylis chaetophora 9

2.3 Habitat 10

2.3.1 Diuris tricolor 10
2.3.2 Prasophyllum petilum 13
2.3.3 Pterostylis chaetophora 15

2.4 Ecology 15

2.4.1 Orchid Detectability 15
2.4.2 Mycorrhizal Fungi 18

2.4.2.1 Diuris tricolor 19

2.4.2.2 Prasophyllum petilum 19

2.4.2.3 Pterostylis chaetophora 19

2.4.3 Pollination and Seed Production 20

2.4.3.1 Diuris tricolor 20

2.4.3.2 Prasophyllum petilum 20

2.4.3.3 Pterostylis chaetophora 20

2.4.4 Reproduction and Dispersal 21

2.4.4.1 Diuris tricolor 21

2.4.4.2 Prasophyllum petilum 21

2.4.4.3 Pterostylis chaetophora 22

3. Criterion (b) – Justification for an Expert Report 23

3.1 Survey Effort 24

3.2 Impact of Drought 26

4. Criterion (c) – Likelihood of Species Presence in the Project Area 29

4.1 Project Area Attributes 29

4.1.1 Land-use History 29
4.1.2 Existing Orchid Records 29
4.1.3 Vegetation Communities 30

4.1.3.1 Plant Community Types 30

4.1.3.2 Comparative Numerical Analyses 35

4.2 Environmental Analysis 39

4.2.1 Project Area 40
4.2.2 Target Orchids Records 42

4.3 Orchid Diversity: A Surrogate for Mycorrhizal Fungi 44

4.4 Field Inspection of the Project Area 45

4.5 Concluding Opinion: Are the Target Species Present? 53

5. Criterion (d) – Size of Population or Habitat 56

6. Criterion (e) – Documents & Data Reviewed 57

7. Criterion (f) – Expert Credentials 58

8. Conclusion 62

9. References 64

Appendix 1 – Dr Stephen Bell DPIE Accreditation 76

Appendix 2 – Floristic Composition of Grassland Habitat (Bell 2012a) 78

Appendix 3 – Biophysical Attributes of the Project Area 81

Appendix 4 – Biophysical Attributes of Orchid Locations 84

Appendix 5 – Resume: Dr Stephen Bell 88

Appendix 6 – Endorsement: Dr Lachlan Copeland 101

Figures

Figure 1 Location of the Mount Pleasant Operation within the context of the Hunter Valley of New South Wales 2

Figure 2 The Project general arrangement. 4

Figure 3 Target orchids (from left): *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora*. 7

Figure 4 Distribution of *Diuris tricolor* (left), *Prasophyllum petilum* (X) and *Pterostylis chaetophora* (□) (right) across eastern Australia, shown relative to the Project Area (circled, 50 km radius). 9

Figure 5 Number of *Diuris tricolor* individuals (n=5120) by pre-1750 vegetation type within the 1492 ha Mangoola study area (unpubl. data). 12

Figure 6 Number of *Prasophyllum petilum* individuals (n=4073) by pre-1750 vegetation type within the 1492 ha Mangoola study area (unpubl. data). 15

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). 16

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, over a period of four to nine years (after Bell 2019a). 18

Figure 9 Distribution of full floristic sample plots completed by the author between March and May 2020. 23

Figure 10 Target orchid surveys undertaken within selected portions of the Project Area, 1-2 October 2020. 26

Figure 11 Monthly and average rainfall for Muswellbrook (station # 61374; c. 6 km from the Project Area) over the past four years. 27

Figure 12 Drought indices for the Ellis Parish, January 2013 to October 2020, showing Intense Drought from April 2018 to January 2019 and December 2019 to January 2020, prior to wetter conditions and a return to non-drought. 27

Figure 13 Contemporary Analysis: nMDS ordination of floristic plot data comprising DNG from the Project Area (n=107) in relation to that known to support *Diuris tricolor* and *Prasophyllum petilum* at Mangoola (n=6). 36

Figure 14 Historical Analysis 1: nMDS ordination of floristic compositions (presence-absence) comprising woodlands and grasslands from the Project Area (P) in relation to that supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola (M). 39

Figure 15 Historical Analysis 2: nMDS ordination of floristic compositions (presence-absence) comprising forest, woodlands and grasslands from the Project Area (P) in relation to favoured *Pterostylis chaetophora* habitat at Columbey (C). 40

Figure 16 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 representative locations within the Project Area (n=93). 44

Figure 17 Point locations of all terrestrial orchids (excluding *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora*) for the Hunter LLS area. 46

Figure 18 Terrestrial orchids reported for the Project Area and immediate surrounds (15 km radius shown). 47

Figure 19 Grassland within the Project Area, dominated by *Bothriochloa decipiens, Eriochloa pseudoacrotricha, Digitaria divaricatissima, Aristida ramosa* and *Chloris truncata*. 48

Figure 20 Grassland supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola, dominated by *Aristida ramosa* and *Cymbopogon refractus*. 49

Figure 21 Grassland within the Project Area, showing swards of *Aristida ramosa* with *Digitaria divaricatissima* and *Digitaria brownii*. 50

Figure 22 *Diuris tricolor* and other orchids growing over a constructed contour bank, Mangoola. 51

Figure 23 *Diuris tricolor* growing with exotic weeds in low quality grassland near Mangoola. 51

Figure 24 *Diuris tricolor* proliferating in mown lawns of a farm homestead near Mangoola. 52

Figure 25 *Pterostylis chaetophora* growing in roadside gutter, Columbey National Park. 52

Tables

Table 1 Land parcels comprising the Project Area. 4

Table 2 Legal status of target orchids within relevant States and Territories. 6

Table 3 Habitat documented for *Diuris tricolor*. 11

Table 4 Habitat documented for *Prasophyllum petilum*. 14

Table 5 Habitat documented for *Pterostylis chaetophora*. 16

Table 6 Field survey effort (grey) and peak orchid flowering periods (black). 25

Table 7 Vegetation communities and Plant Community Types identified for the Project Area (from Hunter Eco 2020) 31

Table 8 Dominant species within defined vegetation communities (from Hunter Eco 2020). 32

Table 9 Vegetation communities previously defined for Mangoola (Bell in review 1) and Columbey (Bell 2009) shown to support populations of one or more of the target orchid species. 37

Table 10 Included datasets in numerical analyses. 38

Table 11 Digital resources utilised to categorise biophysical attributes of the Project Area and compare these with point data for the three target orchids. 41

Table 12 Summary of biophysical attributes of the Project Area. 42

Table 13 Concluding reasoning for orchid absence. 53

1. Introduction

1.1 Background

1. I have been engaged by MACH Energy Australia Pty Ltd (MACH Energy) 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 being prepared by Hunter Eco, which addresses the proposed Mount Pleasant Optimisation Project (the Project). This expert report has been prepared 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] 2020a). It aims to determine the habitat suitability of the Subject land 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 the Subject land. The additional disturbance of planned Project extensions is approximately 470 hectares (ha), the bulk of which comprises native vegetation in varying levels of condition (Hunter Eco 2020). My assessment is required as this large area of land prohibits adequate and comprehensive ground survey within the limited flowering windows for all three orchid species, as per NSW government guidelines for the Biodiversity Assessment Method (DPIE 2020b). I am well acquainted with the land in question at the Mount Pleasant Operation and immediate surrounds, having intensively surveyed the vegetation there across 123 full floristic sampling plots between March and May 2020 (Hunter Eco 2020), further expanded upon in Section 4.

1.2 Project Overview

3. The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

4. MACH Energy acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

5. MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95% owner) and J.C.D. Australia Pty Ltd (5% owner)[1].

6. The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and coal loading infrastructure located approximately

[1] Throughout this report, MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture will be referred to as MACH.

three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of NSW (Figure 1).

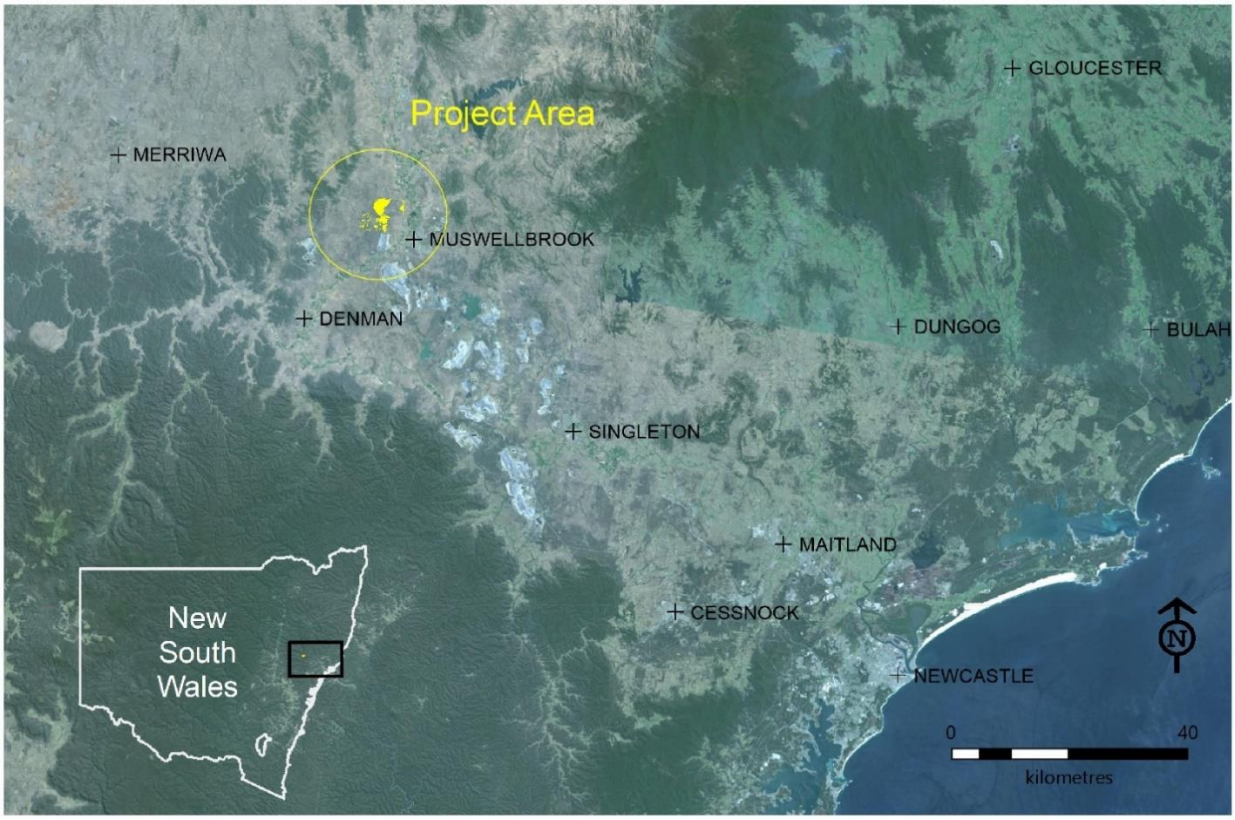


Figure 1 Location of the Project Area (Mount Pleasant Operation) within the context of the Hunter Valley of New South Wales.

7. The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately nine trains per day of thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

8. The Project would include the following development:

- increased open cut coal extraction within Mount Pleasant Operation Mining Leases (MLs) by mining of additional coal reserves, including lower coal seams in North Pit;
- staged increase in extraction, handling and processing of ROM coal up to 21 Mtpa (i.e. progressive increase in ROM coal mining rate from 10.5 Mtpa over the Project life);
- staged upgrades to the existing Coal Handling and Preparation Plant and coal handling infrastructure to facilitate the handling and processing of additional coal;
- rail transport of up to approximately 17 Mtpa of product coal to domestic and export customers;
- upgrades to workshops, electricity distribution and other ancillary infrastructure;
- existing infrastructure relocations to facilitate mining extensions (e.g. local roads, powerlines and water pipelines);

- construction and operation of new water management and water storage infrastructure in support of the mine;
- additional reject dewatering facilities to allow co-disposal of fine rejects with waste rock as part of ROM waste rock operations;
- development of an integrated waste rock emplacement landform that incorporates geomorphic drainage design principles for hydrological stability, and varying topographic relief to be more natural in exterior appearance;
- construction and operation of new ancillary infrastructure in support of mining;
- extension to the time limit on mining operations to 22 December 2048;
- an average operational workforce of approximately 600 people, with a peak of approximately 830 people;
- ongoing exploration activities; and
- other associated infrastructure, plant, equipment and activities.

9. The Mount Pleasant Operation lies west of Muswellbrook and Aberdeen, east of Wybong and immediately north of Bengalla Mine. To focus my report and assist in later discussions, the approximately 1,000 ha of the Project (including the approved disturbance area to be relinquished) (collectively referred to as the Project Area) has been designated into four role-defined parcels of land (see Figure 2 and Table 1).

1.3 Report Criteria & Structure

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

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

b. provide a justification for the use of an expert report (see **Section 3**);

c. indicate and justify the likelihood of presence of the species or population and prepare a species polygon showing the location and area of the species polygon (see **Section 4**);

d. estimate the area of habitat (as identified in the Credit Calculator) for 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 relation to the determination made in the report (see **Section 6**), and;

g. identify the expert and provide evidence of their credentials (see **Section 7**).

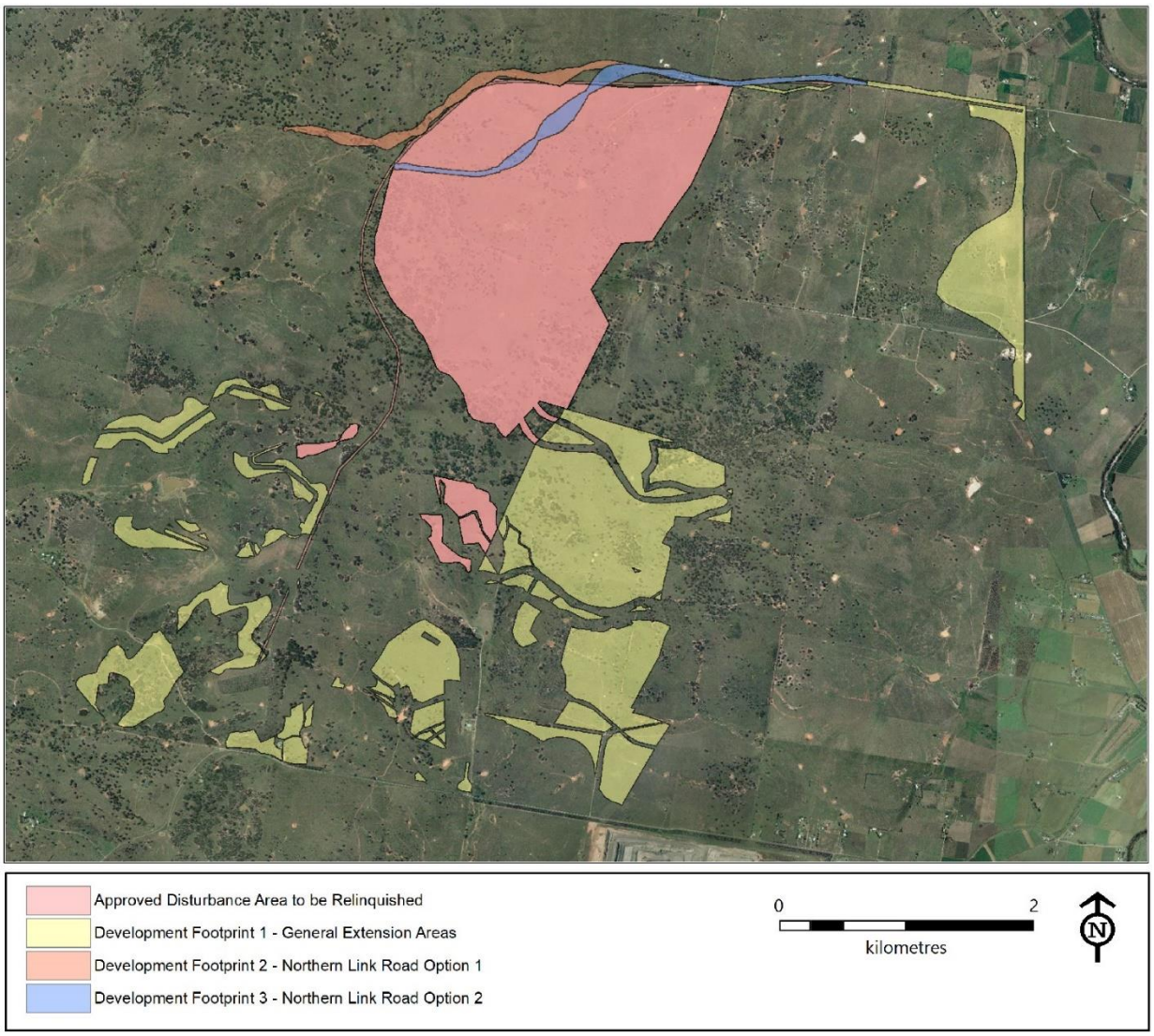


Figure 2 The Project Area, showing layout of proposed disturbance areas.

Table 1 Land parcels comprising the Project Area.

Land Parcel	Details	Size (ha)
Development Footprint 1 – General Extension Areas	various parcels of land in the southern, western and eastern portions of the Project Area	473
Development Footprint 2 – Northern Link Road Option 1	revised Northern Link Road alignment option extending across the northern fringe of the Project Area	31
Development Footprint 3 – Northern Link Road Option 2	revised Northern Link Road alignment option extending across the northern fringe of the Project Area	25
Approved Disturbance Area to be Relinquished (Relinquishment Area)	large parcel of approved disturbance area in the north of the Project Area	510
Total		1,039

1.4 DPIE Approval to Prepare Expert Report

11. 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

12. *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora* (all in family Orchidaceae) 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 local government area (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 (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 [in synonymy under the phrase name *Prasophyllum* sp. Wybong (C.Phelps ORG 5269)], because the Australian Plant Census has not yet accepted this synonymy.

13. 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 ORG5269) 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

14. *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. Historical records of *Pterostylis chaetophora* from the Muswellbrook (2005) and Scone (1998) areas are unfounded and unverified, with the original observations almost certainly misidentifications of similar species

(see discussion in Bell & Hillier 2020). Figure 3 shows images of all three species growing *in situ* in the Hunter region.

15. 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

16. *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.

17. The nearest records of *Diuris tricolor* to the Project Area are in the vicinity of Mangoola Coal Mine, approximately 10 km to the south-west (NSW BioNet; pers. obs.), several observations from 2004-2015 within the Mt Arthur Coal Mine complex along Thomas Mitchell Drive (c. 12 km to the south-south-east; NSW BioNet; Hunter Eco 2013), and at the Bulga Coal 'Condran' offset property at Antienne (c. 16 km to the south-east; pers. obs.). A long-term study of *Diuris tricolor* has been occurring at Mangoola since 2009, involving both targeted surveys across disturbance and offset areas and experimental translocation. I have been involved in this study continually since 2009, and consequently have an in-depth knowledge of the population and habitats there. I have also been monitoring the *Diuris tricolor* population at 'Condran' annually since 2013.

18. 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, and recent surveys during the wetter 2020 also failed to locate any individuals (A. Deveridge, pers. comm.). North Rothbury lies approximately 80 km to the south-east of the Project Area.

19. 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

20. *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.

21. The nearest known occurrence of *Prasophyllum petilum* to the Project Area are also in the vicinity of Mangoola Coal Mine, approximately 10 km to the south-west (NSW BioNet; pers. obs.). A disjunct and historical population also occurs along Thomas Mitchell Drive to the south-east of Muswellbrook, however no plants have been seen there since 2005, and a search by myself during the peak of flowering in 2020 also proved fruitless. The original observation (of ten plants in 1999) was the first of the species for the Hunter Region, and advice from the 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, including the 2020 search, suggesting that the population may now be extinct.

22. All other Hunter Valley observations of *Prasophyllum petilum* are from Mangoola (NSW BioNet; Australia's 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) but have been more prevalent during the wetter 2020.

23. 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).

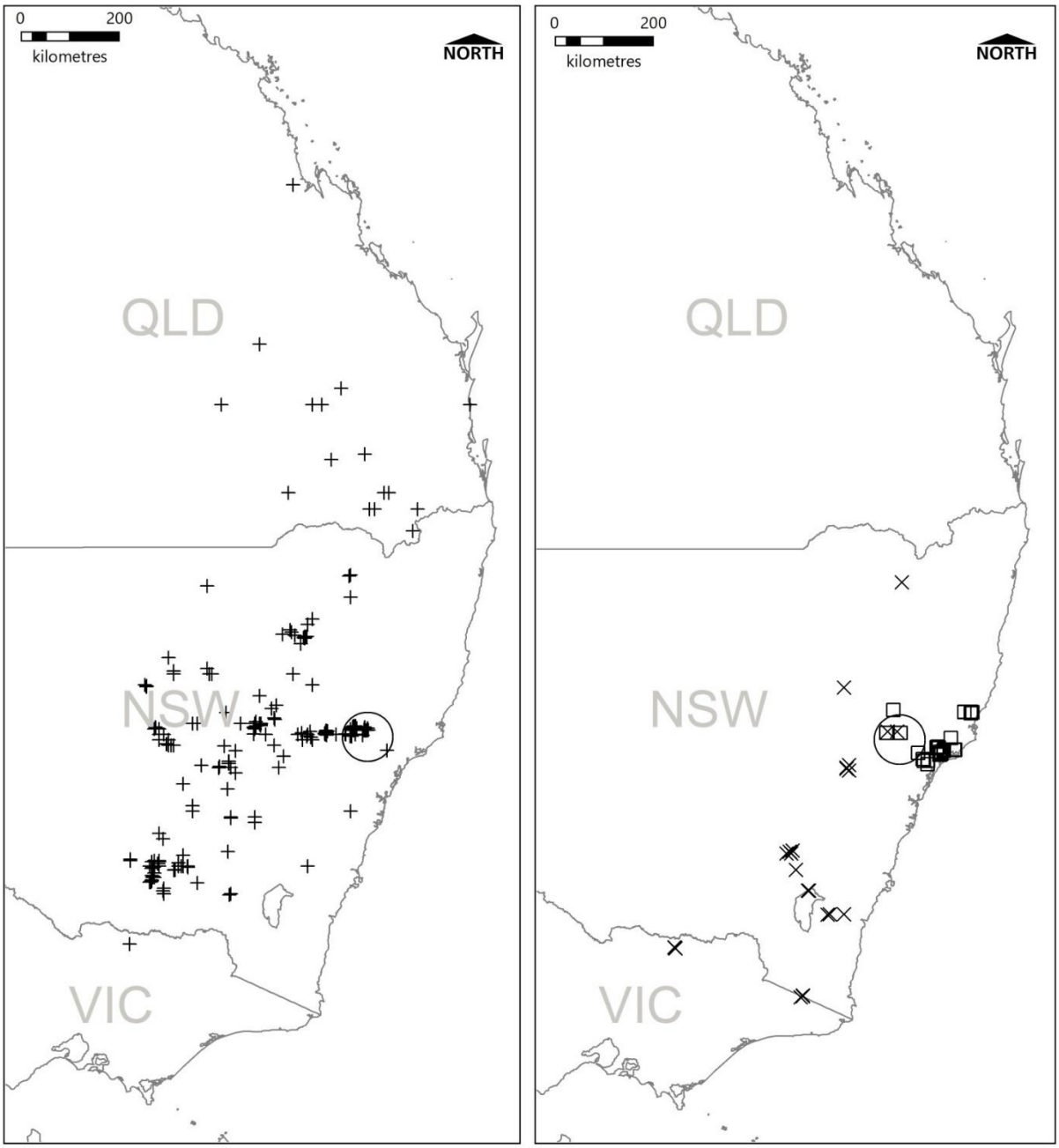


Figure 4 **Distribution of *Diuris tricolor* (left), *Prasophyllum petilum* (X) and *Pterostylis chaetophora* (□) (right) across eastern Australia, shown relative to the Project Area (circled, 50 km radius).** Data from AVH and NSW BioNet, extracted July 2020. Note that near-coastal records of *Diuris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

2.2.3 Pterostylis chaetophora

24. *Pterostylis chaetophora* (Rusty Greenhood) is endemic to the broader Hunter Region, extending from southern Taree to Newcastle and Cessnock (Figure 4). NSW BioNet includes 33 distinct observation records, with most occurring in the lower Hunter Valley (east from Cessnock). 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* (shown as

Pterostylis species 'south-east Queensland' in 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 misidentifications as no recent observations have been made there (see Bell & Hillier 2020). 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. 36 km north of the Project Area), and the second in 2005 by Dougall Herd from what is now a biodiversity offset for the Mangoola Coal Mine (c. 18 km south-west of the Project Area). Both records have since be determined as misidentifications, probably representing the closely related *Pterostylis* aff. *praetermissa* (L. Copeland, pers. comm., and see Bell & Hillier 2020). 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).

25. Consequently, the nearest known confirmed record of *Pterostylis chaetophora* to the Project Area is at North Rothbury (c. 70 km south-east of the Project Area). This population has been monitored annually for the last four flowering seasons, showing heavy grazing of tubers by White-winged Choughs (*Corcorax melanorhamphos*) in some colonies (Bell 2020b) but persistence in others. Columbey National Park, situated near Clarence Town, currently supports the most extensive populations of *Pterostylis chaetophora* (Bell & Hillier 2020), and lies 95 km to the south-east of the Project Area.

2.3 Habitat

2.3.1 Diuris tricolor

26. 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.

27. 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* (Bell 2017a), although no individuals have been seen at that location since.

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

28. Using the Mangoola Coal Mine population of *Diuris tricolor* as a case study, an assessment of vegetation communities supporting 975 GPS-recorded *Diuris tricolor* locations (n=5,120

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=3,089) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 5).

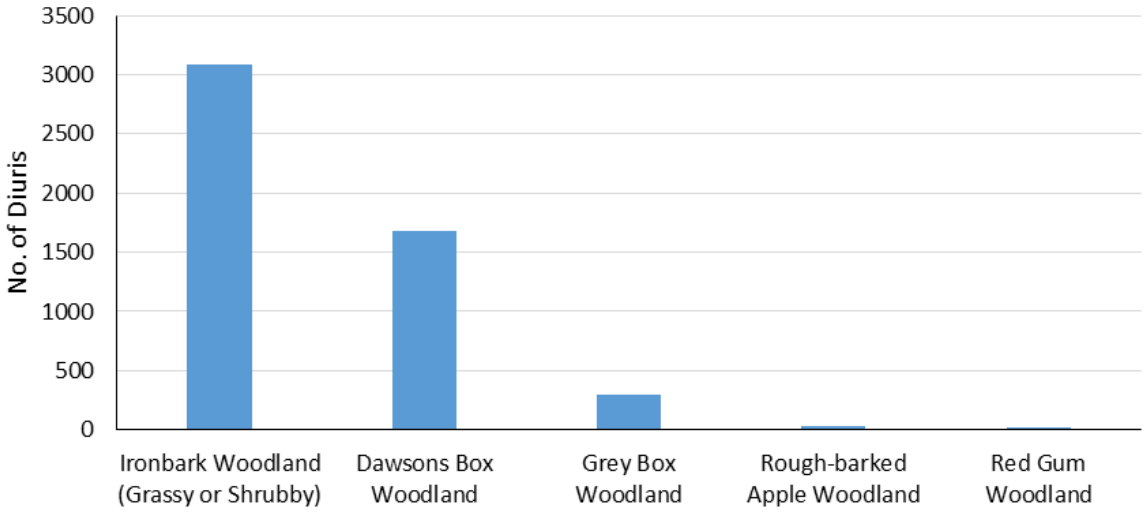


Figure 5 **Number of *Diuris tricolor* individuals (n=5,120) by pre-1750 vegetation type within the 1,492 ha Mangoola study area (unpubl. data).** Note that *Diuris tricolor* records almost all located within derived native grasslands (DNG) from these vegetation types.

29. 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=1,684), and these two communities combined supported >90% of all *Diuris tricolor* records and individuals. Three other communities comprised relatively minor *Diuris tricolor* habitat: Grey Box (*Eucalyptus 'albemol'*) Woodland (6%), Rough-barked Apple (*Angophora floribunda*) Woodland (0.6%), and Red Gum (*Eucalyptus blakelyi*) Woodland (0.3%). 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.

30. At a finer scale, a floristic analysis of derived grasslands undertaken at Mangoola between 2009 and 2011 (comprising 168 plots sampled over 2,000 ha) found that *Diuris tricolor* occurred within three of seventeen grassland types, in descending order of importance (Bell 2012a, Bell in review 1):

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

31. 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 1,069 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 Mount Pleasant Operation discussed later in this report.

2.3.2 Prasophyllum petilum

32. 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.

33. 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* (unpubl. data).

34. Once again, using Mangoola as a case study, an assessment of the vegetation communities supporting 759 GPS-recorded *Prasophyllum petilum* locations (n=4,073 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=2,413) occurring within present or former Ironbark (*Eucalyptus crebra*) Woodland (Figure 6).

35. 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; Ecological 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

36. Floristic analysis of derived grasslands undertaken at Mangoola between 2009 and 2011 (comprising 168 plots sampled over 2,000 ha) found *Prasophyllum petilum* occurring in three of seventeen grassland types, in descending order of importance (Bell 2012a; Bell in review 1):

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

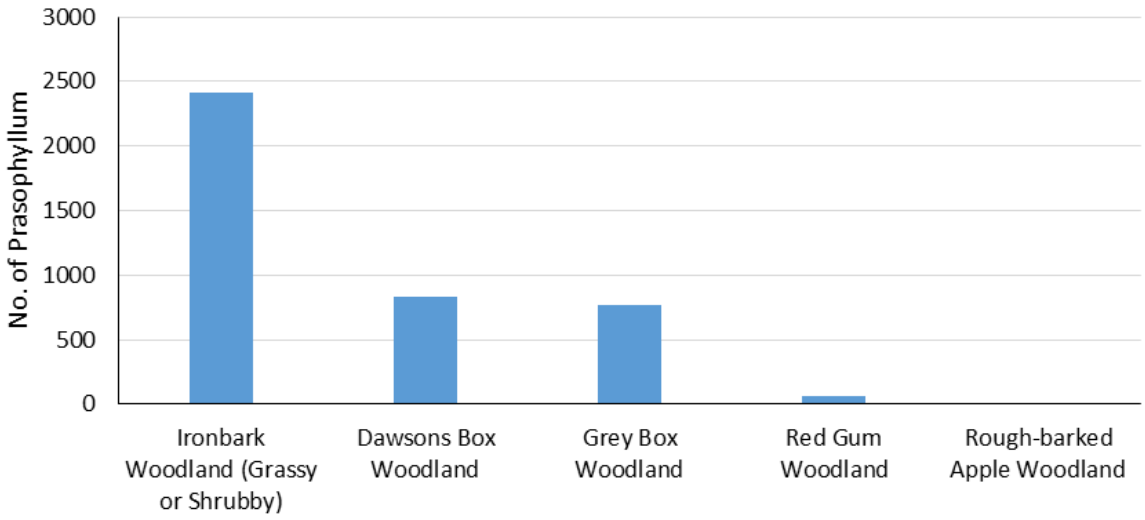


Figure 6 **Number of *Prasophyllum petilum* individuals (n=4,073) by pre-1750 vegetation type within the 1,492 ha Mangoola study area (unpubl. data).** Note that *Prasophyllum petilum* records almost all located within derived native grasslands (DNG) from these vegetation types.

37. *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 1,069 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 Mount Pleasant Operation discussed later in this report.

2.3.3 Pterostylis chaetophora

38. There is limited information available on habitat for the Hunter endemic *Pterostylis chaetophora*, although a recently published paper does outline the major types from which it is known (Bell & Hillier 2020). In that study, key habitats within Columbey National Park were shown to be Floodplain Redgum-Box Forest (where *Eucalyptus moluccana* dominated the canopy), Lower Hunter Spotted Gum-Ironbark Forest and Seaham Spotted Gum-Ironbark Forest (Bell & Hillier 2020: Figure 7), and other locations in the lower Hunter also occur in such vegetation. Paget (2008) provided brief notes on habitat for several other populations of the species, which was incorporated into Bell and Hillier (2020). Table 5 summarises habitat for *Pterostylis chaetophora* from all known populations.

2.4 Ecology

2.4.1 Orchid Detectability

39. 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 absence 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.

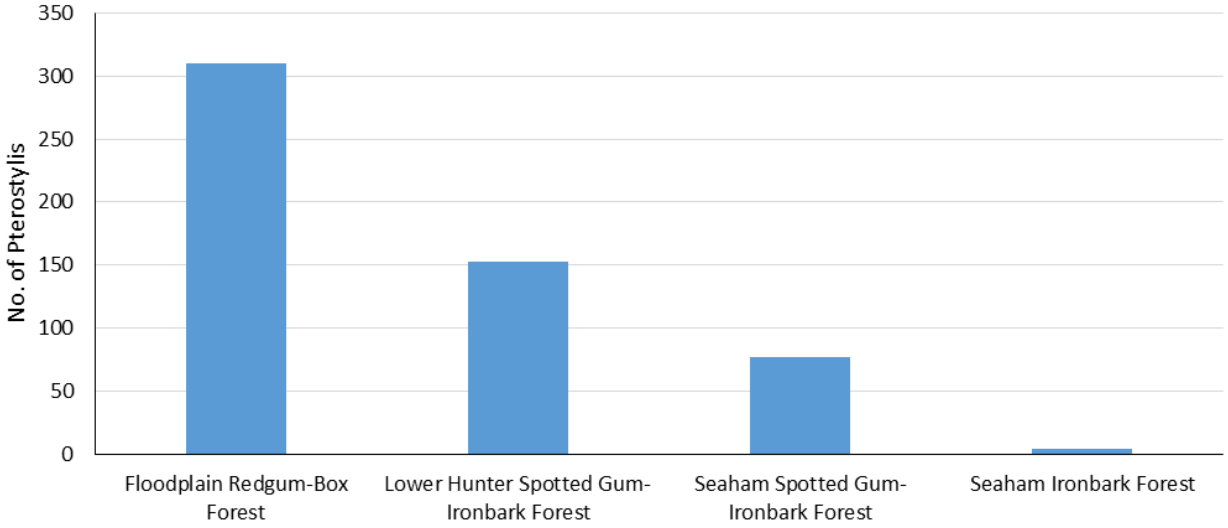


Figure 7 Number of *Pterostylis chaetophora* individuals (n=544) by vegetation type within the 720 ha Columbey National Park study area (after Bell & Hillier 2020).

Table 5 Habitat documented for *Pterostylis chaetophora*.

Habitat	Location	Source
forest of *Eucalyptus fibrosa, Corymbia maculata* and *Eucalyptus umbra*	Columbey NP, Pindimar, Raymond Terrace, Beresfield	Bell & Hillier (2020)
forest of *Eucalyptus moluccana* and/or *Eucalyptus amplifolia*	Columbey NP	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)

40. Part of the difficulty of orchid 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. There is also a certain level of asynchronous flowering in many species which affects detectability, and for *Diuris tricolor* this has been observed closely at a population south-east of Muswellbrook during the 2020 flowering season. At this location, new individuals were progressively detected over the course of four inspections at 10-day intervals (30 days in total), where initial counts of 11 flowering stems ultimately increased to 49, and an additional 10 individuals remained in leaf but did not flower (unpubl. data).

41. 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 Mine (Bell 2019a,b; Bell 2020c; also reported annually in reports to Mangoola). 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 2020c), 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 three to four years since 2015, and four control plots of naturally occurring orchids monitored since 2016 (data not presented here).

42. 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 (the asynchronous flowering noted above), 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 2020c). The wet conditions during 2020 have resulted in earlier peak flowering times (unpubl. data).

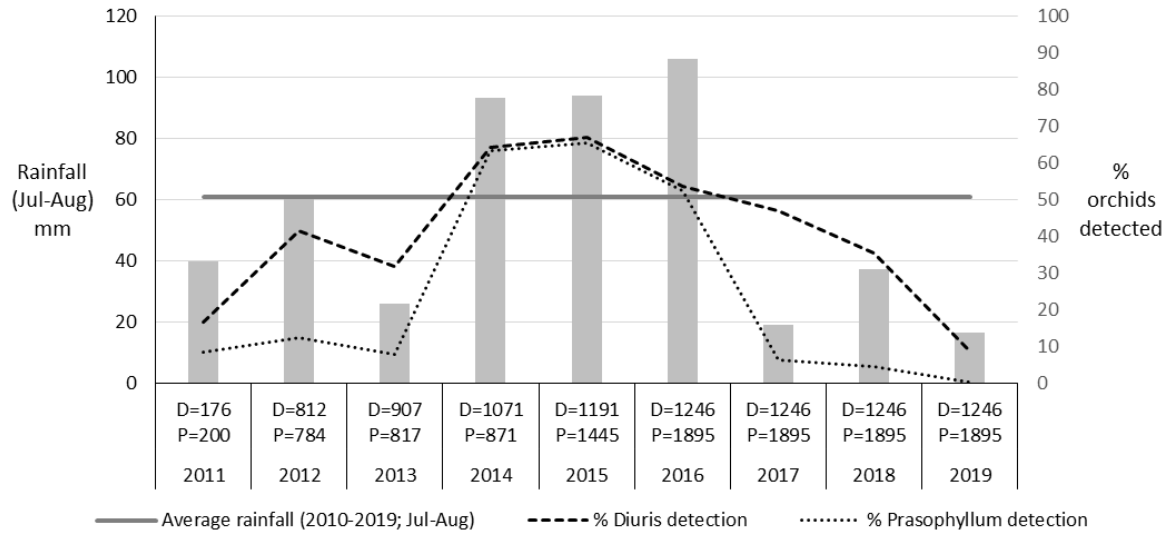


Figure 8 Rainfall received (July to August) and orchid detection (n=2,592) during the course of monitoring across nine recipient plots within derived grassland at Mangoola, over a period of four to nine years (after Bell 2019a).

43. 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 ≤ -4 degrees Celsius [°C]) 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 reduced flowering due to frosts also applies to the Hunter Valley population where these are rarer.

44. 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

45. 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. There is also some evidence to show that environmental factors such as rainfall and fire can alter the specific fungi required during different life stages of an orchid species

(e.g. Jasinge *et al*. 2018). Brundrett (2006) summarised the interaction between all of these factors for orchid persistence, stressing 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.

46. 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 not necessarily reflect observable current-day 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

47. For *Diuris*, the *Tulasnella* genus (family Tulasnellaceae) is the most important mycorrhizal fungi (Weston *et al*. 2005; Smith *et al*. 2010). At Mangoola Coal Mine, 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

48. Weston *et al*. (2005) suggest that the genus *Ceratobasidium* (family Ceratobasidiaceae) is the likely mycorrhizal fungi for *Prasophyllum*, 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 on the important fungi for this species is required.

2.4.2.3 Pterostylis chaetophora

49. Like *Prasophyllum*, the genus *Ceratobasidium* is thought to be the main likely mycorrhizal fungi required for *Pterostylis* (Weston *et al*. 2005). Jusaitis and Sorensen (1993) isolated mycorrhizal fungi from *Pterostylis arenicola* (closely related to *Pterostylis chaetophora*) but did not identify the relevant species. Two species of *Ceratobasidium* fungi were isolated for the common and distantly related *Pterostylis nutans* (Irwin *et al*. 2007), while for *Pterostylis acuminata* a different fungus (*Rhizoctonia solani*) has been implicated (Perkins & McGee 1995). Few other studies within this genus are evident in the literature.

2.4.3 Pollination and Seed Production

50. Pollination in *Diuris*, *Prasophyllum* and *Pterostylis* (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.

51. 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 Mine 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

52. Most *Diuris* 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* are likely to be various colletid bees from the *Trichocolletes* and *Leioproctus* genera, although Walker (1997) suggested opportunistic native halictid bees from the genus *Lasioglossum* were potential pollinators of *Diuris basaltica*. Indsto *et al*. (2006) found male colletid bees of the species *Trichocolletes venustus* to be the primary pollinators of *Diuris maculata* in Sydney.

2.4.3.2 Prasophyllum petilum

53. *Prasophyllum* 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 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 and Burns-Balogh (1986) found that polytrophic flies (family Syrphidae) and opportunistic male bees in the genus *Leioproctus* (family Colletidae) were the principal pollinators.

2.4.3.3 Pterostylis chaetophora

54. For *Pterostylis*, 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*, 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) determined that 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 promotes the wider distribution in this subgenus.

2.4.4 Reproduction and Dispersal

55. 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 ('dust-like'), 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 relative to seed release height 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.

56. Seed dispersal by wind often results in a spatial distribution of orchids consistent with the prevailing winds at the time of capsule dehiscence. I have mapped several Spring flowering orchid populations in the Hunter region which follow a south-west to north-east spread, and these often match reported wind directions. At Columbey National Park, for example, the most frequently occurring winds during November-December blow in a north-easterly direction which corresponds with the mapped distribution of *Pterostylis chaetophora* there (unpubl. data).

2.4.4.1 Diuris tricolor

57. As a genus, *Diuris* 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 localised spread through seed dispersal, and this has been demonstrated through recruitment following translocation experiments (Bell in review 2).

2.4.4.2 Prasophyllum petilum

58. 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.), again consistent with localised seed dispersal.

2.4.4.3 Pterostylis chaetophora

59. In *Pterostylis*, 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

60. A Baseline Flora Report for the Project has been prepared by Hunter Eco (2020). This report details the extent of previous and new surveys of vegetation and flora across the Subject land and surrounds, 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 of the three target orchid species within the Project Area.

61. However, I am well acquainted with the vegetation and habitats of the Project Area following an intensive 18-day plot-based vegetation survey there between March and May 2020. This was undertaken on a sub-contract basis to Hunter Eco, who were managing the flora assessment component of the Project. Surveys undertaken at this time collected data from 123 standard 0.04 ha sample plots, across eight mapped Plant Community Types (PCTs) and 16 vegetation zones, over an area of approximately 1,687 ha. Figure 9 summarises the distribution of these 123 plots in relation to the Project Area.

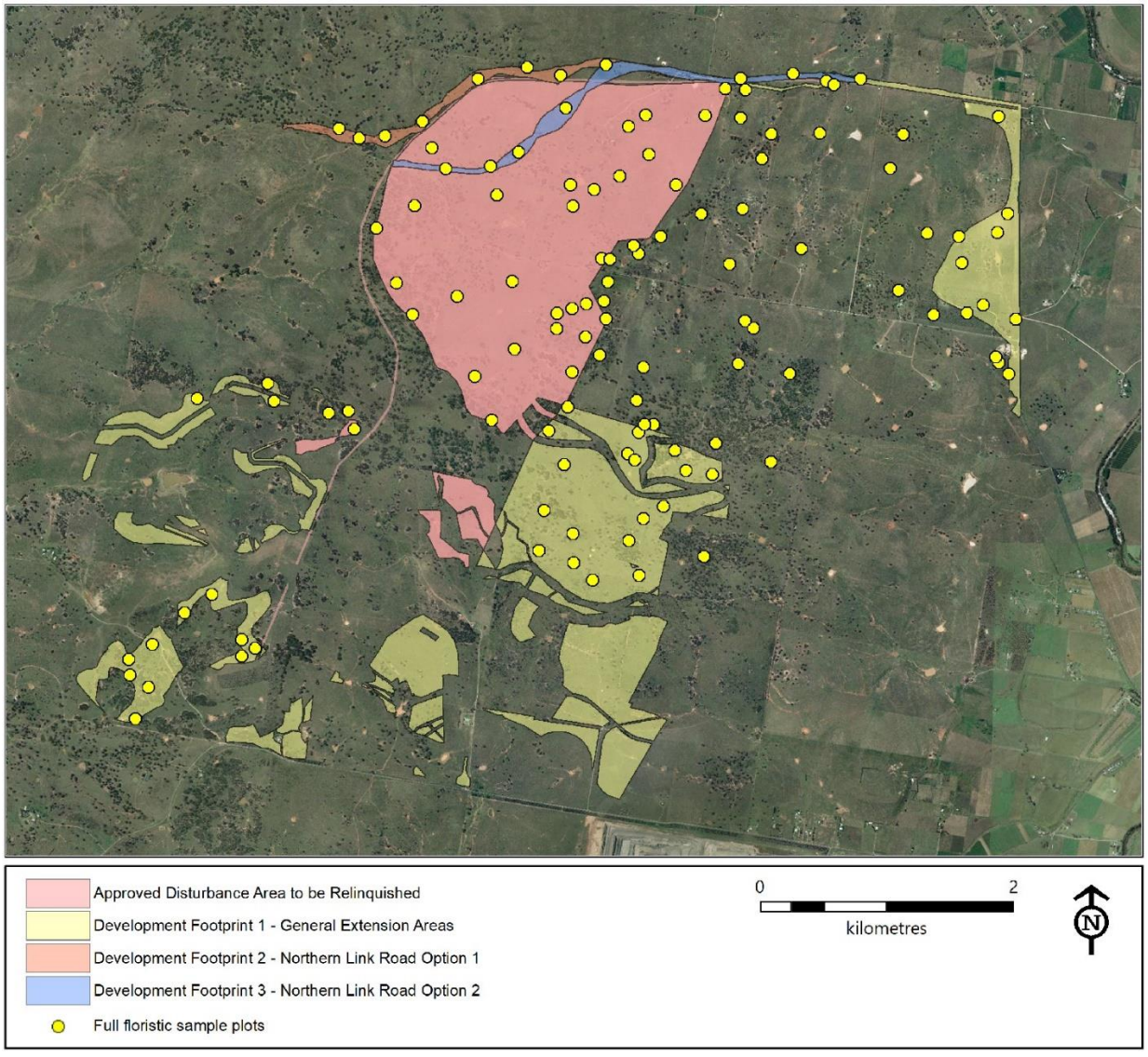


Figure 9 Distribution of full floristic sample plots completed between March and May 2020.

62. This survey during March-May followed good falls of rain in the upper Hunter, and hence species diversity and growth was very impressive. Several species were observed that are rarely reported in the Hunter Valley, and some had not been collected for over 100 years (but were represented in the BioNet database). While undertaking this survey, I was cognisant of the possibility that I may be asked for an opinion on the likely presence of threatened orchids in these habitats, so paid particular attention to areas that may potentially support them. I have used this first-hand knowledge to inform my assessment of orchid presence (detailed in Section 4).

63. Following the collection of plot data mentioned above, Hunter Eco classified and mapped vegetation communities with reference to 3,214 rapid data points previously collected across the Project Area. These communities were equated to PCTs by Hunter Eco, and I then viewed both the map and the accompanying floristic profiles to determine which of these might support viable orchid populations. Based on experience at Mangoola Coal Mine and elsewhere, I considered that two PCTs (1605: *Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*, and 1691: *Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter*) showed some potential to support *Diuris tricolor* and *Prasophyllum petilum*, but none were suitable for *Pterostylis chaetophora*. During early October 2020, myself and Dr Colin Driscoll of Hunter Eco then spent two days inspecting these areas and undertaking walked transects looking for orchids (further detailed in Section 3.1), as a forerunner to more detailed surveys should evidence be found for orchid presence.

64. No threatened flora species were recorded by Hunter Eco (2020) or I during field surveys, although six previously recorded individuals of *Cymbidium canaliculatum* (an endangered population in the Hunter Catchment) were reported in Hunter Eco (2020). The possibility that *Diuris tricolor, Prasophyllum petilum* and/or *Pterostylis chaetophora* may occur within the Project Area would, when following the required survey guidelines (DPIE 2020b), necessitate a large amount of field surveys across the approximately 409 ha of PCTs 1605 and 1691. Given the restricted flowering and survey windows available to detect these orchids, a more achievable avenue of assessment was to prepare this Expert Report (allowable under the BAM [DPIE 2020a]). This option is therefore justified based on the otherwise extensive survey required within a limited survey window.

3.1 Survey Effort

65. Hunter Eco (2020) details (in Section 5 and Table 2) the extent to which the Project Area and wider Subject land have been subject to flora and vegetation surveys. Investigations shown there and elsewhere as occurring within the current Project Area include:

- ERM (1997) – Mount Pleasant Environmental Impact Statement flora and fauna surveys
- Cumberland Ecology (2006) – Mount Pleasant flora and fauna assessment
- Cumberland Ecology (2007a) – Box-Gum woodland analysis
- Cumberland Ecology (2007b) – Mount Pleasant flora plot and targeted surveys
- Cumberland Ecology (2009) – Mount Pleasant flora plot and targeted surveys
- Cumberland Ecology (2010) – Mount Pleasant flora plot and targeted surveys
- Cumberland Ecology (2015) – Mount Pleasant flora and vegetation surveys
- Eco Logical Australia (2017) – Mount Pleasant targeted orchid surveys
- Hunter Eco (2017a) – Mount Pleasant flora and vegetation surveys
- Hunter Eco (2017b) – Mount Pleasant rail flora and vegetation surveys

- Hunter Eco (2020) – Mount Pleasant flora plot and targeted surveys

66. Table 6 summarises the timing of field survey for each of these investigations (where documented), relative to expected flowering periods (i.e. detectability) of the three target orchids. It is evident that some of these survey periods corresponded with peak flowering times in the three target orchids, but many did not. Surveys in early October 2007 by Cumberland Ecology (2007b), Eco Logical Australia in early October 2016 (Eco Logical Australia 2017), late September 2017 by Hunter Eco (2017a) and early October 2020 by Hunter Eco (2020) did not locate any threatened orchids.

Table 6 Field survey effort (grey) and peak orchid flowering periods (black). ERM = Environmental Resources Management Australia Pty Ltd; CE = Cumberland Ecology; ELA = Eco Logical Australia; 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. Projects with no survey periods shown were not evident in reports.

	J	F	M	A	M	J	J	A	S	O	N	D
ERM 1997												
CE 2006												
CE 2007a												
CE 2007b												
CE 2009												
CE 2010												
CE 2015												
ELA 2017												
HE 2017a												
HE 2017b												
HE 2020												
D. tricolor												
P. petilum												
P. chaetophora												

67. During the targeted orchid surveys completed in early October 2020, approximately 51 km of transect were undertaken by two observers (myself and Dr Colin Driscoll) within habitats which I considered offered the best potential to be inhabited by *Diuris tricolor* or *Prasophyllum petilum*. These habitats were the Narrow-leaved Ironbark – Grey Box Grassy Woodland and Derived Native Grassland (Units 4 and 4a of Hunter Eco 2020; PCT1691), and the Narrow-leaved Ironbark Shrubby Forest and Derived Native Grassland (Units 6 and 6a of Hunter Eco 2020; PCT1605). These communities were considered to potentially provide habitat for these orchids based on areas known to support them elsewhere where *Eucalyptus crebra* is prominent in the canopy. Figure 10 shows the distribution of these habitats and the targeted searches undertaken. No orchids were seen during any of these searches.

68. Throughout all targeted threatened species searches and floristic plot surveys, and from the data available to me, no terrestrial orchids of any kind have been located across the Project Area or surrounds by any of the many workers surveying the area. A low diversity of terrestrial orchids is not unusual for this part of the Hunter Valley, based on reported sightings contained in flora databases. Further discussion on the importance of this general lack of terrestrial orchids is presented in Section 4.3.

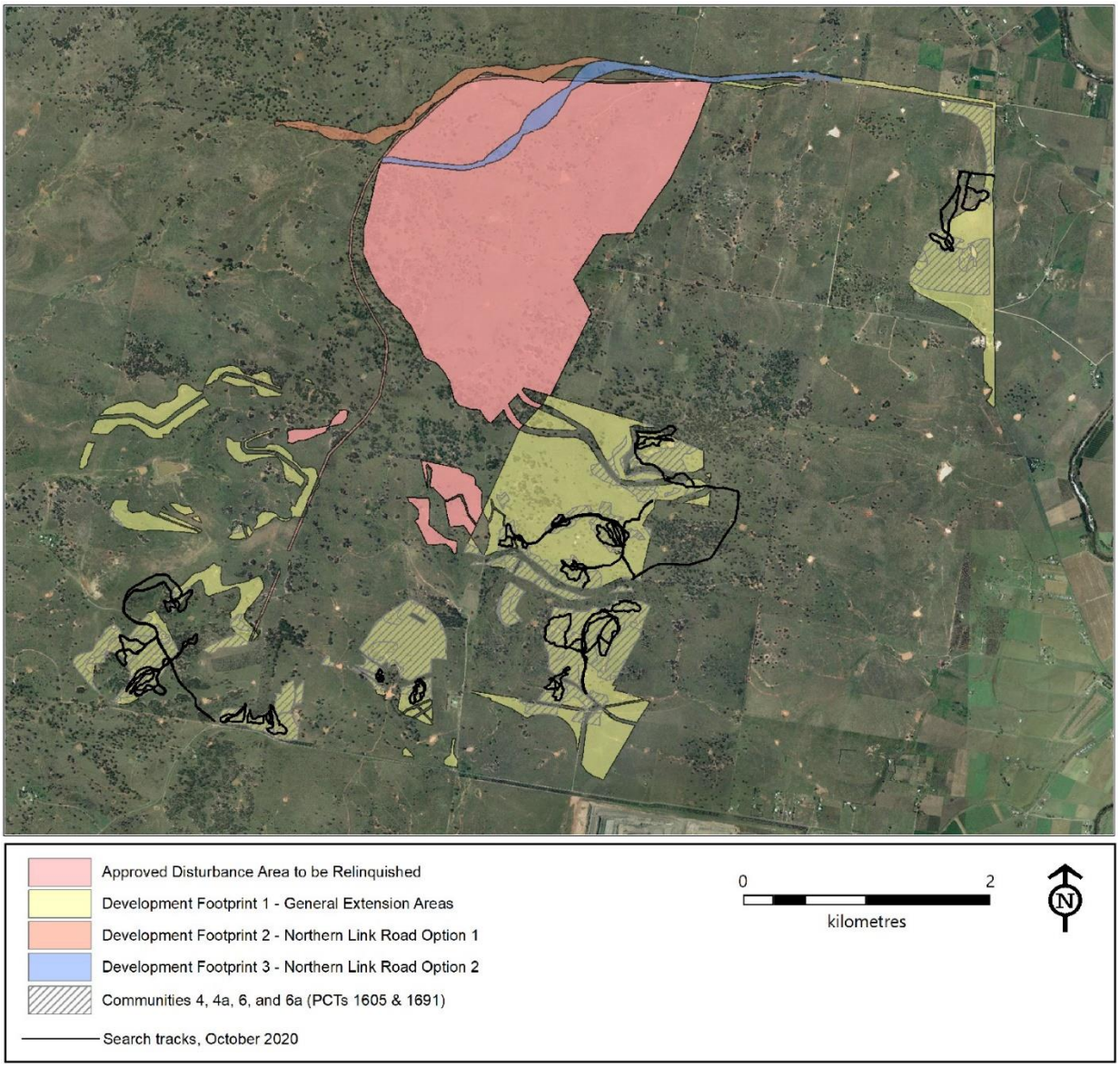


Figure 10 Targeted orchid surveys undertaken within selected portions of the Project Area, 1-2 October 2020.

3.2 Impact of Drought

69. 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 (2017-2019) in the Hunter Valley have been particularly dry. Figure 11 shows that, apart from the very wet months of March 2017, March 2019, and September 2019, average or below-average rainfall has been received from 2017 to 2019 at Muswellbrook. A wetter year has occurred during 2020, with well above-average falls in February, April and July, and near-average falls in January, May, June and September. Dry conditions 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.

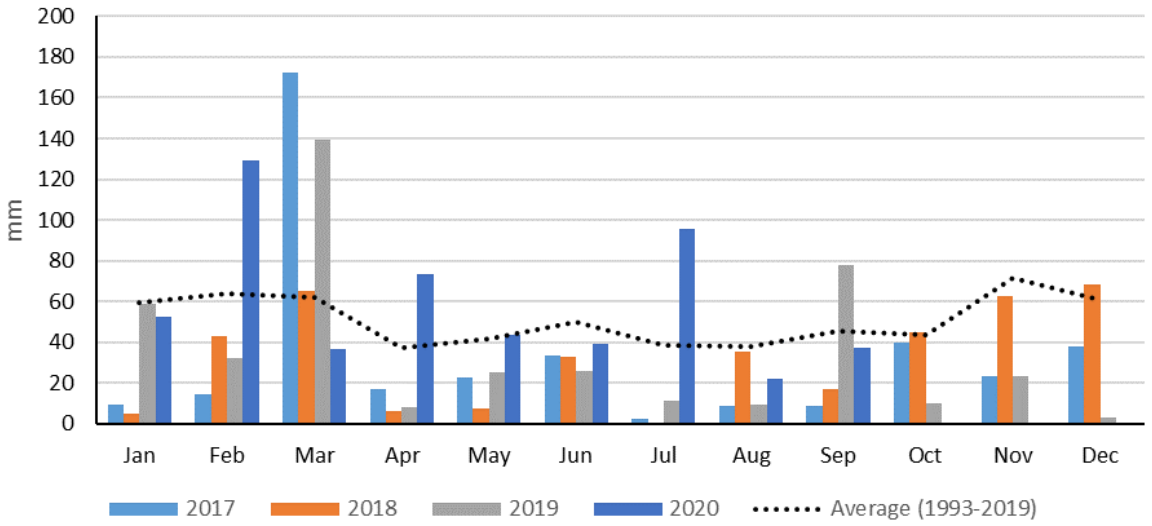


Figure 11 **Monthly and average rainfall for Muswellbrook (station # 61374; c. 6 km from the Project Area) over the past four years.** (Source: Bureau of Meteorology 2020).

70. 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 based on three indices (rainfall index, plant growth index, soil water index). The Ellis Parish (which includes the Project Area) formally experienced varying levels of drought from January 2013 to March 2020 (Figure 12). Intense Drought was experienced between April 2018 and January 2019 (encompassing the 2018 orchid flowering period), and Drought for most of 2019 (including the 2019 orchid flowering season). Clearly, any targeted orchid surveys undertaken during the 2018 and 2019 flowering seasons would be unlikely to detect representative populations of orchids if present.

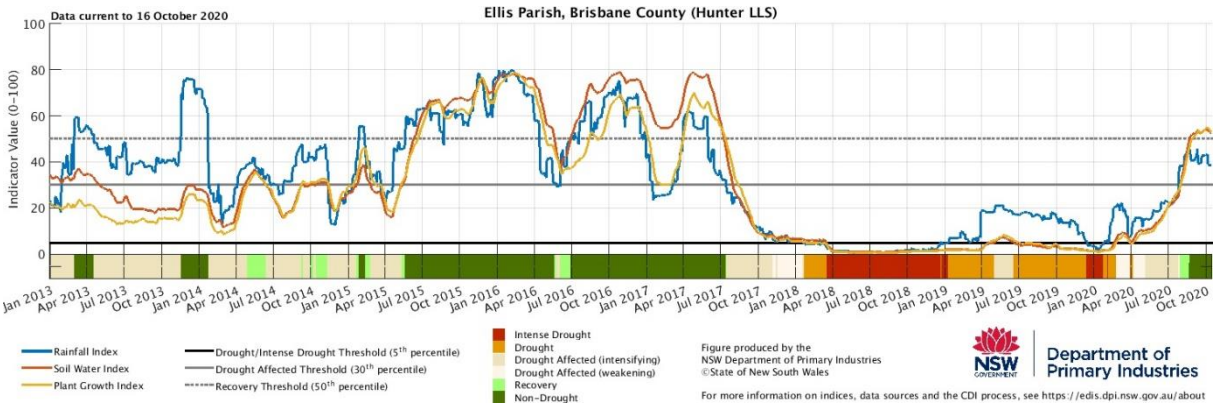


Figure 12 **Drought indices for the Ellis Parish, January 2013 to October 2020, showing Intense Drought from April 2018 to January 2019 and December 2019 to January 2020, prior to wetter conditions and a return to non-drought.** (Source: DPI 2020).

71. 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 over the last few years, and in particular during the Autumn and Winter periods leading up to and including September-October orchid flowering, results from targeted orchid surveys could be misleading. Even during the better conditions experienced in 2020, there is a certain amount of recovery required in the ground flora following prolonged drought. 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 resulting in reduced detection rates during survey. Desiccation through heat and wind in periods of drought will also lessen above-ground periods of flowering orchids.

72. Although the 2020 flowering season for orchids has been the best for several years, the extent of possible habitat (as determined through specified PCT linkage following the BAM [DPIE 2020a]) requiring detailed and intensive survey as per DPIE (2020b) guidelines during a limited flowering window is prohibitive, and this provides justification for this report as an alternative for assessing the likely presence of *Diuris tricolor*, *Prasophyllum petilum* and/or *Pterostylis chaetophora* within the Project Area.

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

73. 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 over 18 days collecting floristic data at Mount Pleasant from March to May 2020, together with some targeted orchid searches on 1-2 October 2020 in areas within the Project Area considered by me to be most likely to support the target species.

4.1 Project Area Attributes

4.1.1 Land-use History

74. As with much of Australia and NSW, the original ecosystems of the 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 sheep and cattle, 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, remnant woodlands, regrowth native and exotic woody vegetation, or planted species (Hunter Eco 2020).

75. Although cattle and sheep have historically grazed the Project Area for over 100 years (Hunter Eco 2020), they have been removed or reduced in number during recent years. It is unknown whether cattle (or sheep) were present across the Project Area during previous flora survey times indicated in Table 6 above, although at least one report (Eco Logical Australia 2017) makes note of their presence. On the surface, all the derived grasslands which now predominate throughout the Project Area potentially provide habitat for orchids including *Diuris tricolor* and *Prasophyllum petilum*, but this is further explored in the following sections.

4.1.2 Existing Orchid Records

76. No populations of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* have been recorded within the Project Area (Hunter Eco 2020). As noted in Section 3.1, a number of flora survey programs (11) have occurred across the Project Area from 1997, but only four of these have coincided with orchid flowering times. Surveys performed by Cumberland Ecology (2007b) in October of that year followed a very wet Winter period (370 millimetres [mm] at the nearby Mangoola Coal Mine, 254 mm above the long-term average), but a dry September-October (28 mm, compared to the long-term average of 88 mm). As noted elsewhere, soil moisture availability during Winter is critical in the emergence of Spring-flowering orchids. Importantly, neither the 83 full floristic plots (68 within the Project Area) nor the targeted surveys completed by Cumberland Ecology (2007b, as reported in Hunter Eco 2020) recorded any Spring-flowering terrestrial orchid species, despite the likely more than adequate soil moisture availability.

77. Surveys by Hunter Eco (2017a) in September and Eco Logical Australia (2017) in October 2017 also failed to locate any terrestrial orchids, however apart from March that year rainfall was

below average for 11 of the 12 months. The absence of orchids recorded during both survey periods is therefore not unexpected.

78. The most recent surveys conducted by myself and Dr Colin Driscoll in October 2020, documented in Hunter Eco (2020), also failed to detect any terrestrial orchids. These targeted searches examined areas of habitat which I considered most likely to support *Diuris tricolor* and/or *Prasophyllum petilum*, based on habitat (PCTs 1605 and 1691). Most of 2020 to date has received above-average rainfall in the Muswellbrook district, with the Winter period receiving 157 mm, 30 mm above the long-term average, while September-October has been around average. It may be expected then that at least some terrestrial orchids would have been visible during early October, particularly when orchids were flowering well at Mangoola Coal Mine at this time.

79. This lack of detection of the three target species (or any terrestrial orchid) over three October flowering periods (2007, 2017, 2020) alludes to the potential unsuitability of the Project Area for these species. Even during drought periods, it is normal for some of the more common orchid species to be detected (e.g. *Microtis unifolia, Pterostylis bicolor*), but survey evidence to date has found none. This points to a possible lack of appropriate soil mycorrhizal fungi in the area, further discussed in Section 4.2.

4.1.3 Vegetation Communities

80. 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, I was able to gain first-hand knowledge of the Project Area through the floristic sampling program undertaken between March and May 2020, on behalf of MACH and documented in Hunter Eco (2020). This survey period coincided with good falls of rain in early 2020 and an abundance of grass and forb growth. During this period, 123 full floristic plots were completed across all habitats within and outside of the Project Area. No Spring-flowering orchids were observed, although the leaves of *Diuris tricolor* would be visible if they were present.

81. This period of field inspection over 18 days also provided me with a thorough understanding of the vegetation communities present across the Project Area, although I did not undertake any analysis of plot data. Numerical analysis of data (n=123) was completed by and reported in Hunter Eco (2020), wherein eight native vegetation communities and seven PCTs were delineated. Each of these comprised a 'woody' (remnant woodland) and 'grassland' (DNG) component (with the exception of PCT 1655, which was only present as DNG). DNG units were assumed to have been derived from previously cleared woodland of that type based on scattered paddock tree identity. Non-native habitats (cropping and grazing land, dams, disturbed areas, dwellings and infrastructure) were also demarcated and mapped. Based on my field experience across the Project Area, I consider this analysis to be a good representation of the ground situation, and it and my own experience has been used to formulate an opinion on the likelihood of *Diuris tricolor*, *Prasophyllum petilum* and/or *Pterostylis chaetophora* potentially occurring within the Project Area (summarised in Section 4.5).

4.1.3.1 Plant Community Types

82. The seven PCTs delineated by Hunter Eco (2020) for the Project Area also occur elsewhere in the Hunter Valley (PCTs 483, 618, 1602, 1605, 1606, 1655, 1691; Table 7). Derived Native Grasslands (DNG), which provide substantial habitat for *Diruis tricolor* and *Prasophyllum*

petilum in other areas, are represented here by all seven PCTs. Collectively, 1,077 ha (or 64% of the total mapped area) of DNG are present within the Project Area. Approximately two-thirds of the 1,077 ha of DNG is comprised of native grasslands derived from Grey Box x White Box Grassy Woodland (Unit 1a; 62%), followed by Narrow-leaved Ironbark Shrubby Forest DNG (Unit 6a; 24%), and Grey Box x White Box – Spotted Gum Grassy Woodland (Unit 2a; 12%). Communities 1a and 2a comprise PCT 483 (Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley), while community 6a (PCT1605) is prevalent on the Permian sediments of the Hunter Valley floor. All other grassland communities each occupy <2% of the total DNG within the Project Area.

Table 7 Vegetation communities and Plant Community Types identified for the Project Area (from Hunter Eco 2020). Condition classes within PCTs not shown.

Community	Plant Community Type (PCT)	Extent (ha, %)
1: Grey Box x White Box Grassy Woodland	483: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	138.0 (8.2%)
1a: Derived Native Grassland	483: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG	664.9 (39.4%)
2: Grey Box x White Box – Spotted Gum Grassy Woodland	483: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	236.3 (14.0%)
2a: Derived Native Grassland	483: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley - DNG	129.3 (7.7%)
3: Forest Red Gum Grassy Open Forest	618: White Box x Grey Box – Red Gum – Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	3.0 (0.2%)
3a: Derived Native Grassland	618: White Box x Grey Box – Red Gum – Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley - DNG	7.3 (0.4%)
4: Narrow-leaved Ironbark – Grey Box Grassy Woodland	1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	23.3 (1.4%)
4a: Derived Native Grassland	1691: Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter - DNG	0.8 (0.05%)
5: Spotted Gum - Narrow-leaved Ironbark Woodland	1602: Spotted Gum – Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter	21.5 (1.3%)
5a: Derived Native Grassland	1602: Spotted Gum – Narrow-leaved Ironbark shrub-grass open forest of the central and lower Hunter - DNG	1.6 (0.1%)
6: Narrow-leaved Ironbark Shrubby Forest	1605: Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	105.4 (6.3%)

Community	Plant Community Type (PCT)	Extent (ha, %)
6a: Derived Native Grassland	1605: Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - DNG	257.3 (15.3%)
7: White Box – Narrow-leaved Ironbark – Blakely's Red Gum	1606: White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter	3.2 (0.2%)
7a: Derived Native Grassland	1606: White Box – Narrow-leaved Ironbark – Blakely's Red Gum shrubby open forest of the central and upper Hunter - DNG	12.9 (0.8%)
8a: Derived Native Grassland	1655: Grey Box – Slaty Box shrub-grass woodland on sandstone slopes of the upper Hunter and Sydney Basin - DNG	3.2 (0.2%)
Plantation, Dams etc	n/a	79.3 (4.7%)
	Total	**1,687.3**

83. Examining the floristic composition and condition of defined vegetation communities presented in Hunter Eco (2020) 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 also Section 4.2). In this regard, Table 8 summarises the key floristic elements of the eight 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 of Hunter Eco (2020).

84. For the most widespread communities within the Project Area (Unit 1, 1a, 2, 2a; 69% of total area), herb-rich grasslands dominated by *Dichanthium sericeum subsp. sericeum, Aristida ramosa, Chloris ventricosa, Bothriochloa decipiens var. decipiens, Cymbopogon refractus, Panicum queenslandicum var. queenslandicum, Chloris truncata and Eriochloa pseudoacrotricha*, with high abundance of exotic species (particularly *Carthamus lanatus* and *Lysimachia arvensis*), characterises these areas (Hunter Eco 2020). In my experience, these diverse grasslands growing on clay-based soils derived from former Box landscapes tend not to support extensive populations of *Diuris tricolor, Prasophyllum petilum* or *Pterostylis chaetophora* (or few other terrestrial orchids).

85. The next most abundant communities within the Project Area are Narrow-leaved Ironbark Shrubby Forest (Unit 6; 6% of total area) and native grasslands (DNG) derived from that community (Unit 6a; 15% of total area). These areas are typified by grasslands of *Aristida ramosa, Bothriochloa decipiens var. decipiens, Microlaena stipoides var. stipoides, Digitaria divaricatissima, Eriochloa pseudoacrotricha, Dichanthium sericeum subsp. sericeum, Digitaria brownii, Panicum effusum, Chloris truncata, Eragrostis lacunaria* and *Enteropogon acicularis*. Although these areas are superficially similar to areas outside of the Project Area known to support the target orchids, they still support a richer composition than is evident elsewhere. Section 4.1.3.2 examines these observations in a more tangible way.

Table 8 Dominant species within defined vegetation communities (from Hunter Eco 2020). * = exotic species. Individual % contributions shown for upper 50% of diversity for that community,

except for Communities 4a and 5a where only single plots were sampled; in these cases, the upper 12 dominant species only are shown.

Community	**Dominant Species (upper 50%, in decreasing order of importance)**
1: Grey Box x White Box Grassy Woodland	*Eucalyptus albens x moluccana (6.33), Chloris ventricosa (4.07), Bothriochloa decipiens var. decipiens (3.99), Aristida ramosa (3.66), Glycine tabacina (3.33), Dichanthium sericeum subsp. sericeum (3.12), Brunoniella australis (3.01), Cymbopogon refractus (2.91), Chrysocephalum apiculatum (2.79), Calotis lappulacea (2.60), Panicum queenslandicum var. queenslandicum (2.40), Eragrostis lacunaria (2.38), Convolvulus graminetinus (2.34), Oxalis perennans (2.19), Einadia polygonoides (2.16), Eremophila debilis (1.96), *Medicago sp. (1.96)*
1a: Derived Native Grassland (Grey Box x White Box Grassy Woodland)	*Dichanthium sericeum subsp. sericeum (6.34), *Carthamus lanatus (4.84), Aristida ramosa (4.14), Chloris ventricosa (4.14), Bothriochloa decipiens var. decipiens (4.02), Glycine tabacina (4.02), *Lysimachia arvensis (4.02), Cymbopogon refractus (3.71), Panicum queenslandicum var. queenslandicum (3.66), Wahlenbergia communis (3.62), Chloris truncata (3.26), Eriochloa pseudoacrotricha (2.80)*
2: Grey Box x White Box - Spotted Gum Grassy Woodland	*Eucalyptus albens x moluccana (4.10), Brunoniella australis (3.90), Glycine tabacina (3.90), Bothriochloa decipiens var. decipiens (3.36), Aristida ramosa (3.36), Asperula conferta (3.31), Chloris ventricosa (3.26), Lomandra confertifolia subsp. pallida (3.07), Cymbopogon refractus (2.90), *Lysimachia arvensis (2.82), Dichondra repens (2.80), Chamaesyce drummondii (2.55), Wahlenbergia communis (2.53), Convolvulus graminetinus (2.44), Rostellularia adscendens var. adscendens (2.33), Chrysocephalum apiculatum (2.23), Oxalis perennans (2.16)*
2a: Derived Native Grassland (Grey Box x White Box - Spotted Gum Grassy Woodland)	*Dichanthium sericeum subsp. sericeum (6.61), Panicum queenslandicum var. queenslandicum (5.70), *Carthamus lanatus (5.50), Bothriochloa decipiens var. decipiens (5.31), Eriochloa pseudoacrotricha (5.24), Glycine tabacina (4.47), Aristida ramosa (4.32), Digitaria divaricatissima (4.32), *Lysimachia arvensis (4.06), Cymbopogon refractus (3.95), Einadia polygonoides (2.92)*
3: Forest Red Gum Grassy Open Forest	*Austrostipa verticillata (9.09), Dichondra repens (9.09), Eriochloa pseudoacrotricha (9.09), Glycine tabacina (9.09), *Hypochaeris albiflora (9.09), Microlaena stipoides var. stipoides (9.09), *Bidens subalternans (4.55), Calotis lappulacea (4.55), *Galenia pubescens (4.55), Glycine clandestine (4.55), *Paspalum dilatatum (4.55), *Plantago lanceolata (4.55), *Senecio madagascariensis (4.55), *Sida rhombifolia (4.55)*
3a: Derived Native Grassland (Forest Red Gum Grassy Open Forest)	*Panicum queenslandicum var. queenslandicum (10.76), Dichanthium sericeum subsp. sericeum (8.25), Digitaria divaricatissima (5.77), Einadia polygonoides (4.95), Aristida ramosa (4.95), Bothriochloa decipiens var. decipiens (4.95),*

Community	Dominant Species (upper 50%, in decreasing order of importance)
	*Eriochloa pseudoacrotricha (4.95), Glycine tabacina (4.95), *Carthamus lanatus (4.95)*
4: Narrow-leaved Ironbark - Grey Box Grassy Woodland	*Eucalyptus crebra (5.77), Eucalyptus moluccana (5.77), Microlaena stipoides var. stipoides (4.49), Eremophila debilis (3.85), Sida corrugata (3.85), Aristida ramosa (3.85), Chloris ventricosa (3.85), Eragrostis leptostachya (3.85), Lomandra confertifolia subsp. pallida (3.85), Desmodium varians (3.85), Glycine tabacina (3.85), Dichondra repens (2.57), Pimelea curviflora var. sericea (2.57)*
4a: Derived Native Grassland (Narrow-leaved Ironbark - Grey Box Grassy Woodland)	Insufficient data to generate diagnostic species with % contributions. However, dominant species from the sole plot sampled included *Enteropogon acicularis, Dichanthium sericeum var. sericeum, Eriochloa pseudoacrotricha, Aristida ramosa, Bothriochloa decipiens var. decipiens, Digitaria brownii, Paspalidium aversum, Chloris ventricosa, Microlaena stipoides var. stipoides, Chrysocephalum apiculatum, Fimbristylis dichotoma, *Carthamus lanatus*
5: Spotted Gum - Narrow-leaved Ironbark Woodland	*Corymbia maculata (5.07), Eucalyptus crebra (3.68), Bothriochloa decipiens var. decipiens (3.55), Brunoniella australis (3.38), Calotis lappulacea (3.38), Dichondra repens (3.38), Sida corrugata (3.38), Aristida ramosa (3.38), Lomandra confertifolia subsp. pallida (3.38), Glycine tabacina (3.38), Cyperus gracilis (2.72), Eremophila debilis (2.69), Glossocardia bidens (2.69), Cymbopogon refractus (2.69), Cheilanthes sieberi subsp. sieberi (2.69), Oxalis perennans (2.66)*
5a: Derived Native Grassland (Spotted Gum - Narrow-leaved Ironbark Woodland)	Insufficient data to generate diagnostic species with % contributions. However, dominant species from the sole plot sampled included *Chloris ventricosa, Aristida ramosa, *Glandularia aristigera, Calotis lappulacea, Eriochloa pseudoacrotricha, Cymbopogon refractus, Chrysocephalum apiculatum, Glycine tabacina, Cheilanthes sieberi subsp. sieberi, Sida corrugata, Enteropogon acicularis, *Sida rhomibifolia*
6: Narrow-leaved Ironbark Shrubby Forest	*Eucalyptus crebra (8.91), Calotis lappulacea (4.31), Microlaena stipoides var. stipoides (4.26), Bothriochloa decipiens var. decipiens (4.17), Aristida ramosa (4.11), Glycine tabacina (4.11), *Sida rhombifolia (3.63), Austrostipa verticillata (3.51), Chrysocephalum apiculatum (3.42), Eriochloa pseudoacrotricha (3.22), Eremophila debilis (2.53), *Galenia pubescens (2.39), Enteropogon acicularis (2.37)*
6a: Derived Native Grassland (Narrow-leaved Ironbark Shrubby Forest)	*Aristida ramosa (5.37), Bothriochloa decipiens var. decipiens (5.10), Cheilanthes sieberi subsp. sieberi (4.91), Digitaria divaricatissima (4.68), Eriochloa pseudoacrotricha (4.19), Dichanthium sericeum subsp. sericeum (3.95), Digitaria brownii (3.94), Glycine tabacina (3.89), *Carthamus lanatus (3.86), Panicum effusum (3.71), Chloris truncata (3.27), *Lysimachia arvensis (2.93), Eragrostis lacunaria (2.90)*

Community	Dominant Species (upper 50%, in decreasing order of importance)
7: White Box - Narrow-leaved Ironbark - Blakely's Red Gum	*Aristida ramosa (4.76), Bothriochloa decipiens var. decipiens (4.19), Eucalyptus blakelyi (3.92), Chrysocephalum apiculatum (3.66), Cymbopogon refractus (3.66), Glycine tabacina (3.66), Eremophila debilis (2.95), Phyllanthus virgatus (2.95), *Plantago lanceolata (2.95), Enteropogon acicularis (2.91), Microlaena stipoides var. stipoides (2.80), Panicum queenslandicum var. queenslandicum (2.37), Calotis lappulacea (2.36), Eriochloa pseudoacrotricha (2.24), *Sida rhombifolia (2.23), Brunoniella australis (2.20), Wahlenbergia communis (2.20)*
7a: Derived Native Grassland (White Box - Narrow-leaved Ironbark - Blakely's Red Gum)	*Digitaria divaricatissima (4.96), Aristida ramosa (4.81), Digitaria brownii (4.45), Panicum effusum (4.39), Glycine tabacina (4.04), *Sida rhombifolia, Oxalis perennans (3.43), Cheilanthes sieberi subsp. sieberi (3.43), Bothriochloa decipiens var. decipiens (3.36), *Medicago sp. (3.34), Panicum queenslandicum var. queenslandicum (2.98), Dichanthium sericeum subsp. sericeum (2.93), Eriochloa pseudoacrotricha (2.93), *Carthamus lanatus (2.88)*
8a: Derived Native Grassland (Slaty Box Woodland)	*Bothriochloa decipiens var. decipiens (6.92), Aristida ramosa (5.78), Panicum effusum (5.78), *Carthamus lanatus (5.78), Chloris ventricosa (5.01), Eragrostis lacunaria (5.01), Eriochloa pseudoacrotricha (4.98), Oxalis perennans (4.61), Dichanthium sericeum subsp. sericeum (4.61), Enteropogon acicularis (4.61)*

4.1.3.2 Comparative Numerical Analyses

86. To further explore floristic compositions between the Project Area and known orchid habitat elsewhere (Mangoola Coal Mine 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 surveys 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 (2020) to classify the vegetation within the Project 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.

87. I undertook two procedures for this comparative analysis, one using current grassland data collected in 2020 (Contemporary Analysis) and the other comparing 2020 data with that sampled up to ten years previously (Historical Analysis). All floristic plot data examined in the following analyses have been collected by me.

88. Contemporary Analysis – For the Contemporary Analysis, I extracted all grassland floristic plot data sampled from the Project Area between March and May 2020 and analysed them with newly collected data (also in May 2020, using identical methods and plot size) from Mangoola where I knew *Diuris tricolor* and *Prasophyllum petilum* occurred. This analysis involved comparing the floristics between 107 grassland plots from the Project Area with six grassland plots from known orchid habitat at Mangoola. While there is considerable discrepancy in sample size between the two datasets, the aim here was to determine whether grassland floristic composition from the Project Area was similar to Mangoola, all sampled in the same

season. Available time prevented a larger dataset from Mangoola being compiled at this time, however any trends should still be evident.

89. I used the SIMPROF routine in combination with the CLUSTER module in Primer to identify statistically significant splits in the dataset ($p<0.01$), although in this case the goal was not to produce a floristic classification of all 113 plots but to determine if plots from Mangoola assimilated within the Project Area plots. This provided a cluster diagram where sites supporting similar floristic combinations were grouped and linked to their most similar neighbours. I also ran the nMDS (non-metric Multi-Dimensional Scaling) routine with a minimum stress level of 0.01 and 25 restarts to produce an ordination plot of the same data.

90. Figure 13 shows the nMDS chart where four of the six Mangoola plots position well distant from the remainder of the dataset. This diversion from the main group occurred at 28% similarity and was the first significant split seen, indicating marked differences in floristic composition between these four plots and all other data. These plots were all located within landscapes formerly dominated by *Eucalyptus crebra*. The remaining two Mangoola plots aligned within the remaining Project Area data (although within their own significant cluster: i.e. supporting a different floristic composition), suggesting some overlap in floristic compositions but with sufficient differences to not be the same. These two plots were in landscapes of *Eucalyptus dawsonii*, with one also supporting *Eucalyptus moluccana* nearby. Importantly, none of the six Mangoola plots were within or near to landscapes formerly dominated by *Eucalyptus albens x moluccana*.

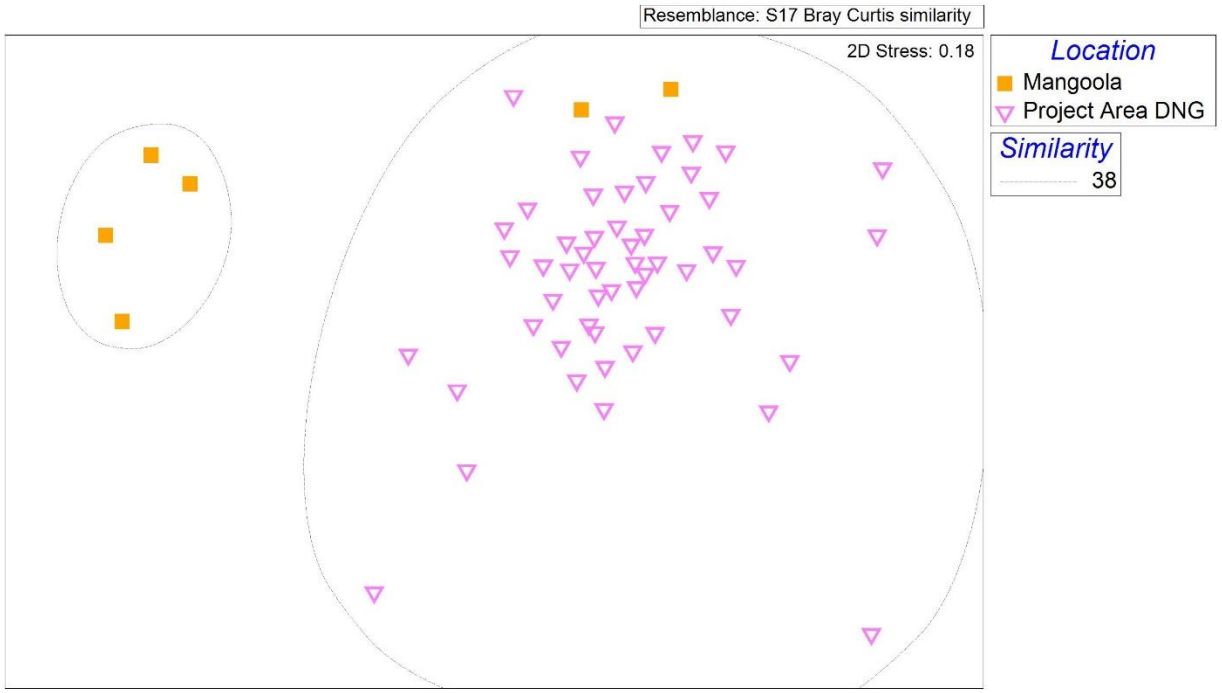


Figure 13 Contemporary Analysis: nMDS ordination of floristic plot data comprising Derived Native Grasslands (DNG) from the Project Area (n=107) in relation to that known to support *Diuris tricolor* and *Prasophyllum petilum* at Mangoola (n=6). Dotted ellipses show similarity level of 40%. Data sampled between March and May 2020 using identical methods.

91. Historical Analysis - Rather than using raw data for historical 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 over several years), 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, 5, 6, 6a, 7, 7a, and 8a for the Project Area (see Table 8), Units 1a and 2 for Mangoola (Bell in review 1), and Units 4, 6, 7 and 8 for Columbey (Bell 2009) (Table 9).

Table 9 Vegetation communities previously defined for Mangoola (Bell in review 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*

92. Separate analyses using both presence-absence data and the percentage contributions allocated to each species through the classification process of each project (as shown in Hunter Eco 2020, Bell in review 1 and Bell 2009) were undertaken. I opted to explore the percentage contributions measure as well as a simple presence-absence analysis to examine if abundance data was more informative. Reducing data from cover abundance or percentage contributions to presence-absence 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. This process allowed me to determine if flora diversity and/or abundance within the Project Area (data collected during the wet year of 2020) correlated well with that for Mangoola where *Diuris tricolor* and *Prasophyllum petilum* were known to occur (data collected between 2009 and 2011, c. average rainfall years), and with Columbey where *Pterostylis chaetophora* is present (data 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.

93. Because habitats of the three target orchids at the specified locations differ (predominantly DNG 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 Units 4a (Narrow-leaved Ironbark - Grey Box Grassy Woodland DNG) and 5a (Spotted Gum - Narrow-leaved Ironbark Woodland DNG) for the Project Area were not included as they both occupy very limited areas and were sampled in only a single plot each, thus prevented development of floristic lists via the numerical techniques used by Hunter Eco (2020).

94. For both analyses, I again used the SIMPROF routine in combination with the CLUSTER module in Primer to identify statistically significant splits in the dataset ($p<0.01$). The resulting cluster diagrams illustrated where sites supporting similar floristic combinations were grouped and linked to their most similar neighbours. I also ran the nMDS 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 habitats) can be better appreciated across this two-dimensional

ordination space than in a cluster diagram, hence the latter is not shown. Note that the Mangoola, Columbey and Project Area datasets all truncated SIMPER routines at 90% contributions.

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, 6a, 7a, 8a) Mangoola (Units 1a, 2)
2	Forests & Woodlands	*Pterostylis chaetophora*	Project Area (Units 1, 2, 3, 4, 5, 6, 7) Columbey (Units 4, 6, 7, 8)

95. In Analysis 1 (Project Area + selected Mangoola grasslands), three significant groups were present in the dataset, evident in both percentage contributions and presence-absence analyses (Figure 14). Unit 3 (Forest Red Gum Grassy Open Forest) from the Project Area aligned well distant from all other delineated communities within that dataset, to be expected given this was the only community sampling riparian areas and supports a different suite of species to hills and slopes. Importantly, the two grassland communities known to support *Diuris tricolor* and *Prasophyllum petilum* at Mangoola were also distinct from all Project Area communities. This demonstrates that the grasslands supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola differ floristically from those present anywhere (grassland or woodland) on the Project Area. The stress level of 0.09 shown in Figure 14 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 analysis, none of the defined units from the Project Area could be considered as providing potential habitat for *Diuris tricolor* and/or *Prasophyllum petilum*.

96. In Analysis 2 (Project Area + selected Columbey forests), it was again clear that the habitats present within the Project Area are floristically different to that known to support *Pterostylis chaetophora* at Columbey (Figure 15). This is not surprising given the wide geographical separation between these two localities (>100 km), although both areas support vegetation that includes dominance by *Eucalyptus moluccana, Eucalyptus crebra* and *Corymbia maculata*, and provide superficially appropriate habitat. Based on this analysis, however, it is unlikely that any habitat within the Project Area is suitable for *Pterostylis chaetophora*.

97. One conclusion to reach from these three analyses is that the floristic composition of virtually all vegetation communities defined for the Project Area differ sufficiently from the DNG 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 was in the Contemporary Analysis, where the alignment of two newly collected plots within former *Eucalyptus dawsonii* woodlands at Mangoola associated with Project Area grassland data. This provides some element of evidence that *Diuris* and *Prasophyllum* may be present within these parts of the Project Area, but this needs to be placed within the context of other outcomes discussed in this report.

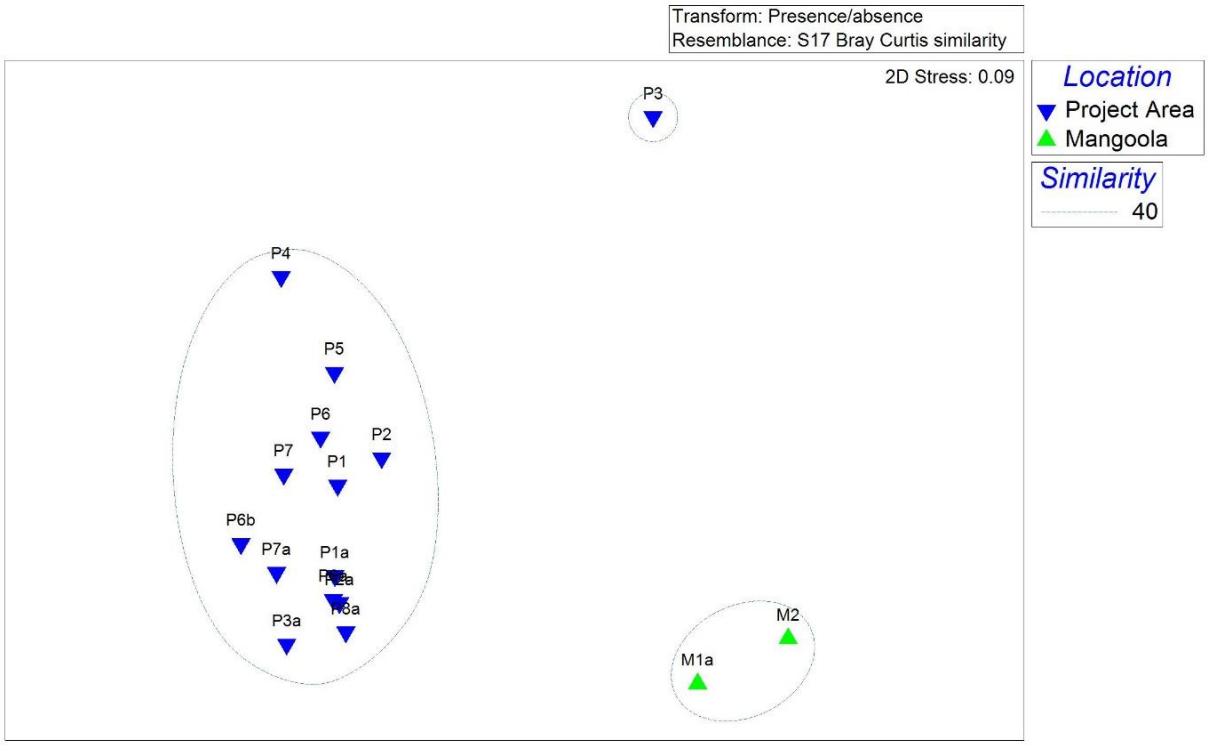


Figure 14 Historical Analysis 1: nMDS ordination of floristic compositions (presence-absence) comprising woodlands and grasslands from the Project Area (P) in relation to that supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola (M). Dotted ellipses show significant groups (p<0.01) defined at a similarity level of 40%. See Table 8 (Project Area) and Table 9 (Mangoola) for explanation of community codes.

98. Notwithstanding the different years of data collection between these locations (Mangoola & Columbey during 2009-11 vs Project Area in 2020) and the different methods of data collection (0.04 ha plots vs 0.01 ha plots) in some of these analyses, 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 (for *Diuris tricolor* and *Prasophyllum petilum*) and Columbey (for *Pterostylis chaetophora*). The two newly sampled grassland plots from Mangoola shown in the Contemporary Analysis as aligning near to Project Area data suggest some similarities, however this was not supported in the other analysis. Nevertheless, some further analysis of environmental factors of occupied habitat (Section 4.2) and basic orchid biology (Section 4.3) is warranted.

4.2 Environmental Analysis

99. 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 *et al*. 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).

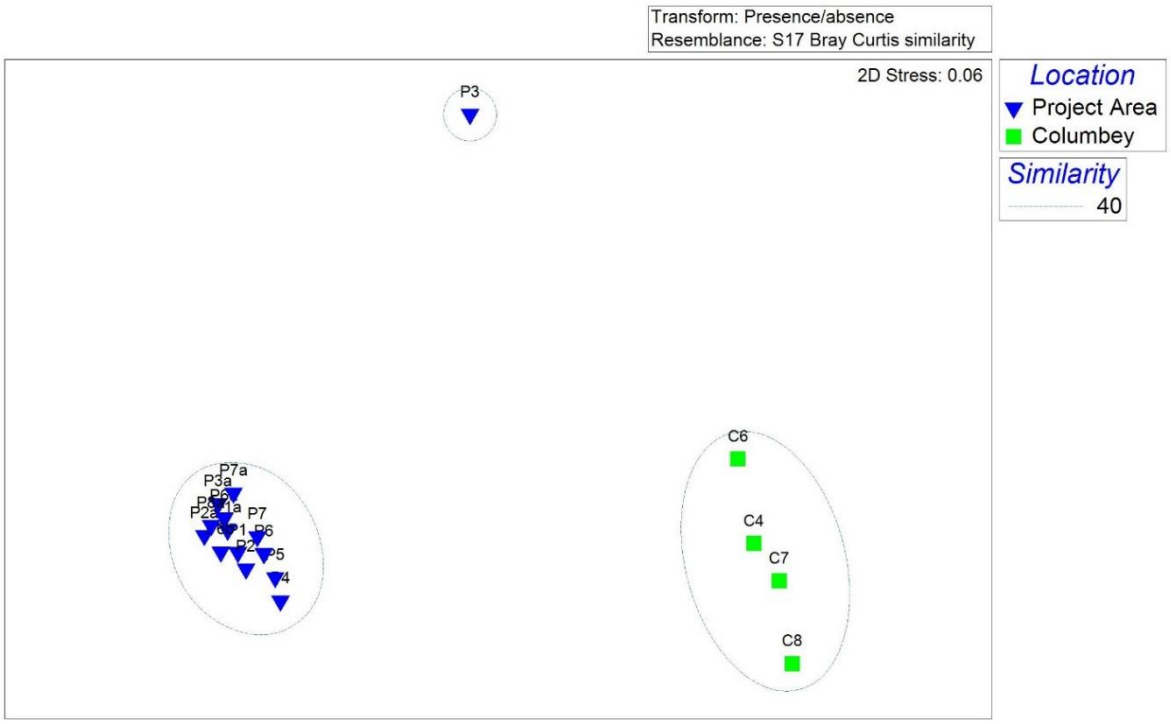


Figure 15 Historical Analysis 2: nMDS ordination of floristic compositions (presence-absence) comprising forest, woodlands and grasslands from the Project Area (P) in relation to favoured *Pterostylis chaetophora* habitat at Columbey (C). Dotted ellipses show significant groups (p<0.01) defined at a similarity level of 40%. See Table 8 (Project Area) and Table 9 (Columbey) for explanation of community codes.

100. 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 (precise location data withheld) this resource was not available.

4.2.1 Project Area

101. Table 12 summarises the environmental characteristics of the Project Area, categorised into the four separate disturbance areas (see also Appendix 3 for graphed details). Two geological units from the Permian Singleton Supergroup comprise the Project Area, with sediments of the Jerrys Plain Subgroup comprising >95%, with a small area (<5%) from the Vane Subgroup in the east. Soils derived from sandstone, shale, mudstone, conglomerate and coal are dominant across most areas, with shales and some basalt in the north. Three soil landscapes have been mapped for the area, the dominant being Roxburgh (c. 90%), then Brays Hill (c. 8%) and a small portion of Bayswater (c. 2%). These mirror the distribution of the Great Soil Groups, where

Yellow Podzolics dominate over Grey, Brown and Red Clays, and Solodic Soils. 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.

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 (2017a) *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 (2017b) *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 (2017c) *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 (2017d) *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 30 metres (m). 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
Development Footprint 1 - General Extension Areas (473 ha)	Almost all Jerrys Plain subgroup geology; dominated by sandstone lithology; predominantly of the Roxburgh soil landscape; supporting mainly Yellow Podzolic (Kurosol) soils of Moderately Low fertility with slow infiltration rates. Annual rainfall is 642 mm (Standard Deviation [StDev]=11.4, n=39) and mean temperature is 16.6°C (StDev=0.18, n=39).
Development Footprint 2 - Northern Link Road Option 1 (31 ha)	All of Jerrys Plains subgroup geology; dominated by sandstone lithology; predominantly of the Brays Hill soil landscape; supporting Red Clays (Vertosol) and Yellow Podzolics (Kurosols), of Moderate to Moderately Low fertility with very slow infiltration rates. Annual rainfall is 645 mm (StDev=21.2, n=9) and mean temperature is 16.5°C (StDev=0.32, n=9).
Development Footprint 3 - Northern Link Road Option 2 (25 ha)	Entirely Jerrys Plains subgroup geology; of sandstone lithology; on the Bayswater and Brays Hill soil landscapes, supporting Red Clays (Vertosol) and Yellow Podzolics (Kurosols), of Moderate to Moderately Low fertility with very slow infiltration rates. Annual rainfall is 632 mm (StDev=14.2, n=5) and mean temperature is 16.7°C (StDev=0.22, n=5).
Approved Disturbance Area to be Relinquished (Relinquishment Area) (510 ha)	Entirely Jerrys Plains Subgroup geology; of sandstone lithology; on the Roxburgh and Brays Hill soil landscapes, supporting Yellow Podzolics (Kurosols) and Red Clays (Vertosol), of Moderately Low to Moderate fertility with slow to very slow infiltration rates. Annual rainfall is 645 mm (StDev=16.7, n=31) and mean temperature is 16.5°C (StDev=0.25, n=31).

102. In terms of water infiltration (hydrology), most soils comprise Group C (slow infiltration rates due to impeded drainage and/or moderately fine textures), with northern and eastern fringes Group D (very slow infiltration rates due to high clay content, high water tables and/or shallow soils over impervious material). For climatic data, average values were computed from GeoScience Australia raster layers at the 123 full floristic sampling plot locations across the Project Area and surrounds (see Section 4.4). Annual rainfall was consequently found to lie between 611 and 676 mm/year across the Project Area, while mean temperature was around 16.6°C.

4.2.2 Target Orchids Records

103. 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 determine 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 DPIE Saving our Species program (Bell & Hillier 2020)
- other miscellaneous records gleaned from unpublished reports or databases

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

104. All data were 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.

105. 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=123, the full floristic plot locations) were graphed to illustrate similarities and differences (see Appendix 4), and a summary is provided in Figure 16. 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 temperature for *Pterostylis chaetophora*, and a moderate match for annual rainfall in this species. Great Soil Group was also very low for *Diuris tricolor* and *Prasophyllum petilum*. Overall, these results suggest there to be little differences and hence potential Project Area suitability in soil class, fertility, hydrology, mean annual rainfall and mean annual temperature for *Diuris tricolor* and *Prasophyllum petilum*, but some differences for *Pterostylis chaetophora*. It also implies that the Project Area is too dry (641 mm/year [yr]) and perhaps slightly too cool (16.9^{o}C) for *Pterostylis chaetophora* (mean 1005 mm/yr; 17.2^{o}C). The Project Area therefore potentially provides suitable soils (albeit derived from different geologies) 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.

106. 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 regional locations supporting *Diuris tricolor* (and 0% 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.

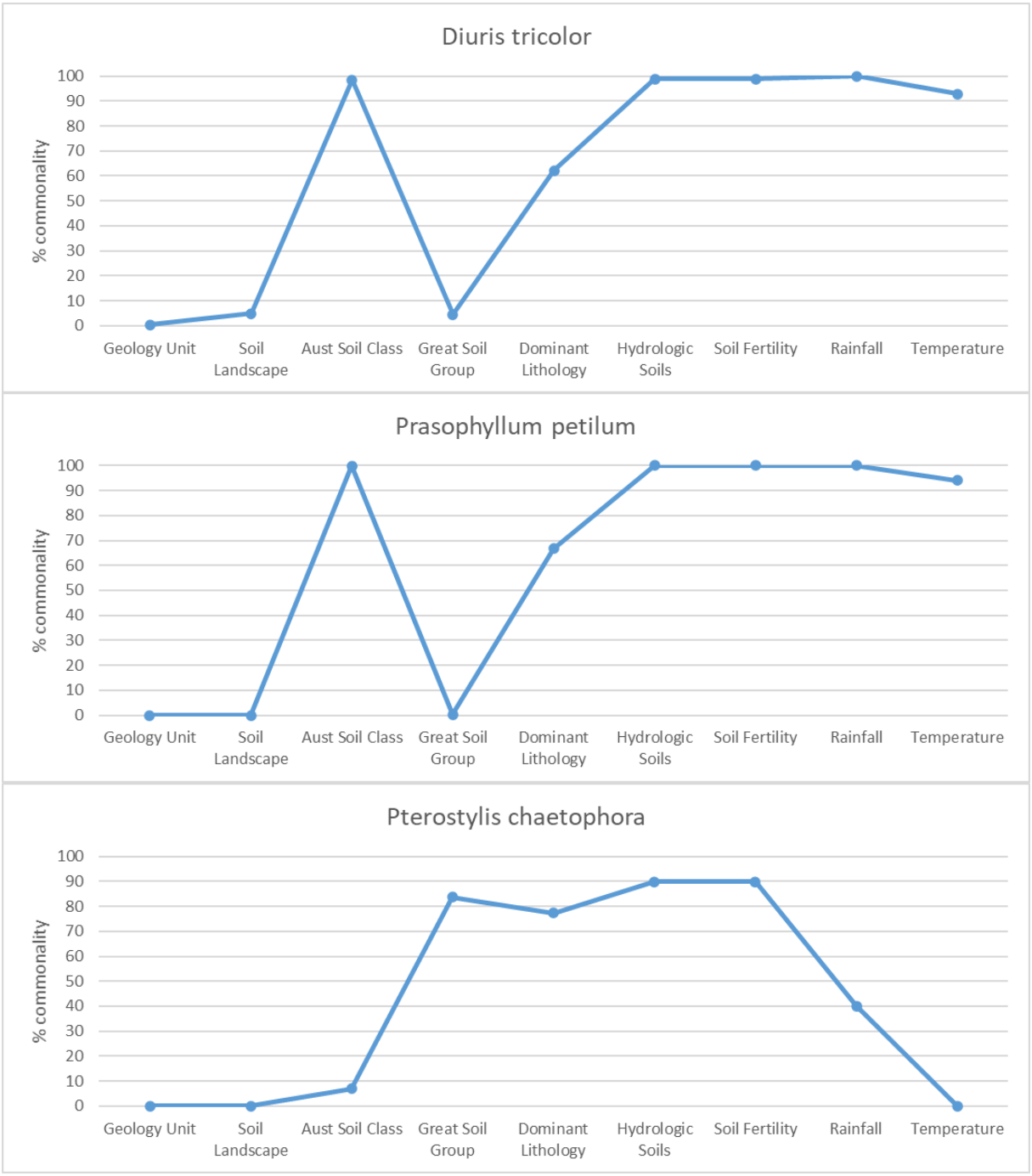


Figure 16 Summary of percentage commonality of selected environmental attributes between known target orchid locations (n=983 *Diuris tricolor*; n=485 *Prasophyllum petilum*; n=128 *Pterostylis chaetophora*) and representative locations within the Project Area (n=123).

4.3 Orchid Diversity: A Surrogate for Mycorrhizal Fungi

107. 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 Mine 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 (3,300 ha; 23 species) near Cessnock (Bell 2004a); and in Columbey National Park (720 ha; 16 species) near Clarence Town (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 five species occur on the 50 ha Condran biodiversity offset property (Bell & Murray 2013), and at North Rothbury (1500 ha) where seven species occur (Bell & Driscoll 2005a).

108. 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 records 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. Obtaining the de-natured co-ordinate data of this dataset was not an issue for this procedure, as the level of resolution was to remain broad.

109. As shown in Figure 17 and Figure 18, 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* and *Prasophyllum petilum*, the few other species recorded on Permian-aged sediments within a 15 km radius of the Project Area occur mainly in the Mangoola vicinity, or in the elevated hills east of Muswellbrook. This paucity of orchids in and around the Project Area is suggestive of limited mycorrhizal fungi presence in these landscapes.

110. Given the level of flora survey that has been expended in and around the Mount Pleasant Operation, Bengalla Mine and Mt Arthur Coal Mine, it may be expected that more terrestrial orchids would be present than is indicated through observed records. For example, surveys for the Continuation of Bengalla Mine (adjacent to the south) revealed no terrestrial orchids (Cumberland Ecology 2013), and a similar outcome was recently evident at Mt Arthur Coal Mine to the south-east, although earlier studies there document four terrestrial species (Hunter Eco 2013). No terrestrial orchids have yet been reported for the current Project Area, with only a single record of a *Calochilus* sp. to the immediate north (see Figure 18).

111. 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. Some research has indicated that mycorrhizal fungi are less prevalent in soils that have been compacted through agricultural activities, and that aeration through tilling may improve habitat for fungi (Smith *et al*. 2007). Recent experimental research on *Diuris tricolor* at Mangoola has indicated that aerated soils in rehabilitated lands appear to improve habitat for fungi persistence (Bell in review 2).

4.4 Field Inspection of the Project Area

112. As noted earlier, I am very familiar with the landscapes and habitats of the Project Area following an intense floristic plot survey program undertaken there between March and May

2020. This involved the collection of floristic data across 123 standard 0.04 ha plots, which were later classified and used for vegetation map production by Hunter Eco (2020). Additional to this, myself and Dr Colin Driscoll (Hunter Eco) also surveyed part of the Project Area specifically for *Diuris tricolor* and *Prasophyllum petilum* on the 1st and 2nd of October 2020. Consequently, there was little need for me to further inspect the Project Area in preparation for this Expert Report.

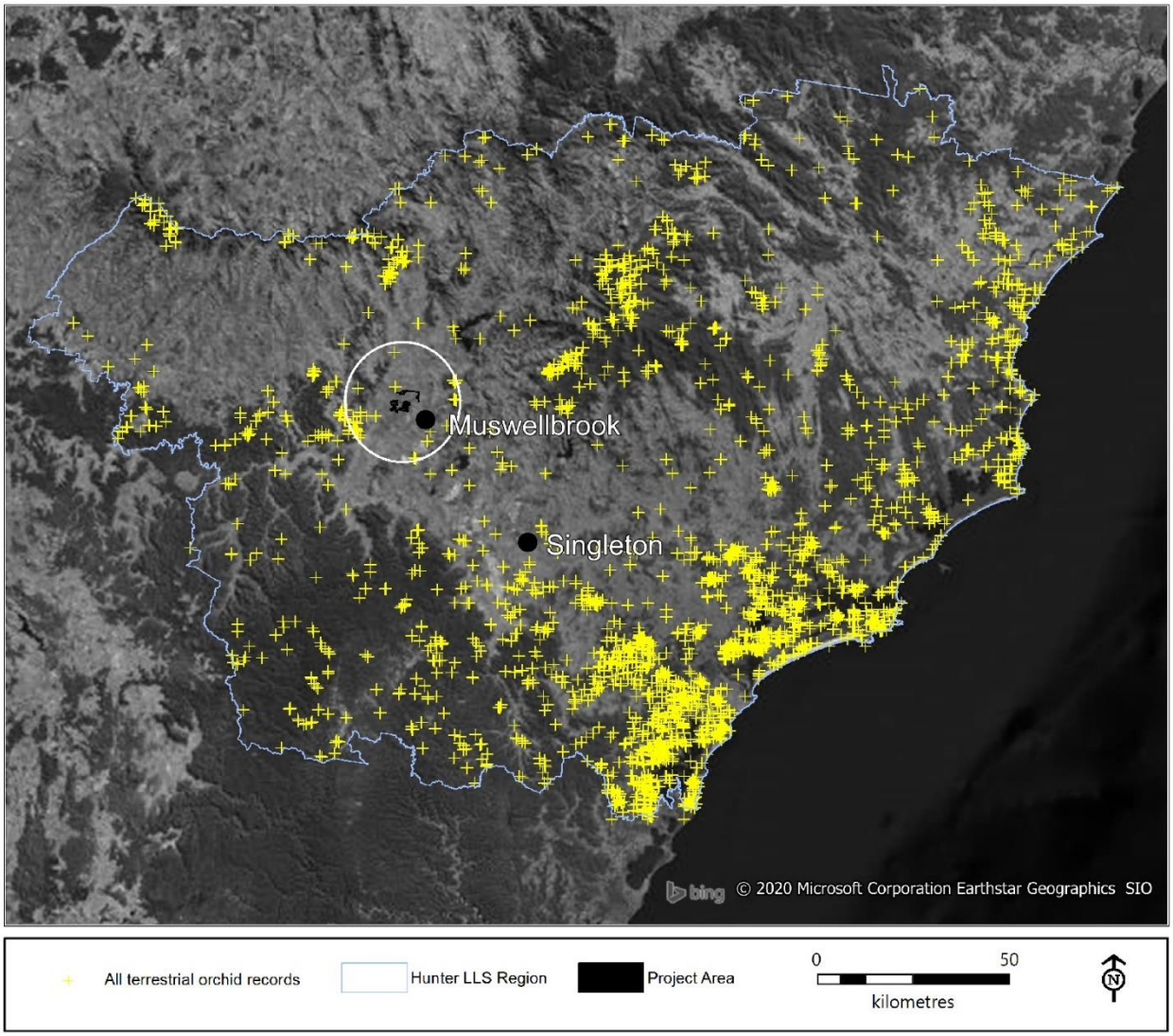


Figure 17 **Point locations of all terrestrial orchids (excluding *Diuris tricolor, Prasophyllum petilum* and *Pterostylis chaetophora*) for the Hunter LLS area.** The Project Area is shown within a 15 km radius circle. Note aggregations of records indicative of diversity 'hotspots' for orchids, and the scarcity of orchid records within the main Hunter Valley region. Data sourced from NSW BioNet, extracted 13 July 2020.

113. My initial impression of the grasslands and woodlands within the Project Area during my floristic plot survey were that they comprised a different floristic composition to that occurring elsewhere where *Diuris tricolor*, *Prasophyllum petilum* and *Pterostylis chaetophora* occur. There was a range of different dominant grass species across most areas, including *Chloris truncata, Panicum buncei, Dichanthium sericeum, Panicum queenslandicum, Aristida leichhardtiana, Austrostipa aristiglumis, Eriochloa pseudoacrotricha, Eragrostis lacunaria,*

Digitaria divaricatissima, Panicum effusum, Chloris ventricosa, Paspalidium aversum, Bothriochloa decipiens and *Microlaena stipoides* var. *stipoides* (Figure 19).

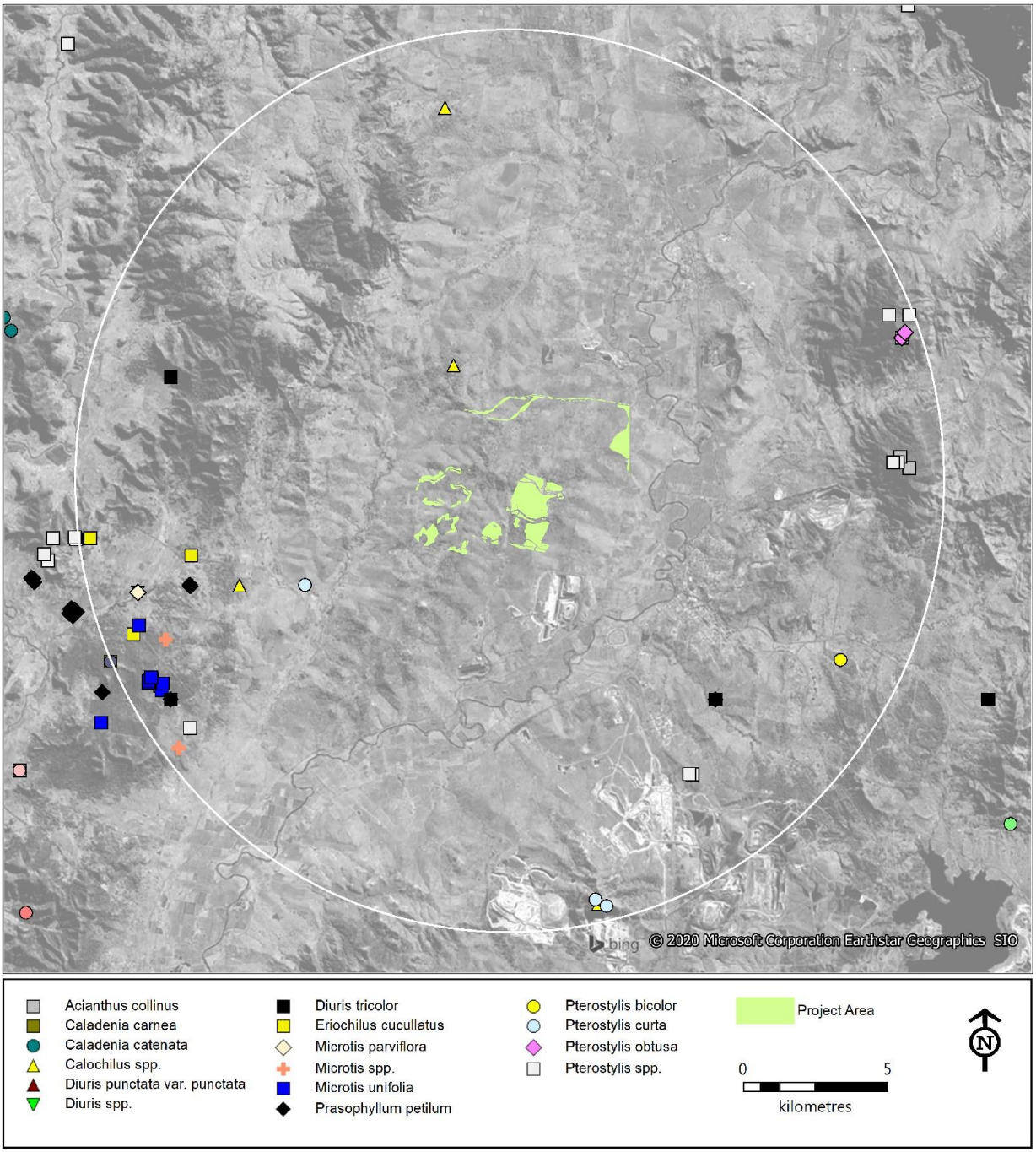


Figure 18 Terrestrial orchids reported for the Project Area and immediate surrounds (15 km radius shown). Note the aggregation of records for the Mangoola area in the lower left, but the scarcity of records in the vicinity of the Project Area. Data sourced from NSW BioNet, extracted 13 July 2020.

114. Within this matrix was an array of flowering herbs and forbs, including Calotis lappulacea, Glycine tabacina, various Vittadinia sp., Erodium crinitum, Sida corrugata, Eremophila debilis, Fimbristylis dichotoma and Chrysocephalum apiculatum. Small 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. These observations were similar to other areas in the upper Hunter where few terrestrial orchids have been recorded, such as around Bayswater Power Station (Bell 2020d) and at the proposed Maxwell coal mine (Bell 2020e).



Figure 19 Grassland within the Project Area, dominated by *Bothriochloa decipiens, Eriochloa pseudoacrotricha, Digitaria divaricatissima, Aristida ramosa* and *Chloris truncata*.

115. 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 20, cf. Figure 19). Herbs and forbs do occur in those habitats, but they are rarely conspicuous or dominant. The grasslands observed within the Project Area are 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). Observations of woodland and remnant canopy species made during my 18 days of field survey earlier in 2020 revealed that almost all of the Project Area appeared to have once supported a woodland dominated by *Eucalyptus 'albemol'*, except for some localised areas where *Eucalyptus crebra*, *Eucalyptus blakelyi* or *Eucalyptus moluccana* occurred.

116. 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.).



Figure 20 Grassland supporting *Diuris tricolor* and *Prasophyllum petilum* at Mangoola, dominated by *Aristida ramosa* and *Cymbopogon refractus*.

117. Despite these observations, I am conscious of the possibility that these perceived differences in floristic composition may reflect recent growth following good falls of rain. This aspect was partially addressed through the plot-based data analysis presented in Section 4.1.3., where newly sampled plots within known orchid habitat at Mangoola showed only marginal overlap with those from the Project Area. However, apart from a few areas within the Project Area where the hardy and grazing-tolerant *Aristida ramosa* dominated some sections (e.g. Figure 21), this species formed only a small component of the bulk of lands inspected; it was nearly always present within sample plots 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 consequently be the dominant grass species, however clearly soil type rather than past land management appears to drive species composition in these landscapes.

118. On the GIS, I examined the vegetation community mapping presented in Hunter Eco (2020) to determine if it accurately portrayed the diversity and distribution of vegetation that I observed during field surveys, and found it to represent well the vegetation patterns within the Project Area. I was satisfied, therefore, that if required I could use the Hunter Eco vegetation community mapping to create maps of likely orchid habitat, so that 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 (presented in this report) and aerial imagery.



Figure 21 Grassland within the Project Area, showing swards of *Aristida ramosa* with *Digitaria divaricatissima* and *Digitaria brownii*.

119. In addition to my field experience and analysis of plot data and community diagnostic species lists (see Section 4.1.3), I drew on knowledge gained 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 four 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 22), in heavily weed-infested derived grasslands where no other native species were apparent (Figure 23), and proliferating on the manicured lawns of farm homesteads (Figure 24). 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 25) 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 22 ***Diuris tricolor*** **and other orchids growing over a constructed contour bank, Mangoola.**



Figure 23 ***Diuris tricolor*** **growing with exotic weeds in low quality grassland near Mangoola Coal.**



Figure 24 ***Diuris tricolor*** **proliferating in mown lawns of a farm homestead near Mangoola Coal.**



Figure 25 ***Pterostylis chaetophora*** **growing in roadside gutter, Columbey National Park.**

4.5 Concluding Opinion: Are the Target Species Present?

120. Given the various floristic and environmental analyses discussed earlier in this section, I conclude that there is very limited evidence to suggest that populations of *Diuris tricolor* and/or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) are present within the Project Area, and that there is no evidence in support of *Pterostylis chaetophora*. I base this opinion largely on the preceding analysis of floristic composition of available habitat, geological unit, soil landscape, soil type, annual rainfall and the inferred absence or paucity of mycorrhizal fungi (using reported orchid presence and diversity as a surrogate). Table 13 summarises these reasons.

Table 13 Concluding reasoning for orchid absence.

Species	Factor	Reasoning
Diuris tricolor	floristic composition	Analysis of historical floristic data (using the upper 90% of species comprising defined vegetation communities within the Project Area) revealed **no association** between Project Area communities with other known sites supporting *Diuris tricolor* at Mangoola.
		Analysis of current-day plot data implied limited association between two Mangoola plots in a Slaty Box (*Eucalyptus dawsonii*) landscape with Project Area grasslands, however this was not supported in other analyses. The small area of land mapped as Slaty Box Woodland DNG (Unit 8a; 3.2 ha) by Hunter Eco (2020) is heavily disturbed and dominated by weed species, and the chances of it supporting a viable population of *Diuris tricolor* are insignificant.
	geological unit	There is **insignificant correlation** (<1%) between geological units within the Project Area and those supporting *Diuris tricolor* elsewhere in the region, although dominant lithology is reasonable at 62%.
	soil landscape	There is only **minor correlation** (5%) between soil landscapes within the Project Area and those supporting *Diuris tricolor* elsewhere in the region.
	soil type	Soil type is a good match at a broad scale, with Australian Soil Class, hydrology and fertility all scoring highly (all 99%), however local-scale Great Soil Group is poor (<5%).
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there is **very limited and/or highly localised mycorrhizal fungi** present in soils, reducing the likelihood of *Diuris tricolor* potentially occurring.
Prasophyllum petilum	floristic composition	Analysis of historical floristic data (using the upper 90% of species comprising defined vegetation communities within the Project Area) revealed **no association** between Project Area communities with other known sites supporting *Prasophyllum petilum* at Mangoola.

Species	Factor	Reasoning
		Analysis of current-day plot data implied limited association between two Mangoola plots in a Slaty Box (*Eucalyptus dawsonii*) landscape with Project Area grasslands, however this was not supported in other analyses. The small area of land mapped as Slaty Box Woodland DNG (Unit 8a; 3.2 ha) by Hunter Eco (2020) is heavily disturbed and dominated by weed species, and the chances of it supporting a viable population of *Prasophyllum petilum* are insignificant.
	geological unit	There is **no correlation** (0%) between geological units within the Project Area and those supporting *Prasophyllum petilum* elsewhere in the region, although dominant lithology is reasonable at 67%.
	soil landscape	There is **no correlation** (0%) between soil landscapes within the Project Area and those supporting *Prasophyllum petilum* elsewhere in the region.
	soil type	Soil type is a good match at a broad scale, with Australian Soil Class (99%), hydrology and fertility (both 100%) all scoring highly, however local-scale Great Soil Group is very poor (<1%).
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there is very limited and/or highly localised mycorrhizal fungi present in the available soils, reducing the likelihood of *Prasophyllum petilum* potentially occurring.
Pterostylis chaetophora	floristic composition	Analysis of floristic data (using the upper 90% 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.
	geological unit	There is **no correlation** (0%) between geological units within the Project Area and those supporting *Pterostylis chaetophora* elsewhere in the region, although dominant lithology is reasonable at 77%.
	soil landscape	There is **no correlation** (0%) between soil landscapes within the Project Area and those supporting *Pterostylis chaetophora* elsewhere in the region.
	soil type	Soil type is a poor match at a broad scale (Australian Soil Class 7%), however local-scale soil Great Soil Type (84%), hydrology and fertility (both 89%) all scored highly.
	annual rainfall	Annual mean rainfall across all locations supporting *Pterostylis chaetophora* (n=128) is 1,005 mm/yr (StDev=98.4), while the annual mean rainfall of the Project Area is **considerably drier** at 641 mm/yr (StDev=5.4).

Species	Factor	Reasoning
	mycorrhizal fungi	Based on few records of all terrestrial orchid species within and around the Project Area, it appears that there is very limited and/or highly localised mycorrhizal fungi present in the available soils, reducing the likelihood of *Pterostylis chaetophora* potentially occurring.
	misidentification	Bell & Hillier (2020) have recently documented misidentifications of *Pterostylis chaetophora* with closely related species, and previous records from the Mangoola and Wingen Maid (Scone) vicinities are no longer considered valid (see also Section 2.2.3). This information therefore restricts this species to the lower Hunter Valley, well east of the Project Area.

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

121. Given the summary information presented in Table 13, I do not consider there to be sufficient evidence to suggest that viable populations of *Diuris tricolor*, *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) or *Pterostylis chaetophora* could potentially occur within the Project Area. Consequently, there is no requirement for me to stipulate a population size or measure of habitat for any of these species.

122. Although we can never be certain about the historical distribution of orchids within a designated landscape, it seems highly likely that if any of the target species were ever present within and around the Project Area that they have been inadvertently removed through 200 years of agricultural occupation. One consequence of grazing by sheep and cattle over extended periods of time is the gradual compaction of soils, which inevitably reduces the suitability for mycorrhizal fungi and the terrestrial orchids that depend upon them. Without these fungi, orchids can never occupy the area even if seed are transported there and all other growing conditions are ideal.

123. While rarely recognised in assessments of potential orchid habitat, the occurrence of these mycorrhizal fungi is possibly the most important determiner of orchid presence or 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).

124. In two earlier reports for the Bayswater and Liddell Power Station upgrade (Bell 2020d) and proposed Maxwell coal mine (Bell 2020e), I conservatively estimated limited areas of potential habitat for *Diuris tricolor* based on soil landscapes, floristics and proximate records. 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* and *Prasophyllum* along Thomas Mitchell Drive (Muswellbrook Industrial Area) and in the 'Diuris Conservation Area' (associated with the proposed Maxwell mine). 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 current Project Area (and only 11 species detected historically within a 15 km radius of it, most as single records), it seems highly unlikely that sufficient mycorrhizal fungi occurs in the soils there to support viable populations of *Diuris tricolor* or *Prasophyllum petilum*.

6. Criterion (e) – Documents & Data Reviewed

125. I have been provided with the following reports and datasets to assist in this review:

- GIS files showing Project boundaries and vegetation community mapping
- flora and vegetation mapping baseline report for the Project (Hunter Eco 2020)
- an extract of the NSW BioNet database, under licence ASH20009, detailing as-held records for the three target orchids within the Hunter LLS area

Given my direct involvement with the collection of floristic plot data from the Project Area, I have also accessed my own notes and data sheets from the 18 days I spent there between March and May 2020, as well as the two days of targeted orchid survey in early October 2020. For numerical analyses, I accessed my own digital datasets for the Project Area, Mangoola and Columbey National Park. 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

126. Under the requirements of the BAM (DPIE 2020a), 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 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. *the expert's history of experience in the ecological research 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 four (*Pterostylis chaetophora*) and twelve (*Diuris tricolor* and *Prasophyllum petilum*) consecutive years at various locations in the Hunter Valley, including the annual monitoring of over 3,000 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) over the previous 10 years*;

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. (in review 1) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (in review).
- Bell, S.A.J. (in review 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* (in review).
- 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. (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* https://doi.org/10.1111/rec.13224.
- Bell, S.A.J. (2020) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*): Maxwell Underground Coal Mine Project*. Unpublished Draft Report to Malabar Coal. July 2020. Eastcoast Flora Survey.

- 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., 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.
- Bell, S.A.J. (2019) *Survey and monitoring of the Vulnerable* Pterostylis chaetophora *(Rusty Greenhood) in the Lower Hunter Valley, NSW: 2018 Results*. Unpublished Report to NSW Office of Environment and Heritage. April 2019. Eastcoast Flora Survey.
- 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.
- Bell, S.A.J., Murray, M., & Sims, R. (2018) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2017 Results*. Unpublished Report to Bulga Surface Operations (Glencore). March 2018. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
- Bell, S.A.J. (2018) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2017 Results*. Unpublished Report to Mangoola Coal. February 2018.
- 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.
- Bell, S.A.J. (2017) *Targeted Orchid Survey: Addendum to Pre-clearance Surveys, Borehole Explorations Areas, Rix's Creek North Mine*. Unpublished Report to Rix's Creek Pty Limited. October 2017. Eastcoast Flora Survey.
- Bell, S.A.J. & Murray, M. (2016) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2015 Results*. Unpublished Report to Bulga Surface Operations (Glencore). May 2016. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

- Bell, S.A.J. & Murray, M. (2015) *Flora and Fauna Monitoring at Condran, Muswellbrook LGA: 2014 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2015. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.
- Bell, S.A.J. & Driscoll, C (2014) *Assessment and mapping of vegetation in the Bylong Valley: Authorisations 287 & 342*. Unpublished Final Report to Hansen Bailey Pty Ltd. Eastcoast Flora Survey. December 2014.
- Bell, S.A.J. (2013) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum *sp. Wybong C.Phelps ORG5269) 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.
- Bell, S.A.J. (2013) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum *sp. Wybong C.Phelps ORG5269) at Mangoola Coal: Status Report 2012*. Unpublished Report to Mangoola Coal. Eastcoast Flora Survey, January 2013.
- Bell, S.A.J. (2012) *Targeted terrestrial orchid surveys at Mangoola Coal, Upper Hunter Valley: Spring 2011*. Unpublished Report to Mangoola Coal. Eastcoast Flora Survey, January 2012.
- Bell, S.A.J. & Copeland, L. (2010) *Targeted terrestrial orchid surveys at Mangoola Coal, Upper Hunter Valley: Spring 2010*. Unpublished Report to Mangoola Coal, October 2010. Eastcoast Flora Survey.
- Bell, S.A.J. & Copeland, L. (2010) *A strategy for the translocation of threatened terrestrial orchids at Mangoola Coal, Upper Hunter Valley*. Unpublished Report to Mangoola Coal, September 2010. Eastcoast Flora Survey.
- Bell, S.A.J. & Copeland, L. (2009) *Targeted terrestrial orchid survey, Mangoola, Upper Hunter Valley*. Spring 2009. Unpublished Report to Mangoola Coal. Eastcoast Flora Survey, November 2009.
- Bell, S.A.J. (2009) *Targeted terrestrial orchid survey of the ex-Nipol property, near Denman, Upper Hunter Valley*. Unpublished report to Mangoola Coal. Eastcoast Flora Survey, November 2009.

d. *their employer's name and period of employment (where relevant)*;

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 over 24 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.

e. *relevant peer reviewed publications*;

I have prepared three publications specifically addressing *Diuris tricolor* and/or *Prasophyllum petilum*: Bell (2019a, assessing translocation success in these species), Bell (2020c, comparing translocation efforts in mined and non-mined lands), and Bell (in review 2, outlining the success of *Diuris tricolor* translocation into mine rehabilitation). A fourth paper (Bell & Hillier 2020), detailing population size and occupied habitat of *Pterostylis chaetophora* in Columbey National Park, was also recently published.

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 or rare 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).

f. *evidence that the person is a well-known authority on the relevant species to which the survey relates*.

I have been surveying and monitoring two of the target species for over 10 years in the Hunter Valley (and the third for four 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

127. MACH Mount Pleasant Operations Pty Ltd (MACH Energy) manages the Mount Pleasant Operation on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy Australia Pty Ltd and J.C.D. Australia Pty Ltd. The Mount Pleasant Operation is located wholly in the Muswellbrook local government area within the upper Hunter Valley of New South Wales. Current approvals for the Mount Pleasant Operation include the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure, and it is authorized to produce up to 10.5 million tonnes per annum of run-of-mine coal. If approved, the Mount Pleasant Optimisation Project (the Project) aims to extend the life of the mine until 2048 and employ on average approximately 600 people.

128. No known records of *Diuris tricolor*, *Prasophyllum petilum* or *Pterostylis chaetophora* exist for the Project Area, and after analysis of floristic and environmental data I consider there to be very limited evidence in support of populations of *Diuris tricolor* and/or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong), and no evidence for *Pterostylis chaetophora*. Historical records of *Pterostylis chaetophora* near Scone and Wybong are erroneous, and there are no other confirmed populations in the upper Hunter Valley. Together with floristic and environmental evidence, the inferred absence or paucity of mycorrhizal fungi (using reported orchid presence and diversity as a surrogate) corroborates this opinion. The habitats present within the Project Area differ sufficiently from those known to support all three target species elsewhere in the Hunter Valley.

129. During intensive field survey of the Project Area and surrounds over 18 days between March and May 2020 I was able to note clear differences in the floristic composition of habitats there compared to other areas where I have studied the three target orchids. The predominance of woodlands and derived grasslands within Box (*Eucalyptus* '*albemol*' and *Eucalyptus moluccana*) landscapes largely conflicts with my experience elsewhere. Numerical analysis of defined vegetation communities revealed clear differences in habitat from the Project Area relative to elsewhere in the region known to support *Pterostylis chaetophora*, and only limited similarities to some habitats typical of *Diuris tricolor* and *Prasophyllum petilum* (those dominated or co-dominated by *Eucalyptus crebra*). Given this superficial similarity of communities potentially supporting *Diuris tricolor* and *Prasophyllum petilum*, pro-active targeted orchid surveys were undertaken in these communities over two days in early October 2020 (the peak flowering time of both species), but no orchids of any kind were observed during this time.

130. In further 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, soil type, and (for *Pterostylis chaetophora*) annual rainfall when compared to the Project Area. Of these, soil landscapes are 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 assessing fungi distribution, a review 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 no populations of *Diuris tricolor* or *Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) are expected across the Project Area.

131. The combination of differing floristic, geological, soil landscape, soil, and rainfall attributes, together with a largely absent Orchidaceae population (used as a surrogate for mycorrhizal fungi) strongly suggest that *Diuris tricolor, Prasophyllum petilum* (syn. *Prasophyllum* sp. Wybong) or *Pterostylis chaetophora* are unlikely to be present on the Subject land and therefore no further assessment is required.

9. References

Abel Ecology (2005) *Flora and fauna report for 168 Bells Lane, Denman in the upper Hunter Valley, New South Wales*. Unpublished Report prepared for Anvil Hill Project Watch Association.

Adams, P.B. & Lawson, S.D. (1993) Pollination in Australian orchids: A critical assessment of the literature 1882-1992. *Australian Journal of Botany* 41: 553-575.

Ba, L., Ning, J., Wang, D., Facelli, E., Facelli, J.M., Yang, Y., & Zhang, L. (2012) The relationship between the diversity of arbuscular mycorrhizal fungi and grazing in a meadow steppe. *Plant and Soil* 352: 143-156.

Backhouse, G. & Cameron, D. (2005) Application of IUCN 2001 Red List categories in determining the conservation status of native orchids of Victoria, Australia. *Selbyana* 26(1,2): 58-74.

Backhouse, G.N., Bates, R.J., Brown, A.P. & Copeland, L.M. (2019) *A Checklist of the Orchids of Australia Including its Island Territories*. Second Edition. Melbourne, Australia. ISBN 978-0-9946489-3-8

Backhouse, G., Kosky, B., Rouse, D., & Turner, J. (2016) *Bush Gems: A Guide to the Wild Orchids of Victoria, Australia*. Published by Authors, Melbourne, August 2016. ISBN: 978-0-9946489-0-7

Bell, S.A.J. (2001a) 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. (2001b) 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.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. (2004a) *The vegetation of the Hunter Economic Zone (HEZ), Cessnock LGA, New South Wales.* Unpublished Report to Harper Somers O'Sullivan, January 2004. Eastcoast Flora Survey.

Bell, S.A.J. (2004b) 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. (2008) Rare or threatened vascular plant species of Wollemi National Park, central eastern New South Wales. *Cunninghamia* 10(3): 331-371.

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. (2012a) *Diversity and condition of derived grasslands at Mangoola Coal, Upper Hunter Valley: Stage 3 - 2011 Surveys*. Unpublished Report to Mangoola Coal, June 2012.

Bell, S.A.J. (2012b) *Assessment of vegetation for expansion of Rix's Creek Mine, Hunter Valley*. Unpublished Report to Rix's Creek Pty Limited. November 2012.

Bell, S.A.J. (2016) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2015 Results*. Unpublished Report to Mangoola Coal. April 2016. Eastcoast Flora Survey.

Bell, S.A.J. (2017a) *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. (2017b) 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.A.J. (2018) Fate of a rare flowering event in an endangered population of *Acacia pendula* (Weeping Myall) from the Hunter Valley, New South Wales. *Cunninghamia* 18: 79-88.

Bell, S. (2019a) 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. (2019b) *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.

Bell, S.A.J. (2019c) 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. (2019d) *Survey and monitoring of the Vulnerable* Pterostylis chaetophora *(Rusty Greenhood) in the Lower Hunter Valley, NSW: 2018 Results*. Unpublished Report to NSW Office of Environment and Heritage. May 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2020a) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2019 Results*. Unpublished Report to Mangoola Coal. February 2020. Eastcoast Flora Survey.

Bell, S.A.J. (2020b) *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. (2020c) Translocation of threatened terrestrial orchids into non-mined and post-mined lands in the upper Hunter Valley of New South Wales, Australia. *Restoration Ecology* https://doi.org/10.1111/rec.13224

Bell, S.A.J. (2020d) *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. (2020e) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor, Prasophyllum petilum, Pterostylis chaetophora*): Maxwell Underground Coal Mine Project.* Unpublished DRAFT Report to Malabar Coal. July 2020. Eastcoast Flora Survey.

Bell, S.A.J. (in review 1) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (in review).

Bell, S.A.J. (in review 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* (in review)

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. & Driscoll, C. (2005a) *Vegetation survey of 'Sweetwater', North Rothbury, mid Hunter Valley, New South Wales*. Unpublished Report to Harper Somers O'Sullivan, October 2005. Eastcoast Flora Survey.

Bell, S. & Driscoll, C. (2005b) New records of the endangered *Hibbertia procumbens* from the Central Coast of NSW. *Australasian Plant Conservation* 13(4): 24-25.

Bell, S. & 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. & 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. & 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. & 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.

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. & 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.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.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.

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.

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. & 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. & 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. & 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., 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., Murray, M., & Sims, R. (2020) *Flora and Fauna Monitoring at Condran VCA, Muswellbrook LGA: 2019 Results*. Unpublished Report to Bulga Surface Operations (Glencore). January 2020. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd.

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., Rockley, C., & Llewellyn, A. (2019) *Flora of the Hunter Region: Endemic Trees and Larger Shrubs*. CSIRO Publishing and University of Newcastle, Australia.

Bernhardt, P. (1995) Notes on the anthecology of *Pterostylis curta* (Orchidaceae) *Cunninghamia* 4(1): 1-8.

Bernhardt, P. & Burns-Balogh, P. (1986) Observations of the floral biology of *Prasophyllum odoratum* (Orchidaceae, Spiranthoideae). *Plant Systematics and Evolution* 153: 65-76.

Bishop, T. (2000) *Field Guide to the Orchids of New South Wales and Victoria*. University of New South Wales Press, Sydney. Second Edition.

Bradshaw, C.J.A. (2012) Little left to lose: deforestation and forest degradation in Australia since European colonization. *Journal of Plant Ecology* 5(1): 109-120.

Brundrett, M.C. (2006) Role of symbiotic relationships in Australian terrestrial orchid conservation. *Australasian Plant Conservation* 15(2): 2-7.

Brundrett, M.C. (2016) Using vital statistics and core-habitat maps to manage critically endangered orchids in the Western Australian wheatbelt. *Australian Journal of Botany* 64: 51-64.

Brundrett, M.C. (2019) A comprehensive study of orchid seed production relative to pollination traits, plant density and climate in an urban reserve in Western Australia. *Diversity* 11, 123; doi:10.3390/d11080123

Brundrett, M.C., Scade, A., Batty, A.L., Dixon, K.W., & Sivasithamparam, K. (2003) Development of in situ and ex situ seed baiting techniques to detect mycorrhizal fungi from terrestrial orchid habitats. *Mycological Research* 107: 1210-1220.

Bureau of Meteorology (2020) *Climate Data Online*. Available at: http://www.bom.gov.au/climate/data/.

Burley, T.M. (1962) The evolution of the agricultural pattern in the Hunter Valley, New South Wales, *Australian Geographer* 8(5): 221-231. DOI: 10.1080/00049186208702383

Burrows, G.E. (1999) A survey of 25 remnant vegetation sites in the South Western Slopes, New South Wales. *Cunninghamia* 6 (2): 283-314.

Cameron, N., Jurskis, V., Peacock, R., & Wilson, R. (2014) *Submission on draft report (released June 2014) on active and adaptive cypress management in the Brigalow and Nandewar State Conservation Areas*. Submission by the Institute of Foresters of Australia, New South Wales Division. August 2014.

Clarke, K.R. & Gorley, R.N. (2006) *PRIMER v6: User Manual/ Tutorial*. PRIMER-E: Plymouth.

Clements, M.A. (1989) Catalogue of Australian Orchidaceae. *Australian Orchid Research* 1: 1-160.

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 2.0 [Digital Dataset].* Geological Survey of New South Wales, Department of Regional NSW, Maitland. Available at https://search.geoscience.nsw.gov.au/product/9232

Cumberland Ecology (2013) *Biodiversity Assessment Report for the Upper Hunter Strategic Assessment: Continuation of Bengalla Mine Project*. Unpublished Report to Hansen Bailey, July 2013.

Cumberland Ecology (2014) *Warkworth Continuation 2014: Ecological Impact Assessment*. Unpublished Report to EMGA Mitchell McLennan. Report No. 14001RP1, June 2014.

Cumberland Ecology (2007b) *Mount Pleasant: ecology gap analysis report*. Cumberland Ecology Pty Ltd, Carlingford Court, NSW.

Cumberland Ecology (2015) *Mount Pleasant Upper Hunter Strategic Assessment BCAM Project. Biodiversity Assessment Report*.

Cunningham, G., Mulham, W.E., Milthorpe, P.L., & Leigh, J.L. (2011) *Plants of Western New South Wales*. CSIRO Publications, Canberra.

de Lacey, C., Bell, S., Chamberlain, S., & Bossard, K. (2012a) Habitat of the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls throughout its known Australian distribution. *The Orchadian* 17(4): 162-174.

de Lacey, C., Bell, S., & Chamberlain, S. (2012b) 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. (2013) Finding the leafless tongue orchid *'Cryptostylis hunteriana'* Nicholls. *Nature New South Wales* Vol. 57 (1) Autumn 2013: 24-25. [online]

Department of Environment, Climate Change and Water (2010) *National Recovery Plan for* Prasophyllum petilum. Department of Environment and Climate Change and Water (NSW), Hurstville. Available at: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-prasophyllum-petilum

Department of Planning, Industry and Environment (2020a) *Biodiversity Assessment Method*. Department of Planning, Industry and Environment for the NSW Government. October 2020.

Department of Planning, Industry and Environment (2020b) *Surveying threatened plants and their habitats: NSW survey guide for the Biodiversity Assessment Method.* Published by the New South Wales Environment, Energy and Science Department of Planning, Industry and Environment, April 2020.

Department of Primary Industries (2020) *Combined Drought Indicator - Seasonal Conditions Information Portal*. Available at: https://edis.dpi.nsw.gov.au/statistics.

Duncan, M. & Moloney, P.D. (2018) Comparing wild and reintroduced populations of the threatened orchid *Diuris fragrantissima* (Orchidaceae) in south-eastern Australia. *Australian Journal of Botany* 66: 459-467.

Duncan, M., Pritchard, A., & Coates, F. (2005) Major threats to endangered orchids of Victoria, Australia. *Selbyana* 26(1/2): 189-195. Retrieved from http://www.jstor.org/stable/41760190

Eco Logical Australia (2017) *Targeted surveys for* Diuris tricolor *and* Prasophyllum petilum – *Mount Pleasant Operation*. Unpublished Letter Report to MACH Energy, March 2017.

Ecological Australia (2015) *MCO OC4 South-west modification: Flora and fauna impact assessment*. Unpublished Report to Moolarben Coal Operations. April 2015.

Ecovision Consulting (2008) *Ecological Impact Assessment, Stage 2 of the Moolarben Coal Project, Ulan, New South Wales*. Unpublished Report to Moolarben Coal Mines Pty Limited. December 2008.

ERM (1997) *Mount Pleasant Mine Environmental Impact Statement for Coal & Allied Operations Pty Ltd*. ERM Mitchell McCotter.

Faast, R. & Facelli, J.M. (2009) Grazing orchids: impact of florivory on two species of *Caladenia* (Orchidaceae). *Australian Journal of Botany* 57(4): 361-372.

Fensham, R.J., Laffineur, B., Collingwood, T.D., Beech, E., Bell, S., Hopper, S.D., Phillips, G., Rivers, M.C., Walsh, N., & White, M. (2020) Rarity or decline: Key concepts for the Red List of Australian eucalypts. *Biological Conservation* 243 108455-108455

FloraSearch (2014) *North Wambo Underground – Longwall 10A modification*. Unpublished Report to Wambo Coal Pty Limited. August 2014.

Gallagher, R.V. (2016) Correlates of range size variation in the Australian seed-plant flora. *Journal of Biogeography* 43: 1287-1298.

Gillman, M.P. & Dodd, M.E. (1998) The variability of orchid population size. *Botanical Journal of the* Linnean Society 126: 65-74.

Hawkeswood, T.J. (2006) Comments on the orchid pollination review paper by P.B. Adams and S.D. Lawson (1993) in the Australian Journal of Botany and a listing of some more recent literature. *Calodema* 7: 1-4.

Heinrich, A. & Dowling, W. (2000) *Rare and threatened plant surveys of Barrington Tops National Park – plateau area*. Unpublished reports prepared for the NSW National Parks and Wildlife Service, Hunter District.

Herd, S. & Herd, D. (2005) ANOS Newcastle, Central Coast Groups lend a hand to the Anvil Hill Project Watch, Denman. *The Orchadian* 15(1): 18-21.

Hosking, J.R. & James, T.A. (1998) Native and exotic flora of the north western slopes upstream of the junction of the Peel and Namoi Rivers, New South Wales. *Cunninghamia* 5(3): 721-766.

Hunter, C. (2010) *People, Property, Power: Plashett, Jerrys Plains*. Anglo American Metallurgical Coal Pty Ltd: Brisbane.

Hunter, J.T. (2008) *Vegetation and floristics of Warrabah National Park*. Unpublished Report to the New South Wales National Parks and Wildlife Service, July 2008. doi: 10.13140/RG.2.1.4446.0649

Hunter, J.T. (2010) *Vegetation and Floristics of Cubbo, Etoo and Dewsons Lease sections of the Pilliga SCA, Pilliga NP and Pilliga West SCA*. Unpublished Report to Department of Environment, Climate Change and Water. May 2010.

Hunter Eco (2013) *Mt Arthur Coal Open Cut Modification Ecological Assessment*. Unpublished Report to BHP Billiton, January 2013.

Hunter Eco (2017a) *Mount Pleasant Operation Mine Optimisation Modification Environmental Assessment: Biodiversity Assessment*. Unpublished Report to MACH Energy, May 2017.

Hunter Eco (2017b) *Mount Pleasant Operation Rail Modification: Terrestrial Ecology Assessment*. Unpublished Report to MACH Energy, December 2017.

Hunter Eco (2020) *Mount Pleasant Optimisation Project: Baseline Flora Report.* Unpublished DRAFT Report to MACH Energy Australia Pty Ltd, October 2020.

Irwin, M., Bougoure, J.J. & Dearnaley, J. (2007) *Pterostylis nutans* (Orchidaceae) has a specific association with two ceratobasidium root-associated fungi across its range in eastern Australia. *Mycoscience* 48: 231-239.

Jacquemyn, H., Duffy, K.J., & Selosse, M-A. (2017) Biogeography of Orchid Mycorrhizas. Chapter 8 IN L. Tedersoo (ed.) *Biogeography of Mycorrhizal Symbiosis* Ecological Studies 230. DOI 10.1007/978-3-319-56363-3_8

Janes, J.K. & Duretto, M.F. (2010) A new classification for subtribe Pterostylidinae (Orchidaceae), reaffirming *Pterostylis* in the broad sense. *Australian Systematic Botany* 23: 260-269.

Janes, J.K., Steane, D.A., & Vaillancourt, R.E. (2010) An investigation into the ecological requirements and niche partitioning of Pterostylidinae (Orchidaceae) species. *Australian Journal of Botany* 58(5): 335-341.

Jasinge, N.U., Huynh, T., & Lawrie, A.C. (2018) Changes in orchid populations and endophytic fungi with rainfall and prescribed burning in *Pterostylis revoluta* in Victoria, Australia. *Annals of Botany* 121: 321–334. https://doi.org/10.1093/aob/mcx164

Jacobs (2017) *Biodiversity Assessment Report: Hunter Water Corporation Proposed Biobank Site Irrawang Swamp – Grahamstown Dam*. Unpublished Report. August 2017.

Jeanes, J. (2015a) *Prasophyllum* aff. *petilum*. VicFlora Flora of Victoria. [Online]. Royal Botanic Gardens Melbourne. Available from: http://data.rbg.vic.gov.au/vicflora/.

Jeanes, J. (2015b) *Diuris tricolor*. VicFlora Flora of Victoria. [Online]. Royal Botanic Gardens Melbourne. Available from: http://data.rbg.vic.gov.au/vicflora/.

Jersáková, J. & Malinová, T. (2007) Spatial aspects of seed dispersal and seedling recruitment in orchids. *New Phytologist* 176: 237–241.

Jones, D.L. (1991) New taxa of Australian Orchidaceae. *Australian Orchid Research* 2: 1-208

Jones, D.L. (1993) *Native Orchids of Australia*. Reed Australia.

Jones, D.L. & Rouse, D.T. (2018) *Prasophyllum argillaceum* (Orchidaceae: Prasophyllinae), a new species in the *Prasophyllum campestre* R.J.Bates & D.L.Jones/ *Prasophyllum petilum* D.L.Jones & R.J.Bates complex. *Australian Orchid Review* 83(5): 50-53.

Jusaitis, M. & Sorensen, B. (1993) Germination of *Pterostylis arenicola* – an endangered greenhood from South Australia. *The Orchadian* 11(1): 18-22.

Kindlmann, P. & Balounova, Z. (2001) Irregular flowering patterns in terrestrial orchids: theories vs empirical data. *Web Ecology* 2: 75-82.

Kuiter, R.H. & Findlater-Smith, M. (2017) Overview of *Pterostylis* pollination (Orchidaceae) in Victoria. *Aquatic Photographics, Seaford* Short Paper 4, July 2017. Available at:

https://www.researchgate.net/publication/318282443_Overview_of_Pterostylis_Pollination_Orchidaceae_in_Victoria

Light, M.H.S. & MacConnaill, M. (2011) Potential impact of insect herbivores on orchid conservation. *European Journal of Environmental Sciences* 1(2): 115-124.

McCormick, M.K. & Jacquemyn, H. (2014) What constrains the distribution of orchid populations? *New Phytologist* 202: 392–400.

McCormick, M.K., Whigham, D.F., & Canchani-Viruet, A. (2018) Mycorrhizal fungi affect orchid distribution and population dynamics. *New Phytologist* 219: 1207-1215.

McQualter, E., Cross, R., McLean, C.B., & Ladiges, P.Y. (2007) *Prasophyllum* and its associated mycorrhizal fungi. *Lankesteriana* 7(3): 497-501.

Mickaill, L.N.N., Bell, S.A.J., & Beranek, C.T. (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(5):333-344.

Nurfadilah, S., Swarts, N., Dixon, K., Lambers, H. & Merritt, D. (2013) Variation in nutrient-acquisition patterns by mycorrhizal fungi of rare and common orchids explains diversification in a global biodiversity hotspot. *Annals of Botany* 111(6): 1233-1241.

Office of Environment and Heritage (2017a) *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

Office of Environment and Heritage (2017b) *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

Office of Environment and Heritage (2017c) *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

Office of Environment and Heritage (2017d) *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

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

Oja, J., Vahtra, J., Bahram, M., Kohout, P., Kull, T., Rannap, R., Koljalg, U., & Tedersoo, L. (2017) Local-scale spatial structure and community composition of orchid mycorrhizal fungi in semi-natural grasslands. *Mycorrhiza* 27: 355-367.

Paget, A. (2008) *Results of searches for the Ruddy Hood* Pterostylis chaetophora *M.A.Clem. & D.L.Jones, syn* Oligochaetochilus chaetophorus *(M.A.Clem. & D.L.Jones), Spring 2008*. Unpublished Report, Hunter-Central Rivers Catchment Management Authority, Taree.

Perkins, A.J. & McGee, P.A. (1995) Distribution of the orchid mycorrhizal fungus, *Rhizoctonia solani*, in relation to its host, *Pterostylis acuminata*, in the field. *Australian Journal of Botany* 43: 565-575.

Perry, T.M. (1955) The spread of rural settlement in New South Wales, 1788–1826. *Historical Studies: Australia and New Zealand* 6(24): 377-395. DOI: 10.1080/10314615508595010

Pfeifer, M., Wiegand, K., Heinrich, W., & Jetschke, G. (2006) Long-term demographic fluctuations in an orchid species driven by weather: implications for conservation planning. *Journal of Applied Ecology* 43: 313–324.

Phillips, R.D., Reiter, N., & Peakall, R. (2020) Orchid conservation: from theory to practice. *Annals of Botany* 126: 345-362. DOI: 10.1093/aob/mcaa093

Phillips, R.D., Peakall, R., Retter, B.A., Montgomery, K., Menz, M.H.M., Davis, B.J., Hayes, C., Brown, G.R., Swartz, N.D., & Dixon, K.W. (2015) Pollinator rarity as a threat to a plant with a specialized pollination system. *Botanical Journal of the Linnean Society* 179: 511–525.

Phillips, R.D., Scaccabarozzi, D., Retter, B.A., Hayes, C., Brown, G.R., Dixon, K.W., Peakall, R. (2014) Caught in the act: pollination of sexually deceptive trap-flowers by fungus gnats in *Pterostylis* (Orchidaceae). *Annals of Botany* 113: 629–641.

Reiter, N., Freestone, M., Brown, G., & Peakall, R. (2019) Pollination by sexual deception of fungus gnats (Keroplatidae and Mycetophilidae) in two clades of *Pterostylis* (Orchidaceae). *Botanical Journal of the Linnean Society* 190(1): 101–116.

Rouse, D.T. (2002) *Report on the taxonomic, ecological and conservation status of taxa in the genus* Prasophyllum *R.Br. in south-eastern Australia*. Unpublished Report. May 2002.

Scaccabarozzi, D., Cozzolino, S., Guzzetti, L., Galimberti, A., Milne, L., Dixon, K.W, & Phillips, R.D (2018) Masquerading as pea plants: behavioural and morphological evidence for mimicry of multiple models in an Australian orchid. *Annals of Botany* 122(6): 1061–1073.

Schiestl, F.P. (2005) On the success of a swindle: pollination by deception in orchids. *Naturwissenschaften* 92: 255–264.

Seaton, P.T. (2007) Orchid conservation: Where do we go from here? *Lankestriana* 7: 13-16.

Shefferson, R.P., Jacquemyn, H., Kull, T., & Hutchings, M.J. (2020) The demography of terrestrial orchids: life history, population dynamics and conservation. *Botanical Journal of the Linnean Society*. 192: 315–332.

Smith Z.F., James E.A. & McLean C.B. (2007) Experimental reintroduction of the threatened terrestrial orchid *Diuris fragrantissima*. *Lankesteriana* 7, 377-380.

Smith, Z.F., James, E.A., & McLean, C.B. (2010) Mycorrhizal specificity of *Diuris fragrantissima* (Orchidaceae) and persistence in a reintroduced population. *Australian Journal of Botany* 58(2): 97-106.

Stanley, T.D. & Ross, E.M. (1989) *Flora of South-eastern Queensland. Volume 3*. Queensland Department of Primary Industries, Brisbane.

Su, Y-Y. & Guo, L-D. (2007) Arbuscular mycorrhizal fungi in non-grazed, restored and over-grazed grassland in the Inner Mongolia steppe. *Mycorrhiza* 17: 689-693.

Thalwitzer, L., Kelly, D., Smissen, R.D., Butler, R., Suckling, D.M., & El-Sayed, A. (2018) Species-specific male pollinators found for three native New Zealand greenhood orchids (*Pterostylis* spp.) suggest pollination by sexual deception. *Australian Journal of Botany* 66: 243-254.

Tierney, D.A., Sommerville, K.D., Tierney, K.E., Fatemi, M., & Gross, C.L. (2017) Trading populations—can biodiversity offsets effectively compensate for population losses? *Biodiversity and Conservation* 26: 2115-2131.

Umwelt (2006) *Ecological Assessment Anvil Hill Project*. Report prepared for Centennial Hunter Pty Limited, June 2006.

Umwelt (2011a) *Baseline ecological studies of potential biodiversity offset site – Highfields, near Manobalai, NSW*. Unpublished Report to Xstrata Coal. October 2011.

Umwelt (2011b) *Baseline ecological studies of potential biodiversity offset site – Wybong Heights, near Manobalai, NSW*. Unpublished Report to Xstrata Coal. October 2011.

Umwelt (2012) *Ecological values and condition of Northern and Western Corridors, as part of Biodiversity Offset Areas for Mangoola Mine*. Unpublished Report to Xstrata Mangoola Pty Limited. January 2012.

Umwelt (2013) *Ecological Impact Statement: Bulga Coal Optimisation Project*. Unpublished Report to Bulga Coal Management Pty Ltd. April 2013.

URS (2009) *Manildra – Parkes 132kV Transmission Line Project: Species Impact Statement*. Unpublished Report to TransGrid. July 2009.

Vizer, C. (2013) *Contributions to the understanding of the ecology and biology of* D. tricolor *and* Prasophyllum *sp. Wybong in the Upper Hunter Region, NSW*. Unpublished BEnv.Sc. & Mgmt (Hons) thesis, University of Newcastle, May 2013.

Vogel, S. (1973) Fungus gnat flowers and fungus mimesis. IN Brantjes, N.B.M. & Linskens, H.F. (eds.), *Pollination and Dispersal*. Nijmegan: Netherlands.

Voyron, S., Ercole, E., Ghignone, S., Perotto, S., & Girlanda, M. (2016) Fine-scale spatial distribution of orchid mycorrhizal fungi in the soil of host-rich grasslands. *New Phytologist* 213: 1428-1439.

Walker, K. (1997) *Natural history information on the presumed pollinator (*Lasioglossum *(*Chilactus*)* lanarium*) of the Small Golden Moth Orchid (*Diuris *sp. aff.* lanceolata*)*. Museum of Victoria unpublished report to the Department of Natural Resources and Environment, Victoria.

Waud, M., Busschaert, P., Lievens, B., & Jacquemyn, H. (2016) Specificity and localised distribution of mycorrhizal fungi in the soil may contribute to co-existence of orchid species. *Fungal Ecology* 20: 155-165.

Waterman, R.J. & Bidartondo, M.I. (2008) Deception above, deception below: linking pollination and mycorrhizal biology of orchids. *Journal of Experimental Botany* 59(5): 1085-1096.

Wells, T.C.E., Rothery, P., Cox, R. & Bamford, S. (1998) Flowering dynamics of *Orchis morio* L. and *Herminium monorchis* (L.) R.Br. at two sites in eastern England. *Botanical Journal of the Linnean Society* 126: 39-48.

Weston, P.H., Perkins, A.J. & Entwisle, T.J. (2005) More than symbioses: orchid ecology, with examples from the Sydney region. *Cunninghamia* 9: 1-15.

Wildthing (2011) *Seven part test on threatened flora and fauna for a proposed subdivision at Lot 122 DP750924 Almond Street Denman, NSW*. Unpublished Report to Highfields NSW Pty Ltd. October 2012.

Wilson, N., Seddon, J. and Baines, G. (2016) *Factors influencing the flowering of the Tarengo Leek Orchid (*Prasophyllum petilum*).* Technical Report 36. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra. Available at: https://www.environment.act.gov.au/__data/assets/pdf_file/0018/1026342/TR36-Factors-influencing-the-flowering-of-the-Tarengo-Leek-Orchid.pdf

Wraith, J. & Pickering, C. (2018) Quantifying anthropogenic threats to orchids using the IUCN Red List. *Ambio* 47: 307-317.

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.

Zoete, T. (2000) Vegetation Survey of the Barrington Tops and Mount Royal National Parks for use in Fire Management. *Cunninghamia* 6(3): 511-578.

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

Locked Bag 1002 Dangar NSW 2309
Level 4, 26 Honeysuckle Drive Newcastle
NSW 2300
ABN 30 841 387 271
www.environment.nsw.gov.au

Planning, Industry & Environment

Our ref: DOC20/443557-1
Your ref: n/a

[redacted]

Dear [redacted]

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
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
Sporobolus 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 perennans	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]:

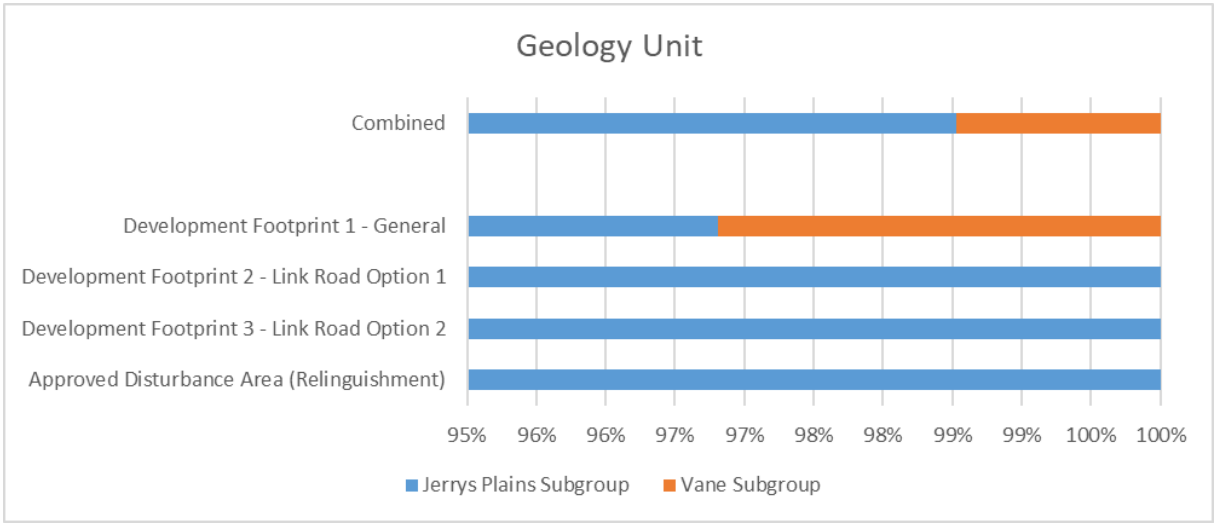
Group 2: Aristida/ Cymbopogon Average similarity: 39.82					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Aristida ramosa var. ramosa	3.43	4.60	2.17	11.55	11.55
*Linum trigynum **	2.18	3.01	2.04	7.56	19.11
Cheilanthes sieberi subsp. sieberi	2.07	2.84	2.01	7.14	26.25
*Anagallis arvensis **	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
Sporobolus 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

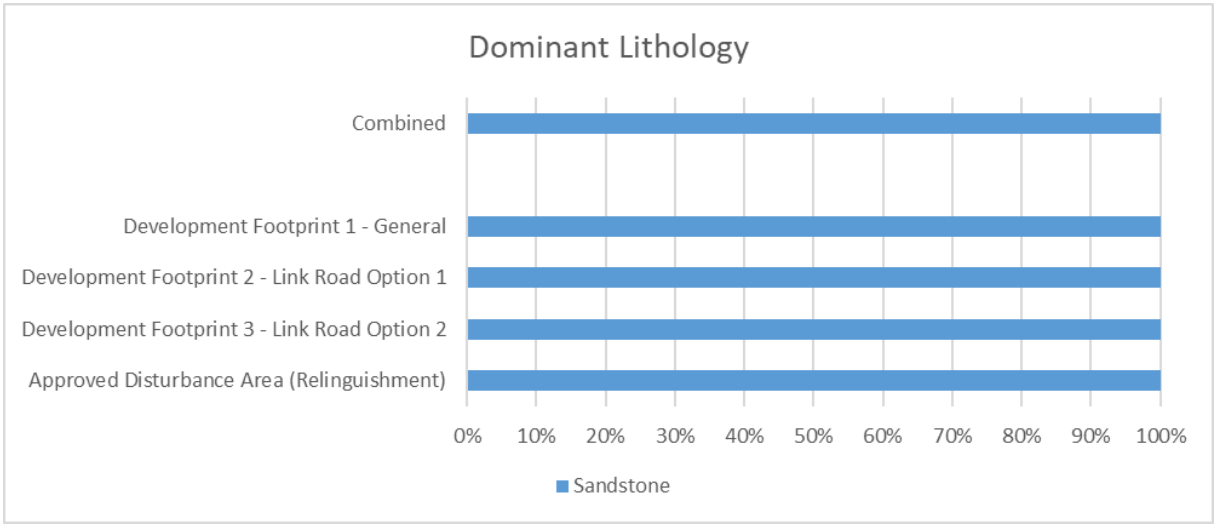
Vittadinia muelleri	0.93	0.58	0.44	1.45	70.83
Dichondra repens	0.77	0.54	0.53	1.35	72.18
Gamochaeta americana *	0.80	0.53	0.52	1.34	73.52
Dichelachne micrantha	0.82	0.52	0.49	1.31	74.83
Taraxacum officinale *	0.80	0.50	0.43	1.26	76.08
Lomandra confertifolia subsp. pallida	0.75	0.48	0.53	1.21	77.30
Tolpis 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 perennans	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

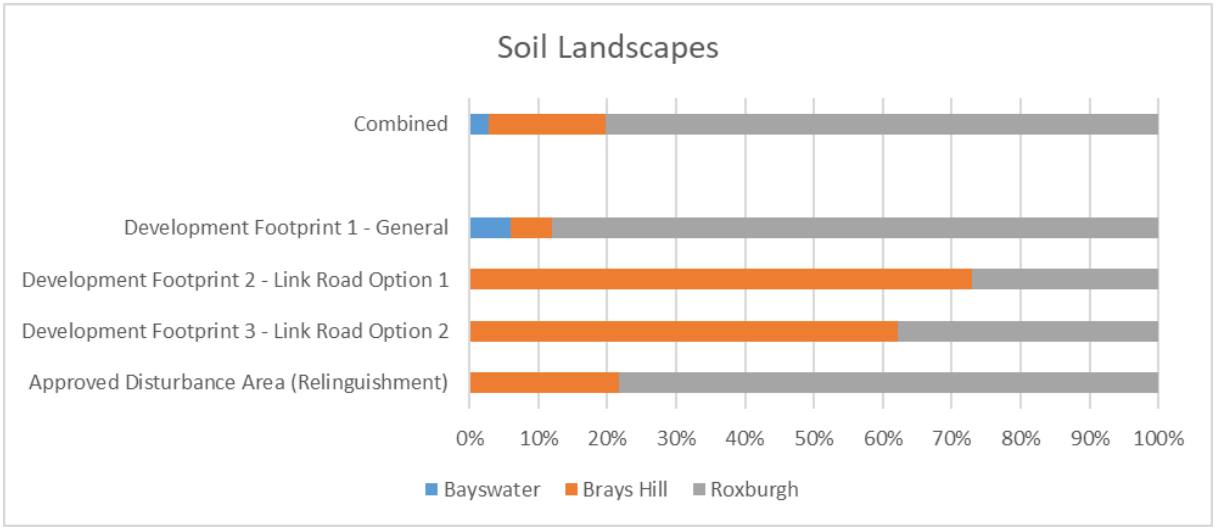
Unit 4: Bothriochloa biloba/ Carthamus/ Danthonia Grassland - Key Diagnostic Species [based on 7 plots]:

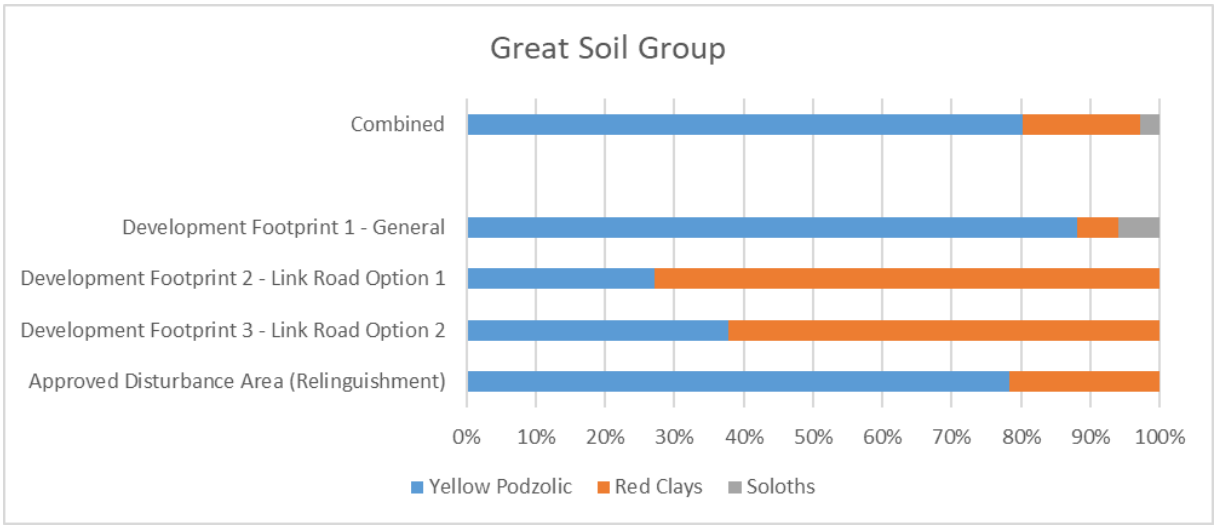
Group 4: Bothriochloa biloba/ Carthamnus/ Danthonia Average similarity: 50.03					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Bothriochloa biloba	5.14	13.03	5.61	26.04	26.04
Carthamnus lanatus *	2.57	6.41	2.45	12.82	38.86
Chloris truncata	1.86	4.86	4.58	9.72	48.57
Austrodanthonia 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

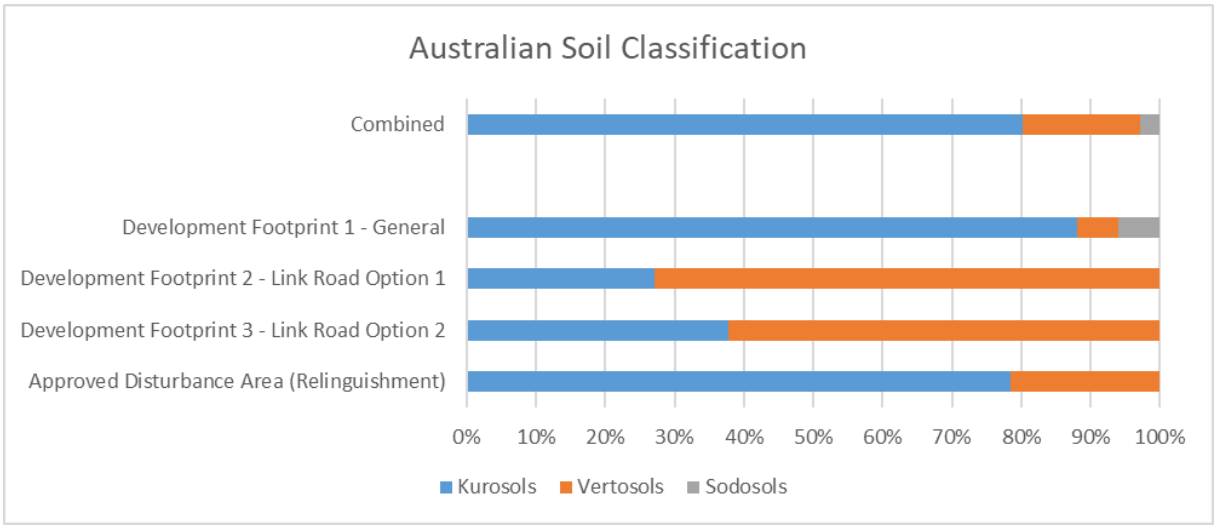
Appendix 3 – Biophysical Attributes of the Project Area

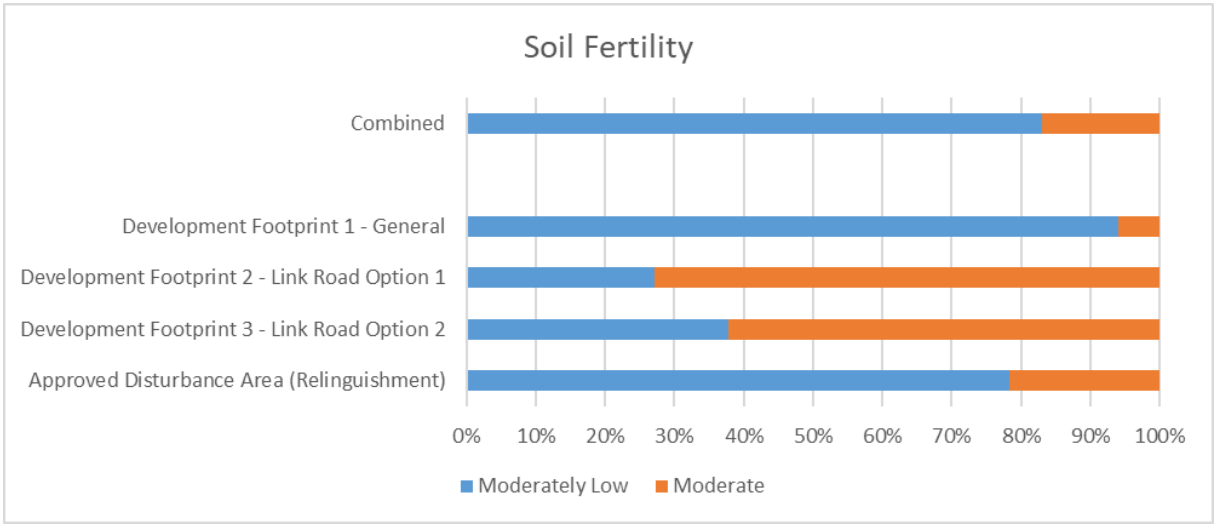


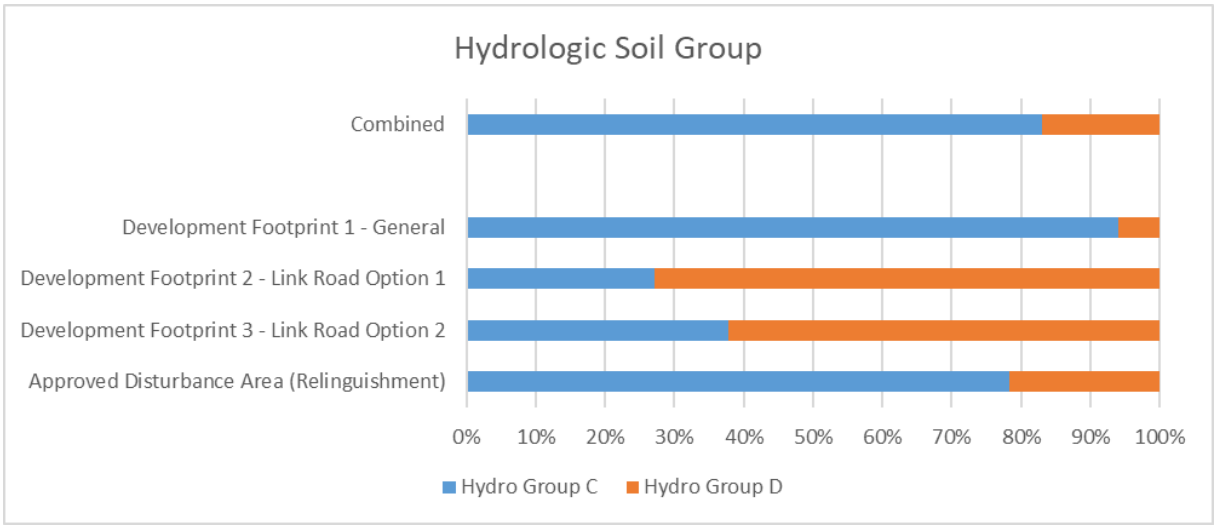


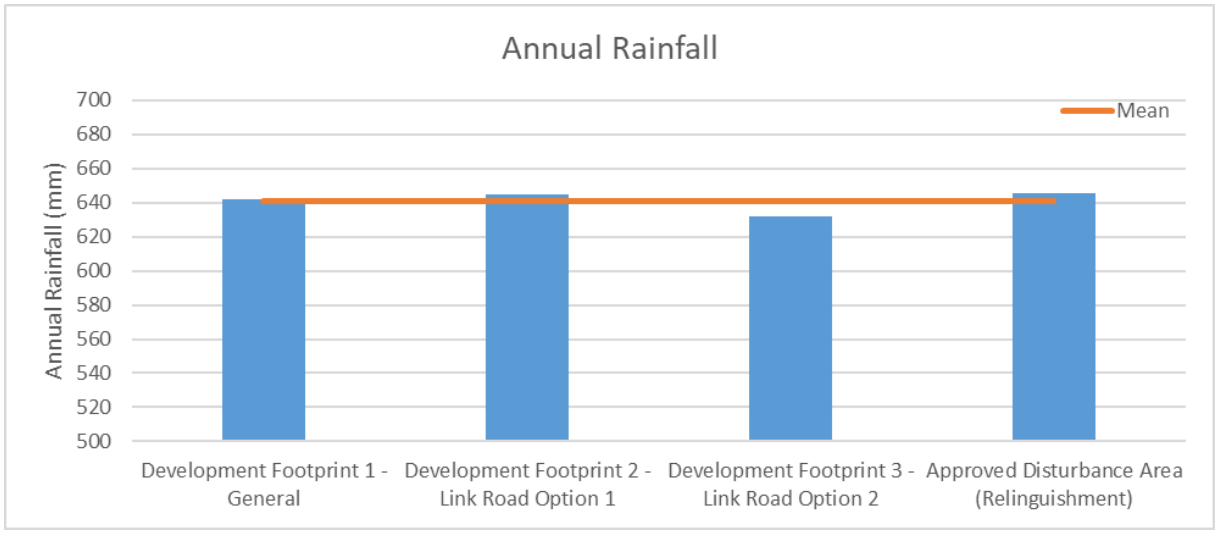


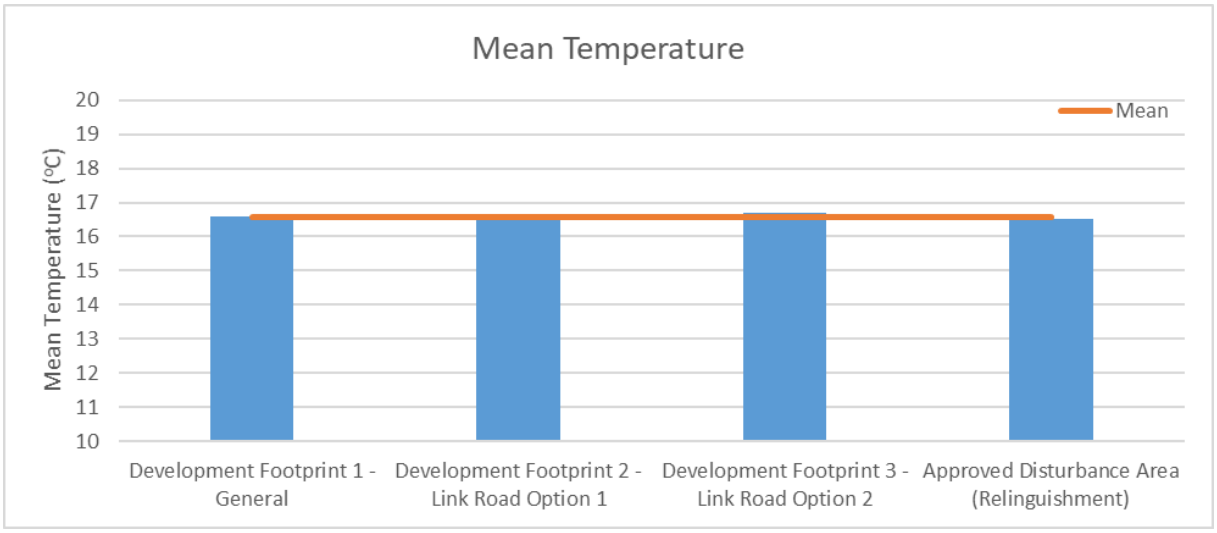

Great Soil Group
Combined
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Yellow Podzolic
Red Clays
Soloths


Australian Soil Classification
Combined
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Kurosols
Vertosols
Sodosols


Soil Fertility
Combined
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Moderately Low
Moderate

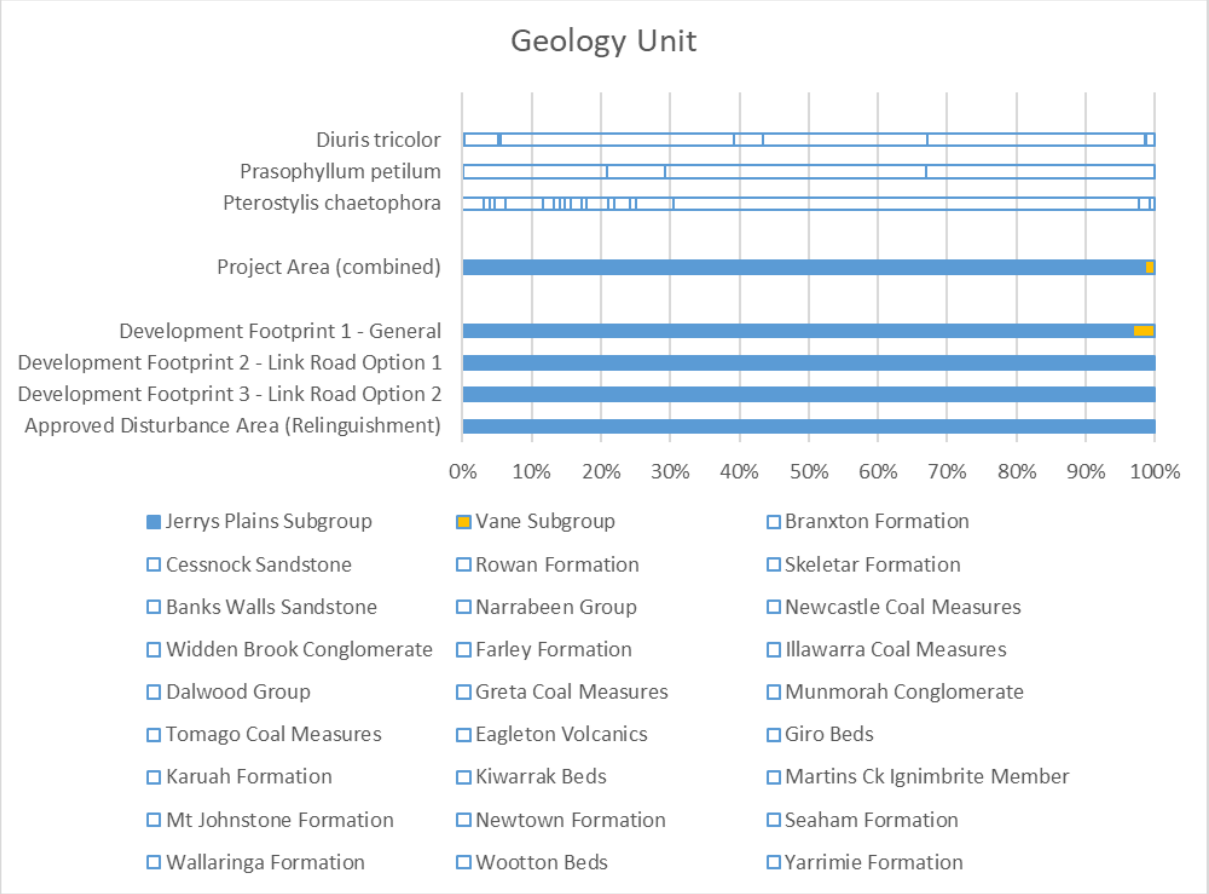

Hydrologic Soil Group
Combined
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Hydro Group C
Hydro Group D

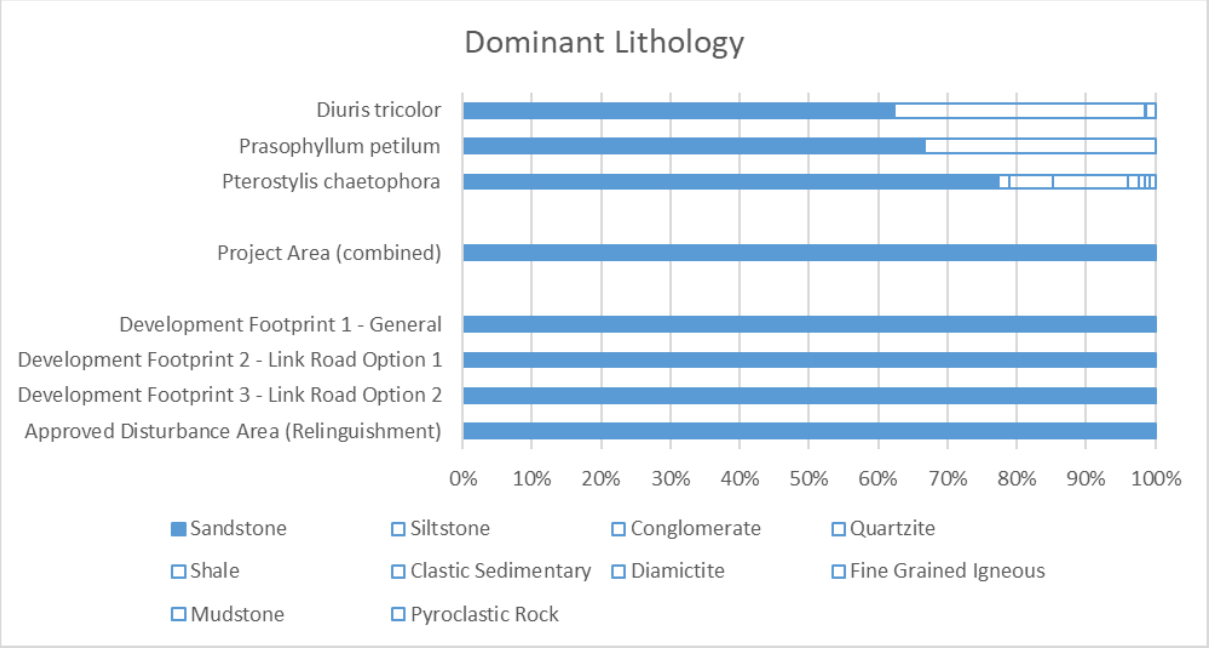

Annual Rainfall
Annual Rainfall (mm)
700
680
660
640
620
600
580
560
540
520
500
Mean
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)

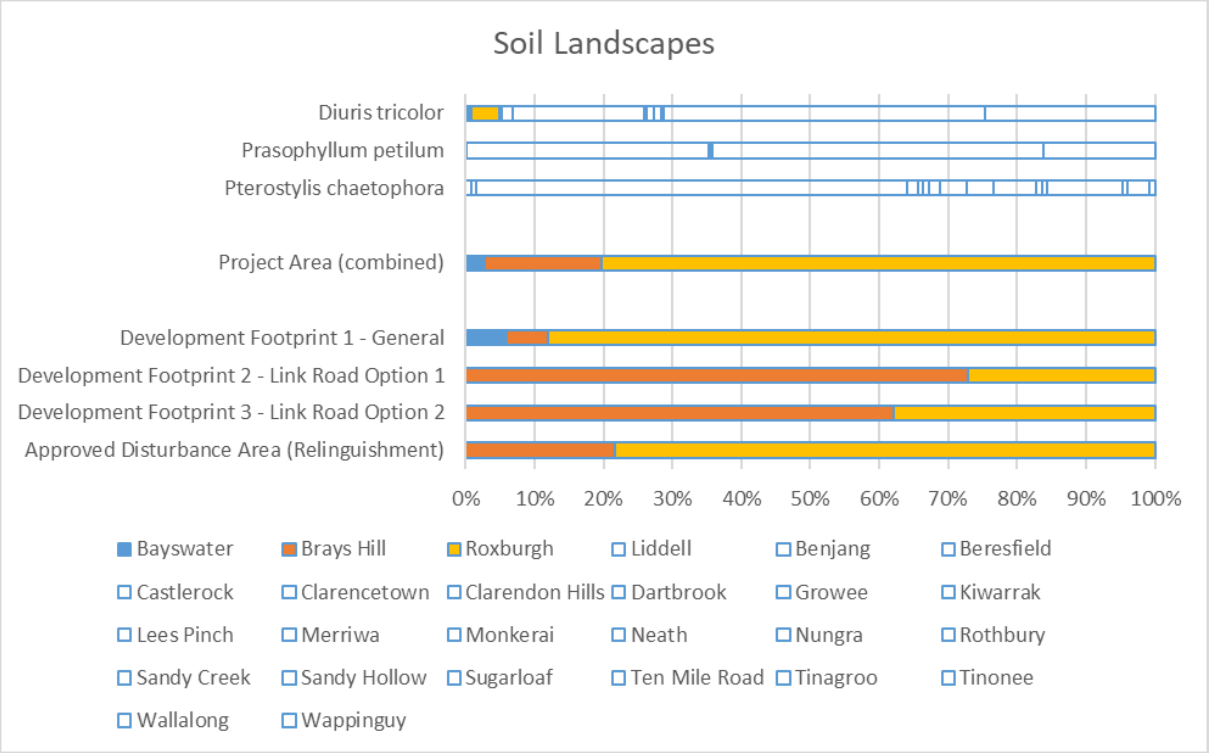

Mean Temperature
Mean Temperature (°C)
20
19
18
17
16
15
14
13
12
11
10
Mean
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)

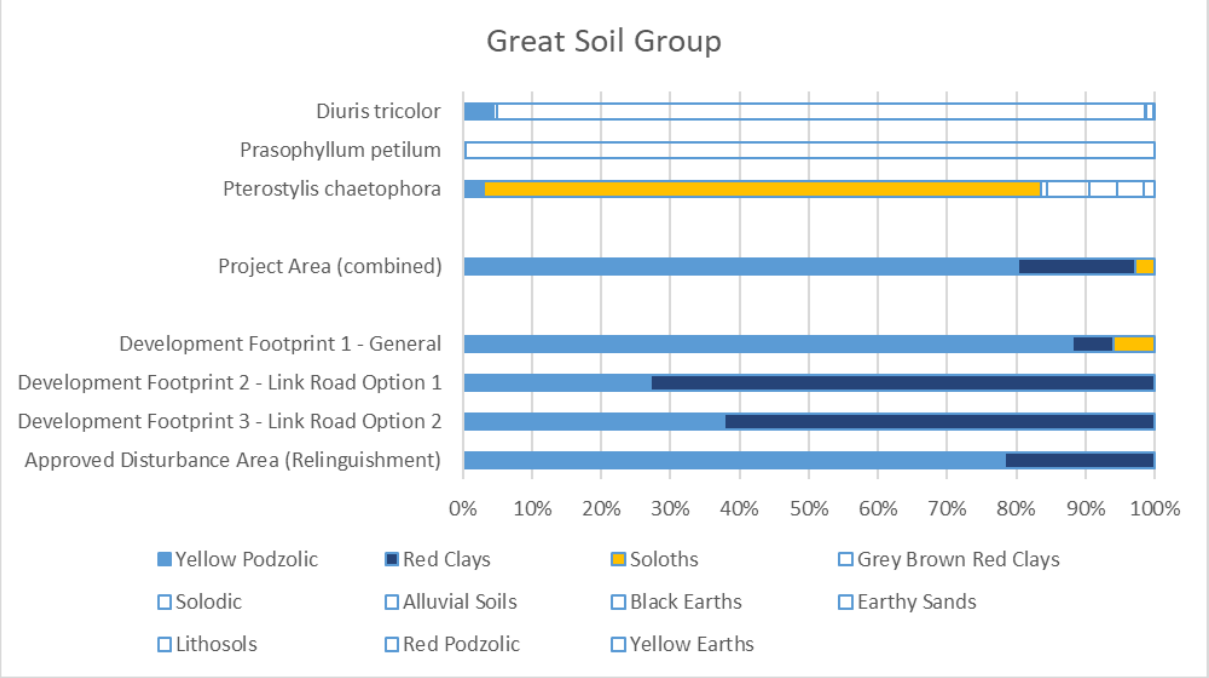
Appendix 4 – Biophysical Attributes of Orchid Locations

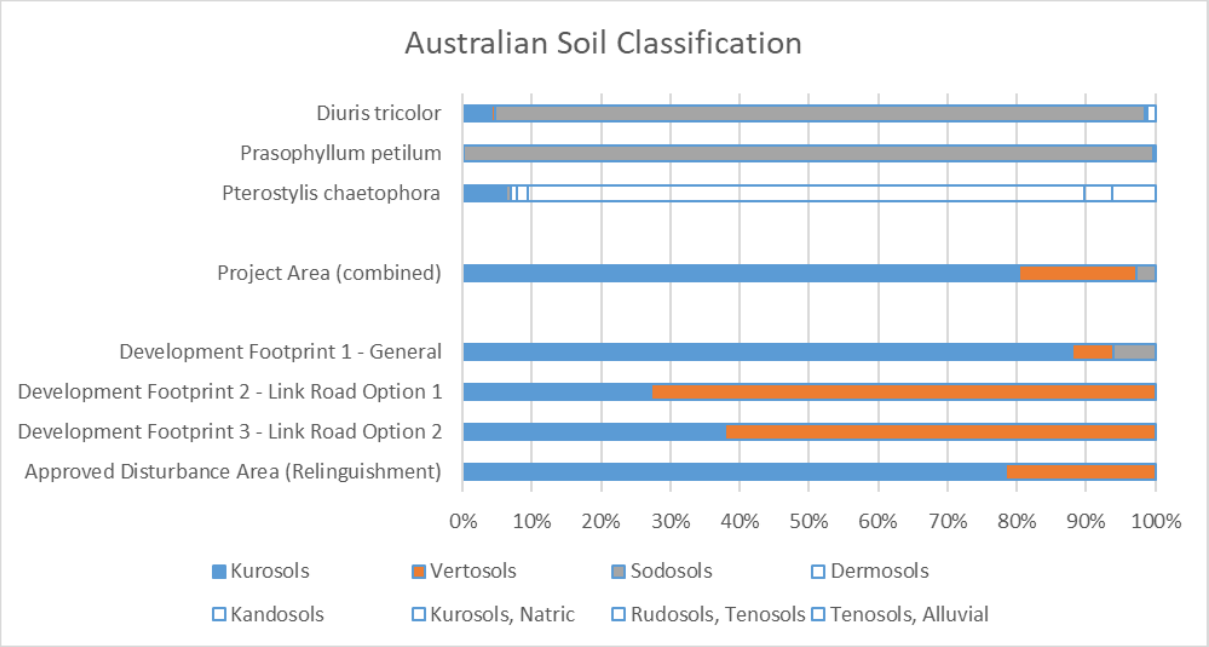
Note: Attributes present within the Project Area are filled in and coloured; those that are absent but are represented in known orchid locations elsewhere are shown open and without colour.

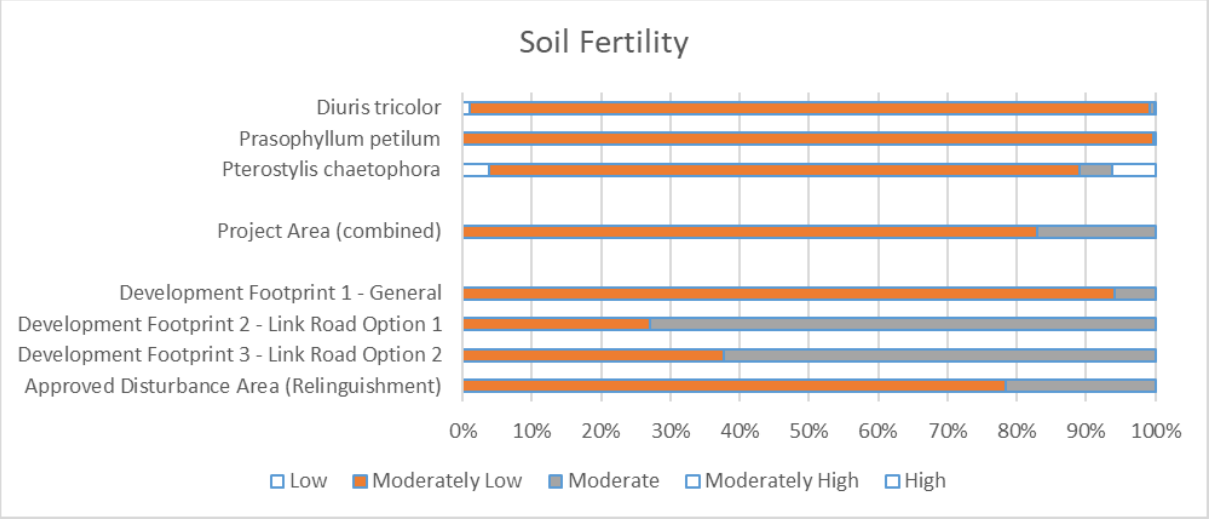


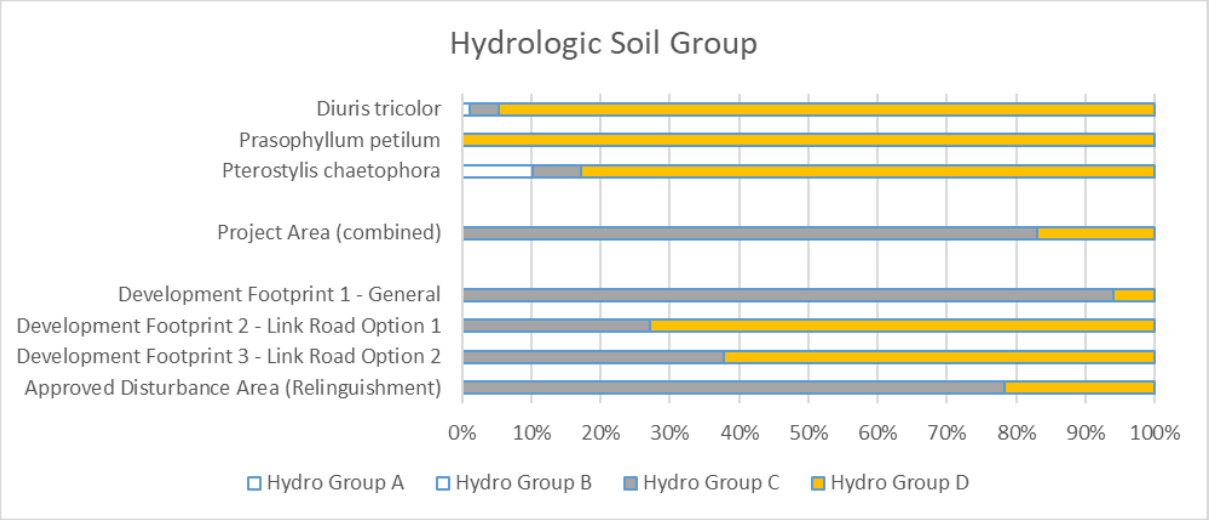


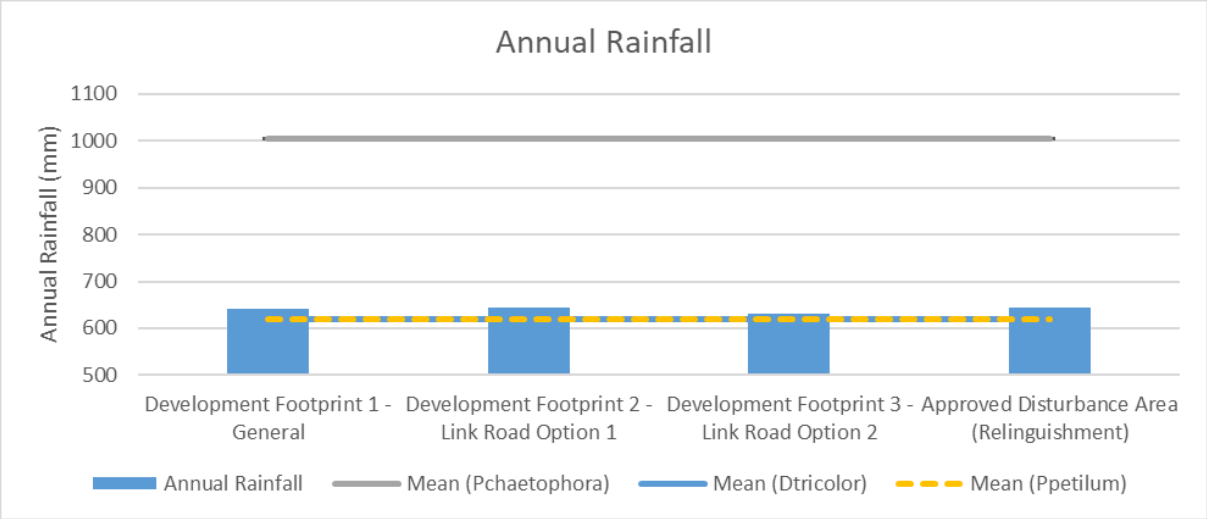

Soil Landscapes
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Bayswater
Brays Hill
Roxburgh
Liddell
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

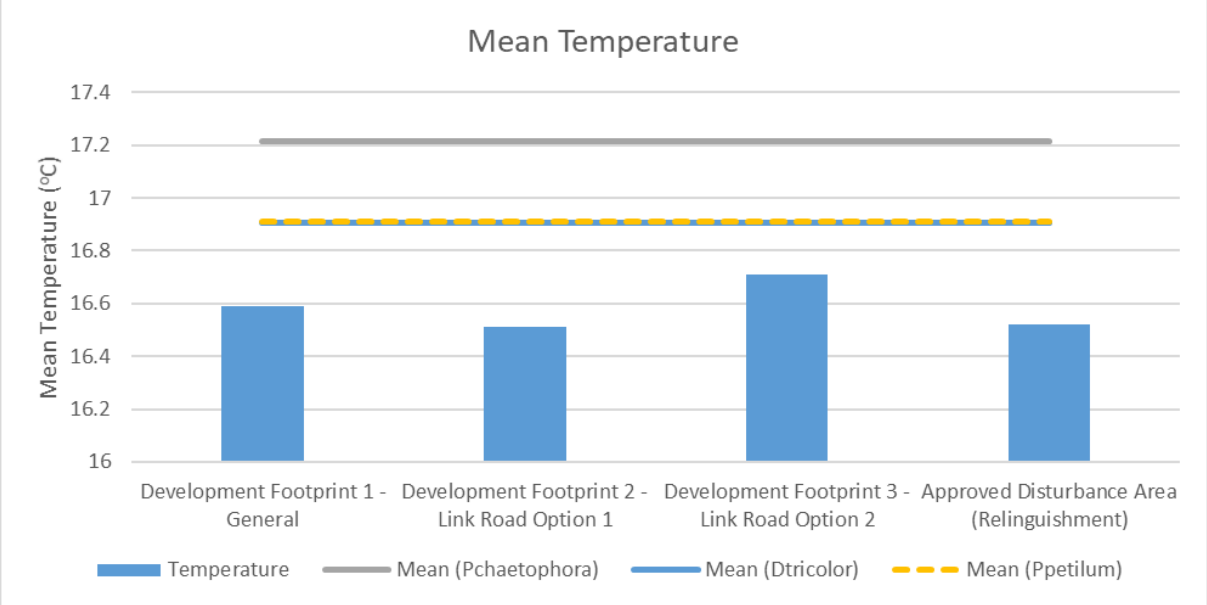

Great Soil Group
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Yellow Podzolic
Red Clays
Soloths
Grey Brown Red Clays
Solodic
Alluvial Soils
Black Earths
Earthy Sands
Lithosols
Red Podzolic
Yellow Earths


Australian Soil Classification
Diuris tricolor
Prasophyllum petilum
Pterostylis chaetophora
Project Area (combined)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
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)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
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)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
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
1100
1000
900
800
700
600
500
Annual Rainfall (mm)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
Annual Rainfall
Mean (Pchaetophora)
Mean (Dtricolor)
Mean (Ppetilum)


Mean Temperature
17.4
17.2
17
16.8
16.6
16.4
16.2
16
Mean Temperature (°C)
Development Footprint 1 - General
Development Footprint 2 - Link Road Option 1
Development Footprint 3 - Link Road Option 2
Approved Disturbance Area (Relinguishment)
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 4700 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 to present - *Vegetation Classification and Survey* (Editorial Board)
- 2019 to present - *Sustainability* (Review Board)
- 2019 to present – *Australian Network for Plant Conservation* (Committee Member)
- 2019 to present – *Don McNair Herbarium, University of Newcastle* (Industry Rep. & 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)

PUBLICATIONS (PEER REVIEWED)

Bell, S.A.J. (in review) Successful recruitment following translocation of a threatened terrestrial orchid (*Diuris tricolor*) into mining rehabilitation in the Hunter Valley of NSW. *Ecological Management and Restoration* (in review)

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. (in review) Floristic community diversity in derived native grasslands: a case study from the upper Hunter Valley of New South Wales. *Cunninghamia* (in review)

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. https://www.rbgsyd.nsw.gov.au/getattachment/Science/Our-work-discoveries/Scientific-publications/Cunninghamia/BGD0604_Cunninghamia-2020-011-BELL-HILLIER-Pterostylis-chaetophora.pdf.aspx?lang=en-AU

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. http://dx.doi.org/10.7751/telopea14543

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* https://doi.org/10.1071/BT20015

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* https://doi.org/10.1071/BT20024

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* https://doi.org/10.1111/rec.13224

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. https://www.rbgsyd.nsw.gov.au/getmedia/d27fcc0f-48eb-40e1-a61b-faaabb869098/BGD0575_Cunninghamia-2020-YARE-Diuris_2.pdf.aspx

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. http://dx.doi.org/10.7751/telopea14104

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 https://doi.org/10.1016/j.biocon.2020.108455

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. https://www.rbgsyd.nsw.gov.au/getattachment/Science/Our-work-discoveries/Scientific-publications/Cunninghamia/BGD0540_Cunninghamia%C2%A0BELL-Wollemi-plants.pdf.aspx?lang=en-AU

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. https://www.rbgsyd.nsw.gov.au/getattachment/Science/Scientific-publications/Cunninghamia/BGD0533_Cunninghamia-Bell_Macrozamia-flexuosa.pdf.aspx?lang=en-AU

Bell, S., Rockley, C., & Llewellyn, A. (2019) *Flora of the Hunter Region: Endemic Trees and Larger Shrubs*. CSIRO Publishing. 136 pp. ISBN: 9781486311026 https://www.publish.csiro.au/book/7865/

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. https://www.rbgsyd.nsw.gov.au/getattachment/Science/Scientific-publications/Cunninghamia/BGD0518_Cunninghamia-journal-Bell_FA.pdf.aspx?lang=en-AU

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. http://dx.doi.org/10.7751/telopea11502

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. https://www.rbgsyd.nsw.gov.au/getmedia/a29f3649-31fa-4307-917e-cf00783a3bc5/Cunninghamia-16-Bell-Driscoll-015.pdf.aspx

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. http://dx.doi.org/10.7751/telopea9226

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.
https://www.rbgsyd.nsw.gov.au/getmedia/260204ab-a93b-4a42-9d6a-eb9b426b03ce/Cun14Bel179.pdf.aspx

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. http://dx.doi.org/10.7751/telopea2012012

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.
https://www.rbgsyd.nsw.gov.au/getmedia/71004a71-7c36-41fc-bcb4-efa4506eafc3/cun122bel143.pdf.aspx

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. (2009) Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales. *Cunninghamia* 11(2): 241-275.
https://www.rbgsyd.nsw.gov.au/getmedia/6c33ea33-6515-4a5d-bb36-a22260c9da2c/Cun112241Bel.pdf.aspx

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.
https://www.rbgsyd.nsw.gov.au/getattachment/Science/Scientific-publications/Cunninghamia/Cunninghamia-10-3-331-Bell-331.pdf.aspx?lang=en-AU

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. https://www.rbgsyd.nsw.gov.au/getmedia/00840003-40f3-473b-8c00-eee1eb085242/Volume-8(4)-2004-Cun8Bel477-484.pdf.aspx

Bell, S.A.J. (2004) Vegetation of Werakata National Park, Hunter Valley, New South Wales. *Cunninghamia* 8(3): 331-347.
https://www.rbgsyd.nsw.gov.au/getmedia/86867762-c95d-4af5-a931-84d1b1833930/Volume-8(3)-2004-Cun8Bel331-347.pdf.aspx

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.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.573.2247&rep=rep1&type=pdf

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.
https://www.biodiversitylibrary.org/item/124537#page/69/mode/1up

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.
https://www.rbgsyd.nsw.gov.au/getmedia/c0dfb222-37e5-44fe-b582-861ada5f4f19/Volume-7(2)-2001-Cun7Bel195-204.pdf.aspx

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.
https://www.rbgsyd.nsw.gov.au/getmedia/72b15b75-1b7a-4b1c-a3aa-dce8f1592ad0/Volume-7(1)-2001-Cun7Bel077-88.pdf.aspx

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. (2020) Voucher specimens vs observation records: why 'collecting' is better than 'observing' for plant conservation. *Australasian Plant Conservation* 29:3-7.

Bell, S. (2020) Check those IDs… the importance of confirming threatened plant identifications before implementing management. *Australasian Plant Conservation* 28: 18-20.

https://search.informit.com.au/documentSummary;dn=093686598112682;res=IELHSS

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.
https://search.informit.com.au/documentSummary;dn=630060994941361;res=IELHSS

Bell, S. (2018) The responsibilities of ecological consultants in disseminating outcomes from threatened species surveys. *Australasian Plant Conservation* 27: 3-6.
https://search.informit.com.au/documentSummary;dn=055941884533703;res=IELHSS

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.
https://search.informit.com.au/documentSummary;dn=055997783447477;res=IELNZC

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.
https://search.informit.com.au/documentSummary;dn=178254394062662;res=IELHSS

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.
https://search.informit.com.au/documentSummary;dn=161328395569227;res=IELHSS

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.
https://search.informit.com.au/documentSummary;res=IELNZC;dn=527297009650678

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.
https://search.informit.com.au/documentSummary;res=IELHSS;dn=698850776024925

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.
https://search.informit.com.au/documentSummary;res=IELNZC;dn=338997888305443

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.
https://search.informit.com.au/documentSummary;res=IELNZC;dn=230155442595307

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.
https://search.informit.com.au/documentSummary;res=IELNZC;dn=021863143090023

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.
https://search.informit.com.au/documentSummary;res=IELHSS;dn=249818913462842

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.
https://search.informit.com.au/documentSummary;res=IELNZC;dn=248961796784965

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.
https://irp-cdn.multiscreensite.com/023a4538/files/uploaded/Warkworth_Sands_Peake_et_al_AZigZ3I7SzoQd9dmO41j.pdf

Bell, S. (2002) Plant profile: The Leafless Tongue Orchid, *Cryptostylis hunteriana. Hunter Flora* 9: 2.

EXPERT REPORTS (2001 – 2020)

Bell, S.A.J. (2020) *Expert Report – Likely occurrence of* Diuris praecox *(Orchidaceae) within Stage 1 of the proposed Central Coast Strategic Conservation Plan*. Unpublished Report to Umwelt (Australia) Pty Limited. August 2020.

Bell, S.A.J. (2020) *Expert Report: Lower Hunter Spotted Gum Ironbark Forest TEC & proposed Newcastle Power Station Project, Tomago*. Unpublished Letter Report to AGL Energy Limited & Kleinfelder, August 2020.

Bell, S.A.J. (2020) *Expert Report - Expected Presence of Threatened Terrestrial Orchids (*Diuris tricolor*,* Prasophyllum petilum*,* Pterostylis chaetophora*): Maxwell Underground Coal Mine Project*. Unpublished Draft Report to Malabar Coal. July 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. (2019) *Expert Report:* Hibbertia procumbens *(Labill.) DC. (Dilleniaceae) at a Proposed Industrial Warehouse Development, Gindurra Road, Somersby*. Unpublished Report to Anderson Environment & Planning.

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).

Bell, S.A.J. (2019) *Expert Peer Review: Assessment of River-flat Eucalypt Forest on Coastal Floodplains TEC at a proposed development site at Gwandalan, Central Coast Council*. Unpublished Report to Resolve Urban Planning. June 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2019) *Expert Peer Review: Assessment of the vulnerable* Tetratheca juncea *at a proposed development site at Gwandalan, Central Coast Council*. Unpublished Report to Resolve Urban Planning. April 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2017) *Expert Report: Leafless Tongue Orchid (*Cryptostylis hunteriana*): Potential presence at Thornton, Hunter Valley, NSW*. Unpublished Report to WSP Parsons Brinckerhoff. 28 April 2017. Eastcoast Flora Survey.

Bell, S.A.J. (2016) *Review of Biodiversity Issues: United Wambo Open Cut Coal Mine Project*. Unpublished Report to EDO NSW, September 2016.

Bell, S.A.J. (2015) *External Review: Draft Threatened Plant Survey Guidelines*. Unpublished Report to Office of Environment & Heritage, NSW Department of Premier and Cabinet. May 2015. Eastcoast Flora Survey.

Bell, S.A.J. (2012) *Comment on potential Blue Gum High Forest CEEC at Jesmond Park, Newcastle LGA*. Report to Newcastle City Council. Eastcoast Flora Survey. April 2012.

Bell, S.A.J. (2012) *Expert Report: Bulga Milbrodale Progress Association v Minister for Planning and Infrastructure and Warkworth Mining Limited*. Land and Environment Court Proceedings No: 10224 of 2012. Unpublished Report to EDO NSW, July 2012.

Bell, S.A.J. (2011) *Review of Greater Hunter Vegetation Mapping: Version 0.1*. Unpublished Report to Office of Environment & Heritage, Department of Premier & Cabinet. August 2011. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *Affidavit: Assessment of vegetation at Lots 3 & 4 (DP399581) Quorrobolong, from field data collected in May 2006*. Unpublished Report to Department of Environment, Climate Change & Water, November 2009. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *Expert Report: Colongra Swamp Nature Reserve*. Unpublished Report to Department of Environment & Climate Change. Eastcoast Flora Survey. June 2009.

Bell, S.A.J. (2008) *Comment on the potential presence of the Critically Endangered* Thelymitra *'*adorata*' at Louisiana Road, Wadalba, Wyong LGA*. Unpublished Report to Travers Environmental, November 2008.

Bell, S.A.J. (2008) *Review of flora issues relating to proposed Coal & Allied development on the Wallarah Peninsula*. Unpublished report to Department of Environment & Climate Change, Newcastle. March 2008.

Bell, S.A.J. (2006) *Expert Report: Providence Projects Pty Ltd v Gosford City Council.* Land and Environment Court Proceedings No: 11626 of 2004; 10101 of 2005. Unpublished Report to Gosford City Council.

Bell, S.A.J. (2005) *Expert Report: Assessment of vegetation, 37 Laycock Street Carey Bay: Lake Macquarie City Council ats. First Cape Management Pty Ltd. L & E Court Proceedings 11475/04*. Report to Land & Environment Court: April 2005.

Bell, S.A.J. (2001) *Expert Report: Hunter Resort v Cessnock City Council*. Land and Environment Court Proceedings.

SELECTED UNPUBLISHED TECHNICAL REPORTS (1993 – 2020)

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. & Oppen, M. (2020) *Management of habitat for the Critically Endangered* Persoonia pauciflora *(Proteaceae) at 'Georgia' (Lot 56 DP755211), North Rothbury, NSW*. Unpublished Report to NSW Biodiversity Conservation Trust. April 2020. Eastcoast Flora Survey.

Bell, S.A.J. (2020) *Identifying potential pollinators in the critically endangered* Banksia conferta *(Proteaceae), Coorabakh National Park, NSW*. Unpublished Report to NSW National Parks and Wildlife Service. March 2020. Eastcoast Flora Survey.

Bell, S.A.J. (2019) *A Re-assessment of Foreshore Vegetation along Tuggerah Lake, Chittaway Bay to The Entrance, Central Coast LGA*. Report to Central Coast Council. November 2019.

Bell, S.A.J. (2019) *Baseline surveys for two threatened mallees* (Eucalyptus castrensis *and* Eucalyptus pumila) *in the lower Hunter Valley of New South Wales*. Unpublished Report to NSW Office of Environment and Heritage. April 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2019) *Survey and monitoring of the Vulnerable* Pterostylis chaetophora *(Rusty Greenhood) in the Lower Hunter Valley, NSW: 2018 Results*. Unpublished Report to NSW Office of Environment and Heritage. April 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2019) *A Revised Interim Vegetation Classification of the Central Coast Local Government Area*. Unpublished Report to Central Coast Council. July 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2019) *Verification Survey of the Critically Endangered* Pomaderris reperta *(Denman Pomaderris) at Aarons Pass Road, Central Tablelands, NSW*. Unpublished Report to Office of Environment & Heritage. February 2019. Eastcoast Flora Survey. [peer review survey, *Pomaderris cotoneaster* rather than *Pomaderris reperta*]

Bell, S.A.J. (2019) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2018 Results*. Unpublished Report to Mangoola Coal. February 2019. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Review of significant vegetation at 100 Bakali Road, Forresters Beach (Lot 9, DP 8857)*. Unpublished Report to Darcy Smith. November 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Monitoring of the endangered* Pterostylis gibbosa *(Orchidaceae) at Milbrodale, Hunter Valley: Year 3 Results*. Unpublished Report to Office of Environment & Heritage. November 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Monitoring of* Acacia pendula *in the Weeping Myall Management Areas, Bulga Coal, Singleton LGA: 2018 Results*. Unpublished Report to Bulga Coal. October 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Monitoring and survey of the Critically Endangered* Pomaderris reperta *(Rhamnaceae) and Vulnerable* Lasiopetalum longistamineum *(Malvaceae), Upper Hunter Valley, New South Wales: 2017-2018 (Year 2) Results*. Unpublished Report to Office of Environment & Heritage. October 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Mt Dangar Multi-species Saving our Species Project: Year 2 (2017-2018) Summary Report*. Unpublished Report to Office of Environment & Heritage. October 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Monitoring of* Acacia pendula *flowering in the Weeping Myall Management Area, Singleton LGA*. Unpublished Report to Bulga Coal. August 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Vegetation and floristics of the Huntlee Offset Lands, Hunter Valley, NSW: Sweetwater (North Rothbury).* Unpublished Report to Office of Environment & Heritage. June 2018. Eastcoast Flora Survey.

Bell, S.A.J. & Sims, R. (2018) *Targeted Surveys for the Vulnerable* Dracophyllum macranthum *(Ericaceae) in Coorabakh National Park, Lansdowne Plateau, NSW*. Unpublished Report to NSW Office of Environment & Heritage. 21 June 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Baseline demography of a significant new population of the Critically Endangered* Banksia conferta *(Proteaceae), Coorabakh National Park, NSW*. Unpublished Report to NSW Office of Environment & Heritage. June 2018. Eastcoast Flora Survey. Final Report.

Bell, S.A.J. (2018) *Vegetation and floristics of the Huntlee Offset Lands, Hunter Valley, NSW: 4. Warrawalong (Cessnock LGA)*. Unpublished Report to Office of Environment & Heritage. April 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Vegetation and floristics of the Huntlee Offset Lands, Hunter Valley, NSW: 3. Corrabare (Cessnock LGA).* Unpublished Report to Office of Environment & Heritage. April 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Vegetation and floristics of the Huntlee Offset Lands, Hunter Valley, NSW: 2. Elderslie (Singleton LGA)*. Unpublished Report to Office of Environment & Heritage. April 2018. Eastcoast Flora Survey.

Bell, S.A.J. (2018) *Monitoring of translocated threatened orchids (*Diuris tricolor, Prasophyllum petilum*) at Mangoola Coal: 2017 Results*. Unpublished Report to Mangoola Coal. February 2018.

Bell, S.A.J. (2017) *Monitoring of the endangered* Pterostylis gibbosa *(Orchidaceae) at Milbrodale, Hunter Valley: Year 2 Results*. Unpublished Report to NSW Office of Environment & Heritage. November 2017. Eastcoast Flora Survey.

Bell, S.A.J. (2017) *A strategy for assessing population size in threatened plant surveys*. Unpublished Report to NSW Office of Environment and Heritage. November 2017.

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. (2017) *Vegetation and floristics of the Huntlee Offset Lands, Hunter Valley, NSW: 1. Cedar Creek (Cessnock LGA).* Unpublished Report to NSW Office of Environment and Heritage. October 2017.

Bell, S.A.J. (2017) *Baseline monitoring and survey of the Critically Endangered* Pomaderris reperta *(Rhamnaceae) and Vulnerable* Lasiopetalum longistamineum *(Malvaceae), Upper Hunter Valley, New South Wales*. Unpublished Report to NSW Office of Environment and Heritage. October 2017.

Bell, S.A.J. (2017) *Field Validation of Wetlands Mapping on the Central Coast of New South Wales*. Unpublished Report to NSW Office of Environment and Heritage.

Bell, S.A.J. (2017) *Mt Dangar Multi-species Saving our Species Project: Year 1 (2016-2017) Summary Report.* Unpublished Report to NSW National Parks and Wildlife Service. June 2017.

Bell, S.A.J. (2017) *Monitoring of the Critically Endangered* Banksia conferta *(Proteaceae) at Coorabakh National Park, NSW*. Unpublished Report to NSW Office of Environment and Heritage.

Bell S.A.J. (2016) *Monitoring of the endangered* Pterostylis gibbosa *(Orchidaceae) at Milbrodale, Hunter Valley, NSW*. Unpublished Report to NSW Office of Environment and Heritage.

Bell S.A.J. (2016) *Distribution and condition of the threatened* Melaleuca biconvexa *(Myrtaceae) on the Central Coast of NSW*. Unpublished Report to NSW Office of Environment and Heritage.

Bell, S.A.J. (2016) *Additional notes on distribution and fragmentation of Warkworth Sands Woodland, from the Hunter Valley of New South Wales*. Unpublished Report to Department of Environment, Ecological Communities Section, Protected Species & Communities Branch, Canberra. April 2016.

Bell, S.A.J. (2016) *An assessment of the vegetation occurring on coastal sands at Pelican Flats, Lake Macquarie LGA*. Lake Macquarie Research Grant Project 2004/2005-01.

Bell, S.A.J. & Driscoll, C. (2016) *Volume 1: Vegetation Mapping Report, Lake Macquarie Local Government Area. Stages 1 - 6.* Unpublished Report to Lake Macquarie City Council. March 2016. Eastcoast Flora Survey.

Bell, S.A.J. (2016) *Volume 2: Vegetation Community Profiles, Lake Macquarie Local Government Area. Working Draft v2*. Unpublished Report to Lake Macquarie City Council. March 2016. Eastcoast Flora Survey.

Bell, S.A.J. (2016) *Vegetation and floristics of the Columbey Conservation Lands (NP & SCA), lower Hunter Valley, New South Wales.* Unpublished Report to Office of Environment & Heritage (Gloucester). January 2016. Eastcoast Flora Survey.

Bell, S.A.J. (2015) *Lower Hunter Spotted Gum-Ironbark Forest: Verification Survey, Proposed Newcastle Inner City Bypass (Rankin Park to Jesmond), Newcastle LGA*. Unpublished Report to Roads and Maritime Services. March 2015. Eastcoast Flora Survey.

Bell, S.A.J. (2015) *Review of Offset Multipliers (Tg values) for Selected Threatened Species*. Unpublished Report to NSW Office of Environment and Heritage. November 2015. Eastcoast Flora Survey.

Bell, S.A.J. (2015) *Distribution, habitat and conservation status of* Macrozamia flexuosa *(Zamiaceae) in Lake Macquarie LGA and the lower Hunter Valley of New South Wales*. Lake Macquarie Research Grant Project 1999/2000-02.

Bell, S.A.J. (2014) *Tablelands Snow Gum TEC: Field Survey & Classification Analysis, Southern Tablelands, New South Wales. Tallaganda & Badja State Forest Trial Areas*. Unpublished DRAFT Report to NSW Office of Environment & Heritage. Eastcoast Flora Survey. November 2014.

Bell, S.A.J. (2014) *Preliminary data analysis of Slaty Gum (*Eucalyptus dawsonii*) Forests & Woodlands in the Hunter Valley*. Unpublished Report to Department of Environment, Ecological Communities Section, Protected Species & Communities Branch, Canberra. August 2014. Prepared as part of deliberations emanating from the Expert Panel assessing the proposed Central Hunter Valley Eucalyptus Forest and Woodland Complex endangered ecological community.

Bell, S.A.J. (2014) *Submission on Warkworth Sands Woodland EEC: Warkworth / Mt Thorley Continuation Project*. Unpublished Submission to NSW Department of Planning and Environment. Eastcoast Flora Survey. July 2014.

Bell, S.A.J. (2013) *Ecological studies on* Acacia dangarensis*: Baseline data to inform management*. Unpublished Report to NSW Office of Environment & Heritage, Mudgee. October 2013. Eastcoast Flora Survey.

Bell, S.A.J. (2013) *Assessment of Alluvial Riparian Blackbutt Forest in Wyong LGA against River Flat Eucalypt Forest EEC*. Unpublished Report to Wyong Shire Council. June 2013. Eastcoast Flora Survey.

Bell, S.A.J. (2013) *A strategy for monitoring revegetation of rehabilitation after coal mining, Ravensworth Operations, Hunter Valley*. Unpublished Report to Ravensworth Operations, Xstrata Coal, April 2013. Eastcoast Flora Survey.

Bell, S.A.J. (2013) *Summary Report of Baseline* Pomaderris reperta *Monitoring Data, Mangoola Coal*. Unpublished Report to Mangoola Coal. Eastcoast Flora Survey.

Bell, S.A.J. (2012) *Update of Listing Advice and Fact Sheet for* Weeping Myall - Coobah - Scrub Wilga Woodland/Low Forest of the Hunter Valley. Unpublished Report to the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities. Eastcoast Flora Survey, June 2012.

Bell, S.A.J. & Carty, A. (2012) *Vegetation mapping of the Singleton Military Area*. Unpublished report to Commonwealth Department of Defence. Eastcoast Flora Survey & SKM, March 2012.

Bell, S.A.J. (2011) *Implementing the NSW Vegetation Classification and Assessment (VCA) Scheme in the Hunter-Central Rivers Region: Attribution of Priority Vegetation Types*. Unpublished Database to Hunter-Central Rivers Catchment Management Authority. Eastcoast Flora Survey.

Bell, S.A.J. (2011) *Diversity and condition of derived grasslands at Mangoola Coal, Upper Hunter Valley: Stage 2 – 2010 Surveys*. Unpublished Report to Mangoola Coal, August 2011. Eastcoast Flora Survey.

DeLacey, C., Bell, S.A.J., & Chamberlain, S. (2011) *Pittwater Vegetation Classification, Vegetation Mapping, pre-1750 Vegetation Mapping and Vegetation Profiles*. Unpublished Report prepared for Pittwater Council.

DeLacey, C., Bell, S., Chamberlain, S., & Bossard, K. (2010) *Prediction of habitat for cryptic plant species: The Leafless Tongue Orchid* Cryptostylis hunteriana *Nicholls as a case study*. A research project funded by the NSW Environmental Trust (2006/RR/0003). October 2010.

Bell, S.A.J. (2010) *Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales: Update with Duns Creek addition*. Unpublished Report to Department of Environment & Climate Change (Gloucester Area). June 2010. Eastcoast Flora Survey.

Bell, S.A.J. (2010) *Lower Hunter Spotted Gum-Ironbark Forest EEC in the Warnervale area, Wyong LGA*. Unpublished Report to Wyong Shire Council, September 2010. Eastcoast Flora Survey.

Bell, S.A.J. (2010) *Lower Hunter Spotted Gum – Ironbark Forest: Distribution and composition in Cessnock, Maitland, Newcastle & Wyong LGAs*. Report to Department of Environment & Climate Change (Coffs Harbour). Eastcoast Flora Survey.

Bell, S.A.J. & Driscoll, C. (2010) *Vegetation of the Worimi Conservation Lands, Port Stephens, New South Wales: Worimi NP, Worimi SCA & Worimi RP*. Unpublished Report to Department of Environment, Climate Change & Water, November 2010. Eastcoast Flora Survey.

Bell, S.A.J. & Copeland, L. (2010) *A strategy for the translocation of threatened terrestrial orchids at Mangoola Coal, Upper Hunter Valley*. Unpublished Report to Mangoola Coal, September 2010. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *Lower Hunter Spotted Gum – Ironbark Forest: Distribution and composition in Lake Macquarie LGA*. Unpublished Draft Report to Lake Macquarie City Council. Eastcoast Flora Survey. May 2009.

Bell, S.A.J. (2009) *Equivalence analysis of Hunter and Central Coast vegetation communities for the Hunter VCA Project*. Report to EcoLogical Australia & Hunter-Central Rivers Catchment Management Authority. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *The natural vegetation of the Gosford local government area, Central Coast, New South Wales*. *Volumes 1 & 2. Fully Revised*. Unpublished Report to Gosford City Council. 2009. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *Vegetation and floristics of Murrurundi Pass and Crawney Pass National Parks, upper Hunter Valley, New South Wales*. Unpublished Report to Department of Environment & Climate Change (Scone Area). February 2009.

Bell, S.A.J. & Driscoll, C. (2009) *Vegetation survey and mapping of Sugarloaf State Conservation Area, Lake Macquarie*. Unpublished report and map to Department of Environment & Climate Change.

Driscoll, C. & Bell, S.A.J. (2009) *The experimental translocation of* Tetratheca juncea *Sm. (Tremandraceae) at Gwandalan, Wyong Shire. Final Report.* Unpublished Report to Crighton Properties Pty Ltd, Wyong Shire Council, and Department of Environment and Climate Change. April 2009.

Bell, S. & Driscoll, C. (2008) *Revised Vegetation Mapping of Wyong LGA: Stage 1 – West of F3 Freeway*. Unpublished report and map to Wyong Shire Council.

Bell, S.A.J. (2007) *The Vegetation of Eraring Power Station, Lake Macquarie, New South Wales*. Unpublished Report to Eraring Energy and HLA ENSR. Eastcoast Flora Survey.

Bell, S. & Driscoll, C. (2007) *Vegetation of the Cessnock-Kurri Region, Cessnock LGA, New South Wales: Survey, Classification and Mapping*. Unpublished report and map prepared for Department of Environment and Conservation.

Bell, S.A.J. & Driscoll, C. (2006) *Vegetation of the Tomago and Anna Bay Sandbeds, Port Stephens, New South Wales: Management of Groundwater Dependent Ecosystems. Part 1 – Vegetation Classification*. Unpublished Report to Hunter Water. Eastcoast Flora Survey. September 2006.

Bell, S.A.J. & Driscoll, C. (2006) *Vegetation of the Salt Ash Air Weapons Range, Medowie, New South Wales*. Unpublished Final Report to Department of Defence. May 2006. Eastcoast Flora Survey.

Bell, S.A.J. & Driscoll, C. (2006) *Vegetation Mapping of Watagans National Park and Jilliby State Conservation Area*. Summary Report to Parks & Wildlife Division, Department of Environment and Conservation. January 2006.

Bell, S.A.J. (2006) Eucalyptus parramattensis *subsp*. decadens: *Status, distribution and habitat*. Unpublished Report prepared for the Department of Environment & Conservation, Newcastle. Eastcoast Flora Survey. June 2006.

Bell, S.A.J. (2006) *Review of floristic and structural vegetation baseline data for* Biometrics*, Hunter & Central Rivers CMA*. Department of Environment & Conservation/ CSIRO.

Bell, S.A.J. & Driscoll, C. (2005) *Assessment of littoral rainforest and coastal headland vegetation, Treachery Head, Myall Lakes National Park*. Unpublished Report to Parks and Wildlife Division, Department of Environment and Conservation. Eastcoast Flora Survey. March 2005.

Bell, S.A.J. (2004) *Umina Coastal Sandplain Woodland: A regional analysis with reference to the vegetation present in Hillview Street, Woy Woy*. Unpublished Report to Gosford City Council. November 2004.

Bell, S.A.J. (2004) *Data audit of vegetation survey within the Central Coast LGA's: 2000 - 2004*. Eastcoast Flora Survey - Report to Hunter Councils. July 2004.

Bell, S.A.J. (2004) *The vegetation of the Hunter Economic Zone (HEZ), Cessnock LGA, New South Wales*. Unpublished Report to Harper Somers O'Sullivan. January 2004. Eastcoast Flora Survey.

Driscoll, C., & Bell, S. (2004) *A taxonomic review of the* Grevillea linearifolia *complex as it occurs in the Central and Lower North Coast of NSW, with particular reference to the threatened* Grevillea parviflora *subsp*. parviflora. Unpublished Report to Lake Macquarie City Council, December 2004.

Bell, S.A.J. & Driscoll, C. (2004) *Population count and habitat assessment of* Rutidosis heterogama *(Asteraceae), Lower Hunter and Central Coast*. Unpublished Report to Wyong Shire Council, April 2004. Eastcoast Flora Survey.

Douglas, S.D. & Bell, S.A.J. (2003) *Vegetation survey and mapping of Clyde River National Park, NSW South Coast*. Unpublished Final Report to NSW NPWS South Coast Region. ESP Ecological Surveys & Planning P/L & Eastcoast Flora Survey. April 2003.

Douglas, S.J. & Bell, S.A.J. (2003) *Vegetation survey and mapping, Bimberamala National Park. NSW South Coast*. Unpublished Final Report to NSW National Parks and Wildlife Service, South Coast Region. ESP Ecological Surveys & Planning P/L & Eastcoast Flora Survey. January 2003.

Bell, S.A.J. (2002) *The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales. Parts 1 & 2*. Report to Wyong Shire Council. Eastcoast Flora Survey.

Bell, S.A.J. & Driscoll, C. (2002) *Population size and habitat of the endangered* Acacia bynoeana *Benth. (Fabaceae: Mimosoideae) in Wyong Shire*. Unpublished Report to Wyong Shire Council. September 2002. Eastcoast Flora Survey.

Bell, S.A.J. & Fallding, M. (2002) *Tomago Sandbeds: Guidelines for weed and bush fire management*. Final Draft Report to Department of Land and Water Conservation. Unpublished. Eastcoast Flora Survey.

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/]

Murray, M., Bell, S., & Hoye, G. (2001) *Lower Hunter and Central Coast Flora and Fauna Survey Guidelines. Version 1.0.* Prepared for the Lower Hunter and Central Coast Regional Environmental Management Strategy. November 2001.

Bell, S.A.J. (2001) *Survey and Assessment of* Angophora inopina *in the Lower Hunter and Central Coast*. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service, Threatened Species Unit, Central Directorate. June 2001.

Bell, S.A.J. (2001) *Distribution, conservation & management of the vulnerable* Angophora inopina*. technical report and conservation management plan*. Eastcoast Flora Survey - Final Draft Report to Wyong Shire Council.

Bell, S.A.J. & Murray, M. (2001) *The Ecological Significance of Bow Wow Creek Gorge, Mulbring, lower Hunter Valley, New South Wales: A Nationally Significant Site*. Unpublished Report to Cessnock City Council. Eastcoast Flora Survey & Forest Fauna Surveys Pty Ltd. June 2001.

Douglas, S. & Bell, S. (2001) *Native vegetation mapping of Areas 1 to 5 in Blue Mountains City local government area*. Unpublished Report to Blue Mountains City Council. ESP Ecological Surveys & Planning Pty Ltd.

Hill, L., Peake, T., Bell, S., & Raine, A. (2001) *The vegetation of Towarri National Park, Cedar Brush Nature Reserve & Wingen Maid Nature Reserve for fire management purposes*. Unpublished Report to NSW National Parks and Wildlife Service, Hunter District. Eastcoast Flora Survey.

Bell, S.A.J. (1998) *Popran National Park vegetation survey. A fire management document*. Volumes 1 - 4. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Central Coast Districts). December 1998.

Bell, S.A.J. (1998) *Glenrock SRA and Awabakal NR vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter District). August 1998.

Bell, S.A.J. (1998) *Lake Macquarie SRA, Pulbah Island NR, and Tingira Heights NR vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter and Central Coast Districts). April 1998.

Bell, S.A.J. (1998) *Wollemi National Park vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Upper Hunter District).

Bell, S.A.J. (1997) *Vegetation Survey and Mapping of Crown Land, South of Manobalai Nature Reserve, Upper Hunter Valley*. Report to the Department of Land and Water Conservation and the NSW National Parks and Wildlife Service Upper Hunter District.

Bell, S.A.J. (1997) *Tomaree National Park vegetation survey. A fire management document*. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter District). May 1997.

Bell, S. & Russell, D. (1993) *A brief survey of the vegetation of the Hunter Valley floor. Report for Inquiry into Proposed Open-cut Mining in Part of Ravensworth State Forest, Near Singleton*. NSW National Parks and Wildlife Service.

Bell, S., Vollmer, J. & Gellie, N. (1993) *Yengo National Park and Parr State Recreation Area. Vegetation Survey for Use in Fire Management*. Report prepared for NSW National Parks and Wildlife Service. Unpublished.

NSW LAND & ENVIRONMENT COURT (EXPERT WITNESS)

Bell, S.A.J. (2016) *Review of Biodiversity Issues: United Wambo Open Cut Coal Mine Project*. Unpublished Report to EDO NSW, September 2016.

Bell, S.A.J. (2012) *Expert Report: Bulga Milbrodale Progress Association v Minister for Planning and Infrastructure and Warkworth Mining Limited*. Land and Environment Court Proceedings No: 10224 of 2012. Unpublished Report to EDO NSW, July 2012.

Bell, S.A.J. (2009) *Affidavit: Assessment of vegetation at Lots 3 & 4 (DP399581) Quorrobolong, from field data collected in May 2006*. Unpublished Report to Department of Environment, Climate Change & Water, November 2009. Eastcoast Flora Survey.

Bell, S.A.J. (2009) *Expert Report: Colongra Swamp Nature Reserve*. Unpublished Report to Department of Environment & Climate Change. Eastcoast Flora Survey. June 2009.

Bell, S.A.J. (2006) *Expert Report: Providence Projects Pty Ltd v Gosford City Council.* Land and Environment Court Proceedings No: 11626 of 2004; 10101 of 2005. Unpublished Report to Gosford City Council.

Bell, S.A.J. (2005) *Assessment of vegetation, 37 Laycock Street Carey Bay: Lake Macquarie City Council ats. First Cape Management Pty Ltd. L & E Court Proceedings 11475/04*. Expert Report to Land & Environment Court: April 2005.

Bell, S.A.J. (2001) *Expert Report: Hunter Resort v Cessnock City Council*. Land and Environment Court Proceedings.

Appendix 6 – Endorsement: Dr Lachlan Copeland

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

Dr Lachlan Copeland
Senior Botanist,
Eco Logical Australia

ATTACHMENT E
BAM BIODIVERSITY CREDIT REPORT - DEVELOPMENT FOOTPRINT 1

BAM Credit Summary Report

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020227

Proposal Name
Mount Pleasant Optimisation Development Footprint 1

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Report Created
28/01/2021

BAM Data version *
36

Assessor Number
BAAS17004

BAM Case Status
Open

Date Finalised
To be finalised

Assessment Revision
1

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

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)	BC Act Listing status	EPBC Act listing status	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits

BAM Credit Summary Report

Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin											
12	1655_DNG	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	3.9	3.9	2.5	Vulnerable Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	1.75		0
										Subtotal	**0**
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley											
8	483_DNG	White Box Yellow Box Blakely's Red Gum Woodland	10.8	10.8	143.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0
10	483_Woodland_SG	White Box Yellow Box Blakely's Red Gum Woodland	60.3	60.3	8.7	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	262
11	483_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	80	80.0	44.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	1780
14	483_DNG_SG	White Box Yellow Box Blakely's Red Gum Woodland	8.2	8.2	6.7	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0
										Subtotal	**2042**

BAM Credit Summary Report

Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter											
2	1691_Woodland	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	53.3	53.3	16.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		434
3	1691_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	7.6	7.6	0.9	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		0
										Subtotal	**434**
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter											
6	1605_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	6.8	6.8	140.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		0

BAM Credit Summary Report

9	1605_Woodland	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	46.7	46.7	66.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		1556
13	1605_Plantation	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	51.5	51.5	11.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		289
										Subtotal	**1845**
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter											
1	1602_Woodland	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	48	48.0	7	Endangered Ecological Community	Not Listed	High Sensitivity to Potential Gain	2.00		168
										Subtotal	**168**
White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
4	1606_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	50.6	50.6	0.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	3

BAM Credit Summary Report

5	1606_DNG	White Box Yellow Box Blakely's Red Gum Woodland	29.7	29.7	0.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	3
										Subtotal	**6**
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley											
7	618_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	73.7	73.7	0.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	4
										Subtotal	**4**
										Total	**4499**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Species credits
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment (Flora)								
1691_Woodland	N/A	N/A	1	Endangered Population	Not Listed	2	False	2
							Subtotal	**2**
Delma impar / Striped Legless Lizard (Fauna)								
1602_Woodland	48.0	48.0	7	Vulnerable	Vulnerable	1.5	False	126
1691_Woodland	53.3	53.3	16.3	Vulnerable	Vulnerable	1.5	False	326
1691_DNG	7.6	7.6	0.9	Vulnerable	Vulnerable	1.5	False	3
1605_DNG	6.8	6.8	140.1	Vulnerable	Vulnerable	1.5	False	359
483_DNG	10.8	10.8	143.6	Vulnerable	Vulnerable	1.5	False	580
1605_Woodland	46.7	46.7	66.6	Vulnerable	Vulnerable	1.5	False	1167

BAM Credit Summary Report

483_Woodland_SG	60.3	60.3	8.7	Vulnerable	Vulnerable	1.5	False	197
483_Woodland	80.0	80.0	44.5	Vulnerable	Vulnerable	1.5	False	1335
1655_DNG	3.9	3.9	2.5	Vulnerable	Vulnerable	1.5	False	4
1605_Plantation	51.5	51.5	11.2	Vulnerable	Vulnerable	1.5	False	216
483_DNG_SG	8.2	8.2	6.7	Vulnerable	Vulnerable	1.5	False	21
1606_Woodland	50.6	50.6	0.1	Vulnerable	Vulnerable	1.5	False	2
1606_DNG	29.7	29.7	0.2	Vulnerable	Vulnerable	1.5	False	2
618_Woodland	73.7	73.7	0.1	Vulnerable	Vulnerable	1.5	False	3
							Subtotal	**4341**
Petaurus norfolcensis / Squirrel Glider (Fauna)								
1602_Woodland	48.0	48.0	7	Vulnerable	Not Listed	2	False	168
1605_DNG	6.8	6.8	33.8	Vulnerable	Not Listed	2	False	115
483_DNG	10.8	10.8	31.9	Vulnerable	Not Listed	2	False	172
1605_Woodland	46.7	46.7	66.6	Vulnerable	Not Listed	2	False	1556
483_Woodland_SG	60.3	60.3	8.7	Vulnerable	Not Listed	2	False	262
483_Woodland	80.0	80.0	44.5	Vulnerable	Not Listed	2	False	1780
1655_DNG	3.9	3.9	0.4	Vulnerable	Not Listed	2	False	1
1605_Plantation	51.5	51.5	11.2	Vulnerable	Not Listed	2	False	289
483_DNG_SG	8.2	8.2	1.2	Vulnerable	Not Listed	2	False	5
1606_Woodland	50.6	50.6	0.1	Vulnerable	Not Listed	2	False	3
1606_DNG	29.7	29.7	0.2	Vulnerable	Not Listed	2	False	3
							Subtotal	**4354**

ATTACHMENT F
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - DEVELOPMENT FOOTPRINT 1

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020227

Proposal Name
Mount Pleasant Optimisation Development Footprint 1

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Names
MACH Energy Australia Pty Ltd

Report Created
28/01/2021

BAM Case Status
Open

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

BAM Biodiversity Credit Report (Like for like)

Species
Nil

Additional Information for Approval

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Haliaeetus leucogaster / White-bellied Sea-Eagle

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
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	17.2	434	0	434
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	0.3	0	6	6
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	217.9	1556	289	1845
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	203.5	1780	262	2042
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	2.5	0	0	0

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	No	262	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	Yes	1780	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	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.

BAM Biodiversity Credit Report (Like for like)

618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

BAM Biodiversity Credit Report (Like for like)

1605-Narrow-leaved Ironbark - Native Olive 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
	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	-	1605_DNG	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.
	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	-	1605_Woodland	Yes	1556	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	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	-	1605_Plantation	No	289	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

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	3	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	3	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

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_DNG	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

BAM Biodiversity Credit Report (Like for like)

	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	Yes	434	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_DNG	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.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	**1691_Woodland**	1.0	2.00

BAM Biodiversity Credit Report (Like for like)

Delma impar / Striped Legless Lizard	**1602_Woodland, 1691_Woodland, 1691_DNG, 1605_DNG, 483_DNG, 1605_Woodland, 483_Woodland_SG, 483_Woodland, 1655_DNG, 1605_Plantation, 483_DNG_SG, 1606_Woodland, 1606_DNG, 618_Woodland**	448.5	4341.00
Petaurus norfolcensis / Squirrel Glider	**1602_Woodland, 1605_DNG, 483_DNG, 1605_Woodland, 483_Woodland_SG, 483_Woodland, 1655_DNG, 1605_Plantation, 483_DNG_SG, 1606_Woodland, 1606_DNG**	205.6	4354.00

Credit Retirement Options

Like-for-like credit retirement options

Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	Spp	IBRA subregion
	Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	Any in NSW
Delma impar / Striped Legless Lizard	Spp	IBRA subregion

BAM Biodiversity Credit Report (Like for like)

	Delma impar / Striped Legless Lizard	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

ATTACHMENT G
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - DEVELOPMENT FOOTPRINT 1

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020227

Proposal Name
Mount Pleasant Optimisation Development Footprint 1

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Name(s)
MACH Energy Australia Pty Ltd

Report Created
28/01/2021

BAM Case Status
Open

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species
Nil

Additional Information for Approval

BAM Biodiversity Credit Report (Variations)

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Haliaeetus leucogaster / White-bellied Sea-Eagle

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
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	17.2	434	0	434.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	0.3	0	6	6.00
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	217.9	1556	289	1845.00
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4.00
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	203.5	1780	262	2042.00
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	2.5	0	0	0.00

BAM Biodiversity Credit Report (Variations)

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Like-for-like credit retirement options					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	No	262	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	Yes	1780	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 1	483_DNG	No	0	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	483_Woodland_SG	No	262	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	483_Woodland	Yes (including artificial)	1780	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	483_DNG_SG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 3 or higher threat status	618_Woodland	Yes (including artificial)	4	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest 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	-	1605_DNG	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.
	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	-	1605_Woodland	Yes	1556	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	-	1605_Plantation	No	289	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					

BAM Biodiversity Credit Report (Variations)

	Formation	Trading group	Zone	HBT	Credits	IBRA region
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_Woodland	Yes (including artificial)	1556	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_Plantation	No	289	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

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	3	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	3	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_Woodland	No	3	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_DNG	No	3	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1655-Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion This includes PCT's: 1176, 1655	-	1655_DNG	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_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

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	Yes	434	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_DNG	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
Grassy Woodlands	Tier 3 or higher threat status	1691_Woodland	Yes (including artificial)	434	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_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	**1691_Woodland**	1.0	2.00
Delma impar / Striped Legless Lizard	**1602_Woodland, 1691_Woodland, 1691_DNG, 1605_DNG, 483_DNG, 1605_Woodland, 483_Woodland_SG, 483_Woodland, 1655_DNG, 1605_Plantation, 483_DNG_SG, 1606_Woodland, 1606_DNG, 618_Woodland**	448.5	4341.00
Petaurus norfolcensis / Squirrel Glider	**1602_Woodland, 1605_DNG, 483_DNG, 1605_Woodland, 483_Woodland_SG, 483_Woodland, 1655_DNG, 1605_Plantation, 483_DNG_SG, 1606_Woodland, 1606_DNG**	205.6	4354.00

Credit Retirement Options

Like-for-like options

Cymbidium canaliculatum - endangered population/ Cymbidium canaliculatum population in the Hunter Catchment	Spp	IBRA region	
	Cymbidium canaliculatum - endangered population/Cymbidium canaliculatum population in the Hunter Catchment	Any in NSW	
	Variation options		
	Kingdom	Any species with same or	IBRA region

BAM Biodiversity Credit Report (Variations)

		higher category of listing under Part 4 of the BC Act shown below	
	Flora	Endangered Population	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 shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	

BAM Biodiversity Credit Report (Variations)

	Petaurus norfolcensis/Squirrel Glider		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT H
BAM BIODIVERSITY CREDIT REPORT - DEVELOPMENT FOOTPRINT 2

BAM Credit Summary Report

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020220

Proposal Name
Mount Pleasant Optimisation Development Footprint 2

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Report Created
28/01/2021

BAM Data version *
36

Assessor Number
BAAS17004

BAM Case Status
Finalised

Date Finalised
28/01/2021

Assessment Revision
1

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

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)	BC Act Listing status	EPBC Act listing status	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley											
1	483_DNG	White Box Yellow Box Blakely's Red Gum Woodland	14.4	14.4	14.8	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0

BAM Credit Summary Report

2	483_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	66.5	66.5	0.4	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	13
8	483_DNG_SG	White Box Yellow Box Blakely's Red Gum Woodland	14.8	14.8	4.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0
9	483_Woodland_SG	White Box Yellow Box Blakely's Red Gum Woodland	82.5	82.5	4.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	190
										Subtotal	**203**
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter											
5	1605_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	4.7	4.7	0.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		0
6	1605_Plantation	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	31.2	31.2	0.4	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		6
										Subtotal	**6**

BAM Credit Summary Report

White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
3	1606_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	50.6	50.6	0.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	13
4	1606_DNG	White Box Yellow Box Blakely's Red Gum Woodland	29.7	29.7	1.7	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	25
										Subtotal	**38**
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley											
7	618_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	73.7	73.7	0.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	4
										Subtotal	**4**
										Total	**251**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Species credits
Delma impar / Striped Legless Lizard (Fauna)								
483_DNG	14.4	14.4	14.8	Vulnerable	Vulnerable	1.5	False	80
483_Woodland	66.5	66.5	0.4	Vulnerable	Vulnerable	1.5	False	10
1606_Woodland	50.6	50.6	0.5	Vulnerable	Vulnerable	1.5	False	9
1606_DNG	29.7	29.7	1.7	Vulnerable	Vulnerable	1.5	False	19
1605_DNG	4.7	4.7	0.6	Vulnerable	Vulnerable	1.5	False	1
1605_Plantation	31.2	31.2	0.4	Vulnerable	Vulnerable	1.5	False	5
618_Woodland	73.7	73.7	0.1	Vulnerable	Vulnerable	1.5	False	3

BAM Credit Summary Report

483_DNG_SG	14.8	14.8	4.3	Vulnerable	Vulnerable	1.5	False	24
483_Woodland_SG	82.5	82.5	4.6	Vulnerable	Vulnerable	1.5	False	142
							Subtotal	**293**
Petaurus norfolcensis / Squirrel Glider (Fauna)								
483_DNG	14.4	14.4	3	Vulnerable	Not Listed	2	False	22
483_Woodland	66.5	66.5	0.4	Vulnerable	Not Listed	2	False	13
1606_Woodland	50.6	50.6	0.5	Vulnerable	Not Listed	2	False	13
1606_DNG	29.7	29.7	1	Vulnerable	Not Listed	2	False	15
1605_DNG	4.7	4.7	0.5	Vulnerable	Not Listed	2	False	1
1605_Plantation	31.2	31.2	0.4	Vulnerable	Not Listed	2	False	6
483_DNG_SG	14.8	14.8	1.1	Vulnerable	Not Listed	2	False	8
483_Woodland_SG	82.5	82.5	4.6	Vulnerable	Not Listed	2	False	190
							Subtotal	**268**

ATTACHMENT I
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - DEVELOPMENT FOOTPRINT 2

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id 00020219/BAAS17004/20/00020220	Proposal Name Mount Pleasant Optimisation Development Footprint 2	BAM data last updated * 21/12/2020
Assessor Name Colin Driscoll	Assessor Number BAAS17004	BAM Data version * 36
Proponent Names MACH Energy Australia Pty Ltd	Report Created 28/01/2021	BAM Case Status Finalised
Assessment Revision 1	Assessment Type Major Projects	Date Finalised 28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

BAM Biodiversity Credit Report (Like for like)

Species
Nil

Additional Information for Approval

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Haliaeetus leucogaster / White-bellied Sea-Eagle

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	24.1	190	13	203
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	2.2	0	38	38
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	1.0	0	6	6
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	13	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	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.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	190	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

BAM Biodiversity Credit Report (Like for like)

1605-Narrow-leaved Ironbark - Native Olive 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
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	-	1605_DNG	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.
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	-	1605_Plantation	No	6	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

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

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	13	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	25	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Delma impar / Striped Legless Lizard	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 618_Woodland, 483_DNG_SG, 483_Woodland_SG**	27.4	293.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG**	11.5	268.00

Credit Retirement Options

Like-for-like credit retirement options

Delma impar / Striped Legless Lizard	Spp	IBRA subregion
	Delma impar / Striped Legless Lizard	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

ATTACHMENT J
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - DEVELOPMENT FOOTPRINT 2

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020220

Proposal Name
Mount Pleasant Optimisation Development Footprint 2

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Name(s)
MACH Energy Australia Pty Ltd

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

Species
Nil

Additional Information for Approval

BAM Biodiversity Credit Report (Variations)

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Haliaeetus leucogaster / White-bellied Sea-Eagle

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
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	24.1	190	13	203.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	2.2	0	38	38.00
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	1.0	0	6	6.00
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4.00

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	13	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	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.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	190	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 1	483_DNG	No	0	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	483_Woodland	No	13	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	483_DNG_SG	No	0	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	483_Woodland_SG	Yes (including artificial)	190	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 3 or higher threat status	618_Woodland	Yes (including artificial)	4	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest 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	-	1605_DNG	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.
	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	-	1605_Plantation	No	6	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 (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_Plantation	No	6	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

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	13	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	25	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_Woodland	No	13	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_DNG	No	25	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
Delma impar / Striped Legless Lizard	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 618_Woodland, 483_DNG_SG, 483_Woodland_SG**	27.4	293.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG**	11.5	268.00

Credit Retirement Options

Like-for-like options

Delma impar/ Striped Legless Lizard	Spp	IBRA region
	Delma impar/Striped Legless Lizard	Any in NSW
	Variation options	

BAM Biodiversity Credit Report (Variations)

	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	
	Petaurus norfolcensis/Squirrel Glider	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT K
BAM BIODIVERSITY CREDIT REPORT - DEVELOPMENT FOOTPRINT 3

BAM Credit Summary Report

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020221

Proposal Name
Mount Pleasant Optimisation Development Footprint 3

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Report Created
28/01/2021

BAM Data version *
36

Assessor Number
BAAS17004

BAM Case Status
Finalised

Date Finalised
28/01/2021

Assessment Revision
1

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

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)	BC Act Listing status	EPBC Act listing status	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley											
1	483_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	64.1	64.1	2.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	83

BAM Credit Summary Report

2	483_DNG	White Box Yellow Box Blakely's Red Gum Woodland	14.9	14.9	15	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0
8	483_DNG_SG	White Box Yellow Box Blakely's Red Gum Woodland	15.2	15.2	0.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	2
9	483_Woodland_SG	White Box Yellow Box Blakely's Red Gum Woodland	46.4	46.4	2.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	58
										Subtotal	**143**
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter											
5	1605_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	4.7	4.7	0.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		0
6	1605_Plantation	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	31.2	31.2	0.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		5
										Subtotal	**5**

BAM Credit Summary Report

White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
3	1606_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	50.6	50.6	0.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	13
4	1606_DNG	White Box Yellow Box Blakely's Red Gum Woodland	29.7	29.7	1.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	24
										Subtotal	**37**
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley											
7	618_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	73.7	73.7	0.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	4
										Subtotal	**4**
										Total	**189**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Species credits
Delma impar / Striped Legless Lizard (Fauna)								
483_DNG	14.9	14.9	15	Vulnerable	Vulnerable	1.5	False	84
1606_Woodland	50.6	50.6	0.5	Vulnerable	Vulnerable	1.5	False	9
1606_DNG	29.7	29.7	1.6	Vulnerable	Vulnerable	1.5	False	18
1605_DNG	4.7	4.7	0.5	Vulnerable	Vulnerable	1.5	False	1
1605_Plantation	31.2	31.2	0.3	Vulnerable	Vulnerable	1.5	False	4
483_DNG_SG	15.2	15.2	0.2	Vulnerable	Vulnerable	1.5	False	1
483_Woodland_SG	46.4	46.4	2.5	Vulnerable	Vulnerable	1.5	False	43

BAM Credit Summary Report

483_Woodland	64.1	64.1	2.6	Vulnerable	Vulnerable	1.5	False	62
618_Woodland	73.7	73.7	0.1	Vulnerable	Vulnerable	1.5	False	3
							Subtotal	**225**
Petaurus norfolcensis / Squirrel Glider (Fauna)								
483_DNG	14.9	14.9	2.7	Vulnerable	Not Listed	2	False	20
483_Woodland	64.1	64.1	2.6	Vulnerable	Not Listed	2	False	83
1606_Woodland	50.6	50.6	0.5	Vulnerable	Not Listed	2	False	13
1606_DNG	29.7	29.7	0.9	Vulnerable	Not Listed	2	False	13
1605_DNG	4.7	4.7	0.4	Vulnerable	Not Listed	2	False	1
1605_Plantation	31.2	31.2	0.3	Vulnerable	Not Listed	2	False	5
483_DNG_SG	15.2	15.2	0.1	Vulnerable	Not Listed	2	False	1
483_Woodland_SG	46.4	46.4	2.5	Vulnerable	Not Listed	2	False	58
							Subtotal	**194**

ATTACHMENT L
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - DEVELOPMENT FOOTPRINT 3

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020221

Proposal Name
Mount Pleasant Optimisation Development Footprint 3

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Names
MACH Energy Australia Pty Ltd

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

BAM Biodiversity Credit Report (Like for like)

Species
Nil

Additional Information for Approval

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Lathamus discolor / Swift Parrot
Miniopterus orianae oceanensis / Large Bent-winged Bat
Phascolarctos cinereus / Koala
Haliaeetus leucogaster / White-bellied Sea-Eagle

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	20.3	0	143	143
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	2.1	0	37	37
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	0.8	0	5	5
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	83	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	2	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	No	58	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

BAM Biodiversity Credit Report (Like for like)

1605-Narrow-leaved Ironbark - Native Olive 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
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	-	1605_DNG	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.
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	-	1605_Plantation	No	5	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

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

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	13	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	24	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Delma impar / Striped Legless Lizard	**483_DNG, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG, 483_Woodland, 618_Woodland**	23.3	225.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG**	10.0	194.00

Credit Retirement Options

Like-for-like credit retirement options

Delma impar / Striped Legless Lizard	Spp	IBRA subregion
	Delma impar / Striped Legless Lizard	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion

	Petaurus norfolcensis / Squirrel Glider	Any in NSW

ATTACHMENT M
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - DEVELOPMENT FOOTPRINT 3

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020221

Proposal Name
Mount Pleasant Optimisation Development Footprint 3

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Name(s)
MACH Energy Australia Pty Ltd

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley

Species
Nil

Additional Information for Approval

BAM Biodiversity Credit Report (Variations)

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Lathamus discolor / Swift Parrot
Miniopterus orianae oceanensis / Large Bent-winged Bat
Phascolarctos cinereus / Koala
Haliaeetus leucogaster / White-bellied Sea-Eagle

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
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	20.3	0	143	143.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	2.1	0	37	37.00
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	0.8	0	5	5.00
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	0.1	4	0	4.00

BAM Biodiversity Credit Report (Variations)

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	83	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	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.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	2	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	No	58	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 1	483_Woodland	No	83	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	483_DNG	No	0	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	483_DNG_SG	No	2	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	483_Woodland_SG	No	58	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	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.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 3 or higher threat status	618_Woodland	Yes (including artificial)	4	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest 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	-	1605_DNG	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.
	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	-	1605_Plantation	No	5	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 (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_Plantation	No	5	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

BAM Biodiversity Credit Report (Variations)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	13	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	No	24	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_Woodland	No	13	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_DNG	No	24	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
Delma impar / Striped Legless Lizard	**483_DNG, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG, 483_Woodland, 618_Woodland**	23.3	225.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1605_Plantation, 483_DNG_SG, 483_Woodland_SG**	10.0	194.00

Credit Retirement Options

Like-for-like options

Delma impar/ Striped Legless Lizard	Spp	IBRA region
	Delma impar/Striped Legless Lizard	Any in NSW
	Variation options	

BAM Biodiversity Credit Report (Variations)

	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	
	Petaurus norfolcensis/Squirrel Glider	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT N
BAM BIODIVERSITY CREDIT REPORT - RELINQUISHMENT AREA

BAM Credit Summary Report

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020228

Proposal Name
Mount Pleasant Optimisation Relinquishment Area

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Report Created
28/01/2021

BAM Data version *
36

Assessor Number
BAAS17004

BAM Case Status
Finalised

Date Finalised
28/01/2021

Assessment Revision
1

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

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)	BC Act Listing status	EPBC Act listing status	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley											
3	483_DNG	White Box Yellow Box Blakely's Red Gum Woodland	16.9	16.9	244.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	2068

BAM Credit Summary Report

6	483_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	65.8	65.8	49.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	1622
8	483_Woodland_SG	White Box Yellow Box Blakely's Red Gum Woodland	77	77.0	119.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	4589
9	483_DNG_SG	White Box Yellow Box Blakely's Red Gum Woodland	25.2	25.2	24.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	306
										Subtotal	**8585**
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter											
5	1605_Woodland	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	57.5	57.5	24.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		696
7	1605_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	24	24.0	16.7	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		200
										Subtotal	**896**

BAM Credit Summary Report

Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter											
11	1602_Woodland	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	45.7	45.7	0.4	Endangered Ecological Community	Not Listed	High Sensitivity to Potential Gain	2.00		9
										Subtotal	**9**
White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
4	1606_DNG	White Box Yellow Box Blakely's Red Gum Woodland	10.5	10.5	6.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	0
10	1606_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	35.8	35.8	2.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	47
										Subtotal	**47**
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley											
1	618_DNG	White Box Yellow Box Blakely's Red Gum Woodland	26	26.0	7.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	97
2	618_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	67.8	67.8	2.9	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	98
										Subtotal	**195**
										Total	**9732**

Species credits for threatened species

BAM Credit Summary Report

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Species credits
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment (Flora)								
1605_Woodland	N/A	N/A	1	Endangered Population	Not Listed	2	False	2
483_Woodland_SG	N/A	N/A	1	Endangered Population	Not Listed	2	False	2
							Subtotal	**4**
Delma impar / Striped Legless Lizard (Fauna)								
618_DNG	26.0	26.0	7.5	Vulnerable	Vulnerable	1.5	False	73
618_Woodland	67.8	67.8	2.9	Vulnerable	Vulnerable	1.5	False	74
483_DNG	16.9	16.9	244.5	Vulnerable	Vulnerable	1.5	False	1551
1606_DNG	10.5	10.5	6.3	Vulnerable	Vulnerable	1.5	False	25
1605_Woodland	57.5	57.5	24.2	Vulnerable	Vulnerable	1.5	False	522
483_Woodland	65.8	65.8	49.3	Vulnerable	Vulnerable	1.5	False	1216
1605_DNG	24.0	24.0	16.7	Vulnerable	Vulnerable	1.5	False	150
483_Woodland_SG	77.0	77.0	119.2	Vulnerable	Vulnerable	1.5	False	3442
483_DNG_SG	25.2	25.2	24.3	Vulnerable	Vulnerable	1.5	False	229
1606_Woodland	35.8	35.8	2.6	Vulnerable	Vulnerable	1.5	False	35
1602_Woodland	45.7	45.7	0.4	Vulnerable	Vulnerable	1.5	False	7
							Subtotal	**7324**
Petaurus norfolcensis / Squirrel Glider (Fauna)								
483_DNG	16.9	16.9	48.3	Vulnerable	Not Listed	2	False	409
1606_DNG	10.5	10.5	4.5	Vulnerable	Not Listed	2	False	24
1605_Woodland	57.5	57.5	24.2	Vulnerable	Not Listed	2	False	696

BAM Credit Summary Report

483_Woodland	65.8	65.8	49.3	Vulnerable	Not Listed	2	False	1622
1605_DNG	24.0	24.0	7.3	Vulnerable	Not Listed	2	False	88
483_Woodland_SG	77.0	77.0	119.2	Vulnerable	Not Listed	2	False	4589
483_DNG_SG	25.2	25.2	11.4	Vulnerable	Not Listed	2	False	143
1606_Woodland	35.8	35.8	2.6	Vulnerable	Not Listed	2	False	47
1602_Woodland	45.7	45.7	0.4	Vulnerable	Not Listed	2	False	9
							Subtotal	**7627**

ATTACHMENT O
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - RELINQUISHMENT AREA

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020228

Proposal Name
Mount Pleasant Optimisation Relinquishment Area

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Names

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

BAM Biodiversity Credit Report (Like for like)

Species
Nil

Additional Information for Approval

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Lathamus discolor / Swift Parrot
Anthochaera phrygia / Regent Honeyeater
Haliaeetus leucogaster / White-bellied Sea-Eagle

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	10.4	98	97	195
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	437.3	6211	2374	8585
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	8.9	0	47	47
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	40.9	0	896	896

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	No	2068	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	Yes	1622	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	4589	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	306	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_DNG	No	97	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	98	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

1605-Narrow-leaved Ironbark - Native Olive 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
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	-	1605_Woodland	No	696	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	-	1605_DNG	No	200	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

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

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	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.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	47	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	**1605_Woodland, 483_Woodland_SG**	2.0	4.00
Delma impar / Striped Legless Lizard	**618_DNG, 618_Woodland, 483_DNG, 1606_DNG, 1605_Woodland, 483_Woodland, 1605_DNG, 483_Woodland_SG, 483_DNG_SG, 1606_Woodland, 1602_Woodland**	497.9	7324.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 1606_DNG, 1605_Woodland, 483_Woodland, 1605_DNG, 483_Woodland_SG, 483_DNG_SG, 1606_Woodland, 1602_Woodland**	267.2	7627.00

Credit Retirement Options

Like-for-like credit retirement options

BAM Biodiversity Credit Report (Like for like)

Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	Spp	IBRA subregion
	Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	Any in NSW
Delma impar / Striped Legless Lizard	Spp	IBRA subregion
	Delma impar / Striped Legless Lizard	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

ATTACHMENT P
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - RELINQUISHMENT AREA

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00020228

Proposal Name
Mount Pleasant Optimisation Relinquishment Area

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Name(s)

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species
Nil

Additional Information for Approval

BAM Biodiversity Credit Report (Variations)

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Lathamus discolor / Swift Parrot
Anthochaera phrygia / Regent Honeyeater
Haliaeetus leucogaster / White-bellied Sea-Eagle

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
618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	10.4	98	97	195.00
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	437.3	6211	2374	8585.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	8.9	0	47	47.00
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	40.9	0	896	896.00

BAM Biodiversity Credit Report (Variations)

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	No	2068	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	Yes	1622	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	4589	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	306	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 1	483_DNG	No	2068	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	483_Woodland	Yes (including artificial)	1622	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	483_Woodland_SG	Yes (including artificial)	4589	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	483_DNG_SG	No	306	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

618-White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_DNG	No	97	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	618_Woodland	Yes	98	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 3 or higher threat status	618_DNG	No	97	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	618_Woodland	Yes (including artificial)	98	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest 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	-	1605_Woodland	No	696	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	-	1605_DNG	No	200	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_Woodland	No	696	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_DNG	No	200	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

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	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.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	47	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_DNG	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_Woodland	No	47	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
Cymbidium canaliculatum - endangered population / Cymbidium canaliculatum population in the Hunter Catchment	**1605_Woodland, 483_Woodland_SG**	2.0	4.00
Delma impar / Striped Legless Lizard	**618_DNG, 618_Woodland, 483_DNG, 1606_DNG, 1605_Woodland, 483_Woodland, 1605_DNG, 483_Woodland_SG, 483_DNG_SG, 1606_Woodland, 1602_Woodland**	497.9	7324.00
Petaurus norfolcensis / Squirrel Glider	**483_DNG, 1606_DNG, 1605_Woodland, 483_Woodland, 1605_DNG, 483_Woodland_SG, 483_DNG_SG, 1606_Woodland, 1602_Woodland**	267.2	7627.00

Credit Retirement Options

Like-for-like options

BAM Biodiversity Credit Report (Variations)

Cymbidium canaliculatum - endangered population/ Cymbidium canaliculatum population in the Hunter Catchment	Spp		IBRA region
	Cymbidium canaliculatum - endangered population/Cymbidium canaliculatum population in the Hunter Catchment		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 Population	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 shown below	IBRA region

BAM Biodiversity Credit Report (Variations)

	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	
	Petaurus norfolcensis/Squirrel Glider	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

ATTACHMENT Q
BAM BIODIVERSITY CREDIT REPORT - WESTERN LINK ROAD RELINQUISHMENT AREA

BAM Credit Summary Report

Proposal Details

Assessment Id
00020219/BAAS17004/20/00022393

Proposal Name
Approved Link Road Relinquished

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Report Created
28/01/2021

BAM Data version *
36

Assessor Number
BAAS17004

BAM Case Status
Finalised

Date Finalised
28/01/2021

Assessment Revision
1

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

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)	BC Act Listing status	EPBC Act listing status	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley											
1	483_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	66.5	66.5	0.6	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	20

BAM Credit Summary Report

5	483_Woodland_SG	White Box Yellow Box Blakely's Red Gum Woodland	87.5	87.5	4.1	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	179
7	483_DNG_SG	White Box Yellow Box Blakely's Red Gum Woodland	53.9	53.9	1.7	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	46
8	483_DNG	White Box Yellow Box Blakely's Red Gum Woodland	15.8	15.8	6.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	51
										Subtotal	**296**
Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter											
4	1605_DNG	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	4.3	4.3	0.5	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00		0
										Subtotal	**0**
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter											
6	1602_Woodland	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	54.6	54.6	0.1	Endangered Ecological Community	Not Listed	High Sensitivity to Potential Gain	2.00		3
										Subtotal	**3**

BAM Credit Summary Report

White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter											
2	1606_Woodland	White Box Yellow Box Blakely's Red Gum Woodland	50.6	50.6	0.2	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	5
3	1606_DNG	White Box Yellow Box Blakely's Red Gum Woodland	29.7	29.7	0.3	Endangered Ecological Community	Critically Endangered	High Sensitivity to Potential Gain	2.00	TRUE	4
										Subtotal	**9**
										Total	**308**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Species credits
Delma impar / Striped Legless Lizard (Fauna)								
483_Woodland	66.5	66.5	0.6	Vulnerable	Vulnerable	1.5	False	15
1606_Woodland	50.6	50.6	0.2	Vulnerable	Vulnerable	1.5	False	4
1606_DNG	29.7	29.7	0.3	Vulnerable	Vulnerable	1.5	False	3
1605_DNG	4.3	4.3	0.5	Vulnerable	Vulnerable	1.5	False	1
1602_Woodland	54.6	54.6	0.1	Vulnerable	Vulnerable	1.5	False	2
483_Woodland_SG	87.5	87.5	4.1	Vulnerable	Vulnerable	1.5	False	134
483_DNG_SG	53.9	53.9	1.7	Vulnerable	Vulnerable	1.5	False	34
							Subtotal	**193**
Petaurus norfolcensis / Squirrel Glider (Fauna)								
483_Woodland	66.5	66.5	0.6	Vulnerable	Not Listed	2	False	20
1606_Woodland	50.6	50.6	0.2	Vulnerable	Not Listed	2	False	5

BAM Credit Summary Report

483_Woodland_SG	87.5	87.5	4.1	Vulnerable	Not Listed	2	False	179
							Subtotal	**204**

ATTACHMENT R
BAM BIODIVERSITY CREDIT REPORT (LIKE FOR LIKE) - WESTERN LINK ROAD RELINQUISHMENT AREA

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00022393

Proposal Name
Approved Link Road Relinquished

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Names

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species
Nil

BAM Biodiversity Credit Report (Like for like)

Additional Information for Approval

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Micronomus norfolkensis / Eastern Coastal Free-tailed Bat

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
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	12.9	179	117	296
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	0.5	0	9	9
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	0.5	0	0	0
1602-Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	0.1	0	3	3

BAM Biodiversity Credit Report (Like for like)

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Like-for-like credit retirement options					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	20	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	179	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	46	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	No	51	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

1602-Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1602_Woodland	No	3	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.

1605-Narrow-leaved Ironbark - Native Olive 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

BAM Biodiversity Credit Report (Like for like)

	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	-	1605_DNG	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.
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

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	5	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

	White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	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.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Delma impar / Striped Legless Lizard	**483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1602_Woodland, 483_Woodland_SG, 483_DNG_SG**	7.5	193.00
Petaurus norfolcensis / Squirrel Glider	**483_Woodland, 1606_Woodland, 483_Woodland_SG**	4.9	204.00

Credit Retirement Options

Like-for-like credit retirement options

Delma impar / Striped Legless Lizard	Spp	IBRA subregion
	Delma impar / Striped Legless Lizard	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

ATTACHMENT S
BAM BIODIVERSITY CREDIT REPORT (VARIATIONS) - WESTERN LINK ROAD RELINQUISHMENT AREA

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00020219/BAAS17004/20/00022393

Proposal Name
Approved Link Road Relinquished

BAM data last updated *
21/12/2020

Assessor Name
Colin Driscoll

Assessor Number
BAAS17004

BAM Data version *
36

Proponent Name(s)

Report Created
28/01/2021

BAM Case Status
Finalised

Assessment Revision
1

Assessment Type
Major Projects

Date Finalised
28/01/2021

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley
White Box Yellow Box Blakely's Red Gum Woodland	Endangered Ecological Community	1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter

Species
Nil

Additional Information for Approval

PCTs With Customized Benchmarks

PCT

BAM Biodiversity Credit Report (Variations)

No Changes

Predicted Threatened Species Not On Site

Name
Micronomus norfolkensis / Eastern Coastal Free-tailed Bat

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
483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	White Box Yellow Box Blakely's Red Gum Woodland	12.9	179	117	296.00
1606-White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter	White Box Yellow Box Blakely's Red Gum Woodland	0.5	0	9	9.00
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	0.5	0	0	0.00
1602-Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	0.1	0	3	3.00

483-Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland	No	20	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_Woodland_SG	Yes	179	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG_SG	No	46	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	483_DNG	No	51	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

BAM Biodiversity Credit Report (Variations)

	Grassy Woodlands	Tier 1	483_Woodland	No	20	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	483_Woodland_SG	Yes (including artificial)	179	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	483_DNG_SG	No	46	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	483_DNG	No	51	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1602-Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1602_Woodland	No	3	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 (Shrub/grass sub-formation)	Tier 3 or higher threat status	1602_Woodland	No	3	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1605-Narrow-leaved Ironbark - Native Olive shrubby open forest 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	-	1605_DNG	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

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1605_DNG	No	0	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

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_Woodland	No	5	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

White Box Yellow Box Blakely's Red Gum Woodland This includes PCT's: 2, 74, 75, 83, 250, 266, 267, 268, 270, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 286, 298, 302, 312, 341, 342, 347, 350, 352, 356, 367, 381, 382, 395, 403, 421, 433, 434, 435, 436, 437, 451, 483, 484, 488, 492, 496, 506, 508, 509, 510, 511, 528, 538, 544, 563, 567, 571, 589, 590, 597, 599, 618, 619, 622, 633, 654, 702, 703, 704, 705, 710, 711, 796, 797, 799, 840, 847, 851, 921, 1099, 1103, 1303, 1304, 1307, 1324, 1329, 1330, 1331, 1332, 1333, 1334, 1383, 1401, 1512, 1601, 1606, 1608, 1611, 1691, 1693, 1695, 1698	-	1606_DNG	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.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_Woodland	No	5	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1606_DNG	No	4	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
Delma impar / Striped Legless Lizard	**483_Woodland, 1606_Woodland, 1606_DNG, 1605_DNG, 1602_Woodland, 483_Woodland_SG, 483_DNG_SG**	7.5	193.00
Petaurus norfolcensis / Squirrel Glider	**483_Woodland, 1606_Woodland, 483_Woodland_SG**	4.9	204.00

Credit Retirement Options

Like-for-like options

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	IBRA region

BAM Biodiversity Credit Report (Variations)

		under Part 4 of the BC Act shown below	
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	
	Petaurus norfolcensis/Squirrel Glider	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.