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UG4 LW409-414 Biodiversity Technical Report

Yancoal Moolarben Coal | 2/10/2024

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Document control

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Glossary and list of abbreviations

Term or abbreviation	Definition
BAM	NSW Biodiversity Assessment Method
BAM-C	NSW Biodiversity Assessment Method Calculator
BC Act	NSW **Biodiversity Conservation Act 2016**
Biota	**The animals and plants living in a particular place, time, or habitat**
BMP	Biodiversity Management Plan
BOA1	Red Hills Biodiversity Offset Area 1
Composition	**Species richness** as defined under the BAM (DPIE 2020)
DBH	Diameter at Breast Height
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DPE	NSW **Department of Planning and Environment**
EIS	Environmental Impact Statement
EPBC Act	Commonwealth **Environment Protection and Biodiversity Conservation Act 1999**
Function	Function attributes include tree stem size classes, number of large trees, tree regeneration, length of fallen logs and leaf litter as defined under the BAM (DPIE 2020)
LW	Longwall
Study Site	A 20 x 50 m plot established within the Study Area
Structure	**Foliage cover including leaves, branches and twigs** as defined under the BAM (DPIE 2020)
MCO	Moolarben Coal Operations Pty Ltd
PCT	Plant Community Type
Reference Area	Red Hills Biodiversity Offset Area 1

Term or abbreviation	Definition
Reference Site	A 20 x 50 m plot established within the Reference Area
RDPs	Rapid Data Points
Study Area	The LW409-414 Study Area is defined as the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetre (mm) predicted subsidence contour
TEC	Threatened Ecological Community
UG4	Underground 4
VIS	Vegetation Integrity Score as defined under the BAM (DPIE 2020)

Table of Contents

Glossary and list of abbreviations **3**

1 Introduction **7**

1.1 Background 7

2 Biodiversity values **9**

2.1 Native vegetation survey and results 9

2.1.1 Existing vegetation condition 9

2.1.2 PCT allocation and mapping 10

2.1.3 Threatened ecological communities 10

2.1.4 Threatened flora 10

2.2 Groundwater Dependent Ecosystems 11

2.3 Fauna habitat 11

2.4 Threatened fauna 12

3 Subsidence Impact review **13**

3.1 Predicted subsidence impacts 13

3.2 Predicted subsidence impacts on natural features 13

3.3 Predicted subsidence impacts on biodiversity values 13

3.4 Review of biodiversity performance measures 18

4 Monitoring Methodology **19**

4.1 Monitoring program 19

4.2 Monitoring program methodology 20

4.2.1 Study Area and reference sites 20

4.2.2 Photo-point monitoring 23

4.2.3 Monitoring for threatened fauna populations – Microbat activity 23

4.2.4 Monitoring for threatened flora populations – *Androcalva procumbens* 24

5 Management of Impacts **25**

5.1 Recommendations for management of impacts 25

5.2 Threatened fauna 25

5.3 Threatened flora 26

5.4 Habitat management 26

5.4.1 Roosting habitat management 26

5.4.2 Native vegetation 27
5.5 Weed management 27
5.6 Additional monitoring 27
6 Conclusion 28
7 References 29
Lists of illustrations and tables 30
List of Figures 30
List of Plates 30
List of Tables 30
Figures 31
Appendices 36
Appendix 1 – PCT descriptions 37
Appendix 2 – Fauna recorded 40

1 Introduction

1.1 Background

The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres (km) north of Mudgee in the Western Coalfield of New South Wales (NSW).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben Pty Ltd [YM] and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia Limited.

The UG4 Underground Mine (UG4) is a component of the approved Moolarben Coal Complex. First workings for UG4 North Mains commenced in October 2020. Secondary extraction in UG4 of the first Longwall (LW) 401 commenced in July 2022. LW401 to LW403 were completed by December 2023. The extraction of LW409 to 414 (hereafter referred to as LW409-414) within UG4 is scheduled to commence in March 2026. The Study Area for LW409-414 is defined as the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetre (mm) predicted subsidence contour (Figure 1).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and continue to be carried out in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified).

Project Approval 05_0117 Condition 77(i) requires the proponent to prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary.

Condition 77(i) states that the proponent is to:

Include a Biodiversity Management Plan which has been prepared in consultation with BCD, which provides for the management of the potential and/or environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats; endangered ecological communities and water dependent ecosystems.

This Biodiversity Technical Report has been prepared to satisfy the requirements of Project Approval (05_0117) (as modified) and to inform the subsequent preparation of a Biodiversity Management Plan (BMP) to manage the potential risks of secondary extraction on threatened and non-threatened species, populations and ecological communities (biota).

Since the Stage 1 Approval (05_0117) in 2007, extensive additional environmental monitoring and studies have been undertaken in the Ulan Coalfields, including MCO's Underground 4 (UG4 LW 401-408) and neighbouring mining operations. The additional studies and monitoring data associated with the inter-mine data sharing have improved the understanding of the predicted underground mining impacts. This contemporary knowledge, supplemented with targeted site surveys, underpins this technical report and the refined impact predictions, performance indicators, management and monitoring measures for the UG4 LW 409-414 extraction plan.

This Biodiversity Technical Report includes:

- A brief description of previous ecological surveys relevant to the Study Area
- A summary of the existing vegetation condition with the Study Area
- A summary of the field validation and baseline assessment results in addition to any threatened ecological communities (TECs) and/or threatened species, populations and their habitats (threatened biota)[1] recorded or likely to occur in the Study Area
- The adaptation of the revised classification of Plant Community Types (PCT) of eastern NSW (NSW Department of Planning and Environment [DPE 2022]) (hereafter referred to as revised PCTs) within the Study Area
- The baseline assessment results in addition to the threatened species, populations and their habitats (threatened biota) recorded or likely to occur in the Study Area
- A review of subsidence predictions for UG4 LW409-414 secondary extraction and an assessment of potential environmental impacts relevant to non-threatened and threatened biota
- Review of Environmental Assessment Biodiversity commitments and performance measures and the likelihood of achieving these targets
- Monitoring methodology designed to target biodiversity values vulnerable to subsidence impacts, including study site locations within the Study Area and associated references sites in the Reference Area
- Recommendations and conclusions.

[1] As listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and/or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2 Biodiversity values

2.1 Native vegetation survey and results

The Study Area has previously undergone ecological survey, including vegetation mapping and targeted threatened species survey, during the preparation of the Stage 1 Environmental Impact Statement (EIS) (Moolarben Biota 2006). Small, linear areas in the north and north-west have also been allocated legacy PCTs due to the addition of ancillary infrastructure (ELA 2019).

A baseline assessment to collect biodiversity data was undertaken by Niche Ecologists Kayla Le Gros and Lily Cains, between 5 and 14 March 2024. The baseline biodiversity data collected was used for both monitoring and vegetation mapping purposes. The floristic composition and cover scores collected were used to aid in the allocation of PCTs in accordance with the NSW vegetation classification database (NSW Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2024a).

A second vegetation mapping field survey was undertaken by Niche Ecologists Kayla Le Gros and Jesse Cass between 29 April and 1 May 2024. The entire Study Area was traversed and Rapid Data Points (RDPs) were taken to ensure that all PCTs within the Study Area had been assessed, and to gather further floristic and landscape information to better inform the allocation and extent of the new eastern PCTs.

2.1.1 Existing vegetation condition

During the baseline and mapping assessment the existing vegetation condition in the Study and Reference Areas was reviewed, and the following influences were identified:

- Reduced canopy cover and PCT structural integrity due to previous dieback events as a result of the 2017 – 2020 prolonged drought
- Increased epicormic growth cover due to previous drought stress
- Minimal herbaceous weed cover
- Minimal evidence of feral pigs, including rooting behaviour and scats.

The most notable impact on the native vegetation within the Study Area result from the previous 2017 – 2020 prolonged drought. A reduction in canopy cover and PCT structural integrity, as well as an increase in canopy epicormic growth cover, were also observed in the broader landscape, including the Reference Area.

The death of individuals or entire populations of flora species vulnerable to water stress was also observed. This was most evident on rocky, shallow soils on plateaus and slopes at higher elevations. Notable drought affected canopy species include *Eucalyptus agglomerata*, *Eucalyptus sparsifolia, Eucalyptus macrorhyncha, Eucalyptus parramattensis* subsp. *parramattensis* and *Eucalyptus rossii*. In the most severely impacted areas, *Eucalyptus crebra* and *Eucalyptus fibrosa* also exhibited canopy dieback and death of individuals. Notable drought affected shrubs include *Allocasuarina diminuta, Allocasuarina littoralis, Leptospermum polygalifolium* and *Leptospermum arachnoides* which exhibited dieback and death of individuals.

2.1.2 PCT allocation and mapping

The vegetation within the Study Area had previously been stratified into vegetation association subunits (Moolarben Biota 2006). The existing vegetation mapping (Moolarben Biota 2006; ELA 2019) and baseline monitoring surveys conducted for this report were used to update the PCTs assigned (hereafter referred to as legacy PCTs) to the revised PCTs (DPE 2022). The following data was used to assist in aligning the vegetation within the Study Area with a PCT:

- Floristics (species composition, cover and abundance)
- Landscape position
- Soil landscape (NSW Department of Planning, Industry and Environment [DPIE] 2022).

The allocation of the revised PCTs is required to allow the biodiversity data to be input into the NSW Biodiversity Assessment Method (BAM) Calculator (BAM-C) to generate a Vegetation Integrity Score (VIS). Vegetation within the Study Area has been stratified by both PCT and condition, to allow for conformity with the NSW vegetation classification database (DCCEEW 2024a).

The conversion of the legacy PCTs to the revised PCTs was not a direct substitution. Some PCTs previously assigned were amalgamated into a single revised PCT, while one legacy PCT was split into two revised PCTs. The revised PCTs are described in Table 1.

The field validated vegetation mapping determined that five revised PCTs in High and Moderate condition are present in the Study Area (Figure 2). A brief description of these PCTs is provided in Appendix 1, Table 6.

Table 1: The revised PCTs for LW409-414 Study Area.

Revised PCT (Niche 2024)
3528 – Western Hunter Flats Apple-Gum Shrub Forest
3530 – Western Hunter Sandy Riparian Red Gum Shrub Forest
3766 – Ulan Sandstone Damp Shrubland
3781 – Ulan Sandstone Ironbark-Pine Woodland
3786 – Western Hunter Scribbly Gum-Pine Woodland

2.1.3 Threatened ecological communities

The PCTs present in the Study Area have no associated TEC. It is therefore considered that no TECs occur within the Study Area.

2.1.4 Threatened flora

No threatened flora species were detected within the Study Area during the Stage 1 EIS (Moolarben Biota 2006). However, a population of *Androcalva procumbens* (listed as Vulnerable under the BC Act and EPBC Act) is known from a location within the Study Area (DCCEEW 2024b), and was identified at that location during the current baseline assessment survey. The population is comprised of five individuals in PCT 3781, occurring approximately 30 m south of LW 413 and approximately 12 m south of the predicted angle of draw (Figure 3).

No other threatened flora species were detected during the baseline assessment survey.

2.2 Groundwater Dependent Ecosystems

No Groundwater Dependent Ecosystems (GDE) were detected within the Study Area during the Stage 1 EIS (Moolarben Biota 2006).

Mapping from the GDE Atlas (BoM 2012) identifies the Goulburn River as a low to moderate potential aquatic GDE, and the vegetation in the vicinity of UG4 as low to high potential terrestrial GDE. The significant depth to water in more elevated areas of the catchments, such as the UG4 area where the depth to the water table is approximately 25 metres (m) to 65 m, indicates that GDE are unlikely to be present in these areas (AGE 2024, *in preparation*).

Springs and groundwater seeps in nearby creek valleys, and localised pools and soaks along the creeks support riparian vegetation. None of these features constitute high priority GDE listed under the Water Sharing Plans relevant to the Moolarben Coal Complex (AGE 2024, *in preparation*).

2.3 Fauna habitat

The Stage 1 EIS (Moolarben Biota 2006) determined that the following two broad fauna habitat types were present within the Study Area:

- Disturbed vegetation
- Sedimentary Scribbly Gum Woodlands.

The baseline assessment and vegetation validation survey undertaken by Niche aimed to identify specific functional fauna habitat types, such as roosting and foraging habitat, within the Study Area. The use of functional fauna habitat types allows for identification and assessment of the likelihood of occurrence of fauna species most likely to utilise available resources. The baseline and vegetation mapping assessment determined that the following fauna habitat features are present in the Study Area:

- Hollow-bearing trees
- A cliff line (CL3) and minor cliff lines containing small caves, overhangs and fissures
- Rock outcrops
- Surface rock
- Coarse woody debris
- Mistletoe
- Moderately steep gullies
- Riparian woodland
- Open woodland
- Low woodland with heath understorey
- Ephemeral waterways and drainage lines.

Based on the diversity of fauna habitat types present within the Study Area (combined with results of bat acoustic recorder deployment and opportunistic survey undertaken during the baseline assessment), the native fauna assemblage present within the Study Area is also likely relatively diverse, consisting of the following:

- Terrestrial and arboreal mammals
- Hollow and cave-dependent microbats
- Birds including large flightless birds (Emu), woodland birds, small and large parrots, nectivorous birds, large forest owls and diurnal raptors
- Reptiles
- Amphibians.

2.4 Threatened fauna

Ecological surveys undertaken for the Stage 1 EIS (Moolarben Biota 2006) and subsequent surveys identified the following threatened fauna species on or adjacent to the Study Area:

- Mammals:
    - Corben's Long-eared Bat *Nyctophilus corbeni* (Vulnerable, EPBC Act and BC Act) formerly Greater Long-eared Bat *Nyctophilus timoriensis*
    - Eastern Cave Bat *Vespadelus troughtoni* (Vulnerable, BC Act)
    - Large Bent-winged Bat *Miniopterus orianae oceanensis* (Vulnerable, BC Act) formerly Eastern Bentwing-bat
    - Large-eared Pied Bat *Chalinolobus dwyeri* (Endangered, EPBC Act and BC Act)
    - Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris* (Vulnerable, BC Act).
- Birds:
    - Black-chinned Honeyeater – eastern subspecies *Melithreptus gularis gularis* (Vulnerable, BC Act)
    - Brown Treecreeper – eastern subspecies *Climacteris picumnus victoriae* (Vulnerable, BC Act)
    - Diamond Firetail *Stagonopleura guttata* (Vulnerable, BC Act)
    - Dusky Woodswallow *Artamus cyanopterus cyanopterus* (Vulnerable, BC Act)
    - Gilbert's Whistler *Pachycephala inornata* (Vulnerable, BC Act)
    - Glossy Black Cockatoo *Calyptorhynchus lathami* (Vulnerable, BC Act)
    - Hooded Robin – south-eastern form *Melanodryas cucullata cucullata* (Vulnerable, BC Act)
    - Painted Honeyeater *Grantiella picta* (Vulnerable, BC Act and EPBC Act)
    - Powerful Owl *Ninox strenua* (Vulnerable, BC Act)
    - Speckled Warbler *Cthonicola sagittata* (Vulnerable, BC Act)
    - Square-tailed Kite *Lophoictinia isura* (Vulnerable, BC Act)
    - Varied Sittella *Daphoenositta chrysoptera* (Vulnerable, BC Act).

Opportunistic fauna survey as well as bat acoustic recorder deployment undertaken during this baseline assessment confirmed the presence of habitat for the above species, and detected the presence of the following threatened fauna species (Figure 3):

- Glossy Black Cockatoo (*Calyptorhynchus lathami*) foraging on *Allocasuarina littoralis* in the north-east of the Study Area in association with PCT 3786
- Three threatened microbat species, Large-eared Pied Bat (*Chalinolobus dwyeri*), Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) near various cliff lines within the Study Area.

A detailed list of all fauna species identified during the baseline assessment (as a result of bat acoustic recorder deployment and analysis, and those opportunistically recorded) can be found in Appendix 2, Table 7.

3 Subsidence Impact review

3.1 Predicted subsidence impacts

An examination of the extent of predicted subsidence associated with secondary extraction at LW 409-414 has been undertaken by Mine Subsidence Engineering Consultants (MSEC 2024). The Extraction Plan Layout of LW 409-414 is the same as the currently approved layout, with the exception of Longwall 413, which will be shorter at the southern end by 125 m, and Longwall 414, which will be 20 m shorter at the northern end. The approved and proposed mining height for the longwalls is 3 m:

- The maximum predicted total conventional subsidence based on the Extraction Plan Layout is 1900 mm.
- The maximum predicted total conventional tilt based on the Extraction Plan Layout is 40 mm per metre (mm/m).
- The maximum predicted total conventional curvature based on the Extraction Plan Layout is 2.0 km^{-1} hogging and 1.6 km^{-1} sagging.

Based on the above, the predicted subsidence conforms with that based on the Approved Layout (MSEC 2024).

3.2 Predicted subsidence impacts on natural features

Predicted subsidence impacts relevant to the natural features of the Study Area include (MSEC 2024):

- Ephemeral waterways and drainage lines – potential for minor changes to gradients, cracking in stream beds and fracturing of bedrock and increased levels of ponding and scouring.
- A cliff (CL3) – potential for cracking, minor rock fall or minor spalling at isolated locations.
- Minor cliffs – potential for fracturing and rockfalls.
- Slopes – potential for surface tension cracking.

The cliff (CL3) (MSEC 2024) is located south of Longwall 413, which has been shortened (in the Extraction Plan Layout relative to the Approved Layout) to reduce the predicted subsidence parameters and potential impacts at CL3.

3.3 Predicted subsidence impacts on biodiversity values

Predicted subsidence impacts (MSEC 2024) on biodiversity values of the Study Area are expected to be limited to the extent of longwall panels, being localised in nature. An analysis of the predicted subsidence impacts on identified biodiversity values has been undertaken (Table 2). This analysis has determined that the majority of impacts in relation to fauna are predominantly indirect impacts to fauna habitat values with direct impacts (DPIE 2020) limited to potential injury or death of individuals due to rock fall. It is also unlikely that the PCTs present and the population of *Androcalva procumbens* in the Study Area will decline as a result of subsidence. Therefore, it has been determined that secondary extraction at LW 409-414 will not significantly impact the biodiversity values within the Study Area.

Table 2. An analysis of the predicted subsidence impacts on biodiversity values.

Aspect	Description	Predicted subsidence impact	Impact assessment
Native vegetation	The PCTs present within the Study Area, including: – PCT 3528 – PCT 3530 – PCT 3766 – PCT 3781 – PCT 3786.	Predicted subsidence impacts relevant to ecological communities of the Study Area include localised surface tension cracking, altered overland flow and surface ponding which may affect water delivery/availability to these PCTs.	Considerable canopy regeneration was observed in all PCTs in response to seasonal rainfall, indicating that the vegetation communities remain resilient post-drought. Post-drought conditions are expected to result in increased canopy cover and leaf litter levels within the Study Area. PCT 3528, 3530 and 3766 are considered the most vulnerable to subsidence impacts due to their reliance on overland flows: – PCT 3528 occurs on the banks of a second order creek, – PCT 3530 occurs on a sandy outwash zone, and – PCT 3766 occurs in shallow sandstone depressions and rock plates. However, predicted subsidence impacts are not expected to result in a significant reduction to the PCTs' species diversity and cover, or structural integrity within the Study Area. This assumption is based on the results of UG4 LW 401-408 monitoring (Niche 2023), in addition to the nature of predicted subsidence impacts described by MSEC (2024).
Threatened species, populations and habitats – Mammals	Threatened cave-dwelling bat species	Predicted subsidence impacts relevant to threatened cave-dwelling microbats utilising the Study Area include localised surface tension cracking, cliff line instability and rock fall which may impact on	Habitat features utilised by cave-dwelling bats were observed in minor cliff lines above LW 410, 411 and 412, and in the cliff line (CL3) to the south of LW 413. The baseline assessment detected a number of bat species that may be using the cliff line as roosting habitat, including the following three threatened microbat species: – Large-eared Pied Bat (*Chalinolobus dwyeri*) – listed as Endangered under the EPBC Act and BC Act – Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – listed as Vulnerable under the BC Act – Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) – listed as Vulnerable under the BC Act.

Aspect	Description	Predicted subsidence impact	Impact assessment
		potential roosting/breeding habitat.	The number of passes on acoustic recorders was quite low for Large Bent-winged Bat and Yellow-bellied Sheathtail Bat. However, the number of passes for Large-eared Pied Bat at CL3 within the southern portion of the Study Area, south of LW 413, was such that it would infer there is a possibility the species is utilising the cliff line as roosting habitat. Predicted subsidence impacts to CL3 and minor cliff lines may result in impacts to cave-dwelling microbats. Impacts may include reductions in habitat suitability and extent in addition to potential injury or mortality to individuals as a result of subsidence induced rock fall. The subsidence impacts are not expected to significantly reduce the suitability or extent of existing habitat for cave-dwelling microbats such that it would adversely affect the lifecycle of these species or cause these species to become extinct within the locality. Habitats suitable for cave-dwelling microbats were identified in MCO biodiversity offset sites within the locality including the BOA1 with additional habitat available in the adjacent Goulburn River National Park (GRNP) to the east. Baseline assessment data indicates that cave-dwelling microbat species are currently utilising suitable habitat in the BOA1 site, demonstrating its suitability as potential refuge for microbat species affected by predicted subsidence impacts.

Aspect	Description	Predicted subsidence impact	Impact assessment
Threatened species, populations and habitats – Birds	Threatened bird species	Predicted subsidence impacts relevant to threatened bird species utilising the Study Area include localised surface tension cracking and altered overland flow which may impact health, abundance and diversity of foraging and sheltering resources.	The baseline assessment identified foraging and nesting habitat for threatened bird species within the Study Area. Foraging habitat for threatened bird species within the broader landscape, including both the Study and Reference Areas, has been affected by the previous 2017 – 2020 drought. A reduction in canopy cover and PCT structural integrity, as well as an increase in canopy epicormic growth cover, were also observed in the broader landscape, including the Reference Area. The previous drought impacts on *Allocasuarina littoralis* are notable, as this species is the preferred foraging resource for the Glossy Black Cockatoo. Regeneration of flora comprising foraging resources, including *Allocasuarina littoralis,* was observed during the baseline assessment; however, regenerating individuals are not expected to provide foraging resources for large parrots for at least five to 10 years. Alterations to hydrology resulting from surface tension cracking or surface ponding may result in localised short-term reduction in the extent and quality of foraging habitat. Impacts to foraging habitat are not expected to significantly impact species within the locality as bird species are highly mobile and are likely to seek alternative foraging habitat elsewhere within the surrounding landscape. Baseline assessment data indicates that bird species are currently utilising foraging habitat in BOA1, demonstrating its suitability as an alternative foraging resource. Additional high quality foraging resources are available in the adjacent GRNP and vegetated surrounds. Based on the above, it is unlikely that subsidence impacts will result in the long-term reduction of foraging habitat such that it would adversely affect the lifecycle of these species or cause these species to become extinct within the locality. Predicted subsidence impacts are expected to be localised in nature (i.e., tree fall), and are not expected to significantly reduce breeding habitats (i.e., suitable tree hollows) within the Study Area.
Threatened species, populations	Threatened flora species	Predicted subsidence impacts relevant to threatened flora species	The known extent of the *Androcalva procumbens* population within the Study Area UG4 occurs approximately 30 m south of LW 413, and approximately 12 m from the predicted angle of draw (Figure

Aspect	Description	Predicted subsidence impact	Impact assessment
and habitats – Threatened flora		within the Study Area include localised surface tension cracking, altered overland flow and surface ponding. This may affect water delivery and habitat suitability for the species.	3). However, as the population may be affected by subsidence, due to altered overland flows, Niche recommends that the populations should be monitored. The population is located on a skeletal, rocky crest in PCT 3781 with a naturally sparse canopy cover and is comprised of five individuals. Some individuals have relatively thick, long runners which indicate their maturity (DCCEEW 2024b). *Androcalva procumbens* is known to have a vegetative and underground thickened rootstock stage, and to remain in the rootstock stage until favourable disturbances occur within its habitat. Vegetative individuals are often found after fires, on roadsides and recently cleared easements (DCCEEW 2024b). As the species is known to respond positively to disturbance, it is likely that it is resilient to predicted subsidence impacts. As such, the predicted subsidence impacts are not likely to adversely affect the population of *Androcalva procumbens* within the Study Area.

3.4 Review of biodiversity performance measures

The EIS (Moolarben Biota 2006) prepared for the Stage 1 Project Approval (05_0117) and subsequent environmental assessments prepared for approved modifications have assessed impacts to biodiversity (including those pertaining to the UG4 LW 409-414 secondary extraction). A complex-wide BMP prepared for Stages 1 and 2 of the Moolarben Coal Complex operation (MCO 2020) contains relevant performance measures and indicators to evaluate the outcomes of management measures. The Stage 1 Project Approval (05_0117) does not include specific subsidence impact performance measures for biodiversity; however, the Project Approval (05_0117) condition 77(i) requires the preparation of a BMP which has been prepared in consultation with BCD, which provides for the management of potential and/or environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats; endangered ecological communities and water dependent ecosystems.

In accordance with Condition 77 (i), Schedule 3 of Project Approval (05_0117), a new BMP is required to be prepared for the LW 409-414 Extraction Plan. Niche recommends that the performance indicators listed in Table 3 are incorporated in the LW409-414 BMP.

All performance indicators have been prepared with due consideration of the existing biodiversity values in the Study Area identified as being vulnerable to subsidence impacts. Although the PCTs described in the Study Area do not conform to a TEC, the vegetation integrity of the community indirectly affects the health of the threatened fauna and flora species identified in the Study Area. The monitoring of PCT condition will therefore be used in conjunction with the performance indicator to describe landscape health, and to inform best practice methods for the management of impacts should the performance indicator be exceeded (see section 5). The recommended monitoring methods are outlined in Section 4 of this report.

Table 3: Recommended performance indicators

Biodiversity value	Monitoring method	Performance Indicator
Threatened fauna	Monitoring for microbat presence and diversity	Reduction of species abundance at impact site is not greater than at reference sites for four consecutive years in conjunction with observed impacts to habitat directly related to subsidence.
Threatened flora	Monitoring for presence	Threatened flora remains present within the Study Area.

4 Monitoring Methodology

4.1 Monitoring program

The monitoring program has been designed to identify early detection of potential subsidence impacts. A review of previous monitoring methodologies for the UG4 LW 401-408 (Niche 2023) has been undertaken to determine the nature and type of data collected.

Fauna species selected for monitoring are those which are considered to occur in habitats sensitive to direct impacts (DPIE 2020). In the Study Area, this consists of geological features such as caves, crevices and fissures in CL3 and minor cliff lines.

It is recommended that the baseline monitoring be conducted prior to mining and further monitoring be conducted annually upon commencement of mining through to an additional two years past the point that mining has been completed, or as determined by monitoring results (i.e., monitoring may continue beyond two years post-mining). Ideally, the recommended monitoring timing would be during the Spring months when the majority of flora and fauna are reproducing and active. The program below allows for one round of monitoring in Spring of each year over the duration of the monitoring period upon approval of the UG4 LW409–414 Extraction Plan.

A summary of the proposed monitoring program is provided below in Table 4 and a detailed description of the methods are provided in Section 4.2. Proposed monitoring locations are shown in Figure 4.

Table 4: Recommended UG4 LW 409-414 monitoring program.

Survey Type	Methods	Timing
Study and reference sites	Floristic survey at specific locations in the Study Area and Reference Area consisting of a 50 x 20 m plot containing a nested 20 x 20 m plot along a fixed transect. The composition, structure and functional attributes of the PCT present and additional tree stress data will be recorded. Any evidence of subsidence within the 50 x 20 m plot will be quantified, described and photographed. Detailed methodology is described in Section 4.2.1.	Annually in Spring
Photo point monitoring	Two photographs (portrait and landscape) to be taken at the established pickets at the start and end of each 50 m transect of all study and reference sites.	Annually in Spring

Survey Type	Methods	Timing
Acoustic monitoring	Four acoustic devices targeting bats (three in the Study Area and one in the Reference Area) to be deployed for four nights.	Twice per survey season (November to January[2])
Population count and health assessment of threatened flora	A population count of threatened flora, a description and photograph detailing population health, and any evidence of subsidence in proximity will be described, quantified, and photographed.	Annually in Spring

4.2 Monitoring program methodology

4.2.1 Study Area and reference sites

Six permanent floristic monitoring plots have been established within the Study Area. The placement of the study sites was stratified such that one was placed in each PCT across UG4 LW 409-414 (Figure 4). An additional six permanent reference sites have also been established in corresponding vegetation classes at the nearby BOA1 (Reference Area). The reference site data will be utilised as a control for comparative analysis, to allow for the control of confounding factors in the monitoring results. The longwall number, representative study site and associated reference sites, the PCT assigned and the corresponding vegetation class, is displayed in Table 5.

Table 5: The longwall number, representative study site and associated reference sites, the PCT assigned and the corresponding vegetation class.

Longwall number	Study site	Study site PCT	Study site vegetation class	Reference sites	Reference site PCT	Reference site vegetation class
LW409	UG4_009	3528	Dry Sclerophyll Forests (Shrub/grass sub-formation)	BOA1_14a	3528	Dry Sclerophyll Forests (Shrub/grass sub-formation)
				BOA1_14b		
LW410	UG4_010	3781	Western Slopes Dry Sclerophyll Forests	BOA_OU3	3781	Western Slopes Dry Sclerophyll Forests
				BOA_OU4		

[2] Survey season specifically targets Large-eared Pied Bat.

Longwall number	Study site	Study site PCT	Study site vegetation class	Reference sites	Reference site PCT	Reference site vegetation class
LW411	UG4_011	3786	Western Slopes Dry Sclerophyll Forests	BOA1_6a	3786	Western Slopes Dry Sclerophyll Forests
				BOA1_6b		
LW412	UG4_012	3530	Dry Sclerophyll Forests (Shrub/grass sub-formation)	BOA1_14a	3528	Dry Sclerophyll Forests (Shrub/grass sub-formation)
				BOA1_14b		
LW413	UG4_013	3766	Western Slopes Dry Sclerophyll Forests	BOA1_6a	3786	Western Slopes Dry Sclerophyll Forests
				BOA1_6b		
LW414	UG4_014	3781	Western Slopes Dry Sclerophyll Forests	BOA_OU3	3781	Western Slopes Dry Sclerophyll Forests
				BOA_OU4		

An initial round of monitoring is to be undertaken in spring prior to commencement of secondary works. This is to record the baseline condition of the PCTs present in spring, in both the Study Area and Reference Area, to be utilised for future comparative analysis after works have begun. Baseline data collection is to focus on flora species diversity and abundance in addition to the structural and functional attributes of native vegetation present at each monitoring location (as recorded through the BAM).

Floristic, structural and functional data within both the study and reference sites is to be collected in accordance with the BAM (DPIE 2020). Additional data, including tree stress, evidence of subsidence and landscape characteristics, will also be collected within the 20 x 50 m plot at both sites. Detailed data collection methods are displayed and described below.

Each study and reference site is to consist of a 20 x 50 m plot (centred around a central 50 m transect) and a nested 20 x 20 m quadrat (refer to Plate 1 below). Each site has been permanently marked with a capped star picket at the start and end, to ensure that the bearing remains consistent and to aid in site identification for future monitoring rounds.

Data recorded within each 20 x 20 m nested quadrat is to consist of:

- A record of each native and exotic species present
- Projected foliage cover of all species in increments of 0.1-1, 1-10 then 5% increments capped at 100%
- Abundance of all species recorded within the quadrat measured at 1, 2, 3, 4, 5 ,6, 7, 8, 9, 10, 20, 50, 100, 500, 1000 or a specified number greater than 1000 if required
- A record of the structural layer/s occupied by each species including the dominant species occupying the canopy, mid-storey and ground layers.

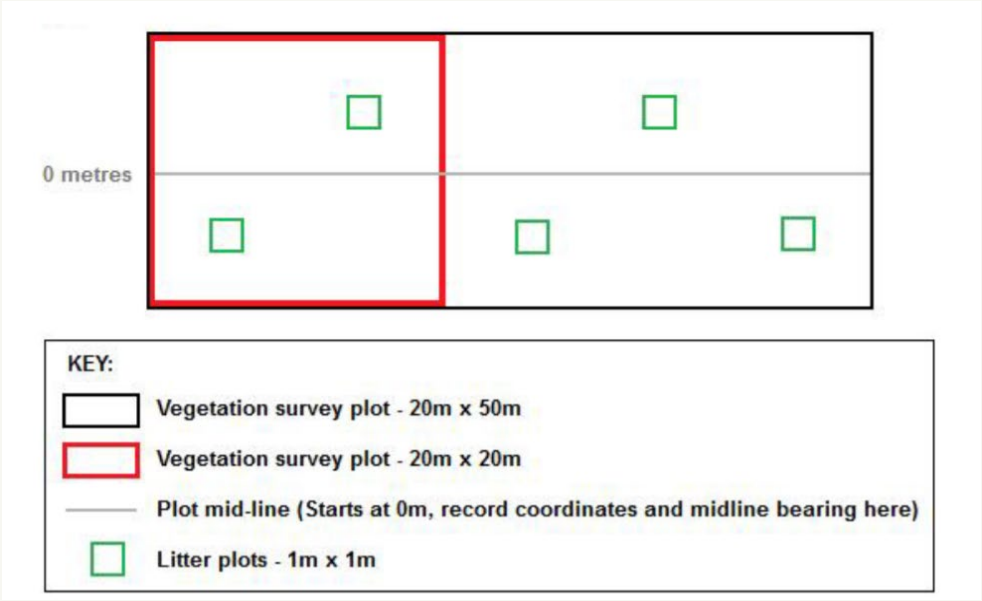

Plate 1: Study and reference site layout as per the BAM 2020 Operational Manual – Stage 1 (DPIE 2020).

Data recorded within each 20 x 50 m plot is to consist of:

- Presence or absence of canopy species within the following Diameter at Breast Height (DBH) size increments: <5 centimetres (cm), 5-10 cm, 11-20 cm, 21-30 cm, 31-40 cm, 41-50 cm, 51 – 80 cm
- Number of large trees (>50 cm DBH)
- Number of hollow-bearing trees
- Length of coarse woody debris measured in metres
- Cover (%) of epicormic foliage relative to total cover of foliage within the plot
- Cover (%) of discoloured canopy foliage relative to total cover of healthy foliage within the plot
- Cover (%) of dieback relative to live vegetation within the plot and the PCT patch
- Cover value (%) of bare branches
- Count of any stags encountered within the plot
- Evidence of subsidence impacts (cracking or ponding) described and photographed
- Extent of subsidence impacts (cracking or ponding) as a percent of the plot area.
- Landscape characteristics recorded at each plot to include percentage cover of surface rock, cryptograms and bare soil.

Baseline data will be used to generate a baseline VIS at each monitoring point. The benchmark values of each PCT at the time of baseline VIS generation will be extracted from the BAM-C and recorded in the baseline report for application during ongoing monitoring.

Monitoring via the assessment of the study site and associated reference sites is to take place every spring from commencement of works, over the duration of secondary extraction, extending for at least two years once mining has been completed under each monitoring site. Annual data analysis will contain the following:

- A qualitative and quantitative analysis of the current VIS, composition, structure and function scores at the study sites as compared to those collected during the baseline and years prior

- A qualitative and quantitative analysis of the current VIS, composition, structure and function scores at the reference sites as compared to those collected during the baseline and years prior
- A qualitative and quantitative analysis of changes in the VIS at the study site as compared to that observed in the associated reference sites (control).

4.2.2 Photo-point monitoring

A photo point is to be established at the start and end of the central 50 m transect of all study and reference sites. During the Spring baseline monitoring and each subsequent monitoring round, two photographs (portrait and landscape) are to be taken at the start and end of the central transect. This visual record will be retained and displayed in the monitoring report.

The photographs, alongside the VIS and additional vegetation stress data, will be used as a visual aid to compare any changes in vegetation integrity to the baseline and previous years monitoring.

4.2.3 Monitoring for threatened fauna populations – Microbat activity

Passive monitoring using acoustic devices is to be undertaken to assess potential impacts to threatened microbats previously recorded in the Study Area. Passive monitoring via acoustic device is easily replicated and analysed and can be used to determine changes over time in abundance, diversity, habitat preference, foraging guild and activity of target microbat species. The diversity, abundance, habitat preference, foraging guild or residency of microbat species within the Study Area may be a useful surrogate for detecting subsidence related impacts in correlation with visible signs of cracking or ponding.

Monitoring of threatened microbat activity will be undertaken twice per survey season (November to January). Monitoring will include:

- Study Area – installation of three Anabat acoustic devices (or equivalent) in proximity of identified microbat habitat for four nights
- Reference Area – installation of one Anabat acoustic device (or equivalent) in proximity of identified microbat habitat for four nights.

The acoustic recordings will be used to identify the presence or absence of threatened microbat species in the Study and Reference Areas, and to approximate the abundance (based on activity and the number of passes) of each species. The results of subsequent monitoring rounds will be compared against the spring baseline and prior monitoring rounds to determine any changes to microbat presence and activity overtime. Microbat presence and activity in the Study Area as compared to the Reference Area will also be compared.

4.2.4 Monitoring for threatened flora populations – *Androcalva procumbens*

Monitoring of the *Androcalva procumbens* population will be undertaken annually in spring. Monitoring will include:

- An estimated population count at each of the known locations
- A description of the population health alongside descriptive photographs
- Any evidence of subsidence impacts in proximity to the population, including cracking and ponding, will be described, quantified and photographed.

Should an additional population of *Androcalva procumbens* or another threatened flora species be detected during subsequent monitoring rounds, their locations will be recorded, and the population will be monitored following the above outlined methods in the annual monitoring report. Should the above outlined methods be unsuitable for the species/population found, an alternative monitoring method will be implemented by a suitably qualified ecologist.

5 Management of Impacts

5.1 Recommendations for management of impacts

The following recommendations are to be enacted in the event that performance indicator criteria outlined in Table 3 of Section 3.4 are greater than predicted. In the event that the performance indicator criteria are close to being exceeded, additional investigation (i.e., more vegetation study sites, additional survey periods, additional acoustic monitoring sites and more intensive data analysis) may be required to understand the nature of the impact and identify the most appropriate management measures that should be applied to avoid exceedance. If monitoring indicates that impacts are occurring which exceed the performance indicator criteria outlined in Table 3 of Section 3.4, and can be directly attributed to physical observations of subsidence, the management measures outlined below will be required.

In the event that subsidence repairs are planned in vegetated areas, a site assessment should be undertaken prior to the commencement of works. The site assessment is to focus on determining the risk of potential impacts of remediation on biodiversity values and provision of recommendations to avoid, minimise or mitigate identified impacts. Recommendations should be enacted prior to commencement of works to ensure that remediation does not create greater impacts than the surface cracking or ponding itself.

Based on the predicted subsidence impacts and vulnerable threatened biodiversity values identified in Section 3.1 through to 3.3 of this report, management measures have been prescribed for:

- Threatened fauna
- Threatened flora.

Additional management measures have been prescribed for non-threatened biodiversity values identified within the Study Area which, if impacted, may have the potential to indirectly affect threatened fauna habitat:

- Habitat management
- Weed management.

5.2 Threatened fauna

Specific threatened fauna habitat management measures will depend on the type and identity of threatened species and the nature of the impacted habitat features. Of the threatened species identified during the baseline assessment in the Study Area, only cave-dwelling microbat species have breeding habitat which occurs in features sensitive to direct impacts (DPIE 2020). As such, the trigger for threatened fauna habitat management measures is a reduction in the abundance of threatened cave-dependent microbat species, as defined in Table 3 of Section 3.4.

If the performance measure for threatened bats (Table 3) is triggered, impacts to habitat would be investigated through:

- Vegetative habitat: changes in condition (e.g. composition, structure) of the species associated PCTs (data collected as part of annual monitoring through BAM plot monitoring in each PCT)
- Potential roosting habitat: impacts to rocky habitat
- Review of subsidence impacts detected as part of reporting requirements related to subsidence monitoring (to be provided by MCO) to assist in the determination of cause and effect.

Where subsidence monitoring results identifies impacts that are greater than predicted (assessment of biodiversity performance indicator for cave dwelling microbats has not been triggered), the management measures detailed below would be implemented.

Recommended management measures for subsidence impacts to cave-dwelling microbat species include:

- Site assessment to determine the level of impacts to cave-dwelling microbats
- Changes to the monitoring program and/or more intensive analysis to determine the causative factors and most appropriate minimisation, mitigation and/or remediation measures
- Installation of alternative roosting habitat for cave-dwelling microbats near CL3 and minor cliff lines identified
- Targeted survey of affected microbat species to gauge the outcomes of enacted measures
- Any other suitable restoration or corrective measures determined by a suitably qualified ecologist.

Where assessment of biodiversity performance indicator for threatened bats has been triggered, MCO would be required to implement a contingency plan, as detailed in the approved complex-wide BMP.

5.3 Threatened flora

A population of the threatened flora species, *Androcalva procumbens* (Vulnerable, BC Act and Vulnerable, EPBC Act), containing five individuals has been recorded in the south-eastern extent of the Study Area, but would not be directly undermined (Figure 3). As the species is known to respond positively to disturbance, it is likely that it is resilient to predicted subsidence impacts. As such, the predicted subsidence impacts are not likely to adversely affect the population of *Androcalva procumbens* within the Study Area.

If performance measures for threatened flora (Table 3) are triggered, impacts to habitat would be investigated through changes in the condition (e.g. composition, structure) of the PCT in which the population occurs (PCT 3781), compared to the associated reference sites (control) in conjunction with subsidence impacts. This data is collected as part of annual monitoring through BAM plot monitoring in each PCT. Analysis would include a review of subsidence impacts detected as part of reporting requirements related to subsidence monitoring (to be provided by MCO) to assist in the determination of cause and effect.

If annual monitoring determines that the species is no longer present in Study Area further investigation into the condition of PCT 3781 would be undertaken to determine whether the decline is a result of subsidence impacts. If it is determined to be a result of subsidence impacts, recommended management measures would include:

- A suitably qualified bush regeneration contractor to collect seed from affected individuals for use in propagation and planting of seedlings in nearby undisturbed areas of associated habitat
- Increased monitoring of threatened flora populations and habitat to measure the outcomes of enacted measures
- Any other suitable restoration or corrective measures determined by a suitably qualified ecologist.

5.4 Habitat management

5.4.1 Roosting habitat management

Specific fauna habitat management measures will depend on the species/fauna habitat features potentially impacted. The majority of fauna recorded in the Study Area (Moolarben Biota 2006; ELA 2019) are reliant on breeding and foraging habitat that is not considered sensitive to subsidence impact. Therefore, the measures recommended below should be implemented only in the unlikely event of significant reduction in foraging habitat or significant loss of hollow-bearing trees directly related to subsidence (as determined by the function component of the study site data).

General fauna habitat management measures recommended include the following:

- In the event that significant reductions in fauna foraging habitat for fauna species known to occur on site are observed, it is recommended that supplementary planting of preferred foraging species be undertaken.
- Any other suitable restoration or corrective measures determined by a suitably qualified ecologist.

5.4.2 Native vegetation

Native vegetation management measures are to be triggered where performance measures or Trigger Action Response Plans (TARPs) indicate impacts to threatened species is linked to impacts to vegetative habitat, including composition and structure. The type of vegetation management measures required to remediate potential subsidence impacts will depend on the identity and functional role of affected flora species and the nature of the impact.

Potential management measures may include, but are not limited to, the following:

- Supplementary planting focused on restoring the structural layer of the impacted PCT using species representative of said PCT
- Implementation of remediation as deemed necessary
- Extension of the monitoring program duration and additional study sites
- Tracking the success of implemented management measures, via the analysis of vegetation integrity, composition, structure and function scores at the established study sites
- Retention of stags and dead shrubs utilised by fauna and mycorrhizal fungi on which some species, particularly orchids, are dependent upon
- Any other suitable restoration or corrective measures determined by a suitably qualified ecologist.

5.5 Weed management

No priority weeds or weeds of national significance were identified within the Study Area. However, a moderate cover of *Echium plantagineum* was observed in the historically cleared portion of the site, north of Saddlers Creek Road, in the Moderate condition of PCT 3530. This area would benefit from targeted weed suppression. The remainder of the Study Area contained extremely low cover of herbaceous annual weed species. Weed management measures should continue to be undertaken in accordance with the BMP (MCO 2020).

5.6 Additional monitoring

In the event that any of the recommended performance indicators outlined in Section 3.4 of this report is exceeded, additional monitoring may be required. Additional monitoring methods to be employed will depend on the exact nature of the exceedance, the impacted biodiversity value and the management measure utilised. Additional monitoring methods should be determined by a suitably qualified ecologist.

6 Conclusion

This biodiversity technical report contains a summary of the extant biodiversity values within the Study Area based on desktop review of previous ecological surveys and the recent baseline assessment undertaken by Niche. The baseline assessment has resulted in the preparation of field validated vegetation mapping for the Study Area in addition to the implementation of the monitoring program, including establishment of study and reference sites. Observations undertaken during the baseline assessment determined that vegetation within both the Study and References Areas, and the broader landscape, has been previously impacted by the 2017 – 2020 prolonged drought. These impacts include a reduction in canopy cover and PCT structural integrity, as well as an increase in canopy epicormic growth cover. Vegetation most affected occurs on plateaus and upper slopes.

Based on a review of predicted subsidence impacts as detailed in MSEC (2024) secondary extraction of UG4 LW 409-414 is considered unlikely to significantly impact non-threatened and threatened biodiversity resident within the Study Area.

Niche have provided recommendations for more detailed evaluation criteria to align with the Stage 1 Project Approval (05_0117) condition 77(i) and have provided recommended management measures to be enacted if evaluation criteria are exceeded. The monitoring program has been built around these performance measures and designed to allow for early detection and identification of impacts to biodiversity values.

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Lists of illustrations and tables

List of Figures

Figure 1: Study Area 32
Figure 2: Field-validated revised PCTs in the Study Area 33
Figure 3: Threatened Biodiversity in the Study Area 34
Figure 4: Monitoring locations 35

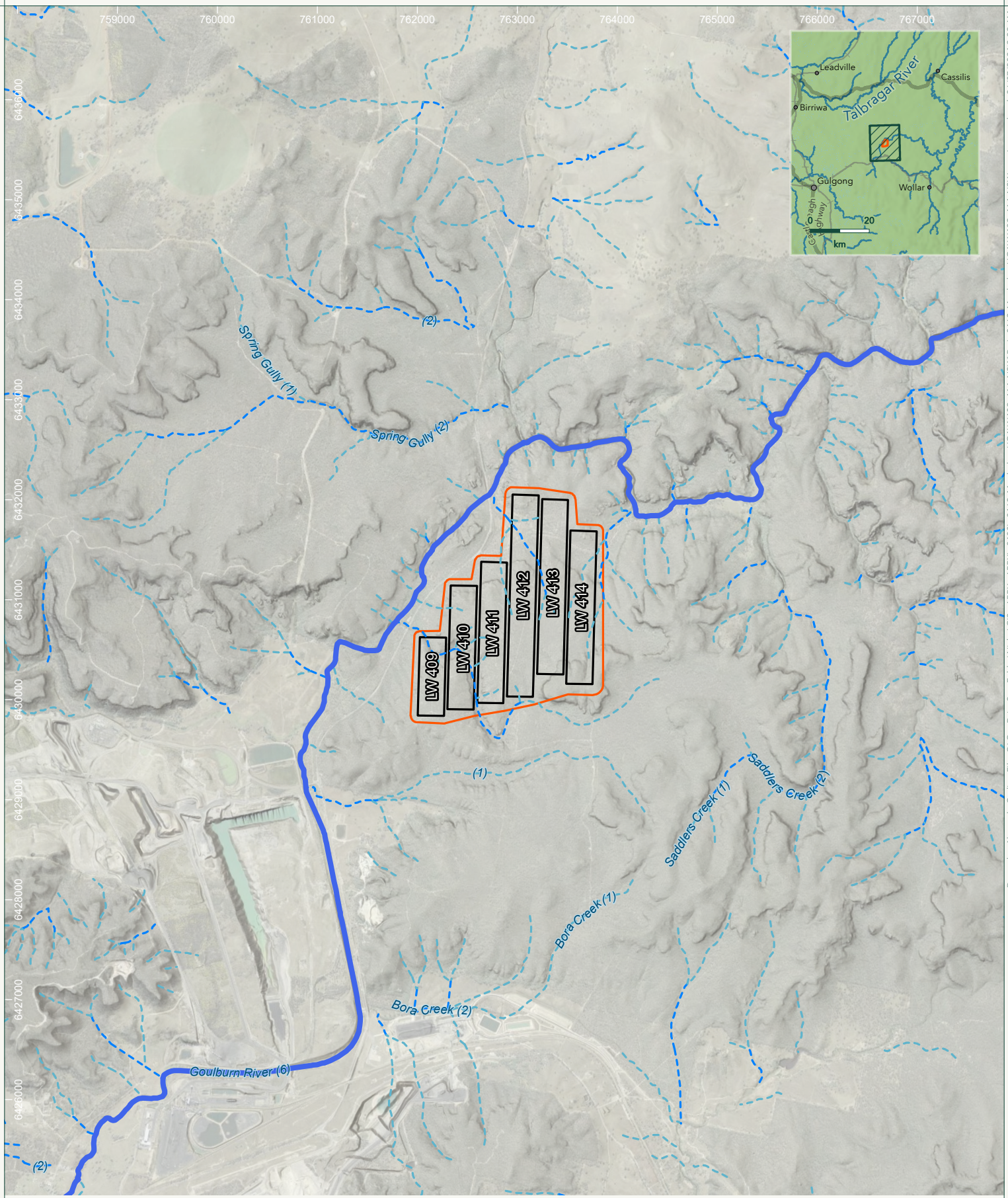
List of Plates

Plate 1: Study and reference site layout as per the BAM 2020 Operational Manual – Stage 1 (DPIE 2020). 22

List of Tables

Table 1: The revised PCTs for LW409-414 Study Area. 10
Table 2. An analysis of the predicted subsidence impacts on biodiversity values. 14
Table 3: Recommended Performance Indicators 18
Table 4: Recommended UG4 LW 409-414 monitoring program. 19
Table 5: The longwall number, representative study site and associated reference sites, the PCT assigned and the corresponding vegetation class. 20
Table 6: A brief description of the revised PCTs within the Study Area. 37
Table 7: Fauna recorded in the Study Area between 5 and 14 March 2024. 40
Table 8: Microbat call analysis and record of passes between 5 and 14 March 2024. 42

Figures



Study Area
UG4 LW 409-414
Strahler Stream Order
1st order stream
2nd order stream
6th order stream

N
0
1
km
GDA2020 MGA Zone 55

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Niche

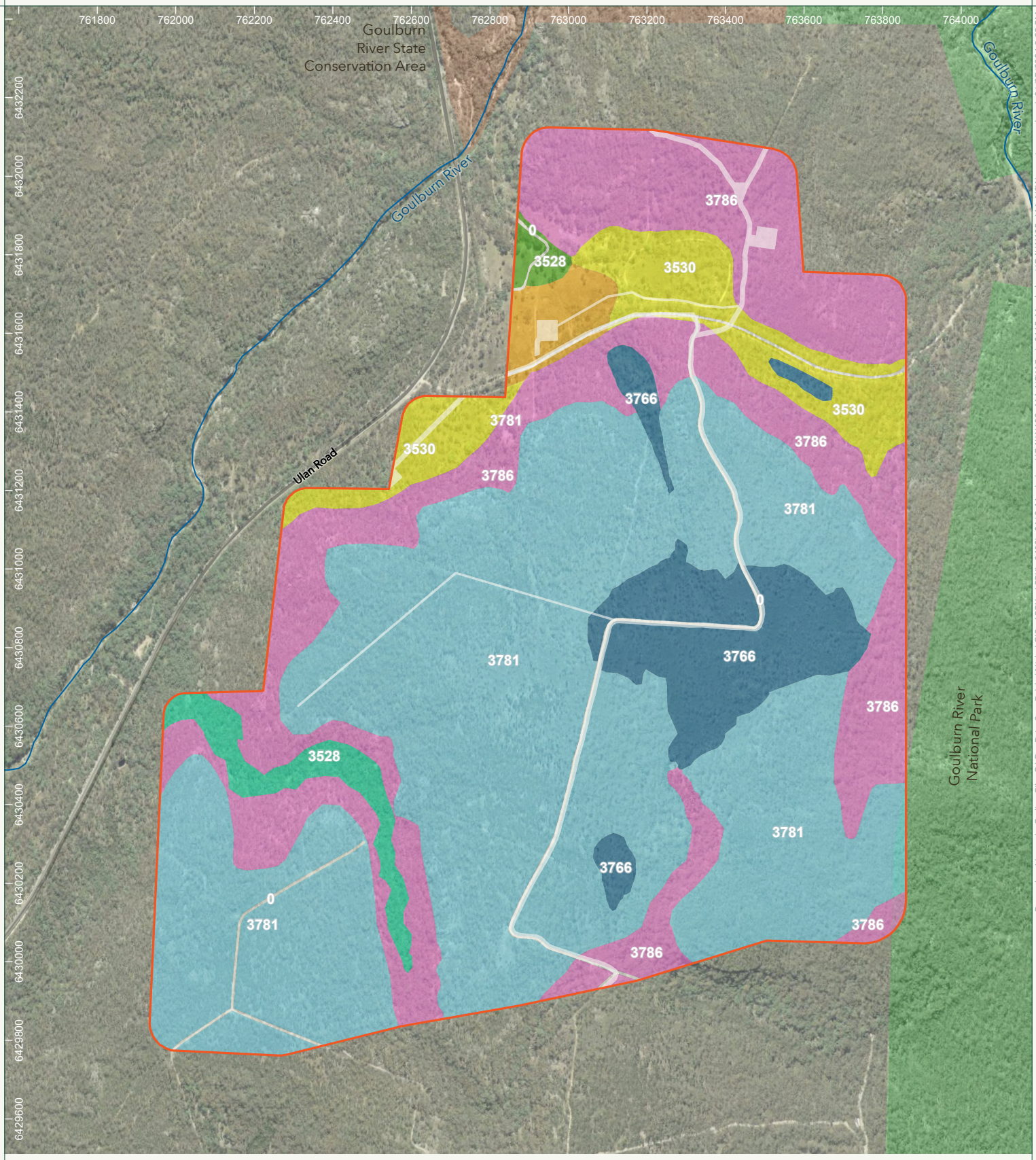
Figure 1

Study Area

Moolarben UG4 LW 409-414

Niche PM: Stephen Bloomfield
Niche Proj. #: 8469
Client: Moolarben Coal Operations Pty Ltd

Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 55 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 55



Study Area

Field-validated revised PCTs

- 0: Not Native - Road
- 3528: Western Hunter Flats Apple-Gum Shrub Forest - High
- 3528: Western Hunter Flats Apple-Gum Shrub Forest - Moderate
- 3530: Western Hunter Sandy Riparian Red Gum Shrub Forest - High
- 3530: Western Hunter Sandy Riparian Red Gum Shrub Forest - Moderate
- 3766: Ulan Sandstone Damp Shrubland - High
- 3781: Ulan Sandstone Ironbark-Pine Woodland - High
- 3786: Western Hunter Scribbly Gum-Pine Woodland - High

Roads

Watercourse

Protected Areas of NSW

- National Park
- State Conservation Area

N

0 200

m

GDA2020 MGA Zone 55

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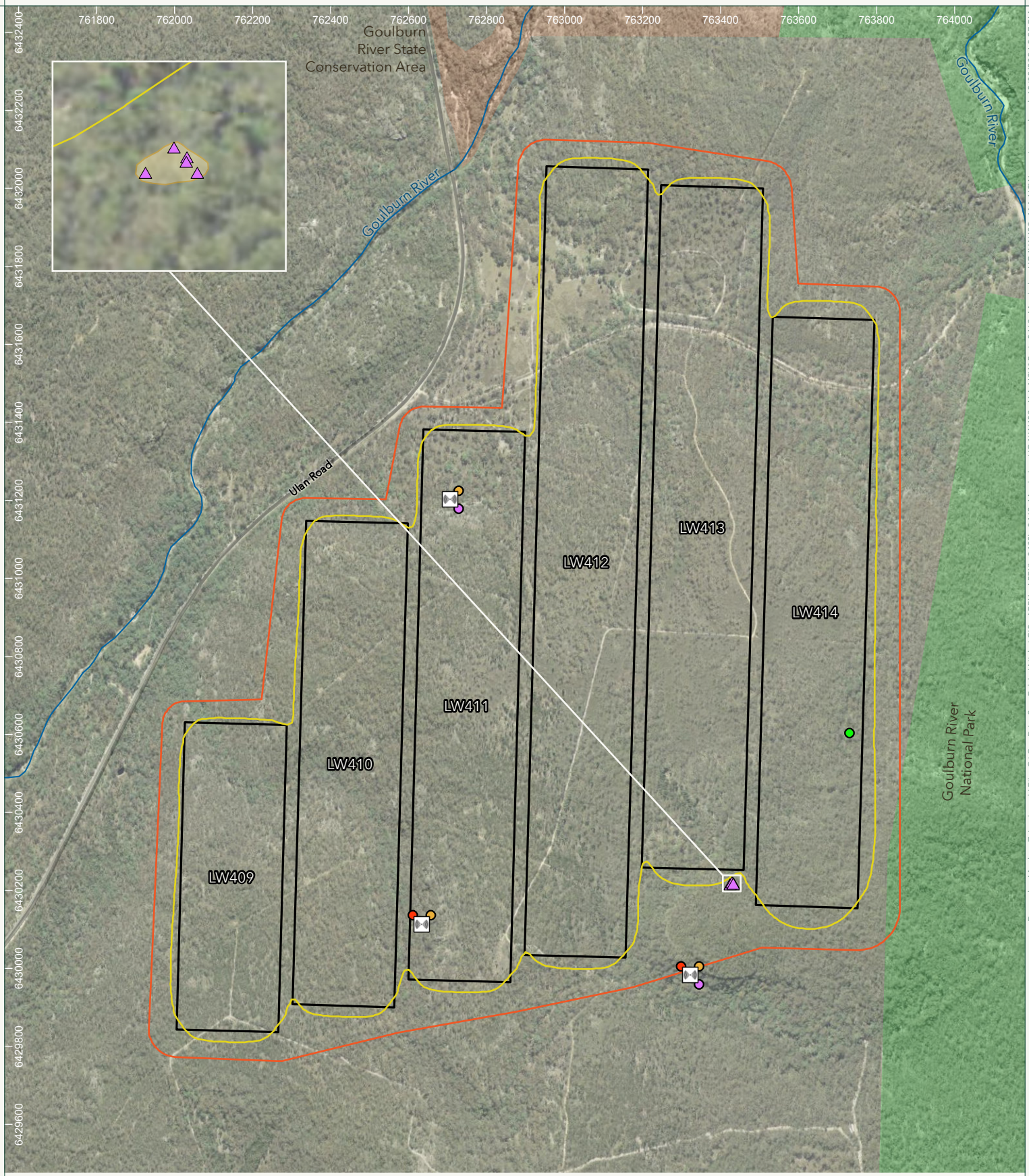
Niche

Figure 2

Field-validated revised PCTs in the Study Area

Moolarben UG4 LW 409-414

Niche PM: Stephen Bloomfield
Niche Proj. #: 8469
Client: Moolarben Coal Operations Pty Ltd



Study Area
UG4 LW 409-414
20mm Subsidence contour
Bat monitoring locations

Threatened Fauna

Glossy Black-Cockatoo (Calyptorhynchus lathami)
Large Bent-winged Bat (Miniopterus orianae oceanensis)
Large-eared Pied Bat (Chalinolobus dwyeri)
Yellow-bellied Sheathtail Bat (Saccolaimus flaviventris)

Threatened Flora

Androcalva procumbens
Androcalva procumbens Species Polygon

Roads
Watercourse

Protected Areas of NSW

National Park
State Conservation Area

N
0 200
m

GDA2020 MGA Zone 55

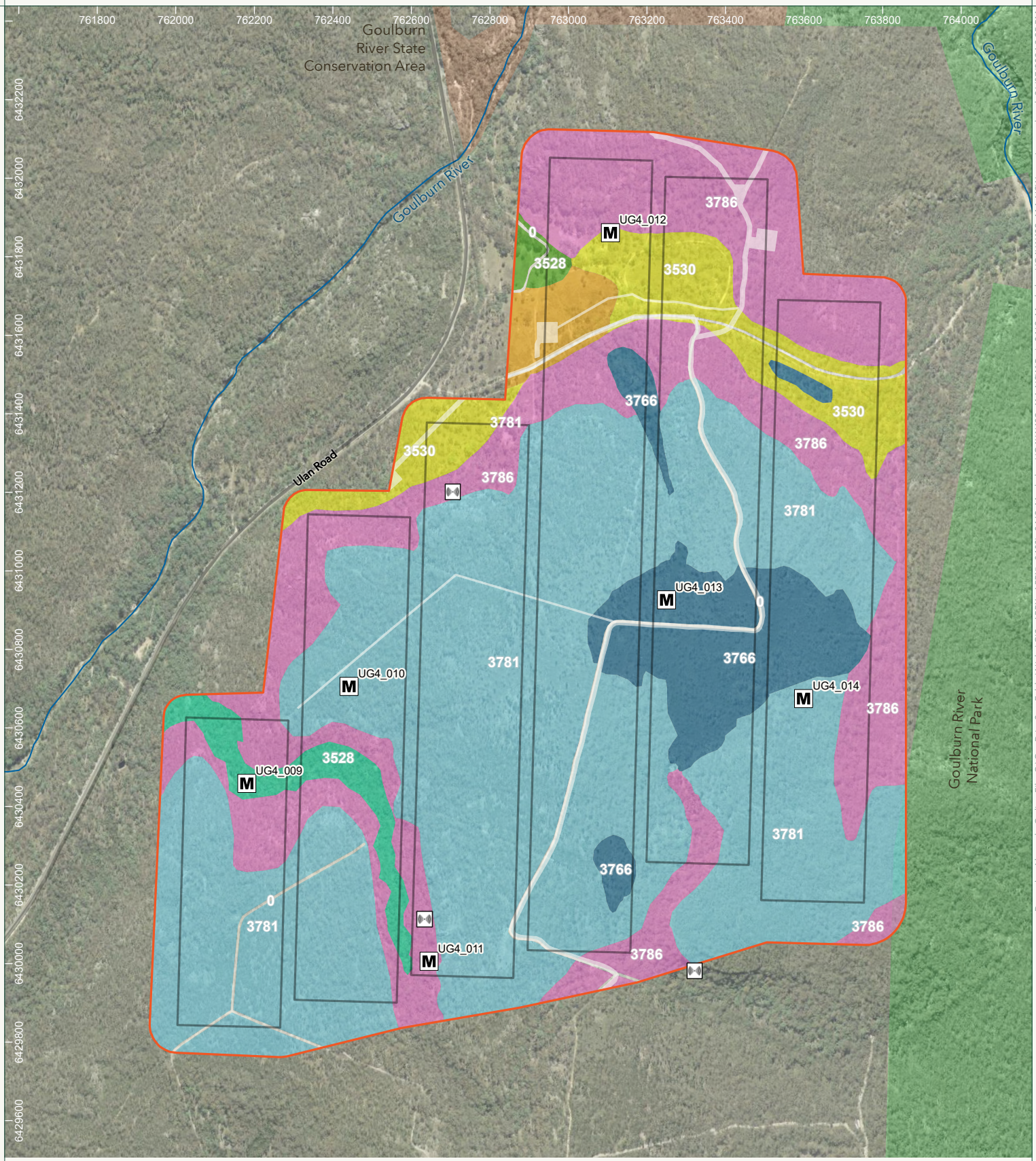
Niche

Figure 3

Threatened Biodiversity in the Study Area

Moolarben UG4 LW 409-414

Niche PM: Stephen Bloomfield
Niche Proj. #: 8469
Client: Moolarben Coal Operations Pty Ltd



Study Area

UG4 LW 409-414

M UG4 409-414 Study area flora monitoring locations

Bat monitoring locations

Field-validated revised PCTs

0: Not Native - Road

3528: Western Hunter Flats Apple-Gum Shrub Forest - High

3528: Western Hunter Flats Apple-Gum Shrub Forest - Moderate

3530: Western Hunter Sandy Riparian Red Gum Shrub Forest - High

3530: Western Hunter Sandy Riparian Red Gum Shrub Forest - Moderate

3766: Ulan Sandstone Damp Shrubland - High

3781: Ulan Sandstone Ironbark-Pine Woodland - High

3786: Western Hunter Scribbly Gum-Pine Woodland - High

Roads

Watercourse

Protected Areas of NSW

National Park

State Conservation Area

N

0 200

m

GDA2020 MGA Zone 55

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Niche

Figure 4

Monitoring Locations

Moolarben UG4 LW 409-414

Niche PM: Stephen Bloomfield
Niche Proj. #: 8469
Client: Moolarben Coal Operations Pty Ltd

Appendices

Appendix 1 – PCT descriptions

Table 6: A brief description of the revised PCTs within the Study Area.

PCT	Condition	Description
3528	Moderate	This vegetation zone occurs on a gentle slope in the north-west portion of the Study Area on sandy loam soil. The area has been historically cleared. Of the regeneration present and the large canopy trees that remain, *Angophora floribunda* and *Eucalyptus blakelyi* have the highest cover. Occasional *Eucalyptus crebra* were present, with a single occurrence of *Brachychiton populneus*. The midstory is sparse consisting of *Leptospermum polygalifolium* regeneration. The ground layer is mid-dense consisting primarily of *Microlaena stipoides*.
3528	High	This vegetation zone occurs in an ephemeral creek flat with sandy loam to sandy soil. It consists of a high cover of *Angophora floribunda* on the grassy flats alongside *Eucalyptus Macrorhyncha*, with *Eucalyptus blakelyi* found on the sandy creek channel. *Acacia linearifolia* is present throughout, with occasional *Callitris endlicheri*. The midstratum is sparsely shrubby, comprised mostly of *Cassinia sifton*, *Cassinia quinquefaria* and *Styphelia triflora*, with mid-dense patches of *Leptospermum polygalifolium* in the sandy channel. The ground layer is sparse to mid-dense and is comprised of grasses, graminoids and forbs. The more common groundcover species observed include *Microlaena stipoides*, *Digitaria diffusa*, *Aristida ramosa*, *Imperata cylindrica*, *Arundinella nepalensis*, *Cheilanthes sieberi subsp. sieberi* and *Lomandra confertifolia*.
3530	Moderate	This vegetation zone occurs on a gentle slope in the north-west portion of the Study Area on sandy loam soil. The area has been historically cleared. Of the regeneration present and the large canopy trees that remain, *Eucalyptus blakelyi* has the highest cover. Occasional *Eucalyptus crebra* were present. The mid stratum is sparse to mid-dense and primarily consists of *Leptospermum polygalifolium* regeneration. The ground layer is sparse, and primarily consists of *Juncus spp, Carex appressa*, *Microlaena stipoides* and *Echium plantagineum*.
3530	High	This vegetation zone occurs on a sandy outwash in the north which has been historically cleared. The canopy is dominated by *Eucalyptus blakelyi*, with a sparse cover of *Angophora floribunda* and occasional *Eucalyptus crebra*, *Callitris endlicheri* and *Acacia linearifolia*. The mid stratum is mid-dense. The most common species in the mid stratum include *Cassinia sifton, Acacia buxifolia*,

PCT	Condition	Description
		Kunzea parvifolia, *Aotus subglauca, Xanthorrhoea sp., Styphelia triflora, Persoonia linearis, Grevillea sericea, Acacia gladiiformis* and *Sannantha cunninghamii*. The ground cover is sparse. The most common ground cover species include *Microlaena stipoides, Digitaria diffusa, Arundinella nepalensis, Aristida ramosa, Aristida vagans, Cyperus gracilis, Eragrostis leptostachya* and *Eragrostis brownii*.
3766	High	This vegetation zone occurs in shallow sandstone depressions and drainage channels. The canopy is dominated by *Eucalyptus parramattensis subsp. parramattensis* and *Eucalyptus rossi*, with occasional *Eucalyptus crebra*. The most common species in the mid stratum include *Leptospermum polygalifolium, Grevillea sericea, Sannantha Cunninghamii, Allocasuarina diminuta, Calytrix tetragona, Kunzea ambigua, Melaleuca thymifolia, Xanthorrhoea sp.* and *leptospermum polygalifolium*. The patchy ground cover is comprised of grasses, sedges, graminoids and small forbs. The most common ground cover species include *Lepyrodia leptocaulis, Platysace ericoides, Arundinella nepalensis, Aristida ramosa, Dianella revoluta, Goodenia paniculata* and *Gahnia aspera*.
3781	High	This vegetation zone occurs on skeletal crests, sandstone plateaus and gentle slopes across a large portion of the Study Area. The canopy is sparse to mid-dense, with *Eucalyptus crebra, Eucalyptus fibrosa, Eucalyptus rossi* and *Callitris endlicheri* having the highest covers, and *Eucalyptus dwyeri* occurring occasionally. A low cover of *Eucalyptus parramattensis subsp. parramattensis* and *Xanthorrhoea sp.* were observed in drainage depressions. The mid stratum is sparse to mid-dense and the most common species observed include *Leucopogon muticus, Bossiaea concolor, Allocasuarina littoralis, Sannantha cunninghamii, Persoonia linearis, Grevillea sericea* and *Acacia buxifolia*. A high cover of *Acacia doratoxylon* and *Olearia ramosissima* was observed on the highest crest, and a high cover of *Acacia triptera* occurred in areas of very skeletal, rocky soils. The ground layer is comprised of hardy grasses, graminoids and small forbs, the most common species include *Platysace ericoides, Lomandra glauca, Lomandra confertifolia, Aristida ramosa, Schoenus apogon, Digitaria parviflora* and *Pomax umbellata*.
3786	High	This vegetation zone occurs on rocky scarps and sandy depressions in areas of sandy loam soil. The canopy is mid-dense and dominated by *Eucalyptus rossii*, occasionally replaced by *Eucalyptus crebra, Eucalyptus sparsifolia* and *Eucalyptus agglomerata*, with *Callitris endlicheri* throughout. The mid stratum is sparse to mid-dense. The most common species observed were *Cassinia sifton, Cassinia quinquefaria, Leucopogon muticus,*

PCT	Condition	Description
		Persoonia linearis, Grevillea sericea, Bossiaea obcordata, Acacia gladiiformis and *Acacia buxifolia*. The ground cover is sparse and dry. The most common ground cover species include *Aristida ramosa, Platysace ericoides, Lomandra glauca, Microlaena stipoides, Gahnia aspera, Lepidosperma laterale* and *Lomandra multiflora subsp. multiflora*.

Appendix 2 – Fauna recorded

Table 7: Fauna recorded in the Study Area between 5 and 14 March 2024.

Scientific name	Common name	BC Act	EPBC Act	Observation method
Birds				
Acanthiza chrysorrhoa	Yellow-rumped thornbill	-	-	Observed
Cacatua galerita	Sulphur-crested cockatoo	-	-	Observed
Calyptorhynchus lathami	Glossy black cockatoo	V	V	Observed
Cormobates leucophaea	White-throated treecreeper	-	-	Observed
Corvus coronoides	Australian raven	-	-	Observed
Dromaius novaehollandiae	Emu	-	-	Observed
Glossopsitta concinna	Musk Lorikeet	-	-	Observed
Grallina cyanoleuca	Magpie-lark	-	-	Observed
Gymnorhina tibicen	Australian magpie	-	-	Observed
Menura novaehollandiae	Superb lyrebird	-	-	Heard call
Platycercus eximius	Eastern rosella	-	-	Observed
Rhipidura leucophrys	Willy wagtail	-	-	Observed
Sericornis frontalis	White-browed scrubwren	-	-	Observed
Mammals				
Macropus giganteus	Eastern grey kangaroo	-	-	Observed
Notamacropus rufogriseus	Red-neck wallaby	-	-	Observed
Oryctolagus cuniculus	European rabbit	-	-	Observed

Scientific name	Common name	BC Act	EPBC Act	Observation method
Vombatus ursinus	Wombat	-	-	Observed
Wallabia bicolor	Swamp wallaby	-	-	Observed
Microbats (confirmed)				
Austronomus australis	White-striped Free-tailed Bat	-	-	Echolocation call analysis
Chalinolobus dwyeri	Large-eared Pied Bat	E	E	Echolocation call analysis
Chalinolobus morio	Chocolate Wattled Bat	-	-	Echolocation call analysis
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	Echolocation call analysis
Ozimops planiceps	Southern Free-tailed Bat	-	-	Echolocation call analysis
Rhinolophus megaphyllus	Eastern Horseshoe Bat	-	-	Echolocation call analysis
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	V	-	Echolocation call analysis
Scotorepens balstoni	Inland Broad-nosed Bat	-	-	Echolocation call analysis
Microbats (ambiguous) *				
Chalinolobus gouldii / Ozimops spp.	Gould's Wattled Bat / unidentified free-tailed bat	-	-	Echolocation call analysis
Myotis macropus / Nyctophilus spp.	Large-footed Myotis / unidentified long-eared bat	V	-	Echolocation call analysis
Vespadelus spp.	Unidentified forest bat	-	-	Echolocation call analysis
Reptiles				

Scientific name	Common name	BC Act	EPBC Act	Observation method
Amphibolurus muricatus	Jacky dragon	-	-	Observed
Lampropholis guichenoti	Common garden skink	-	-	Observed
Pseudechis porphyriacus	Red-Bellied black snake	-	-	Observed
Varanus varius	Lace monitor	-	-	Observed

V = vulnerable, E = endangered

*species with similar calls where exact species cannot be confidently discerned

Table 8: Microbat call analysis and record of passes between 5 and 14 March 2024.

Microbat species		Acoustic recorder and no. of passes		
		UG4_N 11	UG4_S 11	UG4_S 13
Confirmed				
Austronomus australis	White-striped Free-tailed Bat	20	17	27
Chalinolobus dwyeri	Large-eared Pied Bat	6	3	24
Chalinolobus morio	Chocolate Wattled Bat	23	12	31
Miniopterus orianae oceanensis	Large Bent-winged Bat	0	2	4
Ozimops planiceps	Southern Free-tailed Bat	180	134	288
Rhinolophus megaphyllus	Eastern Horseshoe Bat	2	3	8
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	1	0	3
Scotorepens balstoni	Inland Broad-nosed Bat	0	0	1
Ambiguous *				
Chalinolobus gouldii / Ozimops spp.	Gould's Wattled Bat / unidentified free-tailed bat	169	134	292

Microbat species		Acoustic recorder and no. of passes		
		UG4_N 11	UG4_S 11	UG4_S 13
Myotis macropus / Nyctophilus spp.	Large-footed Myotis / unidentified long-eared bat	39	7	6
Vespadelus spp.	Unidentified forest bat	108	105	258

*species with similar calls where exact species cannot be confidently discerned

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