Russell Vale Colliery – Underground Expansion Project: EPBC Act Matters of National Environmental Significance Report - Ecology

FINAL REPORT

Prepared for Umwelt (Australia) Pty Ltd

15 December 2020

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Biosis staff involved in this project were:

- Anne Murray (mapping)
- Lauren Harley (mapping)

Contents

Tables

Figures

Glossary

CBD	Central Business District
DEE	Department of Energy and Environment
DPE	NSW Department of Planning and Environment (replaced by DPIE)
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EES	NSW Environment, Energy and Science Group
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
IAPUM	Independent Advisory Panel on Underground Mining
IPC	Independent Planning Commission
IRAP	Independent risk assessment panel
LGA	Local Government Area
MNES	Matters of National Environmental Significance
MTPA	million tonnes per annum
NSW	New South Wales
PAC	Planning Assessment Commission
PCT	Plant Community Type
PER	Public Environment Report
PPR	Preferred Project Report
PWP	Preliminary Works Project
ROM	run of mine (coal)
RVE	Russel Vale east
SCA	Sydney Catchment Authority
study area	The area covered by the Proposed Action and area within which the influence of proposed mining is considered
UEP	Underground Expansion Project

Summary

The Russell Vale Colliery is an existing underground coal mine located in Russel Vale, north of Wollongong in New South Wales (NSW). The Revised Underground Expansion Project (UEP) is a proposed expansion of Wollongong Coal's mining operations to include extraction of coal from the Wongawilli Coal seam using bord and pillar mining methods, over a project life of five years (the Proposed Action).

Wollongong Coal submitted a referral for the Proposed Action to the Department of Agriculture, Water and the Environment (DAWE) in June 2020. The Proposed Action was determined to be a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for listed threatened Species and communities, and a water resource, in relation to coal seam gas development and large coal mining development.

This report has been prepared to support the assessment of the Proposed Action under the EPBC Act, and provides an impact assessment for ecological Matters of National Environmental Significant (MNES) (i.e. flora, fauna, and ecological communities listed under the EPBC Act and ecological communities potentially impacted by changes to surface and groundwater systems associated with the Proposed Action). This impact assessment is based on the bord and pillar workings mine plan and associated subsidence and groundwater predictions, and biodiversity values as previously identified within the study area.

The Proposed Action does not include any additional direct disturbance of vegetation. The only potential impacts on biodiversity values from the Proposed Action are indirect impacts associated with subsidence impacts and changes to surface and groundwater regimes.

The subsidence assessment undertaken for the Proposed Action (SCT 2019) indicates that the proposed bord and pillar mining methods that will be used for the Proposed Action are not expected to cause any perceptible surface subsidence nor cause any significant interaction with the overlying seams that might in turn become destabilised and lead to additional subsidence. The proposed bord and pillar workings are not considered to have any potential to perceptibly impact on natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir, even taking into consideration cumulative impacts from past mining.

A Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area prepared by (SCT 2020a) and advice commissioned by the NSW Independent Planning Commission (IPC) from the Independent Advisory Panel on Underground Mining (IAPUM) (IAPUM 2020) have also informed the assessment of potential subsidence impacts, particularly potential impacts on Coastal Upland Swamps. This advice states that for the majority of swamps, the incremental impact in tensile strain associated with potential subsidence is unlikely to threaten swamp integrity. However four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) that are predicted to have already experienced high levels of tensile strains from historical subsidence will need careful consideration during detailed design to restrict further vertical subsidence..

The proposed bord and pillar mining method is flexible and can adapt to different strata conditions and be revised to mitigate or avoid potential surface impacts. Through judicious mine design, it is expected the Proposed Action will also be able to meet the overall objective of negligible environmental consequences.

The Proposed Action is not expected to significantly increase interactions between the mine and surface water systems, nor impact water dependent ecosystems beyond levels currently experienced or predicted to occur as a result of existing approved and historical operations (which do not form part of the Proposed Action).

Potential cumulative impacts (which include consideration of the predicted incremental impacts or changes in timing of predicted impacts) are unlikely to have a significant impact on any water dependent ecosystems.

Based on the findings of the subsidence and groundwater assessments completed for the Proposed Action, impacts to identified biodiversity values are predicted to be negligible. As such the Proposed Action will not result in any direct or any significant indirect impacts to threatened species and communities.

Ongoing monitoring of threatened biodiversity values within the study area is recommended so in the unlikely event subsidence does occur, impacts to these species can be quantified and further impact mitigation measures can be developed. The timing and duration of monitoring should be proportionate to the timing of potential indirect impacts which may impact on the focus of the monitoring.

1 Introduction

Biosis Pty Ltd was commissioned by Umwelt (Australia) Pty Ltd to provide a MNES report for ecological values associated with the Russell Vale Colliery UEP (the Proposed Action). This report supports the assessment of the Proposed Action under the EPBC Act.

1.1 Project background and NSW Approval

The Russell Vale Colliery is located approximately 8 kilometres north of Wollongong Central Business District (CBD) in New South Wales (NSW), and is owned and operated by Wollongong Coal Ltd (Figure 1). Wollongong Coal purchased the Colliery in December 2004, but extensive underground mining has been undertaken at the mine, dating from the late nineteenth century. A substantial volume of high quality coking coal resource remains within the Colliery lease holding.

The Colliery holding comprises a number of sub-leases between Wollongong Coal and surrounding mine operators, including Consolidated Coal Lease (CCL) 745, Mining Purposes Lease (MPL) 271 and Mining Lease (ML) 1575, and covers a total area of approximately 6,973 hectares (Figure 1).

The current Proposed Action is the culmination of a protracted approvals process that commenced in 2009. The broader project covered by the NSW approvals process is referred to as the Underground Extension Project.

The original UEP application, submitted by Gujarat NRE Coking Coal Ltd, involved a substantial expansion of longwall mining in the Wongawilli Seam across the Wonga East area (a total of 11 longwall panels) and Wonga West area (a total of seven longwall panels) to extract 31 million tonnes (Mt) of run-of-mine (ROM) coal over a project life of 18 years. In response to concerns from the public and government agencies, the original UEP application was revised, and a Preferred Project was exhibited in 2014 based on a reduced longwall mine plan of eight longwalls in the Wonga East area only.

In order to address residual uncertainty regarding the impacts of longwall mining raised by the NSW Planning Assessment Commission (PAC) in their Second Review Report, a revised mine design has been developed based on a non-caving bord and pillar mining system (Figure 2). The revised mine plan has been designed to be long term stable, to address potential subsidence-related mining impacts on groundwater, surface water and biodiversity within the Cataract Reservoir catchment.

The UEP has recently been approved under the NSW *Environment Planning and Assessment Act 1979* (EP&A Act) by the IPC. As part of the NSW assessment, the NSW Department of Planning, Industry and Environment (DPIE) sought advice from the Independent Expert Scientific Committee on the revised mine plan which is now approved.

It is noted that the broader UEP project covered by the NSW development consent (MP06_0013) includes components that do not form part of the Proposed Action.

Details of the current Proposed Action are outlined in Section 2.

1.2 Scope of MNES report

This report provides an ecological impact assessment for nationally threatened species and ecological communities based on impacts arising from the Proposed Action. This report also provides an ecological impact assessment of indirect impacts associated with changes to surface water and groundwater systems

impacted by the Proposed Action. The report has been prepared with consideration of the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE 2013) (Significant Impact Guidelines).

The objectives of this report are to:

- Provide a description of the Proposed Action (Section 2) and study area (Section 2.1).
- Provide a description of the environment, including identification of any nationally threatened species and ecological communities, or sensitive habitat for such, at risk of impact from the Proposed Action (Section 4).
- Provide an assessment of potential impacts to nationally threatened species and ecological communities resulting from extraction of coal using first working mining methods (Section 5).
- Discuss proposed impact mitigation measures (Section 6).
- Provide a conclusion as to whether the Proposed Action will result in a significant impact to any nationally threatened species and communities (Section 7).

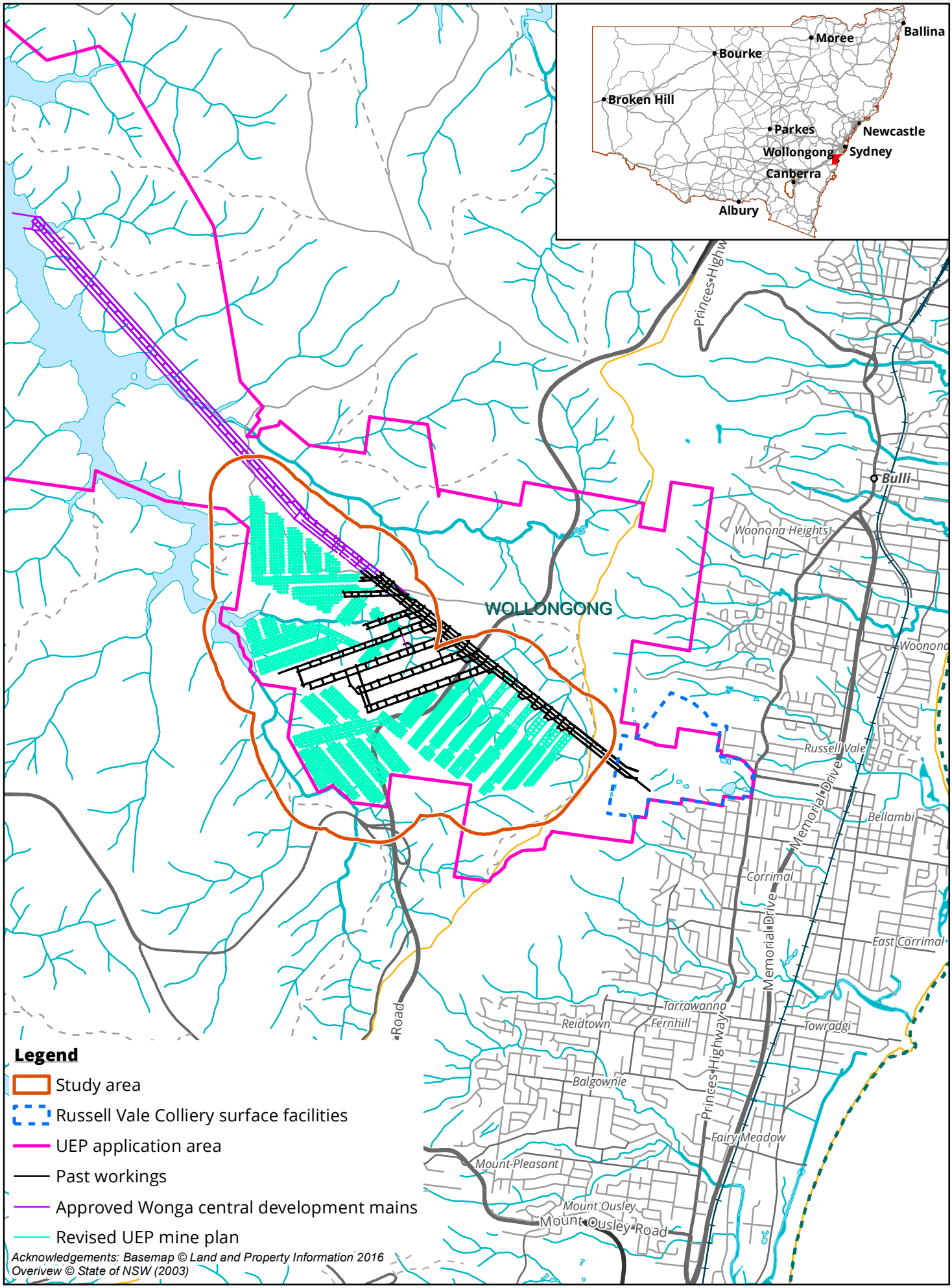

Figure 1 Location of the Russell Vale Colliery, New South Wales

Matter: 30999
Date: 10 February 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30900s\30999\Mapping\

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Metres
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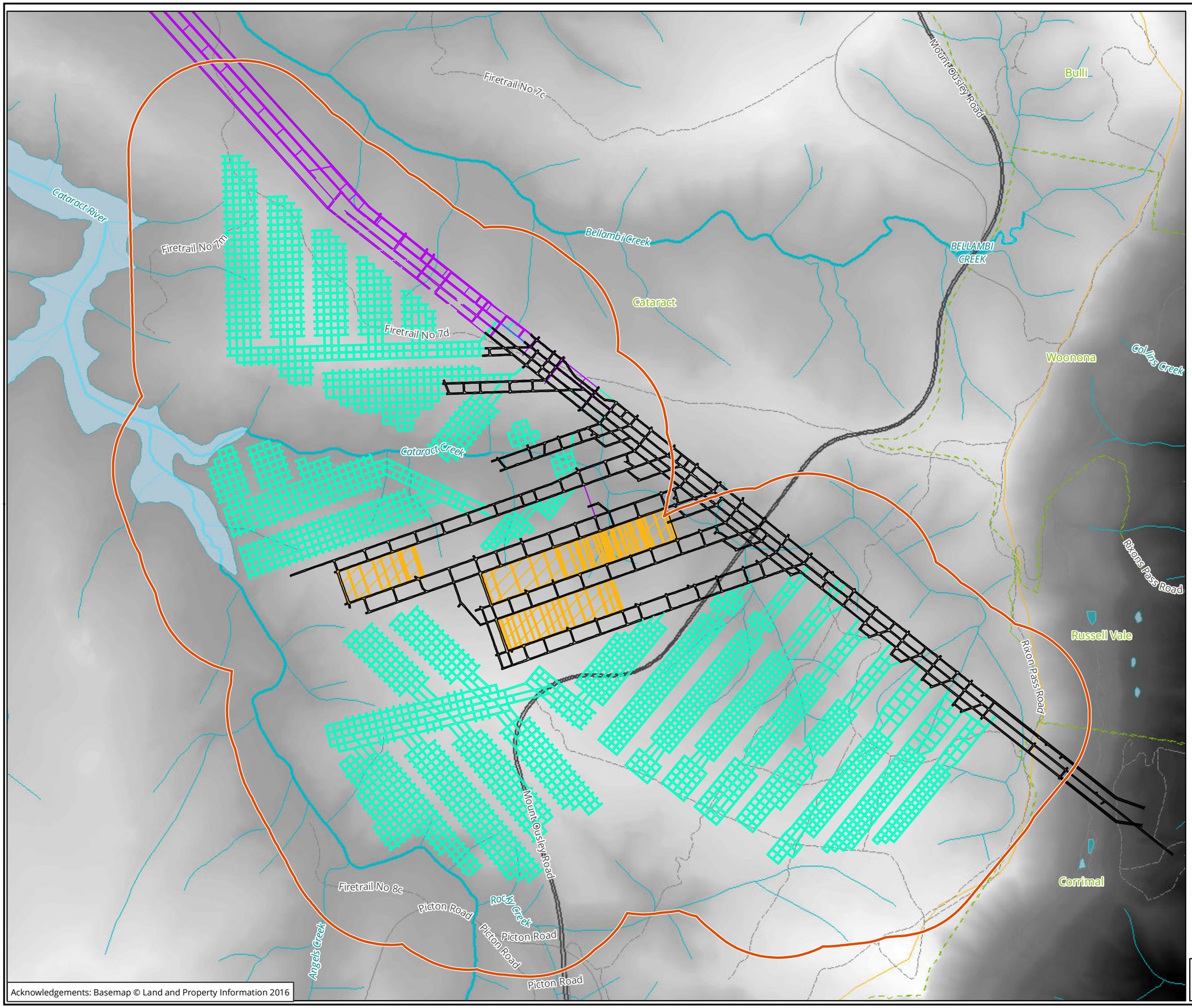
Scale 1:50,000 @ A4, GDA 1994 MGA Zone 56



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan
- RV East old longwall workings

Figure 2 Revised UEP mine plan

0 200 400 600 800

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30999
Date: 10 February 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30900s\30999\Mapping
30999_F2_MinePlan

2 The Proposed Action

2.1 Description of the Proposed Action

The key elements of the Proposed Action are:

- Mining using bord and pillar mining techniques only, with the workings designed to be long-term stable with minimal subsidence impacts (Figure 2). No longwall mining is proposed as part of the ongoing mine plan.
- Extraction of approximately 3.7 million tonnes (Mt) of ROM coal over a period of 5 years at a reduced production rate that will not exceed 1 Mt of product coal per year.
- Mining within the Wongawilli seam within the Wonga East area only, with no mining proposed within the Wonga West area or underneath the full supply level of Cataract Reservoir.

The Proposed Action consists only of the underground bord and pillar mining aspects of the UEP and excludes proposed Pit Top upgrades associate with the UEP, as well as all works, or continued operation of works, currently authorised by existing approvals.

2.2 Definition of the Proposed Action study area

The Wonga East area is located approximately 8 kilometres north-west of Wollongong NSW, within the Local Government Areas (LGAs) of Wollongong and Wollondilly. It is located beneath the Woronora plateau and the Metropolitan Special Areas, administered by WaterNSW for Sydney's drinking water supply. The Metropolitan Special Area is managed in accordance with the *Special Areas Strategic Plan of Management 2015* (WaterNSW & OEH 2015), to ensure protection of water quality and quantity, the conservation of many threatened plant and animal species, and the protection of natural and cultural values.

Substantial modifications to Wollongong Coal's original UEP have been undertaken to avoid and minimise impacts to surface features, as described in the Preferred Project UEP (and outlined in Section 1.1). These changes involved the removal of Wonga West from the application as well as the change in coal extraction methodology, from secondary extraction to bord and pillar (first workings), in Wonga East.

The study area is defined as the area located within 400 metres of the proposed bord and pillar workings and provides an area within which the influence of proposed mining is considered (Figure 2). Along with other special areas and National Parks to the northwest and south, the study area forms part of the large band of native vegetation surrounding the Sydney Metropolitan Area, providing a largely connected corridor of vegetation that supports a diverse range of vegetation communities and associated flora and fauna species.

Coal handling facilities are situated at the Russell Vale Colliery Pit Top, located at the corner of the Princes Highway and Bellambi Lane, approximately 7.2 kilometres north of Wollongong, NSW (Figure 1 and Figure 2).

3 Potential impacts of the Proposed Action

3.1 Direct impacts

No direct impacts to surface features will result from the Proposed Action. The Proposed Action will not result in the direct removal or clearing of any vegetation.

As such there will be no direct impacts to ecological MNES as a result of the Proposed Action.

3.2 Indirect impacts

The only potential impacts to ecological MNES are limited to potential indirect impacts associated with subsidence (such as surface cracking) and hydrological changes affecting surface water regimes or near-surface groundwater.

The predicted subsidence impacts associated with the Proposed Action are summarised below in Section 3.2.1 with a more detailed summary of potential subsidence impacts included in the main text of the Public Environment Report (PER). A description of the potential subsidence related indirect impacts on sensitive habitats is provided in Section 4.2.

3.2.1 Subsidence Effects, Impacts and Consequences

The IAPUM in their advice to the IPC on the UEP (IAPUM 2020) includes a concise summary of the factors to be considered in assessing the potential consequences associated with mining resulting in subsidence:

> *The report "Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield: Strategic Review" (the Southern Coalfield Report, DoP (2008)) drew a distinction between subsidence effects, subsidence impacts and subsidence consequences. The concept is now embedded in subsidence engineering in NSW, with the three subsidence factors being defined as:*
>
> - *Effect - the nature of mining-induced deformation of the ground mass. This includes all mining-induced ground movements such as vertical and horizontal displacements and their expression as ground curvatures, strains and tilts.*
> - *Impact - any physical change caused by subsidence effects to the fabric of the ground, the ground surface, or a structure. In the natural environment these impacts are, principally, tensile and shear cracking of the rock mass, localised buckling of the strata and changes in ground profile.*
> - *Consequence - any change caused by a subsidence impact to the amenity, function or risk profile of a natural or constructed feature. Some consequences may give rise to secondary consequences. For example, the redirection of surface water to the subsurface through mining-induced fractures may be a primary consequence for water inflow to a reservoir and result in secondary consequences for ecology."*

The following sections summarise the predicted subsidence effects, impacts and consequences associated with the Proposed Action and its interaction with past mining activities in the area.

Subsidence impacts

Subsidence effects have the *potential* to impact on biodiversity values through the following impacts:

- Tensile cracking has potential to cause cracking of strata below upland swamps or rock bars associated with swamps which results in changes to the integrity of the swamp.

- Incremental strain on existing cracks causing them to become wider and deeper.
- Cracks in stream beds resulting in loss of surface flows
- Modification of sensitive sandstone and rocky environments including cliff failures and/or surface rock cracking due to changes in underlying bed rock.

Subsidence Consequences

The effects of subsidence can have the following ecological consequences:

- Reduction in swamp capacity to retain water table and soil moisture content.
- Changes in floristic species composition from characteristic swamp species to dry heath or woodland flora species.
- Redirection or loss of surface water leading to a loss of surface pools in creeks removing aquatic habitat.
- Damage to sensitive rocky environments, including loss of habitat for threatened Microbat species and Broad-headed Snake habitat. Also potential for damage to ecosystems located below cliff falls.

3.2.2 Predicted subsidence effects from bord and pillar workings in the Wongawilli seam

The subsidence assessment of the proposed extraction undertaken by SCT (2019) found that irrespective of the strength, load and behaviour of the proposed pillars being utilised in the proposed bord and pillar workings, some low-level deformation is expected within the Wongawilli seam, with elastic compression of the strata above and below the pillars. This strata compression has the potential to result in low-level subsidence movements (less than 100 mm and generally less than 30 mm), as well as some corresponding low levels of tilt and strain. Any such subsidence is likely to occur gradually and movement is expected to be generally imperceptible and insignificant for all practical purposes.

The assessment concluded that "*the small subsidence movements that are forecast for the proposed mining layout are not expected to cause perceptible impacts to any natural surface features including upland swamps, cliffs, steep slopes, drainage lines, creeks, Cataract Creek and Cataract Reservoir*" (SCT 2019). The proposed mining is not expected to have an impact on surface water dependent ecosystems or groundwater.

A peer review of the Russel Vale Colliery subsidence assessment (SCT 2019) undertaken by BK Hebblewhite Consulting supported the claim that the proposed mining is not expected to result in any significant subsidence impacts on surface or sub-surface water regimes, and that proposed pillars are large enough to be long-term stable. The review also supported the claim that the proposed workings are not considered to have any potential to perceptibly impact on any surface features such as escarpments, swamps, cliffs, creeks and drainage lines, or the Cataract Reservoir (B K Hebblewhite Consulting 2019).

The Proposed Action mine plan has been designed to be long term stable. Should an unexpected pillar failure occur, the SCT Subsidence Assessment estimated the potential vertical subsidence associated with a pillar failure in the Wongawilli Seam as being up to 140 millimetres. A risk analysis undertaken by (SCT 2020a) quantifies the risk of such a pillar failure occurring as less than 1 in 100,000 (0.001 % over the life of the project and therefore less than 0.01 % per year). The likelihood of initiating event occurring is considered to be remote. Accordingly, the risk of pillar failure in the Wongawilli Seam is not considered further as a potential causal pathway in this assessment.

Predicted Cumulative Subsidence Effects

The study area has previously been mined, including extraction of the overlying Balgownie Seam and Bulli Seam as well as the extraction of Longwall panels 4, 5 and 6 in the Wongawilli Seam. Subsidence associated

with secondary extraction in these workings has already caused vertical subsidence over much of the proposed bord and pillar mining area.

It is noted by SCT (2019 and 2020a) that there is the potential for further subsidence to occur from historical mining, including ongoing low level ground movements from mining in the Wongawilli Seam, the collapse of any marginally stable pillars in the Bulli Seam or the collapse of any remaining standing pillars within Bulli Seam goaf areas. These risks are discussed further in the SCT Subsidence Assessment (2019) and SCT Subsidence Risk Analysis (2020a). Importantly, it is confirmed by SCT and the peer review process that this risk exists regardless of the whether the Proposed Action proceeds and the Proposed Action does not materially change this existing risk or the environmental consequences associated with this occurring.

The detailed technical assessments prepared for the Proposed Action have considered the potential cumulative impact of the Proposed Action with historical mining operations within and surrounding the study area.

Table A.1 in Appendix 1 provides a summary of predicted existing vertical subsidence and tensile strains associated with extraction of the Bulli and Balgownie Seams for Coastal Upland Swamps located over the proposed bord and pillar workings. These subsidence and strain predictions are based on a range of studies undertaken by SCT over the past decade. Recent work undertaken by SCT indicates that predicted tilts and strains in multi seams environments are likely to be less than that stated in Table A.1. The Proposed Action's incremental vertical subsidence impact is conservatively assumed to be 100 millimetres with an assumed incremental tensile strain of 0.5 millimetres/metre for the purposes of this assessment.[1]

The predictions in Table A.1 assume that all Bulli Seam Goaf areas have fully collapsed however features above any remnant standing pillars in goaf areas may yet to experience the modelled levels of subsidence and the consequences associated with the almost certain subsidence that would occur when these standing pillars eventually fail. As noted above, the failure of these pillars and associated impacts is not caused by the Proposed Action in that both the failure of the pillars and the resulting consequences are inevitable irrespective of whether or not the Proposed Action proceeds. However, the subsidence from such a failure may occur during the life of the Proposed Action and the causal factors in any observed subsidence associated with such a failure needs to be taken into consideration in monitoring.

[1] For the purposes of this assessment, a linear relationship of incremental tensile strains of 0.5 mm/m for every 100 mm of vertical subsidence has been assumed based on the approach taken in the IAPUM Advice (see also SCT 2020). However, as noted in the SCT Response to the IAPUM Advice (SCT 2020b), this is likely to be conservative in the context of the Wonga East area.

3.3 Proposed measures to avoid or reduce impacts on ecological MNES

The proposed measures to avoid and reduce potential impacts on ecological MNES from the Proposed Action inlude:

- Selected mining methodology (revision from longwall to bord and pillar mining methods) and a pillar design that is long term stable.
- Flexibility in bord and pillar mining method allows for rapid response to changes in loading and other circumstances, providing a more responsive adaptive management system to protect environmental values.
- Monitoring and implementation of remediation measures if observed impacts are greater than predicted.

4 Description of the environment

4.1 Literature and database review

In order to provide a context for the study area, information about flora and fauna from within 10 kilometres (the locality) was obtained from relevant public databases. Records from the following databases were collated and reviewed:

- Department of Agriculture, Water, and Environment (DAWE) Protected Matters Search Tool for matters protected by the EPBC Act.
- NSW BioNet - *the database for the Atlas of NSW Wildlife*, EES
- PlantNET (RBGDT 2020).
- The NSW Department of Primary Industries (DPI) Spatial Data Portal for *Fisheries Management Act 1994* (FM Act) listed threatened species, populations and communities.
- BirdLife Australia, the New Atlas of Australian Birds 1998-2013 (BA).

Previous ecological assessments of the Wonga East areas provide a comprehensive inventory of the terrestrial and aquatic biodiversity values of the study area. These include reports produced by ERM (ERM 2013a), Cardno Ecology Lab (2009, 2010, 2012a, 2012b, 2009), and Biosis (2012, 2012, 2013, 2019a, 2019b). This section provides a summary of these assessments.

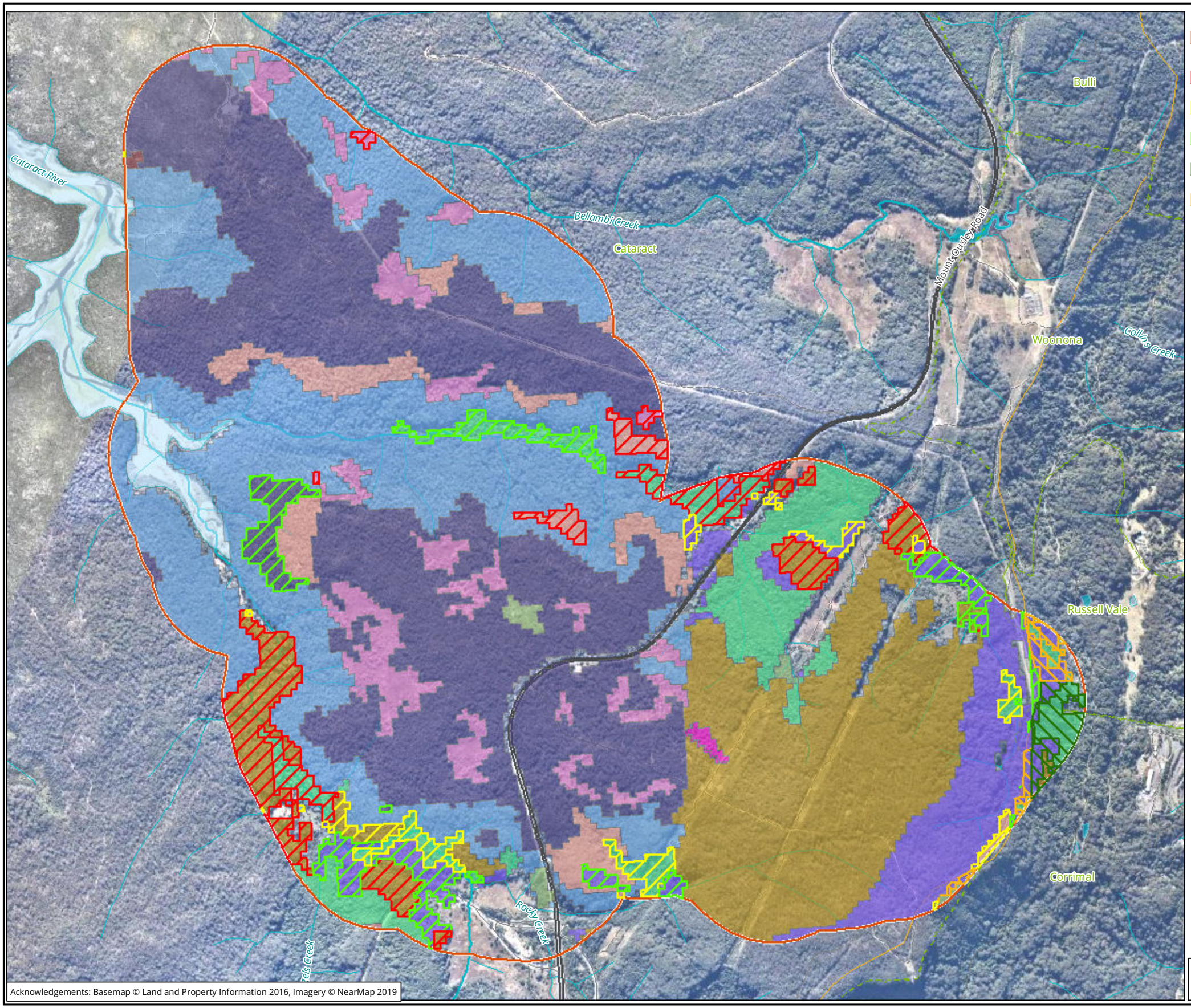
4.1.1 Vegetation communities within the study area

The plant community types (PCT's) within the study area, with the exception of Coastal upland swamps, were mapped using desktop mapping (DPIE 2010). The study area supports 905 hectares of native vegetation, across 10 PCT's. Assessment of the potential for the study area to support groundwater dependent ecosystems (GDEs) was undertaken using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2018), the download of metadata from State of NSW, and the NSW Office of Water Risk Assessment guidelines for groundwater dependent ecosystems (OEH 2012). No areas reliant on the surface expression of groundwater are mapped within the study area according to the GDE Atlas or metadata (DPIE 2016). Ten PCTs, two groundwater dependent wetland community and eight vegetation communities (all identified as 'moderate to high Probability GDEs' in the risk assessment guidelines, and potentially reliant on subsurface expression of groundwater) are mapped within the study area (Table 1 and Figure 3).

Table 1 PCT's and potential GDE's within the study area

Vegetation formation	PCT name	EPBC Act Listing	GDE Potential	Area (ha)
Coastal Rock Plate Heath	PCT 881 Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion	Not listed	Moderate potential GDE	0.48
Coastal Sandstone Gully Forest	PCT 1250 Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin	Not listed	High potential GDE	236.39

Vegetation formation	PCT name	EPBC Act Listing	GDE Potential	Area (ha)
Coastal Sandstone Plateau Heath	PCT 882 Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	Not listed	Moderate potential GDE	3.95
Coastal Sandstone Ridgetop Woodland	PCT 1083 Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin	Not listed	Moderate potential GDE	280.24
Coastal Upland Swamp	PCT 978 Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion EEC	High potential GDE	47.42
Coastal Warm Temperate Rainforest	PCT 905 Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion	Not listed	High potential GDE	63.44
Escarpment Foothills Wet Forest	PCT 878 Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion	Not listed	Moderate potential GDE	37.51
Illawarra Gully Wet Forest	PCT 694 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin	Not listed	High potential GDE	165.69
Tableland Swamp Meadow	PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion EEC	High potential GDE	1.32
Warm Temperate Layered Forest	PCT 1245 Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin	Not listed	High potential GDE	68.78
Total				**905.22**



Acknowledgements: Basemap © Land and Property Information 2016, Imagery © NearMap 2019

Legend

Study area

Groundwater dependent ecosystems

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment
- Low potential GDE - from regional studies
- Moderate potential GDE - from regional studies

Plant community type

- 1083 - Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin
- 1245 - Sydney Blue GumXBangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin
- 1250 - Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin (EEC, BC Act)
- 1256 - Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion (EEC, BC Act and EPBC Act)
- 694 - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin
- 878 - Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion
- 881 - Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion
- 882 - Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion
- 905 - Lilly Pilly - Coachwood warm temperate rainforest on moist sheltered slopes and gullies, Sydney Basin Bioregion and South East Corner Bioregion
- 978 - Needlebush - banksia wet heath on sandstone plateaux of the Sydney Basin Bioregion (EEC, BC Act)

Figure 3 Groundwater dependent ecosystems

0 250 500 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

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Matter: 34330
Date: 01 December 2020,
Checked by: RED, Drawn by: LH, Last edited by: lharley
Location:P:\34300s\34330\Mapping
34330_F6_TerrestrialGDE

4.1.2 Candidate species requiring assessment

The desktop assessment confirmed that one threatened ecological community (TEC), *Coastal upland swamps in the Sydney Basin Bioregion* (Endangered, EPBC Act), was previously mapped within the study area as part of the *Southeast NSW Native Vegetation Classification and Mapping project SCIVI VIS ID 2230* (DPIE 2010). Historical records also exist within the locality for 21 threatened flora and fauna species listed under the EPBC Act. These records are outlined in Appendix 2 (flora) and Appendix 3 (fauna) along with those species and communities identified by the Protected Matters Search Tool, that are considered likely to occur in the study area due to the presence of potential habitat.

Not all of the threatened species and communities that have the potential to occur within the study area are considered to be susceptible to subsidence related impacts. As there are no direct impacts associated with the Proposed Action (i.e. no threatened species habitat will be directly removed), this impact assessment focuses on the species and communities, and their habitats, which have potential to occur in the study area and are considered susceptible to indirect impacts resulting from subsidence. As a result some species have been excluded from requiring further assessment, being species reliant on terrestrial environments that are at negligible risk of impact.

The *Russell Vale Colliery – Underground Expansion Project: Preferred Project Report - Biodiversity* (Biosis 2014a) report identified one ecological community, one flora species and nine fauna species (five terrestrial and four aquatic) listed under the EPBC Act that have the potential to occur or are known to occur in the study area, and are considered susceptible to subsidence impacts. An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2014, and the risk of impact from Proposed Action is provided in Table 2. Further impact assessment details are provided in Section 5.

The likelihood of occurrence for some species in this list has changed since Biosis (2014a) and Hansen Bailey (2015). These changes include:

- The likelihood of occurrence for the Large-eared Pied Bat has been downgraded to a low likelihood of occurrence. Although targeted surveys detected a single possible record, the study area does not support suitable roosting habitat.
- The Broad-headed Snake is now considered a low likelihood of occurrence. Suitable rocky habitat is highly limited in the study area and additional monitoring has not detected the species, or even suitable prey species.
- Littlejohn's Tree Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Suitable habitat is limited in the study area and targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.
- Stuttering Frog is now considered a negligible likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Targeted surveys undertaken between August 2013 and February 2016 have not detected the species in the study area.

Table 2 Threatened species and communities likely to occur in the study area and previously assessed as susceptible to indirect subsidence impacts.

Scientific name	Common name	EPBC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the study area	Risk of impact from Proposed Action
Threatened ecological community					
-	*Coastal upland swamps in the Sydney Basin Bioregion*	E	Coastal upland swamps	Recorded	Negligible
Flora					
Pultenaea aristata	Prickly Bush-pea	V	Coastal upland swamps	Recorded	Negligible
Terrestrial fauna					
Chalinolobus dwyeri	Large-eared Pied Bat	V	Rocky environments	Low	Negligible
Hoplocephalus bungaroides	Broad-headed Snake	V	Rocky environments	Low	Negligible
Heleioporus australiacus	Giant Burrowing Frog	V	Coastal upland swamps / aquatic environments	Recorded	Negligible
Litoria littlejohni	Littlejohn's Tree Frog	V	Coastal upland swamps / Aquatic environments	Low	Negligible
Mixophyes balbus	Stuttering Frog	V	Aquatic environments	Negligible	Negligible
Aquatic fauna					
Bidyanus bidyanus	Silver Perch	CR	Aquatic environments	Recorded	Negligible
Maccullochella macquariensis	Trout Cod	E	Aquatic environments	Recorded	Negligible
Macquaria australasica	Macquarie Perch	E	Aquatic environments	Recorded	Negligible
Maccullochella peelii	Murray Cod	V	Aquatic environments	Recorded	Negligible

4.2 Sensitive habitats

The study area is located on the Woronora plateau in the Sydney Basin bioregion. The Woronora plateau supports a diverse range of vegetation communities and associated flora and fauna species, with disturbance, including weeds, limited to fire trails and infrastructure associated with water storage, electricity easements, transport and mining activities.

Areas of sensitive habitat in the study area include (Biosis 2014a):

- Rocky environments.
- Coastal upland swamps (listed as an endangered ecological community).
- Ground Water dependent terrestrial vegetation communities.
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

Non-ground water dependent terrestrial vegetation communities will not be impacted by the Proposed Action and no further assessment is required.

As discussed in Section 3 the Proposed Action does not include any direct impacts to nationally threatened species or ecological communities as the Proposed Action will not result in the direct removal of any vegetation or habitat. The main potential impact mechanism associated with the Proposed Action is subsidence from mining. Subsidence can result in indirect impacts to biodiversity through associated impacts to geology, including shear cracking of the rock mass, buckling of strata from valley closure and upsidence (DoP 2008).

The potential environmental consequences of these subsidence impacts (DECC 2007, DoP 2008, PAC 2009, PAC 2010), include:

- Impacts to upland swamps, including:
  - Alteration of hydrological regimes through fracturing of bedrock beneath upland swamps or shearing.
  - Changes in concentration of water due to changes in water distribution resulting from changes in tilts.
  - Increased scour and erosion potential due to changes in water distribution due to changes in tilts.
- Impact to aquatic environments, including:
  - Loss of surface flow to the subsurface.
  - Loss of aquatic or in-stream habitats, standing pools or changes in water level.
  - Loss of longitudinal connectivity between pools along streams.
  - Adverse impacts to water quality.
  - Simplification of remaining in-stream habitat due to the growth or iron-oxidising bacteria.
  - Release of gas (methane) into the water column.
- Impacts to rocky environments, including:
  - Cliff falls and rock falls impacting on vegetation or fauna habitat.
  - Fracturing of rocky outcrops impacting on vegetation or fauna habitat.

The location and extent of sensitive habitats within the study area are shown in Figure 4. The extent of each sensitive habitat type within the study area are detailed in the sections below.

4.2.1 Coastal upland swamps

Detailed mapping and characterisation of *Coastal Upland Swamps in the Sydney Basin Bioregion* TEC (listed as Endangered under the EPBC Act) was undertaken by Biosis (2012) throughout the study area. A total of 39 upland headwater swamps (approximately 49 hectares in total) were recorded in the study area. All 39 swamps are considered to meet the requirements for listing under the EPBC Act. The extent of this TEC in relation to the Proposed Action is illustrated in Figure 4.

The upland swamps in the study area are markedly different to other upland swamps on the Woronora plateau in that they are predominantly drier, generally smaller with shallower soils, have less humic material, have more interspersed sandstone outcrops within their outlines, and are less spatially continuous than a "typical" humic, saturated swamp (Biosis 2014b). Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of upland swamps, historic impacts of mining on upland swamps, including impacts to hydrogeological features.

Upland swamps in the study area also provide potential habitat for a number of threatened species listed under the EPBC Act that are susceptible to subsidence, including:

- Prickly Bush-pea
- Giant Burrowing Frog
- Littlejohn's Tree Frog

These species are considered further in Section 5.

4.2.2 Aquatic environments

The proposed Wonga East bord and pillar workings are located within the catchment of three major streams and their tributaries; Cataract River, Cataract Creek and Bellambi Creek.

Cataract River is located to the south of the Wonga East area. Within the study area, Cataract River is a fourth order stream connecting to the south arm of Cataract Reservoir. In the study area Cataract River is bordered by Coachwood Warm Temperate Rainforest vegetation (NPWS 2003). The Proposed Action does not proposed any bord and pillar workings under Cataract River. However, bord and pillar workings will be undertaken beneath some tributaries and the catchment of Cataract River.

Bellambi Creek, a third order stream, is located to the north of the Wonga East area. Vegetation surrounding Bellambi Creek consists of Coachwood Warm Temperate Rainforest (NPWS 2003), Bellambi Creek will not be mined under, however fist workings will be undertaken beneath some tributaries and the catchment of Bellambi Creek.

Cataract Creek is located within the Wonga East area, with bord and pillar workings located external to the south of the main channel on the eastern side. Within the study area Cataract Creek is a third order stream down to Mount Ousley Road, and a fourth order stream downstream of Mount Ousley Road.

The study area also supports a number of first, second and third order tributaries of Cataract Creek. Cataract Creek is bordered by upland swamps, dry sclerophyll forest, wet sclerophyll forest in the upper reaches and wet sclerophyll forest and rainforest vegetation in the lower reaches. In the lower reaches the canopy along Cataract Creek is closed and the creek is shaded, whilst in the upper reaches it is open. The channel morphology of the creek is characterised by sandstone benches and ephemeral pools in the upper reaches and an alternating series of long pools and shorter bars and riffles in the lower reaches. Bars and riffles are composed of various combinations of bedrock, boulders, cobble, pebble and gravel. Large woody debris is

relatively common, forming dams and submerged snags in pools. There is natural variation in water levels both within and between seasons (Cardno Ecology Lab 2012a, Cardno Ecology Lab 2012c, Cardno Ecology Lab 2012b).

Bord and pillar workings will occur beneath parts of Cataract Creek and beneath tributaries and parts of the broader catchment area of Cataract Creek.

Streams in the study area provide potential habitat for a number of threatened species listed under the EPBC Act, including:

- Littlejohn's Tree Frog (tributaries only)
- Giant Burrowing Frog (tributaries only)
- Stuttering Frog (downstream of Mount Ousley Road)
- Silver Perch (lower reaches adjacent to Lake Cataract)
- Trout Cod (lower reaches adjacent to Lake Cataract)
- Macquarie Perch and Murray Cod (lower reaches adjacent to Lake Cataract)

These species are considered further in Section 5.

4.2.3 Rocky environments

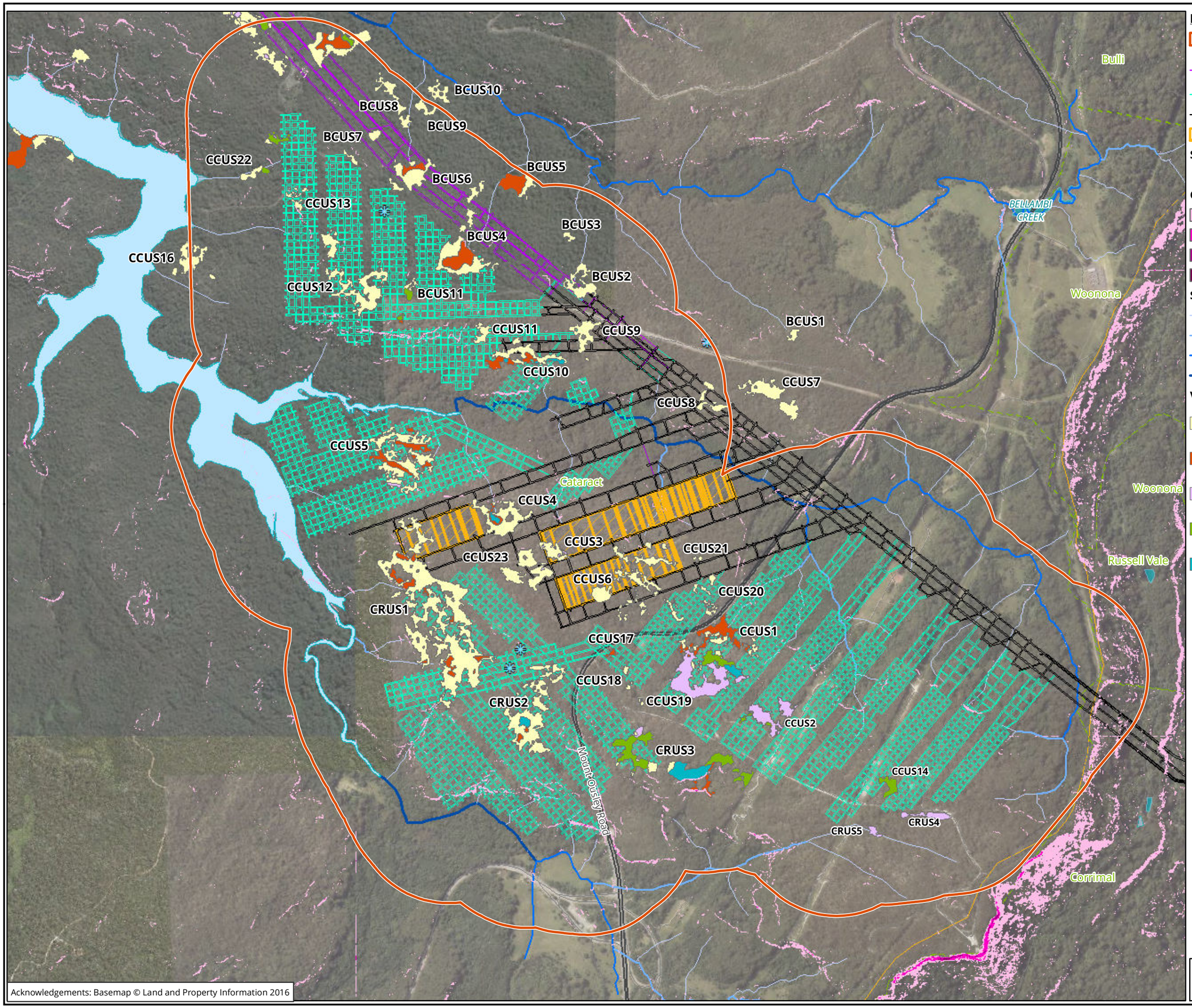
Rocky environments in the study area include cliffs and rocky outcrops. An inspection of cliff formations and steep slopes within Wonga East was undertaken by SCT Operations (2012). In Wonga East, cliff formations along Cataract Creek are typically less than a few metres high, but do extend up to five to 10 metres high in some sections. An assessment of the cliff formations by Biosis did not identify any significant overhangs or caves. Potential roosting habitat for microchiropteran bats is limited in extent and restricted to an area adjacent north of Cataract Creek.

The study area does not contain extensive north-western and western facing sandstone benches that could be considered critical wintering habitat for the threatened Broad-headed Snake (EcoLogical 2009). Whilst there is sandstone benches and overhangs present within the study area, the exfoliating slabs that provide isolated patches of habitat for Broad-headed Snake are largely absent due to the historic removal of bush rock.

Rocky outcrops and cliff lines in the study area provide potential habitat for a number of threatened species listed under the EPBC Act, including:

- Large-eared Pied Bat
- Broad-headed Snake

These species are considered further in Section 5.



Acknowledgements: Basemap © Land and Property Information 2016

Legend

- Study area
- Approved Wonga central development mains
- Revised UEP mine plan
- Past workings
- RV East old longwall workings

Sensitive Habitat

- Rock Outcrop

Cliffs (m)

- 2 - 5
- 5 - 10
- 10 - 15
- 10 - 19

Stream Order

- 1st Order
- 2nd Order
- 3rd Order
- 4th Order

Vegetation Sub-Communities

- MU42, Upland Swamps: Banksia Thicket
- MU43, Upland Swamps: Tea-Tree Thicket
- MU44a, Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b, Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)
- MU44c, Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Figure 4 Sensitive habitat within the study area

0 250 500 750

Metres
Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30999
Date: 10 February 2020,
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4.3 Field survey summary

This section provides a summary of the results of field surveys undertaken within the study area. Survey results are focused on those candidate species and communities listed under the EPBC Act, as identified in Table 2, which are considered likely to occur within the Wonga East area and for which the suitable habitat for these species is deemed susceptible to impacts from subsidence. The methodologies employed during field surveys are provided in Appendix 4 and field survey locations and effort are shown in Figure 5 (flora) and Figure 6 (fauna).

4.3.1 Coastal upland swamps

The mapping of coastal upland swamps completed by (Biosis 2012) is presented in Figure 4, with the extent of this community within the Wonga East area also discussed in Section 4.2. This assessment identified 39 upland headwater swamps within the Wonga-east area, with a total area of 49 hectares. No valley fill swamps were identified as being present.

The majority of upland swamps in the study area (i.e. 34 of 39) support Banksia Thicket (MU42), with 20 upland swamps supporting only this vegetation sub-community. Ten upland swamps support Tea-tree Thicket (MU43). Six upland swamps support a complete range of upland swamp vegetation sub-communities (MU42 Banksia Thicket, MU43 Tea-tree Thicket, MU44 Sedgeland–Heath Complex).

Coastal upland swamp monitoring

Reports detailing the results of the upland swamp floristic monitoring have been provided to Wollongong Coal since the ecological monitoring program commenced in 2011. To date the assessment against upland swamp vegetation monitoring TARPs (WCL 2012, WCL 2015b) in each report have identified that conditions have been consistent with the 'within prediction' TARP levels, consistent with 'Negligible change to the composition or distribution of species within swamps' (WCL 2015b). No 'exceeding prediction' TARP levels for upland swamp vegetation monitoring have been triggered. Monitoring of coastal upland swamps has been is undertaken within Russell Vale East since 2011. The existing monitoring undertaken sets an important baseline against which to compare monitoring observations undertaken during the life of the UEP.

The findings of the most recent (2019) iteration of the terrestrial ecological monitoring program (Biosis 2020) were made in the context of extended drought conditions across the region that have continued and intensified since 2017. The 2019 report includes statistical analysis of swamp vegetation across the whole monitoring dataset collected since 2011 and has been collected as to inform pre-UEP baseline conditions, with the findings summarised below.

The 2019 monitoring report found that impact monitoring swamps CCUS1, CCUS5 and CRUS1 were consistent with the within prediction (level 1) TARP level, on the basis of no statistically significant change in TSR or species composition being attributable to longwall mining and no observations of swamp vegetation dieback being recorded. During 2019, two areas of vegetation dieback were observed in swamps CCUS3 and CCUS4. The observed dieback was determined to be consistent with the 'within prediction' (level 2) TARP level for upland swamp vegetation monitoring.. Similar areas of dieback were observed at control swamps BCUS12 and BCUS13, however the areas of dieback at the impact monitoring sites were identified to be more acute than that at the control sites, indicating that swamps CCUS3 and CCUS4 may have a reduced level of resilience to environmental stressors such as drought (with no mining occurring since 2015). While no statistically significant change in TSR or species composition was detected at these sites, at CCUS3 transects that had been mined beneath appeared to show lower TSR values than transects that had not been mined beneath. Also at CCUS4, the test for yearly trends in species composition at swamp CCUS4 was approaching the adopted significance level in 2019. Indicating that while not meeting the significance level of the statistical analyses, these swamps may be to a degree reflecting differing responses to the environmental conditions

than other swamps. Preliminary field observation findings made during the 2020 iteration of the monitoring program indicate a degree of dieback recovery following a relative increase in rainfall during 2020. It is important to consider these observational findings as no pre-mining data exists with which to compare the current data to on the basis of pre and post mining comparisons at swamps CCUS and CCUS4. The within prediction (level 2) TARP level for upland swamp vegetation monitoring identified at swamp CCUS4 in 2020 is consistent with 'negligible change to the composition or distribution of species within swamps' performance criteria detailed in the Upland Swamp Management Plan (Wollongong Coal 2015). It should be noted that neither swamp CCUS3 or CCUS4 will be undermined by the UEP.

Upland swamp ecological monitoring will continue in 2020 and include assessment against the relevant TARPs. The full floristic monitoring data set is provided as Appendix 5.

4.3.2 Prickly Bush-pea

Prickly Bush-pea has been recorded broadly throughout the study area during targeted surveys, follow up assessments, and during ecological monitoring. During targeted surveys this species was recorded at upland swamps CRUS1, CCUS3, CCUS10, CCUS8 and BCUS7 (ERM 2013a). The species is known to be widely distributed throughout the study area and locality, and occurs in a variety of vegetation communities, particularly drier margins of upland swamps and surrounding sandstone woodland.

The species has not been recorded from wet environments subject to permanent or even intermittent water logging. Rather, it has been recorded from environments where surface water run-off is impeded by low gradient slopes. Soils are generally shallow and consist of mineral sands. The critical habitat component appears to be areas were low gradients result in the impediment of drainage.

Throughout the upland swamp floristic monitoring program (2012 – 2019), this species has not been recorded at any of the impact monitoring transects. The species has only been recorded at one of the control sites, BCUS12, at monitoring transect two. The number of records for this for this species recorded during the monitoring program is provided in Table 3. The full floristic monitoring data set is provided in Appendix 5.

Table 3 Prickly Bush-pea record summary from transect BCUS12-V2

Survey date	Round	Number of individuals
5/07/2012	**Round 2 (Autumn)**	2
7/11/2012	**Round 1 (Spring)**	3
15/05/2013	**Round 2 (Autumn)**	4
22/05/2014	**Round 2 (Autumn)**	2

4.3.3 Threatened frogs

Surveys undertaken by Biosis (2009), EcoLogical (2009) and ERM (2013a) did not record Littlejohn's Tree Frog, Giant Burrowing Frog or Stuttering Frog in the study area during initial surveys.

Habitat assessment undertaken by Biosis (2013) identified suitable breeding habitat for these species along Cataract Creek (Stuttering Frog) and tributaries of Cataract Creek and Cataract River (Littlejohn's Tree Frog and Giant Burrowing Frog) (see Figure 6).

The Giant Burrowing Frog has only been recorded from monitoring transect CRUS2 during targeted surveys as part of the ecological monitoring program, and has been reported on in Biosis (2013, 2017) Adults, metamorphs and tadpoles of this species has been recorded over ten surveys between 2012 and 2016, across winter, autumn and summer seasons. The species has been recorded from a total of ten pools along the 245 metre transect. The Giant Burrowing Frog records from the CRUS2 transect are summarised in Table 4, with the raw records provided in Appendix 5.

Table 4 Giant Burrowing Frog records summary from CRUS2 transect

Survey date	Round	Adult	Metamorph	Tadpoles
28/08/2012	**Winter**	0	0	17
30/08/2012	**Winter**	0	0	11
17/04/2013	**Autumn**	0	0	130
27/05/2013	**Autumn**	0	0	50
27/08/2013	**Winter**	0	0	100
29/08/2013	**Winter**	0	0	127
20/12/2013	**Summer**	0	0	1
13/01/2014	**Summer**	0	9	8
21/01/2014	**Summer**	1	3	6
19/03/2014	**Autumn**	1	1	22
15/04/2014	**Autumn**	0	1	82
24/07/2014	**Winter**	0	0	49
29/07/2014	**Winter**	0	0	55
17/12/2014	**Summer**	0	18	23
13/01/2015	**Summer**	0	13	5
9/04/2015	**Autumn**	0	0	71
21/05/2015	**Autumn**	0	0	46
19/08/2015	**Winter**	0	0	59
9/09/2015	**Winter**	0	0	60
21/12/2015	**Summer**	3	2	29
18/02/2016	**Summer**	0	3	59

No other threatened frog species listed under the EPBC Act have been recorded elsewhere within the study area.

Habitat for the Giant Burrowing Frog and Littlejohn's Tree Frog within the study area consists of small sections of upper tributaries. Detailed surveys undertaken have indicated that other than the tributary of Cataract River below CRUS2, other tributaries are unlikely to support these species, particularly given the survey effort undertaken. The Stuttering Frog is not known from localities with disturbed riparian vegetation or significant human impacts upstream, which may indicate that the species is highly sensitive to perturbations in the environment (Mahony, Knowles, & Pattinson 1997). Identified habitat in Cataract Creek shows was found to exhibit levels of pollution due to run-off from Mount Ousley Road, as well as high levels of iron flocculent from past mining. Although the habitat is suitable, these impacts result in sub-optimal conditions for the species.

4.3.4 Broad-headed Snake

Habitat assessments undertaken by Biosis (2009), EcoLogical (2009) and ERM (2013a) concluded that habitat for the Broad-headed Snake within the Wonga East area is limited. Although a few areas of potential habitat were identified, these areas were generally void of exfoliating sandstone that provide habitat for the species due to historic removal of bedrock. Those areas of habitat identified were monitored across two years (Biosis 2013), however surveys ceased in 2012 due to a lack of detection of the species (or prey species) and a lack of predicted impacts to these areas.

In general, the Wonga East area lacks extensive areas of north to northwest facing sandstone benching with exfoliating sandstone that provide important habitat for this species. Targeted surveys and habitat

assessments did not record the species in the study area. We conclude that although the Broad-headed Snake may occur in the study area, the study area does not support important habitat for this species.

4.3.5 Large-eared Pied Bat

Targeted Microchiropteran bat surveys undertaken during the initial assessment (ERM 2013b) did not record the Large-eared Pied Bat within the study area. The Large-eared Pied Bat was also not recorded during harp trapping by Biosis in 2015 (Biosis 2017).

Habitat assessment undertaken by Biosis identified that cliffs providing suitable roosting habitat for Large-eared Pied Bat are limited in extent within the study area, with suitable cliffs restricted to an area in the northern section of the study area, just north of Cataract Creek (Figure 7). No evidence of occupation of cliffs by Large-eared Pied Bat was observed during the habitat assessment.

4.3.6 Threatened fish

Targeted surveys by Cardno Ecology Lab (2009, 2010, 2012c, 2012b, 2012a) and Biosis (2013, 2014a, 2017, 2019a, 2019b) for threatened fish undertaken in the Wonga East area have confirmed the presence of Macquarie Perch and Silver Perch, and an unidentified freshwater cod, which was assumed to be either Murray Cod or Trout Cod, within the lower reaches of Cataract Creek (Cardno Ecology Lab 2010, 2012c).

The numbers of Macquarie Perch, Silver Perch and Murray Cod/Trout Cod recorded between 2009 and 2012 by Cardno Ecology Lab are presented in Table 5. Fish were captured in Cataract Creek between the confluence of Cataract Creek and the Cataract River, up to 120 metres upstream of the full supply level of Lake Cataract (Figure 7). Targeted surveys further upstream have not recorded Macquarie Perch or Silver Perch in these more upstream reaches.

Table 5 Numbers of threatened fish captured in Cataract Creek (2009 to 2012)

Species	2009/2010	2010/2011	2011/2012
Macquarie Perch	30	90	18
Murray Cod/Trout Cod	65	53	6
Silver Perch	9	9	0

Targeted surveys completed by Biosis as part of annual monitoring for threatened fish have also recorded the EPBC listed Macquarie Perch, Murray Cod and Silver Perch in the lower reaches of Cataract Creek, up to 120 metres upstream of the full supply level of Lake Cataract and reached within the Cataract River. Fish data collected by Biosis between 2014 and 2019 from Cataract Creek, including survey effort, is summarised in Table 6 and Table 7 below.

Table 6 Numbers of threatened fish captured in Cataract Creek (2013 to 2019)

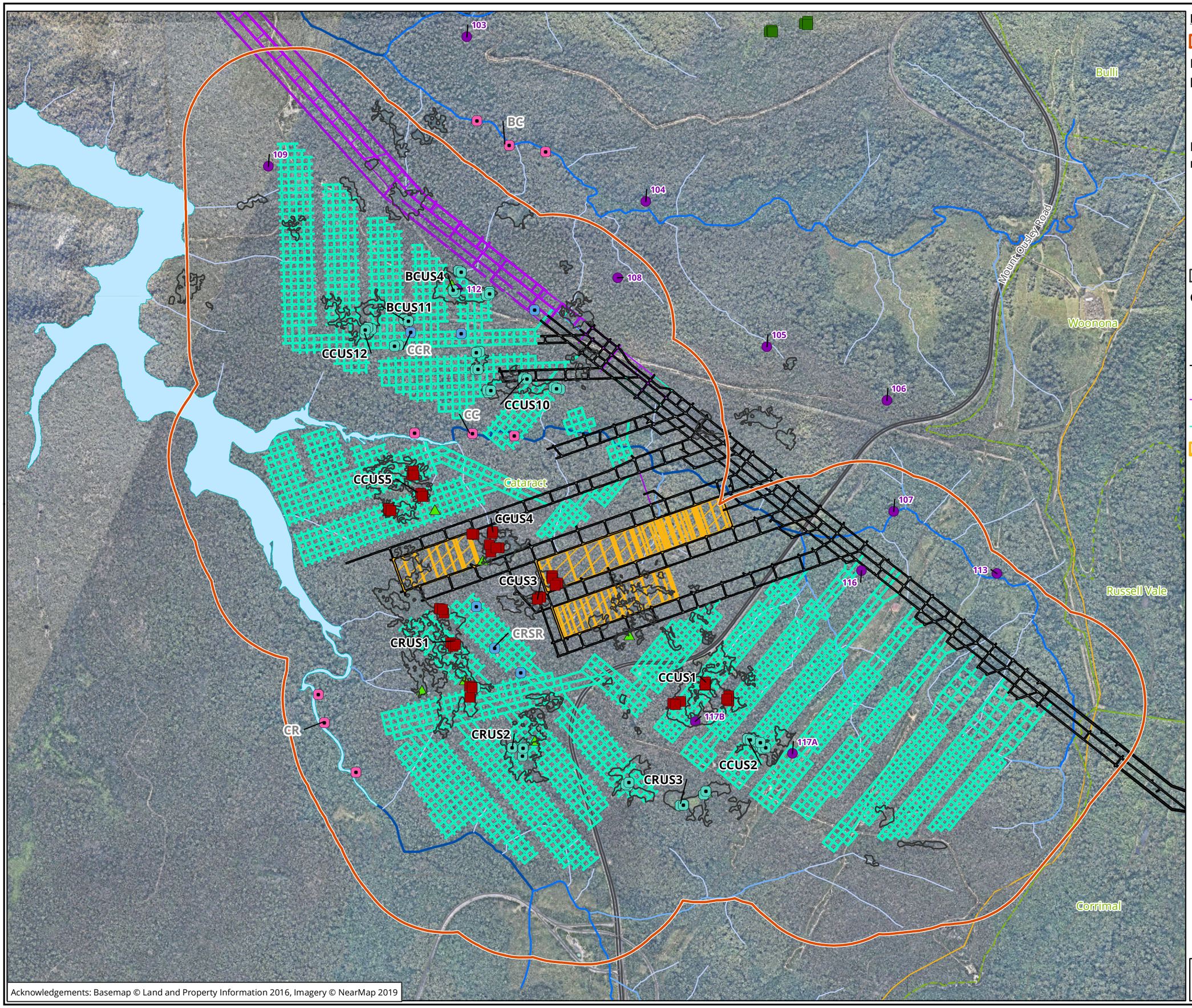
Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		Bidyanus bidyanus	*Macquaria australasica*	*Maccullochella peelii*
22/02/2013	**N/A**	0	0	0
21/02/2013	**N/A**	0	4	7
18/07/2013	**Fyke net***	0	0	1
15/04/2013	**N/A**	0	10	8
20/02/2013	**N/A**	0	0	1

Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		Bidyanus bidyanus	*Macquaria australasica*	*Maccullochella peelii*
12/03/2014	**1412**	0	18	24
26/05/2014	**745**	0	0	0
10/06/2014	**1,599**	0	12	28
13/06/2014	**1,006**	0	3	16
14/03/2014	**948**	0	2	9
9/02/2015	**1,300**	0	3	7
12/02/2015	**360 (boat)**	4	39	15
13/02/2015	**1,236**	0	0	3
24/07/2019	**2,407**	5	0	2
3/09/2019	**2,637**	0	0	1

**3 fyke nets set over 5 hours at the confluence of Cataract Creek and the Cataract River*

Table 7 Numbers of threatened fish captured in the Cataract River (2013 to 2019)

Date	Effort (seconds)	Silver Perch	Macquarie Perch	Murray Cod
		Bidyanus bidyanus	*Macquaria australasica*	*Maccullochella peelii*
22/03/2013	**N/A**	0	4	0
12/03/2014	**1,029**	0	5	8
14/03/2014	**727**	0	1	4
10/02/2016	**475 (boat)**	9	84	20
12/02/2016	**780**	1	1	1
24/07/2019	**1,515**	1	0	0
3/09/2019	**1,756**	0	1	1



Acknowledgements: Basemap © Land and Property Information 2016, Imagery © NearMap 2019

Legend

- Study area

Flora monitoring (Current program)

- Flora Swamp Control Site
- Flora Swamp Impact Site

Flora Monitoring (previously monitored)

- Flora swamp control site
- Flora creek impact site
- Flora ridgeline impact site
- Flora swamp impact site
- Swamp Boundaries

Quadrats (ERM)

- Floristic Quadrat Sites Oct 09
- Floristic Quadrat Sites Sept 11
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan
- RV East old longwall lorkings

Figure 5 Flora surveys

0 250 500 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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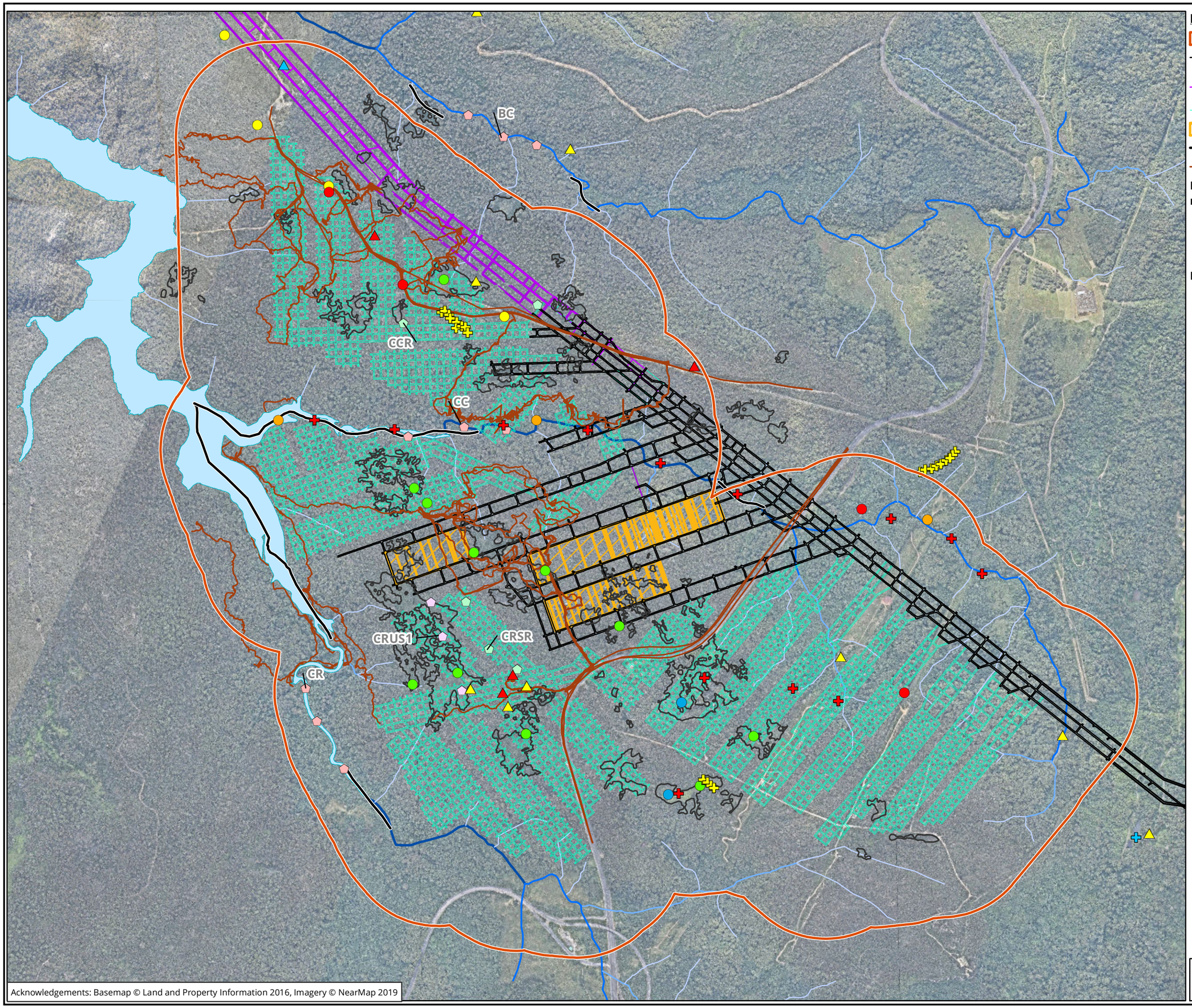
Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 30999
Date: 10 February 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30900s\30999\Mapping
30999_F4_FloraSurveys



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan
- RV East old longwall workings
- Aquatic fish reaches
- Targeted cliff line surveys

Fauna monitoring (previously monitored)

- Fauna creek impact site
- Fauna ridgeline impact site
- Fauna swamp impact site

Fauna Surveys (ERM)

- Anabat locations
- Bird area search
- Bird point counts
- Call broadcasting
- Diurnal frog call-playback
- Nocturnal frog call-playback
- Diurnal herpetofauna search
- Frog habitat survey
- Frog habitat survey sites Sept 11
- Habitat assessment
- Hair funnels

Figure 6 Fauna surveys

0 250 500 750

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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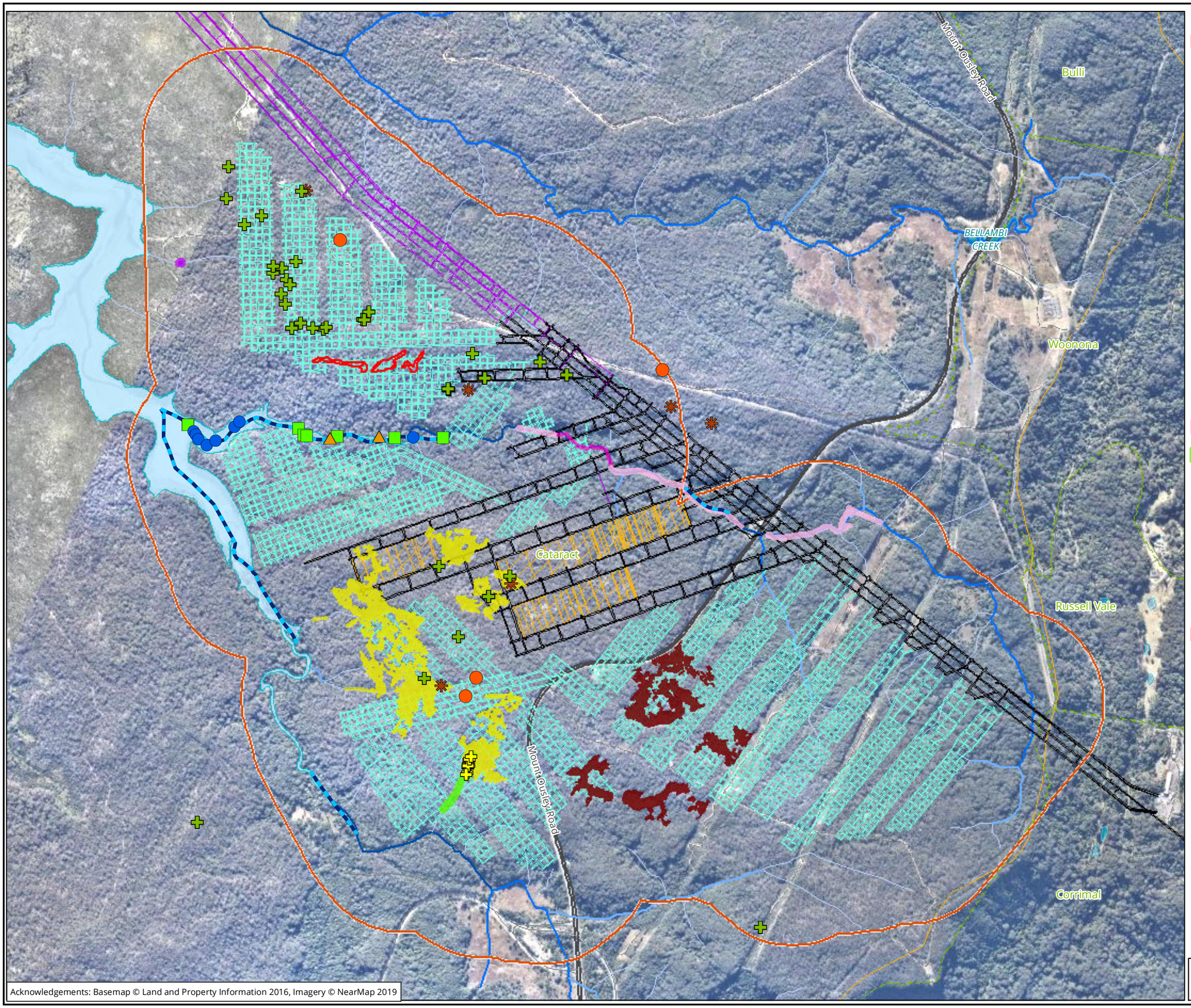
Matter: 30999
Date: 10 February 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
Location:P:\30900s\30999\Mapping
30999_F5_FaunaSurveys



Legend

- Study area
- Past workings
- Approved Wonga central development mains
- Revised UEP mine plan
- RV East old longwall workings
- Threatened fish survey reaches

BioNet flora records

- Prickly Bush-pea - *Pultenaea aristata*

Prickly Bush-pea *(Pultenaea aristata)* recorded by Biosis

- Prickly Bush-pea - *Pultenaea aristata*

Recorded fish locations

- Macquarie Perch
- Murray Cod
- Silver Perch

Giant Burrowing Frog recorded by Biosis

- Giant Burrowing Frog - *Heleioporus australiacus*

Threatened Frog Breeding Habitat

- Stuttering Frog
- Littlejohn's Tree Frog & Giant Burrowing Frog

Threatened Frog non-breeding habitat

- Giant Burrowing Frog
- Littlejohn's Tree Frog
- Stuttering Frog
- Littlejohn's Tree Frog & Giant Burrowing Frog

Large-eared Pied Bat Habitat

- Large-eared Pied Bat potential roosting habitat

Potential Broad-headed Snake habitat

- Rock outcrop

Figure 7 Threatened species records in the study area

0 250 500 750

Metres
Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

N

Matter: 30999
Date: 10 December 2020,
Checked by: MEH, Drawn by: AEDM, Last edited by: lharley
Location:P:\34300s\34330\Mapping
34330_F7_ThrSpecies

5 Impact assessment

This section includes an assessment of potential impacts from the Proposed Action on those threatened species and communities listed under the EPBC Act that are considered susceptible to subsidence impacts (as identified in Table 2 of Section 4.1.2). The assessment considers historic and cumulative impacts from past mining within and surrounding the study area in conjunction with impacts from the Proposed Action. .

Section 4.2 identified three sensitive habitats supporting threatened biota (including flora, fauna, and ecological communities) listed under the EPBC Act. The impacts to each of these sensitive habitats as a result of the Proposed Action are detailed below.

5.1 Coastal upland swamps

5.1.1 Coastal Upland Swamp in the Sydney Basin Bioregion

One EEC has been recorded within the study area that is considered susceptible to impacts from subsidence, *Coastal Upland Swamp in the Sydney Basin Bioregion*.

Tensile strains are a key subsidence effect that has potential to result in environmental consequences for coastal upland swamps. Tensile cracking can cause a loss of soil moisture that can result in a changes in species composition within swamps (IAPUM 2020).

The IAPUM conclude that the 100 millimetres of incremental vertical subsidence that has potential to occur as a result of the Proposed Action is expected to increase maximum tensile strain by around 0.5 millimetres/metre. As indicated by Table A1 (Appendix 1), swamps across the Study Area are predicted to have already experienced varying degrees of cumulative vertical subsidence and tensile strains from mining in the Bulli and Balgownie Seams, ranging from 0.4 millimetres/metre to 10.7 millimetres/metre (Appendix 1). 17 of the 33 swamps are estimated to have experienced more than 3 millimetres/metre tensile strain, and four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) are estimated to have experienced more than 10 millimetres/metre of tensile strain. Given the existing low levels of tensile strain at the majority of swamps, IAPUM concluded that it is implausible that a 0.5 millimetres/metre increase in tensile strain will lead to a catastrophic loss of swamp (defined as the reduction in a swamp's capacity to retain its water table and soil moisture that is so severe as to cause swamp flora species to be replaced by species representative of dry heath of woodland) (IAPUM 2020) .

The IAPUM (2020) note however that the amount of additional vertical subsidence that can be tolerated by the four swamps (CCUS1, CCUS6, CCUS20, and CCUS21) that are estimated to have already experienced the highest tensile strains from historical mining is unknown. Therefore the proposed bord and pillar workings in the Wongawilli Seam beneath these areas needs to be designed judiciously and conservatively in order to restrict vertical subsidence (IAPUM, 2020).

The relevant performance measure for the Proposed Action in relation to coastal upland swamps under the UEP development consent is for negligible environmental consequences. On this basis, Wollongong Coal has committed to undertake swamp specific risk assessments for each of the four swamps that are predicted to have already experienced tensile strains in excess of 10mm/m as part of the NSW Extraction Plan process. Where an unacceptable risk is identified through the risk assessment process, additional mitigation measures will be utilised to avoid subsidence related impacts and maintain negligible environmental consequence from the Proposed Action for these swamps. This may include measures such as installation of additional roof supports or amendments to the mine plan or panel design to reduce the risk of vertical subsidence effects to these swamps.

With the implementation of a swamp specific risk assessment process for CCUS1, CCUS6, CCUS20, and CCUS21 and implementation of any additional mitigation measures identified, impacts to these four upland swamps (and the remaining upland swamps within the Study Area) from the Proposed Action are predicted to be negligible. The Proposed Action is therefore unlikely to have in a significant impact on *Coastal Upland Swamp in the Sydney Basin Bioregion.*

5.1.2 Prickly Bush-pea

One EPBC Act listed flora species, Prickly Bush-pea, is considered likely to occur in the study area and is considered susceptible to impacts from subsidence. Prickly Bush-pea is restricted to the Woronora Plateau, and has been recorded within the study area in open habitats, including upland swamps and adjacent woodland (Biosis 2014a). Despite this species' restricted distribution, it is known to be common and widely distributed in the study area (Biosis 2014a) (Figure 7). Amendments to the mining methodology in the current UEP proposal have addressed the issue of subsidence-related impacts. The first-workings mining method will not result in perceptible levels of subsidence and upland swamp habitat is considered at negligible risk of impact. In addition, the species grows in sandstone areas, on the edges of swamp habitats necessitating a shallow root depth which would be unaffected by changes in water table at depths greater than five metres. Prickly Bush-pea is therefore considered at negligible risk of impact. As such the Proposed Action is unlikely to result in a significant impact on the Prickly Bush-pea.

5.1.3 Threatened frogs

Targeted habitat assessment for threatened frogs identified potential breeding and non-breeding habitat for Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog (Figure 7).

Impacts to terrestrial ecosystems that provide non-breeding habitat for these threatened frogs are generally considered to be at negligible risk of impact from subsidence (DoP 2008, 2009, 2010). Thus, this assessment focuses on impacts to breeding habitat for these species.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features, including upland swamps, creeks, and drainage lines which represent potential breeding habitat for threatened frogs. As a result it is unlikely that the Proposed Action will result in any significant impacts to EPBC Act listed threatened frogs likely to occur within the study area.

Given thefollowing factors, no further survey/assessment required for Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog:

- Survey has been completed in excess of the guidelines – with no individuals recorded.
- Suitable habitat has been mapped but is not considered likely to be significantly impacted by the proposal.
- These areas of suitable structural habitat are likely subject to levels of disturbance and pollution that render it suboptimal for the species.

5.2 Aquatic environments

5.2.1 Threatened fish and frogs

Targeted surveys for threatened fish have recorded Macquarie Perch, Murray Cod and Silver Perch in the lower reaches of Cataract Creek, up to 120 metres upstream of the full supply level of Lake Cataract. Aquatic habitats within the study area also provide potential habitat for some threatened frog species (namely Littlejohn's Tree Frog, Giant Burrowing Frog and the Stuttering Frog).

The proposed bord and pillar workings mine plan is not predicted to have any perceptible surface subsidence, is not predicted to cause subsidence cracking in stream beds that would result in the loss of surface flows, and will not significantly impact baseflows of the drainage lines (SCT 2019, Geoterra/GES, 2020, HydroAlgorythmics 2020). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including small creeks and tributaries, Cataract Creek, and Cataract Reservoir.

Given this, the Proposed Action will not significantly impact this sensitive habitat, and is therefore not predicted to directly or indirectly impact the threatened fish or frog species that may utilise these habitats.

5.3 Rocky environments

As noted in Section 3, the Proposed Action is not considered to have any perceptible surface subsidence which may cause cliff failures and/or surface rock cracking due to changes in underlying bedrock, and is therefore unlikely to impact natural surface features including cliff and steep slope habitats potentially utilised by threatened species.

Therefore the Proposed Action will not significantly impact this sensitive habitat, and will therefore not directly or indirectly impact the threatened species that may utilise these habitats (as described below).

5.3.1 Broad-headed Snake

Habitat assessments concluded that habitat suitable for the species is limited in extent as the Wonga East area lacks extensive areas of north to northwest facing sandstone benching with exfoliating sandstone that provide important habitat for this species (see Section 4.3.4).

Targeted surveys undertaken as part of the ecological monitoring program did not record the species in the study area, therefore the limited available habitat not considered to be important for the survival of the species.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including cliff and steep slope habitats potentially utilised by Broad-headed Snake.

Given the limited extent of habitat, the species not being recorded within the study area, and the imperceptible subsidence expected from the Proposed Action we conclude that the species is unlikely to be significantly impacted by the Proposed Action.

5.3.2 Large-eared Pied Bat

Targeted surveys did not record the Large-eared Pied Bat within the study area (see Section 4.3.5), however subsequent habitat assessments of cliff lines did identify suitable roosting habitat for this species. These sites are limited in extent within the study area, with suitable cliffs restricted to an area north of Cataract Creek (Figure 7). No evidence of occupation of cliffs by Large-eared Pied Bat was observed during the habitat assessment.

The revised mine plan is not considered to have any perceptible surface subsidence (SCT 2019). The Proposed Action is therefore considered to have minimal potential to perceptibly impact on natural surface features including cliff habitats that represent potential roosting habitat for Large-eared Pied Bat.

Furthermore, given the limited extent of suitable roosting sites for Large-eared Pied Bat the risk of impact is considered low, particularly when compared with the availability of suitable habitat in the local area.

The species is considered unlikely to be significantly impacted by the Proposed Action.

6 Impact management

The Proposed Action will not result in any direct impacts to the ecological features identified in the study area. No direct removal of native vegetation or fauna habitat will be undertaken.

In addition, any potential indirect impacts to biodiversity have been avoided by careful mine planning (see Section 3), with the current mine plan unlikely to result in significant or detectable impacts to any threatened species or community listed under the EPBC Act. It should be noted that the bord and pillar mining method is flexible, can be adapted to different strata conditions and be revised to mitigate or avoid potential surface impacts in response to ongoing hazard assessments and monitoring of strata conditions.

As a precautionary measure, Wollongong Coal will undertake swamp specific risk assessment for the four swamps (CCUS1, CCUS6, CCUS20 and CCUS21) that are predicted to have already been subject to estimated cumulative tensile strains in excess of 10mm/m as part of the NSW Extraction Plan process. The risk assessment will be informed by subsidence monitoring data collated during mining of the Proposed Action, with mining to commence in panels well removed from this group of swamps. Where an unacceptable risk to the ecological functioning of the swamp is identified through the risk assessment process, additional mitigation measures will be utilised to reduce the level of risk to an acceptable level. This may include measures such as installation of additional roof supports or amendments to the mine plan or panel design to reduce the risk of additional subsidence effects to these swamps.

Impacts to biodiversity values within the study area are currently managed and monitored in accordance with the Biodiversity Management Plan (WCL 2015a) and Upland Swamp Management Plan (WCL 2015b). These management plans were developed to manage and monitor impacts arising from longwall mining of Longwalls 4, 5 and 6. Wollongong Coal is currently preparing an updated Biodiversity Management Plan and Upland Swamp Monitoring Program in accordance with the UEP NSW Development Consent.

The monitoring design focusses on upland swamps and ecological values that have been identified to be most at risk of cumulative impacts due to extraction (swamps CCUS1, CCUS6, CCUS20 and CCUS21).. All of these swamps are located over Area 6 which is one of the Bulli Seam goaf areas confirmed as having been fully collapsed (SCT 2020a). This monitoring is in line with the impact management recommendations detailed in the *Russell Vale Colliery – Underground Expansion Project: Updated Ecological Impact Assessment* (Biosis 2019a). On this basis, the following monitoring is recommended:

- It is intended that the up to date baseline monitoring will follow the same methodology:
  - Upland swamps considered to be most at risk (CCUS1, CCUS6, CCUS20 and CCUS21); one year prior to extraction, during extraction, and one year post extraction. Monitoring surveys are conducted once in spring and once in autumn.
  - Collection of baseline data at higher value upland swamps proposed to be undermined (BCUS4, CCUS2, CCUS5, CCUS10, CCUS12, CRUS1, CRUS2 and CRUS3); One year prior to extraction. Previous ecological monitoring data has previously been collected at each of these sites which will also assist in the understanding of baseline conditions.
- Relevant control sites will also be monitored during these periods of baseline data collection to assist in distinguishing any effects of environmental conditions from historic mining in the baseline data (ACUS, BCUS12, BCUS13, WACUS, WCUS, S22, S33 and S15A).
- Baseline analysis of swamp extents using LiDAR analyses is recommended prior to UEP extraction for all swamps in the Wonga East area. It is intended that the LiDAR analyses of swamp extents be

undertaken once, prior to UEP extraction occurring. This will provide an accurate and up to date basis for analysis of change over time if any impacts associated with UEP extraction are identified and follow up monitoring is required.

- The detection of changes to soil moisture, shallow groundwater or swamp vegetation as a result of UEP extraction at any upland swamp would trigger the need for additional ecological assessment and monitoring. It is intended that, if triggered, swamp vegetation transect, Giant Dragonfly and observational monitoring will continue (as applicable) for a suitable duration to be determined in consultation with DAWE, the NSW Department of Planning Industry and Environment Biodiversity Conservation Division and any other relevant Authorities.
- Visual inspection of the rock formation that forms the base of upland swamps CCUS1, CCUS4, CCUS5, CCUS6, CCUS10, CCUS20, CCUS21, BCUS4 and BCUS6 also be undertaken during routine monitoring.
- Monitoring of surface water levels and water quality in Cataract Creek and tributaries using the network of existing sites.
- Biodiversity monitoring is to continue in surface areas within the vicinity of the Proposed Action in accordance with (WCL 2018). This will ensure that in the unlikely event that subsidence impacts do impact on threatened species or communities under the EPBC Act, those impacts can be quantified and further management actions prescribed.
- Aquatic monitoring using AusRivas methodology (Turak, Johnstone, & Waddell 2004) is to be undertaken at Cataract Creek one year prior to extraction, during extraction, and one year post extraction. Additional monitoring may be required if trigger thresholds are exceeded.

7 Conclusion

This report provides an outline of biodiversity values associated with the Proposed Action. The report takes the following hierarchical approach to impact assessment:

- Identification of threatened species and communities listed under the EPBC Act with potential to occur within the study area that are susceptible to subsidence impacts. Particular attention has been made to sensitive water-dependent ecosystems that are susceptible to subsidence impacts.
- Outlining surveys that have been undertaken for those species within the study area.
- Outlining potential impacts and assessing the likelihood of those impacts.

In summary, the following species were considered likely to occur within the Wonga East area, and were considered susceptible to impacts due to their reliance on certain habitats for various lifecycle stages, and the susceptibility of these habitats to impacts from subsidence:

- Prickly Bush-pea.
- Threatened frogs, including Littlejohn's Tree Frog, Giant Burrowing Frog and Stuttering Frog.
- Broad-headed Snake.
- Large-eared Pied Bat.
- Threatened fish, including Macquarie Perch, Silver Perch and Murray Cod/Trout Cod.
- Coastal Upland Swamps in the Sydney Basin Bioregion TEC.

Subsidence advice from the IAPUM (2020) has indicated that apart from four swamps that are predicted to have already experienced high levels of tensile strain (i.e. CCUS1, CCUS6, CCUS20, and CCUS21), a significant impact from the Proposed Action to sensitive swamp habitats seems "implausible". For the remaining four swamps, Wollongong Coal has committed to a precautionary swamp-specific risk assessment process to identify any additional mitigation measures necessary to avoid subsidence related impacts and maintain negligible environmental consequence from the Proposed Action for these swamps. Greater than negligible environmental consequences to swamps are therefore not expected as a result of the Proposed Action.

Due to the lack of subsidence impacts and associated impacts to surface water and groundwater regimes, and based on the completed habitat assessment and targeted surveys, the following conclusions are made for these candidate species:

- The Prickly Bush-pea is widely distributed throughout the Wonga East area, with critical habitat component being areas where low gradient slopes result in impediment of surface water run-off. Impacts to this habitat are unlikely to result from the Proposed Action.
- No threatened frog species habitat is likely to be subject to subsidence, or associated impacts. Impacts to these threatened frog species are therefore unlikely to result from the Proposed Action;
- Habitat for the Broad-headed Snake in the Wonga East area is limited in extent. Targeted surveys did not record this species. Subsidence is expected to be imperceptible and therefore impacts to habitat potentially utilised by this species is negligible. For these reasons the Proposed Action is considered unlikely to impact Broad-headed Snake.
- The Large-eared Pied Bat was not recorded within the study area. Although cliffs located north of Cataract Creek provide potential roosting habitat for this species, subsidence is expected to be imperceptible and therefore impacts to these cliff habitats will be negligible. Given the lack of impact

to potential roosting habitat, and the extent of more suitable habitat in the locality, the Proposed Action is considered unlikely to impact this species.

- Three threatened fish species (Macquarie Perch, Silver Perch and Murray Cod/Trout Cod) have been recorded in Cataract Creek. As the proposed workings will result in imperceptible subsidence, there will be no perceptible impacts to small creek and streams, Cataract Creek, or Cataract Reservoir. The Proposed Action is therefore considered unlikely to impact habitat for these species.

The Proposed Action presents a low risk of impacts to threatened species and communities known or predicted to occur in habitats sensitive to subsidence.

Biosis concludes that the Proposed Action will not result in a significant impact to threatened species and communities listed under the EPBC Act.

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Appendices

Appendix 1 Existing swamp impacts

Table A.1 Summary of existing impacts on swamps – Balgownie and Bulli seam working

Table E.1.1 Summary of Existing Impacts on Swamps – Balgownie and Bulli Seam Working

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Vertical Subsidence – Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain - (mm/m)
CCUS1	Area 6	No	Yes	2	10.5
CCUS2	Edge Area 7	No	Yes	1.1	5.8
CCUS3	Edge Area 3	No	No	1.1	5.5
CCUS4	N/A	No	No	0.9	4.7
CCUS5	Pt Area 2	No	Yes	0.6	3.3
CCUS6	Area 6	No	No	2.0	10.5
CCUS7	Nth of Mains	Yes	No	1.0	5.6
CCUS8	N/A	No	No	0.1	0.6
CCUS9	N/A	No	Yes*	0.1	0.5
CCUS10	Pt Area 10	No	Yes	0.6	3.2
CCUS11	Area 10	Yes	Yes	1.0	4.4
CCUS12	Part Area 10	Yes	Yes	0.5	2.1
CCUS13	Area 8	Yes	Yes	0.1	0.4
CCUS14	Area 14	Yes	Edge	1.2	6.5
CCUS15	N/A	No	Yes	0.2	0.9
CCUS16	N/A	N/A	No	0.5	2.5
CCUS17	N/A	No	Yes	0.1	0.5
CCUS18	N/A	No	Edge	0.1	0.5
CCUS19	N/A	No	No	0.1	0.5
CCUS20	Area 6	No	Yes	2.0	10.3
CCUS21	Area 6	No	No	2.0	10.7
CCUS22	Pt area 8	Yes	No	0.5	2.4
CCUS23	N/A	No	No	0.9	4.4
CCUS24	Edge Area 10	Yes	Yes	0.3	1.30
CRUS1	Pt Area 5	No	Part	0.5	2.5
	Edge Area 12	Yes	Yes		
CRUS2	Pt Area 12	Yes	Yes	0.6	4.3
CRUS3	Pt Area 13	Yes	Yes	0.6	3.1
CRUS6	Edge 9	Yes	Yes	0.1	0.40
CRUS7	Area 8	Yes	Yes	0.3	1.3
BCUS1	Nth of Mains	Yes	No	1	5.6
BCUS2	Nth of Mains	No	Yes*	0.5	2.6
BCUS3	Nth of Mains	No	Yes#	0.5	2.8
BCUS4	Area 10	Yes	Yes	0.6	3.1
BCUS5	Nth of Mains	Yes	No	0.5	2.7

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Vertical Subsidence – Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain - (mm/m)
BCUS6	Nth of Mains	No	Yes#	0.1	0.5
BCUS7	Edge Area 8	No	Edge	0.1	0.5
BCUS8	Nth of Mains	No	Yes#	0.1	0.5
BCUS11	Area 10	Yes	Edge	0.5	2.2
BCUS14	Nth of Mains	No	Yes#	0.2	1.0

* Headings only

Mains Headings Only

Appendix 2 Flora

Threatened flora species and ecological communities

The following table includes a list of the threatened flora species that have potential to occur within the study area. The list is based on database searches outlined in Section 4.1.

Notes to tables:

Conservation status – EPBC Act:
CR – Critically Endangered
EN – Endangered
VU – Vulnerable

Most recent record
species predicted to occur by the PMST (not recorded on other databases).
species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched.

Table A.2 Threatened ecological communities recorded / predicted to occur within 10 kilometres of the study area

Scientific name	EPBC Act Status	Does the community occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	EN	**No** Restricted to coastal floodplains. Not recorded within study area.
Coastal Upland Swamp in the Sydney Basin Bioregion	EN	**Yes** Community occurs within the study area and is susceptible to subsidence.
Illawarra and south coast lowland forest and woodland ecological community	CE	**No** Not recorded within study area.
Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	CE	**No** Not recorded within study area.
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	CE	**No** Restricted to within 2 km of the coast or adjacent to a large salt water body. Suitable habitat not present within study area.
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	CE	**No** Occurs at ecotone between clay soils from the shale rock and earthy and sandy soils from sandstone, or where shale caps overlay sandstone. Suitable habitat not present within study area.
Subtropical and Temperate Coastal Saltmarsh Vulnerable Community likely to occur within area	VU	**No** Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within study area.
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	CE	**No** Restricted to Cumberland lowlands. Not recorded within study area.
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	EN	**No** Found on basalt and basalt-like substrates. Suitable habitat not present within the study area.

Table A.3 Threatened flora species recorded / predicted to occur within 10 kilometres of the study area

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Acacia bynoeana	Bynoe's Wattle	VU	2017	1	9,576	**No** Species commonly found in sandstone and gravel based soils, occasionally on rock platforms. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Allocasuarina glareicola		EN	#	-	-	**No** Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Suitable habitat not present.
Caladenia tessellata	Thick Lip Spider Orchid	VU	#	-	-	**No** Perennial terrestrial orchid found in grassy Sclerophyll woodland on clay loam or sandy soils. Suitable habitat not present.
Cryptostylis hunteriana	Leafless Tongue Orchid	VU	#	-	-	**No** Not known from Woronora plateau.
Cynanchum elegans	White-flowered Wax Plant	EN	2017	11	1,939	**No** Known from ecotone between dry rainforest and grassy woodland communities on coastal plain. Suitable habitat not present.
Genoplesium baueri	Bauer's Midge Orchid	EN	#	-	-	**No** Grows in dry sclerophyll forest and moss gardens over sandstone. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Grevillea parviflora* subsp. *parviflora	Small-flower Grevillea	VU	#	-	-	**No** Occurs in sandy or light clay soils, usually over thin shales, in a wide range of vegetation types. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Haloragis exalata* subsp. *exalata	Square Raspwort	VU	#	-	-	**No** Requires protected and shaded damp situations in riparian habitats. Outside known distribution.
Leucopogon exolasius	Woronora Beard-heath	VU	2019	8	8,419	**No** Occurs in a wide range of habitat types, including woodland, rocky hillsides and creeks. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Melaleuca biconvexa	Biconvex Paperbark	VU	#	-	-	**No** Occurs in damp places, often near streams and rivers or low-lying areas on alluvial soils of low slopes or sheltered aspects. Suitable habitat not present.
Melaleuca deanei	Deane's Melaleuca	VU	#	-	-	**No** Occurs in heath communities on sand, and has been recorded from ridgetops, dry ridges and slopes. Strongly associated with sandy loam soils low in nutrient. Potential habitat is present. Not recorded within the study area. Species is not considered to be reliant on microhabitats that are at risk of impact due to subsidence

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Persoonia acerosa	Needle Geebung	VU	2007	1	6,082	**No** Grows in heath, scrubby low-woodland or dry sclerophyll forest. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Persoonia hirsuta	Hairy Geebung	EN	2009#	6	1,689	**No** Occurs in dry sclerophyll forest and woodland with a shrubby understory. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Persoonia nutans	Nodding Geebung	EN	#	-	-	**No** Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Pomaderris brunnea	Brown Pomaderris	VU	1957	2	9,771	**No** Occurs in open forest often on sandstone, clay and alluvial soils of floodplains and creek lines. Potential habitat is present. Not recorded within the study area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Pterostylis gibbosa	Illawarra Greenhood	EN	#	-	-	**No** Occurs on soils derived from Permian sedimentary rocks of the Berry formation at an altitude of 10 to 20m. Outside known altitudinal range.

Scientific name	Common name	EPBC Act status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Pterostylis saxicola	Sydney Plains Greenhood	EN	#	-	-	**No** Grows in heathy forest, sclerophyll forest or woodland in shallow sandy soil over flat sheets of sandstone rock shelves or boulders at altitudes of 10 to 60m. Outside known altitudinal range.
Pultenaea aristata	Prickly Bush-pea	VU	2017#	130	Species is present within study area	**Yes** Occurs in open habitats, including upland swamps and adjacent woodland, where drainage is impeded. Previously located within study area. Fracturing of bedrock may result in changes in hydrology and result in impacts to the species.
Syzygium paniculatum	Magenta Lilly Pilly	VU	2014#	2	8,233	**No** Found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Thelymitra kangaloonica	Kangaloon Sun Orchid	CR	#	-	-	**No** Endemic to the Fitzroy Falls / Robertson / Kangaloon area occurring in swampy sedgeland. Outside known distribution. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Thesium australe	Austral Toadflax	VU	#	-	-	**No** Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.

Appendix 3 Fauna

Threatened fauna species

The following table includes a list of the threatened fauna species that have potential to occur within the study area. The list is based on database searches outlined in Section 4.1.

Notes to tables:

Conservation status – EPBC Act:
CR – Critically Endangered
EN – Endangered
VU – Vulnerable

Most recent record
species predicted to occur by the PMST (not recorded on other databases).
species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched.

Table A.4 Threatened fauna species recorded, or predicted to occur, within 10 kilometres of the study area

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Birds						
Anthochaera phrygia	Regent Honeyeater	CR	1995	1	2,994	**No** Potential foraging habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Botaurus poiciloptilus	Australasian Bittern	EN	2001	3	2,119	**No** Found in terrestrial freshwater wetlands and, rarely, estuarine habitats. Suitable habitat not present.
Calidris canutus	Red Knot	EN	#	-	-	**No** Occurs in marine environment.
Calidris ferruginea	Curlew Sandpiper	CR	#	-	-	**No** Found in terrestrial freshwater wetlands and, estuarine habitats. Suitable habitat not present.
Calidris tenuirostris	Great Knot	CR	1999	1	4,970	**No** Occurs in marine environment.
Dasyornis brachypterus	Eastern Bristlebird	EN	2018	55	Species is recorded within study area	**No** Potential habitat is present. Not recorded within the study area.
Diomedea exulans	Wandering Albatross	EN	2010	57	5,078	**No** Occurs in marine environment.
Diomedea gibsoni	Gibson's Albatross	VU	1979	1	9,488	**No** Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Grantiella picta	Painted Honeyeater	VU	1991	1	7,662	**No** Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Lathamus discolor	Swift Parrot	CR	2018	19	1,660	**No** Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Macronectes giganteus	Southern Giant Petrel	EN	2009	12	4,987	**No** Occurs in marine environment.
Macronectes halli	Northern Giant-Petrel	VU	2009	2	9,003	**No** Occurs in marine environment.
Neophema chrysogaster	Orange-bellied Parrot	CR	#	-	-	**No** Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Numenius madagascariensis	Eastern Curlew	CR	#	-	-	**No** Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
Phoebetria fusca	Sooty Albatross	VU	1975	1	4,400	**No** Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subspecies)	VU	1990	1	3,447	**No** Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Pterodroma leucoptera leucoptera	Gould's Petrel	EN	1985	1	8,876	**No** Occurs in marine environment.
Rostratula australis	Australian Painted Snipe	EN	#	-	-	**No** Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
Thalassarche bulleri	Buller's Albatross	VU	2009	2	5,981	**No** Occurs in marine environment.
Thalassarche cauta	Shy Albatross	VU	2013	4	7,697	**No** Occurs in marine environment.
Thalassarche impavida	Campbell Albatross	VU	1998	2	3,574	**No** Occurs in marine environment.
Thalassarche melanophris	Black-browed Albatross	VU	2013	11	4,507	**No** Occurs in marine environment.
Thalassarche salvini	Salvin's Albatross	VU	1960	1	5,078	**No** Occurs in marine environment.
Thinornis rubricollis	Hooded Plover	VU	2012	3	3,534	**No** Occurs in marine environment.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	VU	#	-	-	**Yes** Species may roost in caves and overhangs in study area. Potential habitat is present in the study area. Species not recorded. Subsidence may result in collapse of cliffs that provide potential roosting habitat for this species.
Dasyurus maculatus	Spotted-tailed Quoll	EN	2019	7	769	**No** Species habitat present in the study area. Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
Eubalaena australis	Southern Right Whale	EN	1998	1	5,416	**No** Occurs in marine environment.
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	EN	2009	2	8,861	**No** Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Petauroides volans	Greater Glider	VU	2017	60	37	**No** Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Petrogale penicillata	Brush-tailed Rock-wallaby	VU	#	-	-	**No** Thought to be locally extinct in Southern Coalfield (DECC 2007).

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Phascolarctos cinereus		VU	2018	33	807	**No** Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Pseudomys novaehollandiae	New Holland Mouse	VU	#	-	-	**No** Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
Pteropus poliocephalus	Grey-headed Flying-fox	VU	2019#	302	Species is recorded within study area	**No** Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Reptiles						
Caretta caretta	Loggerhead Turtle	EN	2010	1	4,432	**No** Occurs in marine environment.
Chelonia mydas	Green Turtle	VU	2009	4	3,940	**No** Occurs in marine environment.
Eretmochelys imbricata	Hawksbill Turtle	VU	2002	1	5,385	**No** Occurs in marine environment.
Hoplocephalus bungaroides	Broad-headed Snake	VU	2019	47	1,192	Y**es** Potential habitat is present in the study area. Subsidence may result in fracturing of rocky outcrops providing habitat for this species.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Frogs						
Heleioporus australiacus	Giant Burrowing Frog	VU	2016	47	Species is recorded within study area	**Yes** Known to inhabit ephemeral and intermittent streams in the locality. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Litoria aurea	Green and Golden Bell Frog	VU	2016	47	580	**No** Inhabits still, shallow water bodies. Restricted to several key known populations. No populations exist within the study area.
Litoria littlejohni	Littlejohn's Tree Frog	VU	2018	488	1,270	**Yes** Known to inhabit ephemeral and intermittent streams in the locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Mixophyes balbus	Stuttering Frog	VU	#	-	-	**Yes** Known to inhabit streams in the locality. Species rare in locality. Potential habitat is present in the study area. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Fish						
Bidyanus bidyanus	Silver Perch	CE	#	-	-	**Yes** Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.

Scientific name	Common name	EPBC Act Status	Most recent record	Number of records	Distance of closest record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Epinephelus daemelii	Black Rockcod	VU	#	-	-	**No** Occurs in marine environment.
Maccullochella macquariensis	Trout Cod	EN	#	-	-	**Yes** Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
Maccullochella peelii	Murray Cod	VU	#	-	-	**Yes** Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
Macquaria australasica	Macquarie Perch	EN	#	-	-	**Yes** Inhabits freshwater streams. Potential habitat is present. Species may have been recorded previously. Subsidence may result in impacts to aquatic environments.
Prototroctes maraena	Australian Grayling	VU	#	-	-	**No** Requires connectivity with marine environment.

Appendix 4 Field survey methodology

Flora surveys

Flora surveys have been undertaken by ERM (2013b) and Biosis (2012a, b, 2013a, 2014d). Flora surveys were undertaken between 2 and 6 February 2009, with additional surveys undertaken between 5 and 9 September 2011. The complete methodology is outlined in *NRE No. 1 Colliery Project Application (09-0013) Environmental Assessment* (ERM 2013b). These surveys included assessment of floristic composition at 16 sites using standardised 400 metres squared (20 metres x 20 metres) quadrats. Quadrat locations were randomly selected within vegetation communities and stratification units. All plants recorded within each quadrat were identified to species level. Random meander searches were undertaken in the areas surrounding each quadrat for between 10 and 15 minutes at each location to increase the likelihood of detecting threatened species.

ERM (2013b) undertook targeted surveys for threatened flora species including Prickly-bush Pea across three sites in the Wonga East Area, concentrated in upland swamps on 7 and 8 October 2009. These targeted surveys involved searches along straight line transects by two ecologists concentrated in upland swamps for a total of 7.6 person hours. These surveys were supplemented by further assessment (Biosis 2012) during the detailed mapping of upland swamps. Whilst the focus of these surveys was mapping of upland swamps, locations of threatened flora species were recorded whilst traversing the study area.

Coastal upland swamp mapping

Coastal upland swamp mapping has been previously undertaken by Biosis (2012). Light Detection and Ranging (LiDAR) data was obtained using Airborne Laser Scanning (ALS) from a fixed wing aircraft on 20 October 2009. Initial areas of 'Potential Wetland' were determined in an automated process using a series of Geographic Information System (GIS) analysis tools in ArcGIS, which were combined into a single ArcGIS Model Builder geoprocessing model. A Canopy Height Model (CHM) was developed by subtracting the values of the ground raster from the non-ground raster.

Boundaries of upland swamps were determined by looking for areas with a rate of change in the CHM of greater than 2 metres within 1 metre, and where the total vegetation height was less than 6 metres. Following the automated processing of LiDAR data into potential wetland polygons, manual 'cleaning' of the polygons was required to further filter out false positives. After comparison with the known swamp control dataset, it was decided that only polygons over 1,000 square metres should be kept in order to filter out further 'background noise'. Any obvious false positives, including areas such as clearings, rods and waterbodies, were manually removed from the dataset using aerial imagery interpretation. This process determined areas of 'Potential Wetlands'. The polygons were then loaded on GIS capable field computers for field staff to locate and ground-truth.

Following automated mapping of 'Potential Wetlands', these areas were ground-truthed to determine whether areas mapped were representative of upland swamps. A team of botanists experienced with the identification of upland swamps on the Woronora Plateau visited all 'Potential Wetlands'. Some areas mapped as 'Potential Wetland' consisted of rocky outcropping, mallee, dry heath vegetation or sparse canopy. These areas were excluded from further analysis. Areas of upland swamp were assessed in detail. Boundaries of all swamps were mapped accurately using a combination of LiDAR data, ground-truthing using a handheld GPS and aerial photo interpretation (API).

Vegetation sub-communities present within swamps were mapped using a combination of ground-truthing using a handheld GPS and API. Sub-communities were mapped according to community profiles contained within NPWS (2003) and included those communities considered part of the Coastal Upland Swamp EEC (TSSC 2014), including:

- MU42 Upland Swamps: Banksia Thicket
- MU43 Upland Swamps: Tea-tree Thicket
- MU44 Upland Swamps: Sedgeland Heath Complex:
  - MU44(a) Sedgeland
  - MU44(b) Restioid Heath
  - MU44(c) Cyperoid Heath.

Boundaries of upland swamps and of sub-communities within swamps were refined in collaboration with GIS staff using API.

Upland swamps were then grouped for naming and further analysis. Initially, areas of upland swamp vegetation connected by Fringing Eucalypt Woodland (MU45) or Mallee Heath (MU46), or upland swamp vegetation separated by rocky outcropping, were grouped and considered part of the one upland swamp complex. In areas where connectivity between proximate upland swamps was not obvious, slope and flow accumulation modelling were used to identify whether these swamps are independent or whether these swamps should be considered as the one upland swamp complex.

Upland swamps that were located in close geographic proximity and were part of the same flow pathway and / or located along terraced slopes were grouped together. Following an initial classification using this method, further refinement of swamp groupings was undertaken, as initial observations indicated that some swamps that would otherwise be considered part of the same swamp were, in fact, located along different flow pathways.

Swamps were then named based on the catchment they were positioned within, generally working from the upstream to downstream extent. Where a valley infill and headwater swamp were connected, this was considered to form one functional unit, and therefore considered part of the same upland swamp. However, due to potential differences in type and degree of impacts they have been considered separately where appropriate.

Upland swamp floristic monitoring

Additionally, Biosis has also undertaken ecological monitoring in Wonga East which consists of flora monitoring (commencing in 2011), at upland swamp CRUS1 and at quadrats located along Cataract River, Cataract Creek and Bellambi Creek. Following a review of the ecological monitoring programs in 2012, undertaken in conjunction with the Office of Environment and Heritage (now Department of Planning Industry and Environment (DPIE), monitoring along creeks was ceased and monitoring of an additional six upland swamps (CRUS2, CRUS3, CCUS1, CCUS2, CCUS3 and CCUS4) commenced. Since 2012 an additional four upland swamps (CCUS5, CCUS10, CCUS12 and BCUS4) were added to the monitoring program.

Monitoring of upland swamps is undertaken along three 15 metre transects within each swamp. The presence of all species within thirty 0.5 metre x 0.5 metre quadrats located along the 15 metre transect is recorded (Biosis 2017, 2019b, 2019a). These monitoring surveys have been conducted once in spring and once in autumn since 2012, summarised in Table A.5. Statistical analysis of flora total species richness (TSR) and species composition between control and impact swamps are used to determine whether there are significant differences between control and impact monitoring sites and at individual sites between years. Floristic data is analysed in partnership with The Analytical

Edge Statistical Consulting to best relate the data analysis with the assessment of Trigger Action Response Plans (TARPS) following mining, and focus on comparing sites based on accurate measures of subsidence impacts.

Table A.5 Upland swamp monitoring program sites

Site	Monitoring commenced
BCUS4 (Bellambi Creek Upland Swamp 4)	Spring 2013
BCUS11 (Bellambi Creek Upland Swamp 11)	Spring 2013
CCUS1 (Cataract Creek Upland Swamp 1)	Autumn 2012
CCUS2 (Cataract Creek Upland Swamp 2) - Photo-point Monitoring	Autumn 2012
CCUS3 (Cataract Creek Upland Swamp 3)	Autumn 2012
CCUS4 (Cataract Creek Upland Swamp 4)	Autumn 2012
CCUS5 (Cataract Creek Upland Swamp 5)	Autumn 2013
CCUS10 (Cataract Creek Upland Swamp 10)	Autumn 2013
CCUS12 (Cataract Creek Upland Swamp 12)	Spring 2013
CRUS1 (Cataract River Upland Swamp 1)	Autumn 2011
CRUS2 (Cataract River Upland Swamp 2) - Photo-point Monitoring	Spring 2012
CRUS3 (Cataract River Upland Swamp 3)	Autumn 2012

The location of the flora surveys is shown in Figure 5. The number of sites monitored in each year of the ecological monitoring program has changed over time, reflecting changes to the relevant mine plans and therefore areas potentially at risk of impact at the time of survey as well as post-mining monitoring requirements. Monitoring ceased at the completion of the 2017 ecological monitoring program. A total of 4.5 years of post-mining data had been collected for those sites that were at risk of impacts from Longwall 4 and Longwall 5, with Longwall 6 being mined during the 2015 monitoring period, three seasons (two and a half years) of post-mining data had been collected for those sites at risk of mining related impacts associated with that longwall. The most recent annual report was provided in 2019. This report evaluated the first year of the recommencement of the ecological monitoring in Russel Vale east (RVE) in the context of the previous years of data, and in response to the TARP trigger levels previously developed for longwall extraction that concluded in RVE in 2015. In order to establish pre-UEP baseline conditions and assess any ongoing levels of impacts following the completion of longwall mining.

Fauna surveys

Fauna surveys have been undertaken by ERM (2013a), Cardno Ecology Lab (2009, 2010, 2012a, 2012c, 2012b), EcoLogical (2009) and Biosis (2009, 2012, 2013, 2017, 2019b).

Fauna surveys undertaken as a part of the environmental impact assessment were undertaken in spring 2009 and summer of 2009/2010. The complete methodology is outlined in (ERM 2013a). These surveys include targeted surveys for threatened frogs, Broad-headed Snake, Microchiropteran bats, and threatened fish.

Fauna survey effort is shown in Figure 6 and a summary of the fauna survey methods are provided in the following sections.

Broad-headed Snake

Targeted surveys for the Broad-headed Snake have focused on identification of suitable habitat in the study area. Surveys have been undertaken by Biosis Research (2009), Biosis (2013a), EcoLogical (2009) and ERM (2013b).

Initial surveys were undertaken in March 2009 (Biosis, 2009). Ridgelines and rocky outcrops were traversed and searched to identify any high quality benched areas with exfoliating sheets of sandstone suitable for use as shelter habitat by the Broad-headed Snake (ERM 2013b). This included examination of ground litter, turning over logs and rocks and searching for prey species of the Broad-headed Snake (Biosis 2009). Follow up surveys were undertaken by EcoLogical (2009) in September and October 2009 using the same methodology.

Areas of habitat identified to be suitable for the species were monitored across two years as part of the ecological monitoring program. This monitoring included targeted searches within suitable habitat (e.g. rocky outcrops) at three 20 metre by 20 metre (400 metres squared) quadrats along each ridgeline (fauna ridgeline impact site) (Figure 6). These surveys consisted of active searching and rock turning at each site for 30 person-minutes. These surveys were undertaken once in autumn 2011 and once in autumn 2012 during periods when the Broad-headed Snake uses rocks and crevices as shelter sites. Monitoring of these sites ceased following a review of monitoring programs, due to the lack of detection of threatened species and lack of predicted impacts to monitored sites.

Threatened frogs

Initial surveys were undertaken by ERM (2013b). Call broadcasting for target frog species was undertaken within suitable habitats. Call broadcasting was undertaken during both daytime and nocturnal periods. A 10W amplifier was used to broadcast a call for three minutes followed by three minutes of listening. Nocturnal searches for frogs were also undertaken in habitat considered suitable for the target species. Habitat searches consisted of an initial five minute listening period followed by active searches of an area of at least 40 metres x 40 metres by searching ground litter, turning logs and rocks and examining low shrubs. Creeks were surveyed with an initial five minute listening period followed by two person hours of active spotlighting of 200 metres of each watercourse. Further survey of streams was undertaken by EcoLogical (2009), including searches for amphibian larvae, detection of calling individuals and searches beneath suitable cover.

Monitoring for Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog have been undertaken in breeding and non-breeding habitat areas identified across the Proposed Action study area as part of annual ecological monitoring programs (Biosis 2013, Biosis 2017), described below.

Transect monitoring

The initial stages of the monitoring program focused on monitoring of three standardised transects per creek along Cataract River, Cataract Creek and Bellambi Creek. Following an initial five minute listening period, active searching of a standardised 50 metre transect was undertaken over a period of 30 minutes. The presence of all frogs located along each transect was recorded. These transects have been monitored twice each spring and autumn from 2011 to 2012.

Breeding habitat monitoring (transects)

Following a review of the ecological monitoring programs in 2012, undertaken in consultation with the then NSW Office of Environment and Heritage, monitoring of standardised transects along creeks was ceased. Due to a better understanding of potential impact mechanisms, the focus of monitoring changed to habitat for threatened frogs, particularly breeding habitat at risk of impact due to draining of breeding pools. In 2012, detailed mapping of potential breeding habitat for threatened

frogs in the study area was undertaken. An initial diurnal habitat assessment was completed across the study area. All areas of potential habitat were mapped and assessed for quality. Potential habitat identified by topography maps and aerials along streams was ground-truthed and all suitable breeding pools were marked using a GPS.

Locations of potential breeding habitat were identified by topographic maps and aerial imagery of the study area, focussed along streams and pools. These areas were ground-truthed by diurnal habitat assessment and all suitable breeding locations were mapped and incorporated into an ongoing monitoring program, based on transect sampling methodology. Following diurnal habitat assessments, locations considered to be suitable habitat of varying quality for the Stuttering Frog, Littlejohn's Tree Frog and Giant Burrowing Frog were then incorporated into the ongoing monitoring program through a transect sampling survey technique.

Transect surveys were undertaken by zoologists familiar with the target species (Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog), and incorporated active Visual Encounter Survey (VES), spotlighting, and call detection techniques. Active nocturnal VES for adults, tadpoles and egg mass were completed in peak breeding times for each species to allow for a higher probability of detecting adult frogs. Spotlighting and call detection were undertaken along transects in areas assessed to contain suitable habitat for each of the species. Surveys were timed around seasonal movements of the target species, with monitoring undertaken in breeding season to detect calling males and the period of high activity in adult frogs, as well as following breeding season to target tadpoles and metamorphs. These monitoring surveys took place twice in autumn, twice in winter and twice in summer at six monitoring transects within suitable habitats between winter 2012 and summer 2015/2016. A summary is provided in Table A.6.

Table A.6 Targeted frog breeding habitat mointoring sites and survey commencement

Site	Survey type	Survey commenced
BCUS2 (1) (Bellambi Creek Upland Swamp 2 - Tributary)	Visual encounter survey, spotlighting and call detection	Summer 2013/14
BCUS2 (2) (Bellambi Creek Upland Swamp 2 (2) - Tributary)	Visual encounter survey, spotlighting and call detection	Summer 2013/14
CCUS4 (Cataract Creek Upland Swamp 4 - Tributary)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS1 (1) (Cataract River Upland Swamp 1 - Tributary 1)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS1 (2) (Cataract River Upland Swamp 1 - Tributary 2)	Visual encounter survey, spotlighting and call detection	Winter 2012
CRUS2 (Cataract River Upland Swamp 2 - Tributary)	Visual encounter survey, spotlighting and call detection	Winter 2012

Non-breeding habitat monitoring (quadrats)

In addition to monitoring of breeding habitat, Biosis has undertaken monitoring of non-breeding habitat identified by Biosis Research (2009) and EcoLogical (2009). Quadrat surveys for threatened frogs in upland swamps were conducted within one to three 25 metre x 25 metre (625 metres squared) quadrats per swamp, centralised around a fixed point. Each point was surveyed twice per season. An initial listening period was followed by active searching (by zoologists familiar with the target species) of all natural features including rocks, vegetation and leaf litter within each quadrat for 25 person minutes. The length of the initial listening period varied depending on the target

species. Five minutes was allocated to those habitats suitable for Littlejohn's Tree Frog, whereas a 30 minute listening period was allocated for those sites containing habitat for the Giant Burrowing Frog, given the time it can take for the species to re-commence calling following disruption. The presence and abundance of threatened species within each 25 metre x 25 metre quadrat was recorded. Between fixed quadrat survey points, randomised transects were surveyed by walking a specific distance through a randomly chosen route. Allowing for detection of threatened and non-threatened species across habitat gradients of the study area.

These surveys were undertaken in 2012. The surveys occurred twice in autumn, twice in winter and twice in summer for Littlejohn's Tree Frog and Giant Burrowing Frog at CCUS4, CRUS1 and CRUS2. Twice in winter and twice in summer for Littlejohn's Tree Frog and Giant Burrowing Frog at CCUS3. Twice in summer for Giant Burrowing Frog at CCUS1, CCUS2 and CRUS3.

Large-eared Pied Bat

Surveys were undertaken for Large-eared Pied Bat using Anabat units. Anabat units were deployed at four locations between 23 and 27 May 2009. At each location Anabat units were deployed for two nights. Anabat units were positioned in and adjacent to flyways, including vehicle tracks, riparian environments, freshwater pools, cliffs, upland swamps and rainforest understorey.

Subsequent detailed habitat assessment has been undertaken by Biosis. This habitat assessment focused on identifying potential roosting habitat for microchiropteran bats along cliff lines in the study area. Cliff lines were mapped using LiDAR data and surveyed to identify potential roosting habitat. These cliff lines were then surveyed by zoologists from Biosis to identify overhangs or caves suitable for roosting by threatened bats species.

Two additional Anabat units were deployed, targeting suitable roosting habitat identified during the habitat assessment outlined above. Anabat units were deployed between 6 and 9 February 2015. Anabat units were positioned adjacent to identified potential roost sites to determine if sites were being used as roosts.

Four harp traps were also set up over six nights in late March 2015 in areas of suitable habitat, with total trapping effort of 24 trap nights.

Threatened fish

Macquarie Perch within the Cataract Reservoir Catchment has been identified as being subject to potential impacts associated with subsidence as a result of underground coal mining in the Southern Coalfields (DECC 2007). To assess the potential impacts to threatened fish species, arising from subsidence associated with longwall mining. Monitoring of Macquarie Perch within Cataract Creek has been the focus of these assessments as other threatened species occur infrequently (Silver Perch and Trout Cod) or are not considered part of an important population (Murray Cod).

Fish survey has been undertaken in Cataract Creek, the focus of monitoring under previous longwall extraction within the RVE area, by Biosis between 2013 and 2019. A Smith-Root LR-24 backpack electrofisher was utilised to collect fish within shallow water environments. The sampling consisted of actively electrofishing a reach of Cataract Creek of between 0.3 to 2 kilometres with one operator and one dip netter. The power-on time and output fishing parameters were adapted according to the prevalent environmental conditions and set to maximise the collection of Macquarie Perch. The fish catch data and survey effort (electrofishing seconds) for each survey are summarised in Appendix 5. This survey effort was complimented by the use of Fyke netting at the confluence of Cataract Creek and Cataract River and boat based electrofishing within the downstream section of Cataract Creel one two separate occasions. In-stream habitat assessments including a description of basic geomorphology and physical attributes (e.g. depth, substrate, flow, cover, habitat connectivity

including barriers to fish passage, refugia and spawning areas, aquatic and riparian vegetation etc.), existing sources of disturbance and in-situ water quality variables (pH, dissolved oxygen, temperature, electrical conductivity, turbidity) were recorded.

Cardno Ecology Lab also undertook backpack electrofishing surveys of Cataract Creek between 2008 and 2012. Four surveys for threatened fish species were undertaken during each summer survey during 2009-2010, 2010-2011 and 2012 using back electrofishing techniques. The surveys were completed between the confluence of Cataract Creek and the Cataract River, up to a rock bar present along Cataract Creek, the same downstream transect along Cataract Creek utilised by Biosis. Collectively, backpack electrofishing surveys of Cataract Creek have occurred over a period of six years.

Assessment against survey guidelines

An assessment of the field survey methodology and survey effort for candidate species against the relevant Commonwealth survey guidelines is provided in Table A.7. The relevant available survey guidelines include:

- Commonwealth *Survey Guidelines for Australia's Threatened Frogs* (Frog Guidelines) (Commonwealth of Australia 2010a).
- Commonwealth *Survey Guidelines for Australia's Threatened Bats* (Bat Guidelines) (Commonwealth of Australia 2010b).
- Commonwealth *Survey Guidelines for Australia's Threatened Reptiles* (Reptile Guidelines) (Commonwealth of Australia 2011a).
- Commonwealth *Survey Guidelines for Australia's Threatened Fish* (Fish Guidelines) (Commonwealth of Australia 2011b).

There are currently no Commonwealth survey guidelines available for coastal upland swamps, or for the Prickly-bush Pea.

Table A.7 Assessment of field survey effort against relevant Commonwealth Survey Guidelines

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Macquarie Perch and Silver Perch		
Timing of surveys	The recommended survey period for the Macquarie Perch is March to September. Surveys should not be conducted throughout the breeding season of October to mid-January.	Surveys for threatened fish species in Cataract Creek and the Cataract River have been undertaken between 2009 and 2019. Surveys undertaken between 2009 and 2012 were undertaken during the breeding season. These surveys were largely undertaken prior to the development of the Fish Guidelines and would be effective in detecting the species. Timing of surveys since 2012 have been according to the Fish Guidelines. Surveys are ongoing.
Methods	The methods can be used individually, but it is often found that a combination of methods provides the best results. Efforts should focus on boat-based electrofishing conducted according to the Australian Code of Practice (NSW Fisheries 1997), fyke nets and snorkelling in clear streams for juveniles.	Surveys have predominantly been backpack electrofishing, considered to be the most suitable method to the target reaches. However fyke netting and boat electofishing methods have also been employed. Due to the shallow depths of the reaches of Cataract Creek and Cataract River being surveyed boat-based electrofishing has generally not been feasible. Methods used in targeted surveys have been according to the Fish Guidelines.
Effort	Regular sampling during and throughout the time of year when the taxa are known to most likely occur at the study area is desirable. Some locations may be occupied by target taxa/taxon in some years but not others, requiring sampling over many years (if feasible).	Surveys completed by Cardno Ecology Lab between 2009 and 2012 (12 survey days) were undertaken at Cataract Creek. Biosis has undertaken 15 days of survey for threatened fish species within Cataract Creek and 7 days of survey in the Cataract River, between 2013 and 2019. Survey effort has been well in excess of the Fish Guidelines.
Area to be covered	Random sampling or systematic sampling, spaced a suitable distance apart to ensure independence of sites.	Fished reaches have varied in length, being typically between 0.3 and 2 km in length. Area covered is consistent with the Fish Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Littlejohn's Tree Frog		
Timing of surveys	Under optimum weather conditions; that is, after heavy rainfall on windless night. At time of peak activity for the species. Seasonal: Active in autumn through winter months. Weather conditions: Within three days of heavy rainfall. Active in summer after heavy rainfall.	Surveys have been undertaken during a wide variety of weather conditions (including within 3 days of heavy rainfall). However, surveys are undertaken using a local reference site to determine calling behaviour. Surveys for Littlejohn's Tree Frog are undertaken during Autumn, Summer and Winter. Autumn and Winter surveys target active calling for adult males, whilst Summer surveys target tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.
Methods	Spotlight and call detection. Accompanied by habitat assessment by appropriately experienced personnel. Larvae are distinctive, often observed at surface, and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all breeding and non-breeding habitat is undertaken according to the methodology outlined above and includes spotlighting, Visual Encounter Surveys (VES), active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of four nights under ideal conditions, covering a range of stream structure.	Surveys of breeding habitat have been undertaken for 16 nights (CRUS1 Tributary 1), 16 nights (CRUS1 Tributary 2), 15 nights (CCUS4 Tributary), and 33 nights (CRUS2 Tributary). Surveys of non-breeding sites have been undertaken for 25 nights (CRUS1), 16 nights (CRUS2), 6 nights (CCUS3) and 16 nights (CCUS4). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	Stream transect of a minimum of 200 m. Isolated pools in headwaters of streams and occasionally on ridges. Also occurs in ponds in forested habitats. Local area study should include reference sites where feasible.	Transects (of 200 m) cover suitable breeding habitat and associated pools identified during the habitat assessment. Surveys of local reference sites are undertaken prior to surveys. Area covered has targeted breeding habitat, mapped during the habitat assessment, which is considered at risk of impact by the Action. A local reference site has been used.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Giant Burrowing Frog		
Timing of surveys	Under optimum weather conditions; that is, wet conditions. At time of peak activity for the species; that is, rainfall in spring and autumn. Seasonal: September–March. Weather conditions: Within one week of heavy rainfall (September–March) (heavy rainfall is >50 mm in seven days)	Surveys have been undertaken during a wide variety of weather conditions. However, surveys are undertaken using a local reference site to determine calling behaviour. Surveys for the Giant Burrowing Frog are undertaken during Summer, targeting calling behaviour and tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.
Methods	Using spotlight surveys on foot and by road. Best results during and immediately after rainfall. Accompanied by habitat assessment by appropriately experienced personnel. Larvae are distinctive and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all breeding and non-breeding habitat is undertaken according to the methodology outlined above and includes spotlighting, VES, active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of four nights under ideal conditions.	Surveys of breeding habitat have been undertaken for 15 nights (CCUS4 Tributary), 16 nights (CRUS1 Tributary 1 and 2) and 33 nights (CRUS2 Tributary). Surveys of non-breeding sites have been undertaken for 25 nights (CRUS1), 16 nights (CRUS2), 9 nights (CRUS3), 4 nights (CCUS1), 4 nights (CCUS2), 6 nights (CCUS3) and 16 nights (CCUS4). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	In the study site, spotlight surveys on foot should cover several square kilometres of track in suitable habitat. In the local area, spotlight road transects should traverse up to 30 km in suitable habitat, repeated sections after a period of about one hour is suitable.	Transects cover all suitable breeding habitat and associated pools identified during the habitat assessment. Surveys of local reference sites are undertaken prior to surveys. Area covered has targeted breeding habitat, mapped during the habitat assessment that is considered at risk of impact by the Action. A local reference site has been used.
Stuttering Frog		
Timing of surveys	Under optimum weather conditions; that is, substrate and leaf litter wet. At time of peak activity for the species. Seasonal: September–March. Weather conditions: Not during heavy rainfall or stream flow. One week after heavy rainfall.	Surveys have been undertaken during a wide variety of weather conditions. Surveys for the Stuttering Frog are undertaken during Summer, targeting calling behaviour and tadpoles in breeding pools. Timing of surveys has been according to the Frog Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Methods	Call playback and spotlighting while walking transect along stream or creek. Most suitably in riparian rainforest and wet sclerophyll forest. Detection by larvae presence. Road transects are effective after heavy rain. Larvae are distinctive and can be collected by dip netting. Multiple sweeps in pools.	Habitat assessment was undertaken by Biosis in 2011 to document all breeding habitat within the study area. Targeted surveys of all suitable habitat is undertaken according to the methodology outlined above and includes call playback, spotlighting, VES, active searching and tadpole surveys in suitable pools. Methods used in targeted surveys have been according to the Frog Guidelines.
Effort	A minimum of two nights under ideal conditions. Should be repeated on at least four separate occasions in activity period.	Surveys of all suitable habitat have been undertaken for 12 nights (CC1) and 12 nights (CC2). Survey effort at all sites has been well in excess of the Frog Guidelines.
Area to be covered	Stream transect of a minimum of 200 m. Local area study should include reference sites where feasible.	Transects cover all suitable habitat and associated pools identified during the habitat assessment. The Stuttering Frog may be extinct in the local area and thus no reference site is available. Area covered has targeted breeding habitat, mapped during the habitat assessment that is considered at risk of impact by the Action. This is in excess of the Frog Guidelines. A local reference site is not available.
Broad-headed Snake		
Timing of surveys	During winter.	Surveys were not undertaken according to the Reptile Guidelines. Surveys were undertaken in Autumn, as this is identified by OEH and experts from the University of Sydney as the best time for survey.
Methods	Searching suitable sheltering sites (under rocks or in crevices) on westerly-facing sandstone cliffs by day during winter. Searching appropriate sheltering sites with torches to detect the presence of the species. Searching rock outcrops by day will only sample a subset of rocky sheltering sites; in particular deep crevices will not be thoroughly examined.	Habitat assessment. Active searching and rock turning. Active searching for prey species. Methods used in targeted surveys have been according to the Reptile Guidelines.
Effort	No guidance provided.	Three 20 m x 20 m (400m2) quadrats surveyed for 30 person minutes each, twice per year. Two sites identified during the habitat assessment were surveyed. Surveys were undertaken in 2011 and 2012. No guidance on survey effort is provided in the Reptile Guidelines.

Parameter	Commonwealth Survey Guidelines	Surveys undertaken
Area to be covered	No guidance provided.	Three 20 m x 20 m (400m^2) quadrats per site. Two sites surveyed. No guidance on area to be covered is provided in the Reptile Guidelines.
Large-eared Pied Bat		
Timing of surveys	October through to March.	Initial surveys by ERM were conducted outside of the period outlined. These surveys were not undertaken according to the Bat Guidelines. Follow up surveys were undertaken by Biosis during this period. These follow up surveys are consistent with the Bat Guidelines.
Methods	Prior to the survey, determine the potential for rocky outcrops, caves and mines to occur in the area. Conduct ground-based surveys for caves and roosts. Passive acoustic detection of a range of potential roost habitats. The use of electronic bat detectors is the best means of non-invasive survey, and the most efficient in terms of data collection and area coverage.	Habitat assessments were undertaken of all cliffs identified using LiDAR data to determine whether potential roost sites were present within the study area. Passive acoustic detection was undertaken at two identified roosts above LW9 using Anabat bat detectors. These were the only two suitable roosts identified. Methods used in targeted surveys have been according to the Bat Guidelines.
Effort	Unattended bat detectors – 16 detector nights for a minimum of four nights. Attended bat detectors – 6 detector hours for a minimum of three nights. Harp traps and/or mistnets – 16 trap or net nights for a minimum of four nights.	Four sites were surveyed in 2009 for five nights each. Two sites were surveyed in 2015 for four nights each. Total survey effort is 28 detector nights across nine nights. Survey effort at all sites is in accordance with the Bat Guidelines; however some surveys were undertaken outside of the survey period identified in the Bat Guidelines.
Area to be covered	In the vicinity of mines, caves and rocky outcrop, and also in foraging sites such as vegetation corridors and flyways, sandstone gorges, over watercourses, isolated waterholes and in representative vegetation types	Potential impacts limited to cliffs. Foraging habitat is at negligible risk of impact. Therefore potential roost sites were targeted. Area covered is in accordance with the Bat Guidelines.

Appendix 5 Collated survey data

Coastal upland swamp monitoring floristic data

The coastal upland swamp monitoring floristic dataset has been provided as electronic excel file '*34330.Russellvale.Flora.Annual.2019.20200305*'.

Giant Burrowing Frog records from site CRUS2

The raw records of Giant Burrowing Frogs recorded during the breeding habitat monitoring program at site CRUS2 has been provided as electronic excel file '*34330.GBF.CRUS2.Export.20201128*'.

Threatened fish survey data

Fish catch data from threatened fish surveys in Cataract Creek and the Cataract River by Biosis between 2013 and 2019 are presented in Table and Table .

Table A.8 Collated fish data collected from Cataract Creek by Biosis between 2013 and 2019

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			Bidyanus bidyanus	*Galaxias brevipinnis*	*Galaxias olidus*	*Galaxias* spp.	*Maccullochella peelii*	*Macquaria australasica*	*Tandanus tandanus*	*Carassius auratus*	*Gambusia holbrooki*
Cataract Creek downstream	**22/02/2013**	**1,545**	0	0	9	0	0	0	0	0	0
Cataract Creek downstream	**21/02/2013**	**1,145**	0	0	0	0	7	4	0	1	3
Cataract Creek downstream	**18/07/2013**	**Fyke nets***	0	0	0	0	1	0	0	8	0

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			Bidyanus bidyanus	*Galaxias brevipinnis*	*Galaxias olidus*	*Galaxias* spp.	*Maccullochella peelii*	*Macquaria australasica*	*Tandanus tandanus*	*Carassius auratus*	*Gambusia holbrooki*
Cataract Creek downstream	**15/04/2013**	**1,289**	0	0	7	0	8	10	0	0	4
Cataract Creek downstream	**20/02/2013**	**1,005**	0	0	1	0	1	0	0	0	1
Cataract Creek downstream	**12/03/2014**	**1,412**	0	0	2	0	24	18	0	45	118
Cataract Creek downstream	**26/05/2014**	**745**	0	0	16	0	0	0	0	0	0
Cataract Creek downstream	**10/06/2014**	**1,599**	0	5	2	0	28	12	0	0	200
Cataract Creek downstream	**13/06/2014**	**1,006**	0	0	5	0	16	3	0	0	0
Cataract Creek upstream	**14/03/2014**	**948**	0	5	2	0	9	2	0	0	0
Cataract Creek downstream	**9/02/2015**	**1,300**	0	60	34	0	7	3	0	50	>1000
Cataract Creek downstream	**12/02/2015**	**360 (Boat)**	4	0	0	0	15	39	0	0	0

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	Galaxias species	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			Bidyanus bidyanus	*Galaxias brevipinnis*	*Galaxias olidus*	*Galaxias* spp.	*Maccullochella peelii*	*Macquaria australasica*	*Tandanus tandanus*	*Carassius auratus*	*Gambusia holbrooki*
Cataract Creek downstream	**13/02/2015**	**1,236**	0	12	0	0	3	0	0	54	>1000
Cataract Creek downstream	**24/07/2019**	**2,407**	5	12	17	0	2	0	1	2	50
Cataract Creek downstream	**3/09/2019**	**2,637**	0	28	3	8	1	0	0	1	300

**3 fyke nets set over 5 hours at the confluence of Cataract Creek and the Cataract River*

Table A.9 Collated fish data collected from the Cataract River by Biosis between 2013 and 2019

Site	Date	Effort (seconds)	Native species							Exotic species	
			Silver Perch	Broad-finned Galaxias	Mountain Galaxias	-	Murray Cod	Macquarie Perch	Eel-tailed Catfish	Goldfish	Eastern Gambusia
			Bidyanus bidyanus	*Galaxias brevipinnis*	*Galaxias olidus*	*Galaxias* spp.	*Maccullochella peelii*	*Macquaria australasica*	*Tandanus tandanus*	*Carassius auratus*	*Gambusia holbrooki*
Cataract River upstream	**22/03/2013**	**N/A**	0	0	2	0	0	4	0	0	0
Cataract River downstream	**12/03/2014**	**1,029**	0	0	0	0	8	5	0	20	480
Cataract River upstream	**14/03/2014**	**727**	0	0	1	0	4	1	0	0	0
Cataract River downstream	**10/02/2016**	**475 (boat)**	9	0	0	0	20	84	0	0	0
Cataract River upstream	**12/02/2016**	**780**	1	5	0	0	1	1	0	0	0
Cataract River	**24/07/2019**	**1,515**	1	36	0	9	0	0	0	0	4
Cataract River	**3/09/2019**	**1,756**	0	35	0	21	1	1	0	0	0