RUSSELL VALE COLLIERY

REVISED UNDERGROUND EXPANSION PROJECT

Extraction Plan

- Biodiversity Management Plan

RVC EC PLN 004

Revision

Property	Value
Approved by	DPE for implementation, Warwick Lidbury WRPL CEO for use
Document Owner	Tom McMahon, WRPL Group Environment Manager
Effective Date	TBC
Review Date	TBC

Revision History

Version	Date reviewed	Review team (consultation)	Nature of the amendment
V1 - D1	05/02/2021	Luke Stone and Rebecca Dwyer (Biosis)	Initial draft plan for submission to WRPL.
V1 - D2	13/04/2021	Luke Stone and Rebecca Dwyer (Biosis) Richard Sheehan (WRPL) David Holmes (Umwelt)	Draft plan for consultation with BCD, WaterNSW, EPA and WCC.
V1 - D3	22/06/2021	Rebecca Dwyer, Luke Stone and Tony Cable (Biosis)	Update plan to incorporate consultation feedback from BCD for submission to DPE for approval.
V1 - D4	14/09/2021	Rebecca Dwyer, Paul Price (Restoration Ecologist), Rebecca Dwyer (Team Leader – NSW Ecology) and Tony Cable Senior Ecologist (Biosis)	Minor amendments for consistency with DCCEEW Final approval.
V1 - D5 Final for EP	06/10/2021	Tony Cable Senior Ecologist (Biosis) Richard Sheehan (WRPL)	Minor amendments for consistency with DCCEEW, minor consistency changes to align with overall EP.
V1 - D6 Final	17/11/2021	Richard Sheehan (WRPL)	Minor amendments following regulator comments.
Approved Plan = R0	19/11/2021	-	-
V2 - D1	4/3/2022	Caragh Heenan and Jane Raithby-Veall (Biosis)	Updates to include Stage 2 area (PC27-PC34) for submission to WRPL.
V2 - D2	6/4/2022	Caragh Heenan and Jane Raithby-Veall (Biosis) Richard Sheehan (WRPL) Trescinda Brown and Matthew Copeland (Umwelt)	Draft plan for consultation with BCD, WaterNSW, EPA and WCC.
V2 – D3	10/6/2022	Caragh Heenan and Jane Raithby-Veall (Biosis) David Holmes (Umwelt)	Minor amendments.
V2 – 4 Final	19/7/2022	Caragh Heenan (Biosis)	-

V2 – 5 Final	7/10/2022	Caragh Heenan and Jane Raithby-Veall (Biosis) Matthew Copeland (Umwelt)	Amendments to address DPE Request for Information.

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1 INTRODUCTION

1.1 Overview

This Biodiversity Management Plan (BMP), as a subplan of the Wollongong Resources Pty Ltd (WRPL, formerly Wollongong Coal Limited) Extraction Plan (EP), details the terrestrial and aquatic monitoring that is intended to continue in surface areas within the vicinity of the Underground Expansion Project (UEP) area, with a focus on monitoring ecological values that have been determined to be most at risk as part of the UEP. A separate Upland Swamp Monitoring Plan (USMP) (*USMP RVC EC PLN 008*) (WRPL 2022a) has been prepared to manage potential subsidence and groundwater impacts on Coastal Upland Swamps present within the EP area and associated biodiversity values, including threatened species which are associated with these swamps.

This BMP has been prepared to satisfy Condition C10(g)(iv) of the Development Consent (DC) MP09_0013, which specifies that WRPL are to prepare and implement a BMP to establish baseline data and provide for the management of potential impacts and/or consequences associated with the mining associated with secondary workings EP.

The USMP (WRPL 2022a) is also subject to the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), with EPBC approval 2020-8702 being granted by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW, formerly Department of Agriculture, Water and the Environment) on 31 August 2021.

This plan has been prepared by Paul Price (Technical Lead - Botany), Dr Caragh Heenan (Consultant Zoologist) and Zoe Goold (Project Zoologist); and reviewed by Jane Raithby-Veall (Associate Director).

1.2 Project background

Russell Vale Colliery (RVC) operates under the current DC granted by the NSW Independent Planning Commission (IPC) on 8 December 2020. The DC, known as the UEP, is based on the Revised Preferred Project Report (RPPR) and Response to Second PAC Review by Umwelt Environmental and Social Consultants Pty Ltd (Umwelt) dated July 2019. Under the DC WRPL may:

- Extract 1.2 Mt of Run of Mine (ROM) coal per annum, with a maximum of 1 Mt of ROM coal being processed from site in a calendar year.
- Undertake mining operations for a period of five years from the date of commencement of mining operations.

The approved workings are contained within Consolidated Coal Lease 745 (CCL 745) and Mining Lease 1575 (ML 1575). In accordance with Condition C10(g)(iv) of the DC, this BMP has been prepared as a component of the RVC EP to manage the potential consequences of the second workings to ensure public safety and manage access across the EP areas. The BMP covers the areas in Figure 1, Figure 2 and Figure 3 relating to:

- PC07, PC08 and PC 21 to PC25 (Stage 1). PC07, PC08 and PC21 to PC25 are situated to the west and south-east of the previously mined Longwall 6 (LW6).
- PC27 to PC34 (Stage 2) are situated to the north and northwest of the previously mined LW6.

The remaining pillars approved under the DC will be mined in stages and will be subject to an amended EP, or future additional EP.

1.3 Purpose and scope

The purpose and scope of this BMP is to:

- Establish baseline data for the existing habitat on the site, including water table depth, vegetation condition, stream morphology and threatened species habitat.
- To provide for the management of potential impacts and/or environmental consequences of the workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, Endangered Ecological Communities (EECs) and groundwater dependent ecosystems.

In accordance with DC Condition A21 and A22, the EP (developed under Condition C10) is intended to be staged, as outlined in Table 1. Mining will generally occur in a staged approach, with the second workings separated into stages (which may be undertaken concurrently). Timeframes for monitoring of Biodiversity Values are discussed in Section 6.

Section 2 of the main EP, 'Project Description', provides a full summary of the project, including details on the:

- Mine planning and design.
- Mining methodologies.
- Phasing of the surface infrastructure relating to the project over 2 stages.
- Staging of the extraction of pillars (staging defined in Figure 3):
  - Stage 1 – PC21 to PC25 and PC07 to PC08.
  - Stage 2 – PC27 to PC34.

Table 1 Extraction Plan Staging and Relevance to this Plan

Stage	Timing and Description	Extraction Plan Relevance
Stage 1 (a)	Mining of panels: ▪ PC21 to PC25	Entirely covered by the EP and this BMP.
Stage 1 (b)	Mining of panels: ▪ PC07 to PC08	Entirely covered by the EP and this BMP. The secondary workings will be commenced in PC07 and PC08 following data acquisition obtained from PC21 monitoring.
Stage 2	Mining of panels: ▪ PC27 to PC34	Entirely covered by the EP and this BMP.
Future Stages	Further mining within the approved UEP Panel configuration with schedule to be included within subsequent EPs.	Pre-mining monitoring referenced within the EP and this BMP.

1.4 Management Plan structure

The remainder of this BMP is structured as follows:

- Section 2: Outlines the statutory requirements applicable to the BMP.
- Section 3: Outlines the baseline data and impact assessments undertaken which support this BMP.
- Section 3.5: Details the potential impacts to surface features that may result from the UEP workings.
- Section 5: Details the performance measures and criteria including indicators that will be used to assess the UEP performance.
- Section 6: Describes the Biodiversity monitoring program.
- Section 7: Describes the management, remediation and mitigation measures that will be implemented to reduce potential impacts as well as the Contingency Plan to manage any unpredicted impacts and their consequences.
- Section 8: Describes the protocols for the handling of incidents, complaints and non-conformances.
- Section 9: Details reporting.
- Section 10: Details how the Plan will be implemented, managed, reviewed and updated.
- Section 11: Details the audit and review program.

Figure 4 shows this Plan's position within the WRPLs Environmental Management Structure.

A summary of the appendices to this BMP is provided within Table 2 below.

Table 2 Summary of Appendices

Appendix	Description
Stage 1	
Appendix A: Agency Consultation	Documents the stakeholder consultation undertaken as part of the preparation of the BMP as detailed in Section 2.6.
Appendix B: Flora and Fauna	Contains a list of the threatened flora species that have potential to occur within the study area based on database searches outlined in Section 3.3.1.
Appendix C: TARPs	Contains all necessary TARPs for the BMP. Relevant to Stage 1 and Stage 2 mining.
Appendix D: Threatened Fish Survey Data	Threatened fish survey data in accordance with baseline data requirements of Condition F5(a).
Stage 2	
Appendix A: Agency Consultation	Copies of agency correspondence and responses.
Appendix B: Flora and Fauna	As above.
Appendix C: TARPs	As above.
Appendix D: Threatened Fish Survey Data	As above.

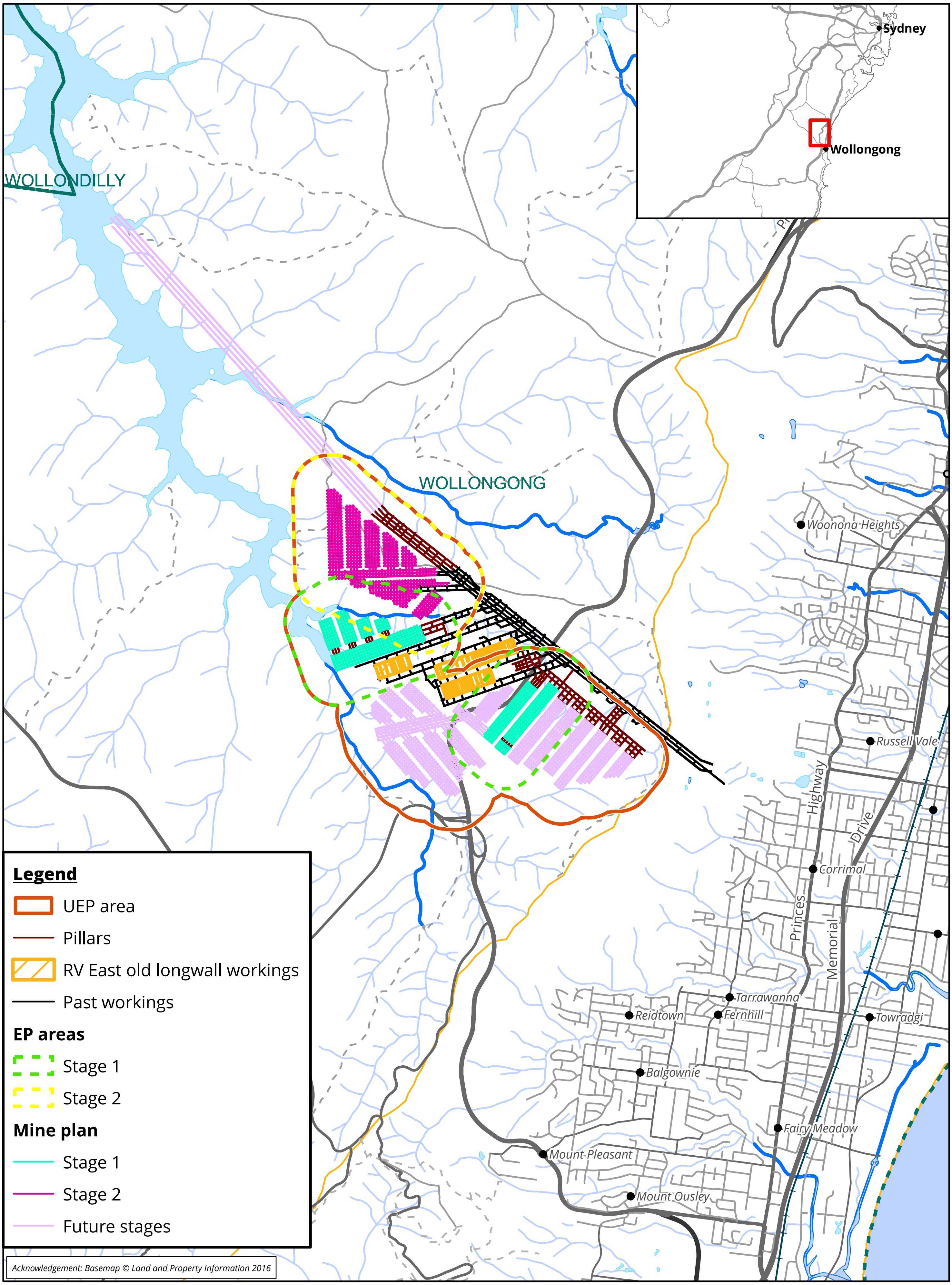


Figure 1 Location of the Russell Vale Colliery

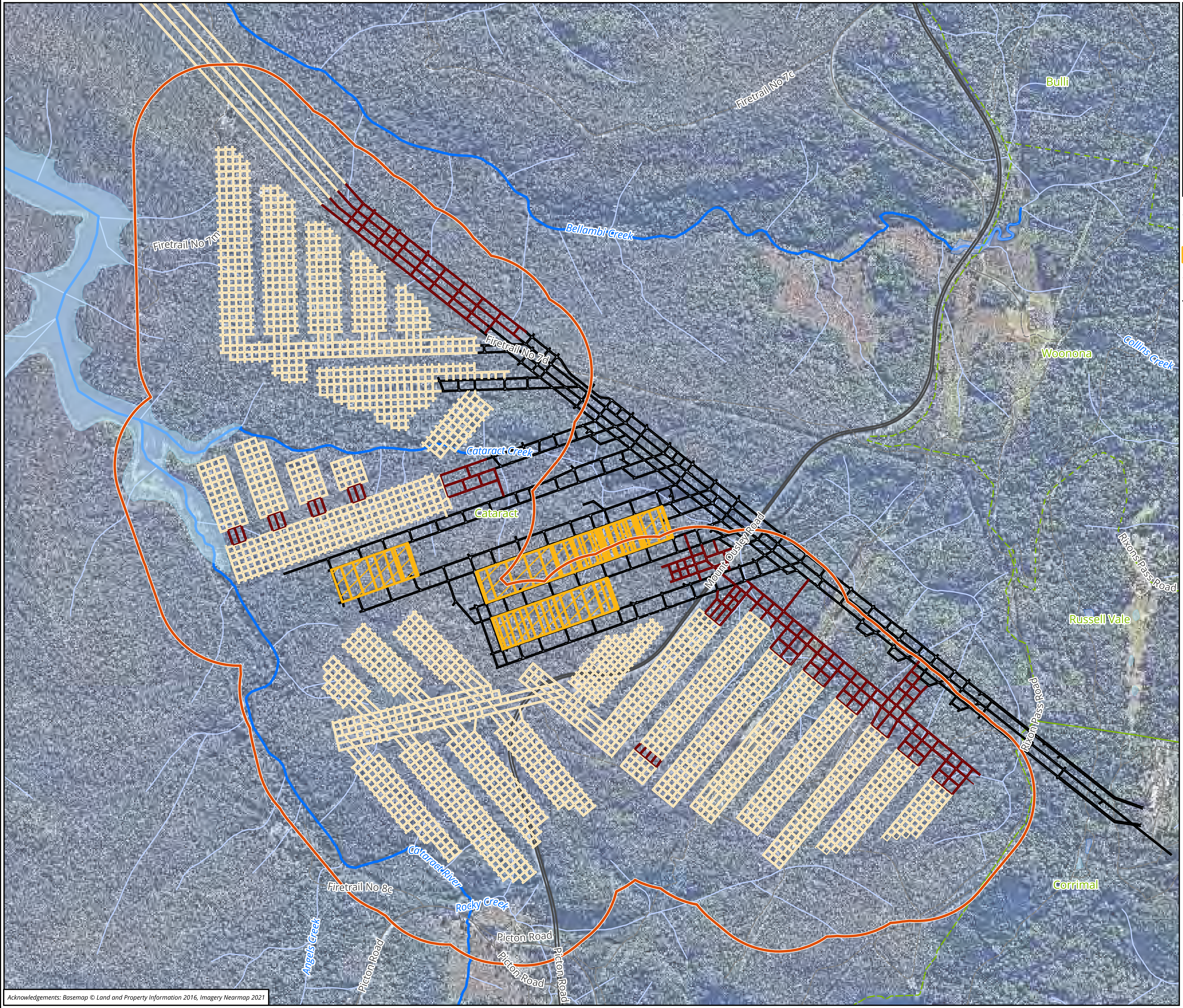
biosis

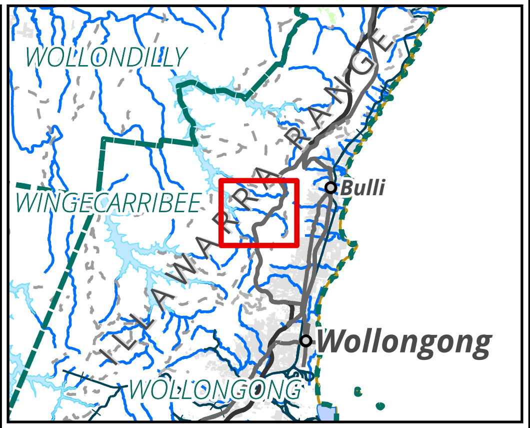
Matter: 36746,
Date: 05 April 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: 36746_F1_Locality
Project: P:\36700s\36746\Mapping\36746_WCL_Stage2_BMP.aprx

0 400 800 1,200 1,600 2,000
Metres
Scale: 1:50,000 @ A4
Coordinate System GDA 1994 MGA Zone 56

N

00





Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings
- Mine plan

0 120 240 360 480 600

Metres

N

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Figure 2 Revised UEP mine plan

biosis

Matter: 36747,
Date: 06 April 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F2_Revised_UEP_MinePlan
Project: P:\36700s\36746\Mapping\
36746_WCL_Stage2_BMP.aprx

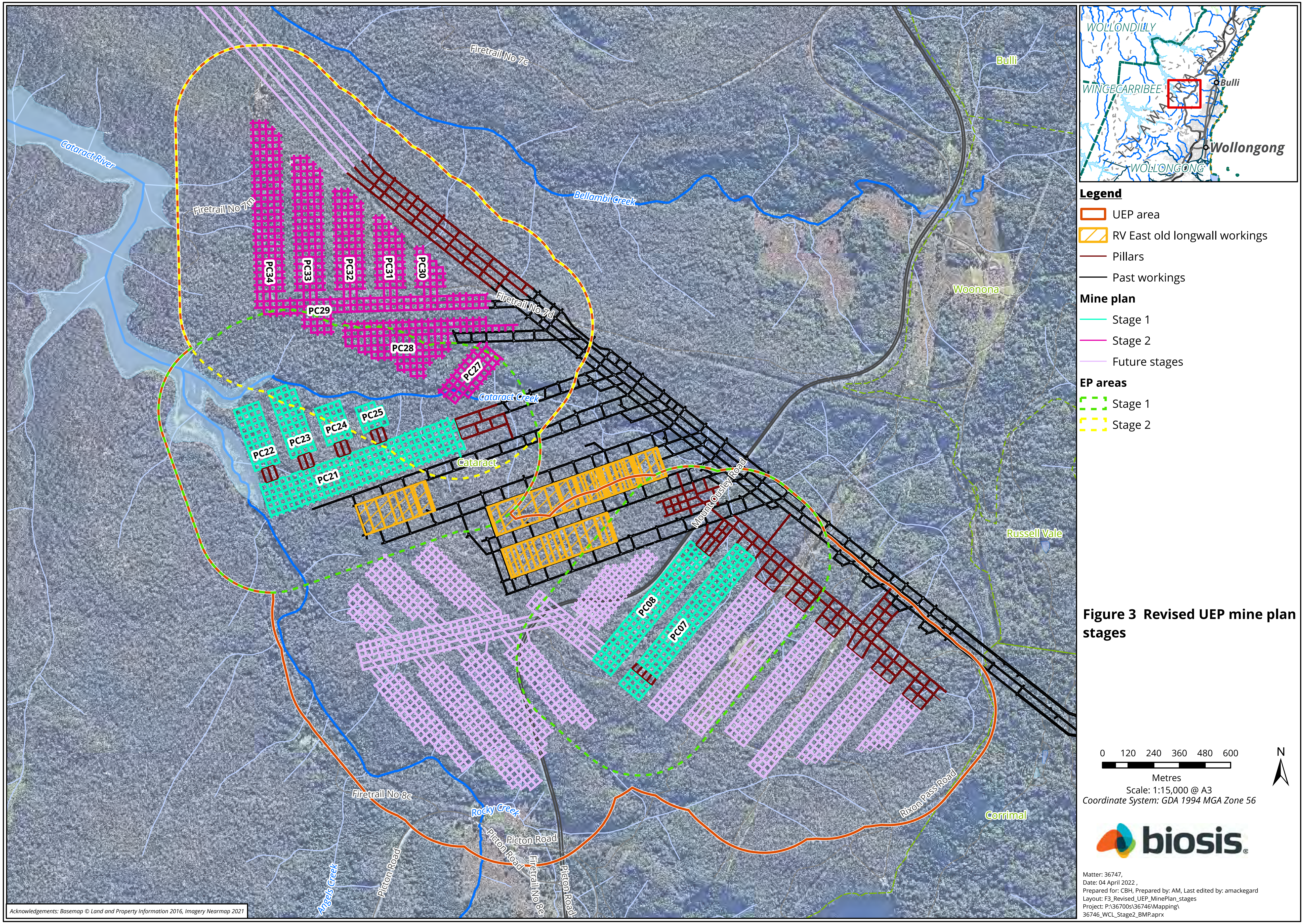
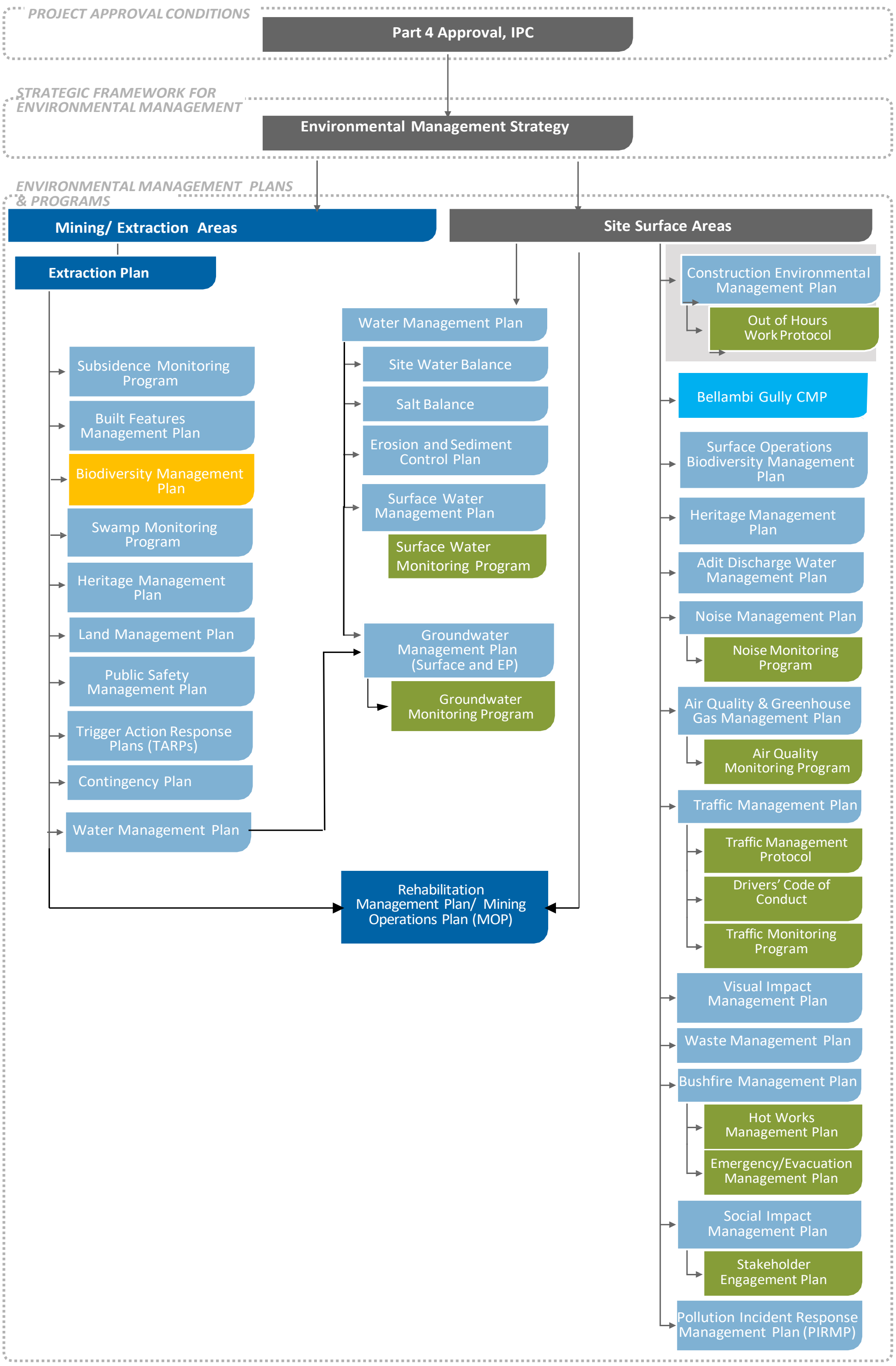


Figure 3 Revised UEP mine plan stages

Figure 4 WRPL Environmental Management Structure



2 STATUTORY REQUIREMENTS

2.1 Development Consent

Condition C10(g)(iv) of the DC MP09_0013 requires the preparation of a BMP in support of the EP. The DC conditions relevant to the BMP are specified in Table 3, with reference to where each component of the condition is addressed within this Plan. The Performance Measures set under Condition C1 (Table 6) which are related to biodiversity features are detailed in Section 5.

Additionally, WRPL is subject to conditions outlined in the EPBC approval 2020/8702 (refer to Section 2.4).

In accordance with Condition C10, WRPL will ensure implementation of this BMP as approved by the Secretary before carrying out any second workings.

Table 3 Addressed components of Schedule 2 Part A, C and F of MP09_0013 within BMP

Condition	Requirement	Where addressed
Part A – Administrative Conditions		
Obligation to minimise harm to the environment		
A1	In addition to meeting the specific performance measures and criteria established under this approval, the Applicant must implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the construction and operation of the project, and any rehabilitation required under this consent.	This plan
Part C - Specific Environmental Conditions - Underground mining		
Biodiversity Management Plan		
C10(g)	Include a:	-
C10(g)(iv)	Biodiversity Management Plan	This plan
	▪ Which has been prepared in consultation with BCD,	Section 2.6.2
	▪ Which establishes a baseline data for the existing habitat on the site, including water table depth, vegetation condition, stream morphology and threatened species habitat, and	Section 3.1
	▪ Provides for the management of potential impacts and/or environmental consequences of the proposed first workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, EECs and water dependent ecosystems;	Sections 3.5, 5, 6, and 6
C10(g)(viii)	Trigger Action Response Plan/s addressing all features in Tables 5 and 6, which contain:	-
	▪ Appropriate triggers to warn of increased risk of exceedance of any performance measure.	Section 7.3
	▪ Specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded.	Section 7.3
	▪ Adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 5 and 6, or where any such exceedance appears likely.	Section 7.3.1, and Appendix C
	▪ An assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures.	Section 7.5.1 and 7.5.2

Condition	Requirement	Where addressed
C10(g)(ix)	Contingency Plan that expressly provides for:	-
	▪ Adaptive management where monitoring indicates that there has been an exceedance of any performance measures in Tables 5 and 6, or where exceedance appears likely.	Section 7.5
	▪ An assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures.	Section 7.5.1 and 7.5.2
C10(g)(xi)	Includes a program to collect sufficient baseline data for future Extraction Plans.	Section 3 of this plan
Offsets		
C4	If the Applicant exceeds the performance measures in Table 6 and the Secretary determines that:	Section 7.5.3
C4(a)	It is not reasonable or feasible to remediate the subsidence impact or environmental consequence; or	
C4(b)	Remediation measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence;	
-	Then the Applicant must provide a suitable offset to compensate for the subsidence impact or environmental consequence, to the satisfaction of the Secretary.	
-	*Notes:* ▪ Any offset required under this condition must be proportionate with the significance of the subsidence impact or environmental consequence. *Any offset required under this condition does not limit other actions by the Department under the penalty powers or enforcement provisions of the EP&A Act.*	-
C5	If required under Condition C4, any offsets for biodiversity and swamps must be undertaken in accordance with the Biodiversity Offsets Scheme of the BC Act.	Section 7.5.3
C6	The offset must give priority to like-for-like physical environmental offsets, but may also consider other offsets under the Biodiversity Offsets Scheme of the BC Act, such as the Biodiversity Conservation Fund established by BCT, or funding or implementing supplementary measures, such as:	Section 7.5.3
C6(a)	Actions outlined in threatened species recovery programs;	
C6(b)	Actions that contribute to threat abatement programs;	
C6(c)	Biodiversity research and survey programs; and/or	
C6(d)	Rehabilitating degraded habitat.	
Part F – Environmental Management, Reporting and Auditing		
Incident notification		
F9	The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must identify the development (including the development application number and name) and set out he location and nature of the incident.	Section 7.4 and 8.1
Non-compliance Notification		
F10	Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The	Section 8.2

Condition	Requirement	Where addressed
	notification must set out the condition of this consent that the development is non-compliance with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.	
Annual Review		
F11	By the end of March each year after the commencement of the development under this consent, or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. This review must:	Section 11.1
F11(a)	Describe the development (including any rehabilitation) that was carried out in the previous calendar year and the development that is proposed to be carried out over the current calendar year;	
F11(b)	Include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:	
F11(b)(i)	Relevant statutory requirements, limits or performance measures/criteria;	
F11(b)(ii)	Requirements of any plan or program required under this consent;	
F11(b)(iii)	Monitoring results of previous years; and	
F11(b)(iv)	Relevant predictions in the document/s listed in Condition A2(c);	
F11(c)	Identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid recurrence;	
F11(d)	Evaluate and report on:	
F11(d)(ii)	Compliance with the performance measures, criteria and operating conditions of this consent;	
F11(e)	Identify any trends in the monitoring data over the life of the development;	
F11(f)	Identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	
F11(g)	Describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.	
F12	Copies of the Annual Review must be submitted to Wollongong City Council, Wollondilly Shire Council and made available to the Community Consultative Committee and any interested person upon request.	Noted
Independent Environmental Audit		
F13	Within one year of commencement of the development under this consent, and three years after, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development. The audit must:	Section 11
F13(a)	Be prepared in accordance with the Independent Audit Post Approval Requirements (Department 2020 or as updated);	
F13(b)	Be led and conducted by a suitably qualified, experienced and independent auditor whose appointment has been endorsed by the Planning Secretary;	

Condition	Requirement	Where addressed
F13(c)	Be conducted by a suitably qualified, experienced and independent team of experts (including any expert in field/s specified by the Planning Secretary) whose appointment has been endorsed by the Planning Secretary;	
F13(d)	Be carried out in consultation with the relevant agencies and the Community Consultative Committee;	
F13(e)	Assess the environmental performance of the development and whether it is complying with the relevant requirements in this consent, water licences and mining leases for the development (including any assessment, strategy, plan or program required under these approvals);	
F13(f)	Review the adequacy of any approved strategy, plan or program required under the abovementioned approvals and this consent;	
F13(g)	Recommend appropriate measures or actions to improve the environmental performance of the development and any assessment, strategy, plan or program required under the abovementioned approvals and this consent; and	
F13(h)	Be conducted and reported to the satisfaction of the Planning Secretary.	
F14	Within three months of commencing an Independent Environmental Audit, or other timeframe agreed by the Planning Secretary, the Applicant must submit a copy of the audit report to the Planning Secretary, and any other NSW agency that requests it, together with its response to any recommendations contained in the audit report, and a timetable for the implementation of the recommendations. The recommendations must be implemented to the satisfaction of the Planning Secretary.	Section 11
Monitoring and Environmental Audits		
F15	Any condition of this consent that requires the carrying out of monitoring or an environmental audit, whether directly or by way of a plan, strategy or program, is taken to be a condition requiring monitoring or an environmental audit under Division 9.4 of Part 9 of the EP&A Act. This includes conditions in respect of incident notification, reporting and response, non-compliance notification, compliance report and independent audit.	Section 11

2.2 Management Plan requirements

Schedule 2, Part F, Condition F5 of the DC MP09_0013 requires the management plans under this DC to be prepared in accordance with the relevant guidelines as detailed. Table 4 details where each component of the condition is addressed within this BMP.

In accordance with Condition C10, WRPL will ensure implementation of this BMP as approved by the Secretary, before carrying out any second workings covered by the plan.

Table 4 Management plan requirements as per Schedule 2 Part F of MP09_0013 within BMP

Reference	Development Consent	Plan Section
F5	Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:	-

Reference	Development Consent	Plan Section
F5(a)	A summary of relevant background or baseline data;	Appendix B, Appendix D, and Section 3
F5(b)	Details of:	-
F5(b)(i)	The relevant statutory requirements (including any relevant consent, licence or lease conditions);	Section 2
F5(b)(ii)	Any relevant limits or performance measures and criteria; and	Section 5
F5(b)(iii)	The specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 5, Section 7.3.1 and Appendix C
F5(c)	Any relevant commitments or recommendations identified in the document/s listed in Condition A2;	Sections 5, 6 and 7
F5(d)	A description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Sections 5, 6 and 7
F5(e)	A program to monitor and report on the:	Section 6 and 11
F5(e)(i)	Impacts and environmental performance of the development; and	
F5(e)(ii)	Effectiveness of the management measures set out pursuant to Condition F5(c);	
F5(f)	A contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 7.4 and Section 7 generally
F5(g)	A program to investigate and implement ways to improve the environmental performance of the development over time;	Section 7.4 and Section 7 generally
F5(h)	A protocol for managing and reporting any	Section 8 and Section 9 The EP (Sections 4 and 5)
F5(h)(i)	Incident; non-compliance or exceedance of any impact assessment criterion or performance criterion;	
F5(h)(ii)	Complaint; or	
F5(h)(iii)	Failure to comply with other statutory requirements;	
F5(i)	Public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	Sections 11 and 12 The EP (Section 5)
F5(j)	A protocol for periodic review of the plan.	
F8	ENVIRONMENTAL MANAGEMENT - Revision of Strategies, Plans and Programs If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary. Where revisions are required, the revised document must be submitted to the Planning Secretary for approval within 6 weeks of the review.	Section 9

Reference	Development Consent	Plan Section
	Note: This is to ensure strategies, plans and programs are updated on a regular basis and to incorporate any recommended measures to improve the environmental performance of the development.	

2.3 Statement of commitments

Section 6 of the RPPR (Biosis 2014a) included a Statement of Commitments (SoC) for the Revised Preferred Project. As a result of submissions received, WRPL committed to additional environmental management and monitoring measures as out lined in the Submission Report (NRE 2013) – Part A and Part B presents an updated consolidated SoC for the Revised Preferred Project (Biosis 2014a).

Table 5 UEP EP SoC

Development Consent	Timing	Plan Section
WRPL will consult with the NSW Biodiversity and Conservation Division as part of the process to review and update the Biodiversity Management Plan and Upland Swamp Management Plan to reflect the Revised Preferred Project and associated management and monitoring measures.	Within 3 months of approval and ongoing	Section 2.6.2
Given that no perceptible subsidence impacts are predicted to occur as a result of the Revised Preferred Project, monitoring of potential biodiversity impacts will be focussed on subsidence monitoring and monitoring required to detect primary impacts to groundwater systems associated with upland swamps, and surface water flow and quality in creeks. If subsidence impacts and/or primary impacts in excess of those predicted are detected, the monitoring program will be reassessed.	Ongoing in accordance with the BMP	Section 6 and Section 7.5 Refer also to the EP

2.4 EPBC Act approval requirements

The Revised Preferred Project for the UEP was referred under the EPBC Act for approval (2020/8702) on 4 August 2020 and subsequently approved by DCCEEW on 31 August 2021.

The relevant conditions of EPBC 2020/8702 relevant to the proposed bord and pillar panels (second workings) and potential impacts on Coastal Upland Swamps are specified in Table 6 with reference to where each component of the condition is addressed within this BMP.

Table 6 Location of addressed components of EPBC 2020/8702 within the BMP

Condition	Requirement	Where addressed
1.	For the protection of water resources, the approval holder must comply with State Development Consent Conditions B12-B20, C1-C3, and C10-C11.	This plan

Condition	Requirement	Where addressed
2.	The approval holder must ensure there is no adverse effect on the function of a water resource as a result of the mining activities of the action.	Section 7
7.	In addition to the monitoring requirements specified in and/or required under Condition B17 and Condition C10 of the State Development Consent, the approval holder must:	-
7.d.	Establish, at least 12 months prior to second workings being within 350 metres (m) (horizontal distance from the closest boundary) of each Coastal Upland Swamp, and maintain, in all potentially impacted Coastal Upland Swamps, and in multiple reference swamps that demonstrate baseline condition, monitoring capable of determining individual water balances for each potentially impacted Coastal Upland Swamp;	Section 6.3
7.f.	Within 20 business days of the end of the three-monthly monitoring period, publish on the website and submit to the Department all monitoring data collected in accordance with Condition 7.e., updated at least once every three months to include the most recent monitoring data. Maintain the data on the website for at least five years after the monitoring program has been completed. Include an evaluation of what the data means in relation to meeting and maintenance of the performance measures relevant to water resources specified in the State Development Consent.	Section 6.3
7.g.	Include, in each compliance report, the monitoring data collected in accordance with Condition 7.b and 7.e, in relation to the period covered by each compliance report. Include an evaluation of performance against the performance measures relevant to water resources specified in the State Development Consent.	Section 9
7.g.	Include, in each compliance report, the monitoring data collected in accordance with Condition 7.b and 7.e, in relation to the period covered by each compliance report. Include an evaluation of performance against the performance measures relevant to water resources specified in the State Development Consent.	Section 9
8.	In addition to the requirements specified in and/or required under condition B19 of the State development consent, the approval holder must:	-
18.	If the approval holder exceeds the performance measure required by State Development Consent Condition CI, and the NSW Planning Secretary determines that an offset is required under State Development Consent Condition C4, the approval holder must provide the Department with details of the offset(s) approved by the NSW Planning Secretary within 10 business days of the approval by the NSW Planning Secretary.	Section 7.5.3
Annual compliance reporting		
25.	The approval holder must by the end of each 12-month period following the date of commencement of the action, or as	Section 9

Condition	Requirement	Where addressed
	otherwise agreed to in writing by the Minister, prepare a compliance report. The approval holder must:	
25.a.	Publish each compliance report on the website within 60 business days following the end of the 12-month period for which that compliance report is prepared;	
25.b.	Notify the Department by email that each compliance report has been published on the website and provide the we blink for the compliance report within five business days of the date of publication of each compliance report;	
25.c.	Keep all compliance reports publicly available on the website until this approval expires;	
25.d.	Exclude or redact sensitive ecological data from compliance reports published on the website; and	
25.e.	Where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication on the website.	
Reporting non-compliance		
26.	The approval holder must notify the Department in writing of any: incident; non-compliance with the conditions; or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify:	Section 8
26.a.	Any condition which has been or may have been in breach;	
26.b.	A short description of the incident and/or non-compliance; and	
26.c.	The location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	
27.	The approval holder must provide to the Department the details of any incident or noncompliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying:	Section 8
27.a.	Any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future;	
27.b.	The potential impacts of the incident or non-compliance; and	
27.c.	The method and timing of any remedial action that will be undertaken by the approval holder.	
Independent audit		
28.	The approval holder must ensure that an independent audit of compliance with the conditions is conducted for the three-year period from the date of this approval and subsequently for every three-year period for the life of the approval, or as otherwise requested in writing by the Minister.	Section 11
29.	For each independent audit, the approval holder must:	Section 11
29.a.	Provide the name and qualifications of the independent auditor and the draft audit criteria to the Department;	

Condition	Requirement	Where addressed
29.b.	Only commence the independent audit once the audit criteria have been approved in writing by the Department; and	
29.c.	Submit an audit report to the Department within the timeframe specified in the approved audit criteria.	
30.	The approval holder must publish the audit report on the website within 10 business days of receiving the Department's approval of the audit report and keep the audit report published on the website until the end date of this approval.	Section 11

2.5 Relevant legislation and guidelines

WRPL will conduct approved mining operations consistent with DC MP09_0013 and EPBC 2020/8702 approval conditions and any other legislation that is applicable. The following Acts are applicable to this plan:

- *Biosecurity Act 2015.*
- *Biodiversity Conservation Act 2016.*
- *Environmental Planning and Assessment Act 1979.*
- *Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).*
- *Fisheries Management Act 1994.*
- *Mining Act 1992.*
- *Protection of the Environment Operations Act 1997.*
- *Water Management Act 2000.*
- *Water NSW Act 2014.*

Relevant licences or approvals required under these Acts will be obtained as required.

2.5.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation. The EPBC Act applies to developments and associated activities that have the potential to significantly impact on Matters of National Environmental Significance (MNES) protected under the Act.

Coastal Upland Swamp in the Sydney Basin Bioregion is listed as an EEC under the EPBC Act and is a groundwater dependent ecosystem (GDE). Potential impacts to ecological MNES are limited to potential indirect impacts associated with subsidence and hydrological changes affecting surface water regimes or near-surface groundwater, which may potentially impact the Coastal Upland Swamp in the Sydney Basin Bioregion EEC.

In addition, there are two flora species (Leafless Tongue-orchid *Cryptostylis hunteriana* and Prickly Bush-pea *Pultenaea aristata*) and five fauna species (Giant Burrowing Frog *Heleioporus australiacus,* Silver Perch *Bidyanus bidyanus*, Trout Cod *Maccullochella macquariensis*, Macquarie Perch *Macquaria australasica*, and Murray Cod *Maccullochella peelii*) listed under the EPBC Act, that have a moderate or greater likelihood of occurrence in the EP area and are susceptible to impacts from subsidence. One additional species listed under the EPBC Act, Littlejohn's Tree Frog *Litoria littlejohni*, has been assumed present within the Stage 2 EP area.

These species and the potential for sensitive habitats to be impacted are addressed in Section 3.3.1, 4.2 and Appendix B.

2.5.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) is the key piece of legislation providing for the protection and conservation of biodiversity in NSW through the listing of threatened species and communities and key threatening processes (KTPs). Impacts to threatened species and communities are assessed under Section 7.3 of the BC Act. The BC Act also establishes the framework for biodiversity offsetting.

Coastal Upland Swamp in the Sydney Basin Bioregion is also listed as an EEC under the BC Act. In addition, there are two flora species (Leafless Tongue-orchid *Cryptostylis hunteriana* and Prickly Bush-pea *Pultenaea aristata*) and three fauna species (Giant Burrowing Frog *Heleioporus australiacus,* Giant Dragonfly *Petalura gigantea*, Red-crowned Toadlet *Pseudophryne australis*) listed under the BC Act that have a moderate or greater likelihood of occurrence in the EP area and are susceptible to impacts from subsidence. One additional species listed under the BC Act, Littlejohn's Tree Frog *Litoria littlejohni*, has been assumed present within the Stage 2 EP area. These species and the potential for sensitive habitats to be impacted are addressed in Section 3.3.1, 4.2 and Appendix B.

2.6 Consultation

2.6.1 Consultation during the environmental assessment process

Extensive community and government consultation has been carried out prior to and during the preparation of the original environmental assessment, the Revised Project Report (Biosis 2014a), the Submissions Report (NRE 2013) and other project-related assessment documentation. The primary objective of consultation was to keep the community, government agencies and other stakeholders informed and involved during project development process.

Community engagement was carried out in two phases and is summarised in Section 4.1.2 and Section 4.1.3 of the Revised Project Report.

A complete summary of previous and ongoing government agency and stakeholder consultation is provided in Table 4.5 of the Revised Project Report (Biosis 2014a). Consulted parties of relevance to this BMP included:

- NSW Department of Planning and Environment (DPE).
- NSW Biodiversity Conservation Department (BCD).
- WaterNSW.

2.6.2 Consultation during the preparation of the Management Plan

This Plan has been prepared in consultation with:

- NSW DPE Planning Division.
- NSW EES.
- DCCEEW including Commonwealth Office of Water Science (OWS).

Details of the consultation are provided in Table 7 below.

Table 7 Project consultation

Agency name and timing of consultation	Subject of consultation	Where addressed
Stage 1		
DPE (Planning) – 9 February 2021	Letter to the department advising on the proposed team for the development of the EP including its subplans for Subsidence, Water, Biodiversity and Swamps.	Section 1.1
EES – BCD – 5 March 2021 and 14 September 2021	Discussed information requirements of the plan to ensure adequacy for monitoring all threatened species and communities potentially affected by the UEP project. See Appendix A for the details of this feedback and associated response.	Section 3.5 and 6, Appendix A
DCCEEW and OWS – 2 March 2021	Discussions in February 2021 IESC advice regarding potential impacts on water dependent ecosystems and Coastal Upland Swamps.	Section 4.2 and 6.3
OWS – 9 April 2021	Discussions in April 2021 regarding approach to use of reference sites for Coastal Upland Swamp biodiversity Monitoring and TARP requirements for threatened species potentially impacted by subsidence or changes in hydrological processes.	Section 6 and Appendix C
BCS – 12 November 2021	Letter recommended that the BMP be updated to include a monitoring program for the Giant Burrowing Frog.	Section 6.4 and Appendix A
Stage 2		
DPE (Planning)	Regular engagement throughout process. No specific comments provided in relation to Biodiversity in relation to Stage 2. Plan reviewed by DPE as part of approval process.	TBD
EES – BCD	Initial email correspondence received from BCD on 09 May 2022, which requested specific information and data regarding Stage 1. Further feedback for Stage 2 was received from DPE BCD on 23 May 2022.	Detailed copies of the relevant correspondence are included in Appendix A. Initial response to feedback provided to BCD via letter on 09 June 2022. Following this, a meeting will be held between WRPL, BCD and DPE on 15 June 2022 to further discuss.
DCCEEW	Consultation with DCCEEW to occur post approval of the Extraction Plan by DPE.	-

Agency name and timing of consultation	Subject of consultation	Where addressed
DPE (Environment)	Letter provided 24 August 2022 requesting information in relation to threatened frog monitoring undertaken to date. Following a response, further correspondence regarding frog habitat and monitoring was received.	Detailed copies of the relevant correspondence are included in Appendix A. A response to the Request for Information was provided to DPE via letter on 9 September 2022. Threatened frog habitat has been assumed in Stage 2 and Sections 3.5, 6.4 and 6.5 updated accordingly.

3 BASELINE DATA

3.1 Summary of baseline data monitoring

Due to the extended history of mining in the UEP area and the assessment process for the UEP, there is a long period of baseline data collection which is relevant to the identification of potential impacts from the mining in the EP area. While some of this monitoring has been undertaken in relation to the monitoring of impacts from Longwall (LW) 4, LW5 and LW6, the sites have had no significant impacts identified to aquatic biodiversity, rocky habitats or other threatened species from this mining that precludes the use of this data as being suitable for setting a baseline for monitoring of impacts associated with the mining covered by the EP. A summary of this monitoring is provided below with a summary of baseline conditions for aquatic ecology in Section 3.3.1, and threatened species provided in Sections 3.3.1, 3.4 and 3.5.

The EP USMP (WRPL 2022a) Section 3 provides details of baseline monitoring for the Coastal Upland Swamps and associated threatened species and groundwater levels within swamps.

3.2 Terrestrial vegetation

The plant community types (PCTs) within the UEP area, with the exception of Coastal Upland Swamps (Figure 5), were mapped using desktop mapping (DPE 2010). The UEP area supports 755 hectares of native vegetation, across 10 PCTs being:

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

It is to be noted that the PCT 978 *Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin* via the Sydney Metro Vegetation Classification

Project 2014, was split on 17 March 2014 within the Sydney metropolitan catchment area into the following communities:

- *PCT 1803: Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin.*
- *PCT 1804: Needlebush - Banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin.*

Whilst the desktop assessment provides the potential distribution of the upland swamp communities, the size and extent of therefore mentioned upland swamp communities are yet to be determined.

Previously mapped Coastal Upland Swamp communities (Biosis 2012) historically recorded the following vegetation types: Upland Swamps: Banksia Thicket (MU42); Upland Swamps: Tea-tree Thicket (MU43); Upland Swamps: Restioid Heath (MU44b) and Upland Swamps: Cyperoid Heath (MU44c). Comparison to current PCTs has indicated that PCT 1078 *Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion* may be present within the EP area (Figure 5), however it has not been confirmed.

Assessment of the potential for the EP area to support GDEs was undertaken using the Australian Government's Bureau of Meteorology, Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BOM 2019), 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 EP area according to the GDE Atlas or metadata (DPE 2010).

The GDE Atlas identified that the EP area contains 10 PCTs (Figure 5), including:

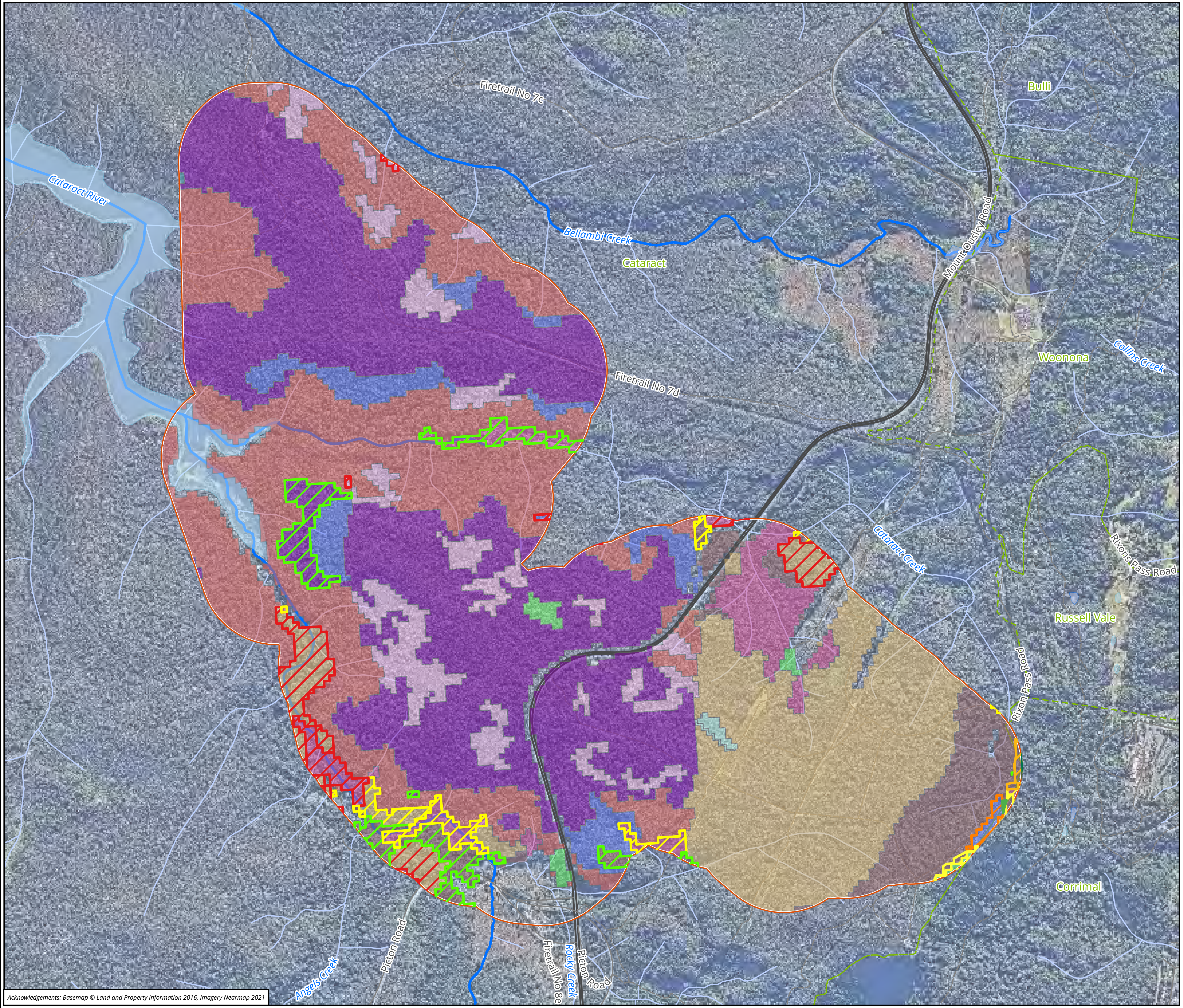
- Two groundwater dependent wetland communities.
- Eight vegetation communities, identified as ‘moderate to high Probability GDEs’ (Table 8) in the risk assessment guidelines, and potentially reliant on subsurface expression of groundwater.

Table 8 PCTs and potential GDEs within the EP area

PCT common names	PCT name	BC Act listing	EPBC Act Listing	GDE potential
Illawarra Escarpment Blackbutt forest	*PCT 694: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin*	Not listed	Not listed	High potential GDE
Coastal sandstone rock plate heath	*PCT 881: Hairpin Banksia - Kunzea ambigua - Allocasuarina distyla heath on coastal sandstone plateaux, Sydney Basin Bioregion*	Not listed	Not listed	Moderate potential GDE

PCT common names	PCT name	BC Act listing	EPBC Act Listing	GDE potential
Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion	*PCT 878: Gully Gum - Sydney Peppermint - Yellow Stringybark moist open forest of coastal escarpments, southern Sydney Basin Bioregion*	Not listed	Not listed	Moderate potential GDE
Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion	*PCT 882: Hairpin Banksia - Slender Tea-tree heath on coastal sandstone plateaux, Sydney Basin Bioregion*	Not listed	Not listed	Moderate potential GDE
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	Not listed	High potential GDE
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	*PCT 1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin*	Not listed	Not listed	Moderate potential GD
Illawarra Escarpment Blue Gum wet forest	*PCT 1245: Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin*	Not listed	Not listed	High potential GDE
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	Not listed	High potential GDE
Tableland swamp meadow on impeded drainage sites of the western Sydney Basin	*PCT 1256: Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion*	Montane Peatlands and Swamps of the New England Tableland, NSW	Montane Peatlands and Swamps of the New England Tableland, NSW	High potential GDE (groundwater dependent

PCT common names	PCT name	BC Act listing	EPBC Act Listing	GDE potential
Bioregion and South Eastern Highlands Bioregion	*and South Eastern Highlands Bioregion*	North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	wetland community)
Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin	*PCT 978: Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin* Includes: *PCT 1803: Banksia - Needlebush - Tea-tree damp heath swamps on coastal sandstone plateaus of the Sydney basin* *PCT 1804: Needlebush - Banksia wet heath swamps on coastal sandstone plateaus of the Sydney basin*	Coastal Upland Swamp in the Sydney Basin Bioregion	Coastal Upland Swamp in the Sydney Basin Bioregion	High potential GDE (groundwater dependent wetland community)



Legend

UEP area

Groundwater dependent ecosystems

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

Plant Community Types

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

Figure 5 Groundwater dependent ecosystems

0 120 240 360 480 600
Metres
N

Scale: 1:16,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

Matter: 36747,
Date: 06 April 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F5_GDE
Project: P:\36700s\36746\Mapping\36746_WCL_Stage2_BMP.aprx

3.3 Aquatic ecological data

Annual reports have been provided to WRPL since the ecological monitoring program commenced in 2011, for works associated with previous long wall mining within the RVE domain. At the completion of the 2017 ecological monitoring program, 4.5 years of post-mining data had been collected for those sites that were at risk of impacts from LW4, LW5 and LW6 which was mined during the 2015 monitoring period. As a result, three seasons (two and a half years) of post-mining data had been collected for those sites at risk of mining related impacts.

The most recent published annual report addressing the 2020 monitoring period was provided in 2021. This report (Biosis 2021) evaluated the second year of the recommencement of the ecological monitoring in the RVE area including analysis of the previous years of data, and to assess 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, the results from the 2020 and 2019 monitoring were reviewed. The results indicate that aquatic habitats and macroinvertebrate communities within the monitoring reaches did not exhibit any signs of disturbance that are attributed to longwall mining (Biosis 2021). As such all, impact monitoring sites were considered to be within prediction (level 1). As mining progress into the Stage 2 area (Figure 3), it is recommended that monitoring continues to be undertaken along Bellambi Creek and Lake Cataract to assess the baseline conditions of these waterways. Once mining has commenced in this Stage 2 area aquatic monitoring is to continue on a bi-annual basis until one after year after mining has concluded, in line with the requirements of the current aquatic monitoring program.

All HABSCORE results were within the Optimal or Suboptimal category; for stage 1, attributed to nominal stream flows and diversity within the physical structure of the reaches. All impact monitoring sites recorded results above the trigger levels requiring immediate supplementary investigation. The AUSRIVAS analyses returned results that were typical of the assessments undertaken in previous years, with all results generally being within the ranges previously recorded, indicating stable water quality and macroinvertebrate communities at all reaches assessed in 2020. A trend of minor decreases in stream health and HABSCORE results was observed at a number of individual sites, however this trend was also observed in the control sites, indicating this trend is occurring at the catchment scale and was attributed to the extended drought conditions observed up to and including 2020.

Macquarie Perch surveys identified ‘young of the year’ Macquarie Perch within Bellambi Creek and Cataract River, but not in Cataract Creek. While ‘young of the year’ Macquarie Perch have been recorded within Cataract Creek previously, breeding is unlikely to occur within Cataract Creek due to the lack of habitat features (riffles adjoining gravel runs) that are traditionally considered suitable for Macquarie Perch breeding. The species is widespread within the Cataract Reservoir catchment. The general fish community structure recorded in 2019 was noted to be consistent with that recorded in previous surveys. The somewhat reduced numbers of Macquarie Perch are likely to be, to a degree, related to the difference in survey method as well but also the extended period of drought contributing to reduced connectivity, habitat condition and availability.

Ongoing monitoring of Macquarie Perch is not recommended to be continued, as although the species is prolific within Cataract Reservoir and its tributaries, no breeding habitat has been identified as subject to impacts. Furthermore, the number of individuals recorded in Cataract Creek is very low, in comparison to the reservoir and other tributaries, which indicates a low reliance on Cataract Creek.

3.3.1 Aquatic ecological monitoring

Aquatic ecological monitoring has been undertaken by Biosis within the UEP area between 2012 and 2022, however, there have been various iterations of monitoring locations due to modifications in the suitability of control sites. The most recent aquatic ecological monitoring was conducted in 2022 (Table 9).

Table 9 Aquatic ecological monitoring locations undertaken in reference to RVE

Site	Waterway	Impact/Control	Monitoring Duration	Methods
Stage 1				
RVE-AQ2	Cataract River	Impact	2010 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ3	Cataract Creek tributary	Impact	2013 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ4	Cataract Creek	Impact	2013 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ5	Cataract Creek	Impact	2010 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ6	Cataract Creek	Impact	2010 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ9	Angels Creek	Control	2014 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ11	Bellambi Creek tributary	Control	2014 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring

Site	Waterway	Impact/Control	Monitoring Duration	Methods
RVE-AQ14	Loddon Creek	Control	2015 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
RVE-AQ15	Bellambi Creek	Control	2015 to current	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring
Stage 2				
RVE-AQ16	Cataract River	Impact	Monitoring to commence in 2022	▪ HABSCORE ▪ AUSRIVAS ▪ Water quality ▪ Photo-point monitoring

3.4 Threatened species

The desktop assessment confirmed that one EEC, *Coastal Upland Swamps in the Sydney Basin Bioregion* (Endangered, EPBC Act and BC Act), was previously mapped within the EP area as part of the *Southeast NSW Native Vegetation Classification and Mapping project SCIVI VIS ID 2230* (DPE 2010). Historical records also exist within the locality for 127 threatened flora and fauna species listed under the EPBC Act and BC Act (Figure 6). In addition, six species have not been recorded within the locality but are considered to have habitat within the EP area. These records are outlined in Appendix B, along with those species and communities identified by the Protected Matters Search Tool and BioNet that are considered likely to occur in the EP area due to the presence of potential habitat.

Not all of the threatened species and communities that have the potential to occur within the EP area are considered to be susceptible to the subsidence related impacts. As there are no direct impacts associated with the UEP program (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 EP area, and are considered susceptible to the indirect impacts resulting from subsidence (See Appendix B and Table 10). 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 EEC, seven flora species and 13 fauna species (nine terrestrial and four aquatic) listed under the EPBC Act and/or BC Act, that have the potential to occur or are known to occur in the EP area, of which two flora and nine fauna species are considered susceptible to subsidence impacts (Figure 6). An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2014, and the risk of impact from mining is provided in Table 10. Further impact assessment details are provided in Section 3.5. The likelihood of occurrence for some species in this list has changed since Biosis (2014a) and

Hansen Bailey (2015) as described in Table 10. Species with a low likelihood of occurrence are not represented on Figure 6 and are not addressed further in the report.

Table 10 Threatened species and communities with potential to occur in the EP area and susceptible to indirect subsidence impacts

Scientific name	Common name	EPBC Act status	BC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the EP area[1]	Risk of impact from UEP workings
Threatened ecological community						
Coastal Upland Swamps in the Sydney Basin Bioregion		Endangered	Endangered	Coastal Upland Swamps	Recorded	Negligible
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions		Endangered	Endangered	Montane Peatlands and Swamps	Predicted – not validated (GDE PCT mapping).	Negligible
Flora						
Cryptostylis hunteriana	Leafless Tongue-orchid	Vulnerable	Vulnerable	Coastal Upland Swamps	Moderate	Negligible
Pultenaea aristata	Prickly Bush-pea	Vulnerable	Vulnerable	Coastal Upland Swamps	Recorded	Negligible
Terrestrial fauna						
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Vulnerable	Rocky environments in the form of cliffs (Habitat not present)	Low[1] – 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 EP area does not support suitable roosting habitat.	Negligible

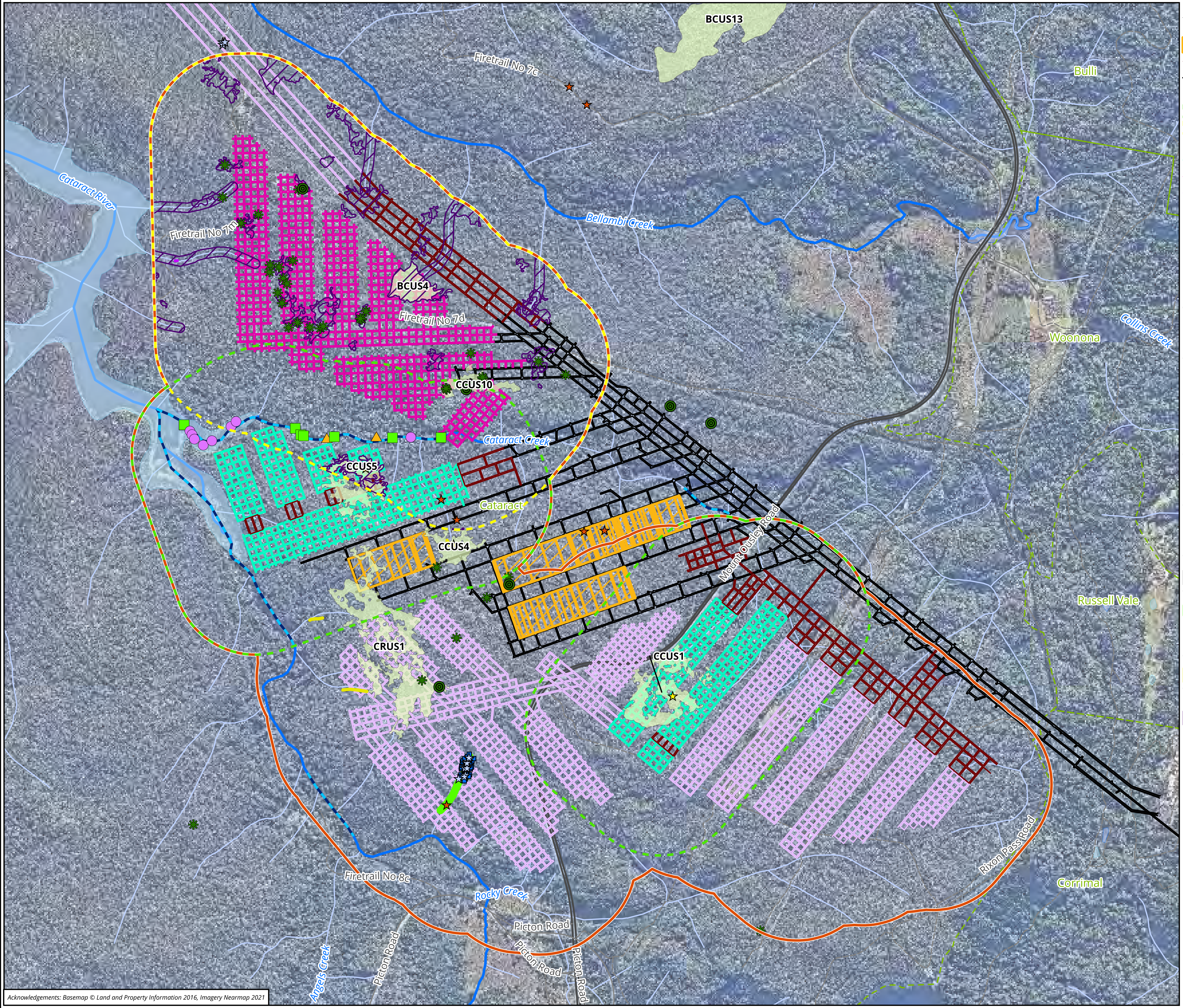
[1] Species with a low likelihood of occurrence are not represented on Figure 6 and are not addressed further in the report.

Scientific name	Common name	EPBC Act status	BC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the EP area[1]	Risk of impact from UEP workings
Heleioporus australiacus	Giant Burrowing Frog	Vulnerable	Vulnerable	Coastal Upland Swamps / aquatic environments / rocky environments	High – Habitat has been assumed present within the Stage 2 EP area for the purposes of offsetting, as per the recommendation provided by the BCD (Appendix A).	Negligible
Hoplocephalus bungaroides	Broad-headed Snake	Vulnerable	Endangered	Rocky environments (Habitat not present)	Low[1] – The Broad-headed Snake is now considered a low likelihood of occurrence. Suitable rocky habitat is highly limited in the EP area and additional monitoring has not detected the species.	Negligible
Litoria littlejohni	Littlejohn's Tree Frog	Vulnerable	Vulnerable	Coastal Upland Swamps / aquatic environments	Low[1] – Littlejohn's Tree Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2016). Suitable habitat is limited in the EP area and targeted surveys undertaken between August 2013 and February 2016 did not detect the species in the EP area. Habitat has been assumed present within the Stage 2 EP area for the purposes of offsetting, as per the recommendation provided by the BCD (Appendix A).	Negligible

Scientific name	Common name	EPBC Act status	BC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the EP area[1]	Risk of impact from UEP workings
Miniopterus australis	Little Bent-winged Bat	-	Vulnerable	Rocky environments in the form of cliffs (Habitat not present)	Moderate – The EP area does not support suitable roosting habitat in the form of cliffs. Habitat in the form of hollow-bearing trees will not be susceptible to subsidence.	Negligible
Miniopterus orianae oceanensis	Large Bent-winged Bat	-	Vulnerable	Rocky environments in the form of cliffs (Habitat not present)	Low[1] – The likelihood of occurrence for the Large Bent-winged Bat has been downgraded to a low likelihood of occurrence. The EP area does not support suitable roosting habitat.	Negligible

Scientific name	Common name	EPBC Act status	BC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the EP area[1]	Risk of impact from UEP workings
Mixophyes balbus	Stuttering Frog	Vulnerable	Endangered	Coastal Upland Swamps / aquatic environments	Low[1] – Stuttering Frog is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2016). Suitable habitat is limited in the EP area and targeted surveys undertaken between August 2013 and February 2016 did not detect the species in the EP area. 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 it was found to exhibit levels of pollution due to run-off from Mount Ousley Road (M1 Princess Motorway). Although the habitat is suitable, these impacts result in sub-optimal conditions for the species.	Negligible

Scientific name	Common name	EPBC Act status	BC Act status	Sensitive habitat feature utilised	Likelihood of occurrence in the EP area[1]	Risk of impact from UEP workings
Myotis macropus	Southern Myotis	-	Vulnerable	Aquatic environments / Rocky environments in the form of cliffs (Habitat not present)	Low[1] – The EP area does not support suitable roosting habitat in the form of cliffs. Habitat in the form of hollow-bearing trees will not be susceptible to subsidence.	Negligible
Petalura gigantea	Giant Dragonfly	-	Endangered	Coastal Upland Swamps	Recorded	Negligible
Pseudophryne australis	Red-crowned Toadlet	-	Vulnerable	Coastal Upland Swamps / aquatic environments	Recorded	Negligible
Varanus rosenbergi	Rosenberg's Goanna	-	Vulnerable	Rocky environments	Low[1]	Negligible
Aquatic fauna						
Bidyanus bidyanus	Silver Perch	Critically Endangered	-	Aquatic environments	Recorded	Negligible
Maccullochella macquariensis	Trout Cod	Endangered	-	Aquatic environments	Recorded	Negligible
Macquaria australasica	Macquarie Perch	Endangered	-	Aquatic environments	Recorded	Negligible
Maccullochella peelii	Murray Cod	Vulnerable	-	Aquatic environments	Recorded	Negligible



Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

EP areas

- Stage 1
- Stage 2

Mine plan

- Stage 1
- Stage 2
- Future stages

Fish survey

- Threatened fish survey reaches

Recorded fish locations

- Macquarie Perch
- Murray Cod
- Silver perch

Threatened fauna (Biosis record)

- Giant Burrowing Frog - *Heleioporus australiacus*

Threatened fauna (Bionet)

- Giant Dragonfly
- Red-crowned Toadlet - *Pseudophryne australis*
- Giant Burrowing Frog - *Heleioporus australiacus*

Threatened flora (Biosis record)

- Prickly bush-pea - *Pultenaea aristata* (Biosis record)

Threatened flora (Bionet)

- Prickly bush-pea - *Pultenaea aristata* (Bionet record)

Threatened species habitat

- Giant Dragonfly habitat

Threatened Frog breeding habitat

- Giant Burrowing Frog
- Red-crowned toadlet - *Pseudophryne australis*

Threatened Frog non-breeding habitat

- Giant Burrowing Frog

Threatened Frog habitat (assumed)

- Giant Burrowing Frog and Littlejohn's Tree Frog

Figure 6 Threatened species records in the UEP area

0 120 240 360 480 600
Metres
Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

Matter: 36746,
Date: 07 October 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F6_ThreatenedSpecies
Project: P:\36700s\36746\Mapping\36746_WCL_Stage2_BMP.aprx

3.5 Threatened fauna baseline monitoring

3.5.1 Giant Burrowing Frog baseline monitoring

Habitat for the Giant Burrowing Frog within the EP area consists of small sections of upper tributaries above the future stages workings. Habitat within the broader RVE area for the Giant Burrowing Frog has only been identified along a 245 m section of a tributary of Cataract River below swamp CRUS2, which is outside the area of potential impact from the Stage 1 and Stage 2 workings. There is potential habitat for Giant Burrowing Frog in the Stage 1 or Stage 2 area, however despite monitoring, it has not been detected within these areas. Habitat for Giant Burrowing Frog has been assumed (for potential offsetting purposes only) within the Stage 2 area, consisting of small tributaries and Coastal Upland Swamps (Figure 6).

Adults, metamorphs and tadpoles of this species have been previously recorded over 13 surveys between 2012 and 2021 near CRUS2, across winter, autumn and summer seasons using visual encounter surveys. The species was not detected during two surveys in spring 2022. The species has been recorded from a total of ten pools along the 245 m transect. A summary of the records is presented in Table 11 below. Detailed surveys undertaken have indicated that other than the tributary of Cataract River below CRUS2, other tributaries within Stage 1 are unlikely to support these species, particularly given the survey effort undertaken.

Table 11 Giant Burrowing Frog records 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
13/10/2021	Spring	0	0	21

Survey date	Round	Adult	Metamorph	Tadpoles
21/10/2021	Spring[2]	0	0	18
19/09/2022	Spring	0	0	0
21/09/2022	Spring	0	0	0

3.5.1.1 Stage 1 (a and b)

Extensive surveys for Giant Burrowing Frog have been undertaken within the Stage 1 EP area. The species has not been detected and no suitable habitat has been identified based on prior surveys and identified in the response to Request for Information (Appendix A).

3.5.1.2 Stage 2

Giant Burrowing Frog has not been detected within the Stage 2 area and no suitable habitat has been identified, however habitat has been assumed present within Stage 2 for the purposes of offsetting, as per the recommendation provided by BCD (Appendix A). Assumed habitat for Giant Burrowing Frog within the Stage 2 EP area consists of upper tributaries and vegetation within 20 metres of the mapped waterways, as well as Coastal Upland Swamps.

Additional baseline surveys will be undertaken within the assumed habitat in the Stage 2 EP area between September 2022 and May 2023, prior to mining commencing.

3.5.2 **Littlejohn's Tree Frog baseline monitoring**

3.5.2.1 Stage 1 (a and b)

Extensive surveys for Littlejohn's Tree Frog have been undertaken within the Stage 1 EP area. The species has not been detected and no suitable habitat has been identified based on prior surveys and identified in the response to Request for Information (Appendix A).

3.5.2.2 Stage 2

Littlejohn's Tree Frog has not been detected within the Stage 2 area and no suitable habitat has been identified, however habitat has been assumed present within Stage 2 for the purposes of offsetting, as per the recommendation provided by BCD (Appendix A). Assumed habitat for Littlejohn's Tree Frog within the Stage 2 EP area consists of upper tributaries and vegetation within 20 metres of the mapped waterways, as well as Coastal Upland Swamps.

Additional baseline surveys will be undertaken within the assumed habitat in the Stage 2 EP area between October 2022 and November 2023 (survey period is July to November), prior to mining commencing.

[2] Diurnal habitat survey

4 POTENTIAL IMPACTS

4.1 Direct impacts

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

As such there will be no direct impacts to terrestrial and aquatic biodiversity (threatened species and ecological communities), listed under the EPBC Act and/or BC Act, as a result of the secondary workings.

The secondary workings will not result in any direct impacts to the ecological features identified in the EP area other than minor impacts associated with the installation of monitoring equipment. The management of these minor impacts will be undertaken through the approval process from Water NSW associated with activities carried out in the WaterNSW special area.

In addition, any potential indirect impacts to biodiversity have been avoided by careful mine planning with the current mine plan unlikely to result in significant or detectable impacts to any threatened species or community listed under the EPBC Act or BC 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.

4.2 Indirect impacts

The only potential impacts to terrestrial and aquatic biodiversity (threatened species and ecological communities), listed under the EPBC Act and/or BC Act, 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 secondary workings are summarised below in Section 4.3. A description of the potential subsidence related indirect impacts on sensitive habitats is provided in Section 4.2.1.

4.2.1 Sensitive habitats

The EP 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. Areas of sensitive habitat in the EP area (Biosis 2014a) include:

- Rocky environments.
- Coastal Upland Swamps (listed as an EEC).
- Ground water dependent terrestrial vegetation communities.
- Aquatic environments (Cataract Creek, Cataract River, Bellambi Creek and their tributaries).

Disturbance, including weeds, is limited to fire trails and infrastructure associated with water storage, electricity easements, transport and mining activities.

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

The secondary workings do not include any direct impacts to threatened species or ecological communities, listed under the EPBC Act and/or BC Act, as the secondary workings will not result in the direct removal of any vegetation or habitat. The main potential impact mechanism associated with the secondary workings 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 subsidence (DECC 2007, DoP 2008, PAC 2009, DoP 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 EP area are shown in Figure 7. The extent of each sensitive habitat type within the EP area are detailed in the sections below.

4.2.2 Coastal Upland Swamps

Detailed mapping and characterisation of Coastal Upland Swamps in the Sydney Basin Bioregion EEC (listed under the EPBC Act and BC Act) was undertaken by Biosis (2012) throughout the EP area. A total of 37 upland swamps were recorded in the Stage 1 and Stage 2 EP area. All 37 swamps are considered to meet the requirements for listing under the EPBC Act and BC Act. The extent of this EEC in relation to the UEP is illustrated in Figure 7. Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of Coastal Upland Swamps, historic impacts of mining on Coastal Upland Swamps, including impacts to hydrogeological features.

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

- Giant Burrowing Frog.
- Giant Dragonfly.
- Leafless Tongue-orchid.
- Littlejohn's Tree Frog[3].
- Prickly Bush-pea.
- Stuttering Frog[3].

4.2.3 Aquatic environments

The revised mine plan is 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 EP area, Cataract River is a fourth order stream connecting to the south arm of Cataract Reservoir and is bordered by Coachwood Warm Temperate Rainforest vegetation (NPWS 2003). There are no secondary workings proposed directly under the Cataract River, however secondary workings will be undertaken beneath some tributaries and the catchment of Cataract River.

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 EP area, Cataract Creek is a third order stream down to Mount Ousley Road (M1 Princess Motorway), and a fourth order stream downstream of Mount Ousley Road. Secondary workings will be undertaken beneath some tributaries and the catchment of Cataract Creek.

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 first workings will be undertaken beneath some tributaries and the catchment of Bellambi Creek.

The EP 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 2012b, Cardno Ecology Lab 2012c).

[3] Low likelihood of occurrence

Second workings will occur beneath parts of Cataract Creek and beneath tributaries and parts of the broader catchment area of Cataract Creek. Streams in the EP area provide potential habitat for a number of threatened species listed under the EPBC Act and/or BC Act, including:

- Giant Burrowing Frog (tributaries only).
- Littlejohn's Tree Frog (tributaries only)[3].
- Macquarie Perch.
- Murray Cod (lower reaches adjacent to Lake Cataract).
- Red-crowned Toadlet.
- Silver Perch (lower reaches adjacent to Lake Cataract).
- Southern Myotis[3].
- Stuttering Frog[3].
- Trout Cod (lower reaches adjacent to Lake Cataract).

4.2.4 Rocky environments

Rocky outcrops and sandstone outcrops in the EP area provide potential habitat for a number of threatened species listed under the EPBC Act and/or BC Act, including:

- Broad-headed Snake[3].
- Giant Burrowing Frog.
- Large-eared Pied Bat[3].
- Large Bent-winged Bat[3].
- Red-crowned Toadlet.
- Rosenberg's Goanna[3].
- Southern Myotis[3].

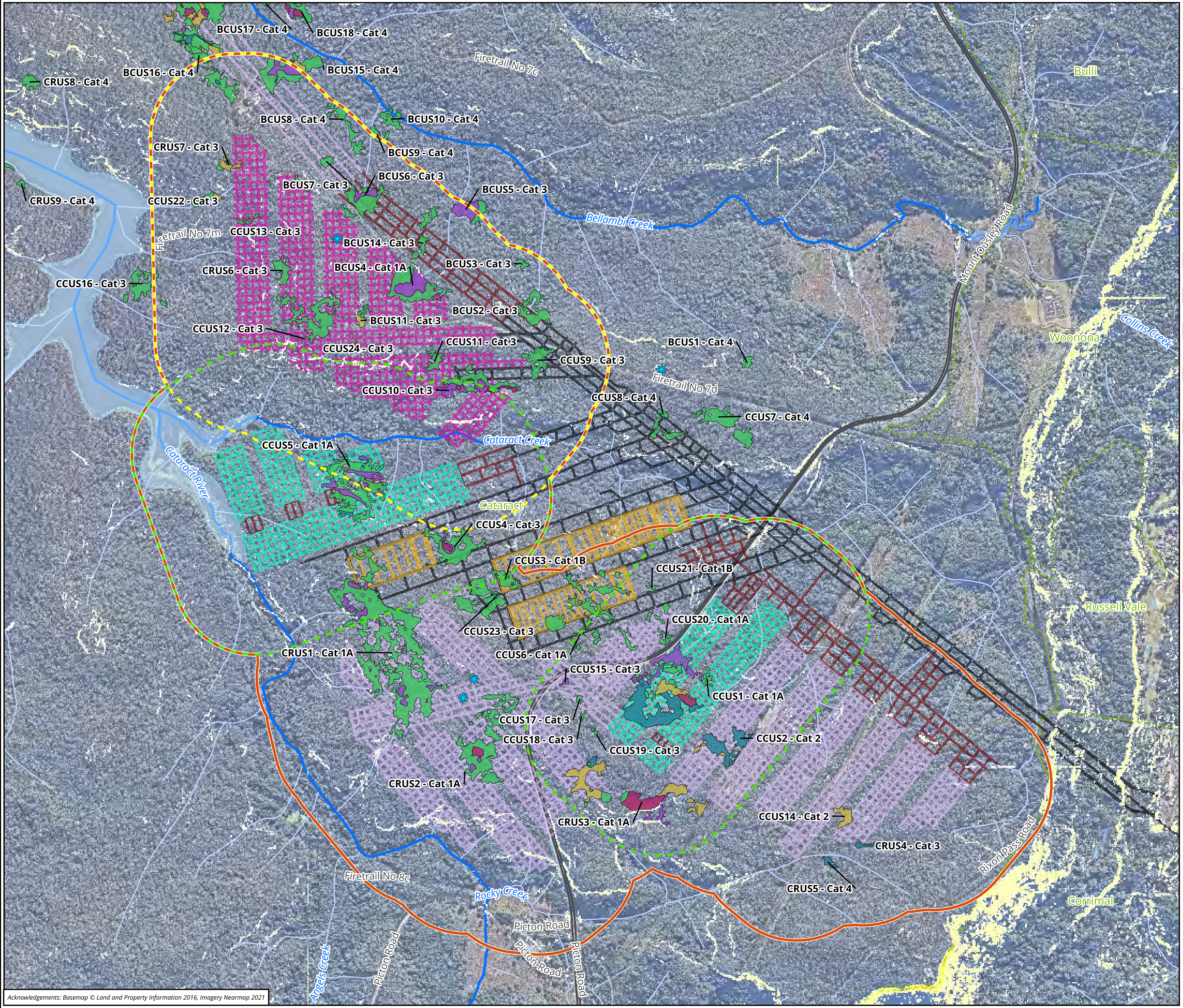
There are no sandstone formations within the EP areas that would be described as cliffs by current mining approval definitions for cliff and steep slopes. The sandstone outcrop formations within the EP areas are all less than 10 m high with no sandstone formations greater than 6 m in height above the planned second working panels.

Rocky environments in the EP areas include cliffs and rocky outcrops. An inspection of cliff formations and steep slopes within Wonga East was undertaken by SCT Operations (2012). In the EP area, cliff formations along Cataract Creek are typically less than a few metres high but do extend up to 6 m high in some sections. An assessment of the cliff formations by Biosis did not identify any significant overhangs or caves, therefore potential roosting habitat for microchiropteran bats is limited in extent and restricted to an area adjacent north of Cataract Creek outside of the UEP area.

As a result of the lack of cliffs, cave and overhang habitat for microbats (Large-eared Pied Bat, Large Bent-winged Bat, Southern Myotis) were considered to be absent from the EP area.

The EP 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 are sandstone benches and overhangs present within the EP area, the exfoliating slabs that provide isolated patches of habitat for Broad-headed Snake are largely absent due to the historical removal of ‘bush rock’. Based on the limited extent of north-western and western facing sandstone benches, in addition to absence of exfoliating slabs, within the Stage 1 and 2 EP areas, and the presence of other suitable habitat in the region, potential impacts on the Broad-headed Snake, or other species dependent on rocky habitat are not likely to be significant.



Acknowledgements: Basemap © Land and Property Information 2016, Imagery Nearmap 2021

Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

Mine plan

- Stage 1
- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Vegetation Sub-Communities

- MU42,Upland Swamps: Banksia Thicket
- MU43,Upland Swamps: Tea-Tree Thicket
- MU44,Upland Swamps: Sedgeland-Heath Complex
- MU44a,Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b,Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)
- MU44c,Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Cliffs (m)

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

Sensitive habitat

- Rock outcrop

Figure 7 Sensitive habitat within the UEP area

0 100 200 300 400 500

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis.

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F7_SensitiveHabitat
Project: P:\36700s\36746\Mapping\
36746_WCL_Stage2_BMP.aprx

4.3 Predicted subsidence effects - General

The updated subsidence predictions for the secondary extraction covered by this EP (SCT 2021, SCT 2022) 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 millimetres [mm] and generally less than 20 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 assessments 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 2021, SCT 2022). The proposed mining is not expected to have an impact on surface water dependent ecosystems or groundwater dependent ecosystems (Umwelt).

A peer review of the RVC 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 (B K Hebblewhite Consulting 2019). The review also supported the claim that the UEP secondary 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 UEP 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 mm for Stage 1 (SCT 2021). The mine plan has been developed to ensure that pillars are long terms stable. The Pillar design has factors of safety exceeding 2.11 which implies a probability of instability of 1 in 1,000,000. The likelihood of an initiating event (pillar failure) occurring is therefore considered to be remote.

The predicted levels of vertical subsidence from mining covered by the EP are in the order of 100 mm directly over the proposed mining panels with very low or no vertical subsidence outside these areas. These low levels of subsidence are not predicted to result in any observable impacts to biodiversity outside the Stage 1 and 2 EP areas. As discussed in Section 3.1, impacts on downstream aquatic environments from mining in the form of either changes in water quality, flows, pool depth or sedimentation are also predicted to be negligible.

There are no sandstone formations within the EP areas that would be described as cliffs by current mining approval definitions for cliff and steep slopes. The sandstone outcrop formations within the EP areas are all less than 10 m high with no sandstone formations greater than 5 m in height above the planned bord and pillar panels.

No significant, additional impacts to sandstone outcrop formations or instability of steeper ground is expected from the low level subsidence effects forecast. Impacts and consequences are expected to be negligible in the context of previous impacts. Cliff falls and rock falls are not anticipated from the low levels of subsidence predicted, however it is noted that rock falls and cliff falls are a natural process associated with the weathering of these features.

4.4 Predicted subsidence effects - Cumulative

The Stage 1 and 2 EP areas have previously been mined, including extraction of the overlying Balgownie Seam and Bulli Seam as well as the extraction of LW panels 4, 5 and part of LW 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, 2020, SCT 2021, SCT 2022) 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 Updated Subsidence Risk Assessment (SCT 2021). Only one section of the Bulli Goaf areas occurs above the proposed EP area (Area #11) which is noted as likely to have collapsed (SCT 2021). There are no creeks or Coastal Upland Swamps located above Area #11 meaning the consequences of the failure of any remnant Bulli Seam pillars that may occur in this area is unlikely to result in any breach of performance measures relevant to biodiversity features. Importantly, it is noted by SCT and the peer review process that this risk exists regardless of the whether the UEP project proceeds and the secondary workings do not materially change this existing risk or the environmental consequences associated with this occurring.

The detailed technical assessments prepared for the UEP have considered the potential cumulative impact of the secondary workings with historical mining operations within and surrounding the EP area.

The majority of planned mining in Stage 2 for PC27-34 is below Bulli seam workings only (SCT 2022). The boundary of the planned mining in PC27-34 is below the worked out area on the south side of the main headings in the Bulli Seam. Although expected to be collapsed, the goaf areas are unconfirmed as collapsed and subsided. The potential for additional subsidence from the Bulli Seam cannot be eliminated, but that potential exists irrespective of any planned mining, and planned mining is not expected to cause a significant change at the Bulli seam mining horizon. While vertical subsidence is expected to be generally less than 100 mm and largely imperceptible over the majority of the Stage 1 and 2 EP area, vertical subsidence of greater than 500 mm is considered possible, but unlikely, in small, isolated areas within and near the edges of Bulli Seam goaf areas where remnant pillars not already collapsed may become unstable (SCT 2021, SCT 2022). The potential for additional subsidence exists regardless of the planned mining.

5 PERFORMANCE MEASURES AND CRITERIA

Performance measures for the UEP are outlined in Schedule 2 Condition C1 Table 5 of the DC. Performance measures relevant to the biodiversity features are outlined in Table 12, in addition to the performance criteria relevant to this performance measure.

The monitoring and management of potential impacts to Upland Swamps and associated threatened species is covered by the USMP (WRPL 2022a). The monitoring and management of potential impacts to aquatic habitat are also covered in further detail in the EP WMP and GMP.

The performance criteria relevant to this performance measure are also outlined in the TARP as outlined in Section 7.3 and Appendix C.

To ensure compliance with the performance measures for biodiversity values, WRPL has adopted the following performance objectives:

- No significant decline in species populations.
- No significant impact to habitats of threatened species.
- No significant impacts to habitats of aquatic species.

Table 12 Biodiversity Performance Measures

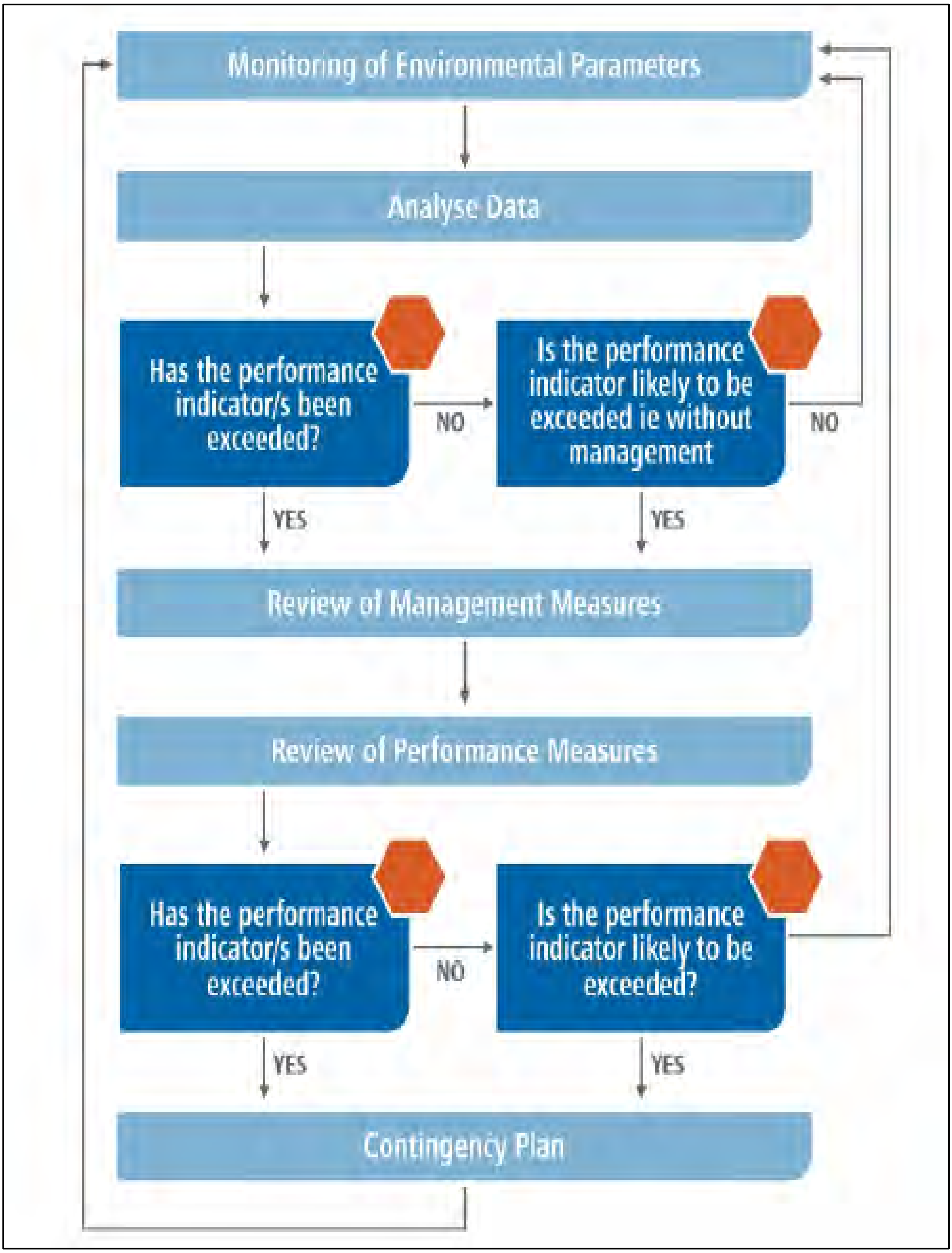
Feature	Performance measures	Performance indicator	Proposed monitoring
Swamps			
Coastal Upland Swamps identified in the figure in Appendix 5 of DC MP09_0013	Negligible environmental consequences including negligible change to the structural integrity of the bedrock base or any controlling rockbar of the swamp	▪ Refer to USMP (WRPL 2022a).	▪ Refer to USMP (WRPL 2022a).
All Coastal Upland Swamps (EPBC 2020/8702)	Vertical subsidence not to exceed 100 mm at any swamp	▪ Refer to USMP (WRPL 2022a).	▪ Refer to USMP (WRPL 2022a).
Biodiversity			
Threatened species, threatened populations, or EECs	Negligible environmental consequences	▪ Change in species abundance. ▪ Change in vegetation condition. ▪ Change in riparian habitat condition. ▪ Refer also to USMP (WRPL 2022a) for	▪ Aquatic Macro Invertebrate monitoring. ▪ Giant Burrowing Frog Monitoring[4]. ▪ HABSCORE assessments of aquatic habitat and use of control sites.

4 Not used for TARP triggers but data collected to enable assessment of potential impacts in event of observed changes on habitat associated with mining.

Feature	Performance measures	Performance indicator	Proposed monitoring
		additional performance indicators as they relate to Coastal Upland Swamps.	▪ AUSRIVAS assessment of downstream creek systems and use of control sites. ▪ Amphibian monitoring (Giant Burrowing Frog, Littlejohns Tree Frog). ▪ Also refer to USMP (WRPL 2022a) (Giant Dragonfly).
Aquatic biodiversity	Negligible environmental consequences	▪ Change in species abundance. ▪ Change in vegetation condition. ▪ Change in riparian habitat condition.	▪ Re-direction of surface water flows and pool level / flow decline >20 % during mining compared to baseline for > two months, considering rainfall /runoff variability. ▪ Observable increases in stream bed or bank erosion, turbidity, iron staining, algal growth, vegetation compared to pre-mining conditions.
Watercourses (Aquatic and Riparian Habitat)			
Watercourses, including Cataract River, Cataract Creek, and associated tributaries	Negligible diversion of flows or changes in the natural drainage behaviour of pools	▪ Reduced flow in creeks.	▪ Flow monitoring. ▪ Depth monitoring at pools. ▪ Visual inspection for cracking in stream bed at monitoring points.
	Negligible gas releases	▪ Evidence of gas releases into creek water (bubbles).	▪ Visual inspection of watercourse at monitoring locations.
	Negligible increase in water cloudiness	▪ Increased cloudiness of water.	▪ Visual Inspection at creek monitoring points.
	Negligible increase in bank erosion	▪ Increased erosion in creek banks. ▪ Elevated levels of total suspected solids (TSS).	▪ Visual monitoring of stream banks at monitoring points. ▪ Downstream monitoring of TSS.
	Negligible increase in sediment load	▪ Total suspected solids.	▪ Downstream monitoring of TSS.
Water Supply (Aquatic Habitat)			
Cataract Reservoir	Negligible leakage from reservoir	▪ Increased inflow of water into	▪ Visual monitoring of inflow rates to underground workings.

Feature	Performance measures	Performance indicator	Proposed monitoring
		underground workings.	▪ Measurement of dewatering volumes. ▪ Monitoring of underground and Permian groundwater quality. ▪ Groundwater modelling.
	Negligible reduction in water quality of reservoir	▪ Change in water quality within Reservoir.	▪ Monitoring of inflow water quality. ▪ Monitoring of water quality within reservoir (WRPL and WaterNSW).
	No connective cracking between the reservoir surface and the underground workings	▪ Increased inflow of water into underground workings.	▪ Visual monitoring of inflow rates to underground workings. ▪ Measurement of dewatering volumes. ▪ Monitoring of underground and Permian groundwater quality. ▪ Groundwater modelling.
Land (Rocky ecosystems)			
Cliffs, steep slopes and rock face features	Negligible environmental consequence (including subsidence induced rock falls, displacement or dislodgement of boulders or slabs, or fracturing)	▪ Rock falls. ▪ Fracturing of rock slabs. ▪ Instability of steep slopes.	▪ LiDAR monitoring. ▪ Visual inspections.

Figure 8 Environmental Management Process



6 BIODIVERSITY MONITORING PROGRAM

The RVE UEP is not anticipated to have any significant impacts on terrestrial or aquatic biodiversity. Monitoring will therefore be designed around the monitoring of responses to higher than expected subsidence impacts and/or the investigation of the causes of any observed changes in groundwater levels and vegetation within the swamps complementing the baseline and ongoing regular seasonal monitoring. Baseline and ongoing monitoring will be important in monitoring compliance with biodiversity and upland swamp performance measures.

Groundwater monitoring and vegetation monitoring (qualitative and quantitative) will form the basis of the monitoring. Subsidence monitoring will also be used to identify whether additional monitoring may be required.

6.1 Monitoring period

Monitoring will occur over the following periods:

- Pre-mining: Baseline monitoring as per USMP (WRPL 2022a).
- During mining: As per USMP (WRPL 2022a) and ongoing monitoring of existing non-swamp biodiversity (Refer to Sections 6.4 to 6.8 below).
- Post-mining: Monitoring post-mining as per USMP (WRPL 2022a) to confirm negligible environmental consequences as a result of the mining.

6.2 Groundwater monitoring

Monitoring of groundwater levels within the upland swamps of the Stage 1 and 2 EP areas have been undertaken since 2012 (Figure 9). There are four categories of surface water and groundwater monitoring undertaken which is relevant to aquatic biodiversity habitat:

- Visual inspection of watercourses and swamps to identify potential changes in; channel flows, stability (i.e. erosion and scouring), and downstream impacts from discharges (controlled and uncontrolled).
- Upland swamp monitoring to identify potential changes to soil moisture and ponding depths within the upland swamps.
- Flows at monitoring points within the Cataract River and Cataract Creek – to identify potential impacts to flows as a result of underground mining operations.
- Groundwater levels and quality throughout the EP area – to identify potential impacts to the regional groundwater levels and qualities as a result of the underground mining operations.

Details of swamp, surface water and groundwater monitoring requirements and locations are provided in the USMP (WRPL 2022a), WMP (WRPL 2022b) and GMP (WRPL 2022c), respectively.

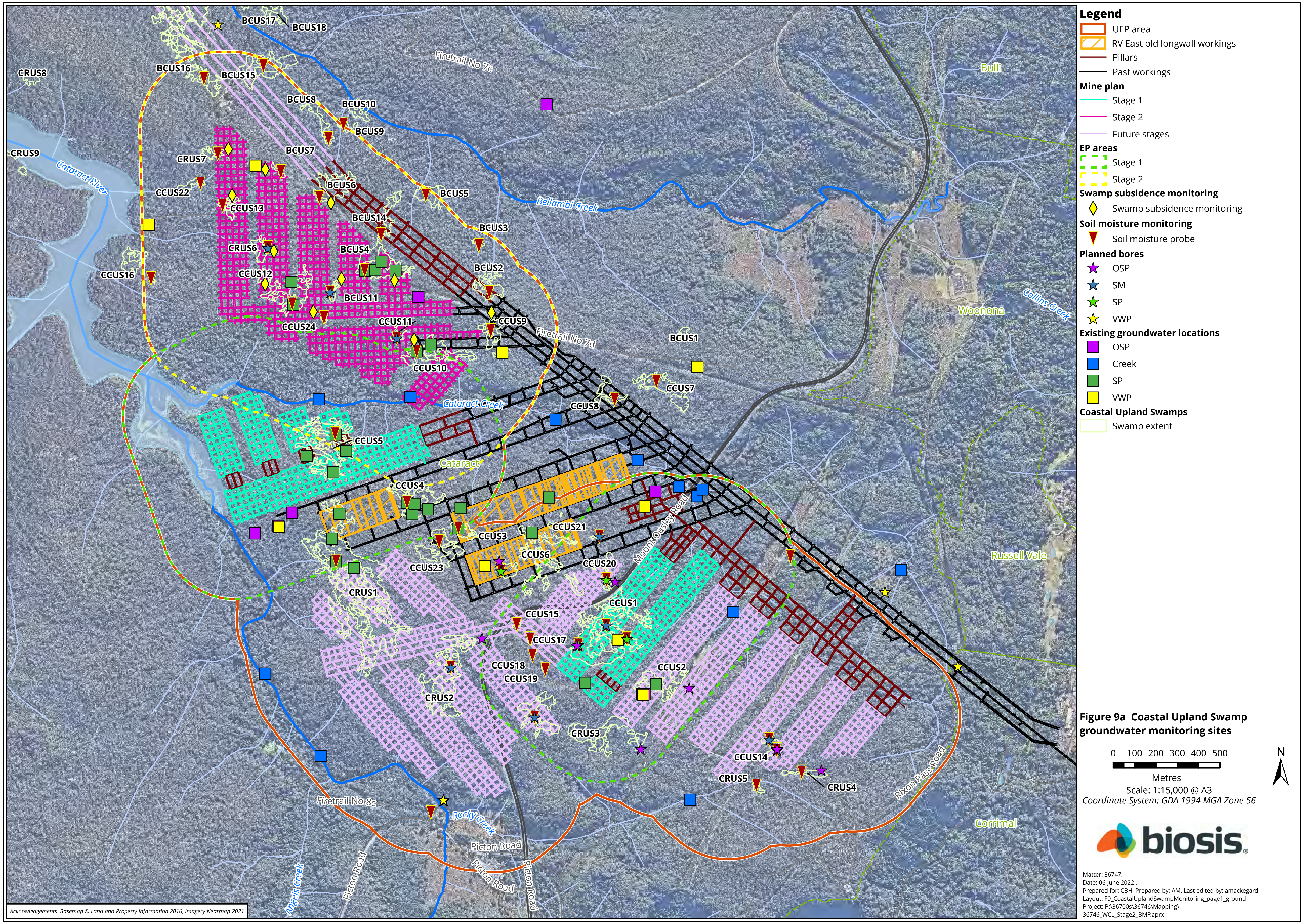


Figure 9a Coastal Upland Swamp groundwater monitoring sites

biosis

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Date: 06 June 2022 ,
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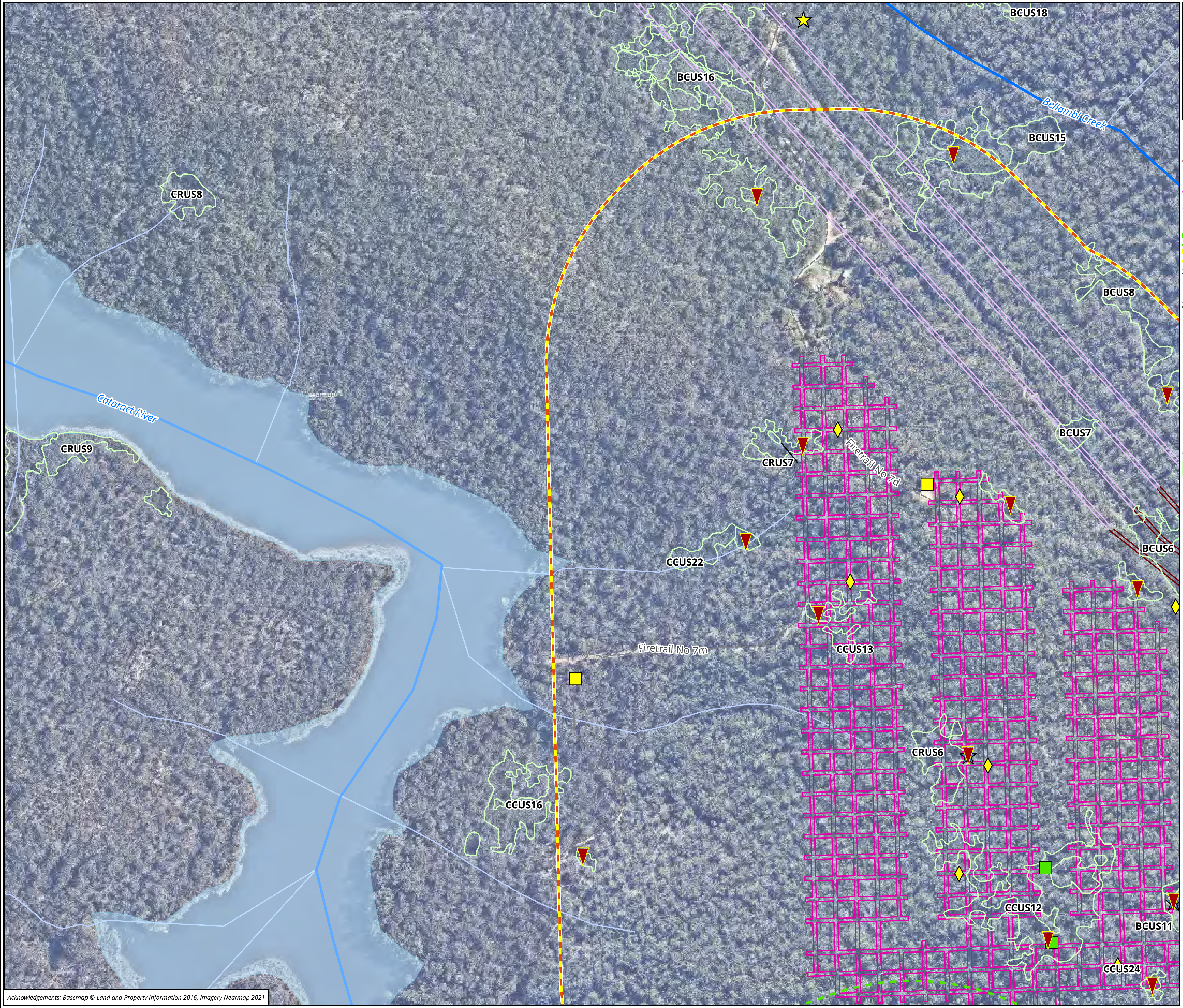

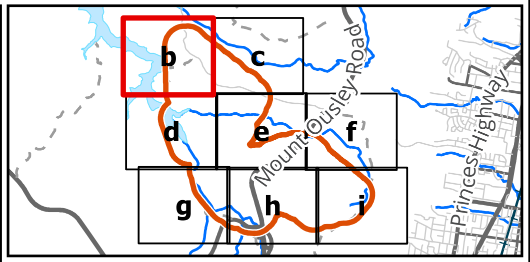

Legend

- UEP area
- Pillars

Mine plan

- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Swamp subsidence monitoring

- Swamp subsidence monitoring

Soil moisture monitoring

- Soil moisture probe

Planned bores

- SM
- VWP

Existing groundwater locations

- OSP
- SP
- VWP

Coastal Upland Swamps

- Swamp extent

Figure 9b Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 36747,
Date: 06 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F9_CoastalUplandSwampMonitoring_ground
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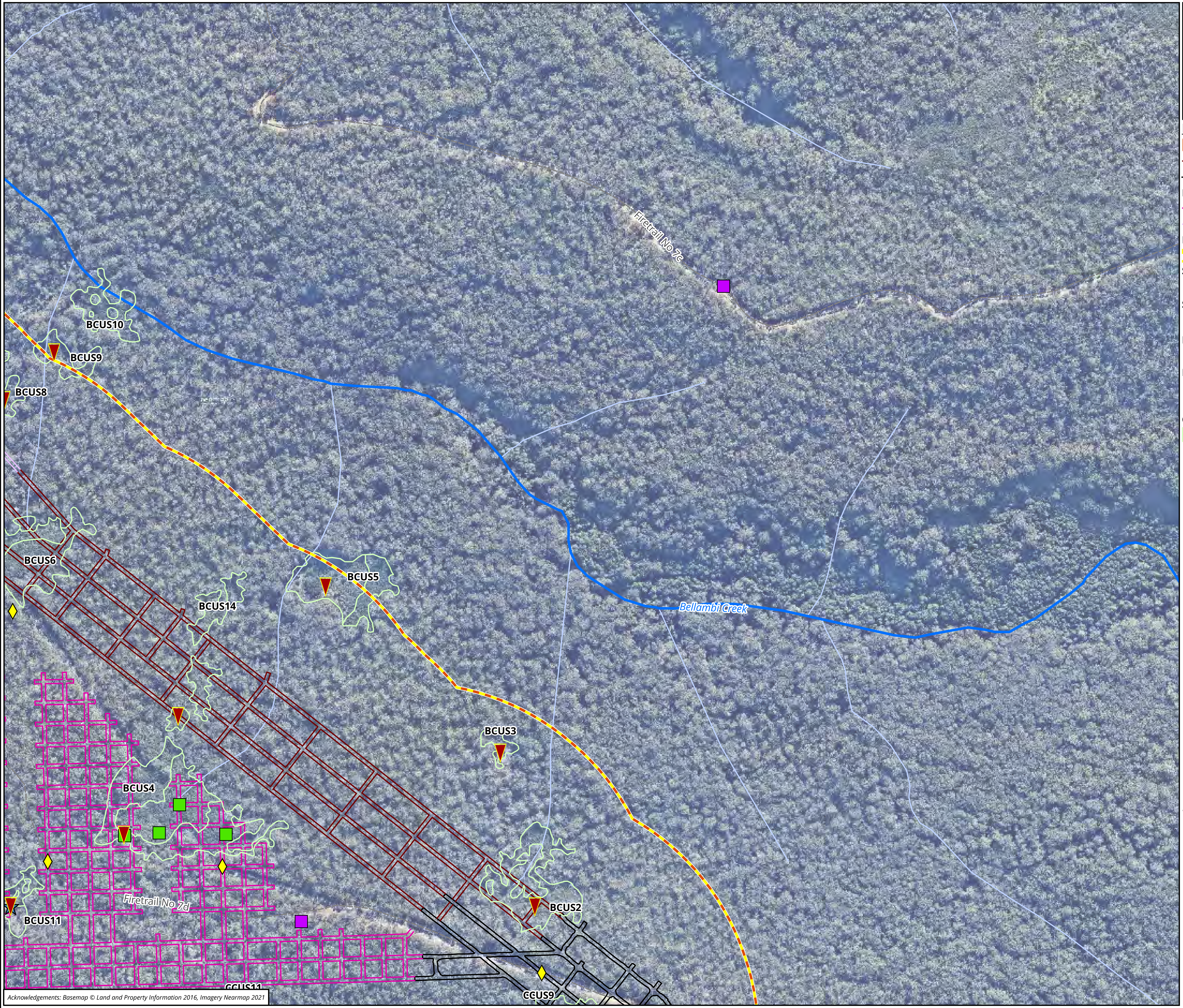

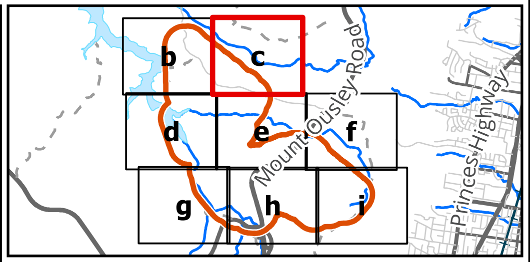

Legend

UEP area
Pillars
Past workings

Mine plan

Stage 2
Future stages

EP areas

Stage 2

Swamp subsidence monitoring

Swamp subsidence monitoring

Soil moisture monitoring

Soil moisture probe

Planned bores

SM

Existing groundwater locations

OSP
SP

Coastal Upland Swamps

Swamp extent

Figure 9c Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200
Metres
N
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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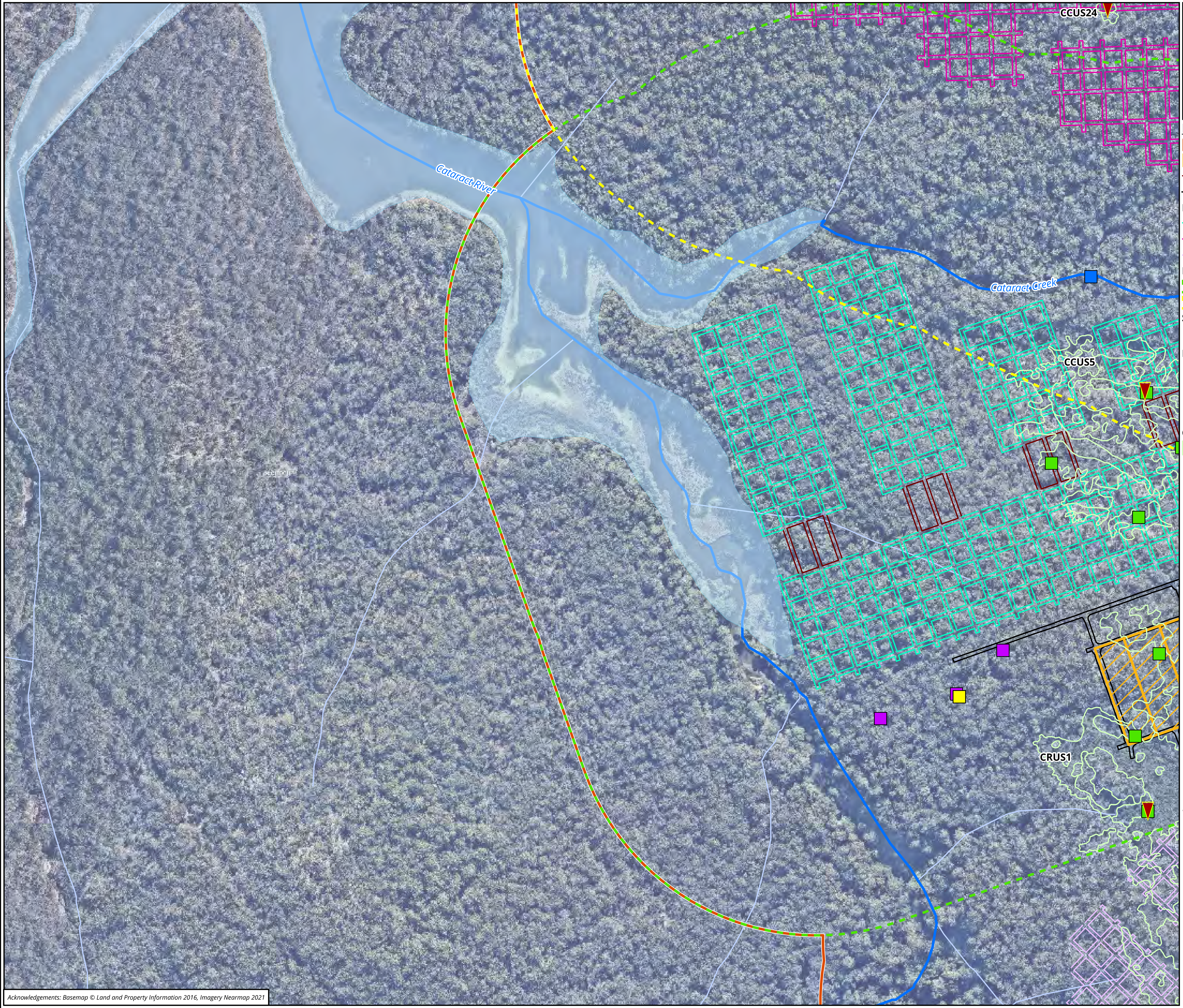

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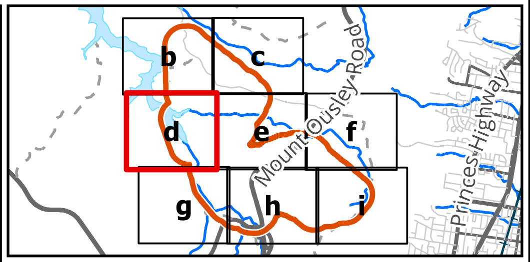

Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

Mine plan

- Stage 1
- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Soil moisture monitoring

- Soil moisture probe

Existing groundwater locations

- OSP
- Creek
- SP
- VWP

Coastal Upland Swamps

- Swamp extent

Figure 9d Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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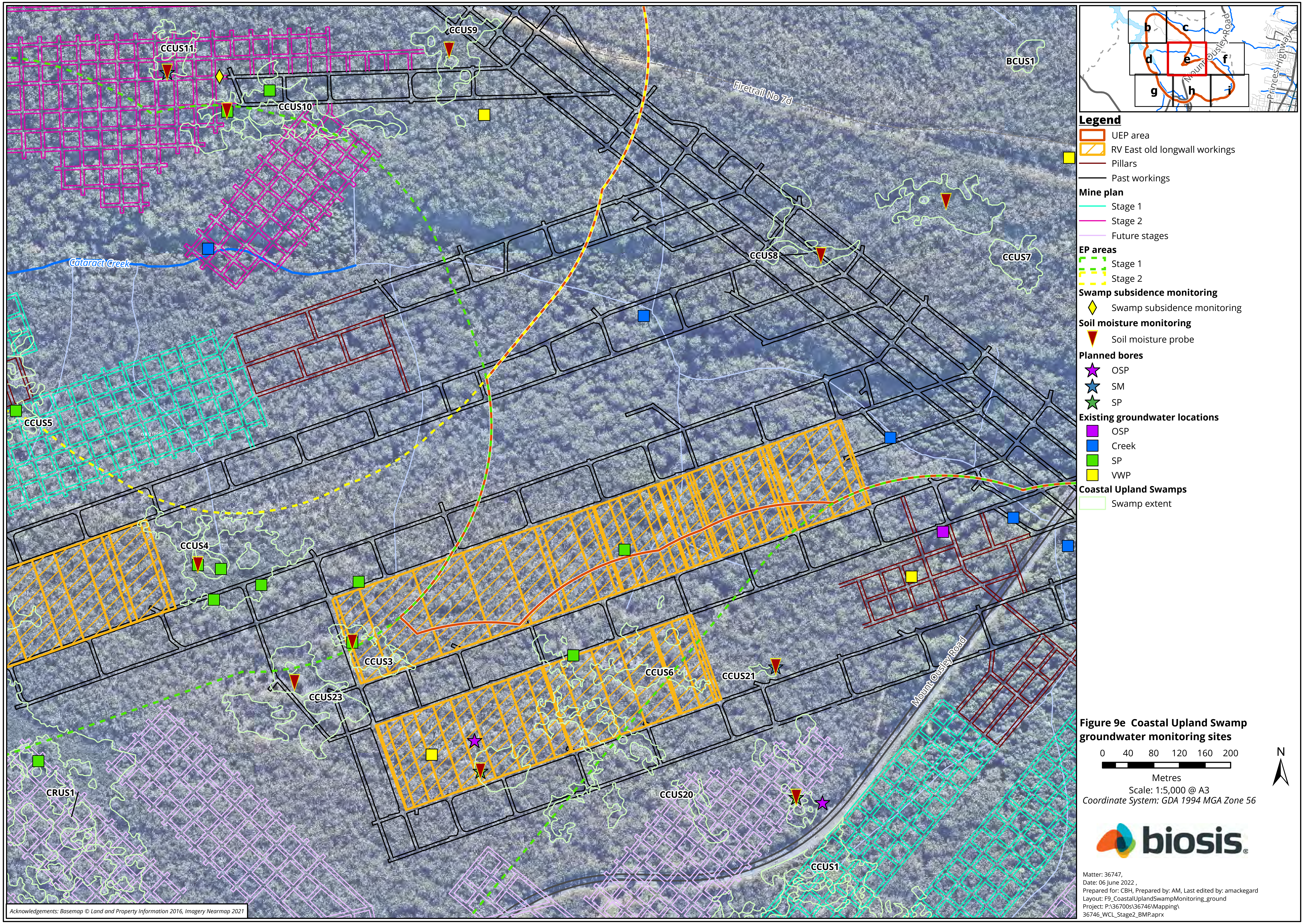
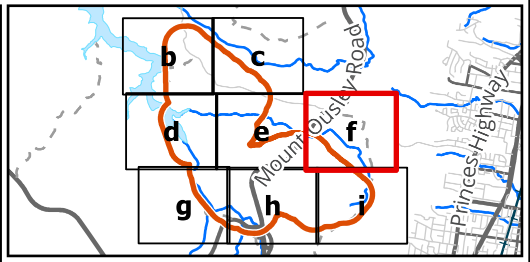


Figure 9e Coastal Upland Swamp groundwater monitoring sites



Legend

UEP area
Pillars
Past workings

Mine plan

Stage 1
Future stages

EP areas

Stage 1

Soil moisture monitoring

Soil moisture probe

Existing groundwater locations

Creek
VWP

Figure 9f Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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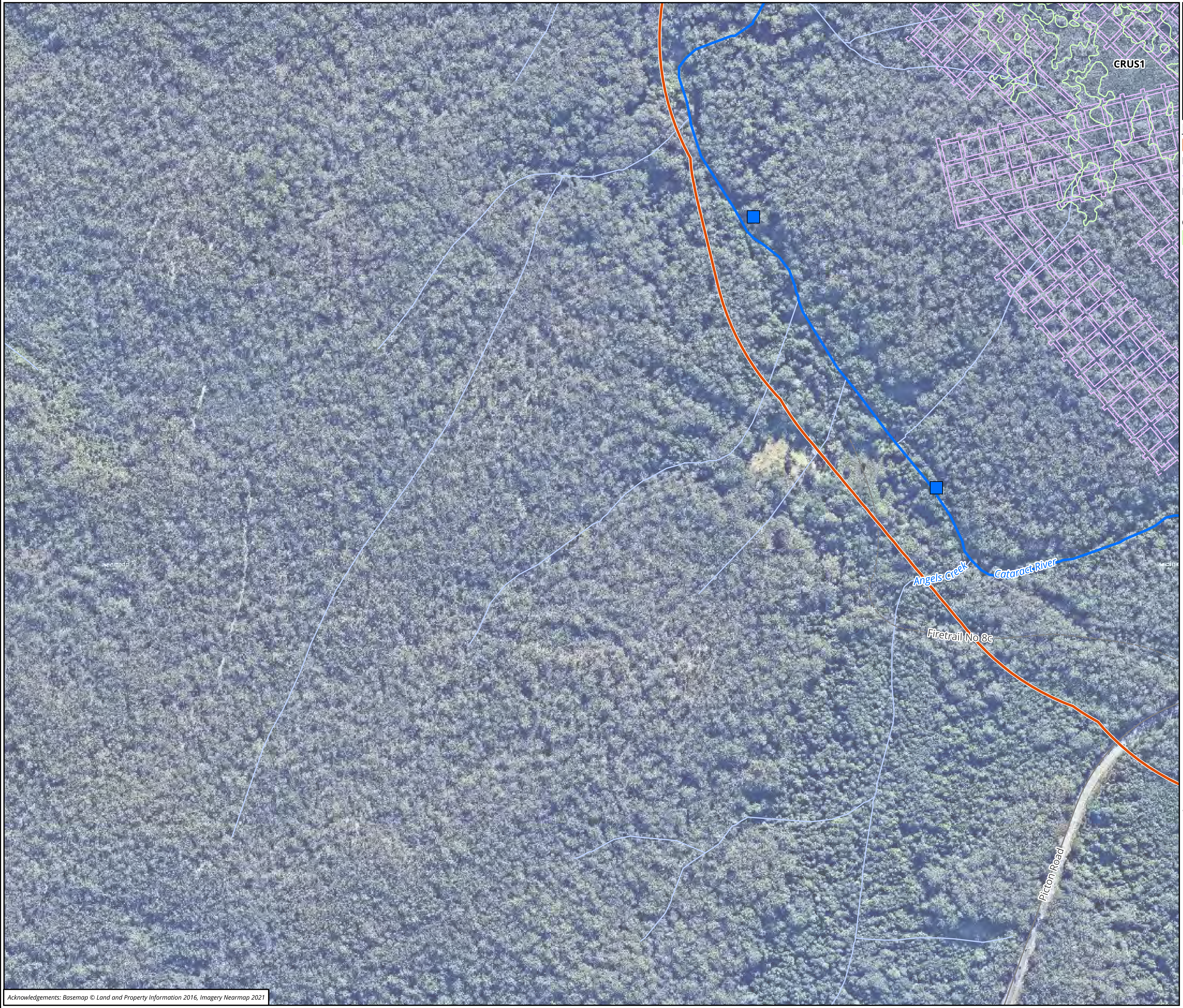

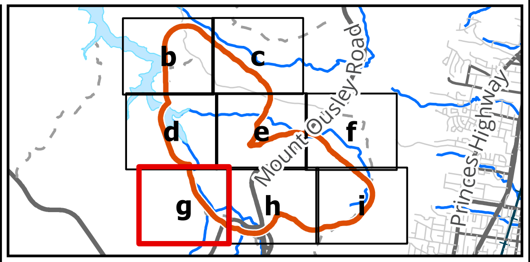

Legend

UEP area

Mine plan

Future stages

Existing groundwater locations

Creek

Coastal Upland Swamps

Swamp extent

Figure 9g Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200

Metres

N

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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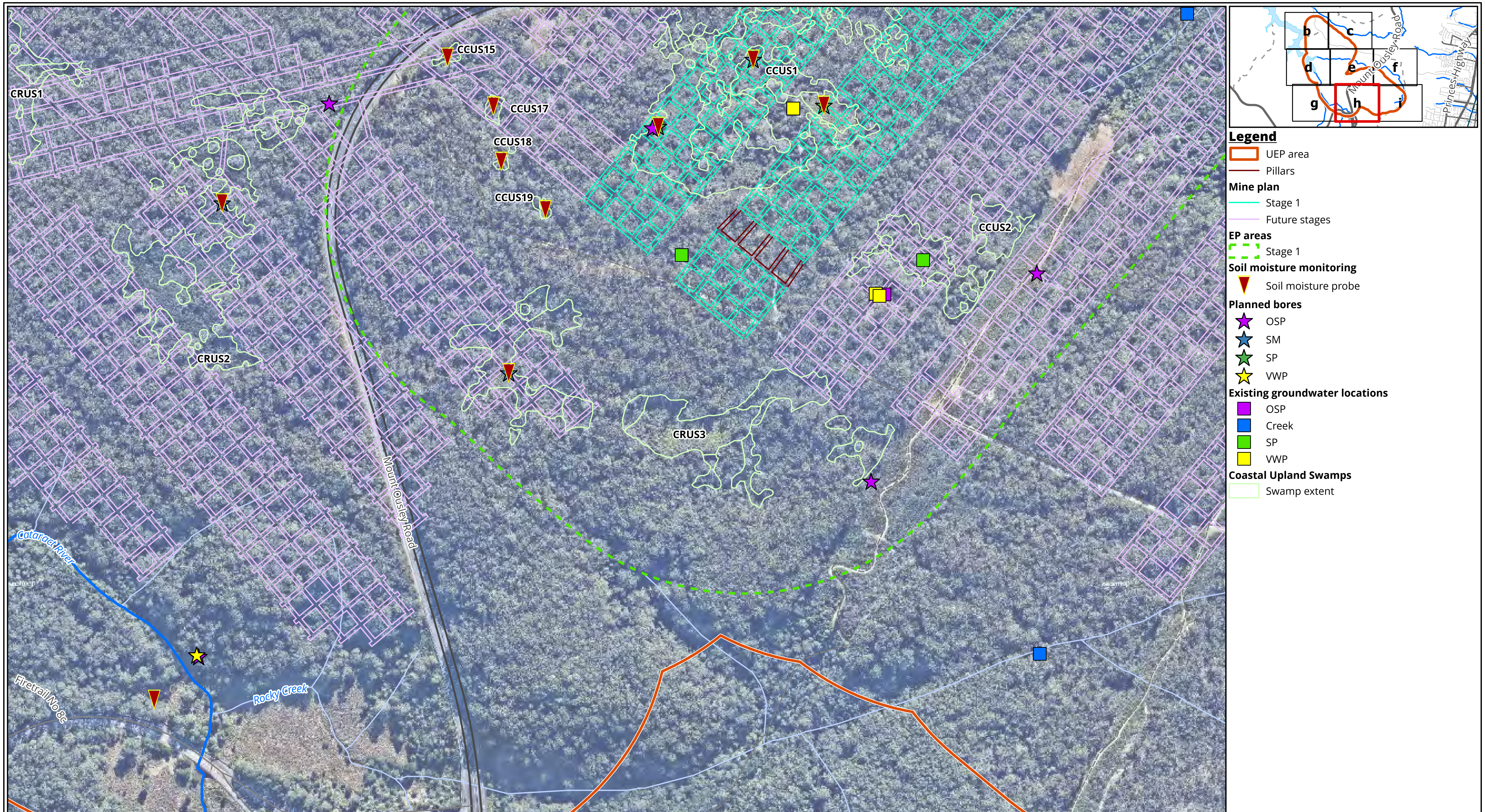

Figure 9h Coastal Upland Swamp groundwater monitoring sites

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Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F9_CoastalUplandSwampMonitoring_ground
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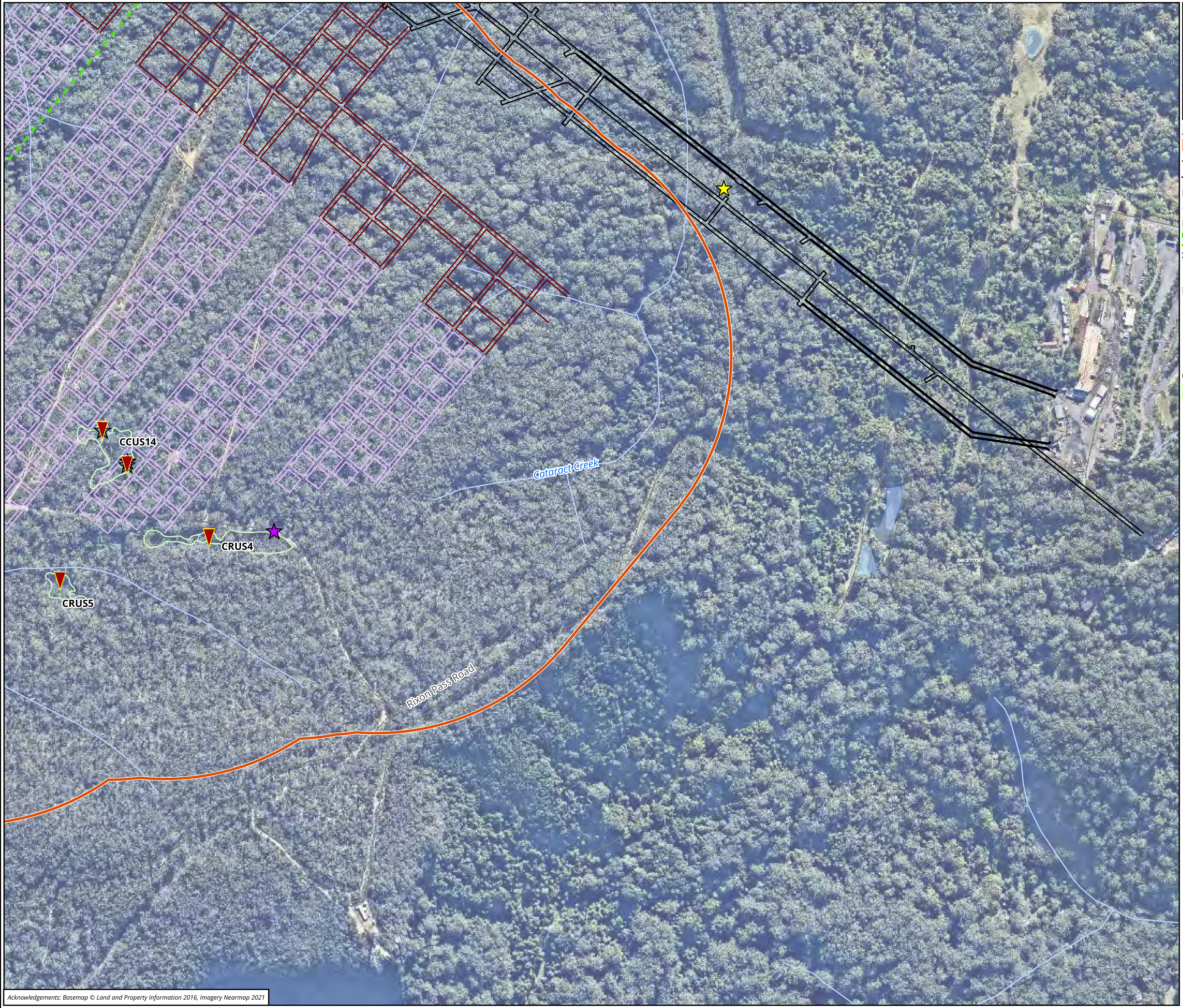

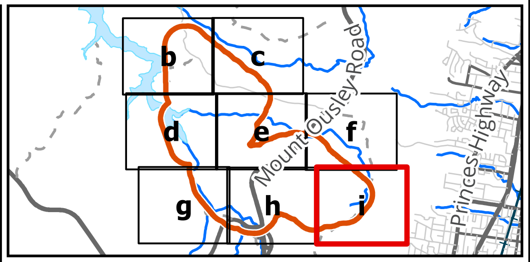

Legend

UEP area

Pillars

Past workings

Mine plan

Future stages

EP areas

Stage 1

Soil moisture monitoring

Soil moisture probe

Planned bores

OSP

SM

SP

VWP

Coastal Upland Swamps

Swamp extent

Figure 9i Coastal Upland Swamp groundwater monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

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6.3 Upland Swamp ecological monitoring approach

Given the sensitive nature of upland swamps, this BMP has been prepared as a separate management plan, and part of the broader WRPL EP, in accordance with Condition C10(g)(v) of the DC MP09_0013.

6.4 Giant Burrowing Frog monitoring

The Giant Burrowing Frog has been identified within a 245 metre section of a tributary of Cataract River below swamp CRUS2 during previous ecological monitoring in the RVE area. Habitat is within future stages and is not within the Stage 1 or Stage 2 EP areas. The species was detected consistently as tadpoles and is to be used as an indicator of breeding activity. The irregular records of adults and metamorphs does not provide any meaningful data and will not be part of any future monitoring, beyond incidental records.

While potential impacts to this species are considered to be negligible, a survey was undertaken in 2021 to determine that tadpoles are still present within the tributary of Cataracts River prior to mining commencing. Sampling was undertaken in summer, with monitoring focusing on tadpole (or adults/egg masses) presence (Figure 10).

A total of 26 tadpoles were recorded within the tributary of Cataract River below swamp CRUS2, in pool 12 and 13 during sampling in undertaken in 2021, however no tadpoles or adults were observed during 2022 monitoring. Given the ongoing presence of this species within the future stages area, additional monitoring for this species should be undertaken if impacts are detected within the identified habitat for this species, if impacts to water quality are detected or if subsidence TARPs level 2 or higher are triggered (Appendix C), as per the recommendation provided by the BCD (Appendix A).

6.4.1 Stage 1 (a and b)

Ongoing Giant Burrowing Frog monitoring is not required within the Stage 1 EP area, as no habitat is considered to be present based on prior surveys and identified in the response to Request for Information (Appendix A).

6.4.2 Stage 2

Ongoing Giant Burrowing Frog monitoring is not required within the Stage 2 EP area, based on previous monitoring which indicates the species is not present. Habitat has, however, been assumed for the purposes of offsetting, and additional baseline surveys will be undertaken within the Stage 2 EP area prior to mining commencing to further refine whether the assumed presence for offsetting purposes is appropriate (refer to Section 3.5). Additional monitoring for this species should only be undertaken if impacts are detected within the identified habitat for this species, if impacts to water quality are detected or if subsidence TARPs level 2 or higher are triggered (Appendix C), as per consultation (Appendix A).

As this species has not previously been detected in the Stage 1 or Stage 2 areas, the absence of this species in future monitoring is not considered to be evidence of an impact on this species as a result of the Project in the absence of any material impacts to potential habitat and/or a lack of observed impact on other frog species which utilise the same habitats (noting that this species is not considered to be more vulnerable to subsidence related impacts than other species known to be present in the area).

6.5 Littlejohn's Tree Frog monitoring

6.5.1 Stage 1 (a and b)

Ongoing Littlejohn's Tree Frog monitoring is not required within the Stage 1 EP area, as no habitat is considered to be present based on prior surveys and identified in the response to Request for Information (Appendix A).

6.5.2 Stage 2

Ongoing Giant Burrowing Frog monitoring is not required within the Stage 2 EP area, based on previous monitoring which indicates the species is not present. Habitat has been assumed for the purposes of offsetting, and additional baseline surveys will be undertaken within the Stage 2 EP area prior to mining commencing to further refine whether the assumed presence for offsetting purposes is appropriate (refer to Section 3.5). This additional baseline monitoring will focus on areas with the highest potential for the species being present and will not involve monitoring in all swamps. Additional monitoring for this species should only be undertaken if impacts are detected within the identified habitat for this species, if impacts to water quality are detected or if subsidence TARPs level 2 or higher are triggered (Appendix C), as per consultation (Appendix A).

As this species has not previously been detected in the Stage 1 or Stage 2 areas, the absence of this species in future monitoring is not considered to be evidence of an impact on this species as a result of the Project in the absence of any material impacts to potential habitat and/or a lack of observed impact on other frog species which utilise the same habitats (noting that this species is not considered to be more vulnerable to subsidence related impacts than other species known to be present in the area).

6.6 Giant Dragonfly monitoring

Given the correlation with Giant Dragonfly habitat requirements and Upland Swamps, Giant Dragonfly monitoring methodology has been included in the USMP (WRPL 2022a), a sub plan to the WRPL EP.

6.7 Aquatic ecological monitoring

The aquatic ecological monitoring program has been developed to provide a means of detecting decreases in aquatic ecological condition that may be attributable to subsidence related impacts and ensure impacts can be measured and managed in accordance with the TARPs.

A substantial aquatic ecological monitoring program has been in place within the Wonga East (now RVE) area since 2011.This program provides a substantial amount of aquatic ecological data for waterways within the RVE area that provides a useful dataset upon which to base any future comparisons for stream health monitoring.

Aquatic ecological monitoring of waterways is intended to focus on waterways considered to be most at risk from further mining / UEP extraction (i.e. Cataract Creek, Bellambi Creek, Cataract River and an unnamed tributary) and will include impact and control monitoring sites. The monitoring methodology is summarised in Section 6.7.1, the monitoring program is summarised in Table 13 and Figure 10 shows the location of the monitoring sites.

To ensure monitoring is capable of identifying impacts as specified in the TARPs, the following components are assessed as part of the aquatic monitoring program:

- Aquatic habitat assessments including HABSCORE assessments (Barbour et al. 1999).
- Aquatic macroinvertebrate community assessments using the NSW AUSRIVAS assessment and analysis methodology (Turak, Johnstone, & Waddell 2004).

Collated data is to be utilised for the comparison of ecological conditions between impact and control monitoring sites, in addition to post-impact monitoring data to pre-impact monitoring data In order to detect any impacts associated with mining.

Table 13 Preliminary Aquatic Ecological Monitoring Program Summary

Monitoring	Impact Site	Control site	Survey timing	Methodology
AUSRIVAS monitoring surveys	Stage 1: ▪ RVE-AQ2 ▪ RVE-AQ3 ▪ RVE-AQ4 ▪ RVE-AQ5 ▪ RVE-AQ6 Stage 2: ▪ RVE-AQ16 ▪ Additional sites if required following consultation with WRPL	Stage 1 and 2: ▪ RVE-AQ9 ▪ RVE-AQ11 ▪ RVE-AQ14 ▪ RVE-AQ15	▪ One year prior to extraction ▪ During extraction ▪ One year post extraction	Each site is assessed bi-annually according to the NSW AUSRIVAS protocols. Including: ▪ Visual aquatic habitat assessments (HABSCORE), following Barbour et al. (1999). ▪ Supplementary water quality measurements for a basic suite of parameters including pH, dissolved oxygen, electrical conductivity. ▪ Photo point monitoring. This data is used to compare ecological condition between impact and control monitoring sites, as well as post-impact monitoring data to pre-impact monitoring data in order to detect any impacts associated with mining.

The detection of changes in stream flow or water chemistry as a result of secondary workings at any waterway, would through the implementation of the EP WMP monitoring program TARPs trigger the need for additional ecological assessment and monitoring and or contingency options.

Any additional aquatic ecological monitoring will be tailored to the detected impact and will utilise previous baseline data as relevant. The method and duration of monitoring will be developed in consultation with relevant authorities.

6.7.1 AUSRIVAS monitoring data analysis

The macroinvertebrate community data are analysed according to the assessment and analysis methodology (Turak, Johnstone, & Waddell 2004). The results of each monitoring season are compared to the long-term aquatic ecological monitoring dataset for the RVE area to identify any sites that are indicative of impacts to stream health or declining conditions. Comparisons of control and impact site results are made, along with comparisons between pre-impact baseline data and post-impact monitoring data. This allows for identification of any mining induced impacts. Trigger values for further investigation, based upon the long-term aquatic ecological monitoring dataset in the RVE area have also been specifically developed to aid the assessment against the relevant TARPs. The macroinvertebrate data analysis methods are described below.

Results are analysed using the AUSRIVAS software package, which contains predictive models that assess the ecological health of a site by comparing its macroinvertebrate community with those of similar 'reference sites within the model. The macroinvertebrates recorded at these reference sites are considered to be a strong representation of what macroinvertebrate communities would be expected to occur at a study site, if it is in a 'reference' or undisturbed condition. If a site does not contain the taxa expected by the model, then its condition is described as being 'lower than reference'.

The AUSRIVAS model provides several outputs, including a ratio of the macroinvertebrates recorded at a study site to those predicted by the model. This is a ratio of observed taxa versus expected taxa and is called an 'O/E score' (Observed/Expected). Many macroinvertebrates are very rare, so the full list of expected taxa will often contain animals that have only been recorded once and typically at only one control site. If these were expected by the model to be present at a study site the result would often be very low O/E scores, so the most commonly used ratio is the 'O/E50' score which only gives the ratio of observed/expected taxa that have a greater than 50 % chance of occurring at a site (that is, the taxa which were recorded at more than 50 % of matching control sites within the model). The second output from the model is a 'Band' rating of each study site. Band ratings are a simple description of stream condition and indicate the level of impairment detected.

The Signal2 (Stream Invertebrate Grade Number Average Level) biotic index score (Chessman 2001) applies a revised sensitivity grade to macroinvertebrate families, based upon the original Signal grade (Chessman 1995) and is considered a more accurate grading. The Signal2 index describes the tolerance of macroinvertebrate taxonomic families to pollution. The index provides a comprehensive ecological indicator that produces an average Signal2 score for each monitoring site as an indication of the macroinvertebrate community's overall tolerance to pollution or disturbance.

These macroinvertebrate data analyses are supported by, and assessment of, physiochemical conditions at each site during the surveys, including an examination of the HABSCORE assessments, providing an indication of the physical condition of instream and riparian habitats, and water quality readings indicating the prevailing water quality conditions at each site at the time of survey.

6.7.2 HABSCORE assessments

HABSCORE assessments were completed at each site to provide a relative measure of aquatic habitat health even when the site is dry and no AUSRIVAS assessment can be completed. HABSCORE is a visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour et al. 1999). The application of the HABSCORE assessments provide site context for the AUSRIVAS analysis.

HABSCORES range from Poor to Optimal condition and reflect the current category condition of the water resource. Categories are derived from the sum of scores divided by the sum of the characters assessed. This provides an ecological indicator that produces information on the water resource when AUSRIVAS assessments cannot be undertaken (i.e. dry conditions).

HABSCORE assessments are based on the presence and condition of the following features:

- Pool substrate characterisation.

- Pool variability.
- Channel flow status.
- Bank vegetation (score for each bank).
- Bank stability (score for each bank).
- Width of riparian zone (score for each bank).
- Epifaunal substrate/available cover.

The aquatic habitat within the EP area was described in terms of four category types (Barbour et al. 1999). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

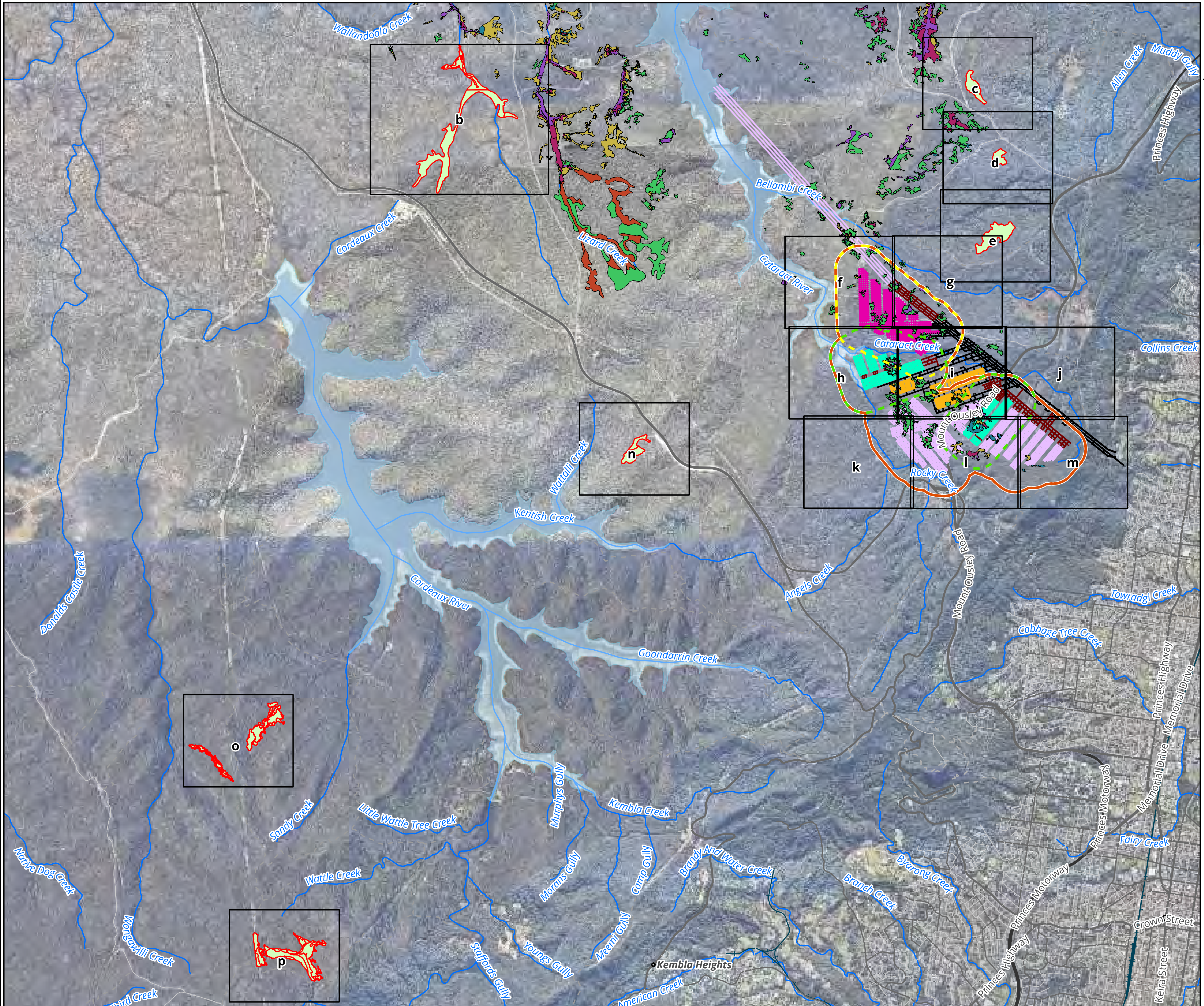
- Optimal: Watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.
- Suboptimal: Watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.
- Marginal: Watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.
- Poor: Watercourses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

6.8 Rocky ecosystem biodiversity monitoring

Monitoring of potential impacts to rocky ecosystem biodiversity features will only occur in the event that subsidence monitoring indicates that there has been subsidence above predictions. As there are no significant cliff lines within the Stage 1 and 2 EP areas, this monitoring is not anticipated to be required.

No cracking of rock slabs is considered likely to occur hence there are not expected to be any significant impacts on fauna that may be reliant on these features.

Accordingly, no additional monitoring is considered to be required in relation to potential impacts to rock slab features.



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Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

Mine plan

- Stage 1
- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Control swamp

- Swamp extent

Vegetation Sub-Communities

- MU42,Upland Swamps: Banksia Thicket
- MU43,Upland Swamps: Tea-Tree Thicket
- MU44,Upland Swamps: Sedgeland-Heath Complex
- MU44a,Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b,Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)
- MU44c,Upland Swamps: Sedgeland-Heath Complex (Cyperoid Heath)

Figure 10a Coastal Upland Swamp ecological monitoring sites

0 600 1,200 1,800 2,400 3,000 N

Metres

Scale: 1:55,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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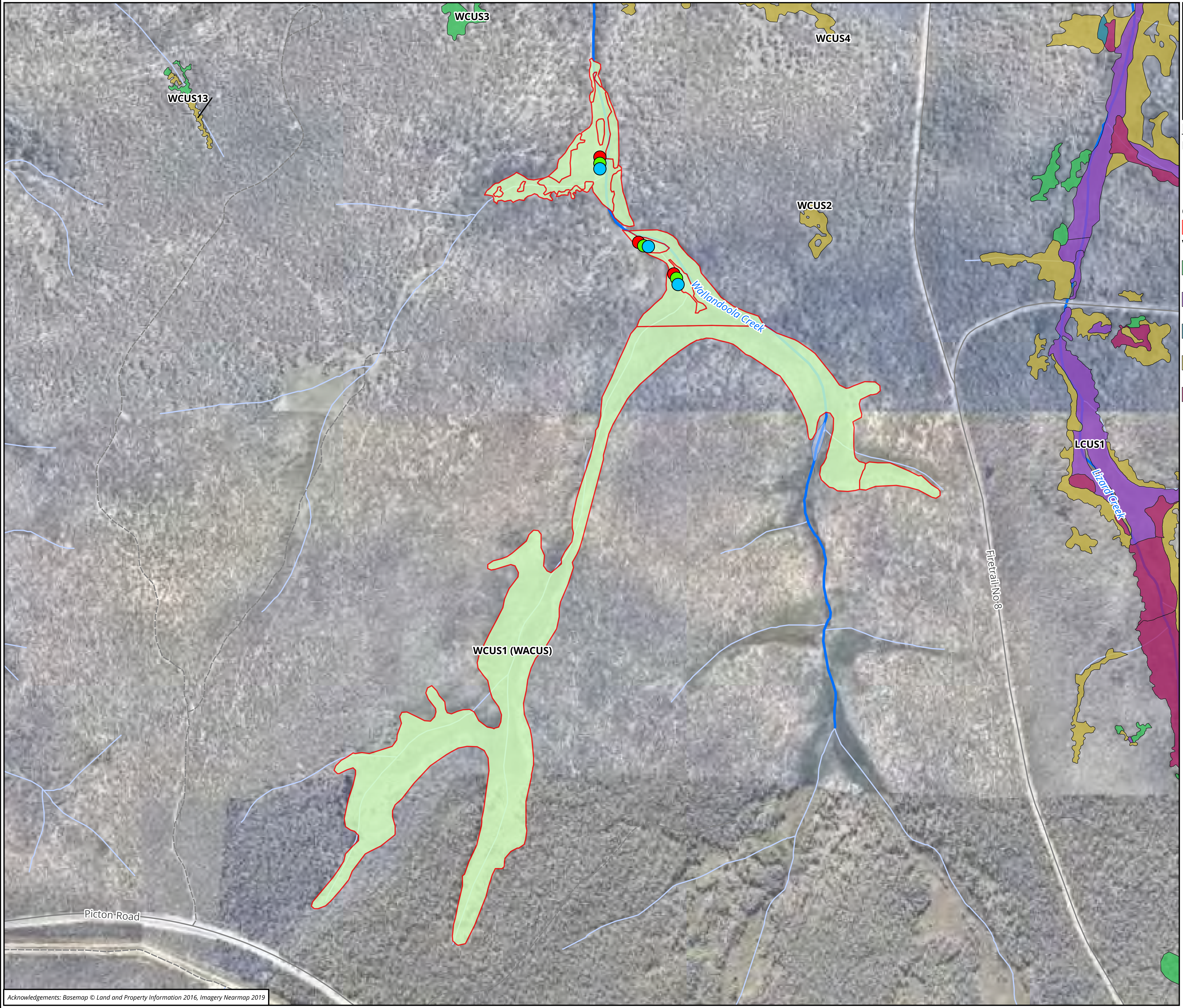

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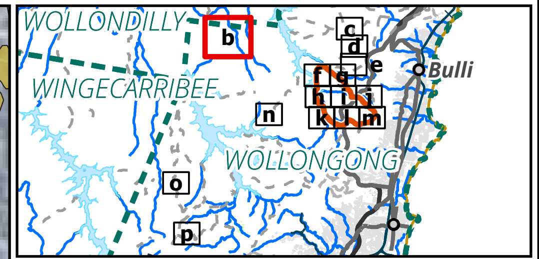

Legend

Flora monitoring

- Photo Point
- Transect End
- Transect Start

Control swamp

- Swamp extent

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 10b Coastal Upland Swamp ecological monitoring sites

0 70 140 210 280 350

Metres

Scale: 1:9,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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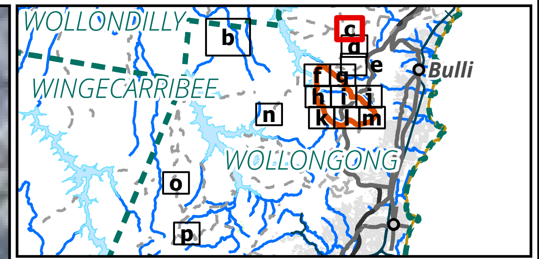

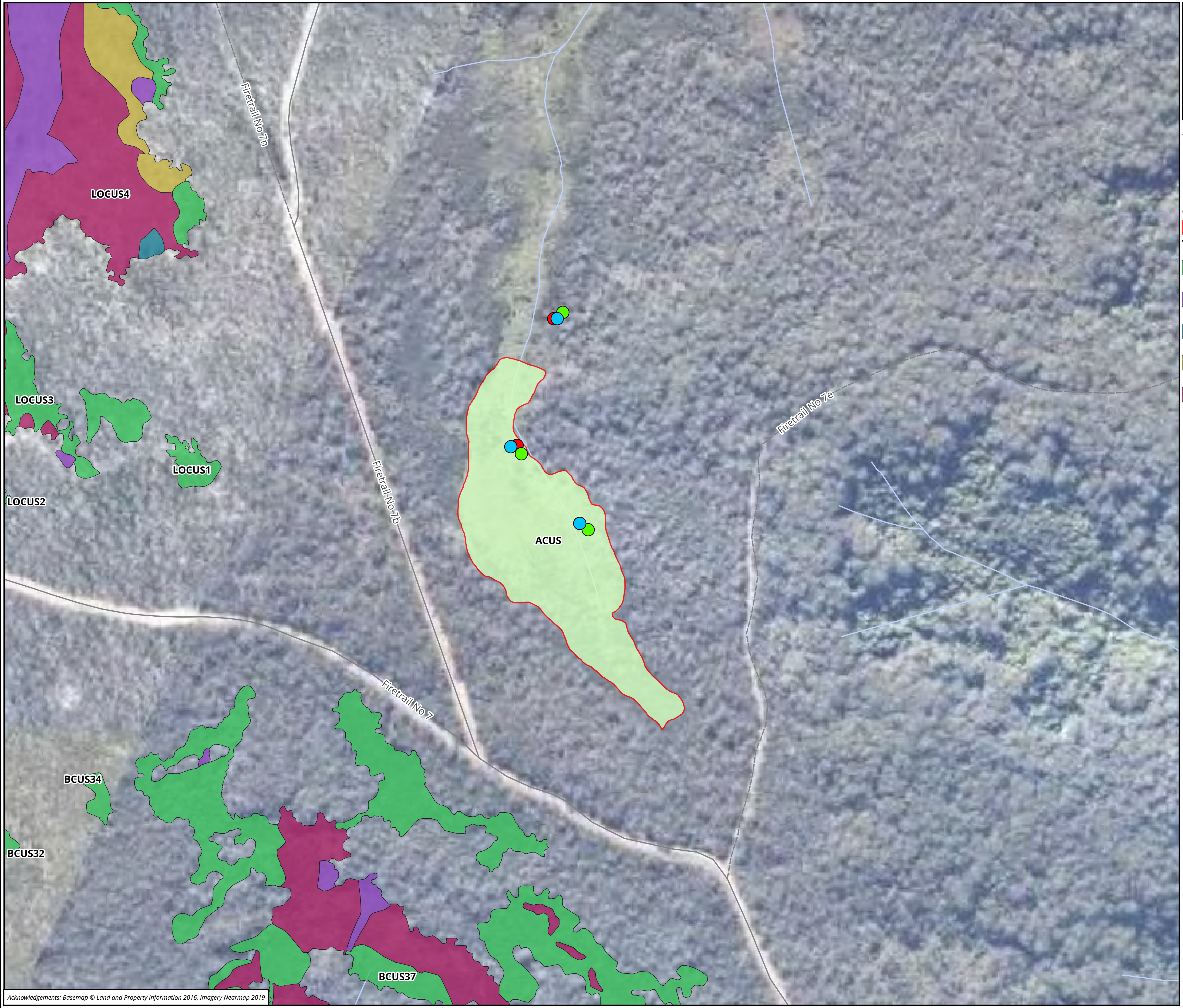

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Legend

Flora monitoring
- Photo Point
- Transect End
- Transect Start

Control swamp
- Swamp extent

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 10c Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

N

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 10 June 2022 ,
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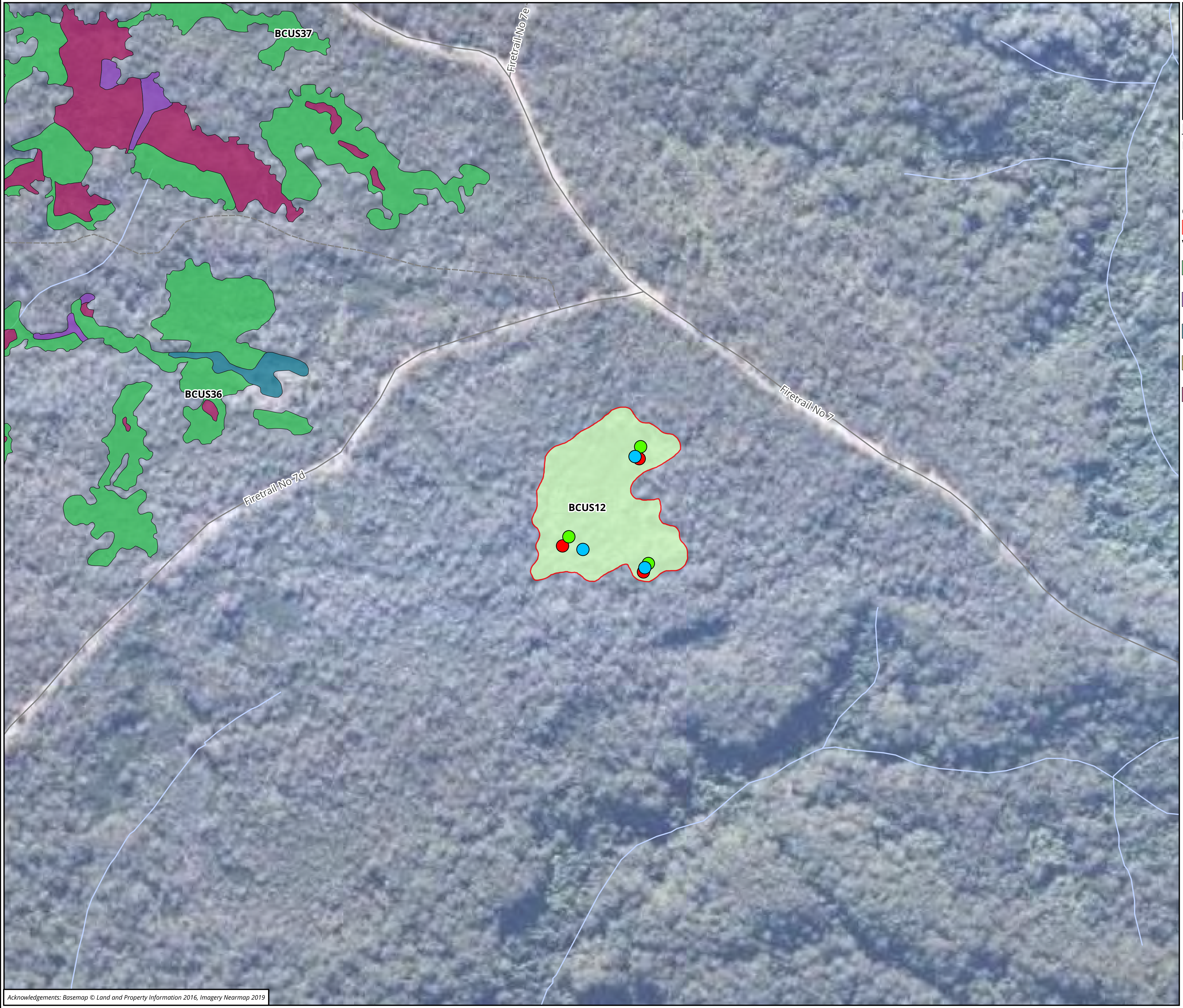

Legend

Flora monitoring
- Photo Point
- Transect End
- Transect Start

Control swamp
- Swamp extent

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 10d Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200
Metres
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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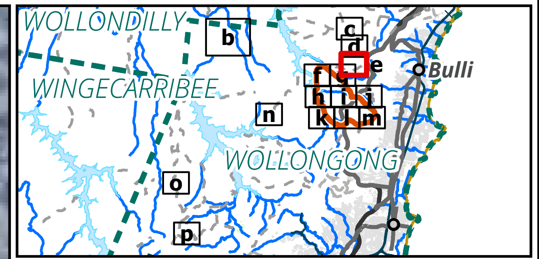

Legend

Flora monitoring

- Photo Point
- Transect End
- Transect Start

Control swamp

- Swamp extent

Figure 10e Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

N

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis.

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F10_CoastalUplandSwampMonitoring
Project: P:\36700s\36746\Mapping\
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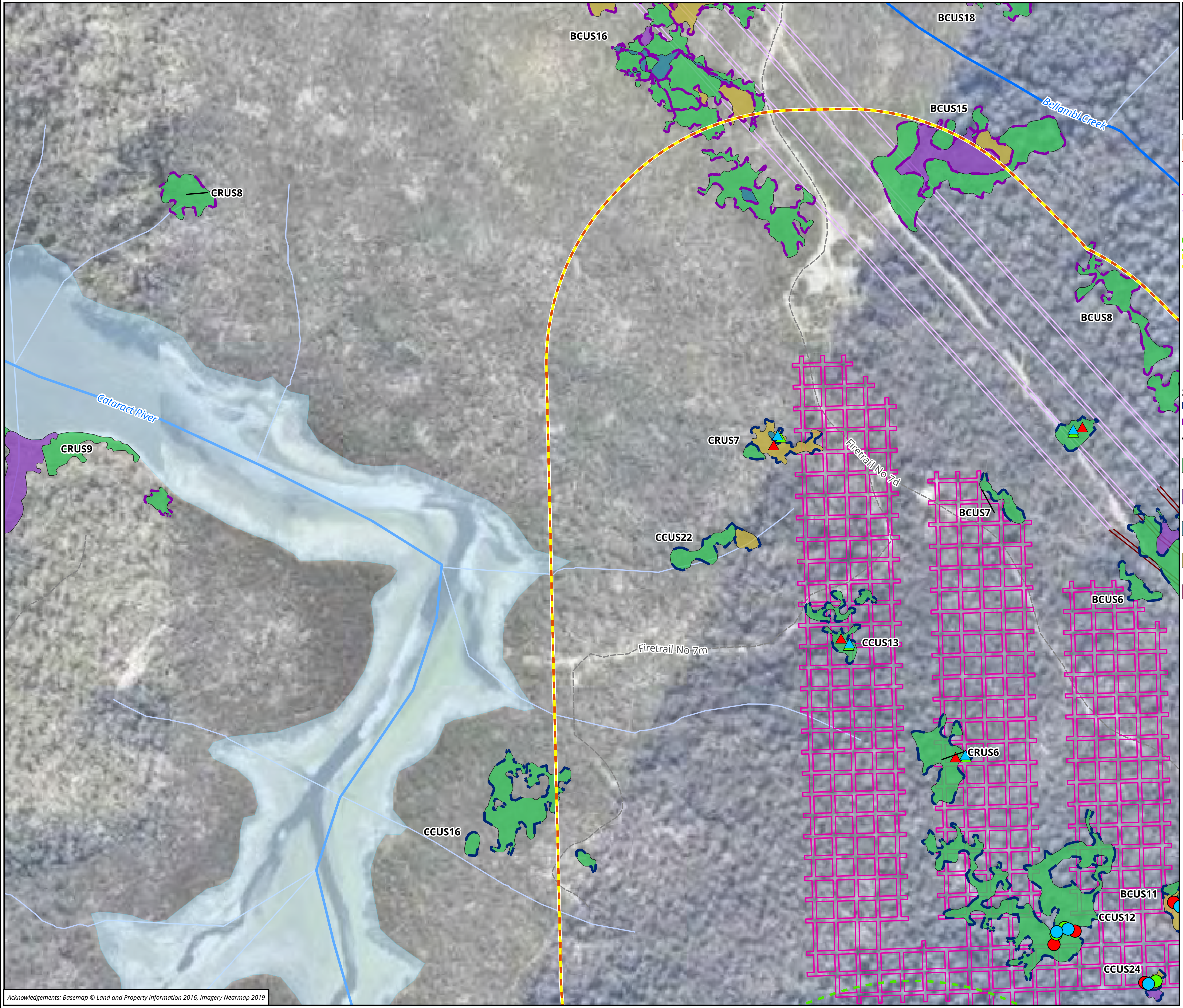

Legend
UEP area
Pillars
Mine plan
Stage 2
Future stages
EP areas
Stage 1
Stage 2
Flora monitoring
Photo Point
Photo Point - proposed
Transect End
Transect End - proposed
Transect Start
Transect Start - proposed
Swamp survey status
3
4
Vegetation Sub-Communities
MU42,Upland Swamps: Banksia Thicket
MU43,Upland 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 10f Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200
Metres
N
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

biosis

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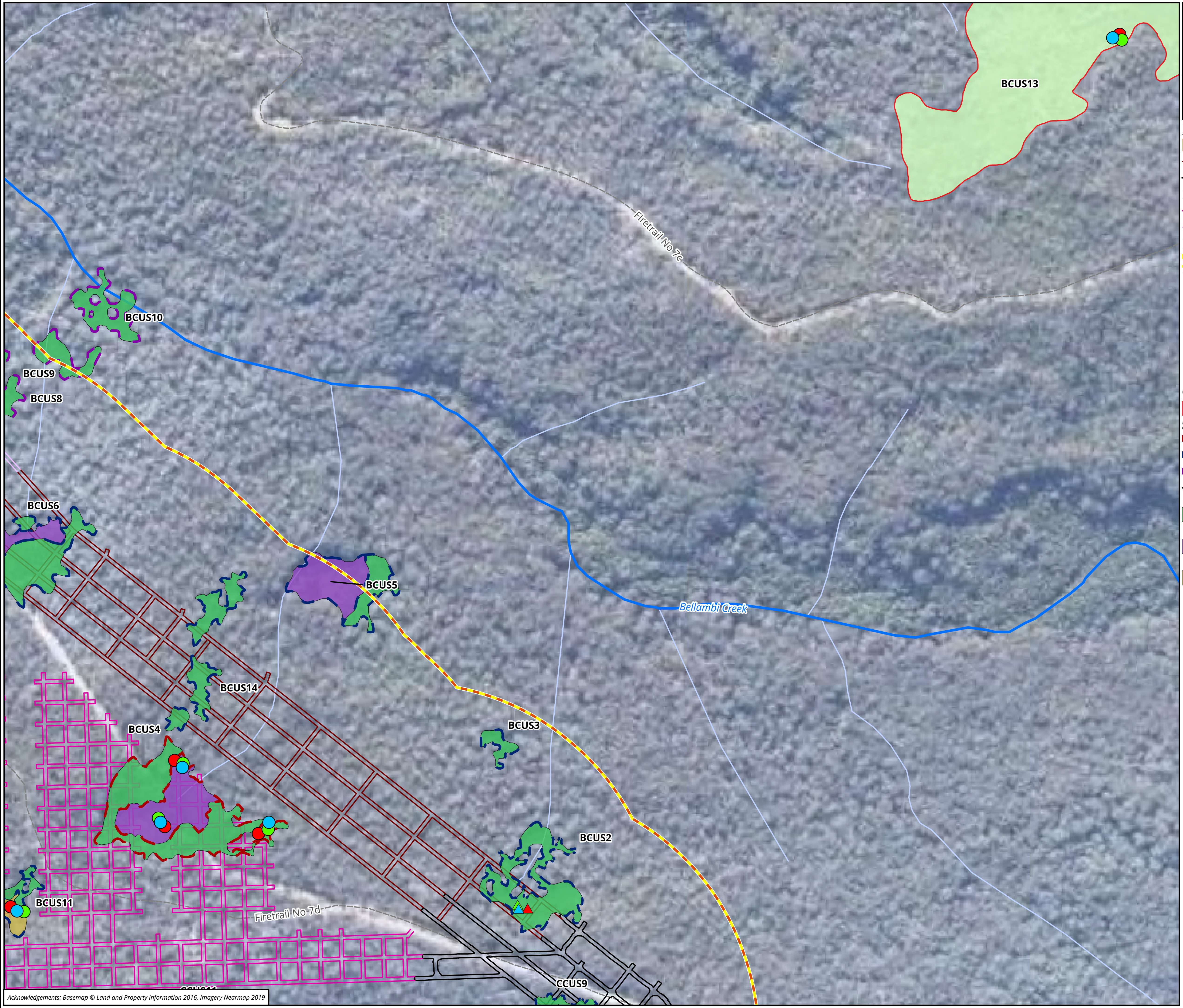

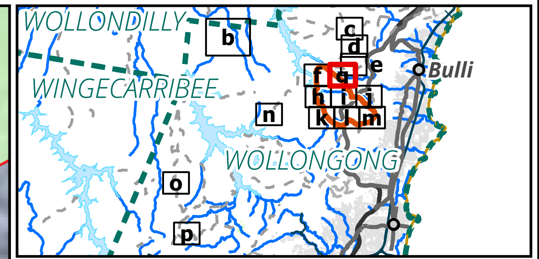

Legend

- UEP area
- Pillars
- Past workings

Mine plan

- Stage 2
- Future stages

EP areas

- Stage 2

Flora monitoring

- Photo Point
- Photo Point - proposed
- Transect End
- Transect End - proposed
- Transect Start
- Transect Start - proposed

Control swamp

- Swamp extent

Swamp survey status

- 1A
- 3
- 4

Vegetation Sub-Communities

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

Figure 10g Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F10_CoastalUplandSwampMonitoring
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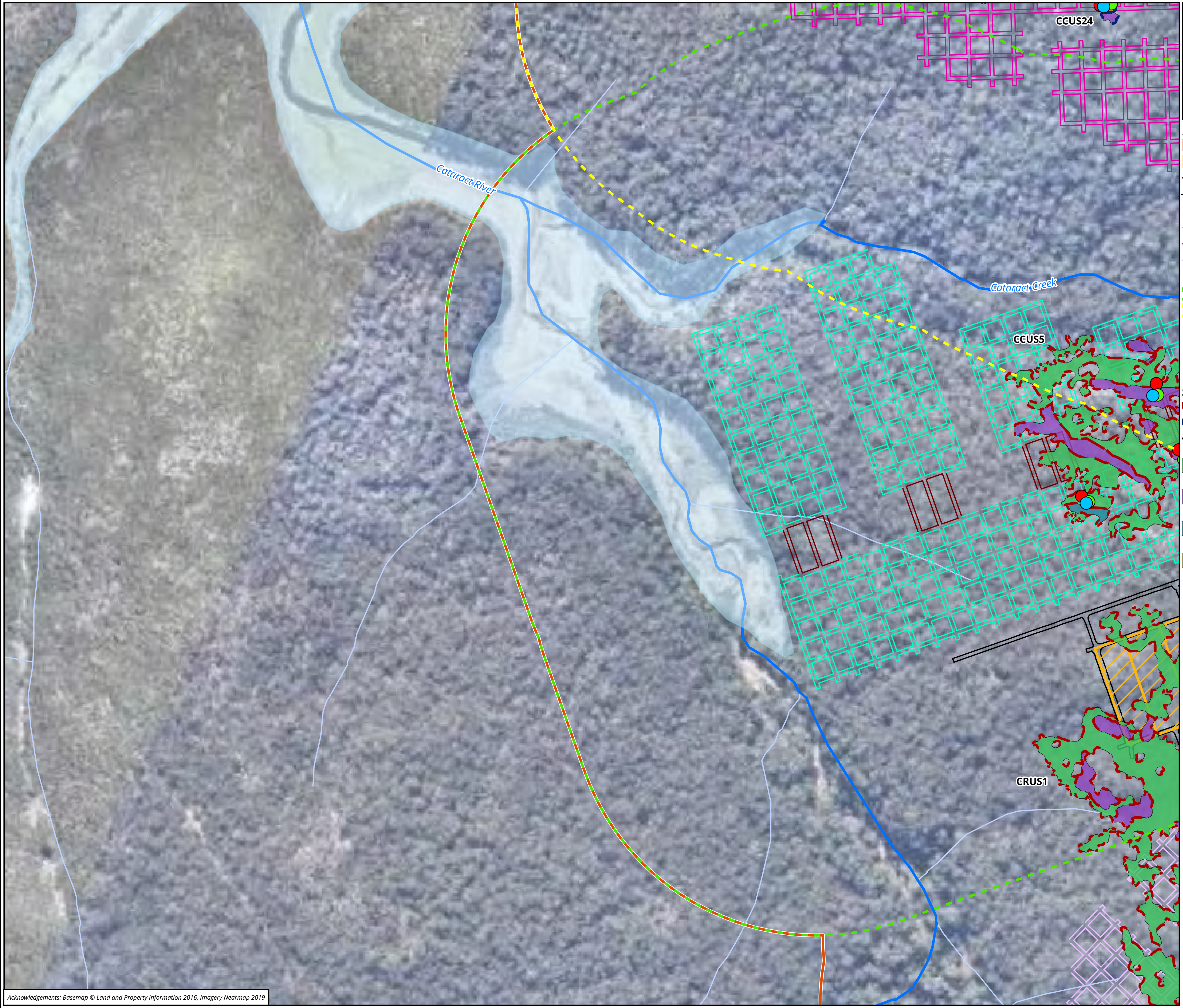

Figure 10h Coastal Upland Swamp ecological monitoring sites

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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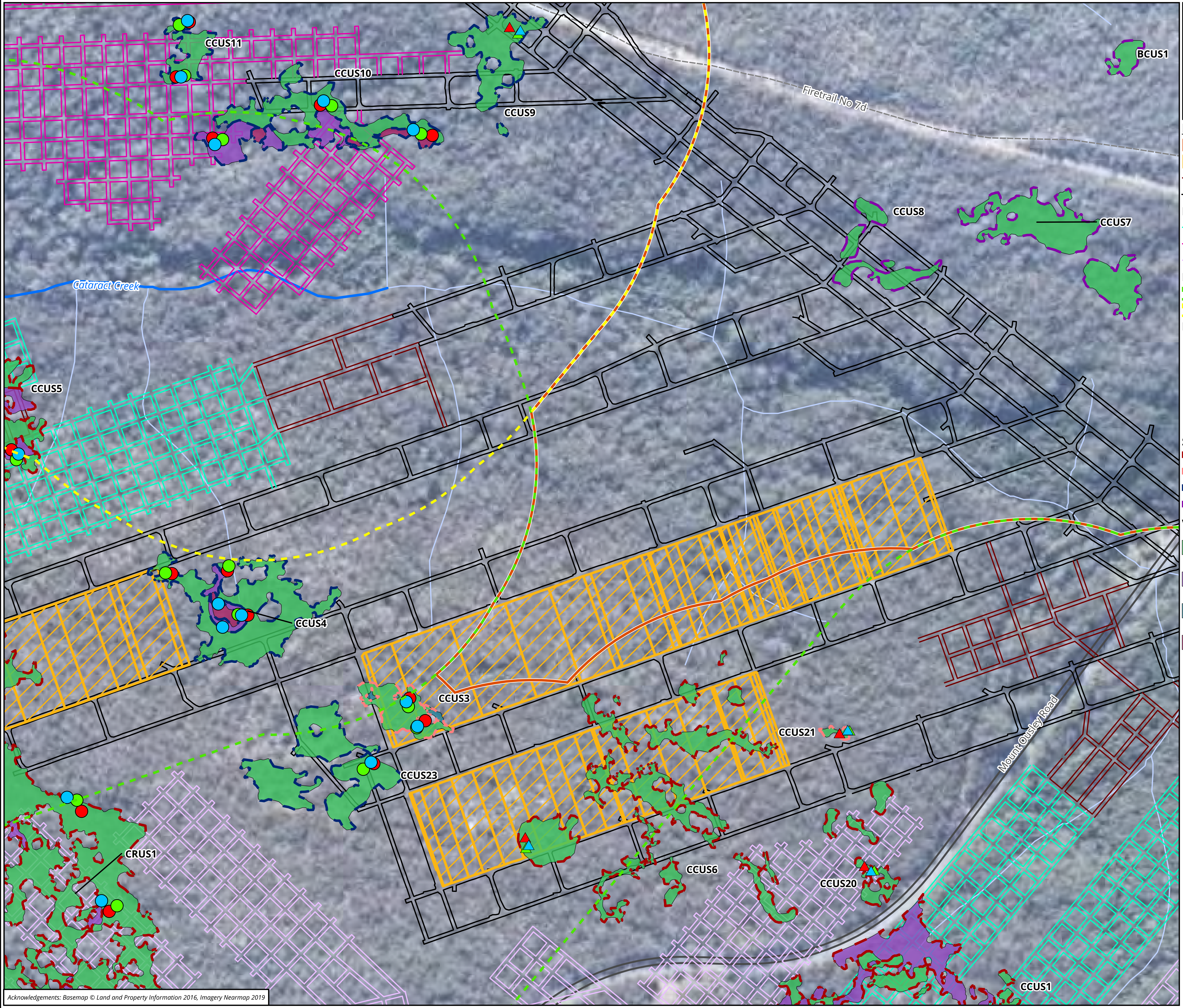

Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

Mine plan

- Stage 1
- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Flora monitoring

- Photo Point
- Photo Point - proposed
- Transect End
- Transect End - proposed
- Transect Start
- Transect Start - proposed

Swamp survey status

- 1A
- 1B
- 3
- 4

Vegetation Sub-Communities

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

Figure 10i Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F10_CoastalUplandSwampMonitoring
Project: P:\36700s\36746\Mapping\
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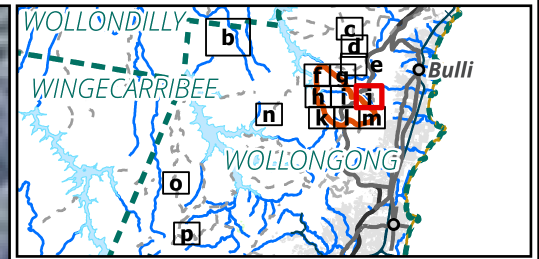

Legend

- UEP area
- Pillars
- Past workings

Mine plan

- Stage 1
- Future stages

EP areas

- Stage 1

Figure 10j Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 36747,
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Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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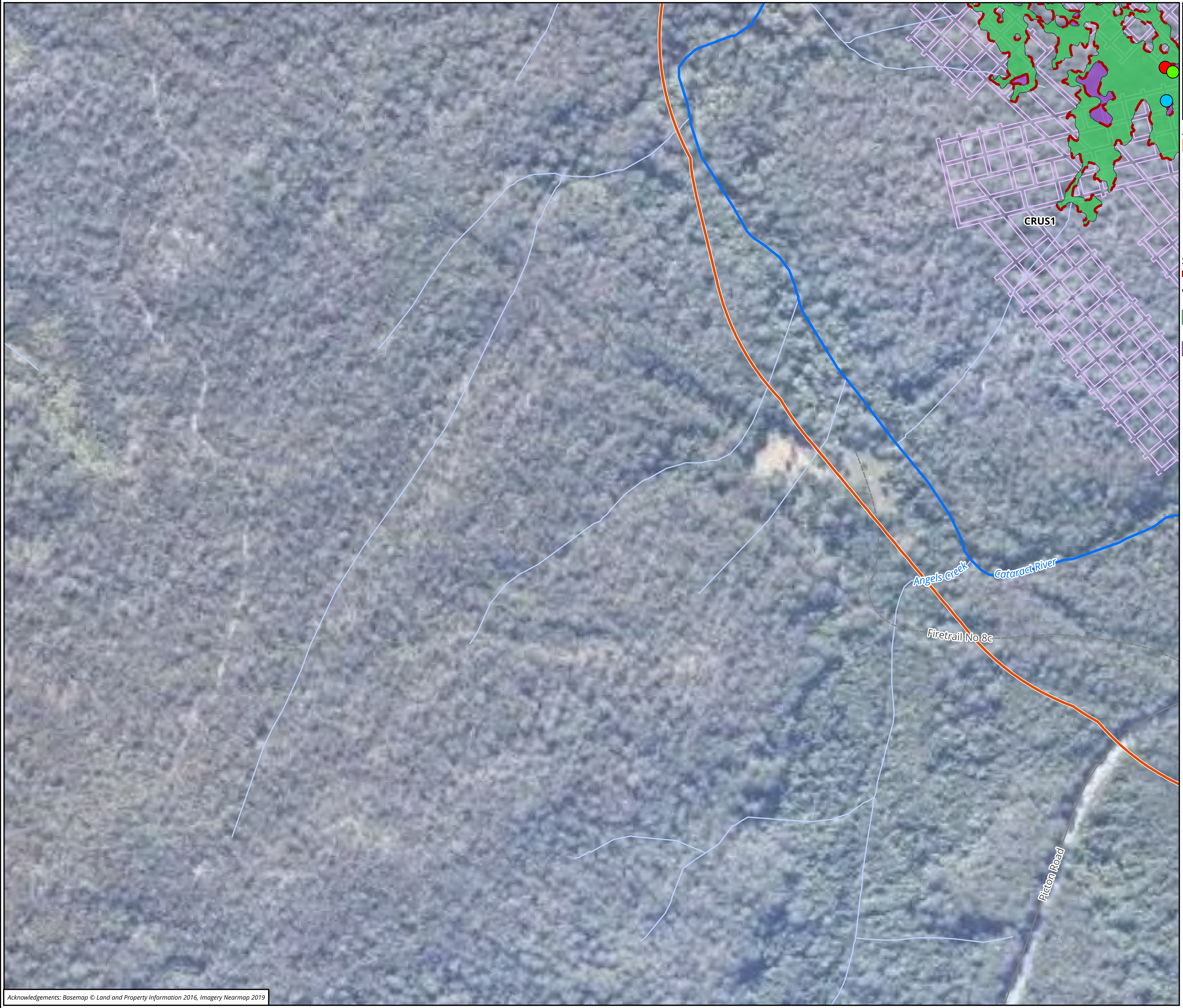

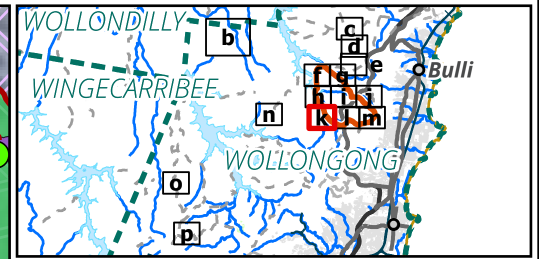

Legend

UEP area

Mine plan

Future stages

Flora monitoring

Photo Point

Transect End

Transect Start

Swamp survey status

1A

Vegetation Sub-Communities

MU42,Upland Swamps: Banksia Thicket

MU43,Upland Swamps: Tea-Tree Thicket

Figure 10k Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 36747,
Date: 10 June 2022 ,
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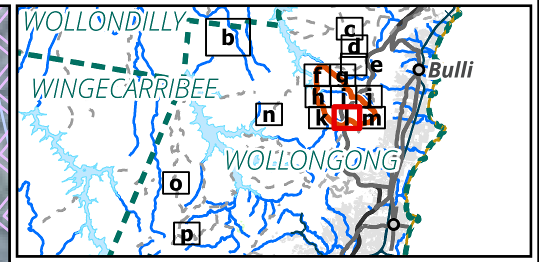

Legend

- UEP area
- Pillars

Mine plan

- Stage 1
- Future stages

EP areas

- Stage 1

Flora monitoring

- Photo Point
- Photo Point - proposed
- Transect End
- Transect End - proposed
- Transect Start
- Transect Start - proposed

Swamp survey status

- 1A
- 2
- 3

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)

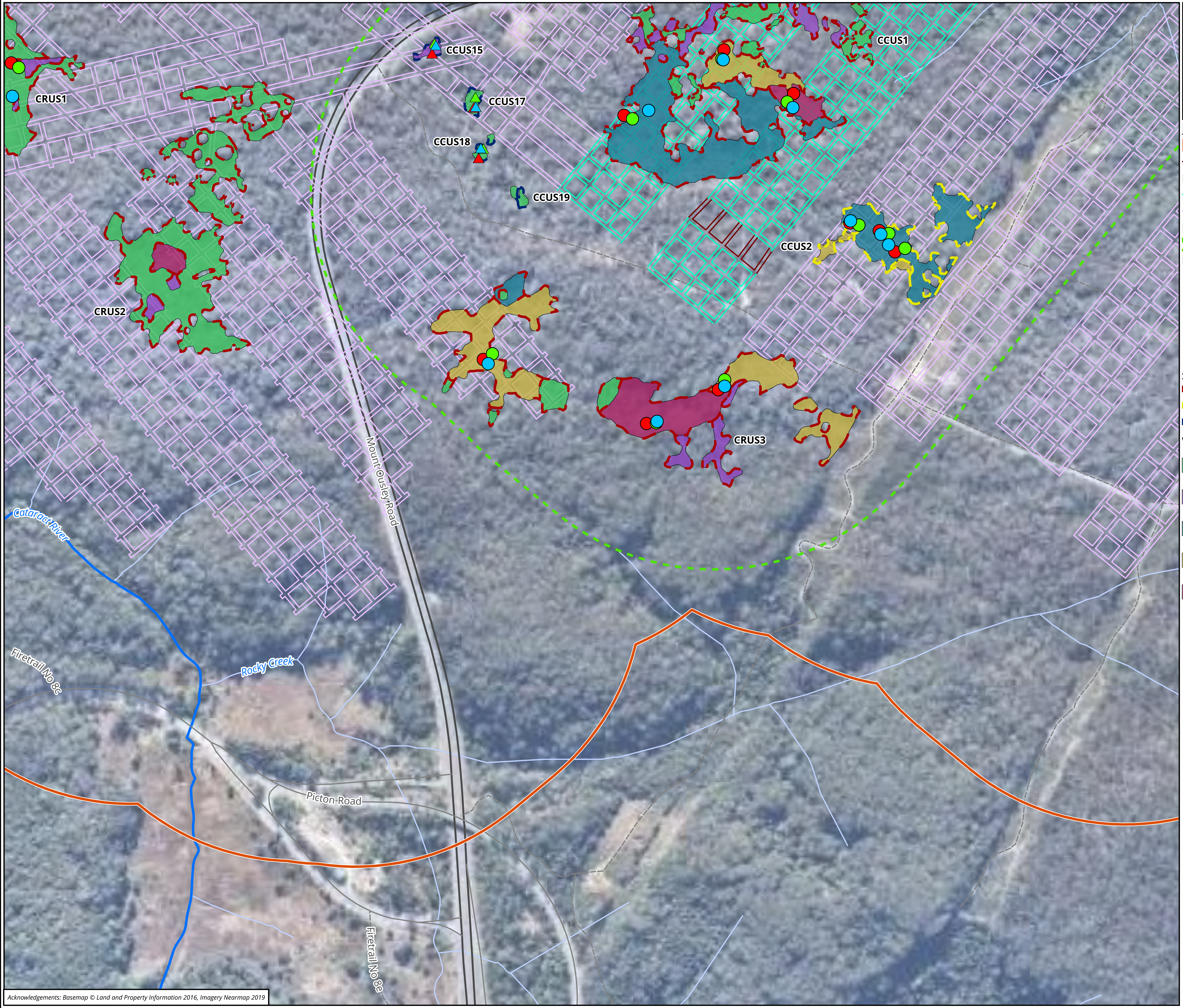

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Figure 10l Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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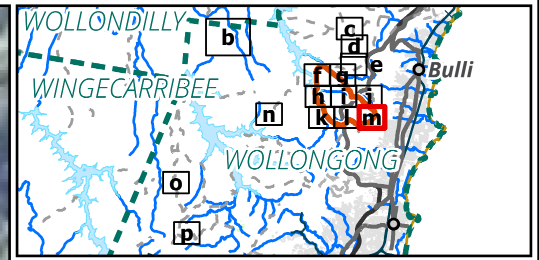

Legend

- UEP area
- Pillars
- Past workings

Mine plan

- Future stages

EP areas

- Stage 1

Flora monitoring

- Photo Point - proposed
- Transect End - proposed
- Transect Start - proposed

Swamp survey status

- 2
- 3
- 4

Vegetation Sub-Communities

- MU44a,Upland Swamps: Sedgeland-Heath Complex (Sedgeland)
- MU44b,Upland Swamps: Sedgeland-Heath Complex (Restioid Heath)

Figure 10m Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

N

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 36747,
Date: 10 June 2022 ,
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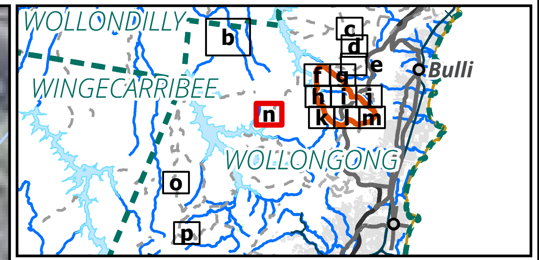

Legend

Flora monitoring

- Photo Point
- Transect End
- Transect Start

Control swamp

- Swamp extent

Figure 10n Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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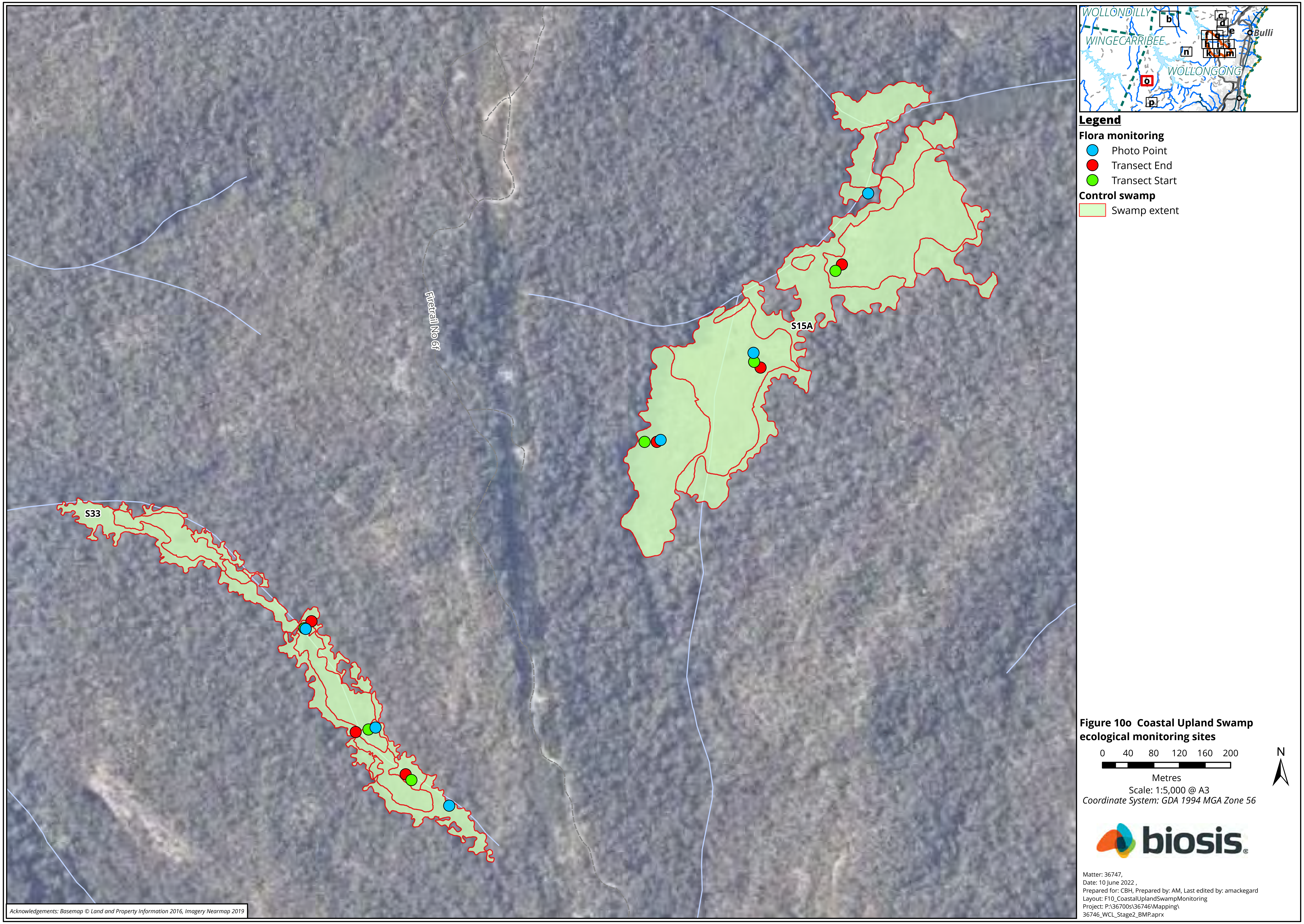

Figure 10o Coastal Upland Swamp ecological monitoring sites

Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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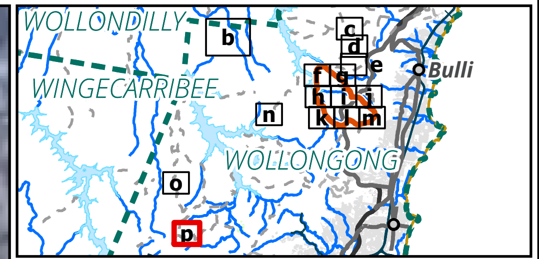

Legend

Flora monitoring

- Photo Point
- Transect End
- Transect Start

Control swamp

- Swamp extent

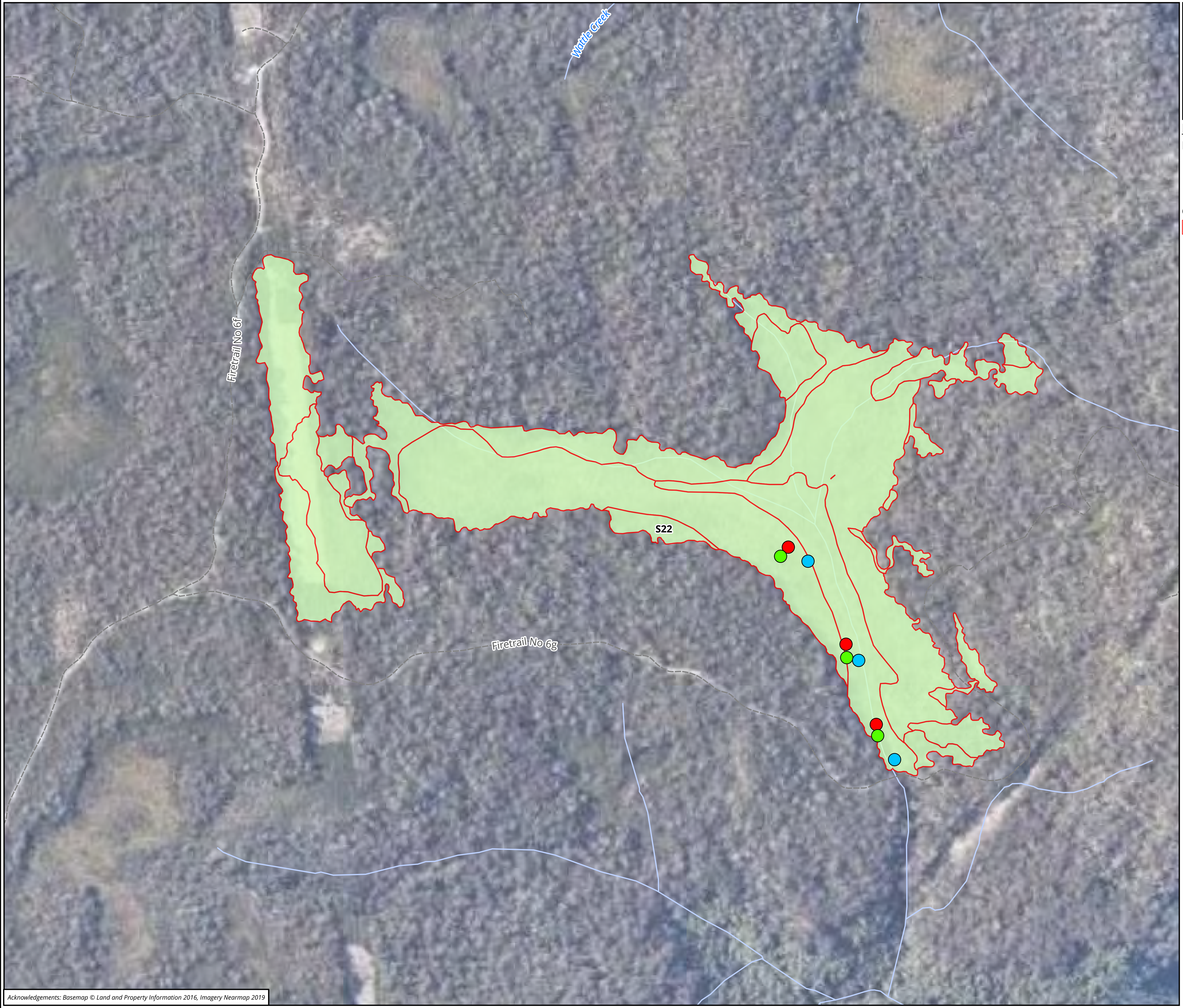

Figure 10p Coastal Upland Swamp ecological monitoring sites

0 40 80 120 160 200

Metres

N

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 36747,
Date: 10 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
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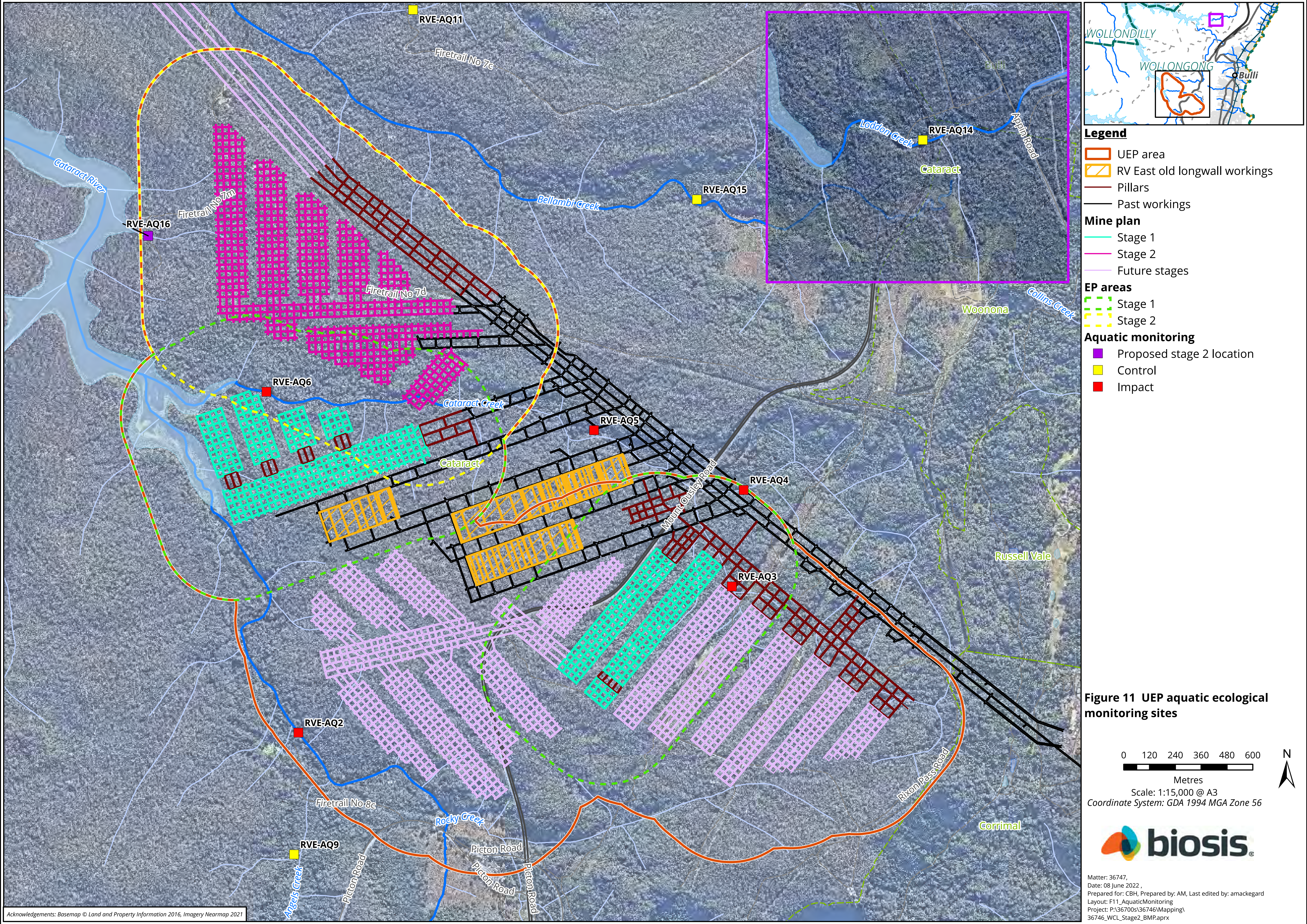

Legend

- UEP area
- RV East old longwall workings
- Pillars
- Past workings

Mine plan

- Stage 1
- Stage 2
- Future stages

EP areas

- Stage 1
- Stage 2

Aquatic monitoring

- Proposed stage 2 location
- Control
- Impact

Figure 11 UEP aquatic ecological monitoring sites

0 120 240 360 480 600

Metres

N

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 36747,
Date: 08 June 2022 ,
Prepared for: CBH, Prepared by: AM, Last edited by: amackegard
Layout: F11_AquaticMonitoring
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7 MITIGATION AND MANAGEMENT STRATEGIES

7.1 RVC Environmental Management Strategy

RVC operate under the RVC Environmental Management Strategy (RVC EMS, RVC EC STD 001) which provides a framework to ensure activities at WRPL are undertaken in an environmentally responsible manner and in general accordance with the following:

- Russell Vale Revised Preferred Underground Expansion Project DC MP09_0013.
- ISO14001 Environmental Management Standard.
- Legislative and other requirements.

While the EMS includes general requirements for the reporting and management of incidents, the EP provides specific requirements in relation to the management of subsidence related impacts associated with the mining covered by the EP and the EP requirements (including the requirements set out in this Plan) prevail to the extent of any inconsistency between documents.

7.2 Proposed measures to avoid or reduce impacts on terrestrial biodiversity

The proposed measures to avoid and reduce potential impacts on terrestrial biodiversity from the secondary workings include:

- 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 contingency actions and remediation measures as detailed if observed impacts are greater than predicted.

7.3 TARPs

In accordance with Schedule 2 Condition C10(g)(viii) of the DC, the EP and associated sub plans will identify TARPs to be implemented to manage potential impacts associated with underground mining.

These TARPs include the following:

- Monitoring requirements (may include different locations).
- Trigger levels that indicate a potential non-compliance or flag implementation of contingency measures.
- Management and contingency actions (i.e. corrective and preventative actions) and reporting requirements.
- Responsibilities.
- Timing.

These TARPs detail how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements. They also form the framework for and contingency actions.

The TARP, as presented in Appendix C, has been designed specifically for this EP BMP to illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for adaptive management and contingency actions.

The TARP system provides a simple, transparent and useable record of the monitoring of environmental performance and the implementation of management and/or contingency measures. Due to the nature of predicted impacts associated with the proposed second workings, Performance Measure TARPs have been established under this EP BMP.

Triggers that indicate a greater than negligible impact to aquatic threatened species, threatened populations or EECs are outlined below:

- EP Aquatic ecology:
  - Reduction in aquatic habitat at impact sites illustrated by a short term (one year) reduction in aquatic habitat, as shown by:
    - A decline in OE50Taxa Score since mining commenced compared to control sites.
    - Change in AUSRIVAS Band since mining commenced compared to control sites.
  - Reduction in aquatic habitat at impact sites only for an extended timeframe (>2 years), as shown by:
    - A decline in OE50Taxa Score since mining commenced compared to control sites.
    - Change in AUSRIVAS Band since mining commenced compared to control sites.

If monitoring indicates a Level 2 or 3 trigger has been reached, an investigation will occur in all circumstances. The nature of the investigation will depend on the feature being monitored, the location of the trigger exceedance and trigger level exceeded among other matters. Different investigation options are discussed in detail in the management plans specific to the feature being monitored.

<u>Note: Level 3 Performance Measure TARP triggers do not, of themselves, constitute an incident or non-compliance under the DC. Investigations following a Level 3 trigger will determine whether an exceedance or non-compliance of the performance measures or DC conditions is likely or has occurred.</u>

In the unlikely event that investigations of Level 3 Performance Measure TARP trigger exceedances determine that material harm has occurred *and* is attributable to the development approved under the DC, the contingency plan and adaptive management measures outlined within Section 7.3.1 will be implemented. In certain cases, management measures may be implemented in the absence of any clear link between the approved development and the observed impact to mitigate adverse environmental outcomes. Response to matters which are identified as Incidents or Non-Compliances will be implemented in consultation with relevant stakeholders.

Figure 12 provides a flow chart covering the Performance Measure TARP Process. Note TARPs for subsidence (EP subsidence monitoring program), land management i.e. cliffs, rock outcrops and slabs and steep slopes (EP Land Management Plan), Coastal Upland Swamps (USMP (WRPL 2022a)), surface water and groundwater (EP Water Management Plan) as contained in other EP component plans will also be relevant to the assessment of potential impacts on threatened species, threatened populations or EECs.

7.3.1 Adaptive management

Where investigations triggered by the Performance Measure TARPs indicate that the changed conditions of sites have been, or are likely to have been, caused by mining operations, the response to these impacts include adaptive management measures to ensure further impacts to the site will not occur or be mitigated or that impacts to future sites do not occur in the future. Due to the nature of the proposed mining and low likelihood of underground mining resulting in any impacts to the site provided subsidence impacts remain within predictions, these adaptive management measures that will be implemented, will be considered in the investigation process. Adaptive management measures to be implemented in the event of a clear linkage between the mining authorised under the DC MP09_0013 and Biodiversity values in the UEP area will include a review of the design and layout of future mining within areas that may potentially impact on such items to avoid a recurrence of any such impacts.

These adaptive management measures include:

- Stop mining and investigate causes of the exceeding of subsidence predictions.
- Undertake a review of the panel design parameters in consultation with the resource regulator.

The Contingency Planning process set out in Section 7.5 also covers this process.

The TARPs in Appendix C contain adaptive management measures for subsidence which inform decisions regarding underground mining operations, should higher than predicted vertical subsidence effects be observed. The purpose of these adaptive management measures are to implement additional measures where necessary to:

- Enable potential impacts associated with higher than predicted subsidence impacts to be monitored.
- The implementation of changes in mining operations to prevent performance criteria from being exceeded.

WRPL will assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in the DC MP09_0013 in accordance with Condition F4 of Schedule 2. Any exceedance of the Subsidence criteria and/or performance measures constitutes a breach of the DC MP09_0013 and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding offsetting actions taken. Where any exceedance of these criteria and/or performance measures has occurred, WRPL will at the earliest opportunity to the satisfaction of the Secretary:

- Take all reasonable and feasible steps to ensure the exceedance ceases and does not re-occur.

- Consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action.
- Within 14 days of the exceedance occurring, submit a report to the Secretary describing these remediation options and any preferred remediation measures or other course of action.
- Implement remediation measures as directed by the Planning Secretary.

7.4 Potential incident notifications

Level 3 triggers in the TARPs are set at a level that may indicate more than trivial environmental harm. Where monitoring indicates a Level 3 Performance Measure TARP trigger related to biodiversity values has been exceeded but the cause of the trigger being exceeded is unclear, DPE and BCD will be notified of a *potential* Incident in accordance with the processes described in Figure 12. Potential incident notifications related to surface or groundwater impacts or which may have consequent impacts of groundwater or surface water will also be provided to Water NSW.

The notification will include the same matters required to be included in an Incident Notification as required by Condition F9 including the development (including the development application number and name) and set out the location and nature of the potential incident.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance. A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPE and other relevant stakeholders.

The investigation process will also consider any remedial action that may be required.

7.5 Contingency plan

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in Section 6, WRPL will implement the following Contingency Plan:

- The observation will be reported to the Environmental Superintendent and Group Environment Manager as soon as possible.
- The observation will be recorded.
- An investigation will be undertaken to identify the cause of the observed impacts (noting that the proposed Development is not anticipated to have any more than negligible impacts on biodiversity values).
- WRPL will report any exceedances of the performance measure to the Secretary of DPE and other relevant stakeholders including BCD as soon as practicable after WRPL becomes aware of the exceedances.
- WRPL will assess the exceedances referred to in the TARP (outlined in Section 7.3) and where appropriate, implement safety measures in accordance with the appropriate Management Plan/s.

- The Group Environment Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impact(s), in consultation with specialists and/or relevant agencies if necessary.
- WRPL will identify an appropriate action plan to manage the identified impact(s), in consultation with other specialists and/or key stakeholders.
- WRPL will submit the proposed course of action to DPE for approval.
- WRPL will implement the approved course of action to the satisfaction of DPE.
- WRPL will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of the Management Plan. Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

If either it is not reasonable or feasible to remediate the impact, or remediation measures implemented by WRPL have failed to satisfactorily remediate the impact, WRPL will provide a suitable offset to compensate for the impact, to the satisfaction of the Secretary of DPE in accordance with Section 7.5.3.

7.5.1 Investigation tools

In the event that Level 2 or 3 TARP triggers are exceeded, an investigation into the potential cause of trigger exceedances will be undertaken.

Unless the cause of the exceedance is clearly identifiable at the time the exceedance, the first step will be to investigate the likely cause or causes of the exceedance.

A preliminary investigation plan will be developed to guide this investigation process and a copy provided to DPE and other relevant stakeholders.

There is a suite of monitoring undertaken than can inform the investigation into potential causes of level 2 and 3 trigger exceedance as detailed in this plan including:

- Subsidence monitoring, including review of historical LIDAR, and the record of continuous GNSS data.
- Groundwater monitoring.
- Water quality and flow monitoring.
- Observation of underground mining conditions.

Additional monitoring as outlined in this plan can also be implemented following the exceedance of Level 2 or 3 TARP triggers (e.g. higher than predicted groundwater or surface water impacts). This additional monitoring may include:

- Ecological survey of areas around cliff falls.
- Additional riparian and aquatic habitat survey locations in the event of higher than predicted vertical subsidence below creek lines.
- Environmental water tracing studies.

- Investigation of whether changes in groundwater or surface water quality is associated with mining related groundwater impacts or increased inflows or changes of 'fresher' groundwater inflow quality is the result of increased connectivity between Permian groundwater systems and the Cataract Reservoir. Water balance models of polls within Cataract Creek can also be developed if there are indications that mining related impacts have affected the level of water in pools or baseflow within the creek.
- Additional investigation tools such as the use of swamp specific water balances can be used to investigate potential causes of observed changes in swamp systems.

7.5.2 General mitigation measures

Due to the absence of any likely causal impact pathways the identification of specific rehabilitation or impact mitigation management measures that would be implemented under specific scenarios is not reasonable or feasible.

In the unlikely event that subsidence impacts exceed predicted levels and/or surface effects are higher than anticipated from these low level subsidence effects, the specific mitigation of any impacts will depend on a range of factors to be investigated at the time of any identified impact and confirmation of causation attributable to mining including:

- The location of the impact.
- Nature and magnitude of the impact.
- Risk of further adverse impacts (including downstream impacts) that may arise from the observed impact and potential mitigation options.
- Approval requirements and timeframe for different mitigation options.

These factors will be considered as part of the impact mitigation process discussed with stakeholder as a part of the Incident and investigation processes.

Rehabilitation and remediation measures to remedy subsidence impacts have been outlined in NSW Planning Assessment Commission (2010) and NSW Department of Planning (2008). It is expected that impacts will be minimal and no remediation is expected to be required.Rehabilitation and remediation options for upland swamps are further outlined in the USMP (WRPL 2022a).

7.5.3 Offsets

In accordance with Condition C4 of the DC, if the secondary workings exceeds the performance measures in Table 12 and the Secretary determines the following:

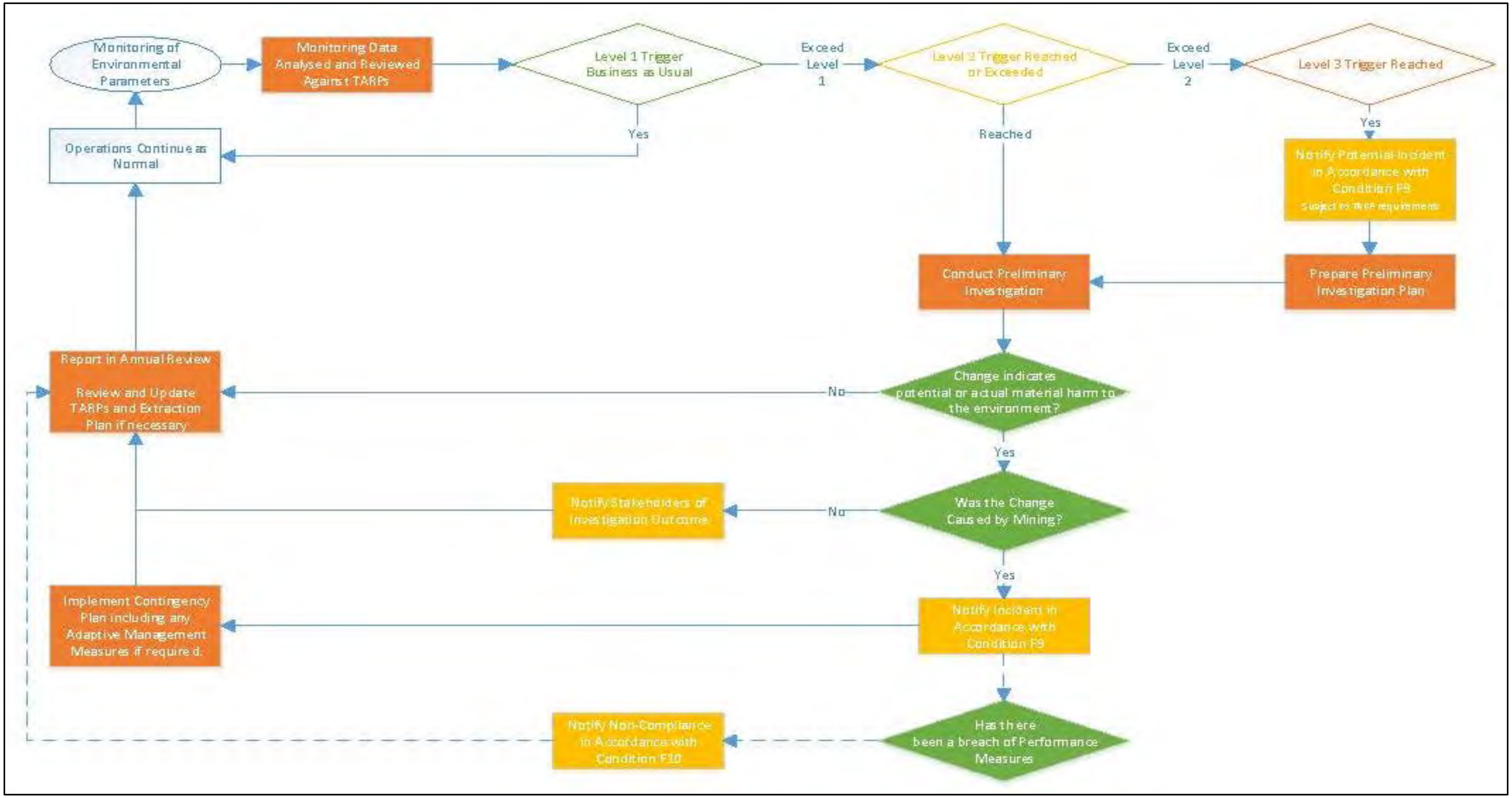
- It is not reasonable or feasible to remediate the subsidence impact or environmental consequence; or
- Remediation measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence;

Then the Applicant must provide a suitable offset to compensate for the subsidence impact or environmental consequence, to the satisfaction of the Secretary. Offsetting requirements for species assumed to be present will be assessed on a proportionate basis to the offsetting required for impacted potential habitat (e.g., Coastal Upland Swamp communities and associated tributaries) unless post-impact monitoring indicates the species is present in the area of potential impact. If detected post-impact, offsetting requirements will be reviewed pending further consideration of the extent of likely impact on the species.

It is be noted that, as per the DC, Conditions C4 – C6:

- Any offsets for biodiversity and swamps must be undertaken in accordance with the Biodiversity Offsets Scheme of the BC Act and must be proportionate with the significance of the subsidence impact or environmental consequence.
- Any offset required under Condition C4 does not limit other actions by the Department under the penalty powers or enforcement provisions of the EP&A Act.
- The offset must give priority to like-for-like physical environmental offsets, but may also consider other offsets under the Biodiversity Offsets Scheme of the BC Act, such as the Biodiversity Conservation Fund established by BCT, or funding or implementing supplementary measures, such as:
  - Actions outlined in threatened species recovery programs.
  - Actions that contribute to threat abatement programs.
  - Biodiversity research and survey programs.
  - Rehabilitating degraded habitat.

Figure 12 Flow Chart Covering TARP Process



8 INCIDENTS, COMPLAINTS AND NON-CONFORMANCES

8.1 Incidents

The DC MP09_0013 defines an 'incident' to be "An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance". Incidents will be managed through established WRPL procedures. In accordance with Condition F9 WRPL must "immediately notify the DPE and any other relevant agencies immediately after it becomes aware of an incident". The notification must identify the following items:

- The development application number and name.
- The location and nature of the incident.
- A detailed report of the incident shall be provided to DPE within 7 days of the incident occurring.

In accordance with Condition 16 of the DC 2020/8702, WRPL must cease second workings and notify the Department within two business days if subsidence limits have been reached or exceeded. The notification must specify:

- Any condition which has been or may have been in breach.
- A short description of the incident and/or non-compliance.
- The location (including co-ordinates), date, and time of the incident and/or non-compliance.

Details of any incident must then be provided within 10 business days after becoming aware of the incident, specifying:

- Any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future.
- The potential impacts of the incident or non-compliance.
- The method and timing of any remedial action that will be undertaken by the approval holder.

WRPL must not recommence second workings until it can be demonstrated that new or increased impacts will not occur and the Minister approves, in writing, the recommencement of second workings.

As discussed in Section 3, the proposed 'second workings' which trigger the requirement for this EP are long term stable bord and pillar workings which are predicted to have only negligible subsidence effects.

Incidents and associated reporting requirements will be managed through established procedures set out in Section 4.2 of the EP.

The Performance Management TARP Process will be implemented with a *Potential* Incident notification being made and an investigation being carried out to determine whether the impacts has been caused by development approved under the DC. Formal incident notification, as required by Condition F9 will occur if the investigation indicates that the event has likely been cause by the development and has caused material harm (i.e. more than trivial) to the feature).

Specifically, all incident notification related to biodiversity features will be sent to DPE and BCD Incident notifications related to surface or groundwater impacts, or which may have consequent impacts of groundwater or surface water will also be provided to Water NSW.

8.2 Non-compliance protocol

The DC MP09_0013 defines a non-compliance as an occurrence or set of circumstances that is a breach of the DC. Except in the case where a non-compliance has been notified as an incident, WRPL will within seven days of becoming aware of the non-compliance, notify DPE of the non-compliance.

The notification must set out:

- The condition of this DC that the development is non-compliant with.
- Why it does not comply, and the reasons for the non-compliance (if known).
- What actions have been, or will be, undertaken to address the non-compliance.

In accordance with Condition 26 of the DC EPBC 2020/8702, WRPL must notify the Department in writing of any non-compliance with the conditions or non-compliance with the commitments made in plans within two business days after becoming aware of the non-compliance. The notification must specify:

- Any condition which has been or may have been in breach.
- A short description of the incident and/or non-compliance.
- The location (including co-ordinates), date, and time of the incident and/or non-compliance.

Details of any non-compliance must then be provided within 10 business days after becoming aware of the non-compliance, specifying:

- Any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future.
- The potential impacts of the incident or non-compliance.
- The method and timing of any remedial action that will be undertaken by the approval holder.

WRPL will manage and report non-compliances against statutory requirements in accordance with an established protocol developed as a component of the EMS (in the case of pit top and associate activities) and/or the EP.

8.3 Complaints handling

Complaints will be managed through established WRPL procedures as described in Section 4.7 of the EMS as required by Condition F5(h) of the DC MP09_0013. All complaints will be logged with the RVC Environmental Superintendent and Group Environment Manager to ensure that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary. A copy of a complaints register (updated on a Monthly basis) is kept on the WRPL website.

A summary of complaints will be available to regulatory authorities on request and provided in the Annual Review.

9 REPORTING

The Reporting Framework set out in Section 5.2 of the EP will apply to the implementation of this plan.

This reporting framework relevant to non-swamp biodiversity values includes:

- Incident reporting.
- Six monthly reporting.
- Impact reporting (in the event of an observed impact associated with the development covered by the EP).
- Annual review reporting requirements.
- Annual ecological monitoring summary report.

This annual ecological monitoring report will be provided to WRPL by their ecological consultants in July each year for incorporation into annual reporting as required is required under Condition F11 of the DC MP09_0013 and annual compliance reporting under Condition 25 of DC EPBC 2020/8702.

10 PLAN ADMINISTRATION

10.1 Roles and responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this BMP are outlined in WRPLs Management Operating System.

10.2 Resources required

In accordance with the WRPL SYS POL 003 Environmental Policy, Management shall ensure that the appropriate resources are made available to achieve the implementation of this Plan.

It is the role of the Group Environment Manager to ensure that these requirements are communicated to WRPL Management.

10.3 Training

All training and inductions that relate to this BMP are to be undertaken as per the WRPL training procedures.

10.3.1 Staff training

Staff training will be undertaken as detailed in the EMS. This consists of three levels of training applicable to different types of staff:

- Level 1 – High level training on biodiversity requirements (management staff).
- Level 2 – Operational level training (project managers, supervisors, control room operators).
- Level 3 – Basic awareness of biodiversity issues (underground staff, all personnel).

Training will be provided as deemed necessary to WRPL employees and contractors to provide them with the knowledge, skills and awareness to minimise impacts associated with their activities.

10.3.2 Inductions

All personnel, including contractors, sub-contractors and staff, are required to attend a compulsory site induction that includes an environmental component prior to commencement on site.

The environmental component will include an overview of:

- Relevant details of this BMP, including purpose and objectives.
- Key environmental issues (e.g. activities with potential to result in environmental impacts).
- Consent Conditions, relevant licences, and permits.
- Specific management requirements, responsibilities and mitigation measures.
- Incident response and reporting requirements.

A record of all environment inductions will be maintained and kept on site. The Site Environment Representative may authorise amendments to the induction where required to address project modifications, legislative changes or amendments to this BMP or related documentation.

The Group Environment Manager or delegate will review and endorse the induction program and monitor its implementation.

11 AUDIT AND REVIEW

11.1 Annual review

In accordance with Part F – Environmental management, Condition F11 of the DC MP09_0013 and Condition 25 of DC 2020/8702, an annual review of the environmental performance of the BMP is to be prepared.

In accordance with DC MP09_0013 the annual review will:

- Describe the works carried out in the past year, and the works proposed to be carried out over the next year.
- Include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - Relevant statutory requirements, limits or performance measures/criteria.
  - Monitoring results of previous year/s.
  - Relevant predictions in the EA(s).
- Identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance.
- Identify any trends in the monitoring data over the life of the Project.
- Identify any discrepancies between the predicted and actual impacts and analyse the potential cause of any significant discrepancies.
- Describe what measures will be implemented over the next year to improve the environmental performance of the Project.

11.2 Auditing

In accordance with Part F of the DC MP09_0013 and Condition 28 to 30 of DC 2020/8702 an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Secretary according to the following:

- Within 12 months of the approval and every three years after that (DC MP09_0013).
- Within three years of commencement and every three years after that (DC 2020/8702).

In line with the DC MP09_0013, this audit must:

- Be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary.
- Include consultation with the relevant agencies.
- Assess the environmental performance of the project and assess whether it is complying with the requirements in the DC and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals).
- Review the adequacy of strategies, plans or programs required under the abovementioned approvals.

- Recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals.

In line with DC 2020/8702, this audit must:

- Provide the name and qualifications of the independent auditor and the draft audit criteria to the Department.
- Only commence the independent audit once the audit criteria have been approved in writing by the Department.

In accordance with Condition F14 of the DC MP09_0013, WRPL would submit a copy of the audit report, along with responses to any recommendations contained within the report to the Planning Secretary, as well as the Department in accordance with Condition 29c of the DC 2020/8702. The audit and response to recommendations would be submitted within three months of the completion of the audit unless otherwise agreed by the Planning Secretary and according to approved audit criteria.

WRPL must publish the audit report on the website within 10 business days of receiving the Department's approval of the audit report and keep the audit report published on the website until the end date of the DC 2020/8702.

12 RECORDS AND DOCUMENT CONTROL

12.1 Plan revision

In accordance with Condition F7 of the DC, this BMP will be reviewed to determine their ongoing suitability within three months of:

- The submission of an incident report.
- The submission of an annual review.
- The submission of an Independent Environmental Audit.
- Any modification to the conditions of approval (unless the conditions require otherwise or as otherwise agreed with DPE).

The revision status of this plan is indicated in the front of each copy. Revisions to any documents listed within this Plan will not necessarily constitute a revision of this document.

In accordance with DC Condition F8 ensure strategies, plans and programs are updated on a regular basis, if necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary to incorporate any recommended measures to improve the environmental performance of the development..

Where revisions are required, the revised document must be submitted to the Planning Secretary for approval within 6 weeks of the review.

Any revisions required to be undertaken as above will be the responsibility of WRPL and notifications will be sent accordingly to the stakeholders identified in Section 2.6

During the next major update of the plan as would likely be associated with subsequent EPs, further consultation with the identified stakeholders will be sought and the plan will be amended accordingly.

12.2 Record keeping and control

Environmental records are to be managed in accordance with the WRPL SYS PRO 001 Document and Data Control procedure.

All records of the EMS will be stored so that they are readily retrievable and suitably protected from deterioration or loss. Archiving will be managed in accordance with the WRPL SYS PRO 001 Document and Data Control procedure.

WRPL will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent controlled version is maintained on WRPLs secure server, website, and hard copy at the Russell Vale Colliery, 7 Princes Highway, Corrimal NSW 2518.

The stakeholder list as described in Section 2.6 applies for distribution of any updated controlled copies

12.3 Information access

Before the commencement of construction until the completion of all rehabilitation, WRPL will ensure the information and documents as stipulated in Condition F17 of DC MP09_0013, EPBC

2020/8702, and the EMS, are made publicly available on its website as they are obtained, approved or as otherwise stipulated within the conditions of the DC MP09_0013.

This information must be kept up to date to the satisfaction of the planning secretary.

12.4 Public sources of information

To assist the public and other stakeholders understand the impacts from the development, including monitoring results, newsletters and updates, and in accordance with Condition F5(i) of DC MP09_0013, WRPL will:

- Publish information on the company website.
- Notify the local community through the Russell Vale CCC.
- Contact individuals by direct notification (email subject to registration of interest) where relevant.

Information required to be published in accordance with Condition F17, such as CCC minutes, current statutory approvals and complaints register will also be included on the company website.

In addition, in accordance with Condition 7c, 7f, 9d, 15c, 23b, 25a and 30 of EPBC 2020/8702, monitoring data, plans, annual compliance reports and audit reports will be published on the website and retained until the end date of the DC.

This information will be updated as required.

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14 GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
BCD	Biodiversity Conservation Division within the DPE
BMP	Biodiversity Management Plan
DAWE	Commonwealth Department of Agriculture, Water and the Environment (now Commonwealth Department of Climate Change, Energy, the Environment and Water)
DC	Development Consent
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water (formerly Commonwealth Department of Agriculture, Water and the Environment)
DPE	Department of Planning & Environment (formerly Department of Planning, Industry & Environment)
DPIE	Department of Planning, Industry & Environment (now Department of Planning & Environment)
EEC	Endangered Ecological Community
E&C	Environment and Community
EM	Environment Manager
EMS	Environmental Management System
EP	Extraction Plan
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environmental Protection Authority
EPBC	Environmental Planning and Biodiversity Conservation Act 1999
EPL	Environmental Protection Licences
GDE	Groundwater Dependent Ecosystems
IPC	Independent Planning Commission
LGA	Local Government Area
Mtpa	Million tonnes per annum
NRAR	Natural Resources Access Regulator
PCT	Plant Community Type

ROM	Run of Mine
TARP	Trigger Action Response Plan
WCC	Wollongong City Council
WCL	Wollongong Coal Limited (now Wollongong Resources Pty Ltd)
WRPL	Wollongong Resources Pty Ltd (formerly Wollongong Coal Limited)

Terms	
Environmental consequences	The environmental consequences of subsidence impacts, including damage to built features, loss of surface flows to the subsurface, loss of standing pools, slope changes to streams, adverse water quality impacts, development of iron bacterial mats, cliff falls, rock falls, landslides, damage to aboriginal heritage sites, impacts on aquatic ecology, and ponding.
First Workings	Development of main headings, gate roads, related cut throughs, and other workings for mine access and ventilation.
Incident	An occurrence or set of occurrences that causes or threatens to cause material harm and which may or may not cause a non-compliance.
Mining operations	The carrying out of mining, including the extraction, processing, stockpiling and transportation of coal on the site and the associated removal, storage, and/or emplacement of vegetation, topsoil, overburden and reject material.
Non-Compliance	An occurrence or set of occurrences or development that is in breach of this consent.
the Colliery	Russell Vale Colliery.
the Planning Secretary	The Planning Secretary of the Department of Planning and Environment (DPE).
Reasonable	Mean applying judgement in arriving at a decision, taking into account mitigation benefits, cost of mitigation versus benefits provided, community views and the nature of and extent of potential contamination.
Secondary workings	Extraction of coal from board and pillar workings.
Subsidence	The totality of subsidence impacts and environmental consequences of subsidence impacts.
Subsidence effects	Deformation of the ground mass due to mining, including all mining induced ground movements, such as vertical and horizontal displacement, tilt, strain, and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.
the Project	the Revised Preferred Project.

APPENDIX A – AGENCY CONSULTATION

Richard Sheehan

From:	no-reply@majorprojects.planning.nsw.gov.au
Sent:	Friday, 12 February 2021 8:36 AM
To:	richard.sheehan@wcl.net.au
Cc:	richard.sheehan@wcl.net.au; daniel.martin@dpie.nsw.gov.au
Subject:	Russell Vale Underground Expansion - Russel Vale Colliery Extraction Plan Authors
Attachments:	__Appointment of Experts_09022021_061146.pdf__.dat

Dear Richard ,

The Department has completed its assessment of the Russel Vale Colliery Extraction Plan Authors for the Russell Vale Underground Expansion

The Department's comments are attached.

If you have any enquiries, please contact Daniel Martin at daniel.martin@dpie.nsw.gov.au.

To sign in to your account click here or visit the Major Projects Website.

Please do not reply to this email.

Kind regards

The Department of Planning, Industry and Environment

Department of Planning and Environment

Our ref: DOC22/397326
Senders ref: MP09_0013-PA-45

23 May 2022

Simon Pigozzo
Wollongong Coal
E-mail: simon.pigozzo@wcl.net.au

Dear Simon

Subject: Russell Vale Underground Expansion – Extraction Plan Stage 2– Comments on Biodiversity Management Plan and Swamp Monitoring Plan

Thank you for referring the above post-approval matter to the Biodiversity and Conservation Division (BCD) of the Department of Planning and Environment (DPE). We apologise for the delay and appreciate the extra time to respond.

The Plan was prepared in accordance with Condition C10 of the Project Approval. You have requested our input on the Biodiversity Management Plan and the Swamp Management Plan which are sub-plans of the broader Extraction Plan. The Biodiversity Management Plan (BMP) focuses on monitoring ecological values that have been determined to be most at risk as part of the Underground Expansion Project (UEP) while the Swamp Management Plan (SMP) has been prepared to manage potential subsidence and groundwater impacts on Coastal Upland Swamps.

We provide a detailed summary of comments and actions required to update the Plan in Attachment 1. We also refer you to our previous comments in relation to Stage 1 (our reference DOC21/1002718).

If you have any questions or require further advice, please do not hesitate to contact Vanessa Allen, Senior Conservation Planning Officer, via Vanessa.Allen@environment.nsw.gov.au or 4224 4186.

Yours sincerely

Chris Page
Senior Team Leader (Planning Illawarra)
Biodiversity and Conservation Division

Attachment 1: BCD comments on the Swamp Management Plan and Biodiversity Management Plan

Reference	Comments
1. Biodiversity Management Plan	
Condition of Approval C10(g)(iv) Page 17	This condition requires a BMP which establishes baseline data for the existing habitat on the site, including **vegetation condition** and **threatened species habitat**, Table 8 describes monitoring methods, including "Photo-point monitoring". How will vegetation data (including baseline data) be collected and analysed for non-swamp vegetation, noting that a Briefing Note sent to BCD, dated 4/6/2021, described the use of BAM plots for baseline data to inform offsetting requirements? BAM plots are mentioned in the SMP but not the BMP. Please clarify when and how BAM plots will be used.
Threatened frogs	Habitat mapping and occupancy of frogs needs to be done more accurately in the possibly impacted areas. Likelihood of detection needs to be considered for all monitoring proposals – frog breeding periods will mean tadpoles are present at different times. Consider using eDNA monitoring techniques for screening streams (note this should not be used as a replacement for normal monitoring, for further advice, consult BCD). The BMP should discuss how monitoring data is to be collected in accordance with current Threatened Frog Survey Guidelines: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/nsw-survey-guide-for-threatened-frogs-200440.pdf
Littlejohn's tree frog	Habitat is not limited to tributaries only. It is unclear what remediation will be worthwhile if monitoring detects an impact. Further information required.
Red-crowned toadlet	Red-crowned toadlet is a localised species that appears to be largely restricted to the immediate vicinity of suitable breeding habitat. Due to this tendency for discrete populations to concentrate at particular sites, a relatively small, localised disturbance may have a significant impact on a local population if it occurs on a favoured breeding or

	refuge site. Mining impacts (eg changes to soil moisture) could adversely impact this species.
Giant burrowing frog Section 6.4.2	Giant burrowing frogs only breed February to May and therefore tadpoles are only present during that time. Only a 245 metre section of a tributary of Cataract River has been identified as habitat when other similar areas of habitat exist. Section 6.4.2 states that “giant burrowing frog monitoring is not required within the stage 2 EP area as no habitat is considered to be present”. Based on information provided in the BMP, adequate surveys have not been carried out for this species to be able to exclude Stage 2 areas as non-habitat. Consider using eDNA screening as part of the monitoring program.
Section 3.4 Page 39 Section 6.4.2 Page 69	Overall, it is not clear that adequate survey has been done to determine whether certain threatened species occur within the Stage 2 Extraction Plan area and thus whether baseline data requirements in accordance with CoA 10(g)(iv) are met. The Preferred Project Report identified a number of threatened species which have potential to occur and may be impacted by subsidence. Further monitoring has occurred, but no detail is provided.
Figure 6 Page 46	It is unclear why swamps in Stage 2 do not contain habitat for giant dragonfly? None of the swamps mapped in Stage 2 are mapped as habitat.
2. Swamp Management Plan	
Figure 11a	All swamp monitoring sites should be identified in a Table with co-ordinates or provide BCD with an excel file of latitude/longitude or easting/northing for each identified swamp. A shapefile of all swamps should be provided. We could not find the following swamps: ACUS, BCUS12, BCUS13. WACUS, WCUS, S22, S33, S15A.
	A table is required that clearly demonstrates whether all swamps potentially affected by the mining are monitored and what monitoring takes place in those swamps (ie water level, soil moisture, vegetation quadrat, giant dragonfly) and their choice of accompanying reference swamps for comparison in a rigorous BACI design. If a swamp is within the defined

	mining footprint and is not monitored, a justification for this is required.
	Rationale should be provided underlying the choice of swamps for dragonfly monitoring and the justification for not monitoring all swamps that could potentially be affected by the mining (bearing in mind cumulative impacts form previous mining in the area).
Attached document: *Analysis of RV East flora data for Biosis,* prepared by The Analytical Edge Statistical Consulting Page 150	This document analyses vegetation data in terms of total species richness (TSR). This document states: *"TSR is not a good metric to reflect the complex nature of community composition and species turnover, since some species may become locally extinct or invade a region, yet the TSR can remain stable."* We agree with this conclusion which clearly indicates that community composition data should be the focus for any BACI Assessment. The Plan does not include the use of community composition data as a means of identifying impact (or lack thereof) in a rigorous BACI design. This needs rectification.
	All piezometer, soil moisture, vegetation quadrat, flow, pool level and water quality data should be provided to BCD so an independent analysis can be conducted and the appropriateness/rigour of the proposed BACI design tested.

Department of Planning and Environment

Our ref: MP09_0013-PA-45

Tom McMahon

NRE No.1 Colliery 7

Princes Highway

Corrimal NSW 2518

24 August 2022

Subject: Russell Vale Underground Coal Mine Stage 2 Extraction Plan – Request for Information

Dear Tom

I refer to the Russell Vale Underground Expansion Stage 2 Extraction Plan submitted to the Department of Planning and Environment (the department) as required under the conditions of consent for the Russell Vale Underground Expansion. After careful consideration, the department is requesting that you provide additional information.

You are requested to submit the additional information detailed in **Attachment A**.

You are requested to provide the information, or notification that the information will not be provided, to the department by 7 September 2022. If you are unable to provide the requested information within this timeframe, you are requested to provide, and commit to, a timeframe detailing the provision of this information.

If you have any questions, please contact Allison Sharp on 4345 4403 or via email at Allison.Sharp@planning.nsw.gov.au.

Yours sincerely,

JEvans

Jessie Evans

Director
Energy and Resources Assessments

Attachment A – Request for information

Russell Vale Underground Coal Mine – Stage 1 and 2 Extraction Plan

Biodiversity Management Plan

Giant Burrowing Frog Monitoring

The Biodiversity Management Plan (BMP) describes 13 surveys undertaken along a 245 m section of a tributary of Cataract River below swamp CRUS2. The BMP states that detailed surveys indicate that other tributaries are unlikely to support the species, and the species is not present within the Stage 2 extraction area.

BCD has provided the attached advice. The department has reviewed WCL's response to similar advice in Appendix E – Attachment 4 of the Biodiversity Management Plan. Appendix B of the 2022 BMP details the year of the most recent record, the number of records, and the distance of the records from the Study Area. The data included in Appendix B does not sufficiently justify the exclusion of the Giant Burrowing Frog from baseline data collection surveys prior to mining in the Stage 2 EP area.

The preferred project report biodiversity assessment (Umwelt, 2019) draws a conclusion regarding the potential for impact on the Giant Burrowing Frog stating:

"Although often associated with upland swamps, this association is not direct, rather that upland swamps are associated with minor drainage lines that provide suitable breeding pools and burrowing habitat for this species (DECC 2007). SCT (2018) predicts that the imperceptible levels of subsidence resulting from the revised UEP mine plan will not result in perceptible impacts to creeks. As such, the Giant Burrowing Frog is considered at negligible risk of impact."

The department acknowledges to low risk of impact. However, conditions C4-C6 of MP09_0013 provide for biodiversity impact offsetting if WCL exceeds the performance measures. If required, offsets must be undertaken in accordance with the Biodiversity Offsets Scheme (BOS). The BOS requires a suitable baseline dataset collected in accordance with the Biodiversity Assessment Method. To justify the exclusion of the Giant Burrowing Frog from the baseline dataset, the department requires the following:

- maps demonstrating the survey effort conducted for the Giant Burrowing Frog other than at CRUS2
- survey data associated with the mapped survey effort
- detailed outline of any other criteria used for each swamp to justify the exclusion of the species from further survey

Frog Species Monitoring

Threatened frog monitoring listed in Appendix B-Attachment 1 of the Biodiversity Monitoring Plan includes:

- two transects for *Litoria littlejohni* and *Heleioporus australiacus*, and
- four transects for *Mixophyes balbus*

The department requests more information including:

- maps of the transect locations references in Appendix B-Attachment 1 and any other survey transects completed for threatened frog species
- details of survey effort at the monitoring transect locations, and any other locations including date, number of days/hours
- detailed outline of any other criteria used for each swamp to justify the exclusion of the above species from further survey

Subsidence Monitoring

Explanation of GNSS monitoring locations

The proposed GNSS locations are mapped on Figure 11a of the Upland Swamp Monitoring Plan (USMP). Table 13 of the USMP details the subsidence monitoring relevant to Coastal Upland Swamps. The relevance/purpose of GNSS units is described as:

- located over second workings to provide information about subsidence occurring within that panel
- located within or at the edge of swamps provide an indication of subsidence levels within the swamp
- where possible, located at a point within the swamp or at a point between the swamp and the second workings

The department requests WCL identify which GNSS units are intended for one or more of the purposes outlined in Table 13 of the USMP.

Subsidence baseline monitoring

All GNSS units require a baseline monitoring period of 12 months prior to mining. The Subsidence Monitoring Plan (SMP) provides baseline monitoring results for GNSS units #1 - #17. The department does not consider GNSS units #1 - #17 provide a representative baseline data set for GNSS units within the Stage 2 extraction plan area.

The SMP and Master TARP must define the timeframe for baseline subsidence data collected ‘prior to mining’.

The department requests confirmation from WCL that subsidence monitoring by GNSS units will be conducted for a minimum of 12 months prior to undermining.

LiDAR

The Stage 2 Subsidence Assessment (SCT, July 2022) states “Broad-area remote monitoring (LiDAR) across the entire area is to check for unexpected movements, particularly any that may be associated with instability of remnant pillars in or in the vicinity of Bulli Seam goaf areas.” The subsidence monitoring plan (Section 4.1) re-states this and details that the planned LiDAR surveys have an accuracy of +/- 200mm over the majority of the survey area. The accuracy and purpose of LiDAR is also detailed in Table 5 of the SMP.

The Master Trigger Action Response Plan (Master TARP) is inconsistent with the proposed subsidence monitoring outlined in Table 5 of the SMP. The Master TARP lists a LiDAR survey trigger level of >100mm of subsidence. The TARPs of >100mm of subsidence appear to be inconsistent with the Subsidence Assessment (SCT, July 2022) and the SMP.

The department requires clarification of how LiDAR can be used for subsidence levels <200mm, or alternatively, align TARPs measured by LiDAR with the limitations of the method.

GNSS Units #31 and #32

Please clarify the locations of GNSS Units 31 and 32

Groundwater Monitoring

The department requires an outline of groundwater monitoring undertaken at control sites. The outline must include the location name, month, and year of data collection and whether monitoring is ongoing or has ceased.

Caragh Heenan

From: no-reply@majorprojects.planning.nsw.gov.au
Sent: Tuesday, 27 September 2022 12:33 PM
To: richard.sheehan@wcl.net.au
Cc: Allison.Sharp@planning.nsw.gov.au
Subject: Russell Vale Underground Expansion - MP09_0013 RussellVale Stage 2 Extraction Plan MP09_0013-PA-45 - Request for Additional Information

Dear Richard Sheehan,

The Department is requesting that you provide additional information in relation to the Russell Vale Underground Expansion - MP09_0013 RussellVale Stage 2 Extraction Plan .

Please access your profile for details of this request and to upload your response. You are requested to provide this response by 11/10/2022 .

If you have any enquiries, please contact Allison Sharp on 02 4345 4403 /at Allison.Sharp@planning.nsw.gov.au .

To sign in to your account click here or visit the Major Projects Website.

Please do not reply to this email.

Kind regards

The Department of Planning and Environment

NSW GOVERNMENT

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Upload RFI Response

Actions

Details of Request

Message

Thankyou for your recent response to RFI dated 9 September 2022.

The department requests that WCL submit a revised version of the final Stage 1 and 2 UEP. The revised version needs to include the changes proposed in the 9 September response to RFI, including TARPs/LiDAR, mapping of GNSS units #31 and #32.

The department is likely to condition the Stage 1 and 2 UEP to require WCL to assume the Giant Burrowing Frog and Little John's Treefrog are present in the Stage 2 area. The department is also likely to require WCL to include both frog species in the biodiversity monitoring program, including baseline monitoring. Alternatively, WCL have the option revise the Stage 1 and 2 UEP to assume both frog species are present and revise the monitoring program and relevant TARPs.

Richard Sheehan
Environmental Manager
NRE NO. 1 Colliery 7
Princes Highway
Corrimal, NSW, 2518

09/02/2021

Dear Mr Sheehan

Russell Vale Underground Expansion (MP09_0013)
Extraction Plan

I refer to your request (MP09_0013-PA-3) for the Planning Secretary's approval of suitably qualified persons to prepare the Extraction Plan for the Russell Vale Underground Expansion (MP09_0013).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Consequently, I can advise that the Planning Secretary approves the appointment of the experts to prepare the Extraction Plan.

Accordingly, the following experts are approved as authors for the Extraction Plan.

Consent Condition	Extraction Plan Requirement	Expert/Author
Schedule C Condition 10	Extraction Plan	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(i)	Subsidence Monitoring Plan	Dr Ken Mills – SCT Stephen Wilson - SCT
Schedule C Condition 10 (g)(ii)	Built Features Management Plan	Dr Ken Mills – SCT Stephen Wilson - SCT
Schedule C Condition 10 (g)(iii)	Water Management Plan	Susan Shield – Engeny Clare Stephenson - Umwelt
Schedule C Condition 10 (g)(iv)	Biodiversity Management Plan	Paul Price - Biosis
Schedule C Condition 10 (g)(v)	Swamp Monitoring Plan	Luke Stone - Biosis
Schedule C Condition 10 (g)(vi)	Land Management Plan	Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(vi)	Heritage Management Plan	Dr Amanda Markham - Biosis
Schedule C Condition 10 (g)(vii)	Public Safety Management Plan	Warwick Lidbury – RVC Mine Manager
Schedule C Condition 10 (g)(viii)	Trigger Action Response Plan/s	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt
Schedule C Condition 10 (g)(ix)	Contingency Plan	Warwick Lidbury – RVC Mine Manager Luke Bettridge – Umwelt David Holmes – Umwelt

If you wish to discuss the matter further, please contact Daniel Martin at daniel.martin@dpie.nsw.gov.au

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Planning Secretary

DOC21/911837-2

Ms Gabrielle Allan
Department of Planning, Industry and Environment
GPO Box 39
SYDNEY NSW 2001

Email: gabrielle.allan@dpie.nsw.gov.au

Dear Ms Allan

EPA Comments - Russell Vale Underground Expansion Project - Stage 1 Extraction Plan

I am writing in reply to the Department's request for comments on the Russell Vale Extraction Plan dated 8 October 2021.

The plan was submitted by Wollongong Coal Ltd for approval to extract coal from Stage 1 areas of the Russell Vale coal mine.

The EPA has reviewed the plan and provides the following comments on surface facilities that fall within the premises of the mine's Environment Protection Licence number 12040.

The plan has divided the installation of surface infrastructure into two stages. Stage 1 includes construction of new noise walls, noise bunds and a new primary sizer. Board and pillar mining will be undertaken and the coal will be loaded onto trucks from the ROM stockpile using front-end loaders. The coal will be transported to PKCT for export.

The plan states that Stage 1 includes an "evaluation of the feasibility of a coal processing plant (CPP) to be installed as part of the new Stage 2 surface infrastructure".

The EPA understands that the Revised Preferred Project Report and evaluation of environmental impacts during the planning approval included a new coal processing plant. If the plant is built as part of the project, the EPA recommends that expert confirmation be provided by Wollongong Coal that noise and dust impacts will be no more than those predicted in the environmental assessment and approved in the Consent.

If you have questions regarding the above, please phone Andrew Couldridge on (02) 4224 4100.

Yours sincerely

William Dove

22.10.2021

WILLIAM DOVE
Unit Head Regulation

Our ref: DOC21/910629

Gabrielle Allan
Team Leader
Energy Resource Assessment
DPIE

By email: gabrielle.allan@dpie.nsw.gov.au

Dear Ms Allan

HERITAGE COUNCIL COMMENTS ON DRAFT STAGE 1 EXTRACTION PLAN FOR RUSSELL VALE COLLIERY (MP09_0013-PA-12)

Thank you for your referral dated 18 October 2021 inviting comments from the Heritage Council of NSW on the Draft Stage 1 Extraction Plan (for bord and pillar mining of sub-panels PC07, PC08 and PC21 to PC25) for Russell Vale Colliery.

It is understood that the subject modification was approved on 8 December 2020. The following condition is relevant: Schedule 2, Part C Condition C10 (Extraction Plan). Heritage NSW previously provided comments to the Historic Heritage Management Plan (HHMP), dated 5/3/2021 as per letter of 14 April 2021 (DOC21/211102).

The following report was considered:
Russell Vale Colliery Revised Underground Expansion Project – Extraction Plan Stage One – PC07, PC08 & PC21 to PC25, prepared by Wollongong Coal, dated 8 October 2021.
This Extraction Plan includes the updated Heritage Management Plan:

Russell Vale Colliery, Russell Vale East – Revised Underground Expansion Project, Cultural and Historical Heritage Management Plan, prepared by Wollongong Coal, dated 30/9/2021.

The following comments are provided to address the applicant's response to the heritage issues raised:

- Section 8.2 of the HHMP states that vertical subsidence impacts are predicted to be less than 100mm and the Performance Measure for vertical subsidence has been set at 300mm under the development consent; and that this level of subsidence impact would be restricted to the edge of the FSL area immediately adjacent to the Extraction Plan area and will have no observable impacts on the Reservoir and would not have any effect on the heritage values of the Cataract Dam.

  It is noted that the previously recommended actions in case of vibration and subsidence within Cataract Dam SHR curtilage included stopping activity in surrounding area, followed by urgent rehabilitation of the area and submission of a report to HNSW outlining the actions taken. Table 23 of the TARP (Trigger Action Response Plan) within Appendix A of the HHMP includes actions for three subsidence prediction levels. The previously recommended actions have not been included into the TARP. It is requested that the monitoring and remediation actions be incorporated into the HHMP, particularly at Level 2 (100-300mm recorded subsidence) and 3 (greater than 300mm recorded subsidence), where changes in site conditions are observable.

- It is noted that section 10.4.3 of the HHMP includes actions to be taken in instances of discovery of ‘relics’, as per the provisions of s.146 of the *Heritage Act 1977*. This is supported.

If you have any questions regarding the above advice, please contact Veerle Norbury, Senior Heritage Assessment Officer at Heritage NSW, on 9873 8616 or veerle.norbury@environment.nsw.gov.au.

Yours sincerely

Steven Meredith
Director, Heritage Programs
Heritage NSW
Department of Premier and Cabinet
As Delegate of the Heritage Council of NSW
4 November 2021

Response History

Public Authority Response

Monday, 25 October 2021 12:30:01 AM AEDT

Notes:

To whom it may concern,

Heritage NSW has reviewed the Wollongong Coal has submitted an Extraction Plan (EP) for Stage 1 bord and pillar mining (sub-panels PC07, PC08 and PC21 to PC25), in accordance with condition C10 of the project approval for the Revised Underground Expansion Project (MP09_0013).

Heritage NSW has no additional recommendations or comments on the submitted extraction plan.

Regards Nicole Davis

Nicole Davis | A/Senior Team Leader,
Aboriginal Cultural Heritage Regulation - North
Heritage NSW, Community Engagement,
Department of Premier and Cabinet
Level 6, 10 Valentine Ave, Parramatta |
Locked Bag 5020 Parramatta 2124
T: 02 4927 3156 M: 0409 394 343 | nicole.davis@environment.nsw.gov.au

MINING, EXPLORATION & GEOSCIENCE ADVICE RESPONSE

DOC21/932107

Gabby Allan
Planning & Assessment Group
Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2150

Gabby.Allan@planning.nsw.gov.au

Dear Gabby

Project: Russell Vale U/G Expansion – Stage 1 – Revised Extraction Plan variation
Stage: Post Approval Assessment
Development Application: MP09_0013-PA-31

I refer to your correspondence dated 18 October 2021 inviting the Department of Regional NSW – Mining, Exploration & Geoscience (MEG) to provide comments on the Russell Vale U/G Expansion – Stage 1 – Revised Extraction Plan variation (the Project), submitted by Wollongong Coal Limited (the Proponent).

MEG has reviewed the information supplied and raises no issues regarding the Russell Vale U/G Expansion – Stage 1 – Revised Extraction Plan variation.

MEG considers the extraction plan to adequately recover coal resources and provide an appropriate return to the NSW Government.

For further advice concerning this matter, please contact Industry Advisory & Mining Concierge on 02 4063 6534 or mining.concierge@regional.nsw.gov.au.

Yours sincerely

Scott Anson
Manager Industry Advisory & Mining Concierge
Industry Development
Department of Regional NSW – Mining, Exploration & Geoscience
2 November 2021

for
Anthony Keon
Executive Director Strategy, Performance & Industry Development
Department of Regional NSW – Mining, Exploration & Geoscience

DOC SF21/137908
MAAG0012517

Gabrielle Allan
Principal Planning Officer
Planning and Assessment Group
Department of Planning, Industry and Environment

Via: Major Project Portal / Email

Dear Ms Allan,

Re. Russell Vale Underground Expansion - Stage 1 Extraction Plan

I refer to your request of 18 October 2021 for advice regarding Russell Vale Underground Expansion - Stage 1 Extraction Plan. The Resources Regulator has reviewed the request.

Assessment
Based on the review of the draft conditions, the Resources Regulator advises that the holder of relevant mining leases is required to ensure that the rehabilitation commitments outlined in any approved Extraction Plan are included in the Mining Operations Plan / Rehabilitation Management Plan regulated by the Resources Regulator pursuant to the conditions of the mining leases under the Mining Act 1992. The holder of the mining leases must ensure the Mining Operations Plan / Rehabilitation Management Plan for the area covered by this Russell Vale Colliery Revised Underground Expansion Project - Extraction Plan Stage 1 is updated where necessary.

Due to the required Performance Measures, i.e. "*Always safe and serviceable*", for the Key Public Infrastructure as set out in Condition C7 of the Development Consent (MP09_0013, dated 8 December 2020), we suggest that the Approving Authority obtains the infrastructure operators' written endorsement of the proponent's proposed Built Features Management Plan prior to the determination of approval of the above-mentioned Extraction Plan.

Note – The above-mentioned Built Features Management Plan is part of Russell Vale Colliery's Extraction Plan (RVE EC PLN 010, Version: 02, Effective: 8 October 2021).

The endorsement by the operators of the Key Public Infrastructure as set out in Condition C7 of the Development Consent (MP09_0013, dated 8 December 2020) is to ensure:

- Completion of consultation between the proponent and the infrastructure operators in relation to all the actions raised and/or questions/requests asked by the infrastructure operators;
- Accuracy of the proponent's understanding of the Key Public Infrastructure at the subject site (e.g. the proponent's statement in the Extraction Plan that the 132kV transmission line at the subject site is managed/operated by TransGrid is incorrect); and

- Risk assessments and the subsequent development of management and contingency plans is undertaken in consultation with the infrastructure operators. The infrastructure operators' expertise and resources form a fundamental part of the risk management system. It follows that the endorsement by the infrastructure operators of the Built Features Management Plan is fundamentally important to ensure the proponent's compliance with the requirements under the Development Consent (MP09_0013, dated 8 December 2020).

Note that the infrastructure operators' endorsement (or agreement) has been suggested in Appendix D (i.e. Subsidence Assessment) of the proponent's Extraction Plan (RVE EC PLN 010, Version: 02, Effective: 8 October 2021) as follows:

These management plans and risk control measures need to be developed in consultation and with the agreement of the asset owners and relevant stakeholders through risk assessments.

Limitations
The Extraction Plan is assessed and determined by DPIE under the conditions of the development consent. The Resources Regulator provides advice to DPIE to assist in the determination.

Regulatory requirements if approved
The authorisation holder is required to ensure that the rehabilitation commitments outlined in any approved Extraction Plan are included in the Mining Operations Plan / Rehabilitation Management Plan regulated by the Resources Regulator under the conditions of the mining lease and the *Mining Act 1992*. The authorisation holder must ensure the Mining Operations Plan / Rehabilitation Management Plan for the area covered by this Extraction Plan is updated where necessary.

The Resources Regulator may undertake assessments of the mine operators' proposed mining activities under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulation as well as other WHS regulatory obligations.

Subsidence associated with the proposed Extraction Plan will be regulated by under relevant provisions of WHS laws in particular Clause 33 and Clause 67 of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* relating to High Risk Activities and Subsidence.

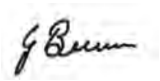
Background
The NSW Resources Regulator is responsible for compliance and enforcement of the Extraction Plan is so far as it relates to requirements under the Mining Act 1992 and Work Health and Safety legislation. This role principally relates to rehabilitation, workplace safety and public safety.

The Mining Act Inspectorate within the Resources Regulator undertake risk-based compliance and enforcement activities in relation to obligations under the *Mining Act 1992*. This includes undertaking assessment and compliance activities in relation to mine rehabilitation activities and determination of security deposits.

The Mine Safety Inspectorate within the Resources Regulator is responsible for ensuring the mine operators' compliance with the Work Health and Safety (WHS) legislation, in particular the effective management of risks associated with the principal hazards as specified in the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*.

Contact
Should you require any further information or clarification, please contact the Office of the Executive Director (ED.ResourcesRegulator@planning.nsw.gov.au)

Yours sincerely,



Garvin Burns
Executive Director
NSW Resources Regulator

8 November 2021

PO Box 398, Parramatta NSW 2124
Level 14, 169 Macquarie Street
Parramatta NSW 2150
www.waternsw.com.au
ABN 21 147 934 787

5 November 2021

Contact: Ravi Sundaram
Telephone: 0428226152
Our ref: *D2021/116712*

Jessie Evans, Director Resource Assessments, DPIE
Email: Jessie Evans@DPIE.nsw.gov.au

Dear Jessie

Russell Vale Colliery Underground Expansion Project - Stage 1 – PC07-08 and 21 -25 Extraction Plan

WaterNSW appreciates the opportunity to review the above application located within the Metropolitan Special Area and the Upper Nepean Catchment (specifically within the upper catchment of the Cataract Reservoir).

WaterNSW has an important statutory role "*to protect and enhance the quality and quantity of water in declared catchment areas*". It also has a set of 'Mining Principles' which underpin WaterNSW decision making in relation to managing mining impacts in the declared Sydney catchment area and on catchment infrastructure.

WCL has consulted with WaterNSW in preparing several key management plans required under the approval including Water Management Plan, Land Management Plan, Swamp Monitoring Program, and the Public Safety Management Plan. The EP has addressed feedback provided by WaterNSW to these plans.

The EP includes the revised and updated subsidence assessment including risk of "pillar run" in multi-seam mining areas. The EP predicts that vertical subsidence is expected to be less than 100mm and generally imperceptible over most of the EP Areas. As a result, the EP expects the impacts, and consequences to natural, surface, and sub-surface features to be negligible and imperceptible in the undeveloped bushland setting over most of the EP subject areas.

WaterNSW notes that the EP has comprehensively addressed the pillar stability and pillar failure issues through changes to mine design including:

- Increased pillar dimensions in PC07 and PC08 area from 19.5m by 24.5m (as originally identified in the Response to Second PAC Review and Revised Project Assessment (Umwelt 2019) to 22.5m by 24.5m to below the Balgownie Seam longwall goafs
- Pillar generally square in shape in PC21 and PC22-25 area with minimum coal pillar dimensions of 24.5m by 24.5m
- Longer rectangular barrier type pillars incorporated into the three headings entries to the PC22-25 sub-panels, and
- Three barrier pillars (coal) separate the PC22-PC25 sub-panels.

The EP reports that risk analysis undertaken (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 remote.

WaterNSW considers that:
- The mining method and mine design adopted by WCL would result in negligible impacts on water resources, biodiversity, and catchment environmental values.
- WCL have addressed the potential risk of 'pillar run' for proposed extraction in a multi-seam area where overlying seams have been extracted previously.
- The proposed monitoring and management measures are appropriate for the planned mining method and subsidence predictions.

- The underground mine water balance monitoring system is expected to be effective as a guide to any unexpected inflows and inrush events from previously mined overlying seams and from Cataract Reservoir.
- The Trigger Action Response Plans (TARPs) for water and swamp monitoring including stream and swamp triggers developed based on baseline monitoring of performance indicators and anticipated subsidence effects are reasonable and appropriate.

WaterNSW does not have any concerns to the approval of the EP and extraction as it has taken into consideration WaterNSW's Mining Principles, poses low risk to overlying catchment values and water resources, and is likely to meet the performance measures set in the development consent.

Please contact Dr. Ravi Sundaram if you would like to discuss any of the above matters further.

Yours sincerely

Daryl Gilchrist

Daryl Gilchrist
Manager, Catchment Protection

<u>Attachment B – Request for clarifications - Russell Vale UEP Stage 1 Extraction Plan</u>

General Comments

- Please provide a consolidated summary of the status of baseline monitoring relevant to this EP.
- Please provide a summary of how BCD/EES comments on the Upland Swamp Monitoring Plan (dated 11 May 2021) were addressed in the updated plan, including justification if comments have not been addressed.

TARP Comments – General

- Where TARPS have multiple performance indicators, it is sometimes unclear whether these performance indicators are related or independent of each other. A review of the TARP performance indicators is requested to clarify whether 'and' or 'or' should be added between multiple performance indicators. E.g. for the Heritage TARP, it's unclear whether both a change in condition and exceedance of vertical subsidence trigger is required to trigger a level 2 or level 3 event, or whether triggering one of these two indicators is sufficient to activate the TARP.

Surface Water TARP – Swamps

- Water level is noted as a performance indicator for swamps CCus3, CCus4c and CRus1c in order to determine if mining operations are impacting surface water quality of swamp outflows, however no monitoring parameter relevant to water level is provided.
- The level 2 performance indicator for swamps (*Subsidence impacts: Potential change in steady water levels (i.e., significant increase / decrease*)) does not define the magnitude of change required to trigger this performance indicator, or how this would be monitored.
- The level 3 performance indicator for swamps (*Subsidence impacts: Swamp has dried (loss of water))* is not well defined, does not reflect the highly variable nature of water flow in swamps and does not provide for long term changes in water level that could result in an exceedance of the performance measure for swamps. There is also no indication of how this would be monitored.

Groundwater TARP – Swamp Water Level

- It is noted that the performance indicator in the Groundwater - Swamp Water Level TARP refers to a 'water level trigger' which is cross-referenced to a footnote providing the values for the water level trigger. Please consider a clearer method of presenting the trigger levels in the body of the TARP.
- Further to the point above, it is noted that the cross-reference to water level trigger values is not carried across to the Master TARP, with no values provided in the footnotes of the TARP.

Subsidence TARP

- Why is the upper limit of vertical subsidence considered by the General Subsidence TARP less than 300mm? Similarly, why is the Cataract Creek Valley Closure TARP limited to less than 300mm? What actions / responses will occur if subsidence or closure exceeds 300mm?
- The subsidence section of the Master TARP states that the relevant 'Aspect' being monitored for Valley Closure across Cataract Creek is vertical subsidence rather than closure. The Department assumes this reference to vertical subsidence is made in error and should be corrected.

Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW, NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

19th November 2021

Jessie Evans
Director - Resource Assessments
Department of Planning, Industry and Environment
4 Parramatta Square, 12 Darcy Street
Parramatta, NSW, 2150

Re: Russell Vale Underground Expansion (MP09_0013) - Stage 1 Extraction Plan - Request for additional information

Dear Jessie,

I refer to the Department of Planning, Industry and Environment (DPIE) correspondence dated 8 November 2021, in which further information is requested to effectively address additional matters raised by agencies in regard to the Extraction Plan for Stage 1 as submitted to DPIE on 8 October 2021.

Wollongong Coal Pty Ltd (WCL) has considered and responded to each of the additional matters raised by the agencies in the correspondence provided from NSW EPA, Heritage NSW, NSW Resource Regulator (see Appendix A – Agency Response) and would welcome the opportunity to discuss with the Department and or specific agencies if required.

WCL also have submitted a revised Extraction Plan which includes a revised Extraction Plan and updated sub plans.

Attachment A – Includes correspondence NSW EPA. Heritage Council, Heritage NSW – Aboriginal Cultural Heritage Regulation, Department of Regional NSW – Mining, Exploration & Geoscience (MEG, NSW DPIE (Resources Regulator), WaterNSW

Attachment B – DPIE RFI

Attachment C – BCS / ESS Response

Should you have any questions or queries in relation to the content of this letter please do not hesitate to contact me on 0404 972 746.

Yours sincerely

19/11/2021.

Richard Sheehan
Wollongong Coal Group Environment Manager
E: Richard.sheehan@wcl.net.au

Ph: 0412 766 849

Enc
Appendix A – Correspondence from stakeholders on EP

Appendix B – DPIE RFI regarding EP

Appendix C – BCD/EES correspondence regarding EP

Appendix A

DPIE NSW - WCL Response to DPIE Additional Information Request

Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Table A.1 **DPIE RFI Response**

Item	Agency	Feedback provided	Request for information	WCL Response to Additional Information Request
1	NSW EPA	The plan has divided the installation of surface infrastructure into two stages. Stage 1 includes construction of new noise walls, noise bunds and a new primary sizer. Board and pillar mining will be undertaken and the coal will be loaded onto trucks from the ROM stockpile using front-end loaders. The coal will be transported to PKCT for export. The plan states that Stage 1 includes an "evaluation of the feasibility of a coal processing plant (CPP) to be installed as part of the new Stage 2 surface infrastructure". The EPA understands that the Revised Preferred Project Report and evaluation of environmental impacts during the planning approval included a new coal processing plant.	If the plant is built as part of the project, the EPA recommends that expert confirmation be provided by Wollongong Coal that noise and dust impacts will be no more than those predicted in the environmental assessment and approved in the Consent	The CPP continues to progress through a process to evaluate the feasibility of a coal processing plant. WCL notes the EPA recommendation and should the CPP feasibility study confirm the plant installation as required will carry out a review with suitably qualified and experienced expert consultants to ensure expert confirmation that noise and dust impacts will be no more than those predicted in the revised preferred project report (RPPR) and approved in the UEP project.
2	Heritage NSW – Heritage Council	The following report was considered: Russell Vale Colliery Revised Underground Expansion Project – Extraction Plan Stage One – PC07, PC08 & PC21 to PC25, prepared by Wollongong Coal, dated 8 October 2021. This Extraction Plan includes the updated Heritage Management Plan: Russell Vale Colliery, Russell Vale East – Revised Underground Expansion Project, Cultural and Historical Heritage Management Plan, prepared by Wollongong Coal, dated 30/9/2021. The following comments are provided to address the applicant's response to the heritage issues raised:	It is noted that the previously recommended actions in case of vibration and subsidence within Cataract Dam SHR curtilage included stopping activity in surrounding area, followed by urgent rehabilitation of the area and submission of a report to HNSW outlining the actions taken. Table 23 of the TARP (Trigger Action Response Plan) within Appendix A of the HHMP includes actions for three subsidence prediction levels. • The previously recommended actions have not been included into the TARP. It is requested that the	The feedback provided by NSW Heritage Office has been incorporated into a revised Heritage Management Plan as detailed: • Section 8.2 of the HHMP has been updated to describe the monitoring program, • Table 23 of the TARP (Trigger Action Response Plan) within Appendix A of the HHMP has been revised to include monitoring and remediation actions particularly at Level 2 (100-300mm recorded subsidence) and 3 (greater than 300mm recorded subsidence), where changes in site conditions are observable.

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Item	Agency	Feedback provided	Request for information	WCL Response to Additional Information Request
		• Section 8.2 of the HHMP states that vertical subsidence impacts are predicted to be less than 100mm and the Performance Measure for vertical subsidence has been set at 300mm under the development consent; and that this level of subsidence impact would be restricted to the edge of the FSL area immediately adjacent to the Extraction Plan area and will have no observable impacts on the Reservoir and would not have any effect on the heritage values of the Cataract Dam.	monitoring and remediation actions be incorporated into the HHMP, particularly at Level 2 (100-300mm recorded subsidence) and 3 (greater than 300mm recorded subsidence), where changes in site conditions are observable. • It is noted that section 10.4.3 of the HHMP includes actions to be taken in instances of discovery of 'relics', as per the provisions of s.146 of the Heritage Act 1977. This is supported	Noted. No action required
3	Heritage NSW – Aboriginal Cultural Heritage Regulation	Heritage NSW has reviewed the Wollongong Coal submitted Extraction Plan (EP) for stage 1 bord and pillar mining (sub panels PC07, PC08, and PC21-25) in accordance with condition C10 of the project approval for the Revised Underground Expansion Project.	Heritage NSW has no additional recommendations or comment on the submitted extraction plan.	Noted. No action required
4	Department of Regional NSW – Mining, Exploration & Geoscience (MEG)	I refer to your correspondence dated 18 October 2021 inviting the Department of Regional NSW – Mining, Exploration & Geoscience (MEG) to provide comments on the Russell Vale U/G Expansion – Stage 1 – Revised Extraction Plan variation (the Project), submitted by Wollongong Coal Limited (the Proponent). MEG has reviewed the information supplied and raises no issues regarding the Russell Vale U/G Expansion – Stage 1 – Revised Extraction Plan variation.	MEG considers the extraction plan to adequately recover coal resources and provide an appropriate return to the NSW Government. For further advice concerning this matter, please contact Industry Advisory & Mining Concierge on 02 4063 6534 or mining.concierge@regional.nsw.gov.au.	Noted. No action required
5	NSW DPIE (Resources Regulator)	I refer to your request of 18 October 2021 for advice regarding Russell Vale Underground Expansion - Stage 1 Extraction Plan.	Based on the review of the draft conditions, the Resources Regulator advises that the holder of relevant mining leases is required to ensure that the	A review of the Russell Vale Colliery Revised Underground Expansion Project – Extraction Plan Stage 1 will be carried out post approval to ensure all rehabilitation commitments are included in the Mining

WOLLONGONG COAL

Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

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		The Resources Regulator has reviewed the request. **Assessment.**	rehabilitation commitments outlined in any approved Extraction Plan are included in the Mining Operations Plan /Rehabilitation Management Plan regulated by the Resources Regulator pursuant to the conditions of the mining leases under the Mining Act 1992. The holder of the mining leases must ensure the Mining Operations Plan / Rehabilitation Management Plan for the area covered by this Russell Vale Colliery Revised Underground Expansion Project – Extraction Plan Stage 1 is updated where necessary.	Operations Plan, with the plan updated where necessary.
			Due to the required Performance Measures, i.e., “Always safe and serviceable”, for the Key Public Infrastructure as set out in Condition C7 of the Development Consent (MP09_0013, dated 8 December 2020), we suggest that the Approving Authority obtains the infrastructure operators’ written endorsement of the proponent’s proposed Built Features Management Plan prior to the determination of approval of the above-mentioned Extraction Plan. *Note – The above-mentioned Built Features Management Plan is part of Russell Vale Colliery’s Extraction Plan (RVE EC PLN 010, Version: 02, Effective: 8 October 2021).* The endorsement by the operators of the Key Public Infrastructure as set out in	Wollongong Coal has undertaken a comprehensive and detailed consultation program with the key public infrastructure owners being Transport for NSW (TfNSW), TransGrid, and Endeavour Energy wherever possible inclusive of the NSW Resource Regulator. The records of this consultation are detailed in the Extraction Plan Built Features Management Plan (BFMP). Feedback from this consultation process has been included in the BFMP with reference to where the details have been addressed in the document.

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
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			Condition C7 of the Development Consent (MP09_0013, dated 8 December 2020) is to ensure:	
			• Completion of consultation between the proponent and the infrastructure operators in relation to all the actions raised and/or questions/requests asked by the infrastructure operators;	Noted. Detailed and specific consultation has been carried out with all infrastructure operators. Feedback has been detailed within the BFMP inclusive of reference points. In addition the draft management plan has been wherever possible provided to the infrastructure operators for feedback.
			• Accuracy of the proponent's understanding of the Key Public Infrastructure at the subject site (e.g., the proponent's statement in the Extraction Plan that the 132kV transmission line at the subject site is managed/operated by TransGrid is incorrect); and	Noted and addressed.
			• Risk assessments and the subsequent development of management and contingency plans is undertaken in consultation with the infrastructure operators. The infrastructure operators' expertise and resources form a fundamental part of the risk management system. It follows that the endorsement by the infrastructure operators of the Built Features Management Plan is fundamentally important to ensure the proponent's compliance with the requirements under the Development Consent (MP09_0013, dated 8 December 2020).	Where identified as being required during the course of or in response to the detailed consultation risk assessments have been carried out with the key infrastructure operators. Such records have been included in and appended to the BFMP.
			Note that the infrastructure operators' endorsement (or agreement) has been	

WOLLONGONG COAL

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PO Box 281
FAIRY MEADOW NSW 2519
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Fax +61 2 4283 7449
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			suggested in Appendix D (i.e., Subsidence Assessment) of the proponent's Extraction Plan (RVE EC PLN 010, Version: 02, Effective: 8 October 2021) as follows: *"These management plans and risk control measures need to be developed in consultation and with the agreement of the asset owners and relevant stakeholders through risk assessments."*	
			Limitations The Extraction Plan is assessed and determined by DPIE under the conditions of the development consent. The Resources Regulator provides advice to DPIE to assist in the determination.	Noted. No further action required
			Regulatory requirements if approved The authorisation holder is required to ensure that the rehabilitation commitments outlined in any approved Extraction Plan are included in the Mining Operations Plan / Rehabilitation Management Plan regulated by the Resources Regulator under the conditions of the mining lease and the Mining Act 1992. The authorisation holder must ensure the Mining Operations Plan / Rehabilitation Management Plan for the area covered by this Extraction Plan is updated where necessary. The Resources Regulator may undertake assessments of the mine operators' proposed mining activities under the	Noted. No further action required

Head Office
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CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
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Item	Agency	Feedback provided	Request for information	WCL Response to Additional Information Request
			Work Health and Safety (Mines and Petroleum Sites) Act 2013 and Regulation as well as other WHS regulatory obligations. Subsidence associated with the proposed Extraction Plan will be regulated by under relevant provisions of WHS laws in particular Clause 33 and Clause 67 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 relating to High Risk Activities and Subsidence.	
		WCL has consulted with WaterNSW in preparing several key management plans required under the approval including Water Management Plan, Land Management Plan, Swamp Monitoring Program, and the Public Safety Management Plan. The EP has addressed feedback provided by WaterNSW to these plans. The EP includes the revised and updated subsidence assessment including risk of "pillar run" in multi-seam mining areas. The EP predicts that vertical subsidence is expected to be less than 100mm and generally imperceptible over most of the EP Areas. As a result, the EP expects the impacts, and consequences to natural, surface, and sub-surface features to be negligible and imperceptible in the undeveloped bushland setting over most of the EP subject areas. WaterNSW notes that the EP has comprehensively addressed the pillar stability and pillar failure issues through changes to mine design including:	WaterNSW does not have any concerns to the approval of the EP and extraction as it has taken into consideration WaterNSW's Mining Principles, poses low risk to overlying catchment values and water resources, and is likely to meet the performance measures set in the development consent.	Noted. No further action required

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
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Fax +61 2 4283 7449
www.wollongongcoal.com.au

Item	Agency	Feedback provided	Request for information	WCL Response to Additional Information Request
		• Increased pillar dimensions in PC07 and PC08 area from 19.5m by 24.5m (as originally identified in the Response to Second PAC Review and Revised Project Assessment (Umwelt 2019) to 22.5m by 24.5m to below the Balgownie Seam longwall goafs • Pillar generally square in shape in PC21 and PC22-25 area with minimum coal pillar dimensions of 24.5m by 24.5m • Longer rectangular barrier type pillars incorporated into the three headings entries to the PC22-25 subpanels, and • Three barrier pillars (coal) separate the PC22-PC25 sub-panels. The EP reports that risk analysis undertaken (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 remote. WaterNSW considers that: • The mining method and mine design adopted by WCL would result in negligible impacts on water resources, biodiversity, and catchment environmental values. • WCL have addressed the potential risk of 'pillar run' for proposed extraction in a multi-seam area where overlying seams have been extracted previously.		

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CORRIMAL, NSW 2518

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FAIRY MEADOW NSW 2519
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Fax +61 2 4283 7449
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		• The proposed monitoring and management measures are appropriate for the planned mining method and subsidence predictions. • The underground mine water balance monitoring system is expected to be effective as a guide to any unexpected inflows and inrush events from previously mined overlying seams and from Cataract Reservoir. • The Trigger Action Response Plans (TARPs) for water and swamp monitoring including stream and swamp triggers developed based on baseline monitoring of performance indicators and anticipated subsidence effects are reasonable and appropriate.		

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Appendix B

DPIE NSW – RFI Attachment B Request for clarifications

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Table B.2 **DPIE RFI Attachment B Response**

Comment Source	Comment	Russell Vale Response
General Comments	Please provide a consolidated summary of the status of baseline monitoring relevant to this EP	Consolidated summary of baseline monitoring completed and attached as Appendix B - Attachment 1. Baseline data is included in the respective sub plans. Actions undertaken by WCL and subconsultants, post submission of the EP, as well as baseline monitoring required to be undertaken prior to second workings, is also outlined in Attachment 1.
	Please provide a summary of how BCD/EES comments on the Upland Swamp Monitoring Plan (dated 11 May 2021) were addressed in the updated plan, including justification if comments have not been addressed.	A summary of the response has been included in Appendix J of EP. The response was not included as an attachment to the USMP in the submitted EP, this was as an administrative oversight. The response is also included as Appendix B - Attachment 2 and has been be added to the sub plan.
TARP Comments – General	Where TARPS have multiple performance indicators, it is sometimes unclear whether these performance indicators are related or independent of each other. A review of the TARP performance indicators is requested to clarify whether 'and' or 'or' should be added between multiple performance indicators. E.g. for the Heritage TARP, it's unclear whether both a change in condition and exceedance of vertical subsidence trigger is required to trigger a level 2 or level 3 event, or whether triggering one of these two indicators is sufficient to activate the TARP.	The logic for any triggers with multiple performance indicators has been included in the Master TARP (Appendix A to the EP) and in the subplans of the EP.
Surface Water TARP - Swamps	Water level is noted as a performance indicator for swamps CCus3, CCus4c and CRus1c in order to determine if mining operations are impacting surface water quality of swamp outflows, however no monitoring parameter relevant to water level is provided.	There are a range of parameters other than water level which provide appropriate TARPs for the management of swamps, and as such the utilisation of a water level trigger has been removed from the TARP. As per Section 7.3.1.1.1 of the Water Management Plan, surface water level is too variable to allow for the development of water level based triggers. This has been previously discussed with BCD (24th May 2021 meeting between BCD, Wollongong Coal, Umwelt and Biosis– see Appendix B - Attachment 3 Page 1). The relatively shallow nature of the swamps was discussed (<2 m in depth). The swamps are also ephemeral and the swamps are dry up to 40% of the time under normal conditions (see attached Briefing note: 4 June 2021 (Attachment 3) which was submitted to DPIE on 09 June 2021 (this was as an attachment on the correspondence outlined in Appendix B - Attachment 4)).

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
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Fax +61 2 4283 7449
www.wollongongcoal.com.au

	The level 2 performance indicator for swamps (Subsidence impacts: Potential change in steady water levels (i.e., significant increase / decrease)) does not define the magnitude of change required to trigger this performance indicator, or how this would be monitored.	As per surface water TARP response above.
	The level 3 performance indicator for swamps (Subsidence impacts: Swamp has dried (loss of water)) is not well defined, does not reflect the highly variable nature of water flow in swamps and does not provide for long term changes in water level that could result in an exceedance of the performance measure for swamps. There is also no indication of how this would be monitored.	As per surface water TARP response above.
Groundwater TARP – Swamp Water Level	It is noted that the performance indicator in the Groundwater - Swamp Water Level TARP refers to a 'water level trigger' which is cross-referenced to a footnote providing the values for the water level trigger. Please consider a clearer method of presenting the trigger levels in the body of the TARP.	Trigger levels for Groundwater TARP – Swamp Water Level, Level 2 and Level 3 have been revised to include the information which was referenced in the footnotes to the table within the TARP, please note there has been no change to the TARP values. Six groundwater monitoring sites have been included in the TARP across the Stage 1 EP Area for Level 2 and 3 triggers. The sites and corresponding groundwater trigger levels within the EP Area as per the Ground Water TARP are presented below. Level 2: One monthly water level reading above the water level trigger of: PCc10A: 0.56 mbgl; or PCc2: 1.6 mbgl; or PCc4C: 1.05 mbgl; or PCc5B: 1.13 mbgl; or PCr1B: 0.68 mbgl; or and the trigger is recorded during a period with rainfall above 20 mm/month Level 3: Two consecutive monthly water level readings above the water level trigger of: PCc10A: 0.56 mbgl; or

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

		PCc2: 1.6 mbgl; or PCc4C: 1.05 mbgl; or PCc5B: 1.13 mbgl; or PCr1B: 0.68 mbgl; or and the trigger is recorded during a period with rainfall above 20 mm/month
	Further to the point above, it is noted that the cross-reference to water level trigger values is not carried across to the Master TARP, with no values provided in the footnotes of the TARP.	Master TARP Trigger levels have been revised to reflect the Level 2 and 3 trigger levels listed as per above.
Subsidence TARP	Why is the upper limit of vertical subsidence considered by the General Subsidence TARP less than 300mm? Similarly, why is the Cataract Creek Valley Closure TARP limited to less than 300mm? What actions / responses will occur if subsidence or closure exceeds 300mm?	Subsidence TARPs have been updated to change the upper limit of the Level 2 Subsidence TARP to 300 mm and Level 3 to be greater than 300 mm. This change will be carried through to each of the relevant subplans.
	The subsidence section of the Master TARP states that the relevant 'Aspect' being monitored for Valley Closure across Cataract Creek is vertical subsidence rather than closure. The Department assumes this reference to vertical subsidence is made in error and should be corrected.	Vertical subsidence is utilised as the measure to monitor for valley closure. TARPS in Appendix A have been updated to reflect revisions to TARPS made within the respective sub plans.

App B Attachment 1 – Baseline monitoring summary

App B Attachment 2 – Biosis responses (21 September 2021) to BCD Comments from 11 May 2021

App B Attachment 3 – Briefing note to BCD re: Swamp Offset Policy

App B Attachment 4 – Email BCD to WCL re clarification of USMP Comments

Appendix B Attachment 1

Mgt plan	EP Appendix	Plan baseline section reference	Monitoring type	Commentary on status of baseline monitoring (as per respective sub plan), as at submission of EP	Actions completed by WCL/sub-consultant following EP Submission	Baseline monitoring associated with Stage 1a and 1b.
Built Features	E	3 Appendix C	LiDAR GNSS Attended ground-based survey	**Monitoring Undertaken** **As per Section 3:** For some (built) features surveys date back to 2012. These surveys provide context on the baseline condition of built features. They provide a record of the historic subsidence experienced at these features and inform the baseline condition for those aspects/features. The baseline monitoring program includes the following: • Lidar • GNSS continuous subsidence monitoring • Attended ground-based survey. **Appendix C of BFMP :** LiDAR was flown on 31 August 2021 over 'Area of Interest', prior to commencement of mining operations to capture baseline spatial information In addition, a baseline survey of Cataract Creek closure measurements were undertaken and included in Appendix C. Baseline survey measurements for CC1, CC2, CC3 and CC4 are included to 30 June 2021. Monitoring data for GNSS units #1, #2, #3, #5, #6, #7, #8, #9, #11, #12, #13, #14, #15 has also been included in Appendix C to 5 October 2021. (GNSS units #10, #16 and #17 noted in Appendix C as yet to be installed).	An email from Richard Sheehan (WCL) to Gabrielle Allan (DPIE) on 1 November 2021 showed updated GNSS unit measurements for Cataract Creek. The email included updated data to 28 October 2021 in addition to those as mentioned in the main EP. Units #16 and #17 have also now been installed, and additional data was presented in the email from 13 October to 28 October 2021 Unit #10 scheduled to be installed in November 2021.	<u>GNSS Units:</u> #1, #2, #3, #5, #6, #7, #8, #9, #10, #11, #12, #13, #14, #15, #16, #17 <u>RMS Survey Point</u> Mount Ousley Road - Carriageway general - Carriageway Cataract Creek - Mount Ousley Road Ridge (P46) - Slopes - Picton Road Interchange Bridge and Steel Arch and Culvert over Cataract River - Cataract Creek Culverts <u>Creek Closure Points</u> #1, #2, #3, #4 <u>Tower Locations</u> *330 kV -* TWR-T54, TWR-T55, TWR-T56, TWR-T57, TWR-T58 *132kV -* TWR-E63, TWR-E64, TWR-E65, TWR-E66, TWR-E67, TWR-E68, TWR-E69
Public Safety Management Plan	F	3	As per BFMP	As per BFMP	As per BFMP	See Built Features and Land Management
Water Management Plan	G	3	Surface monitoring network, and groundwater monitoring network, including - Piezometer - Soil moisture probe	**As per section 3.1:** An extensive surface and groundwater monitoring network is currently in place at WCL. Surface and groundwater monitoring sites are monitored every 2 – 6 months. **As per section 3.2.3:** Analyses of the baseline water quality monitoring data for pH, EC, TSS, and TDS at each monitoring location along watercourses, tributaries and upland swamps is presented in Appendix F (of the WMP). The analysis included the identification of the exceedance limits for selected parameter and percentiles, suitable for the specification of trigger values.	No further monitoring undertaken since submission of the EP. WCL to continue to monitor baseline data at the current frequency up to initiation of mining	See matrix following this table.

Mgt plan	EP Appendix	Plan baseline section reference	Monitoring type	Commentary on status of baseline monitoring (as per respective sub plan), as at submission of EP	Actions completed by WCL/sub-consultant following EP Submission	Baseline monitoring associated with Stage 1a and 1b.
			- Vibrating wire piezometer	**As per section 3.2.4:** A comprehensive visual and photographic survey of Cataract Creek was conducted between monitoring sites CC5 and CC7 in April 2012. Visual inspection of these sites is to be undertaken prior to, during, and following mining activities (Appendix D of the WMP). Monitoring will commence at least two months prior to mining within the vicinity of each monitoring location, to allow for the current channel conditions and potential mine related impacts to be identified. **As per section 3.3:** Regarding Cataract Reservoir; stream flow, height and water quality monitoring installations were installed by WCL on 12 April 2012. **As per Table 6 Section 3.1** Regarding Cataract Reservoir; stream height and water quality at monitoring stations have been monitored on a two-monthly basis since 2012 at CR1, CR2 and CR3. **As per Tables 8 to 11, Section 3.2** Regarding Cataract Reservoir; insufficient samples have been recorded at CR4 due to its position in the high water zone and CR4 has not been included in Table 12 (of the WMP) as a monitoring location.		
Groundwater management plan	F	5	As per WMP	As per WMP	As per WMP	
Biodiversity Management Plan	I	3	Ecological monitoring, including: - Aquatic and terrestrial monitoring - Plant community monitoring - Threatened and endangered species surveys	**As per section 3.1:** Aquatic ecological monitoring has been undertaken by Biosis within the UEP area between 2012 to 2020, however, there have been various iterations of monitoring locations due to modifications in the suitability of control sites. The aquatic ecological monitoring sites in Table 6 (of the Biodiversity MP) have been the subject of monitoring since 2015. The most recent aquatic ecological monitoring report has been prepared by Biosis (2020). Monitoring will continue in 2021. **As per section 3.2:** The plant community types (PCT's) within the UEP area, with the exception of Coastal upland swamps (Figure 4 of the Biodiversity MP), were mapped using desktop mapping (DPIE 2010). **As per section 3.3:** Annual reports have been provided to Wollongong Coal since the ecological monitoring program commenced in 2011.	Nil	<u>Aquatic Impact Monitoring</u> RVE-AQ3, RVE-AQ6 <u>Flora Impact Monitoring Site</u> 3 × CCUS5 Transects & Photopoints 3 × CCUS10 Transect & Photopoint 3 × CCUS4 Transects & Photopoints 3 × CRUS1 Transect & Photopoint 3 x CCUS2 Transects & Photopoints 3 x CRUS3 Transects & Photopoints 3 x CCUS1 Transects & Photopoints <u>Threatened Fish Monitoring Reach</u> 3 x Threatened Fish Monitoring Reaches (WGE-AQ4/AQ5-FISH; WGE-AQ2DS-FISH; WGE-AQ6DS-FISH) <u>Threatened Frog Impact Monitoring Transects</u>

Mgt plan	EP Appendix	Plan baseline section reference	Monitoring type	Commentary on status of baseline monitoring (as per respective sub plan), as at submission of EP	Actions completed by WCL/sub-consultant following EP Submission	Baseline monitoring associated with Stage 1a and 1b.
				As per section 3.4: A desktop assessment confirmed that one EEC, Coastal upland swamps in the Sydney Basin Bioregion (Endangered, BC Act and 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 and BC Act (Figure 6 of the Biodiversity MP). These records are outlined in Appendix B – FLORA AND FAUNA (of the Biodiversity MP), along with those species and communities identified by the Protected Matters Search Tool and BioNet 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 the subsidence related impacts. As there are no direct impacts associated with the UEP program (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 the indirect impacts resulting from subsidence (See Appendix B – FLORA AND FAUNA and Table 7, both of the BioMP). 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 EEC, two flora species and nine fauna species (five terrestrial and four aquatic) listed under the EPBC Act and/or BC Act, that have the potential to occur or are known to occur in the study area (Figure 6 of the BioMP), 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 the approved UEP is provided in Table 9 (of the BioMP).		4 x *Mixophyes balbus* transects 2 x *Litoria littlejohni* & *Heleioporus australiacus* transects
Heritage Management Plan	L	5 Appendix D	Visual inspection and identification	**As per Section 5:** An updated baseline assessment of Aboriginal heritage sites previously identified in the vicinity of the first workings mine panels was undertaken. This section outlines the results of the updated baseline assessment, the process of survey and site identification, and updated impact assessment for Aboriginal heritage sites included in the Consent. **As per Section 5.1:** There are 18 Aboriginal heritage sites recorded as part of the Project approval (Appendix 6 of Development Consent) as outlined in Table 9 (of the HMP). The location of these sites is shown in Figure 8 (of the HMP). Details for Aboriginal heritage sites within the Project Area for this HMP are provided below as summarised from the site cards and the updated baseline recording can be found in APPENDIX D (of the HMP). Refer to sections 5.1.1 to 5.1.1.8 for detailed descriptions of specific heritage sites.	Nil	Within Stage 1 EP Area: 52-2-4171, 52-2-4170, 52-3-0325, 52-3-0323 Within 350 m of Stage 1 first workings 52-3-0311, 52-3-0313

Mgt plan	EP Appendix	Plan baseline section reference	Monitoring type	Commentary on status of baseline monitoring (as per respective sub plan), as at submission of EP	Actions completed by WCL/sub-consultant following EP Submission	Baseline monitoring associated with Stage 1a and 1b.
				As per Section 5.2: An updated AHIMS search was conducted on 22 January 2021 (Client Service ID: 563187), which identified an additional six Aboriginal sites. These sites are listed below in Table 10 (of the HMP) and shown in Figure 8 (of the HMP). Two additional sites (52-2-4171, 52-2-4170) were identified within the six that are relevant to Stage 1.		
Land Management Plan	K	3	Visual inspections LiDAR	**As per Section 3:** Previous longwall mining extraction within the Bulli and Balgownie seams has resulted in various subsidence impacts within the EP Area. These impacts occur mostly as rock falls and surface cracking on hard rock surfaces (SCT, 2019). Changes in the character of stream channels such as cracking, iron staining, and sediment infilling in areas where the stream bed has been subsided have also occurred due to previous mining. **As per Section 3.1 (Rock falls):** The subsidence assessment completed for the UEP (SCT, 2019) notes that previous inspections of cliff formations have identified several rock falls consistent with previous mining activity within the Bulli and Balgownie seams. Note there are no identified cliffs (defined as greater than 10 m in height) within the EP Area. **As per Section 3.2 (Surface Cracking):** The previous subsidence assessment (SCT, 2019) noted that surface cracking has previously been documented on subsidence plans prepared during and after mining of the Balgownie Seam longwall panels. Most of the cracks can be found within proximity to the start of the previously mined Longwall 3 on a topographic ridge. Similar cracks are likely to have occurred at other locations but most of these would be in bushland locations where they would be difficult to detect. Inspections conducted in association with previous cracking identified on Mount Ousley Road show that there are a series of tension cracks and minor sinkholes evident along the northern side of the ridgeline between Cataract River and Cataract Creek. These cracks are locally aligned with the direction of one of the principal joint directions in the Hawkesbury Sandstone.	No further visual inspections or LiDAR undertaken since submission of the EP.	No specific monitoring sites. Visual inspection across Stage 1 EP Area.
Upland Swamp Monitoring Program	J	3	Mapping and characterisation Ecological surveys Surface and groundwater monitoring	**As per section 3:** Detailed mapping and characterisation of Coastal Upland Swamps in the Sydney Basin Bioregion EEC (listed under the EPBC Act and BC 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 and BC Act. Refer to Biosis (2014b) for comprehensive details on the regional and local distribution of Coastal Upland Swamps, historic impacts of mining on Coastal Upland Swamps, including impacts to hydrogeological features.	Nil	<u>Swamp Monitoring Sites:</u> See matrix following this table.

Mgt plan	EP Appendix	Plan baseline section reference	Monitoring type	Commentary on status of baseline monitoring (as per respective sub plan), as at submission of EP	Actions completed by WCL/sub-consultant following EP Submission	Baseline monitoring associated with Stage 1a and 1b.
				As per section 3.1: Monitoring of soil moisture within swamps is currently conducted at Coastal Upland Swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1. Water level monitoring is also conducted along with soil moisture monitoring at swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1. **As per section 3.1.1:** Water level trends for site monitoring piezometers show a good correlation to rainfall trends, with water levels in the swamps rising to at or near surface generally in response to rainfall (i.e. over 100 mm/month). Across the RVE swamp monitoring network the available manual dipped water levels indicate unsaturated conditions approximately 47% of the time. For periods when the swamps are saturated, the median (50th percentile) of readings indicates water present around 0.57 m below surface. **As per Section 3.1.2:** Water quality monitoring of the shallow swamp piezometers has occurred since March 2012. A summary of the swamp water quality data is presented in Table 7 and timeseries pH and EC trends shown in Figure 8 and Figure 9 respectively. The swamp water quality is generally acidic to neutral (pH 3.3 – 8.5) and fresh (EC 23 – 420 µS/cm). **As per Section 3.2:** Upland swamp ecological monitoring has been undertaken in the RVE domain since autumn 2011. **As per Section 3.2.1:** Monitoring is undertaken according to a modified Before-After Control-Impact (BACI) design where data is collected before (baseline) and after impact at control and impact sites. **As per Section 3.2.1.4:** Annual reports have been provided to Wollongong Coal since the ecological monitoring program has commenced. The most recent annual report covered the 2019 year of monitoring (Biosis 2020). This report evaluated the first year of the recommencement of the ecological monitoring in RVE in the context of the previous years of data, and in response to the TARP trigger levels previously developed for longwall extraction.		

GREEN highlight denotes sites monitored as per EP

Area	Site	Type	Sampling parameters	Pre Mining Sampling Interval	During Mining Sampling Interval	Post M iningSampling Interval
Russel Vale East Swamp Piezos and Soil Moisture* Exisiting sites	SP1	Swamp piezo	**Field Analysis** EC, pH, DO, ORP, temp and turbidity	Field analysis: 2 monthly	Field analysis: 2 monthly	Field analysis: 2 monthly
	SP2	Swamp piezo		Discrete analysis: Quarterly	Discrete analysis: Quarterly	Discrete analysis: Quarterly
	PCc2*	Swamp piezo + Soil Moisture		Full analysis: Annual	Full analysis: Annual	Full analysis: Annual
	PCc3	Swamp piezo	**Discrete analysis** Field analysis +			
	PCc4A	Swamp piezo	Laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total P, Total alkalinity			
	PCc4B*	Swamp piezo + Soil Moisture				
	PCc4C*	Swamp piezo + Soil Moisture	+			
	PCc4D*	Swamp piezo + Soil Moisture	Filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba.			
	PCc5A*	Swamp piezo + Soil Moisture				
	PCc5B*	Swamp piezo + Soil Moisture	**Full analysis** Field analysis			
	PCc5C	Swamp piezo	+ Discrete analysis			
	PCc5D*	Swamp piezo + Soil Moisture	+ Additional dissolved metals B, Cd, Co, Hg, Se and Ag			
	PCc6	Swamp piezo				
	PCr1A*	Swamp piezo + Soil Moisture				
	PCr1B*	Swamp piezo + Soil Moisture				
	PCr1C*	Swamp piezo + Soil Moisture				
	PCR1D	Swamp piezo				
	PB4A*	Swamp piezo + Soil Moisture				
	PB4B*	Swamp piezo + Soil Moisture				
	PB4C	Swamp piezo				
	PB4D*	Swamp piezo + Soil Moisture				
	PCc10A*	Swamp piezo + Soil Moisture				
	PCc10B*	Swamp piezo + Soil Moisture				
	PCc12A*	Swamp piezo + Soil Moisture				
	PCc12B*	Swamp piezo + Soil Moisture				
	SP1 C	Swamp drainage line				
	SP2 C	Swamp drainage line				
	Cc4c	Swamp drainage line				
	Cr1c	Swamp drainage line				

Additional UEP sites	PCC1A*	Swamp piezo + Soil Moisture				
	PCC1B	Soil moisture				
	PCC1C*	Swamp piezo + Soil Moisture				
	PCC20*	Swamp piezo + Soil Moisture				
	PCC21	Soil moisture				
	PCC6B*	Swamp piezo + Soil Moisture				
	PCC14A*	Swamp piezo + Soil Moisture				
	PCr6	Soil moisture				
	PCc14B	Soil moisture				
	PCr2	Soil moisture				
	PB11	Soil moisture				
	PCc11	Soil moisture				
	PCr3	Soil moisture				
Cataract River (Surface Water)	CR1	Creek	**Field Analysis** EC, pH, DO, ORP, temp and turbidity **Discrete analysis** Field analysis + Laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total P, Total alkalinity + Filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba. **Full analysis** Field analysis + Discrete analysis + Additional dissolved metals Al, B, Cd, Co, Hg, Se and Ag + NO2, TKN	Field analysis: Monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: Monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: 2 monthly Discrete analysis: 6 monthly Full analysis: Annual
	CR2	Creek				
	CR3	Creek				
Cataract Creek (Surface Water)	CC1	Creek	**Field Analysis** EC, pH, DO, ORP, temp and turbidity **Discrete analysis** Field analysis + Laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total P, Total alkalinity + Filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba.	Field analysis: Monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: Monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: 2 monthly Discrete analysis: 6 monthly Full analysis: Annual
	CC2	Creek				
	CC3	Creek				
	CC4	Creek				
	CC5	Creek				
	CC6	Creek				
	CC7	Creek				
	CC8	Creek				

	CC9 CD1 CT1	Creek Dam Tributary	**Full analysis** Field analysis + Discrete analysis + Additional dissolved metals Al, B, Cd, Co, Hg, Se and Ag + NO2, TKN			
Cataract Creek Weirs	CT1A CT2 CT3 CT3A CC3 CC4 CT4A CT4B	Tributary Tributary Tributary Tributary Creek Creek Tributary Tributary	**Field Analysis** EC, pH, DO, ORP, temp and turbidity **Discrete analysis** Field analysis + Laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total P, Total alkalinity + Filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba. **Full analysis** Field analysis + Discrete analysis + Additional dissolved metals Al, B, Cd, Co, Hg, Se and Ag + NO2, TKN	Field analysis: 2 monthly Discrete analysis: 2 monthly	Field analysis: 2 monthly Discrete analysis: 2 monthly	Field analysis: 2 monthly Discrete analysis: 2 monthly
RV East Open Stand Pipe Piezos Existing sites	NRE 1A NRE 1C NRE 1D NRE 1 GW01A RV18 RV19 RV21 RV22A RV23A	Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water	**Field Analysis** EC, pH, DO, ORP, temp and turbidity **Discrete analysis** Field analysis + Laboratory analysis of TDS, TSS, major ions (Na, K, Ca, Mg, Cl, SO4), F, HCO3, CaCO3, NO3, Total N, Total P, Total alkalinity + Filtered DOC and dissolved metals Al, P, Cu, Pb, Zn, Ni, Sb, Fe, Mn, Mo As, Li and Ba. **Full analysis** Field analysis + Discrete analysis + Additional dissolved metals B, Cd, Co, Hg, Se and Ag	Field analysis: 2 monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: 2 monthly Discrete analysis: Quarterly Full analysis: Annual	Field analysis: 2 monthly Discrete analysis: Quarterly Full analysis: Annual
Additional UEP sites	RV39 RV41 RV42 RV40 RV45 RV44 RV43A	Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water Shallow ground water		Field analysis: 2 monthly Discrete analysis: 2 monthly Full analysis: Annual	Field analysis: Monthly in areas actively undermined Discrete analysis: 2 monthly Full analysis: Annual	Field analysis: 2 monthly Discrete analysis: 2 monthly Full analysis: Annual

	RV46	Shallow ground water				
	RV47	Shallow ground water				
RV East Vibrating Wire Piezos Existing sites	NRE 1B (3913)	Ground water, Vibrating wire piezo (4)	Water head pressure	2 monthly download	Monthly download in areas actively undermined	2 monthly download
	NRE 1D (939)	Ground water, Vibrating wire piezo (4)				
	NRE1 GWO1 (2501)	Ground water, Vibrating wire piezo (8)				
	NRE1 A (SWM3 (909))	Ground water, Vibrating wire piezo (4)				
	RV16 (3460)	Ground water, Vibrating wire piezo				
	RV17 (3667)	Ground water, Vibrating wire piezo				
	RV20 (3953)	Ground water, Vibrating wire piezo (5)				
	RV22 (3891)	Ground water, Vibrating wire piezo (8)				
	RV29 (8007)	Ground water, Vibrating wire piezo				
	RV24 (7793	Ground water, Vibrating wire piezo				
	RV25 (7772)	Ground water, Vibrating wire piezo				
	RV27	Ground water, Vibrating wire piezo				
	RV35	Ground water, Vibrating wire piezo				
	RV36	Ground water, Vibrating wire piezo				
	RV23 (3923)	Ground water, Vibrating wire piezo (8)				
Additional UEP sites	RV43	Ground water, Vibrating wire piezo				
	RV48	Ground water, Vibrating wire piezo				

Appendix B – Attachment 2

BCD comments 11/05/2021 Biosis response 21/09/2021

Section	Comments	How addressed
3.1	Page 17: Please fix error in text reference to Table 3 and check the table is complete and contains all water monitoring locations and details.	Fixed
3.22	This section is poorly written and difficult to follow. Some graphs or tables of results or summary findings could be provided.	3.22 deleted and report from biometrician is included as an appendix.
	Page 24: Please add in text reference to TARP level definitions at each mention and provide better explanation of the TARP trigger levels in this section.	To avoid confusion between old TARPs and new TARPs, the old tarps are specified in the biometricians report. New TARPs and levels are specified in 7.3 and Appendix D.
4.1	Page 25 “Aspects of the proposed monitoring program will not be directly linked to TARPs but will instead be undertaken to inform investigations into the cause of potential impacts should the identified TARP triggers be exceeded.” This statement is unclear. Please explain what you are monitoring and what TARPS you are proposing to use as triggers. If you are not using the previously defined TARPS, please provide a clear explanation of what has changed and why in this section of the report. Linking monitoring to TARPs is important for transferability of results between prior studies and ongoing monitoring results. The relationship between TARPs and what is being proposed to be monitored in the monitoring plan is unclear and needs to be better defined and justified throughout.	This seems to be poor wording that has been amended. The TARPs are specifically what is being tested during the data analysis.
	Page 25: Please fix reference errors	Fixed

Section	Comments	How addressed
	Page 25: "It is to be noted that there are currently no groundwater monitoring sites at swamps CCUS1, CCUS14, CCUS20, CCUS21, CRUS2 and CRUS6. Additional monitoring sites for these locations have been proposed and will be installed at least 2 months prior to each swamp being mined under." This project identified that there was likely to be negligible environmental consequences for upland swamps as a result of predictions of negligible total subsidence. As a result, DPIE concurs that application of the "Upland Swamp Offset Policy" is highly unlikely to be triggered. However, swamps CCUS1, CCUS20, CCUS21 have been identified as most likely to be affected by subsidence as a result of undermining. Therefore, collecting adequate baseline data for these swamps should be a priority of the monitoring program. The installation of groundwater monitoring piezometers 2 months prior to commencement is insufficient to provide adequate data to describe baseline groundwater regime in these swamps. The "Upland Swamps Offset Policy" requires a minimum of two years baseline data on which to assess compliance with negligible impacts on groundwater level and swamp water balance. This also contradicts minimum monitoring periods stated in the following sections of the report. Please clarify minimum pre-mining monitoring periods.	This has been resolved during project approval with monitoring being required 12 months prior to the commencement of workings. This has been reflected throughout the plan.
4.1	Page 26: Please include minimum monitoring periods for pre-impact, during mining and post mining monitoring in this section and ensure it matches the information provided in Table 7 and references the "Upland Swamps Offset Policy". As currently written, it is difficult to determine the total monitoring periods suggested for the study.	We have included confirmation of the pre-mining requirements now that they have been received. This has been provided in the instrument of approval and has been included to specify 12 months prior to mining and post mining monitoring requirements.
	Page 26: "In this regard, swamps which are yet to be directly undermined can be used as reference swamps for the swamps which are mined under. Additionally, swamps which have been mined under but which show no adverse effects from this mining can be used as part of the reference site network where there is confidence that potential impacts are unlikely to occur post mining." Reference sites should be independent from impacted sites and assigned to control treatments prior to commencement of study period in order to comply with BACI monitoring standards. Please outline the methods and statistical analysis you will undertake to assess the suitability of "less impacted sites" to be considered as a reference sites. Include details on the minimum time frame for monitoring of prior impacted sites to be considered reference condition and the specific criteria assessed.	The proposal here is to use nearby swamps as additional controls, up until the point that mining occurs within 350 metres of the boundary. As these swamps are closer together the power of analysis is increased (removing variation) and the number of control swamps is higher (greater df). The only shortfall of this method is that the power of analysis decreases as less "control" swamps are available over time. The purpose of the proposed is to improve statistical analysis at any point, given the limited availability of true control sites.

Section	Comments	How addressed
	Page 27: Swamp specific water balances should be developed for swamps to be directly undermined in order to comply with the consent conditions and requirement for negligible environmental consequences. Please see previous comments regarding requirements for baseline data in individual swamps.	Swamp specific water balances can be developed based on the data collected if these are considered to be of benefit to the investigation of potential causes of any observed changes in swamp groundwater regimes. However it was determined that soil moisture and shallow piezos will provide a more accurate account of the likely effects to the swamps caused by subsidence.
	Page 32: replace "prior" with period	Fixed
4.21	Page 35 Table 9: Swamps to be used as control sites need to be subject to the same baseline monitoring prior to mining as impacted sites. Baseline data needs to be collected and directly comparable between control and impact categories. Will these additional control sites have the same baseline monitoring durations and ecological monitoring as the impacted sites?	All control sites are monitored for swamp extent, TSR and species composition the same as a CAT 1 swamp.
	Page 35: "Control sites will not have been mined beneath during the monitoring period being investigated." Will swamps that have been mined beneath or in close proximity to undermining outside of the monitoring period be excluded as control sites? Please provide additional details on the requirements and criteria for additional sites to be considered control swamps.	Addressed for p.26 comment. There is limited availability of suitable control sites, we have proposed 8 and how the data is analysed is in 6.4. To be used as a control the swamp, first it must meet the descriptors for an upland swamp and second be outside of the area of influence of the proposed activity.
4.4	Page 39: The definitions of treatments provided here are unclear. Please use the same terminology as Table 5 which refers to 'Control' and 'impact' swamps. Pre-mining and Post-mining monitoring should occur at both control and impacted sites. Pre-mining impact sites and pre-mining control sites data should not be pooled.	Please see above comments.
	Page 40: Please give more details on the methods and analysis that will be performed to determine suitability of control sites for inclusion in the study, including the minimum number of control sites needed for the study. What constitutes ecological similarity? You should define the parameters used to determine this prior to analysis.	Please see above comments.
4.42	Page 41: A measure of relative abundance of each species would enable more analysis options and diversity could also be calculated which would address the consent condition for negligible consequences for biodiversity - the current monitoring plan is not measuring diversity in swamps.	Total species richness as proposed in the monitoring is a measure of species diversity.

Section	Comments	How addressed
	Page 41: When describing the statistical analysis performed you refer to 'mining status' as a predictor rather than the previously defined 'control/impact' treatment and this is confusing. It would be clearer if you used the same terminology to refer to treatment groups (Control versus impact) in your study design throughout the document.	Control vs impact is a simplification of the methods proposed. We use before, after, control, impact and year. This allows for drivers of change to be identified through the use of generalised linear mixed models. We have a variety of scenarios tested and the resultant tests of those models give us the AIC, which provides the model of best fit. Please see report from biometrician for further information.
5	Page 56: "Significant statistical difference between control and impact sites or between before and after mining at the control sites (one year duration – first year after mining commences)." This should read: significant statistical difference between control and impact sites or between before and after mining at the impact sites No change in control sites is expected. A change in impact sites indicates greater than negligible impact has occurred.	Typo has been fixed.
	Page 56: Swamp water quality (two consecutive readings above the trigger, or below for pH) The relevance of these trigger values needs to be justified especially with the inclusion of new control sites in the study design. Data should be provided to validate these. Will these values be revised after the inclusion of new control sites in the study?	Detail is provided in the Water management plan.
	Ideally the 20th and 80th percentile values of baseline water quality in control swamps should be used as a trigger – you should identify which TARP this relates to. Page 56-58 & Appendix D Triggers for Performance measures and TARPS: The description of triggers for performance measures here does not match the triggers described in following section, and their relationship to the TARPS in Appendix D is confusing. Please revise these sections and state clearly which triggers will be used in the proposed monitoring plan – are you using all of the TARPS in Appendix D as triggers for further monitoring or just those mentioned in the triggers for performance measures section? A Table in the body of the report would help. If you are proposing different triggers for the revised monitoring plan then consider including a section in the report where you explain this. The reference to triggers and TARPs in sections 3 & 4 of the report should likewise be clarified and consistent throughout.	TARPs sections have undergone multiple revisions and have been finalised. The plan now reflects these changes.

Richard Sheehan

From:	Chris Page <Chris.Page@environment.nsw.gov.au> on behalf of Chris Page
Sent:	Thursday, 1 July 2021 10:52 AM
To:	Richard Sheehan
Cc:	Vanessa Allen
Subject:	RE: Russell Vale UEP BMP comments

Hi Richard,

Apologies for any confusion.

We have no further comments on the upland swamp monitoring program and management plan.
Thank you for forwarding the information to us.

Regards

Chris Page
Senior Team Leader, Planning (Illawarra)
South East Branch

Biodiversity and Conservation Division | Department of Planning, Industry and Environment
T 02 4224 4180 | **E** chris.page@environment.nsw.gov.au
Level 3, 84 Crown Street, Wollongong NSW 2500
www.dpie.nsw.gov.au

Please note I do not work Fridays

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Monday, 28 June 2021 5:38 PM
To: Chris Page <Chris.Page@environment.nsw.gov.au>
Cc: Vanessa Allen <Vanessa.Allen@environment.nsw.gov.au>
Subject: Re: Russell Vale UEP BMP comments

Thankyou Chris

Further to the meeting we had with Calvin in regard to the comments on the draft plan and the presentation outlining our approach amd how we sought to address the points raised did you have anything further to add in regard to the upland swamp monitoring program and management plan?

Regards

Richard Sheehan
Wollongong Coal Environment and Approvals Manager

On 28 Jun 2021, at 3:42 pm, Chris Page <Chris.Page@environment.nsw.gov.au> wrote:

Hi Richard,

Please be advised that we have no further comment to make on the above BMP.

Regards

Chris Page
Senior Team Leader, Planning (Illawarra)
South East Branch

Biodiversity and Conservation Division | Department of Planning, Industry and Environment
T 02 4224 4180 | **E** chris.page@environment.nsw.gov.au
Level 3, 84 Crown Street, Wollongong NSW 2500
www.dpie.nsw.gov.au

Please note I do not work Fridays

From: Richard Sheehan <richard.sheehan@wcl.net.au>
Sent: Thursday, 24 June 2021 11:20 PM
To: Chris Page <Chris.Page@environment.nsw.gov.au>
Cc: Vanessa Allen <Vanessa.Allen@environment.nsw.gov.au>
Subject: Re: Russell Vale UEP BMP comments

Good evening Chris

Further to this correspondence as below with regard to the Wollongong coal Russell vale underground expansion project swamp monitoring plan are you able to advise if the department has any further comment as we would like to close off this matter as having been resolved.

Regards

Richard Sheehan
Wollongong Coal Environment and Approvals Manager

On 9 Jun 2021, at 4:43 pm, Richard Sheehan <richard.sheehan@wcl.net.au> wrote:

Good afternoon Vanessa,

Thank you for the detailed feedback on the Wollongong Coal UEP BMP.

Further to your comments on the Wollongong Coal UEP USMP and the meeting that we had between WCL and BCD in relation to this feedback provided on this Management Plan (as attached for ease of reference) we have attached a copy of the presentation and a briefing note on the applicability of "Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence" to UEP projects bord and pillar mining program as approved under MP09_0013 for the departments review and further consideration.

Should you have any further feedback on the USMP in consideration of this briefing note in the next week please advise and we can organise a time to discuss.

Regards

Richard Sheehan
Group Environmental & Approvals Manager

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Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Appendix C

BCS/EES Correspondence regarding EP

WOLLONGONG COAL

Wollongong Coal Ltd

ACN 111 244 896
ABN 28 111 244 896

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

Table C.3 BCS/EES Response

Aspect of BCD response	WCL Response
1. Comment on the BMP regarding Giant Burrow Frog	The Giant Burrowing Frog has been identified within a 245 metre section of a tributary of Cataract River below swamp CRUS2 during previous ecological monitoring in the Russell Vale East area. The species was detected consistently as tadpoles and is to be used as an indicator of breeding activity. The irregular records of adults and metamorphs does not provide any meaningful data and will not be part of any future monitoring, beyond incidental records. Habitat for the Giant Burrowing 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. While potential impacts to this species are considered to be negligible, a one year survey program will be undertaken covering both pre-mining and mining, with sampling undertaken during and after breeding (spring to autumn). Monitoring will focus on tadpole (or adults/egg masses) presence. Should the species be found to be present a review would be undertaken to determine the requirements for ongoing monitoring. Ongoing monitoring of potential impacts to habitat for this species will only occur in the event that subsidence monitoring indicates that there has been an impact to the identified habitat for this species or impacts to swamp water quality are detected. The Biodiversity Management Plan has been updated to include this monitoring.
2. Clear documentation of the Methods and statistical analyses to assess "less impacted sites" as reference sites.	Information regarding the methods and statistical analysis is included in two documents which are included as attachments to this letter. The attachments referenced in this email include: **Appendix B Attachment 3:** Briefing Note to BCD regarding Applicability of "Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland Swamps impacted by longwall mining subsidence" to bord and pillar mining approved under MP09_0013". **Appendix B Attachment 2:** Biosis response to BCD comments on draft plan 11/05/2021. It is noted that these two attachments were not included in the consultation appendix of the Upland Swamp Monitoring Plan (USMP) as included in the Extraction Plan submitted to DPIE on 8 October 2021. These attachments were omitted from the Appendix of the USMP due to an administrative error. **Attachment 1** – Notes the following in relation to this aspect. "*The proposal here is to use nearby swamps as additional controls, up until the point that mining occurs within 350 metres of the boundary. As these swamps are closer together the power of analysis is increased (removing variation) and the number of control swamps is higher (greater df). The only shortfall of this method is that the power of analysis decreases as less "control" swamps are available over time. The purpose of the proposed is to improve statistical analysis at any point, given the limited availability of true control sites*".

	The Coastal Upland Swamp Ecological Monitoring approach is detailed in Section 3.2.1, 6.4.1 and 6.4.2 of the USMP. This includes detail regarding the utilisation of both impact monitoring and control sites.
3. Minimum monitoring periods for pre-impact, during mining and post mining be provided in accordance with the policy. 12 month monitoring appears to have been proposed.	In a presentation to BCD (May 2021), Umwelt and WCL indicated that the application of the swamp offset policy is not relevant for proposed board and pillar mining as the policy was developed for longwall mining, even when considering the cumulative impact of past mining. “Primary monitoring” has limited application as being definitive of impacts from proposed mining. Secondary monitoring of vegetation is extensive with two years of baseline data available at 12 swamps over the proposed mining area in addition to reference swamps (refer to **Attachment 2**). Biosis / WCL have confirmed, refer to **Attachment 1**, and also as included in Section 6.1 of the USMP that the following monitoring will occur: • Minimum 12 months of baseline monitoring prior to mining occurring within 350 m of Coastal Upland Swamps • Monitoring during mining. • A minimum of 12 months of monitoring post-mining to confirm negligible environmental consequence as a result of mining. It is also noted that it is proposed to utilise nearby swamps as additional control sites, refer to item 4. Section 6 of the USMP details the proposed Coastal Upland Swamp Monitoring Program.
4. Monitoring program should clearly define an appropriate monitoring design that identifies impact and control (reference) sites/swamps	**Attachment 1** – Notes the following in relation to this aspect. “*The proposal here is to use nearby swamps as additional controls, up until the point that mining occurs within 350 metres of the boundary. As these swamps are closer together the power of analysis is increased (removing variation) and the number of control swamps is higher (greater df). The only shortfall of this method is that the power of analysis decreases as less “control” swamps are available over time. The purpose of the proposed is to improve statistical analysis at any point, given the limited availability of true control sites”.* The Coastal Upland Swamp Ecological Monitoring approach is detailed in Section 3.2.1, 6.4.1 and 6.4.2 of the USMP. This includes detail regarding the utilisation of both impact monitoring and control sites.
5. Capture adequate baseline data prior to undermining.	Refer to Item 3.
6. Rigorous QA/QC program to accompany the Environmental monitoring program	An overview of the QA / QC process applied to Swamp and Biodiversity Monitoring data includes: • Flora transects and photo points are marked with gps coordinates in the field and are re-visited during each survey. • Transect start points, transect end points and photo points are all marked with a star picket and flagging tape, ensuring exact points can be revisited on each repeat survey. • 30 quadrats measuring 0.5 m x 0.5 m are surveyed along each 15 m transect, such that they are precisely side by side.

Head Office
7 Princes Highway
CORRIMAL, NSW 2518

PO Box 281
FAIRY MEADOW NSW 2519
Phone +61 2 4223 6800
Fax +61 2 4283 7449
www.wollongongcoal.com.au

	• Field survey are undertaken by Botanists experienced with the identification of upland swamp vegetation. • Proforma field data sheets are used to record the field data. • Quality assurance is undertaken on each field datasheet prior to entry into the flora monitoring dataset. • Quality assurance is then again completed on the entry of this data into the dataset. • This dataset is validated prior to analysis by a specialist statistician. • The suitability of control sites selected for analysis are compared to using exploratory data analysis to confirm that the data were statistically suitable and available for the same period of time as impact sites.
7. The Subsequent reporting and analysis of data should conform to a statistically rigorous BACI design.	Section 3.2.1 of the USMP details the current swamp monitoring program. Section 3.2.1.2 provides detail on the BACI monitoring with Section 3.2.1.3 on the analysis undertaken. Appendix B of the USMP also details the statistical analysis which is applied to the data which is monitored. A summary of the monitoring undertaken is included in Section 6.9 of the USMP. Further discussion of this is also included in Section 4.1 of **Attachment 1** which states: "The proposal here is to use nearby swamps as additional controls, up until the point that mining occurs within 350 metres of the boundary. As these swamps are closer together the power of analysis is increased (removing variation) and the number of control swamps is higher (greater df). The only shortfall of this method is that the power of analysis decreases as less "control" swamps are available over time. The purpose of the proposed is to improve statistical analysis at any point, given the limited availability of true control sites.
8. Provide data in Excel File format including: • Swamp water level and soil moisture data • Vegetation quadrat and fauna count data • Raw groundwater data.	WCL have included the following data as an attachment: • swamp water level and soil moisture data from soil moisture probes back to 2019. • Raw groundwater data from the installed groundwater wells - GW1, NRE A, NRE B, NRE D, RV16, RV17, RV20, RV22, RV23, RV24, RV25, RV29 • Ecological monitoring data

Our Ref: Ltr-chris page re BCD submission 220520

10 June 2022

Chris Page
Senior Team Leader, Planning (Illawarra)
Department of Planning and Environment
Biodiversity and Conservation Division

E| chris.page@environment.nsw.gov.au

Dear Chris

RE: BCD Comments on Russell Vale East Extraction Plan Stage 2

I refer to your email to Richard Sheehan dated 9 May 2022 regarding the Stage 2 Extraction Plan for bord and pillar panels in the approved Russell Vale East mining area.

This letter provides some additional background to both the mining which has been approved under MP09_0013 and the assessment process undertaken in the approval of the bord and pillar panels which are the subject of the Extraction Plan. This response includes:

- Background to the project design and current approval processes.
- Clarifications around the IAPUM Advice considered in Attachment B 12 November 2021 Biodiversity Conservation Division (BCD) Letter and the nature of predicted impacts to swamps and other biodiversity features.
- Additional background on the proposed monitoring approach.

Additional comments are provided around the Stage 1 area presenting a lower relative risk to swamps that the Stage 1 Area.

Also attached to this letter are responses to specific issues raised in the BCD comments dated 23 May 2022. These comments should be read in the context of the background information contained in this letter and the other attached documentation that formed part of the broader assessment processes for the approved mining.

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Quality Outcomes.

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ABN 18 059 519 041

T| 1300 793 267
E| info@umwelt.com.au

www.umwelt.com.au

Background and consideration of November 2021 BCD Submission

As you are aware, the Independent Planning Commission (IPC) approved the bord and pillar panel workings on 8 December 2020 subject to the requirement for an extraction plan to contain further details of specific monitoring and subsidence management measures for the bord and pillar panels (MP09_0013). Additionally, the Commonwealth Minister for the Environment approved the workings on 31 August 2021 (EPBC Approval (2020/8207).

In granting these approvals both the IPC and the Commonwealth Minister for the Environment had direct regard to the advice from the Independent Advisory Panel on Underground Mining (IAPUM) which has been referred to in the 12 November 2021 Biodiversity Conservation Division (BCD) Letter Attachment B.

A key feature of the approved mining method is that it significantly minimises subsidence and groundwater impacts by using a long term stable bord and pillar mining method that is designed/required to be "non caving" and "non subsiding". The primary reason for the use of this method in the Russell Vale East area is precisely due to the existing multi-seam mining environment and the nature of the overlying environment which is located in the Sydney drinking water catchment and contains sensitive ecological features including upland swamps. While the phrase 'second workings' has been used in the consent documentation, the proposed mining method does not involve any secondary extraction (that may induce caving of the overburden and potential subsidence) and, in this regard, is significantly different in terms of impacts to longwall mining and pillar extraction mining methods. WCL has given a commitment (other than the recovery of the Longwall 6 equipment) that there will be no additional secondary extraction in the Wongawilli Seam.

As a result of the commitment to this long term stable bord and pillar mining method, impacts to groundwater and surface features are predicted to be negligible, with a high degree of confidence in these predictions.

Comments on BCD analysis of IAPUM Advice

The comments contained in Attachment B of the 12 November 2021 letter appear to have misunderstood the nature of the proposed (and now approved) mining and the IAPUM Advice to the IPC. Additionally, the comments in Attachment B do not appear to have had regard to the:

- Response to the IAPUM Report prepared by Umwelt dated November 2020.
- Subsidence Assessment provided with the Stage 1 Extraction Plan.
- WCL's response to the 11 May 2021 BCD comments on the Upland Swamp Monitoring Program (USMP) (June 2021).
- Material presented to BCD in a presentation on 24 May 2021.

The following specifically addresses a number of the areas of apparent misunderstanding in relation to issues considered by the IAPUM in its advice.

'Russell Vale mining proposal is far from ordinary'

In Attachment B, the comment is made in the third paragraph that *the 'Russell Vale mining proposal is far from ordinary'.* While the multi-seam mining conditions are not 'ordinary', they are also not unique and this is specifically recognised on numerous occasions in the IAPUM advice. While the consideration of potential subsidence impacts in a multi-seam mining environment has additional complexities relative to a single seam mining operation, this does not mean the assessment of impacts (including cumulative impacts) cannot be made with a reasonable level of confidence. Indeed, the IAPUM itself provides its own predictions of potential subsidence impacts in which it has sufficient confidence to use as a recommended subsidence performance measure.

The Tipping Point Issue

The complexities associated with the multi-seam mining environment and the passage extracted from the IAPUM advice on page 3 of Attachment B have been interpreted as suggesting that there is potential that a tipping point will be reached due to cumulative impacts. While the IAPUM correctly identifies the risk of tipping points from cumulative mining in the RVE area, the advice specifically considered whether the proposed mining would result in this tipping point being exceeded. The IAPUM's conclusions in relation to the likelihood of the tipping point being reached having regard to cumulative impacts provides (pg 12):

> *Insight into the significance on the integrity of the swamps overlying Russell Vale Colliery of an increase in tensile strain of 0.5 mm/m can be gauged from Table 3, which is based on the assumption that there are no pockets of marginally stable pillars still standing in the Bulli Seam goaves. The table shows that the estimated cumulative tensile strains due to workings in both the Bulli Seam and the Balgownie Seam range from 0.4 mm/m to 10.7 mm/m, with 17 of the 33 swamps estimated to have experienced more than 3 mm/m tensile strain, and with 4 of these estimated to have experience more than 10 mm/m tensile strain.* ***<u>As there are no reports of subsidence having had negative consequences for any of these swamps, it seems implausible that an incremental strain of only 0.5 mm/m could initiate a catastrophic loss of a swamp.</u> The tabulated results suggest that, based on site specific historical performance, at least two-thirds of the swamps could still tolerate ten times this much incremental strain without suffering negative consequences other than possibly a change in species mix, which cannot be excluded from having occurred in the past.***[1]

This issue is further considered in Umwelt's Response to IAPUM Advice, the May 2021 presentation to BCD and the June 2021 response to the 11 May 2021 BCD comments which are provided with this letter as **Attachments 1, 2 and 3,** respectively.

Contrary to the comment on page 4 of Attachment B, there is not a 'real risk' of significant impacts to coastal upland swamps from the predicted incremental 100mm of subsidence (i.e. on top of existing cumulative impacts). On this issue, the IAPUM advice concludes at page 12: '*the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible*.'

As noted in the footnote on page 12 of the IAPUM advice, the potential for a tipping point being reached was the very reason that the approval of Longwall 6 precluded mining under CCUS 4. Despite this very risk being acknowledged in the advice for the previously approved longwall mining, the IAPUM advice did NOT recommend that the proposed bord and pillar mining method also be precluded from occurring under the

---

[1] In the footnote on page 11 of the IAPUM advice, the IAPUM make an assumption that the reference to 3.7m subsidence being experienced at CCUS6 was a typographical error. The 3.7m vertical subsidence prediction from the IAPUM is correct however it also includes measured subsidence from the mining of Longwall 5 in the Wongawilli Seam (predictions stated in the table relate only to mining in the Balgownie and Bulli Seams). CCUS6 remains a functioning Upland Swamp despite this level of vertical subsidence and associated tensile strains, providing further support for the conclusion by the IAPUM that the impacts from the proposed bord and pillar mining are extremely unlikely to have a significant impact on any swamps in the area even having regard to cumulative impacts.

swamps. Indeed, the IAPUM concluded in its advice that, in its view, a vertical subsidence limit of 300 mm would be appropriate to manage risks, significantly higher than the 100 mm predicted by SCT.

A full review of the IAPUM Advice and the IPC reasoning makes it clear that managing vertical subsidence through the proposed mining method to under 300 mm results in a mine plan that is unlikely to have a significant impact on any coastal upland swamps present in the mining area. This is significantly at odds with the summary of the advice contained in Attachment B.

The Subsidence Assessment accompanying the Stage 1 and Stage 2 Extraction Plan (noting that the original Stage 1 Extraction Plan is already approved) also includes additional consideration regarding risks of pillar failure in the overlying Bulli Seam workings. While there is a low risk that standing pillars in areas where the 'goaf' areas of the Bulli seam workings cannot be confirmed as collapsed may be present and may fail during the proposed mining, the potential implications of this on swamps was directly considered by the IAPUM which concluded that such collapses would be '*extremely unlikely to result in a catastrophic loss of a swamp'* and also notes that the cumulative impacts associated with a potential pillar collapse in these goaf areas is already factored into the cumulative impact considerations.

In the absence of *incremental* subsidence impacts over the 100 mm vertical subsidence performance measure at swamps (and 300 mm elsewhere), the proposed mining method is not predicted to have any impacts on ecological features. There is a high degree of confidence in this impact prediction. Accordingly, ensuring the approved mining meets this subsidence impact criteria provides a high degree of confidence that the performance measures regarding swamps and other ecological features will also be satisfied. In this regard, the proposed mining differs significantly from the longwall mining methods in that no ecological impacts are expected from the proposed mining method (even having regard to the historical mining environment). Put slightly differently, the underlying assumption is that any changes in vegetation or aquatic ecosystems observed over the RVE are *not* the result of mining, whereas any impacts observed over active longwall or other secondary extraction mining operations would be assumed to be caused by mining.

Proposed Monitoring Approach

As detailed in the USMP, the approach to both groundwater and surface water monitoring of upland swamps over and in the vicinity of the approved bord and pillar mining panels is based on a risk based approach that has specific regard to cumulative impacts as well as swamp size and complexity. In general, those swamps which have higher levels of pre-existing vertical subsidence (and therefore tensile strain) effects and/or are larger and have greater complexity will have a higher level of monitoring undertaken. The monitoring proposed in Category 1 swamps is similar to that required under the Upland Swamps Offset Policy in relation to longwall mining. The proposed departures from this policy are discussed in detail in **Attachment 3**. This higher level of monitoring is proposed as a precautionary approach to verify that the impact predictions from Umwelt, SCT, Biosis and the IAPUM are correct.

As has been previously discussed with both BCD (refer to **Attachments 2** and **3**) and DAWE (and the Office of Water Science), the monitoring of swamp hydrology in the Russell Vale East area cannot be used as a tool for adaptive management given the lag between the subsidence caused by mining (or reductions in water table) and observed impacts. Subsidence monitoring has therefore been identified as the appropriate leading adaptive management monitoring process to ensure the levels of subsidence caused by the mining operations remain within the levels of impact predicted and therefore impacts to swamps remain unlikely. This approach has been specifically acknowledged in the conditions of the

EPBC Approval 2020/8207 and the staged approval of the Stage 1 Extraction Plan by the Department of Planning and Environment (DPE).

The purpose of the groundwater monitoring within swamps is therefore primarily directed towards identifying whether any changes in vegetation observed though ongoing vegetation monitoring are associated with swamp hydrology changes and, to a lesser extent, identifying potential changes in hydrology ahead of observed changes in swamp ecology. The nature and location of swamp hydrology monitoring is therefore a balance between the purpose of the monitoring and the impacts associated with the installation, operation and decommissioning of the monitoring itself. As discussed in the Stage 1 and Stage 2 Extraction Plan, a risk based approach to the monitoring proposed at each swamp has been adopted.

Based on the discussion above, subsidence monitoring is the identified primary mechanism for managing all impacts. Provided subsidence remains within predicted levels (generally less than 100 mm), no impacts to swamps or other biodiversity features would be expected. While ecological and groundwater monitoring will also be undertaken, this aspect of the monitoring program is designed around enabling unexpected impacts to be identified and investigated or providing a baseline against which the mine's impacts can be investigated in the unlikely event of higher than anticipated subsidence impacts. As both ecological and groundwater impacts are lagging indicators of mining related impacts, the monitoring of these features is of limited utility in proactively informing management practices.

Importantly, the monitoring program also recognises that the environmental impacts from monitoring itself (particularly impacts associated with subsidence monitoring and groundwater bore installation) may be greater than those predicted from the mining provided subsidence impacts remain within predicted levels. While the desire for higher levels of monitoring is understood, this must be balanced against the risks presented by the mining method.

Relative risks presented by Stage 2 mining

Following consideration of the EP as a whole and the November 2021 submission from BCD, the Secretary of the DPE gave conditional approval for the Stage 1 Extraction Plan (Stage 1 EP) in December 2021. The approval covered the mining of the bord and pillar Panels PC21-25 and PC 07-08 however approval to mine PC22-25 and PC07-08 were contingent upon:

- A review of subsidence monitoring data to demonstrate to the satisfaction of the Planning Secretary that subsidence movements from the extraction of PC21 are within predicted levels and that the subsidence impact performance measures outlined in Table 6 and Table 7 of MP 09_0013 are expected to be met across the Stage 1 Extraction Plan area.
- Review and confirmation that the risk control measures proposed for the key public infrastructure outlined in Condition C7 of MP 09_0013, based on the results of monitoring from the extraction of PC21.
- A minimum of 12 months of baseline groundwater data being obtained from CCUS1 and suitable reference swamps.

It is noted that the 12 months of groundwater monitoring data requirement also aligns with the EPBC Approval requirements for mining in the vicinity of this swamp.

There are several key points to note regarding this staged approval:

- DPE specifically acknowledge that '*the proposed long term stable bord and pillar mining method is a highly effective risk control measure that will avoid subsidence related impacts on the surrounding environment*'.
- DPE considers '*that the impacts of the planned mining on the surrounding environment would be negligible. In particular the planned mining method would have negligible impacts on swamps and a neutral impact on water quality within the catchment*'.
- DPE are satisfied that the proposed monitoring framework (including the proposed ecology and groundwater monitoring timing and methodology) is appropriate for the approved mining but see merit in obtaining data from the mining of PC21 which confirms subsidence predictions before allowing mining in other areas.
- DPE are satisfied that 12 months baseline groundwater monitoring in CCUS1 and CCUS5 is sufficient having regard to the nature of proposed mining and the differing risk profiles for different swamps.

Having regard to the above background, the following points are made in relation to the current application:

- The Stage 2 Area has been subject to lower levels of pre-existing mining effects and potential impacts than the Stage 1 Area as only the Bulli Seam has been mined in this area. As a result, any risk of a tipping point being exceeded is substantially lower than the Stage 1 Area (which the IAPUM has also identified as being unlikely to reach a tipping point from the levels of subsidence predicted).
- Given the lower levels of potential cumulative impacts, the Stage 2 Area represents a lower level of risk to swamps and other biodiversity features than the Stage 1 Area. Accordingly, the monitoring program considered to be acceptable for the Stage 1 Area by DPE will also be appropriate for the Stage 2 Area.
- Near-real-time subsidence monitoring will be undertaken at locations representative of swamps being mined under. This monitoring, together with the observations /monitoring from underground mine workings will be used to manage mining to ensure subsidence impacts remain below 100mm at all swamps.
- Regular LiDAR monitoring (at least every 6 months) will be undertaken to monitor subsidence effects across the broader mining area.
- All swamps located over the Stage 1 and Stage 2 mining area will have at least one round of Autumn and Spring ecological monitoring prior to being mined under.
- All swamps overlying the proposed Stage 2 workings will also have swamp piezometers and/or soil moisture probes to monitor changes in moisture levels.
- Subsidence monitoring (both above ground and underground) will remain the primary monitoring measure to inform impact management measures. Provided vertical subsidence effects remain within predicted levels, there is no reason to anticipate any adverse impacts to swamps or other surface features.

There is nothing about the Stage 2 Area that presents any increased subsidence risks relative to the approved Stage 1 Area (and, in fact, to the contrary, none of the Stage 2 Area was subject to past mining in the Balgownie Seam – only the Bulli Seam). Accordingly, cumulative impacts in this area will remain well below any threshold where impacts to swamps or other ecological features would be expected. To use the words of the IAPUM, "*it seems implausible that a incremental strain of only 0.5mm/m could initiate a catastrophic loss of a swamp*".

Concluding Comments

The use of a risk-based approach to the monitoring of swamps (and other biodiversity features) is both appropriate and consistent with good regulatory practice. Due to the difference between the approved mining methods at Russell Vale East and longwall mining as well as the nature of the swamps present in the RVE area, the requirement for monitoring in accordance with the Upland Swamp Offset Policy is not considered appropriate, nor is it considered likely to improve the assessment of whether or not performance measures have been exceeded relative to the currently approved monitoring program.

Following a further review of the November 2021 DPE submission, we have revised the Swamp classification processes to better explain the thresholds for each swamp Category. The Categorisation of swamps will also remain fixed for all current and future extraction stages however the monitoring requirements will only be triggered by approved 'second workings' in the vicinity of the swamps. Accordingly, some swamps may not require the level of monitoring identified in the updated table until future mining stages are approved. The updating of the swamp category thresholds has resulted in some minor changes to swamp classification. This is described further in the updated USMP.

Specific comments regarding the proposed monitoring for specific species contained in the BCD Submission of 23 May 2022 are contained in **Attachment 4.**

We note that WaterNSW have reviewed the Extraction Plan for Stage 1 and Stage 2 (including sub plans) and are satisfied that the proposed monitoring and management measures in the EP are appropriate having regard to the nature of the proposed mining. A copy of the WaterNSW response is enclosed as **Attachment 5** to this letter.

We trust this information meets with your current requirements and that no further amendments to the Stage 1 and Stage 2 Extraction Plan (including the Upland Swamp Monitoring Program) are required. Please do not hesitate to contact the undersigned on 1300 793 267 should you require clarification or further information.

Yours sincerely

David Holmes
Principal Environmental Consultant

E | dholmes@umwelt.com.au

cc Department of Planning and Environment

Our ref: DOC22/397326
Senders ref: MP09_0013-PA-45

23 May 2022

Simon Pigozzo
Wollongong Coal
E-mail: simon.pigozzo@wcl.net.au

Dear Simon

Subject: Russell Vale Underground Expansion – Extraction Plan Stage 2– Comments on Biodiversity Management Plan and Swamp Monitoring Plan

Thank you for referring the above post-approval matter to the Biodiversity and Conservation Division (BCD) of the Department of Planning and Environment (DPE). We apologise for the delay and appreciate the extra time to respond.

The Plan was prepared in accordance with Condition C10 of the Project Approval. You have requested our input on the Biodiversity Management Plan and the Swamp Management Plan which are sub-plans of the broader Extraction Plan. The Biodiversity Management Plan (BMP) focuses on monitoring ecological values that have been determined to be most at risk as part of the Underground Expansion Project (UEP) while the Swamp Management Plan (SMP) has been prepared to manage potential subsidence and groundwater impacts on Coastal Upland Swamps.

We provide a detailed summary of comments and actions required to update the Plan in Attachment 1. We also refer you to our previous comments in relation to Stage 1 (our reference DOC21/1002718).

If you have any questions or require further advice, please do not hesitate to contact Vanessa Allen, Senior Conservation Planning Officer, via Vanessa.Allen@environment.nsw.gov.au or 4224 4186.

Yours sincerely

Chris Page
Senior Team Leader (Planning Illawarra)
Biodiversity and Conservation Division

Attachment 1: BCD comments on the Swamp Management Plan and Biodiversity Management Plan

Reference	Comments
1. Biodiversity Management Plan	
Condition of Approval C10(g)(iv) Page 17	This condition requires a BMP which establishes baseline data for the existing habitat on the site, including **vegetation condition** and **threatened species habitat**, Table 8 describes monitoring methods, including “Photo-point monitoring”. How will vegetation data (including baseline data) be collected and analysed for non-swamp vegetation, noting that a Briefing Note sent to BCD, dated 4/6/2021, described the use of BAM plots for baseline data to inform offsetting requirements? BAM plots are mentioned in the SMP but not the BMP. Please clarify when and how BAM plots will be used.
Threatened frogs	Habitat mapping and occupancy of frogs needs to be done more accurately in the possibly impacted areas. Likelihood of detection needs to be considered for all monitoring proposals – frog breeding periods will mean tadpoles are present at different times. Consider using eDNA monitoring techniques for screening streams (note this should not be used as a replacement for normal monitoring, for further advice, consult BCD). The BMP should discuss how monitoring data is to be collected in accordance with current Threatened Frog Survey Guidelines: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/nsw-survey-guide-for-threatened-frogs-200440.pdf
Littlejohn’s tree frog	Habitat is not limited to tributaries only. It is unclear what remediation will be worthwhile if monitoring detects an impact. Further information required.
Red-crowned toadlet	Red-crowned toadlet is a localised species that appears to be largely restricted to the immediate vicinity of suitable breeding habitat. Due to this tendency for discrete populations to concentrate at particular sites, a relatively small, localised disturbance may have a significant impact on a local population if it occurs on a favoured breeding or

	refuge site. Mining impacts (eg changes to soil moisture) could adversely impact this species.
Giant burrowing frog Section 6.4.2	Giant burrowing frogs only breed February to May and therefore tadpoles are only present during that time. Only a 245 metre section of a tributary of Cataract River has been identified as habitat when other similar areas of habitat exist. Section 6.4.2 states that "giant burrowing frog monitoring is not required within the stage 2 EP area as no habitat is considered to be present". Based on information provided in the BMP, adequate surveys have not been carried out for this species to be able to exclude Stage 2 areas as non-habitat. Consider using eDNA screening as part of the monitoring program.
Section 3.4 Page 39 Section 6.4.2 Page 69	Overall, it is not clear that adequate survey has been done to determine whether certain threatened species occur within the Stage 2 Extraction Plan area and thus whether baseline data requirements in accordance with CoA 10(g)(iv) are met. The Preferred Project Report identified a number of threatened species which have potential to occur and may be impacted by subsidence. Further monitoring has occurred, but no detail is provided.
Figure 6 Page 46	It is unclear why swamps in Stage 2 do not contain habitat for giant dragonfly? None of the swamps mapped in Stage 2 are mapped as habitat.
2. Swamp Management Plan	
Figure 11a	All swamp monitoring sites should be identified in a Table with co-ordinates or provide BCD with an excel file of latitude/longitude or easting/northing for each identified swamp. A shapefile of all swamps should be provided. We could not find the following swamps: ACUS, BCUS12, BCUS13. WACUS, WCUS, S22, S33, S15A.
	A table is required that clearly demonstrates whether all swamps potentially affected by the mining are monitored and what monitoring takes place in those swamps (ie water level, soil moisture, vegetation quadrat, giant dragonfly) and their choice of accompanying reference swamps for comparison in a rigorous BACI design. If a swamp is within the defined

	mining footprint and is not monitored, a justification for this is required.
	Rationale should be provided underlying the choice of swamps for dragonfly monitoring and the justification for not monitoring all swamps that could potentially be affected by the mining (bearing in mind cumulative impacts form previous mining in the area).
Attached document: *Analysis of RV East flora data for Biosis,* prepared by The Analytical Edge Statistical Consulting Page 150	This document analyses vegetation data in terms of total species richness (TSR). This document states: *“TSR is not a good metric to reflect the complex nature of community composition and species turnover, since some species may become locally extinct or invade a region, yet the TSR can remain stable.”* We agree with this conclusion which clearly indicates that community composition data should be the focus for any BACI Assessment. The Plan does not include the use of community composition data as a means of identifying impact (or lack thereof) in a rigorous BACI design. This needs rectification.
	All piezometer, soil moisture, vegetation quadrat, flow, pool level and water quality data should be provided to BCD so an independent analysis can be conducted and the appropriateness/rigour of the proposed BACI design tested.

ATTACHMENT 1 – RESPONSE TO IAPUM ADVICE

Environmental & Social Consultants

RESPONSE TO IAPUM ADVICE

Russell Vale Colliery Revised
Underground Expansion Project
MP09_0013

FINAL

November 2020

RESPONSE TO IAPUM ADVICE

Russell Vale Colliery Revised Underground Expansion Project MP09_0013

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Wollongong Coal Limited

Project Director:	Barbara Crossley
Project Manager:	Gabrielle Allan
Technical Director:	David Holmes
Report No.	3687D/R19
Date:	November 2020

umwelt
Environmental & Social Consultants

Newcastle

75 York Street
Teralba NSW 2284

T| 1300 793 267
E| info@umwelt.com.au

www.umwelt.com.au

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
FINAL	Gabrielle Allan		Barbara Crossley	30/11/20

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Figures

Tables

Appendices

1.0 Introduction

1.1 Background to Report

The Independent Advisory Panel on Underground Mining (IAPUM) was asked by the Independent Planning Commission (IPC) to provide advice on 8 specific questions which related to a number of issues raised during the NSW *Environmental Planning and Assessment Act 1979* assessment process for the Russell Vale Colliery Revised Underground Expansion Project MP09_0013 (the Project). These questions are set out below and the IAPUM advice dated November 2020 is attached as **Appendix A** to this Report.

> *1. In terms of the STC report and Dr Hebblewhite's peer review, are the risk and extent of the predicted subsidence impacts in the catchment reasonable? This needs to be considered in two scenarios:*
>
> *(i) that all the overlying Bulli Seam pillars have collapsed; and*
>
> *(ii) that some of the pillars have not collapsed.*
>
> *2. Is it likely that the Applicant will be able to develop a Mine Plan and Principal Hazard Management Plan that meets the requirements of the Resources Regulator and limits the level of subsidence to 100mm?*
>
> *3. Beyond a 100mm target what is likely to be the worst-case local subsidence scenario if residual pillars in the Bulli Seam collapse?*
>
> *4. Dr Gang Li has made comments and raised concerns relating to the local subsidence impacts and mine stability due to the possible existence of un-collapsed "marginally stable pillars". Are these concerns adequately addressed by the approach proposed by the Applicant and the guidance given in the Resource Regulator's Letter to Commission from Resources Regulator on 16 October, 2020?*
>
> *5. We note that the Resources Regulator has recommended that the applicant undertake investigations to identify and define the existence and distribution of any marginally stable pillars in the overlying Bulli Seam. Are there proven non-invasive methods available to determine the subsurface presence of voids either from existing surface access points or from underground prior to development commencing in sections of the mine which may undercut areas identified as 'unconfirmed' with respect to pillars in the Bulli Seam?*
>
> *6. To what extent should the status of any voids in sections of the old Bulli workings be determined before mining commences or is it appropriate to do this by measurement (and observation) of abutment stresses once mining commences?*
>
> *7. Is the claimed stability of the pillars in the current application likely to be realised given the ground conditions expected in the poorer quality coal remaining in the Wongawilli Seam above that part of the Wongawilli Seam that is proposed to be mined?*
>
> *8. Could any of the above matters be reasonably addressed through conditioning, and if so, how?*

The IAPUM Advice relied primarily on the material provided to it by the IPC however this information does not appear to have included the following most recent subsidence assessment reports, or the Recommended Conditions for the Project:

- SCT Report: *Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russell Vale East* dated 3 October 2019 (SCT Subsidence Assessment) (SCT 2019)

- Dr Bruce Hebblewhite Peer Review of the SCT Subsidence Report: *Report No. 1907/01.2 Peer Review – Russell Vale Colliery Subsidence Assessment Supplementary Summary Report* dated 12 October 2019 (Hebblewhite Consulting, 2019) and

- *Russell Vale Revised UEP Recommended Conditions* prepared by the NSW Department of Planning, Industry and Environment (DPIE) prepared as part of the DPIE Assessment Report (Recommended Consent Conditions).

The IAPUM Advice discusses both the adequacy of the proposed mine plan and risks of pillar failure and subsidence in relation to the proposed workings in the Wongawilli Seam together with the potential subsidence impacts associated with pillar failure in the overlying Bulli Seam workings.

The IAPUM specifically focussed its assessment on the potential impacts from subsidence impacts on Upland Swamps present above parts of the proposed workings. Their response acknowledges that there are a number of matters for which they didn't have access to relevant information and suggests clarification by the Proponent in relation to such matters. The IAPUM did not have the benefit of review of the Recommended Consent Conditions which include the requirement for the preparation of an Extraction Plan for all underground mining in the Bulli Seam undertaken as part of the Project. Notwithstanding, the IAPUM has acknowledged that:

> *The Panel concurs with SCT that it is very unlikely that there are pockets of pillars still standing in the 14 goaf areas identified in the SCT quantitative risk assessment report.*
>
> *The predictions of incremental vertical subsidence are considered soundly based and reasonable.*
>
> *… it seems implausible that an incremental strain of only 0.5 mm/m could initiate a catastrophic loss of a swamp*
>
> *In all but one case, the predictions of SCT (2020b) and the Panel of worst case outcomes for vertical surface subsidence agree to within 200 mm, as documented in Table 5. The one exception is highly unlikely to be realistic in the given conditions and not pursued further.*
>
> *… the Panel agrees with the Regulator [NSW Resource Regulator] that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the applicant to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.*
>
> *If the IPC assesses these impacts to be tolerable and/or able to be managed to a tolerable level through approval conditions, the need to resolve most, if not all, the geotechnical uncertainties is removed.*

As acknowledged in the 16 October 2020 letter from the Resources Regulator to the IPC:

> *[T]he Resources Regulator's position remains that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the proponent to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.*

This view is supported by the IAPUM Advice in its response to Question 4. Further discussion on the process of detailed mine design, management and monitoring is provided in **Section 3.0**.

1.2 Purpose of Report

This Report has been prepared to respond to the observations made in the IAPUM Advice and provide additional input to the consideration of the matters posed to the IAPUM as recommended by the IAPUM Advice. The Report also provides the IPC with further details regarding the application of the existing NSW regulatory regime to the proposed mining operations and how this regulatory framework and additional management measures proposed by the Proponent provide a high degree of confidence that the minimal level of impact predicted in the assessment documentation related to subsidence impacts can be achieved.

1.3 Structure of Response

Section 2.0 includes further discussion regarding the nature of the risk presented by the potential presence of remnant pillars in Bulli Seam goaf areas in terms of both likelihood and consequence of such pillar failure occurring. Additional information regarding the existence and distribution of marginally stable pillars is contained in the SCT Subsidence Assessment.

Section 3.0 of this Report provides further details of the regulatory regime and management measures that will apply to and be implemented for the proposed mining of the Wongawilli Seam at Russell Vale.

Section 4.0 provides a consolidated summary of the response to the questions posed to the IAPUM by the IPC and the IAPUM response to those question.

Appendix B to this Report includes a detailed technical response by SCT to specific observations made in the IAPUM Advice.

Appendix C includes additional observations from Dr Bruce Hebblewhite in relation to both the IAPUM observations and conclusions and the response provided by SCT.

Appendix D contains a summary of proposed subsidence monitoring measures to be implemented.

Appendix E contains a summary of predicted subsidence impacts from previous mining for relevant upland swamps.

2.0 Comments on Risks Associated with Subsidence

2.1 General comments on Bulli Seam Workings

The Bulli Seam at Russell Vale Colliery was initially mined using hand bord and pillar mining techniques from the 1890's through until pillar extraction became possible with improvements in mining technique and the arrival of mechanised mining (SCT, 2019). Within the Bulli Seam workings, some of the standing pillars associated with the main headings and original mining areas were extracted during the later stages of retreat.

The assessment documentation includes the phrases 'potential pillar instability', 'marginally stable pillars' and 'standing pillars' in relation to the Bulli Seam workings and there appears to be some confusion as to the meaning of these terms and their consideration in the SCT Subsidence Risk Assessment and SCT Subsidence Assessment, particularly as these phrases have been used interchangeably.

Appendix A, Section A1.1 of the SCT Subsidence Assessment includes a comprehensive discussion of past workings within the Bulli Seam and predicted impacts associated with these Seams. The following summarises the two different types of remnant pillars in the Bulli Seam considered in the Subsidence and risk assessments and these phrases will be used throughout this report and **Appendix B** and **Appendix C**.

2.1.1 Marginally Stable Pillars

The phrase 'marginally stable pillars' and discussion around 'potential pillar instability' relates to consideration of irregularly shaped bord and pillar workings adjacent to the Bulli Seam main headings. These are shown in Figure 16 of the SCT Subsidence Assessment (reproduced below in **Figure 2.1**). The SCT Subsidence Assessment includes the following commentary regarding these 'marginally stable pillars':

> *Similar workings were directly mined under by the Balgownie Seam longwall panels and it is clear from the underground inspection that these overlying pillars were destabilised in the area directly above the Balgownie Seam longwall goaf. Both these areas are shown in Figure 16* [refer to **Figure 2.1**]*. There did not appear to be any evidence that the footprint of instability extended significantly beyond the footprint of the underlying goaf, but it is considered possible that this potential may exist in some places where there are localised areas of standing pillars remaining.*
>
> *The formation of isolated roadways in the Wongawilli Seam is not expected to have potential to cause instability in these Bulli Seam pillars. There is no known evidence of this effect at the Russell Vale site. However, the possibility cannot be ruled out completely.*

While the terminology used is different, Section 2.3.3 of the SCT Subsidence Risk Assessment specifically considered the risk of subsidence associated with the failure of these pillars. The SCT Subsidence Assessment concludes in relation to these pillars:

> *These pockets of smaller pillars have potential to become unstable and collapse with some subsidence possible irrespective of any proposed mining in the Wongawilli Seam. Proposed mining is not expected to significantly affect their stability. The limited size of the pockets of standing pillars means that maximum surface subsidence is expected to be less than about 0.3-0.5m.*

There are no swamps located in the vicinity of these pockets and so the impacts to swamps of instability of these pockets of standing pillars is considered negligible even if instability were to occur at any time unrelated to proposed mining.*

As is noted in the SCT Subsidence Assessment and the SCT Subsidence Risk Assessment, the dimensions and shape of these pillars are such that they have potential to become unstable and collapse (with some associated subsidence impacts) *irrespective* of the proposed mining in the Wongawilli Seam.

It is therefore important to recognise that the consequences of subsidence associated with the failure of these marginally stable pillars is almost certain to occur at some time in the future irrespective of whether or not the Project proceeds. The Project therefore does not cause the subsidence impacts that will arise from the eventual failure of these pillars (this is the result of historical mining which occurred prior to 1950), however the potential for the Project triggering the failure of these pillars cannot be ruled out.

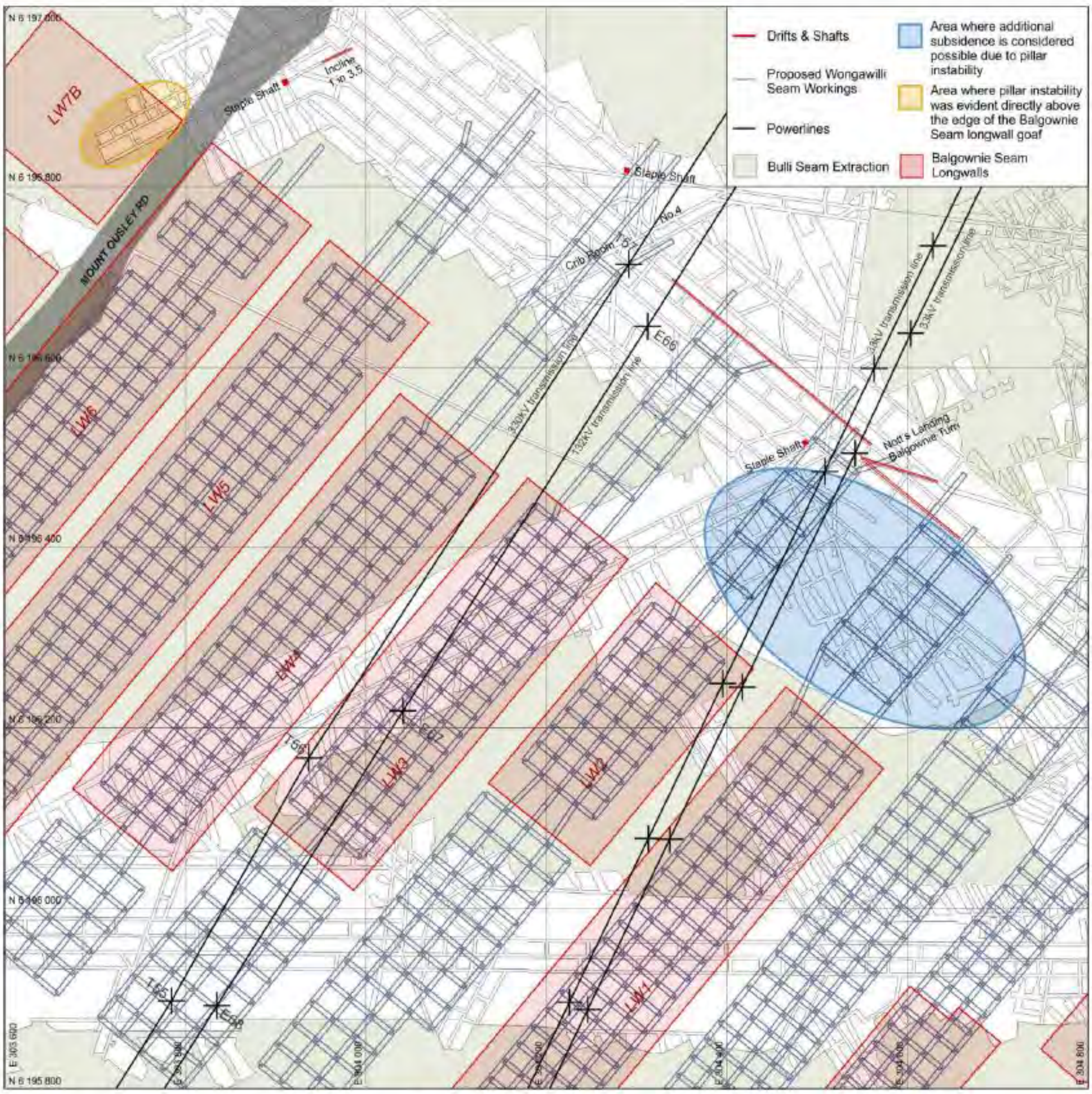

Figure 16: Plan showing areas of existing and potential pillar instability in overlaying Bulli Seam.

Figure 2.1 Marginally Stable Pillars

None of the marginally stable pillars are located below swamps nor is the failure of these pillars likely to impacts on any creeks, cliff lines or rockshelf features. As such, the environmental impacts of a failure of these pillars is likely to be negligible. These pillars are however located in close proximity to high voltage transmission line towers (refer to **Figure 2.1**) and the detailed mine design will need to have regard to the management of these features. This is discussed further in **Section 3.0**.

2.1.2 Standing Pillars

The use of the phrase 'standing pillars' in this Report relates to the potential for there to be remnant pillars or parts of pillars remaining within areas shown on the Bulli Seam record tracings as shaded (refer to black/grey areas in Figure 14 of the SCT Subsidence Assessment - reproduced in **Figure 2.2**) which have potential to fail. These areas are described in the SCT Subsidence Assessment as follows:

> *Where large areas have been shaded (refer to Figure 14) to represent the completion of mining, the detail of the Bulli Seam extraction is not available. These areas are likely to include different levels of mining ranging from solid coal, large standing pillars, standing pillars associated with Welsh bords, and goaf areas where there has been pillar extraction or the pillars have previously collapsed.*

These grey/black shaded areas correspond to the 14 'Bulli Seam goaf areas' considered in the SCT Subsidence Risk Assessment (SCT, 2020: refer to Figure 1 in the SCT Subsidence Risk Assessment – reproduced in **Figure 2.3**). Section 2.3.2 of the SCT Subsidence Risk Assessment (SCT, 2020a) describes these areas as follows:

> *Figure 1 shows fourteen large areas of Bulli Seam pillar extraction, referred to as Bulli Seam goaf areas. There is evidence available from subsidence monitoring and observation of roadway conditions in the Wongawilli Seam to confirm seven of these areas have fully collapsed with no potential for further subsidence. The seven collapsed goaf areas are numbered in Figure 1 as 1-7.*
>
> *It is almost certain that the other seven goaf areas (8-14) have also fully collapsed because the mining systems used in each are similar and the areas extracted are of similar size. Confirmation of collapse in all these areas would be reassuring for the sake of completeness. Proposed mining in the Wongawilli Seam would not change the potential for further subsidence from the Bulli Seam. This potential would exist irrespective of proposed mining. The benefit of knowing that all the Bulli Seam goaf areas have collapsed and fully subsided is that this risk could then be eliminated.*

Section 4.2.2.1 of the SCT Subsidence Risk Assessment (SCT, 2020a) provides further information regarding these areas:

> *The overburden depths in the Southern Coalfield are typically greater than 300m. At this depth, the abutment loads from a goaf are large enough to cause smaller pillars to become overloaded at the goaf edge. Pillars required to maintain a stable goaf edge at 300m need to be more than about 30-35m wide. Pillars of this size are large enough to either show on the mine record tracings or be too large to be at risk of becoming overloaded in the future. Their width to height ratio is nominally 14-16 and as such they continue to gain load carrying capacity as they become loaded and deform.*
>
> *The implication of this observation is that any pillar instability within a shaded area of goaf in the Bulli Seam is likely to cause pillar instability across the full shaded area. It is difficult to conceive of a pillar geometry that could involve a large area of standing pillars remaining stable for an extended period when surrounded by a goaf. The pillars have either already become overloaded and subsided, so they no longer present a hazard or are so large that they continue to gain load-bearing capacity as they deform and so no longer present a hazard.*

The ‘standing pillars’ referred to in this Report are those pillars that may (but are unlikely to) occur in Bulli Seam goaf areas 8-14 that were not designed to be long term stable and, in many cases, would be designed to fail as mining retreated from the area. Notwithstanding the expectation (and intention) that these pillars would fail, there is potential for some of these to remain in isolated areas of the Bulli Seam goaf areas 8-14. If present, these pillars would be largely surrounded by goaf material associated with the failure of surrounding pillars. Unlike the marginally stable pillars, the location of any standing pillars in the Bulli Goaf Areas cannot be determined from historical records and physical access to these areas is unavailable due to the goafing that has already occurred.

The eventual failure of these pillars is almost certain and all subsidence predictions have assumed that pillars in these areas have already collapsed, that is, predictions of cumulative subsidence impacts, tilts and strains have already considered the impacts associated with the failure of the pillars in these areas. This is acknowledged in the IAPUM Advice however, as correctly noted in the IAPUM Advice, if any pillars remain in Bulli seam Goaf Areas 8 to 14, features above these standing pillars 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.

SCT remain of the view that it is extremely unlikely that the proposed first workings below any of these standing pillars will further destabilise them however it is acknowledged that it cannot be entirely ruled out. However, as with the marginally stable pillars, the Project will not increase the consequences associated with these pillars failing (other than the predicted incremental subsidence associated with the proposed first workings) in that these consequences will eventually occur (if they haven’t already) irrespective of the Project proceeding. The Project could however bring the timing of these consequences forward if the works did result in destabilisation.

Figure 14: Plan showing extent of previous secondary extraction in Bulli Seam (black), Balgownie Seam (red) and Wongawilli Seam (grey) in the Application Area.

Figure 2.2 Areas of Secondary Extraction

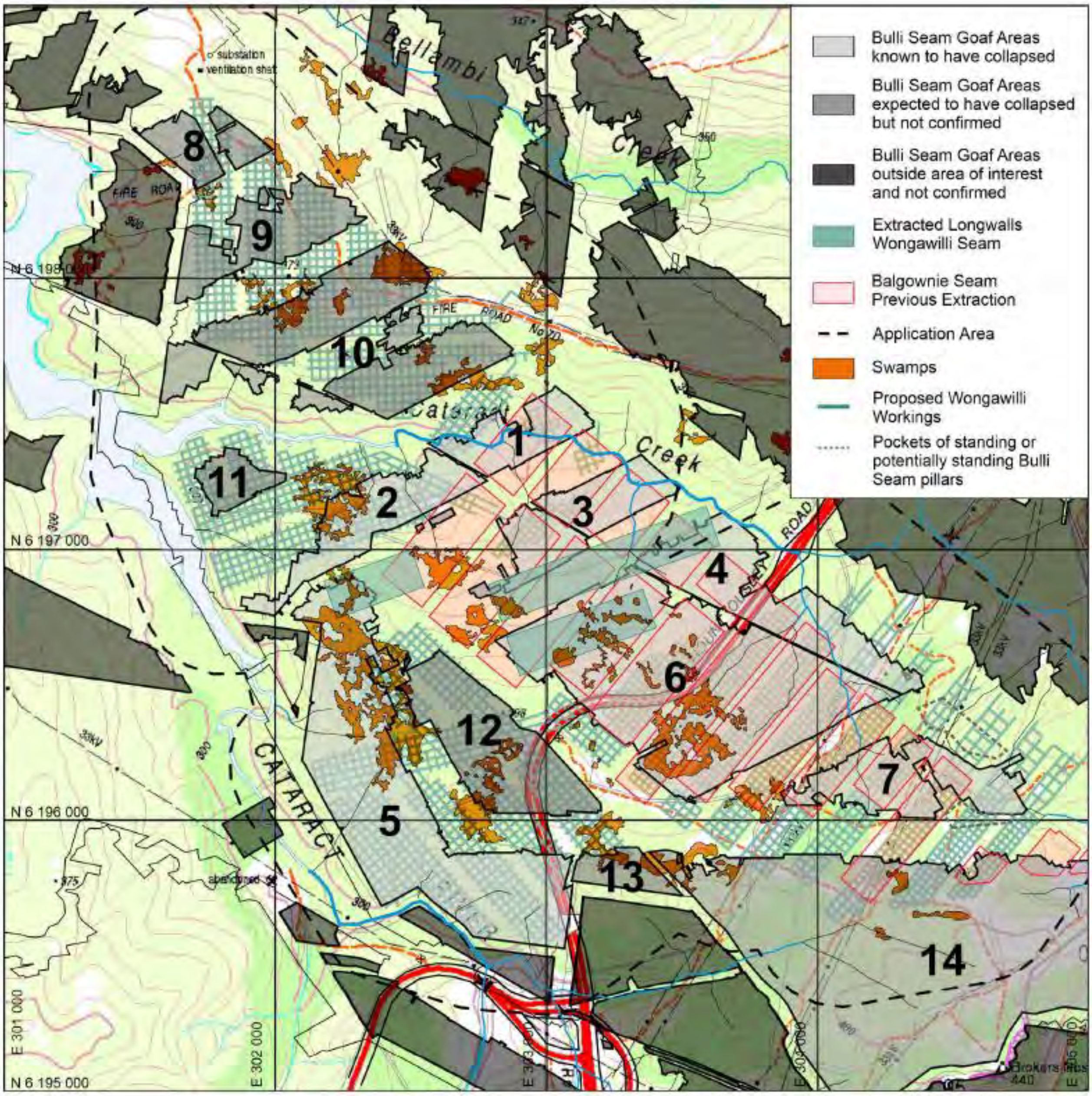

Figure 1: Plan showing location of swamps and proposed first workings in the Wongawilli Seam relative to previous secondary extraction in Bulli Seam (Grey), Balgownie Seam (Red) and Wongawilli Seam (Dark Green).

Figure 2.3 Goaf Areas Considered in SCT Subsidence Risk Assessment

2.2 Consequences of Standing Pillar Failure

As detailed in the SCT Subsidence Risk Assessment (SCT 2020a) and **Appendix B**, there is evidence available that confirms Bulli Seam Goaf Areas 1-7 have collapsed. This evidence is available directly through measurement of subsidence, borehole measurements or indirectly through observations of goaf edge abutment loading in underlying seams. In all seven of the goaf areas where evidence is available, the Bulli Seam pillars are confirmed as having been extracted or collapsed. The potential for further subsidence in these areas is limited to residual movements. Over the 80-90 years since mining was completed, any residual movements are expected to have occurred (SCT, 2020).

2.2.1 Potential Impacts on Upland Swamps

The IAPUM Advice has made specific reference to the existing predicted impacts to upland swamps presented in Table 3 of the IAPUM Advice in its assessment of likely impacts on upland swamps. At page 12 of the advice it states:

It is concluded that:

- *even allowing for those swamps overlying goaves where it is yet to be 'proven' that vertical subsidence has not been impeded by marginally stable pillars and, therefore, would be less than estimated in Table 3, the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible. (It could be helpful and improve confidence in impact predictions for swamps if SCT, as the originators of Table 3, were to reproduce it having regard to the location of areas where vertical displacement would be less than estimated if there are still standing pillars in the Bulli Seam goaves.)*

- *based on historical performance, the failure of standing pillars in the Bulli Seam is extremely unlikely to result in catastrophic loss of a swamp (noting that the values for these swamps in Table 3 would need to be reduced accordingly if they are in fact located over pillars that are still standing).*

- *the additional amount of vertical subsidence that can be tolerated by the four swamps overlying both Bulli Seam workings and Balgownie Seam workings that are estimated to have already experienced around 10.5 mm/m tensile strain is unknown and, therefore, bord and pillar workings in the Wongawilli Seam beneath these areas need to be designed judiciously and conservatively in order to restrict vertical subsidence in the event of them becoming unstable.[8]*

  [Footnote 8: It was the high risk of reaching a swamp's tipping point (i.e. the point where the swamp can no longer function effectively as a swamp) due to a predicted incremental increase in tensile strain of 11 mm/m that caused the PAC to limit the extraction of LW 6 in the Wongawilli Seam to the western edge of swamp CCUS4 (DoP, 2014).]

Table 3 of the IAPUM Advice doesn't cover all swamps over the proposed first workings mine plan area and a number of swamps shown in Table 3 are not over the proposed mine workings area. **Appendix E** contains an updated list of upland swamps and the predicted cumulative subsidence and tensile strain impacts experienced at each of these swamps associated with mining in the Balgownie Seam and Bulli Seam. In total, there are 27 swamps located over the proposed first workings.

The IAPUM Advice noted that it would be helpful if maximum subsidence predictions in areas where pillars may still be standing could account for these pillars remaining. As noted in **Section 2.1** above and the SCT Subsidence Risk Assessment, in the absence of mining under the Bulli Seam goaf areas, it is not possible to identify where (if at all) any standing pillars may remain and therefore account for this in the subsidence predictions. The subsidence and tensile strain predictions therefore assume there are no standing pillars in any of the Bulli Goaf Areas. These predictions represent the maximum subsidence and tensile strain impacts that could occur if these standing pillars remain in the absence of further impacts associated with mining in the Wongawilli Seam.

The swamps within the vicinity of the proposed first workings are shown in **Figure 2.4**.

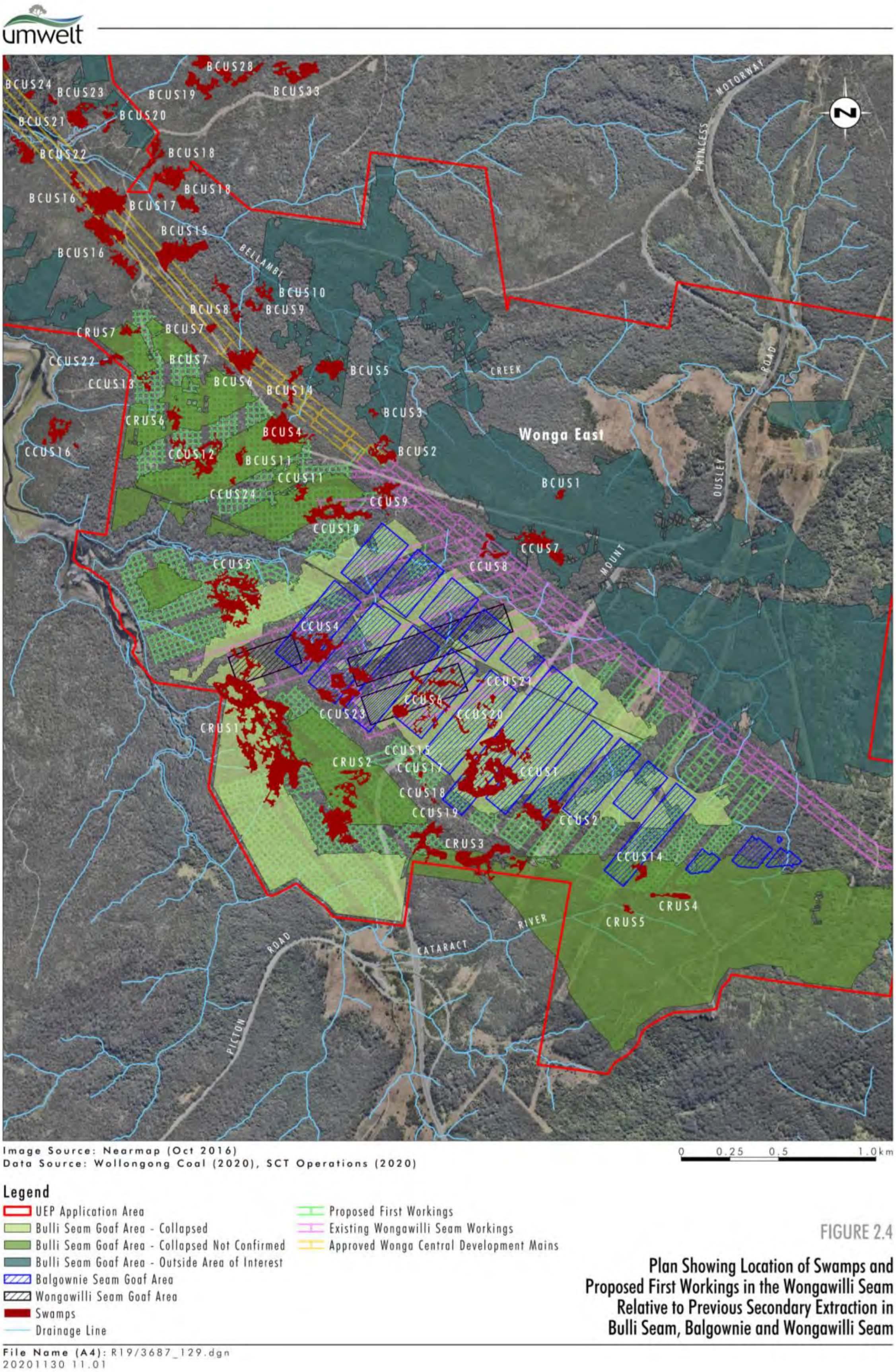

Figure 2.4 Upland Swamps Considered by IAPUM

Table 2.1 lists the 27 swamps which are located over areas of proposed first workings.

Table 2.1 Swamps over Proposed First Workings

<table>
<tr><th>Swamp</th><th>Bulli Seam Goaf Area</th><th>Potential for Standing Pillars Under Swamp</th><th>Located over Proposed First Workings</th><th>Max Predicted Subsidence - Bulli and Balgownie Seams (m)</th><th>Estimated Max Tensile Strain (mm/m)</th></tr>
<tr><td>CCUS1</td><td>Area 6</td><td>No</td><td>Yes</td><td>2</td><td>10.5</td></tr>
<tr><td>CCUS2</td><td>Edge Area 7</td><td>No</td><td>Yes</td><td>1.1</td><td>5.8</td></tr>
<tr><td>CCUS5</td><td>Pt Area 2</td><td>No</td><td>Yes</td><td>0.6</td><td>3.3</td></tr>
<tr><td>CCUS9</td><td>N/A</td><td>No</td><td>Yes*</td><td>0.1</td><td>0.5</td></tr>
<tr><td>CCUS10</td><td>Pt Area 10</td><td>No</td><td>Yes</td><td>0.2</td><td>0.9</td></tr>
<tr><td>CCUS11</td><td>Area 10</td><td>Yes</td><td>Yes</td><td>1.0</td><td>4.4</td></tr>
<tr><td>CCUS12</td><td>Part Area 10</td><td>Yes</td><td>Yes</td><td>0.5</td><td>2.1</td></tr>
<tr><td>CCUS13</td><td>Area 8</td><td>Yes</td><td>Yes</td><td>0.1</td><td>0.4</td></tr>
<tr><td>CCUS14</td><td>Area 14</td><td>Yes</td><td>Edge</td><td>1.2</td><td>6.5</td></tr>
<tr><td>CCUS15</td><td>N/A</td><td>No</td><td>Yes</td><td>0.2</td><td>0.9</td></tr>
<tr><td>CCUS17</td><td>N/A</td><td>No</td><td>Yes</td><td>0.1</td><td>0.5</td></tr>
<tr><td>CCUS18</td><td>N/A</td><td>No</td><td>Edge</td><td>0.1</td><td>0.5</td></tr>
<tr><td>CCUS20</td><td>Area 6</td><td>No</td><td>Yes</td><td>2.0</td><td>10.3</td></tr>
<tr><td>CCUS24</td><td>Edge Area 10</td><td>Yes</td><td>Yes</td><td>0.3</td><td>1.30</td></tr>
<tr><td rowspan="2">CRUS1</td><td>Pt Area 5</td><td>No</td><td>Part</td><td rowspan="2">0.5</td><td rowspan="2">2.5</td></tr>
<tr><td>Edge Area 12</td><td>Yes</td><td>Yes</td></tr>
<tr><td>CRUS2</td><td>Pt Area 12</td><td>Yes</td><td>Yes</td><td>0.6</td><td>4.3</td></tr>
<tr><td>CRUS3</td><td>Pt Area 13</td><td>Yes</td><td>Yes</td><td>0.6</td><td>3.1</td></tr>
<tr><td>CRUS6</td><td>Edge 9</td><td>Yes</td><td>Yes</td><td>0.1</td><td>0.40</td></tr>
<tr><td>CRUS7</td><td>Area 8</td><td>Yes</td><td>Yes</td><td>0.3</td><td>1.3</td></tr>
<tr><td>BCUS2</td><td>Nth of Mains</td><td>No</td><td>Yes#</td><td>0.5</td><td>2.6</td></tr>
<tr><td>BCUS3</td><td>Nth of Mains</td><td>No</td><td>Yes#</td><td>0.5</td><td>2.8</td></tr>
<tr><td>BCUS4</td><td>Area 10</td><td>Yes</td><td>Yes</td><td>0.6</td><td>3.1</td></tr>
<tr><td>BCUS6</td><td>Nth of Mains</td><td>No</td><td>Yes#</td><td>0.1</td><td>0.5</td></tr>
<tr><td>BCUS7</td><td>Edge Area 8</td><td>No</td><td>Edge</td><td>0.1</td><td>0.5</td></tr>
<tr><td>BCUS8</td><td>Nth of Mains</td><td>No</td><td>Yes#</td><td>0.1</td><td>0.5</td></tr>
<tr><td>BCUS11</td><td>Area 10</td><td>Yes</td><td>Edge</td><td>0.5</td><td>2.2</td></tr>
<tr><td>BCUS14</td><td>Nth of Mains</td><td>No</td><td>Yes#</td><td>0.5</td><td>1.0</td></tr>
</table>

* Headings only
# Mains Headings Only

2.2.1.1 Swamps with existing tensile stains >10 mm/m

The four upland swamps identified in the IAPUM Advice as already having experienced tensile strain impacts of over 10 mm/m (CCUS1, CCUS6, CCUS20 and CCUS21) are all located over Area 6 (refer to **Figure 2.4** and **Table E.1.1** in **Appendix E**). Area 6 is one of the Bulli Seam goaf areas confirmed as having been fully collapsed. Of these four swamps, neither CCUS6 and CCUS21 will be directly undermined by the proposed first workings in the Wongawilli Seam and are unlikely to experience any additional subsidence effects from the proposed mining.

The management of potential impacts on CCUS1 and CCUS 20 are discussed further in **Section 3.0**.

2.2.1.2 Swamps with existing tensile stains <10 mm/m

It is noted that not all of these swamp areas are located over the proposed first workings and 5 (BCUS2, BCUS 3, BCUS8 and BCUS14) are only located over areas of mains headings which are extremely unlikely to experience any observable subsidence impacts due to the large pillar size in mains headings. Accordingly, potential subsidence impacts associated with these swamps are not considered further other than to note that parts of the Bulli Seam north of the Mains heading is identified as being goaf and there remains potential for remnant standing pillars in these areas to collapse irrespective of the Project (the mains headings in the Wongawilli Seam do not undermine these Bulli Seam goaf areas). Accordingly, any subsidence impacts limits set for the Project and monitoring program must have regard to the potential for future subsidence impacts to arise in this northern area which is unrelated to the Project.

Of the remaining 22 swamps, 10 swamps are located over Bulli Seam goaf areas where there is evidence that all remaining pillars have fully collapsed. Potential subsidence impacts in these areas will therefore be limited to the subsidence associated with compression of the Wongawilli Seam Pillars. These incremental impacts are predicted to be between 30 and 100 mm (SCT 2019) with maximum impacts unlikely to exceed 140 mm even in the event of a collapse of pillars in the proposed first workings (SCT 2020). Based on the IAPUM Advice estimated predictions, the maximum additional subsidence (i.e. in addition to that specified in **Table 2.2**) that likely occur as a result of the Project at any of these 10 swamps is in the order of 150 mm based on the IAPUM Advice calculation which conservatively takes into account potential for additional goaf activation. With the possible exception of CCUS1 and CCUS 20 (refer to **Section 2.2.1.1**), it is, to use the language of the IAPUM Advice, implausible that the incremental tensile strains associated with this additional vertical subsidence could initiate a catastrophic loss of any of these swamps.

The 12 swamps which are wholly or partly located over both Bulli Seam goaf areas where there is potential for standing pillars to remain (Areas 8-14) and the proposed first workings in the Wongawilli Seam are listed in **Table 2.2**.

Table 2.2 Swamps over both proposed Wongawilli Seam Workings and Bulli Seam goaf areas 8-14

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Subsidence - Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain (mm/m)
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
CCUS24	Edge Area 10	Yes	Yes	0.3	1.30
CRUS1	Edge Area 12	Yes	Yes	0.5	2.5

Swamp	Bulli Seam Goaf Area	Potential for Standing Pillars Under Swamp	Located over Proposed First Workings	Max Predicted Subsidence - Bulli and Balgownie Seams (m)	Estimated Max Tensile Strain (mm/m)
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
BCUS4	Area 10	Yes	Yes	0.6	3.1
BCUS11	Area 10	Yes	Edge	0.5	2.2

While the incremental subsidence associated with the Project is unlikely to exceed 100mm (up to 150mm mm based on the conservative IAPUM estimates), the observed subsidence could be larger if standing pillars remained in the Bulli Seam goaf areas and these pillars failed during the life of the Project (up to 300mm in the event of an unlikely pillar failure based on IAPUM estimates). The observed subsidence at any of the swamps could not exceed the sum of the incremental subsidence (100mm) plus the maximum predicted subsidence levels as set out in **Table 2.2**. Any additional subsidence over the incremental subsidence predictions would be limited to localised areas around the failed standing pillar. As noted in the SCT response to the IAPUM Advice (**Appendix B**), the maximum extent of subsidence should any pillars still be present and fail during the life of the Project is likely to be lower than the IAPUM estimates.

As noted in **Section 2.1**, this additional subsidence associated with the standing pillars in the Bulli Goaf Areas is not caused by the Project but is rather an inevitable consequence of the mining previously undertaken in the former Bulli Seam Workings. Notwithstanding, even assuming such a pillar failure did occur during the life of the Project, it is considered extremely unlikely that these levels of subsidence would result in a catastrophic loss to upland swamps above these workings given that significantly higher impacts have occurred at other locations without any observable adverse impacts on these swamps. This conclusion is supported by the discussion on page 12 in the IAPUM Advice.

2.2.1.3 Summary of potential impacts to swamps

There are 27 swamps located above the proposed first workings. The predicted subsidence impacts on these swamps associated with subsidence due only to the proposed first workings in the Wongawilli seams is 100mm (SCT 2019). The IAPUM has estimated that slightly higher levels of subsidence of up to 150 mm could occur. Based on well-established principles, an incremental vertical subsidence of 100mm could be expected to result in an incremental tensile strain of up to 0.5mm/m (although, as discussed by SCT in **Appendix B**, this is likely to be conservative in the Russell Vale context). There are 10 swamps (including CCUS 1 and CCUS 20) for which this is the maximum likely extent of subsidence impacts.

With the possible exception of swamps CCUS1 and CCUS20, the IAPUM has indicated that "*it seems implausible that an incremental strain of only 0.5 mm/m could initiate a catastrophic loss of a swamp*." And "*the catastrophic loss of a swamp due to only 100mm of incremental vertical subsidence is hardly credible*." This conclusion would also extend to the incremental tensile strains associated with the additional 50mm of subsidence that the IAPUM conservatively assumed was possible. Consistent with the advice of the IAPUM, the design of bord and pillar workings below CCUS1 and CCUS20 will need to be designed judiciously and conservatively to restrict adverse impacts on these two swamps. It is noted that neither of these swamps are located over Bulli Seam goaf areas where there is any potential for standing pillars to remain. This is discussed further in **Section 3.0**.

12 swamps are located over Bulli Seam goaf areas where there are potential for standing pillars to remain. As noted in the IAPUM Advice:

> *The Panel concurs with SCT that it is very unlikely that there are pockets of pillars still standing in the 14 goaf areas identified in the SCT quantitative risk assessment report.*

Even where such a failure occurs during the course of the Project, or at some time in the future, this is an inevitable consequence of the former Bulli Seam workings in these areas as these pillars were never intended to remain standing for long periods of time (and hence the high degree of confidence expressed by both SCT and the IAPUM that it is unlikely that any such pillars remain).

Swamps located over Bulli Seam goaf areas 1-7 which are known to have fully collapsed have not experienced any catastrophic failure of ecological function. The predicted maximum vertical subsidence and tensile strains in all of the 12 swamps over Bulli Seam goaf areas 8-14 are lower than the maximum levels predicted and/or observed in Bulli Seam goaf areas 1-7. As noted by the IAPUM, based on the predicted maximum vertical subsidence and tensile strains predicted as being experienced at the 12 swamps:

> *based on historical performance, the failure of standing pillars in the Bulli Seam is extremely unlikely to result in catastrophic loss of a swamp.*

2.2.1.4 Impacts to groundwater and surface water systems

The groundwater impact assessment prepared by Geoterra (2020) and the uncertainty assessment undertaken by HydroAlgorithmics (2020) was based on modelling of fully collapsed Bulli Seam goaf areas. Should there be any standing pillar in these areas that fail during the life of the Project, the potential impacts associated with these failures has already been considered in the Groundwater and Surface Water cumulative impact assessment and sensitivity analysis.

2.2.1.5 Impacts to other sensitive features

Additional subsidence below cliff lines and under rock platforms and shelfs has the potential to cause cliff line instability and cracking of rock features. The predicted incremental vertical subsidence impact associated with the Project of up to 100mm (and a consequent 0.5mm/m tensile stain) are considered unlikely to result in any cliff line instability or additional observable surface cracking in rocks. Even the incremental impacts associated with an unlikely failure of a Wongawilli Seam Pillar (up to 140mm) is considered unlikely to have a significant impact on these surface features. Should there be any standing pillars in the Bulli Seam goaf areas which fail during the life of the Project, additional vertical subsidence and tensile cracking could be observed depending on the magnitude of the additional subsidence. Significant additional vertical subsidence could also cause cliff instability.

As noted above, any additional observed subsidence associated with the failure of standing pillars in the Bulli Seam goaf areas is largely inevitable irrespective of the project occurring due to the inherent instability. Accordingly, impacts to cliffs or rock shelves associated with standing pillar failure are a consequence of historic mining and not the Project even were they to occur during the life of the Project.

WCL will remain liable for rehabilitation of mining related impacts covered by the mining leases held by them and this includes liabilities associated with the former Bulli Seam Workings. Accordingly, the monitoring and management measures implemented as part of the Project will need to have regard to impacts associated with the potential failure of standing pillars in the Bulli Seam. This is discussed further in **Section 3.0**.

2.3 Consequences of Failure of Marginally Stable Pillars

The failure of marginal pillars will have similar levels of subsidence impacts (vertical subsidence, strains and tilts) to those predicted for standing pillars in the Bulli Seam goaf areas.

None of the marginally stable pillars are located below swamps nor is the failure of these pillars likely to impacts on any creeks, cliff lines or rockshelf features. As such, the environmental impacts of a failure of these pillars is likely to be negligible. These pillars are however located in close proximity to high voltage transmission line towers (refer to **Figure 2.1**) and the detailed mine design will need to have regard to the management of these features. The specific mine design and management process is discussed further in **Section 3.0**.

2.4 Subsidence Attributed to the Project

The IAPUM Advice quantifies both potential subsidence impacts associated with the proposed Wongawilli Seam workings as well as maximum subsidence impacts should standing pillars in Bulli Goaf areas also fail. As discussed above, while there is a potential for this maximum scenario to occur during the life of the Project, the eventual failure of any standing pillars in the Bulli Seam goaf areas is expected due to the nature of these pillars and the mining system used in these areas (SCT2019, SCT 2020a, SCT 2020b). As a result, the consequences of the subsidence associated with these Bulli Seam pillars is almost certain to occur irrespective of the Project.

While cumulative impacts are relevant to the overall assessment of the Project, the key issue to note is that the potential for additional subsidence impacts to arise during the course of the Project which are due to a failure of inherently unstable pillars in the Bulli Seam is an impact that would occur irrespective of the Project occurring.

Monitoring will necessarily pick up the cumulative impact of both the inevitable impacts of former workings and those associated with the Project. Where impacts occur due to either proposed or former workings, the Proponent, as the holder of the relevant mining leases, will have an obligation under the mining leases to undertake appropriate rehabilitation measures. However, from a compliance perspective, it is expected that specific performance measures will be set for the Project based on impact predictions and commitments. This is discussed further in **Section 3.0**.

3.0 Regulatory and Management Measures

3.1 Regulatory Framework

The two main approval processes which regulate the carrying out of underground mining activities which have potential to cause subsidence impacts are:

- development consent under the Environmental Planning and assessment Act including:
  - Extraction Plan (see for example Recommended Consent Condition C10)
  - performance measures (see for example Recommended Consent Condition C1 and C7)
  - rehabilitation and offsetting requirements (see for example Recommended Consent Condition B42 and C4, C4 and C6) C5)
  - monitoring and adaptive management processes (see for example Recommended Consent Condition C2, C3, monitoring requirements under the Extraction Management Plan)
- development and implementation of principal hazard management plans under the *Work Health and Safety (Mine and Petroleum Sites) Regulation 2014* (WHS Mining Regulation).

The Extraction Plans required under the terms of the Recommended Consent Conditions must be prepared in consultation with the Resources Regulator which also administers the WHS Mining Regulation. Extraction Plans must be approved by the Secretary of DPIE prior to the works covered by those Plans being undertaken. In practice, there is a close alignment between Extraction Plans prepared in accordance with the development consent and Subsidence Principal Hazard Management Plans.

In addition to the above the Ground and Strata Failure Hazard Principal Hazard Management Plan will also include specific procedures related to pillar design and strata control which are relevant to the long term stability of pillars such as proposed for the Wongawilli Seam. The Ground and Strata Failure Hazard Principal Hazard Management Plan will also include underground monitoring processes, including those discussed in **Appendix D**.

The efficacy of the WHS Mining Regulation process in managing subsidence related risks is emphasised in the Resources Regulator Letter of 16 October to the IPC which provides:

> *I confirm that the Resources Regulator's position remains that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the proponent to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.*
>
> *…*
>
> *Further, it is our view that the NSW work, health and safety laws can be appropriately applied to manage risks to the health and safety of workers and other persons to deal with the above identified risks. In this respect, clause 24 of the Work Health and Safety (Mine and Petroleum Sites) Regulation 2014 reference to clause 3C(d) of Schedule 1, of the Regulation and requires the development of a principal hazard management plan in relation to subsidence. Notably, the subsidence PHMP requires consideration of the following when developing the control measures to manage the risks of subsidence:*
>
>> *"the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings"*

The views of the Resources Regulator are also supported by the IAPUM Advice response to Question 4 where it provides:

> *[T]he Panel agrees with the Regulator that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the applicant to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.*
>
> *Further, the Panel supports the Regulator in its view that work health and safety laws can be appropriately applied through, int this matter, the development of a principal hazard management plan for subsidence.*

3.2 Proposed Monitoring and Management Measures

The Response to Second PAC Review Report (Umwelt 2019a) and Response to Submissions Reports A and B (Umwelt 2019c and 2019d) include a comprehensive suite of proposed monitoring and management commitments and strategies.

3.2.1 Subsidence Monitoring

Appendix D provides a summary of proposed subsidence monitoring to be undertaken as part of the Project prepared by SCT and includes the following:

- a description of the ongoing subsidence monitoring program within Wonga East (RVE) area.
- a description of the proposed subsidence monitoring program for the UEP.
- a description of any additional subsidence monitoring that may be required in order to identify and differentiate any additional subsidence from Bulli Seam goaf areas from impacts associated with the UEP.
- plans showing the location of monitoring and, as relevant, key features such as the seven Bulli Seam goaf areas yet to be confirmed as collapsed.
- a description of the process for confirming the status of the Bulli Seam goaf areas yet to be confirmed as subsided (noting specifically that this is an existing risk not related to, or exacerbated, by the project).
- a description of any specific subsidence management measures to be implemented for the UEP.
- a description of the process for reviewing and validating subsidence predictions.

Additional monitoring of groundwater, surface water, and biodiversity values and well as targeted monitoring of cliff lines and other sensitive features will be detailed in specific management plans developed for these matters as part of both the extraction plans and general operations.

3.2.2 Subsidence Management

Specific management plans will be developed or existing plans updated to cover the proposed operations. Compliance with these management plans is a requirement under the development consent or WHS Mining Regulation. The existing Subsidence Management developed and approved for Longwall 6 will be applied to the remaining extraction associated with the removal of the longwall miner.

Extraction plans required under the development consent and managements plans required under the WHS Regulations will be developed for specific areas or panels of proposed first workings. These Extraction Plans, Subsidence Principal Hazard Management Plans and Ground and Strata Failure Hazard Principal Hazard Management Plans will include further details regarding:

- key risks associated with the mining of the specific are covered by the plan
- the specific monitoring to be undertaken for the first workings extraction areas covered by the management plan.
- management measures to be implemented through design features (e.g. pillar design)
- adaptive management measures to be implemented, and
- Trigger Action Response Plans related to the management of specific impacts or potential impacts which are identified through monitoring.

Under the proposed wording of the Recommended Consent Conditions, works requiring an extraction plan cannot be carried out unless the relevant plan is approved by the Secretary for the DPIE.

The Extraction Plan(s) and Subsidence Principal Hazard Management Plan(s) developed for the first workings potentially affecting swamps CCUS1, CCUS6, CCUS20 and CCUS21 will have specific regard to any updated subsidence, groundwater and swamp monitoring in the development of the mine plan below and in the vicinity of these swamps. The mine plan and monitoring in these areas will require careful consideration of cumulative impacts on these swamps and the potential for tensile strains to exceed thresholds that may present a risk to these swamps.

As recommended by the Resources Regulator in its letter of 16 October 2020, initial mining operations will also commence in panels to the west of the Mt Ousley Road to enable further investigation of marginally stable pillars to the east of Mount Ousley Road and any mine design or other considerations required to mitigate potential impacts to surface infrastructure (discussed in **Section 2.1.1**). The management of risks associated with these marginally stable pillars will be contained in the Extractions Plans, Subsidence Principal Hazard Management Plans and Ground and Strata Failure Hazard Principal Hazard Management Plan developed for the proposed mining in areas where these marginally stable pillars are contained.

As highlighted by the IAPUM Advice:

> *Bord and pillar mining as proposed in the Wongawilli Seam offers many advantages in these types of situations because it is flexible and amenable to rapid changes in mine layout to respond to changed mining conditions and risk profiles.*

This flexibility is important in that it enables mining operations (and associated economic benefits to the State) to quickly adapt to changed circumstances and continue operations in circumstances that may otherwise cause a suspension of operations for mini-wall or longwall mining operations.

Other management plans covering the broader operations will be developed or updated as necessary. These management plans will be revised periodically in response to annual reviews, TARP triggers and specific changes associated with management measures proposed in the more detailed extraction plans when approved.

4.0 Response to IPC Questions

4.1 Question 1

In terms of the STC report and Dr Hebblewhite's peer review, are the risk and extent of the predicted subsidence impacts in the catchment reasonable? This needs to be considered in two scenarios:

(i) that all the overlying Bulli Seam pillars have collapsed; and

(ii) that some of the pillars have not collapsed.

SCT concurs with the conclusions reached in relation to Question 1, especially given the limited information provided to the IAPUM. As the IAPUM states:

> *There is nothing particularly unique or abnormal about what is being proposed and that has not been done before and, apart from the matters noted already, the SCT report addresses the extent of the impacts adequately.*

4.2 Question 2

Is it likely that the Applicant will be able to develop a Mine Plan and Principal Hazard Management Plan that meets the requirements of the Resources Regulator and limits the level of subsidence to 100mm?

The 100mm limit used in the SCT Subsidence Risk Assessment was intended as a conservative guide to estimating the risk of vertical subsidence causing catastrophic loss of a single swamp and wasn't based on any specific risks to individual swamps. The mine plan has been specifically designed to meet this limit. Notwithstanding, given the experience of the IAPUM in determining swamp impacts, a higher value is accepted as more appropriate to use as a general performance indicator and for the development of Extraction Plans and Principal Hazard Management Plans for subsidence.

Management plans, including Extraction Plan and Principal Hazard Management Plan will be developed based on the specific conditions relevant to the plans including the specific circumstances of individual swamps.

The IAPUM has specifically acknowledged that the proposed pillar mining system is flexible and can be easily modified to respond to changes in loading and other circumstances allowing for more responsive adaptive management systems.

4.3 Question 3

Beyond a 100mm target what is likely to be the worst-case local subsidence scenario if residual pillars in the Bulli Seam collapse?

The SCT Response in **Appendix B** supplements the IAPUM Advice as follows:

> *The IAPUM indicate 1150mm of subsidence may be possible if failure is confined to remnant pillars in the Bulli Seam and, in the very unlikely scenario of pillar failure in the Wongawilli Seam, subsidence of up to 1300mm may be possible.*

The Bulli Seam mining height across most of the Russell Vale East area is approximately 2.2m. On the assumption that there are still standing pillars capable of supporting the 250-300m of overburden strata that would subsequently need to collapse to give rise to surface subsidence, a value of subsidence equal to 1150mm (50% of seam thickness) appears quite high. Even total extraction from longwall mining only causes 55%-65% of mining height. A maximum value of additional subsidence from collapse of standing pillars in Bulli Seam goaf areas is considered likely to be limited to less than 1m and probably significantly less than 1m if the collapse area is narrower than the overburden depth.

It should be recognised that the original figure that forms the basis for Figure 1 presented in the IAPUM report is slightly misleading in that the panel width (W) relates to the width of individual panels. This width is normalised when divided by overburden depth (H). However, the maximum subsidence normalised by dividing by mining height relates to the subsidence across multiple panels of width W, not just a single panel as drawn. It is very unusual to see surface subsidence above a single panel when the panel width is less than one third of overburden depth. The guidelines from the Reynolds Inquiry (Reynolds 1977) take advantage of this geometry to control subsidence below stored waters.

4.4 Question 4

Dr Gang Li has made comments and raised concerns relating to the local subsidence impacts and mine stability due to the possible existence of un-collapsed "marginally stable pillars". Are these concerns adequately addressed by the approach proposed by the Applicant and the guidance given in the Resource Regulator's Letter to Commission from Resources Regulator on 16 October, 2020?

The IAPUM Advice addresses this issue.

The commitment from WCL to commence operations to the west of Mt Ousley Road to enable mine design and management processes to be proven prior to mining below areas of marginally stable pillars is consistent with the recommendation of the Resources Regulator.

4.5 Question 5

We note that the Resources Regulator has recommended that the applicant undertake investigations to identify and define the existence and distribution of any marginally stable pillars in the overlying Bulli Seam. Are there proven non-invasive methods available to determine the subsurface presence of voids either from existing surface access points or from underground prior to development commencing in sections of the mine which may undercut areas identified as 'unconfirmed' with respect to pillars in the Bulli Seam?

The SCT response in **Appendix B** concurs with the IAPUM Advice on this issue. SCT also advise the following:

It would not be practical or necessary to drill holes across the entire area of Bulli Seam goafs. Other methods are likely to be more effective.

Mining conditions in the Wongawilli Seam are expected to provide clearer evidence of the presence of goaf edges in the Balgownie and Bulli Seams above. The presence of standing pillars in the Bulli Seam does not cause a sharp change in vertical stress, whereas mining below a goaf edge does cause a sharp change in vertical stress under the increased abutment loads generated by a large area of extracted pillars. The proposed method of confirming the collapse of pillars in the Bulli Seam from mining conditions encountered in the Wongawilli Seam is considered a practical and robust approach.

4.6 Question 6

To what extent should the status of any voids in sections of the old Bulli workings be determined before mining commences or is it appropriate to do this by measurement (and observation) of abutment stresses once mining commences?

SCT, as part of the preparation of their Subsidence Assessment (SCT2019) which wasn't part of the material provided to the IAPUM, had the opportunity to review detailed mine plans and recording tracings of the Bulli Seam mining and to inspect areas in the Bulli Seam, Balgownie Seam and Wongawilli Seam workings where there is interaction between seams. With the benefit of this additional background knowledge of the site, SCT concurs with the IAPUM assessment and response.

All currently available information indicates that the Bulli Seam goaf areas have almost certainly collapsed. The IAPUM Advice also acknowledges that it would be unlikely for any standing pillars to remain in these areas. Deteriorated mining conditions below the goaf edge when mining in the Wongawilli Seam will provide unequivocal confirmation of this expectation.

4.7 Question 7

Is the claimed stability of the pillars in the current application likely to be realised given the ground conditions expected in the poorer quality coal remaining in the Wongawilli Seam above that part of the Wongawilli Seam that is proposed to be mined?

The IAPUM refers to a description of the Wongawilli Seam roof strata being "weak coal/shale roof in a thick seam environment" (SCT 2019) contrasting with field monitoring data from AMIRA (1995) that supports the finding that Wongawilli Seam pillars are observed to generate confinement consistent with strong roof and floor conditions. This issue was specifically addressed in the updated Subsidence Assessment provided with the Response to Submissions Report B (see SCT, 2019a).

This issue is discussed further in **Appendix B** where it is noted that:

> "these two observations are not in conflict. Field monitoring experience supports the strength of Wongawilli Seam pillars as being consistent with pillars in strong roof and floor conditions despite the roof material comprising "weak coal/shale roof in a thick seam environment".

SCT further note in **Appendix B** in relation to this issue:

> *The stability of the Wongawilli Seam pillars will be critical to the maintenance of productive roadway conditions during mining. The pillars are large enough not to collapse suddenly. Any potential for them to become heavily loaded will become evident through rib and potentially roof deterioration. Such deterioration will significantly impact mining productivity. The mining system is flexible enough to allow modification to the layout as part of the ongoing adaptive mine management system proposed. There will be significant value to the mine in ensuring that pillars do not become heavily loaded and productive mining conditions are maintained.*

4.8 Question 8

Could any of the above matters be reasonably addressed through conditioning, and if so, how?

We note that the IAPUM were not provided with a copy of the Recommended Consent Conditions which include a comprehensive framework around the management of mining operations that have potential to cause subsidence impacts. The approach reflected in the Recommended Consent Conditions are consistent with the approval framework that has been successfully applied to underground mining operations in NSW (including the mining of Longwalls 4, 5 and 6 in the Bulli Seam at Russell Vale Colliery) for over 15 years.

The views expressed by the IAPUM Advice and the Resources Regulator that these matters can be managed through the existing and proposed regulatory framework are supported.

The SCT Advice in **Appendix B** provides further discussion on this point.

5.0 Summary

The Project has been designed to minimise subsidence impacts and the proposed first workings mine plan has had specific regard to the former workings in overlying seams. The SCT Subsidence Assessment (SCT, 2019) prepared for the Project has been prepared based on extensive monitoring data and observations from the Russell Vale Colliery as well as accepted pillar design principals such as the UNSW Pillar Design Methodology (Galvin et al., 1999).

WCL remain committed to the design and implementation of a first workings, long term stable mine plan that meets the performance criteria set out in Condition C1 of the Recommended Consent Conditions. The predicted incremental vertical subsidence impacts associated with the proposed first workings mine plan is up to 100mm (SCT 2019). The IAPUM Advice has provided a slightly more conservative assessment of potential impacts of up to 150 mm of vertical subsidence.

Additional subsidence impacts may be observed over the Bulli Seam goaf areas 8-14 in the unlikely event that standing pillars remain in localised areas in these goaf areas and fail during the life of the Project. Subsidence impacts associated with these pillar failures are assumed to have already occurred and have been factored into cumulative impact assessment considerations. To the extent that this risk is present, it is a pre-existing risk which applies irrespective of whether the Project occurs.

In terms of potential impacts on upland swamps which are present over some areas of the proposed first workings, tensile strains associated with subsidence are identified in the IAPUM Advice as being the key risk in terms of swamp functioning. To date, there is no evidence that historical mining below these swamps has caused any significant harm to the functioning of these swamps. The IAPUM have acknowledged that the incremental tensile strains associated with the proposed first workings (taking into account the predicted full extent of subsidence associated with the mining of the Bulli and Balgownie Seams) are unlikely to result in a catastrophic loss of any swamps, however they have advised that the mine design will need to have specific regard to the pre-existing conditions present at swamps CCUS1, CCUS6, CCUS20 and CCUS21. As also acknowledged in the IAPUM Advice, the flexible nature of bord and pillar mining systems means risks associated with the low level of predicted subsidence can be effectively managed to avoid significant risks, including in areas below the four swamps identified by the IAPUM as having larger pre-existing predicted higher levels of tensile strains and the marginally stable pillars.

The Recommended Consent Conditions (and particularly the requirement for the preparation of Extraction Plans to the satisfaction of the Secretary of DPIE) and the WHS Mining Regulation contain a detailed and proven regulatory process for the management of potential subsidence impacts associated with the Project.

6.0 References

Galvin N., Hebblewhite J.M, and Salamon B.K, M.D.G. 1999. University of New South Wales Pillar Strength Determinations for Australian and South African Conditions. Paper presented at the Second Int. Workshop on Coal Pillar Mechanics and Design., Vail, CO, 6-9 June 1999.

Geoterra/GES, 2020, Russell Vale Colliery Underground Expansion Project Russell Vale East First Workings Groundwater Assessment: Revised Assessment Report", dated 5 February 2020

HydroAlgorithmics Pty Ltd, "Russell Vale Colliery Underground Expansion Project – Groundwater Peer Review", dated 3 February 2020

Hebblewhite Consulting 2019 "Peer Review - Russell Vale Colliery Subsidence Assessment. Report: Supplementary Summary Report", No. 1907/01.2."

Hebblewhite Consulting 2020 "Peer Review - Russell Vale Colliery Assessment of Risk of Pillar Failure. Report No. 2003/03.5."

SCT 2014 "Update of Subsidence Assessment for Wollongong Coal Preferred Project Report Russell Vale No 1 Colliery" SCT Report WCRV4263, 18 June 2014.

SCT 2019. "Russell Vale Colliery: Subsidence Assessment for Proposed Wongawilli Seam at Russel Vale East" SCT Report UMW4609 3 October 2019.

SCT 2020a "IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area" SCT Report WCRV5111 REV4 12 June 2020.

SCT, 2020b Response to Advice from Independent Advisory Panel for Underground Mining, SCT Letter Report WCRV5269 , 30 November 2020.

SCT, 2020c Response to Advice from Independent Advisory Panel for Underground Mining, SCT Letter Report WCRV5269 , 30 November 2020.

APPENDIX A

IAPUM Advice

INDEPENDENT ADVISORY PANEL FOR UNDERGROUND MINING

ADVICE RE:

RUSSELL VALE UNDERGROUND EXPANSION PROJECT

November 2020

EXECUTIVE SUMMARY

On 5 November 2020, the Independent Planning Commission (IPC – the '**Commission**') requested the advice of the Independent Advisory Panel for Underground Mining (IAPUM – the '**Panel**') in relation to predicted surface subsidence for the Russell Vale Underground Expansion Project. The Commission's request was framed in the form of eight questions and supported with relevant reference documents.

The crux of the matter relates to coal pillar system design in a multiseam mining environment and the risk of the catastrophic loss of a swamp presented by vertical surface subsidence. As aspects of the matter are technically complex, the Panel's advice is structured around first presenting some basic geotechnical principles relevant to understanding the issues. Risk, which is a combined measure of the consequences of an event and the likelihood that the event will occur, is then evaluated by considering each of these components separately and drawing conclusions. This approach informs the Panel's answers to the Commission's questions that conclude this advice.

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1. INTRODUCTION AND SCOPE OF WORKS

On 5 November 2020, the Independent Planning Commission (IPC – the '**Commission**') requested the advice of the Independent Advisory Panel for Underground Mining (IAPUM – the '**Panel**') in relation to predicted surface subsidence for the Russell Vale Underground Expansion Project. The Commission's request was framed in the form of eight questions and supported with the following documents:

1. Applicant's response to the advice, dated 15 June 2020, of the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development Advice (IESC)
2. SCT Report, dated 14 January 2020, titled IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area. SCT Report No: WCRV5111 (SCT, 2020a)
3. Dr Hebblewhite's Peer Review Report, dated 7 April 2020, of SCT's 14 January 2020 report, (Hebblewhite Consulting, 2020a)
4. SCT's finalised report, dated 12 June 2020, titled IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area. SCT Report No: WCRV5111_Rev 4 (SCT, 2020b)
5. Transcript of Verbal Submission by Dr Gang Li to the Commission, dated 13 October 2020; and
6. Resources Regulator's letter to the Commission, dated 16 October 2020.

The crux of the matter relates to coal pillar system design in a multiseam mining environment and the risk of the catastrophic loss of a swamp presented by vertical surface subsidence. Dr Ann Young and Em. Professor Jim Galvin have expertise in these areas and have prepared this advice.

Dr Young is a geomorphologist and environmental scientist with more than 40 years experience in sandstone terrain, with particular emphasis on upland swamps. She is author/co-author of books on sandstone landforms worldwide, Australian soils, environmental impact in Australia and upland swamps in the Sydney region. Dr Young has contributed to several public inquiries on mining in the Southern Coalfield and was peer reviewer for the 2014 Commonwealth Independent Expert Scientific Committee Report on Temperate Highland Peat Swamps on Sandstone.

Professor Galvin has some 45 years international experience in mining and geotechnical engineering that includes research and practical mining experience in multiseam mining, coal pillar design and subsidence engineering. He is one of the two principal developers of the internationally recognised UNSW coal pillar strength formulations (Salamon et al., 1996) that form the basis of the UNSW Pillar Design Methodology (Galvin et al., 1999) and to which some of the Commission's questions relate. Professor Galvin is familiar with Russell Vale from visiting it a number of times during his career and as a member of the Planning Assessment Commission Panel for the Russell Vale Colliery PAC determination for Preliminary Works Project – Commencement of Longwall 6 (MP 10_0046 MOD 2) (DoP, 2014).

This advice is structured around first presenting some basic geotechnical principles relevant to understanding the Panel's advice. Risk, which is a combined measure of the consequences of an event and the likelihood that the event will occur, is then evaluated by considering each of these components separately and drawing conclusions which inform the answers to the Commission's questions that conclude this advice.

Aspects of the matter are technically complex and the documentation provided to the Panel does not include a detailed account of all of these and how they have been addressed by the Applicant. Due to the short timeframe allocated to provide this advice, the Panel has been constrained in making further inquiries of stakeholders and sourcing additional information, which it would normally do. Nevertheless, the Panel considers that it is unlikely that additional information would impact materially on its responses to the questions posed by the IPC.

2. BASIC PRINCIPLES

2.1. PILLAR STABILITY

The Russell Vale Underground Expansion Project is premised on conducting bord and pillar mining in the Wongawilli Seam beneath existing bord and pillar and pillar extraction workings in the Bulli Seam and beneath longwall panels in some areas of the Balgownie Seam, some 5 to 10 m below the Bulli Seam and 20 m above the Wongawilli Seam. The stability of bord and pillar layouts is determined by the strength of the coal pillars left to support the superincumbent strata and the load (stress) acting on the coal pillars. The ratio of these two parameters is defined as the 'Factor of Safety'.

$$Factor\ of\ Safety = \frac{Pillar\ strength}{Pillar\ working\ stress}$$

The strength of the pillars is determined by five primary components which collectively constitute the 'pillar system'. These are:

- the in-seam element, which is generally referred to as 'the coal pillar';
- the pillar/roof interface(s);
- the immediate roof strata (typically within 10 m);
- the pillar/floor interface(s), and
- the immediate floor strata (typically within 10 m).

The interaction between these five components can be complex and require numerical analysis to assess, especially if the immediate floor and roof strata are not competent and homogenous. The bearing capacities of the immediate roof and floor strata must be sufficient to sustain the load acting through a coal pillar in order for the coal pillar to reach its maximum load carrying capacity. Low friction and/or cohesion interfaces in these strata can act as slip surfaces for the coal pillar to expand laterally and fail in tension rather than loading up in compression. Since the tensile strength of rock is typically 10 to 30 times less than its compressive strength, this behaviour can also result in a significant reduction in the load carrying capacity and stability of the pillar system.

Calculation of the pillar working stress is also complex and usually requires the use of analytical and/or numerical techniques. This is because the working stress acting on a pillar is a function of both the stiffness[1] of the coal pillar and the stiffness of the surrounding strata. Both of these are a function of elastic modulus of the rock mass, which cannot be changed, and geometry, which can be varied as part of mine design.

Against this background, uncertainty is associated with both the estimation of the strength of a coal pillar system and the estimation of the load acting on the coal pillar system. Consequently, this uncertainty flows through to the calculation of the factor of safety and the reliance that can be placed on this parameter. Two designs with the same factor of safety can have very different stability risk profiles, and conversely, two designs with the same risk profile can have very different factors of safety.

Two design approaches have been developed which allow this uncertainty to be quantified but, importantly, only for specific circumstances. These are founded on the power coal pillar strength formulation developed by Salamon & Munro (1966, 1967) on the basis of a South African database and

[1] Stiffness is the engineering term used to describe the relationship between load and displacement. It is a measure of the 'springiness' of the structure being loaded (Galvin, 2016).

its extension by Salamon et al. (1996) on the basis of an Australia database to produce both a power coal pillar strength formula and a linear coal pillar strength formula.[2]

The documentation under review relies on the application of the power pillar strength formula developed by Salamon et al. (1996), which has come to be known as the 'UNSW power pillar strength formula'. This formula is founded on a statistical analysis of both failed and unfailed coal pillar layouts (using the maximum likelihood method) for circumstances where the load acting on the pillars could be estimated with a relatively high degree of confidence and where case studies were confined to situations in which instability could be attributed to failure of the coal pillar element of the pillar system; that is, where the roof and strata were competent and unaffected by natural or mining-induced structural disturbances and not the initiating cause of the instability.

On the basis that the load acting on a pillar system at the time of failure was known reasonably accurately, geomechanically-based pillar strength formulations that gave the closest fit to the known pillar failure loads could be derived statistically. This approach also enabled the reliability of the (three) formulations to be quantified by correlating factor of safety with field performance, as shown in Table 1 for the two UNSW formulations.

Table 1: Statistical confidence levels associated with UNSW pillar design formulae (Galvin, 2016).

Probability of Failure	**Safety Factor**	
	UNSW Linear Formula	**UNSW Power Formulae**
8 in 10	0.84	0.87
5 in 10	1.00	1.00
1 in 10	1.30	1.22
5 in 100	1.40	1.30
2 in 100	1.53	1.38
1 in 100	1.62	1.44
1 in 1 000	1.85	1.63
1 in 10 000	2.09	1.79
1 in 100 000	2.42	1.95
1 in 1 000 000	2.68	2.11

Of particular relevance to this matter is that the approaches of Salamon and Munro (1967) and Salamon et al. (1996) do not predict the probability of stability on an annualised basis. Salamon et al. (1996) noted that:

> *In this and some previous publications on the matter (Salamon and Munro, 1967, 1966), the importance of pillar life was bypassed. This was achieved by the introducing (sic) a minimum period that must elapse before a layout is declared 'unfailed'. This approach recognises by implication that some of the unfailed cases will collapse in due course. This problem cannot be avoided altogether. No respectable pillar design method can guarantee permanent pillar stability.*[3]

[2] The terms 'power' and 'linear' refer to the manner in which the effect of pillar width-to-height ratio on pillar strength is taken into account in a pillar strength formulation.
[3] Page 58, Salamon et al (1996)

These basic principles are relevant to the Russell Vale Underground Extension Project because the confidence that can be placed in the factors of safety and the corresponding probabilities of instability depends both on the accuracy of pillar load predictions and on the coal pillar element being the weakest element of the coal pillar system. Furthermore, the probabilities of instability cannot be equated to annualised probabilities, which was the form adopted in the IESC advice.

2.2. SURFACE SUBSIDENCE

As the width, W, of an excavation increases relative to its depth, H, below surface, the stiffness of the superincumbent strata progressively reduces and the strata sags into the excavation to result in increasing surface subsidence. This is illustrated in Figure 1. At the relatively shallow depths associated with Russell Vale Colliery, this process involves the immediate roof caving into the mine workings, with bulking of the fallen material causing the cave to ultimately choke and so limit the height of caving into the roof. The remaining overburden fractures and sags, decreasing in severity with distance above the excavation, and ultimately reporting as vertical subsidence of the surface (surface subsidence).

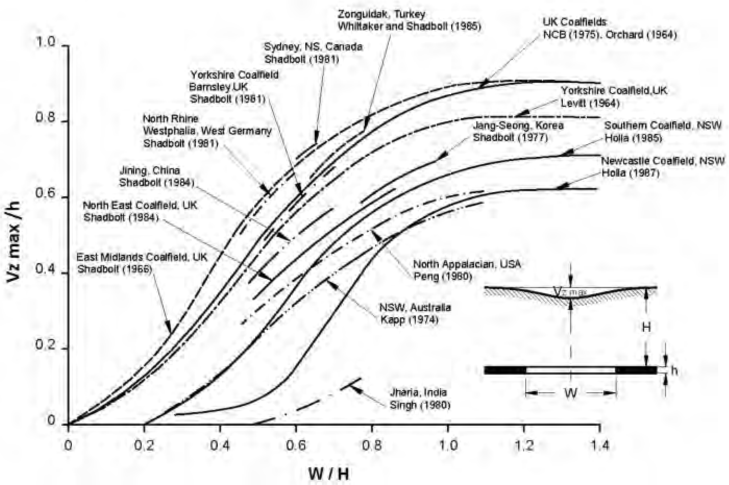

Figure 1: Influence of extraction panel width-to-depth ratio, W/H, on maximum vertical surface displacement, $V_{z\,max}$, expressed as a fraction of mining height, h, for isolated total extraction panels (adapted by Galvin (2016) from Whittaker and Reddish (1989)).

For all other factors remaining constant, the magnitude of vertical surface subsidence in a single seam mine depends on the mining method. Bord and pillar workings (as proposed in the Wongawilli Seam) cause the least amount of subsidence because the percentage areal extraction associated with them is least and because, unless the failed coal pillars have a small width-to-height ratio, they do not uniformly ‘flow’ into the roadways but retain a core which provides ongoing resistance against subsidence. Pillar extraction workings (which already exist in the Bulli Seam) result in more subsidence because the percentage areal extraction is much higher. However, although this mining method is classified as a ‘total extraction’ method, it usually results in coal being left in the goaf in a variety of forms of remnant pillars and as broken coal on the ground and this unrecovered coal impedes subsidence. Longwall mining achieves total extraction in the mining horizon and, consequently, results in the greatest subsidence.

In many coal mining countries, including Australia, maximum vertical subsidence at the surface arising from the total extraction of a single seam is typically of the order of 50 to 65% of the extracted height. Of importance in this matter, however, is that extraction of subsequent seams results in proportionally greater subsidence, variously reported to be of the order of 90 to 100% of the incremental extracted height (Galvin (1981), Schumann (1993), Li et al. (2010) and others). This is believed to be due to either or both enhanced caving of the superincumbent strata of the second seam extracted and reconsolidation of the goaf of the first seam extracted.

These basic principles are relevant to the Russell Vale Underground Extension Project in respect of the coal pillar loads used in the design of the Wongawilli Seam workings; surface subsidence predictions should the proposed bord and pillar workings in the Wongawilli Seam become unstable; and Dr Gang Li's concerns as to the state of stability of existing workings in the Bulli Seam and the potential for vertical surface subsidence to be more than predicted.

2.3. STRESS DISTRIBUTION IN MULTISEAM WORKINGS

At low values of mining panel width-to-depth ratio, W/H, a large proportion of the overburden bridges across the excavation even though the immediate roof may have fallen and resulted in the workings becoming choked off. This results in a large component of the weight of the undermined overburden being transferred to the abutments of the panel, thus generating what is referred to as 'abutment load' or 'abutment stress'. As panel width-to-depth ratio continues to be increased, a point is ultimately reached where the overburden stiffness reduces to zero and the full weight of overburden strata above the centre of the panel once again acts on the floor of the excavation. However, because the overburden does not cave vertically around the abutments of the panel but rather cantilevers out over the panel, the panel abutments are still subjected to elevated levels of stress. These elevated stress levels extend down into the floor strata. Two potential implications of this for the stability of underlying workings are that 1) the roof of the underlying workings could be fractured, and 2) the load acting on the pillars in the underlying workings could be variable, depending on their location relative to the workings in overlying seam(s).

Reasons for these basic principles being relevant to the Russell Vale Underground Extension Project include that SCT (2020b) reports that elevated stress levels are evident in the Wongawilli Seam due to past pillar extraction workings in the Bulli Seam, *'with roadway conditions observed to deteriorate significantly in these areas indicating that abutment loads are present adjacent to the goaf edge'*.[4] SCT proposes that these conditions can be used to determine whether pillars in the Bulli Seam have already failed. The proposed mine layout in the Wongawilli Seam is based on reducing pillar size under the goaves of total extraction panels in the Balgownie Seam, on the basis that vertical load at floor level in this upper seam is less than full overburden load.

[4] SCT (2020b), page 8

3. ADVICES OF OTHERS

The documentation provided to the Panel and the IPC's questions are primarily concerned with matters arising out of advices provided to the IPC by the IESC and by the Principal Subsidence Engineer for the Resources Regulator.

3.1. IESC ADVICE

The Panel has had regard to the advice provided to the Department by the IESC because the two SCT reports provided as reference documents for preparing this advice (SCT, 2020a, 2020b) and the peer reviews of both these reports (Hebblewhite Consulting, 2020a, 2020b) were prepared in an endeavour to satisfy that advice. Elements of the IESC's advice that are of particular relevance in this matter (extracted from the Applicant's response to the IESC's advice) are:

> *The IESC November Advice notes that WCL's Revised Preferred Project Report states that there is a "negligible risk" of pillar failure, but that this risk has not quantitatively assessed the residual risks.*
>
> *The IESC November Advice states that if the likelihood of pillar failure is "extremely rare" (less than 0.01% per year in accordance with the Australia Institute for Disaster Resilience Guideline (2015) and does not result in the catastrophic loss of a single swamp, then the IESC would not regard this proposal as being of material concern.*
>
> *The IESC November Advice notes that the legacy mining environment requires a quantitative assessment of the risks of pillar failure that is independently reviewed by a recognised expert in multi-seam geomechanical stability. The assessment should include an empirical analysis of mining failures in the area since the 1880s and should recognise the risks posed by mining a third seam under the already mined Bulli and Balgownie seams. The assessment should also quantify the potential magnitude and extent of impacts to water resources should these pillars be destabilised by the project. Without such an assessment, a "negligible risk" cannot be fully ascribed.*
>
> *The IESC November Advice states that "negligible risk" is expected that [sic] the likelihood of pillar failure is less than 0.01% per year in accordance with the Australia Institute for Disaster Resilience Guideline (2015).*

The intent of the IESC advice is sound but the manner in which the IESC proposes that it is addressed is not practically achievable and does not fully reflect contemporary principles of subsidence engineering and stability assessment. This has complicated the assessment of what is already a complex matter from a subsidence engineering perspective. Further complexity is added by the manner in which SCT (2020b) has attempted to address the issues raised by the IESC and this is reflected in some of the IPC's questions. Consistent with risk management principles, the IESC's advice has two components; one focused on consequence of coal pillar system failure and the other on likelihood of coal pillar system failure. The Panel has addressed the IESC advice and other matters relevant to answering the Commission's question by considering each of these components in turn in the next two chapters.

3.2. PRINCIPAL SUBSIDENCE ENGINEER'S CONCERNS

In his oral presentation to the IPC on 13 October 2020, Dr Gang Li, Principal Subsidence Engineer for the Resource Regulator, expressed concern that first workings in the Wongawilli Seam could cause instability of any areas of standing pillars in the Bulli Seam and that the presence of any such workings needed to be confirmed ahead of mining. Dr Li referred to subsidence measurements over LW 4 and LW 5 in the Wongawilli Seam that he considered to be substantially higher than predicted. He interpreted this as a strong indication that there had been standing pillars and open voids in the overlying Bulli Seam workings.

4. CONSEQUENCE OF SURFACE 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.

This concept has supported a change in approach to mine approvals in that the focus is no longer on the accuracy of predictions of subsidence effects but rather on designating acceptable subsidence impacts.

In this matter, vertical surface subsidence and ground strain induced by curvature of the ground surface as it subsides into the subsidence trough are 'subsidence effects'. Cracking beneath swamps is a 'subsidence impact', while changes in soil moisture content and species composition in swamps are 'subsidence consequences'.

The IESC has not defined what constitutes *'catastrophic loss of a single swamp'*. Based on experience in the Sydney Basin Biogeographic Region, the Panel associates catastrophic loss with a reduction in the capacity for a swamp to retain its water table and soil moisture that is so severe as to cause the swamp flora species to be replaced by species representative of dry heath or woodland. This process is exacerbated by bushfires since dry swamps and their organic-rich sediments are susceptible to very hot burns, as evident by the fires in the Western Coalfield late last year (see, for example Keith et al. (2020)). The Panel is not aware of this degree of consequence having been experienced over the workings of Russell Vale Colliery in the more than 130 years that the mine has been in operation.

Rather, it appears that in the area of this proposal (the Wonga East area of Russell Vale Colliery), mining operations in the Bulli and Balgownie Seams have not resulted to date in adverse consequences for swamps that can be linked unequivocally to mining impacts. Three reasons postulated for this outcome in previous approval processes (e.g. DoP (2014)) are:

1. The magnitude of the subsidence impacts, principally tensile cracking, are not sufficient to cause a significant change in swamp moisture content.
2. Loss of swamp water through tensile cracks is compensated for by (high) rainfall on the escarpment.
3. If the swamps have had vertical drainage increased due to undermining, the mix of flora species in the swamps has changed over the decades to adapt to the modified soil moisture conditions and gone unnoticed due to a lack of monitoring; the sub-communities may have altered (for example, from cyperoid heath to banksia thicket) but still are within the Coastal Upland Swamp Ecological Community.

In endeavouring to address the IESC's advice, SCT (SCT, 2020b) has advised that:

> *'SCT has expertise in assessing pillar stability and potential; for surface subsidence but does not have expertise in assessing factors that affect the health of swamps. Our quantitative assessment assumes subsidence of less than about 100mm would not cause catastrophic loss of any swamp. In the probability assessment, 1 in 100 swamps subject to 100mm of subsidence are assumed to suffer catastrophic loss. We understand from discussion with experts on swamp impacts and experience of historic mining below swamps in the Southern Coalfield that these assumptions are conservative.'*[5]

Hence, SCT's assessment of risk is based on both an assumed correlation between a subsidence effect (100 mm of vertical subsidence) and a subsidence consequence of catastrophic proportions and on an assumed probability of the number of times this amount of vertical subsidence will result in the catastrophic outcome. The Panel assumes that SCT's selection of 100 mm of vertical subsidence is based on this being about the maximum level of vertical subsidence that SCT predicts will result from a stable bord and pillar layout in the Wongawilli Seam.

A limitation with the SCT approach is that subsidence consequences are a function of cumulative subsidence effects and not incremental increases in subsidence effects. In this case, the consequences of a 100 mm increase in vertical subsidence can be expected at some stage to be relative to how much vertical subsidence has already occurred.

In order to assess the implications of the SCT approach to endeavouring to conform to the advice of IESC, the Panel has had regard to subsidence effects associated with multiseam mining in the past at Russell Vale Colliery.[6] Figure 2 shows the location and nature of workings in each of the three seams extracted to date and Figure 3 shows the location of overlying swamps. The following summary characterises these mining operations. Because monitoring was very limited at the time of extracting the top two seams, subsidence effects due to mining in these seams can only be estimated and there is variability in estimates between the various reports that contain this information.

- Bulli Seam: Bord and pillar first workings and extensive secondary pillar extraction in the period circa 1890 to 1950. Typical extraction height 2.2 m. Estimated maximum vertical subsidence of 1 m.
- Balgownie Seam: Located some 5 to 10 m below the Bulli Seam. Longwall mining circa 1970 to 1982. Typical extraction height 1.5 m. Estimates of maximum vertical subsidence range up to 1 m.
- Wongawilli Seam: Located some 20 m below the Balgownie Seam. Longwall mining in area of interest undertaken 2012 to 2014 and confined to the extraction of longwall panels LW 4, LW 5 and LW 6. Extraction height 2.4 m but could be up to 2.8 m. Predictions of subsidence effects for these three panels and measurements of these effects at the time that LW5 was still being extracted are recorded in Table 2.

[5] Page 2 of (SCT, 2020b)
[6] Some of this information was produced during the PAC's 2014 determination in regard to LW6 at Russell Vale (DoP, 2014)

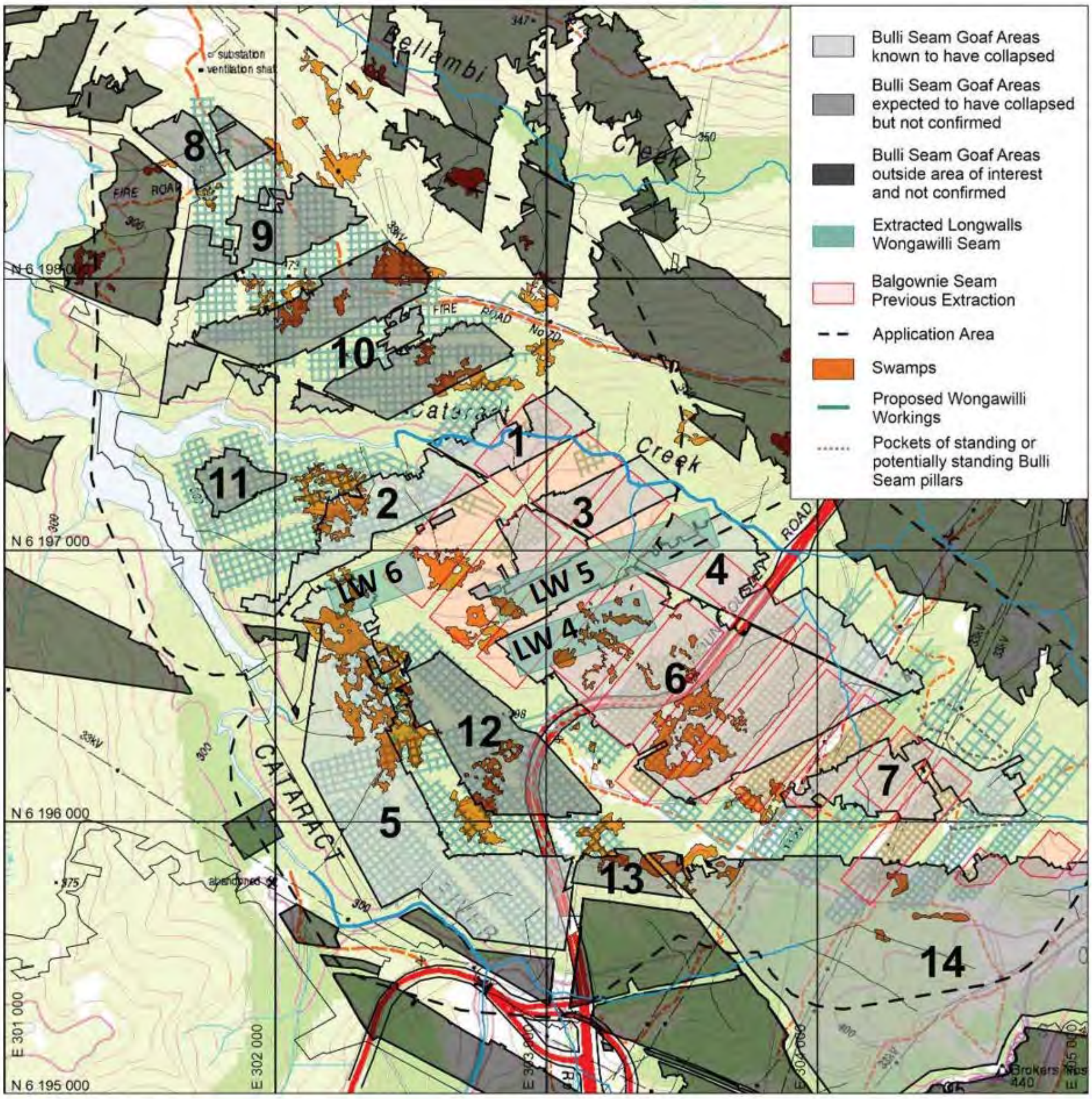

Figure 1: Plan showing location of swamps and proposed first workings in the Wongawilli Seam relative to previous secondary extraction in Bulli Seam (Grey), Balgownie Seam (Red) and Wongawilli Seam (Dark Green).

Figure 2: Location and nature of workings in each of the three seams at Russell Vale, sourced from SCT (2020b) and annotated to identify longwall panel numbers in the Wongawilli Seam.

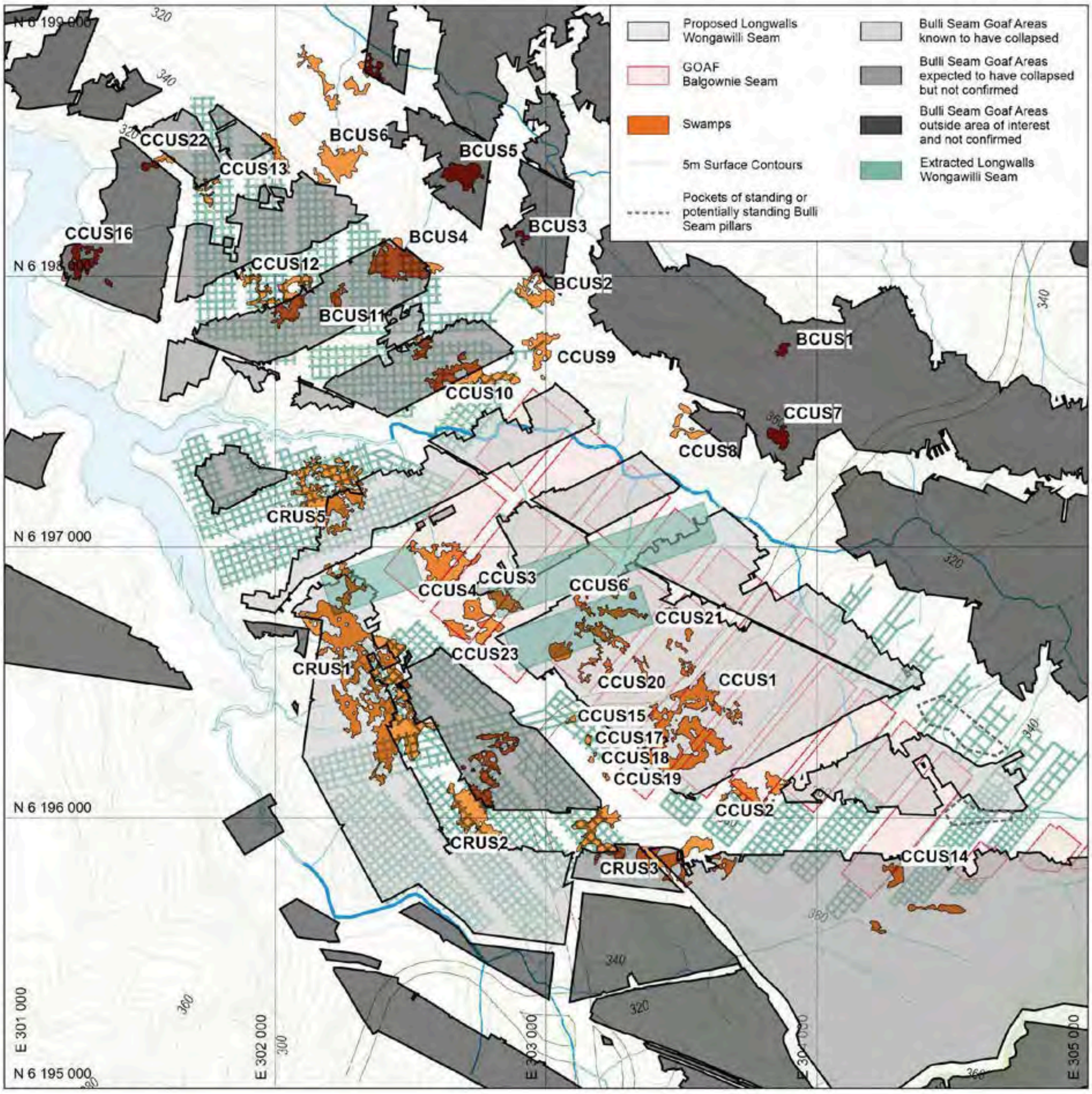

Figure 3: Identification and location of swamps in area of interest (SCT, 2020b) .

Table 2: Estimates of cumulative subsidence effects due to mining operations in the Bulli and Balgownie Seams and predicted (and some measured) subsidence effects associated with extracting LW 4, LW 5 and LW 6 in the Wongawilli Seam (AECOM, 2014).

Table 2 – Predicted Subsidence for the Russell Vale Colliery Underground Expansion Project (LW4, LW5 and LW6)

Subsidence Parameter	Long Wall Panel		
	[illegible]	[illegible]	[illegible]
Overburden depth to Wongawilli Seam (m)	300	265	285
Previous Bulli and Balgownie Seam subsidence (m)	1.9	0.9	1.5
Predicted subsidence for Wongawilli Seam (measured data) (m)	2.1 (1.6)	1.9 (1.5*)	2.1
Predicted tilt for Wongawilli Seam and (measured data) (mm/m)	35 (30)	36 (16*)	38
Predicted tensile strain for Wongawilli Seam and (measured data) (mm/m)	10.5 (7.5)	10.8 (4.5*)	11
Predicted compressive strain for Wongawilli Seam and (measured data) (mm/m)	21 (14)	22 (14*)	23
Predicted maximum closure on Cataract Creek (Southern Tributary) (mm)	N/A	210 (20*)	400

*Mining in progress at the time of the assessment (SCT, 2013)

Table 3 records estimated cumulative effects at specific swamps due to past mining in the Bulli and Balgownie Seams. Together, Table 2 and Table 3 provide a basis for assessing SCT's assumptions that subsidence of less than about 100 mm would not cause catastrophic loss of any swamp[7] and that 1 in 100 swamps subject to 100 mm of subsidence will suffer catastrophic loss.

Table 3: Estimated cumulative subsidence effects at specific swamps (SCT, 2014).

Cumulative Subsidence at the Completion of Bulli and Balgownie Seam Mining

Swamp	Subsidence Used (m)	Overburden Depth (m)	Max Tensile Strain (mm/m)	Max Comp Strain (mm/m)	Max Tilt (mm/m)
CCUS1	2	285	10.5	21.1	35
CCUS2	1.1	285	5.8	11.6	19
CCUS3	1.1	300	5.5	11.0	18
CCUS4	0.9	290	4.7	9.3	16
CCUS5	0.6	272	3.3	6.6	11
CCUS6	2	285	10.5	21.1	35
CCUS7	1	270	5.6	11.1	19
CCUS8	0.1	270	0.6	1.1	2
CCUS9	0.1	293	0.5	1.0	2
CCUS10	0.6	280	3.2	6.4	11
CCUS11	1	340	4.4	8.8	15
CCUS12	0.5	355	2.1	4.2	7
CCUS13	0.1	335	0.4	0.9	1
CCUS14	1.2	275	6.5	13.1	22
CCUS15	0.2	325	0.9	1.8	3
CCUS16	0.5	300	2.5	5.0	8
CCUS17	0.1	325	0.5	0.9	2
CCUS18	0.1	325	0.5	0.9	2
CCUS19	0.1	325	0.5	0.9	2
CCUS20	2	290	10.3	20.7	34
CCUS21	2	280	10.7	21.4	36
CCUS22	0.5	317	2.4	4.7	8
CCUS23	0.9	310	4.4	8.7	15
CRUS1	0.5	300	2.5	5.0	8
CRUS2	0.6	210	4.3	8.6	14
CRUS3	0.6	295	3.1	6.1	10
BCUS1	1	270	5.6	11.1	19
BCUS2	0.5	285	2.6	5.3	9
BCUS3	0.5	265	2.8	5.7	9
BCUS4	0.6	295	3.1	6.1	10
BCUS5	0.5	273	2.7	5.5	9
BCUS6	0.1	308	0.5	1.0	2
BCUS11	0.5	335	2.2	4.5	7

[7] SCT (2020b) states that '*the probability of a swamp being catastrophically impacted by subsidence of 100 mm is considered very low given that these swamps have all been subsided by Balgownie Seam and Bulli Seam mining by more than 1m and up to 3.7m*'. The figure of 3.7 m corresponds to maximum subsidence after the extraction of the Wongawilli Seam. Presumably, 3.7 m should read 2m.

It is common in subsidence engineering to associate the onset of tensile cracking with a tensile strain of 0.5 mm/m. Once fractures are initiated, further extension of the ground surface tends to be concentrated at these fracture sites. That is, strain is no longer uniformly distributed. In virgin conditions, the impact of a tensile strain of 0.5 mm/m is most likely to result in a hairline fracture, in which case it is of little consequence to the integrity of an overlying swamp. Thereafter, incremental strain is most likely to cause existing cracks to become wider and deeper, until a tipping point is reached where the width and depth of the crack/s (the subsidence impact) have serious negative consequences for the moisture retaining capacity of that portion of a swamp overlying the fracture/s.

It can be concluded from both predicted and measured vertical subsidence and tensile strain values recorded in Table 2 and Table 3 that in the case of longwall mining in the Wongawilli Seam, 100 mm of incremental vertical subsidence resulted in an incremental increase in maximum tensile strain of around 0.5 mm/m. The database concerning surface subsidence behaviour above bord and pillar workings comprised of high width-to-height ratio coal pillars, as now proposed for the Wongawilli Seam, is very limited and the corresponding maximum tensile strain induced by a 100 mm increment in those circumstances in unknown but likely to be less than for longwall mining. The Panel's advice is based on assuming that 100 mm of vertical surface subsidence induced by bord and pillar workings in the Wongawilli Seam will cause around a 0.5mm/m increase in tensile strain. It should be confirmed by a subsidence prediction specialist that it is at least conservative (that is, it overpredicts rather than underpredicts tensile strain).

Insight into the significance on the integrity of the swamps overlying Russell Vale Colliery of an increase in tensile strain of 0.5 mm/m can be gauged from Table 3, which is based on the assumption that there are no pockets of marginally stable pillars still standing in the Bulli Seam goaves. The table shows that the estimated cumulative tensile strains due to workings in both the Bulli Seam and the Balgownie Seam range from 0.4 mm/m to 10.7 mm/m, with 17 of the 33 swamps estimated to have experienced more than 3 mm/m tensile strain, and with 4 of these estimated to have experience more than 10 mm/m tensile strain. As there are no reports of subsidence having had negative consequences for any of these swamps, it seems implausible that an incremental strain of only 0.5 mm/m could initiate a catastrophic loss of a swamp. The tabulated results suggest that, based on site specific historical performance, at least two-thirds of the swamps could still tolerate ten times this much incremental strain without suffering negative consequences other than possibly a change in species mix, which cannot be excluded from having occurred in the past.

It is concluded that:

- even allowing for those swamps overlying goaves where it is yet to be 'proven' that vertical subsidence has not been impeded by marginally stable pillars and, therefore, would be less than estimated in Table 3, the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible. (It could be helpful and improve confidence in impact predictions for swamps if SCT, as the originators of Table 3, were to reproduce it having regard to the location of areas where vertical displacement would be less than estimated if there are still standing pillars in the Bulli Seam goaves.)
- based on historical performance, the failure of standing pillars in the Bulli Seam is extremely unlikely to result in catastrophic loss of a swamp (noting that the values for these swamps in Table 3 would need to be reduced accordingly if they are in fact located over pillars that are still standing).
- the additional amount of vertical subsidence that can be tolerated by the four swamps overlying both Bulli Seam workings and Balgownie Seam workings that are estimated to have already experienced around 10.5 mm/m tensile strain is unknown and, therefore, bord and pillar workings in the Wongawilli Seam beneath these areas need to be designed judiciously and conservatively in order to restrict vertical subsidence in the event of them becoming unstable.[8]

[8] It was the high risk of reaching a swamp's tipping point (i.e. the point where the swamp can no longer function effectively as a swamp) due to a predicted incremental increase in tensile strain of 11 mm/m that caused the PAC to limit the extraction of LW 6 in the Wongawilli Seam to the western edge of swamp CCUS4 (DoP, 2014).

5. LIKELIHOOD OF SURFACE SUBSIDENCE

5.1. PILLAR DESIGN FOR WONGAWILLI SEAM

The Applicant's response to the IESC advice relies on the UNSW power pillar strength formulation and the correlation between likelihood of pillar stability and factors of safety for this formulation, shown in Table 1. This approach is premised on the coal pillar being the weakest element in the pillar system and on knowing the pillar load reasonably accurately. In respect of coal pillar strength, SCT (2020b) does not include consideration on the impact that abutment stress may have had on the structural integrity of the roof, coal pillar and floor strata in the Wongawilli Seam. This may have been addressed elsewhere as mine design is not the primary focus of this SCT report. This should be confirmed if reliance is to be placed on the predictions of likelihood of pillar stability when utilizing the UNSW power pillar strength formula.

Additionally, the peer review by Hebblewhite Consulting (2020a) of SCT (2020a) noted that:

> *'SCT makes reference to 1994 work in support of the data presented in Figure 2, showing w/h ratio pillars of 8 and 10 continuing to increase in their load-carrying capacity. Further in support of this position, the statement is made that "pillar behaviour in the Wongawilli Seam is observed to be more consistent with strong roof and floor conditions allowing frictional strength to develop". This may well be the case based on the evidentiary data from 1994, but a further explanation of this claim should be provided here, given that in the 2019 Subsidence Assessment Report, SCT referenced the fact that the Wongawilli Seam roof was not strong. SCT stated in that report: "despite Wongawilli Seam workings being characterised as having a weak coal/shale roof in a thick seam environment …" (SCT 2019, page 22).'* [9]

Subsequently, Hebblewhite Consulting (2020b) concluded that SCT (2020b) has adequately responded to substantive comments. The manner in which the important point noted above has been responded to is not apparent from reading SCT (2020b).

The design of the bord and pillar workings for the Wongawilli Seam has been based on two pillar sizes, which SCT refers to as 30 m pillars and 25 m pillars. 30 m pillars are proposed throughout the Wongawilli Seam other than under the goaves of the longwall panels in the Balgownie Seam and under two small areas of standing pillars in the Bulli Seam, where 25 m pillars are proposed.

SCT's reference to coal pillars as being either 30 m pillars or 25 m pillars (SCT, 2020b) is based on the centre distance between the coal pillars; that is, it is the sum of half the roadway width on one side of a pillar, the actual pillar width and half of the roadway width on the other side of the pillar. Although SCT qualifies this in its report (SCT, 2020b), it is not the form most often used to define pillar width. The peer reviewer made the point that the solid pillars are actually 24.5 m square and 19.5 m square, respectively (Hebblewhite Consulting, 2020a).

The analysis of stability undertaken by SCT for the nominal 24.5 m square and 19.5 m square pillars is based on a maximum overburden depth to the Wongawilli Seam of 380 m. The Panel regards this as a conservative approach since, as reference to Table 2 shows, there are areas where overburden depth is considerably less.

SCT (2020b) reports[10] that the 30 m pillars (i.e. 24.5 m square pillars) have a (UNSW power formula) factor of safety of 2.09 and that this indicates that the probability of failure is less than 1 in 100,000. In fact, as reference to Table 1 shows, the probability of failure is only marginally less than 1 in 1,000,000. However, analysis undertaken by the Panel for 24.5 m wide pillars surrounded by 5.5 m wide roadways

[9] Page 17, last paragraph of peer review report
[10] Page 15

returns a factor of safety of 2.12 and, hence, a probability of failure is actually less than a 1 in 1,000,000 threshold.

While a conservative approach has been taken in basing these calculations of pillar stability on maximum depth of cover load, they do not take account of abutment load around the goaves of pillar extraction workings in the Bulli Seam and longwall panels in the Balgownie Seam. SCT cites visual changes in the condition of workings in the Wongawilli Seam induced by abutment stress as a means of confirming that goaf areas in the Bulli Seam, some 25 to 30 m above, have collapsed. However, no indication of the magnitude of these elevated stresses is given in the documentation under review. Rather than taking the additional pillar loading into account in pillar stability calculations, SCT accounts for it in the following manner:

> *'Pillars in the proposed layout for the Wongawilli Seam have minimum width to height ratios in the range of 8-10. These pillars are large compared to the variations in loading. They are also large enough that although one pillar may become more heavily loaded, their stress-strain characteristic (as shown in Figure 4) allow load to be redistributed to other adjacent pillars without any loss of loading bearing capacity.'*

This approach contrasts with standard approaches to the design of bord and pillar first workings abuting goaves, as reflected for example in Salamon and Oravecz (1976), Galvin and Hebblewhite (1995) and Galvin (2016). Sound bord and pillar design requires explicit and site-specific consideration to pillar loading. The Panel is not aware of whether this is planned to be the case if the Russell Vale Expansion Project is approved.

Additional uncertainty is associated with the 19.5 m square pillars beneath the Balgownie Seam longwall panels. It appears that SCT (2020b) has misreported the loading on these pillars as 6.3 MPa when, based on SCT's assumptions, it is actually of the order of 10.3 MPa. This has not carried over to SCT's calculation of a (UNSW power formula) factor of safety of 2.11, which it reports as a probability of failure of less than 1 in 100,000 when, as reference to Table 1 shows, it also qualifies as a probability of failure of less than 1 in 1,000,000.

The Panel has concerns regarding the loading assumptions on which the SCT stability assessment is based for the 19.5 m square pillars. It appears that pillar width has been reduced under the goaves of the Balgownie Seam longwall panels in the belief that due to the limited width, W, of these panels in comparison to their depth below surface, H, full overburden load is not transferred to the floor of the longwall panels and, hence onto the pillars in the Wongawill Seam. If this is the case, the concept does not appear to have regard to the reduction in the stiffness of the overburden due to caving, fracturing and subsidence and, therefore, its capacity to tranfer load to panel abutments of total extraction workings in the overlying Bulli Seam.

Based on the layout of mine workings shown in Figure 1, the lateral extent (W) of collapsed workings in Area 6 is much greater than their depth below surface (H). Consistent with the subsidence engineering principles shown in Figure 1, the floor of the Bulli Seam over most of Area 6 should therefore be subjected to full cover load. In turn, longwall mining in the Balgownie Seam will result in caving of the 5 to 10 m parting to the floor of the Bulli Seam and, thus, should result in the full cover load being transferred to the floor of the Balgownie Seam. This contrasts with the pillar stability analysis reported by SCT which is based on the pillars in the Wongawilli Seam only having to support some 65% of the overburden load. If the 19.5 m square pillars are subjected to full overburden load, their factor of safety drops to 1.4, corresponding to around a 2 in 100 likelihood of pillar failure, which is some 2000 times greater than for 24.5 m square pillars.

Should the load estimated by SCT for the 19.5 m square pillars turn out to be reasonable, further consideration then needs to be given to the size of these pillars. This is because that portion of the full overburden load that does not act on the floor of the Balgownie Seam workings has had to have been transferred to the panel abutments, including the chain pillars between the Balgownie Seam longwall panels. This increase in abutment stress creates a pressure bulb beneath the chain pillars that extends vertically and laterally into the floor strata, in a similar manner to that which is reported to exist beneath the flanks of the pillar extraction goaves in the Bulli Seam. Reference to Figure 2 shows that the 19.5 m square pillars in the Wongawilli Seam abut the sides of the chain pillars in the Balgownie Seam. Hence, these pillars will be subjected to additional abutment load.

SCT (2020b) goes on to state that:

> *'Allowing for abutment loads from Bulli Seam goafs adjacent to the main heading pillars, the most heavily loaded 25 m [19.5 m square] pillars in the Wongawilli Seam are still not as heavily loaded as their nominal strength.'*

Caution is required with this approach. There is no accurate formula for determining pillar strength. The probabilities of failure correlated in Table 1 are a measure of the reliability of the respective pillar strength formula derived from back-analysis of field performance and only relate to situations where pillar load is known reasonably accurately. They show, for example, that even when pillar load is only 80% of the predicted UNSW power pillar strength (that is, FoS = 1/0.8 = 1.25), nearly 1 in every 10 panels of pillars can be expected to fail.

The preceding discussion leads the Panel to conclude that pillar size should not be reduced from 24.5 m to 19.5 m under longwall panels in the Balgownie Seam unless based on site-specific studies that include reliably estimating pillar load.

5.2. PROBABILITY ASSESSMENT

The IESC advice sets a probability threshold that is expressed in terms of an annualised probability of pillar failure and equated in accordance with the Australian Institute for Disaster Resilience Guideline (2015) (AIDRG) to an event that is 'extremely rare'. SCT (2020b) expresses the view that the approach suggested by the IESC '*appears to be more relevant to recurring human emergencies such as flood risk, rather than the management of one-off environmental risks such as potential subsidence impacts to swamps.*' The peer reviewer recommends that the risk assessment of a pillar design should be based on assessing the likelihood or probability of such a one-off failure within the life cycle of life expectancy of a pillar system and gives an example based on a 20 year life of mine.

In this matter, however, the pillar system is required to remain permanently stable. Its life expectancy is indefinite. Therefore, the Panel considers that the concept of annualised probability is appropriate and notes that it does find application in other facets of geotechnical engineering as reflected, for example, in the Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning developed by the Australian Geomechanics Society (Australian Geomechanics Society, 2007).

However, while the application of annualised probability to coal pillar system stability is appropriate in theory, international attempts to apply it to coal pillar systems have been unsuccessful. This is because the size of the pillar failure database (including the international database) is too small to enable meaningful annualised probabilities to be derived (Galvin (2016)).

The IESC advice also makes reference to undertaking an empirical analysis of mining failures in the Russel Vale area since the 1880s. While this is a sensible approach in theory, it is also not practical to execute. This is because, as is usually the case, records of these types of events were not made and/or retained in the mining industry up until a few decades ago.

SCT have made best endeavours to overcome these limitations by utilising the probabilities of failure derived by Salamon et al. (1996) for the UNSW power pillar strength formula. These probabilities are based on the failure of panels of pillars, and not individual pillars. This has implications for the stability analysis presented in SCT (2020b) and based on the following equation:

$$P = P_{initiating\ event}\ x\ P_{exposure}\ x\ P_{receptor\ affected}$$

In applying this equation, SCT have set the probability of the initiating event to be 1 in 100,000. This was derived from the analysis reviewed in the previous section of this Panel advice. Since this probability relates to the likelihood of the failure of a single panel of pillars, it should more correctly be multiplied by the number of panels that could potentially fail.

Probability of exposure has been calculated on the basis of the proportion of total surface area over pillars of a given width that is occupied by swamps, rather than their location relative to past and proposed mining panels as shown in Figure 3. The SCT approach is effectively an averaging approach since it does not have regard to site-specific factors such as the location of individual swamps relative to profiles of surface subsidence, the physical characteristics of swamps, the amount of subsidence and tensile strain to which they have already been subjected (see Table 3) and to individual vulnerability. As such, the approach is not consistent with a contemporary approach to the risk management of swamps whereby, in these types of circumstances, each swamp would be risk assessed on its own merits. If the probability equation is to be persevered with, it would be more appropriate to assess the probabilities of both the initiating event and exposure on a mining panel by mining panel basis.

The value for the probability of a receptor being affected is based on SCT's assumption that 1 in 100 swamps could be catastrophically impacted by (incremental) vertical displacement of 100 mm. For reasons noted earlier, although conservative, this is not considered realistic.

6. MAGNITUDE OF SURFACE SUBSIDENCE

6.1. SUBSIDENCE CONTRIBUTION FROM BULLI SEAM WORKINGS

The proposed bord and pillar mining in the Wongawilli Seam underlies 14 areas where pillar extraction has been undertaken in the Bulli Seam. SCT (2020b) reports that seven of these areas, numbered 1 to 7 in Figure 2, are confirmed as 'subsided'.[11] It goes on to state that

> *'There is evidence available from subsidence monitoring and observation of roadway conditions in the Wongawilli Seam to confirm seven of these areas have fully collapsed with no potential for further subsidence.'*[12]

Reference to Figure 2 shows that these seven areas have been undermined by longwall mining in the Balgownie Seam, some 5 to 10 m below the Bulli Seam. The Panel interprets the SCT statement to mean that the subsidence measured as a result of longwall mining in the Balgownie Seam confirms that the workings were already in a collapsed state prior to longwall mining in the Balgownie Seam.

The Panel agrees that based on the evidence present in SCT (2020b) and additional information relevant to Dr Li's concerns, the pillar extraction panels in the Bulli Seam had collapsed prior to mining in the Balgownie Seam. However, SCT goes further in stating that the areas have **fully collapsed** with **no potential** for further subsidence. Ground engineering is characterized by pervasive uncertainty and these are bold statements, especially when dealing with caved ground that contains voids and has the potential to undergo further consolidation with the passage of time and mining-induced changes in the stress field.

In relation to the remaining seven areas, SCT states that:

> *'Proposed mining provides the opportunity to confirm the status of the Bulli Seam goaf. Deterioration of roadway conditions consistent with the presence of abutment loading when goaf edges are mined under in the Wongawilli Seam would unequivocally demonstrate each goaf area has already collapsed and that there is no risk of further subsidence.'*[13]
>
> and
>
> *'The observation of abutment loading in the Wongawilli Seam roadways below goaf edges in the Bulli Seam would bring certainty that all pillars in the goaf have collapsed and there is no potential for future subsidence.'*[14]

Similarly, the Panel is in general agreement that the visual signs of abutment loading would indicate that the overlying Bulli Seam workings have caved (goafed) but, once again, it cautions against concluding that there is **no risk** of further subsidence. The Panel does not concur that the observation of abutment loading would bring **certainty**, let alone in regard to **all pillars in the goaf** having collapsed. The detection of signs of abutment stress is not a guarantee that all pillars have collapsed, let alone fully collapsed.

SCT is of the view that:

[11] SCT (2020b), Table 1.
[12] SCT (2020b), page 4.
[13] SCT (2020b), page 2.
[14] SCT (2020b), page 23

'Proposed mining in the Wongawilli Seam would not change the potential for further subsidence from the Bulli Seam'[15]

and

'If the Bulli Seam goaf areas have already subsided, there is no residual risk of further subsidence associated with proposed mining in the Wongawilli Seam'[16]

The Panel does not fully support this view. This is because although pillars may have failed in the Bulli Seam, pressure bulbs can still be present under remnant portions of partially extracted pillars in the goaf and these can be expected to extend into Wongawilli Seam, just as abutment stress does. The formation of bord and pillar workings has the potential to disturb these pressure bulbs, especially if they are located above roadways, and so cause reactivation of the goaf leading to further subsidence. The magnitude and extent of the additional subsidence is dependent not only on the area occupied by the remnant pillars but also on how much load and how far load is redistributed as a result of disturbing remnant pillar/s. However, given the considerable depth of mining, any additional convergence is expected to be barely detectable as surface subsidence in most cases.

6.2. ESTIMATED MAXIMUM INCREMENTAL VERTICAL SUBSIDENCE

There are a number of components that can contribute to vertical surface subsidence above the proposed Wongawilli Seam mining panels at Russell Vale Colliery, the principal ones being:

1. Compression of the pillar system and also roof and floor strata somewhat remote from the pillar system in response to the additional load placed on this strata when coal is removed to form roadways (bords) and when the pillars are subjected to additional abutment load in the vicinity of goaf edges. SCT (2020b) does not provide insight into the calculation of this potential contribution to surface subsidence but it does appear to acknowledge it in the statement that *'there is no potential for mining these [25m and 30m pillars] to cause surface subsidence of more than a few tens of millimetres.*[17] Numerical modelling that includes provision for taking abutment loads into account would aid in confirming the reasonableness of this estimate.
2. Punching of the coal pillars into the roof or floor strata. This has not been explicitly addressed in SCT (2020b) but may have been elsewhere. It may or may not make a contribution to surface subsidence.
3. Yielding of the coal pillars and further ongoing convergence determined by their post-yield behaviour. In this matter, SCT contends that the coal pillars will undergo strain hardening to result in an increase in their load carrying capacity. The Panel concurs. SCT states '*that assuming all pillars were to fail and all roadways were to become completely filled with coal without any bulking – an extreme case used for the purpose of illustration – maximum subsidence would still be less than 140 mm.*'[18] SCT does not explain how it arrived at the value of 140 mm. The Panel questions the value since, for 19.5 m square pillars, this extreme case would result in a convergence of 940 mm at seam level. Based on subsidence behaviour in the Southern Coalfield, surface subsidence could be expected to be somewhere in the range of 40 to 60% of this convergence, or 375 to 560 mm. In any event, this extreme case is unrealistic. There are very few points of reference for failed pillars of the size proposed for Russell Vale Colliery. One useful case relates to the Crandall Canyon disaster where 2.44 m high roadways converged about 300 mm over an area of some 50 acres following a dynamic pillar failure event (Gates et al., 2008). When allowance is made for the fact that Crandall Canyon Coal Mine was around twice as deep as Russell Vale

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[15] SCT (2020b), page 4
[16] ***page 12
[17] Page 15, last paragraph.
[18] Page 16, 2nd paragraph.

Colliery, surface subsidence of the order of 100 to 150 mm at Russell Vale Colliery does not seem to be an unreasonable estimate.

4. Yielding of standing pillars in the Bulli Seam. SCT (2020b) acknowledges that there is a possibility that bord and pillar first workings in the Wongawilli Seam could cause instability of any standing pillars in the Bulli Seam. It estimates the probability of this to be less than 1% but does not explain how it arrived at this figure. If this situation arises, history shows that it could result in an increase in maximum vertical subsidence of the order of 1 m.
5. Reactivation of existing goaves. Given that there is a possibility that bord and pillar first workings in the Wongawilli Seam could cause instability of any standing pillars in the Bulli Seam then there must also be a possibility the Wongawilli Seam workings could cause some reactivation of overlying goaves in the Bulli Seam and the Balgownie Seam. The amount of incremental vertical surface subsidence that could result from this behaviour is unknown to the Panel. However, given that surface subsidence due to total extraction longwall mining in a multiseam situation is some 10 to 15% greater than in a single seam situation, it seems reasonable to expect that reactivation of goaves caused by interactions with bord and pillar first workings would not cause more than one to two percent increase in subsidence. Based on Table 2, this equates to 10 to 20 mm in areas where only the Bulli Seam has been totally extracted and 20 to 40 mm where both the Bulli Seam and the Balgownie Seams have been totally extracted.

When the contribution of all these components except pillar punching of the roof and floor strata (or bearing capacity failure) is summed, it can be concluded that, based on a 2.4 m mining height in the Wongawilli Seam:

1. Stable bord and pillar first workings in the Wongawilli Seam are unlikely to result in more than 150 mm of surface subsidence in areas where there are no standing pillars in the Bulli Seam.
2. Unstable bord and pillar first workings in the Wongawilli Seam are unlikely to result in more than 300 mm of surface subsidence in areas where there are no standing pillars in the Bulli Seam.
3. Stable bord and pillar first workings in the Wongawilli Seam could result in up to 1150 mm of surface subsidence in areas where failure of standing pillars in the Bulli Seam is induced.
4. Unstable bord and pillar first workings in the Wongawilli Seam could result in up to 1300 mm of surface subsidence in areas where failure of standing pillars in the Bulli Seam is also induced.

The extreme (and unrealistic) case is associated with total seam convergence in the Wongawilli Seam due to pillars punching the roof and/or floor strata, in which case incremental vertical subsidence is unlikely to exceed 550 mm in areas where there are no standing pillars in the Bulli Seam and 1600 mm where failure of standing pillars in the Bulli Seam is induced.

It might be argued that some of these values are overestimated by 50 to 150 mm. However, it must be remembered that subsidence prediction is not a precise science and very susceptible to localized changes in ground conditions and that some allowance should be made in recognition that ground engineering is characterized by pervasive uncertainty.

6.3. PRINCIPAL SUBSIDENCE ENGINEER'S CONCERNS

The concerns raised by Dr Gang Li in his presentation to the IPC on 13 October 2020 regarding the potential for first workings in the Wongawilli Seam to destabilise any areas of standing pillars in the Bulli Seam, and the need to confirm the presence of Bulli Seam workings ahead of mining are considered by the Panel to be important and relevant and to warrant assessment. Dr Li referred to vertical subsidence measurements over LW 4 and LW 5 of 1.77 m and 1.75 m, which he considered to be substantially higher than predicted. He interpreted this as a strong indication that there had been standing pillars and open voids in the overlying Bulli Seam workings.

The End of Panel Report for LW 5 (Wollongong Coal, 2014) sheds light on Dr Li's concerns. It records that the Subsidence Management Plan (SMP) predicted a maximum vertical subsidence of 1.4 m and that the exceedance of this value triggered a red trigger level exceedance. Presumably, Dr Li would have been notified of that exceedance. However, the End of Panel Report then goes on to advise that the predicted maximum vertical subsidence was revised to 1.9 m in the Preferred Project Report (for LW 6), which reflects the values record in Table 2 of this Panel advice. One effect of that revision is that measured maximum vertical subsidence over LW 5 has gone from being 28% greater than predicted to 6% less than the revised prediction.

Table 4 summarises subsidence factors (being vertical subsidence expressed as a percentage of extraction height) for LW 4 and LW 5. The high factors (68% and 75%) based on the revised predictions indicate that the subsidence predictions have taken account of the reduce stiffness of the overburden. This addresses another of Dr Li's concerns. Furthermore, SCT was commissioned in 2013 to provide the revised subsidence predictions. As (SCT, 2020b) maintains that prior to extracting the longwall panels in the Balgownie Seam, the pillars in the Bulli Seam had already collapsed, this is significant. This is because it provides further confidence that the collapse of standing pillars is not required in order to generate the elevated levels of vertical subsidence. Rather, these levels of elevated subsidence can result above areas where pillars have already failed in the Bulli Seam.

Table 4: Comparison between subsidence factors for LW 4 & LW 5 at Russell Vale Colliery (derived from Wollongong Coal (2014) and (AECOM, 2014))

	LW 4	LW 5
Initial Predicted Subsidence/Extraction Height		50%
Measured Subsidence/Extraction Height	63%	63%
Revised Predicted Subsidence/Extraction Height (Table 2)	75%	68%

7. RESPONSE TO COMMISSION'S QUESTIONS

7.1. QUESTIONS 1 TO 7

1. *In terms of the SCT report and Dr Hebblewhite's peer review, are the risk and extent of the predicted subsidence impacts in the catchment reasonable? This needs to be considered in two scenarios:*

   i. *that all the overlying Bulli Seam pillars have collapsed; and*

   ii. *that some of the pillars have not collapsed.*

   Generally

   - The Panel presumes, on the basis of the information provided to it, that the question is confined to subsidence impacts on swamps.
   - Given the challenges associated with sourcing data to satisfy the IESC's advice regarding quantifying the probability of the catastrophic loss of a swamp triggered by the instability of the proposed workings in the Wongawilli Seam, limitations associated with the alternative approach adopted, and the appropriateness of the input data to that approach, the Panel considers that considerable uncertainty is associated with predicted probabilities (Refer to Sections 4 and 5).
   - The Panel has reservations about the pillar loads used in arriving at 19.5 m square pillars beneath the longwall panels in the Balgownie Seam. It is possible that this load may have been underestimated, in which case the probability of instability of these pillars could be considerably higher than predicted. If pillar instability is intolerable, it would be judicious not to reduce pillar size from 24.5 m to 19.5 m under longwall panels in the Balgownie Seam until the pillar loading environment under these longwall panels has been confirmed from mining experience (Refer to Section 5)
   - The predictions of incremental vertical subsidence are considered soundly based and reasonable. In recognition of the pervasive uncertainty that characterises geotechnical engineering, it would be judicious to include an allowance in the predictions for conditions and situations that are unknown in advance of mining and to not be dogmatic as to the certainty of geotechnical states of stability and what can and cannot occur, especially in and around old mine workings and goaves.
   - Based on the limited information provided to the Panel, it appears that an objective subsidence impact assessment has not been undertaken for swamps. Rather, a limit has apparently been placed on a subsidence effect (being incremental vertical subsidence) that has no direct relationship to its impact on swamps. Nevertheless, that approach is likely to be conservative; that is, swamps are able to tolerate a level of incremental vertical subsidence.
   - The Panel questions the merits of a blanket 100 mm limit on incremental vertical surface subsidence and wonders if it would not be more sensible and practical to determine tolerable incremental vertical subsidence on a swamp-specific basis that has regard to how much vertical displacement is likely to have already occurred at each swamp. Such an approach is more in line with contemporary subsidence impact assessment and may assist greatly in addressing concerns relating to whether there are still pockets of standing pillars in the goaves of the Bulli Seam – it may simply not matter in most (if not all) cases – and deliver lower risk outcomes.

   i

   - The Panel has nothing to add. There is nothing particularly unique or abnormal about what is being proposed and that has not been done before and, apart from the matters noted already, the SCT report addresses the extent of the impacts adequately.

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- But for the apparent constraint of 100 mm on incremental vertical subsidence, there is also nothing particularly unique or abnormal about what is being proposed and the conditions under which it is being undertaken. One can never be entirely sure of the state of goaves in old workings and cannot rely on the completeness or accuracy of what is shown on mine plans.
- The Panel concurs with SCT that it is very unlikely that there are pockets of pillars still standing in the 14 goaf areas identified in the SCT quantitative risk assessment report.
- Notwithstanding this, the Panel concurs with the peer reviewer that endeavours should be made to confirm that there are no standing pillars in the goaves. This is for reasons relating to managing operational risks as well as for managing subsidence impacts.
- The information provided to the Panel gives no insight into the options available should pillars still be found to be standing in the goaves. It could prove very difficult to identify the presence of the pillars sufficiently ahead of mining operations to prevent mining impacting on their state of stability and, thus, on not exceeding 100 mm of incremental subsidence.

2. *Is it likely that the Applicant will be able to develop a Mine Plan and Principal Hazard Management Plan that meets the requirements of the Resources Regulator and limits the level of subsidence to 100mm?*

- Given the pervasive uncertainty associated with geotechnical engineering and based on the information supplied to the Panel, the achievement of this value could be marginal on occasions. (Refer to Section 6.2).
- For reasons noted in addressing Question 9, it would be judicious to specify a higher limit.

3. *Beyond a 100mm target what is likely to be the worst-case local subsidence scenario if residual pillars in the Bulli Seam collapse?*

- ~1150 mm if failure is confined to remnant pillars in the Bulli Seam.
- ~1300 mm if failure also involves pillars in the Wongawilli Seam. This is possible but very unlikely.
- (Refer to Sections 6.1and 6.2)

4. *Dr Gang Li has made comments and raised concerns relating to the local subsidence impacts and mine stability due to the possible existence of un-collapsed "marginally stable pillars". Are these concerns adequately addressed by the approach proposed by the Applicant and the guidance given in the Resource Regulator's 'Letter to Commission from Resources Regulator on 16 October, 2020'?*

- It has been established in Panel advice (see Section 6.3) that Dr Li's concerns regarding elevated levels of vertical subsidence arise out of subsidence predictions that did not properly account for increased subsidence in a multiseam mining situation; that is, subsidence had been under-predicted rather than excessive for a multiseam situation. This deficiency appears to have been overcome by appointing SCT to undertake subsidence predictions.
- Nonetheless, this explanation does not diminish the validity of Dr Li's concerns. The risk could still potentially exist in other areas of the mine.
- The applicant proposes to identify the presence of unfailed pillar workings in the Bulli Seam on the basis of an absence of abutment stress in the Wongawilli Seam. This is considered feasible but the information provided to the Panel is too limited for it to determine if it will cover all situations (the only mine plan which the Panel has is that which constitutes Figure 2

of this advice and it is does not contain the necessary information to inform further comment). The concept should be subjected to a risk assessment.

- The Panel is not in possession of all the material that the Resource Regulator notes in its response to this issue (for example, the conditions recommended by the Department). Nonetheless, the Panel agrees with the Regulator that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the applicant to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.
- Further, the Panel supports the Regulator in its view that work health and safety laws can be appropriately applied through, int this matter, the development of a principal hazard management plan for subsidence.

5. *We note that the Resources Regulator has recommended that the applicant undertake investigations to identify and define the existence and distribution of any marginally stable pillars in the overlying Bulli Seam. Are there proven non-invasive methods available to determine the subsurface presence of voids either from existing surface access points or from underground prior to development commencing in sections of the mine which may undercut areas identified as 'unconfirmed' with respect to pillars in the Bulli Seam?*

   - If non-evasive means that there is to be no disturbance of the strata, then the Panel is not aware of any proven methods other than, given the right conditions as apparently exist in the Wongawilli Seam, visual observations as proposed by the applicant. Otherwise, one is effectively searching for pillars and roadways (only portions of which may still open) somewhere within an environment that is extremely disordered and chaotic. Unless the standing pillars are close to the abutment of goaves, non-invasive methods are extremely unlikely to penetrate the debris and make sense of the chaos. A point of reference in this regard is activities associated with searching for and recovering persons and equipment buried in goaf falls.
   - If non-evasive does not preclude the drilling of boreholes and the use of borehole cameras then, in theory, it is technically feasible to locate marginally stable pillars in goaf environments. However, the depth of the Bulli Seam and the nature of the topography will almost certainly exclude extensive drilling from surface. Drilling from the Wongawilli Seam is an option but success is very likely to depend on 1) having a reasonable idea of the location of the target pillars, and 2) being able to drill near vertical holes which, in turn, is likely to require at least some roadway development beneath the target zone; that is, a degree of undercutting.

6. *To what extent should the status of any voids in sections of the old Bulli workings be determined before mining commences or is it appropriate to do this by measurement (and observation) of abutment stresses once mining commences?*

   - In order to provide a properly informed answer, the Panel would need to be supplied with mine plans for both old mine workings and the proposed workings in the Wongawilli Seam. However, for reasons noted in answering Question 5, it is very unlikely that the status of voids can be determined in the Bulli Seam workings other than by interpreting visual observations of ground conditions in the Wongawilli Seam. The Panel does not have sufficient information to form a view on how fail safe that approach may be. However, if one is relying on the absence of abutment stress as an indicator of standing pillars in the Bulli Seam, careful consideration would need to be given to if this could be detected in time for the Wongawilli Seam workings not to have already had an adverse impact on the state of stability of the standing pillars.
   - This is not a unique situation. For example, mines which work beneath water bodies can be required to drill ahead to prove that no direct hydraulic connections exist to the water body. Bord and pillar mining as proposed in the Wongawilli Seam offers many advantages in these types of situations because it is flexible and amenable to rapid changes in mine layout to respond to changed mining conditions and risk profiles.

- It is not uncommon for bord and pillar first workings to take place in seams that have old workings in various and unknown states of stability above them, and for the lower seam workings to be impacted by abutment stress from the old workings in the upper seam.

7. *Is the claimed stability of the pillars in the current application likely to be realised given the ground conditions expected in the poorer quality coal remaining in the Wongawilli Seam above that part of the Wongawilli Seam that is proposed to be mined?*

- The Panel has no information in regard to this issue. The only insight it has into it is the query raised by Professor Hebblewhite in his peer review of the January 2020 version of the SCT report (being (SCT, 2020a)), viz

> *SCT makes reference to 1994 work in support of the data presented in Figure 2, showing w/h ratio pillars of 8 and 10 continuing to increase in their load-carrying capacity. Further in support of this position, the statement is made that "pillar behaviour in the Wongawilli Seam is observed to be more consistent with strong roof and floor conditions allowing frictional strength to develop". This may well be the case based on the evidentiary data from 1994, but a further explanation of this claim should be provided here, given that in the 2019 Subsidence Assessment Report, SCT referenced the fact that the Wongawilli Seam roof was not strong. SCT stated in that report: "despite Wongawilli Seam workings being characterised as having a weak coal/shale roof in a thick seam environment …" (SCT 2019, page 22).*[19]

- The Panel does not have any evidence and if and how this query was addressed.
- The issue is very important for designing stable pillars, no matter what design procedure is adopted for this purpose. Experience attests to pillar system strength being significantly reduced when the roof or floor strata are weak and/or comprise laminated strata (reference, for example, Peng (1978) and Wagner (1980)).
- The issue is also very important if the probabilities of pillar stability developed by Salamon et al. (1996) are to be relied upon since these were developed specifically for situations where pillar instability is due to failure of the coal pillar element and not to failure of the roof or floor strata.

7.2. QUESTION 8

8. *Could any of the above matters be reasonably addressed through conditioning, and if so, how*?

With or without a 100 mm incremental vertical subsidence limit in place, it might appear attractive and reasonable to require a mine operator to adopt a blanket maximum probability of instability of 1 in 1,000,000 for all mine workings in order to minimise (almost eliminate) the likelihood of a pillar instability developing in the first place. The choice of a pillar design methodology is one for the mine operator, who would only be required to demonstrate to the satisfaction of the Regulator that the design does not exceed the designated likelihood of instability.

However, while this approach does have considerable merit in theory, it is almost certainly unworkable in all situations in practice because a probability of instability cannot be assigned to all the individual components that go to make up a pillar system, let alone to how two or more may interact to cause pillar instability. As such, it would constitute an approval condition that could not be uniquely defined and confirmed as having been satisfied.

[19] Page 17, last paragraph of peer review report

An alternative approach which does factor in issues raised in the preceding questions and caters for unknowns is to base project conditioning on one or more clearly measurable worst-case outcomes. In the circumstance specific to Russell Vale Colliery, this outcome could quite possibly be incremental vertical subsidence. The logic and foundations for the concept are detailed in the following subsections to assist the Commission in assessing its merits.

7.2.1.Subsidence Effects

1. In single seam mining operations, stable bord and pillar workings result in minimal surface subsidence.

2. The design of stable bord and pillar workings requires consideration to be given both to the capacity (strength) of the ‘pillar system’ to sustain load and to the load that will be acting on the pillar system.

3. The pillar system comprises the in-seam coal pillar, its contact surfaces with the immediate roof and floor strata, and the immediate roof and floor strata.

4. The stability of the coal pillar system is a function of:

    i. The width-to-height ratio, w/h, of the coal pillars. Pillar strength increases with increasing confinement to the pillar core which, in turn, increases as pillar width increases and decreases as pillar height is increased.

    ii. The nature of the immediate roof and floor strata.

        a. The bearing capacity of the roof and the floor strata must be sufficient to sustain the peak pillar load.

        b. Low friction/cohesion materials and parting planes in the roof or floor strata limit the amount of confinement provided to the pillar core and, thus, also the peak strength of the coal pillar.

    iii. The stability of the roof strata above the bords. Roof falls result in an increase in the effective height of the coal pillars, leading to a reduction in pillar strength.

5. The geomechanical properties that influence the stability of the pillar system can deteriorate over time and, therefore, the stability of bord and pillar workings can be time dependent.

6. In situations where the coal pillar element is the weakest component of the coal pillar system, the pillar width-to-height ratio is the primary variable that determines pillar strength.

7. For all other factors (parameters) remaining constant, as pillar width-to-height ratio increases

    i. vertical surface subsidence over unfailed bord and pillar mining decreases.

    ii. the maximum possible vertical surface subsidence that can occur over failed workings decreases. This is because the percentage extraction of coal is lower, meaning that there is comparatively less void space available to accommodate seam convergence before the workings become choked off.

8. At pillar width-to-height ratios greater than about 8 to 10:

    i. It is generally not possible in most practical situations (where maximum bord width is restricted to the order of 6 m) for bord and pillar first workings to be able to generate the loads require to exceed the peak load carrying capacity of the coal pillars. Some pillars or portions of pillars also need to be extracted (secondary extraction) in order to generate the high loads required to initiate yielding.

ii. After reaching its yield point, a coal pillar will behave in a manner referred to as 'strain hardening' whereby the pillar will continue to accept load when subjected to further convergence (strain), with each increment of convergence causing the pillar to generate a higher resistance to the next increment of convergence. That is, the pillar becomes 'stronger' with increasing seam convergence and has a greater resistance to further convergence.

9. The calculation of the load acting on a pillar system is also complex (except for one special situation which does not apply to Russell Vale Colliery) and there is a range of uncertainty associated with the outcomes.

10. Additional complexity and uncertainty is associated with the prediction of the load acting on pillar systems in multiseam situations, especially when the workings in each seam are not based on the same mining method and not superimposed, as in the case of the Russell Vale Extension Project.

7.2.2. Application to Russell Vale Colliery

1. A range of uncertainties associated with the prediction of pillar system stability are noted in the documentation provided to the IEPUM and reflect the complexity associated with mine design in the circumstances. For example, uncertainties are associated with estimates of pillar system load and the nature of the immediate roof strata.

2. A considerable amount of time and resources could be devoted to addressing these geotechnical uncertainties without any guarantee of resolution or improved confidence in the mine design. This is not unusual in mining geomechanics, which is characterised by pervasive uncertainty.

3. A pragmatic way to deal with this uncertainty is to base impact assessment on worst case predictions of subsidence effects.

4. In all but one case, the predictions of SCT (2020b) and the Panel of worst case outcomes for vertical surface subsidence agree to within 200 mm, as documented in Table 5. The one exception is highly unlikely to be realistic in the given conditions and not pursued further.[20] The 200 mm difference is associated with allowances by the Panel for possible reactivation of goaves in both the Balgownie Seam and the Bulli Seam. The Panel's predictions are utilised for the purpose of this logic tree but should not be adopted by the IPC without seeking input from the Applicant as to their reasonableness.

5. If the IPC assesses these impacts to be tolerable and/or able to be managed to a tolerable level through approval conditions, the need to resolve most, if not all, the geotechnical uncertainties is removed.

[20] It is noted in the IAPUM draft advice of 16/11/2020

Table 5: Predicted Worse Case Vertical Surface Subsidence

Situation	SCT (mm)	IAPUM (mm)
Unstable Wongawilli Seam bord and pillar workings only	30 to 100	300
Unstable Wongawilli Seam bord and pillar workings and destabilisation of standing pillar in the Bulli Seam	1100	1300

7.2.3.Impact Assessment for Swamps

7.2.3.1.Foundation

1. Vertical surface displacement, changes in surface tilt, and tensile and compressive strain are all subsidence effects which can impact swamps. However, tensile strain is the most critical impact as it can induced cracking of the base of swamps that has the potential to reduce soil moisture and groundwater levels in the swamps.

2. Table 2and Table 3and featured in the PAC's 2014 determination of the length of LW 6 to manage subsidence impacts on swamps. Table 3 is based on estimates of subsidence effects at each swamp in the area of interest due to previous mining in the Bulli Seam and Balgownie Seam. The locations of the swamps are shown in Figure 3. It is the IAPUM's understanding that the estimates were based on there being no areas of standing pillars in the Bulli Seam. (This should be confirmed by the Applicant.)

3. Based on Table 2 and Table 3 of this advice, it can be deduced that each incremental increase in vertical subsidence of 100 mm results in an incremental increase in tensile surface strain of about 0.5 mm/m. (This should be confirmed by the Applicant.)

4. It is reported in a range of documentation produced by the Applicant that swamps do not appear to have suffered adverse consequences that can be linked unequivocally to mining impacts.

5. Table 3 lists four swamps that have been subjected to estimated tensile strains of around 10.5 mm/m. A total of eight swamps have been subjected to tensile strains estimated to be in excess of 5 mm/m.

6. As a point of reference, swamp CCUS4 was a particular point of focus in the PAC's 2014 determination of the length of LW 6. The swamp lies predominantly over LW 6 as shown in Figure 3, the extraction of which was predicted to result in a maximum increase in incremental tensile strain of 11 mm/m. The 2014 PAC concluded that

   'The Commission recognises the uncertainty regarding the potential impacts to CCUS4 and the risks associated with those impacts, from mining beneath this swamp. Any previous impacts to the swamp's integrity are unknown, and as a result the risk of reaching the swamp's tipping point, (i.e. the point where the swamp can no longer function effectively as a swamp) is high.

In the circumstances, the Commission considers a cautious approach should be adopted. That is to limit extraction of LW6 to the western edge of CCUS4 to allow monitoring and data collection of any changes in the swamp. Monitoring should include hydrological changes. The monitoring results would provide empirical information for the assessment and prediction of the extent of changes to CCUS4 and formulation of adaptive management plan if mining is to proceed through the whole of LW6.'

7. The Panel is unaware of the outcomes of the recommended monitoring. The following advice needs to take these outcomes into account and be tested against them.

8. The Panel suggests that, should the project be approved, the IPC give consideration to a consent condition based on an upper limit of incremental vertical subsidence. Framing a consent condition on a subsidence effect, especially vertical displacement, is something that one tries to avoid in contemporary approval processes because subsidence effects do not always have a relevant or reliable relationship to the subsidence impact that needs to be managed. However, on this occasion there does appear to be a reasonably reliable relationship between incremental vertical displacement and incremental tensile strain, which is turn, can be expected to have a relationship to the frequency, width and depth of cracking beneath swamps. But, in the case of swamps, the problem with basing performance measures on the characteristic of mining-induced cracking or tensile strain is that they are not suited to being measured. Hence, the reversion to incremental vertical subsidence.

9. The determination of consent conditions should have regard to the outcomes of monitoring over LW 6.

7.2.3.2. No Standing Pillars in the Bulli Seam

1. A maximum incremental vertical subsidence of 100 mm (corresponding to an incremental; strain of ~0.5 mm/m) would be consistent with not exceeding the predictions presented in SCT (2020b) but leaves little opportunity for unplanned deviations, which are a feature of geotechnical engineering. On the other hand, the Panel's upper limit of 300 mm (~1.5 mm/m) may be generous.
2. Based on historical performance and geotechnical considerations, the Panel considers it very unlikely that such small changes could result in an impact of catastrophic proportions.
3. It seems reasonable to expect that the four swamps which have already experienced more than 10 mm/m tensile strain would be most vulnerable to being negatively impacted by an increase in strain (but it would be judicious to seek confirmation that the characteristics of some other swamps do not make those swamps more vulnerable). The IPC could consider a consent condition that requires that 1) these four swamps are not subjected to any further vertical subsidence, or 2) no more than 'x' mm of vertical further incremental vertical subsidence, where 'x' is <300 mm, and perhaps of the order of 100 mm.
4. Otherwise, consent conditions could allow for a fixed amount of incremental vertical subsidence of all other swamps. Whatever value the IPC chooses, monitoring to verify that this limit does not result in unacceptable impacts to swamps should be undertaken and provisions made to reduce the limit accordingly. If the IPC were to specify a lower end value of 100 mm, the same process could be applied to have the value increased in future, if need be.

7.2.3.3. Standing Pillars in Bulli Seam

1. The Panel is unaware if there are particular locations where standing pillars are more likely to be found in the Bulli Seam. The Applicant is relying on the absence of abutment stress to identify the presence of standing pillars. It needs to be established if there are areas where the absence of abutment stress is the norm, in which case standing pillars may not be detected by visual observation underground.

2. If pillars are still standing and swamps are located within their area of influence, then the estimates of subsidence effects for these swamps presented in Table 3 need to be discounted. It would be remarkable if all those swamps not overlying the Balgownie Seam and listed as having subsided one or more metres had, in fact, not subsided and, therefore, are creating a misleading impression of the tolerance of swamps to subsidence in this particular geographical setting.
3. With the resolution of Dr Li's concerns, the Panel is unaware of any evidence that suggests there could still be pillars standing in the Bulli Seam. However, this is not sufficient reason to dismiss the possibility.
4. At this point in time, all that the Panel can advise in dealing with this specific issue is to include provisions for 1) offsetting subsidence impacts on swamps, and 2) for requiring all significant exceedances of predicted subsidence effects, including outside areas containing swamps, to be investigated with a view to informing mine design going forward.

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APPENDIX B

SCT Response to IAPUM Advice

29 November 2020

SCT Operations Pty Ltd
ABN 23 078 328 953
www.sct.gs

HEAD OFFICE
Cnr Kembla & Beach Streets Wollongong NSW 2500 Australia
PO Box 824 Wollongong NSW 2520 Australia
Telephone +61 2 4222 2777 Fax: +61 2 4226 4884
Email: sctnsw@sct.gs

BRISBANE OFFICE
Telephone 0428 318 009 (international +61 428 318 009)
Email: p.cartwright@sct.gs

BENDIGO OFFICE
Telephone: +61 3 5443 5941
Email: s.macgregor@sct.gs

Devendra Vyas
Project Manager
Wollongong Coal Ltd
PO Box 281
FAIRY MEADOW NSW 2519

WCRV5269_Rev 1

Dear Devendra

RESPONSE TO ADVICE FROM INDEPENDENT ADVISORY PANEL FOR UNDERGROUND MINING

Wollongong Coal Limited (WCL/Applicant) plans to mine coal from the Wongawilli Seam at Russell Vale Colliery near Wollongong in NSW by forming large pillars in an area east of Cataract Reservoir known as Russell Vale East. On 5 November 2020, the Independent Planning Commission (IPC) assessing the mining proposal requested the advice of the Independent Advisory Panel for Underground Mining (IAPUM/Panel) in relation to predicted surface subsidence for the Russell Vale Underground Expansion Project (UEP). WCL commissioned SCT to review the IAPUM advice and provide a technical response to the various issues raised. This letter report presents SCT's response to the IAPUM advice.

The report is structured to provide an overview of the key points of the IAPUM findings, considerations relating to the assessment approach used by SCT and a review of Section 7 of the IAPUM response to eight specific questions posed by the IPC.

1. OVERVIEW OF KEY POINTS

Key points to draw from the IAPUM's comments are:

> *The Panel concurs with SCT that it is very unlikely that there are pockets of pillars still standing in the 14 goaf areas identified in the SCT quantitative risk assessment report.*
>
> *The predictions of incremental vertical subsidence are considered soundly based and reasonable.*
>
> *… it seems implausible that an incremental strain of only 0.5 mm/m could initiate a catastrophic loss of a swamp.*
>
> *In all but one case, the predictions of SCT (2020b) and the Panel of worst case outcomes for vertical surface subsidence agree to within 200mm, as documented in Table 5. The one exception is highly unlikely to be realistic in the given conditions and not pursued further.*

> *... the Panel agrees with the Regulator [NSW Resource Regulator] that the identified risks can be suitably and appropriately managed post approval provided that appropriate inquiries and investigations are undertaken by the applicant to further identify and define the existence and distribution of the marginally stable pillars in the overlying Bulli Seam.*
>
> *If the IPC assesses these impacts to be tolerable and/or able to be managed to a tolerable level through approval conditions, the need to resolve most, if not all, the geotechnical uncertainties is removed.*

The IAPUM note at the beginning of the advice, and SCT concurs, that:

> *Aspects of the matter are technically complex and the documentation provided to the Panel [IAPUM] does not include a detailed account of all of these and how they have been addressed by the Applicant [WCL].*

Most of the issues raised by the IAPUM relate to technically complex aspects of:

- pillar behaviour in the short and longer term
- surface subsidence in a multi-seam environment
- interaction of this subsidence with swamps, many of which have been previously subsided much more than the maximum expected from the proposed mining.

SCT has considered and assessed all these issues at various stages. However, the IAPUM has not been provided with all the information relating to the various assessments undertaken and has not had the opportunity to discuss the technically complex issues relating to these various assessments with SCT. The IAPUM notes:

> *Nevertheless, the Panel considers that it is unlikely that additional information would impact materially on its responses to the questions posed by the IPC.*

Some misunderstandings have crept into the discussion and further clarification of these aspects would remove some of the concerns expressed by the IAPUM. The nature of this response as a public document, the technical complexity of the subject matter, and the timeframe available to respond do not allow all the various issues to be fully explored and discussed. This document focuses instead on those issues which are materially significant to the eight questions asked by the IPC. SCT would welcome the opportunity to further address any outstanding aspects in a meeting with the IPC and IAPUM if and when necessary.

2. SCT Assessment Approach and Related Considerations

SCT took a deliberately conservative approach in assessing the risk of "catastrophic loss of a single swamp" in SCT (2020) because of the importance of this issue to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) for which the assessment was made and the broader community.

The IAPUM has identified several areas where a more appropriate, but less conservative approach is justified and SCT agrees with the IAPUM findings but recognises the need to be conservative in these situations. The areas identified by the IAPUM as suitable to adopt a less conservative approach include:

- Adopting a threshold of 300mm of vertical subsidence for significant swamp impacts is accepted as more credible than 100mm. The 100mm threshold was adopted as being clearly conservative in the absence of detailed assessments of individual swamps; such assessments were beyond the scope of the risk assessment undertaken for the IESC and presented in SCT (2020).

- Using a less conservative probability of failure table with the latest UNSW pillar design is accepted. The probability of failure table presented by the authors of the original UNSW pillar design formula was used in the assessment. This table of probabilities is more conservative than the more recent version of the table for the latest UNSW pilar design formula.

The IAPUM also identify areas where they are uncertain of the detail and suggest a more conservative approach. These include:

- Estimates of pillar loading under the Balgownie Seam goafs. There is no doubt that abutment loads will be concentrated on the Balgownie Seam chain pillars. It follows that loading on pillars directly below the goaf will therefore be reduced to some extent. The loading used in the pillar calculations below the Balgownie is based on SCT's experience of monitoring pillars loads and understanding overburden caving behaviour. The proposed mining will offer the opportunity to measure these loads directly and inform short-term panel design considerations in a timely manner. In the absence of such measurements, SCT considers the approach used to estimate load is reasonable. If the pillar loading is found to be higher than expected, the mining system is flexible enough to allow pillar sizes to be increased as required.

- The IAPUM refers to a description of the Wongawilli Seam roof strata being "weak coal/shale roof in a thick seam environment" (SCT 2019) contrasting with field monitoring data from AMIRA (1995) that supports the finding that Wongawilli Seam pillars are observed to generate confinement consistent with strong roof and floor conditions. These two observations are not in conflict. The monitoring experience and other field monitoring experience supports the strength of Wongawilli Seam pillars as being consistent with pillars in strong roof and floor conditions despite the roof material comprising "weak coal/shale roof in a thick seam environment".

The IAPUM identifies some differences of approach. These include:

- Estimating pillar loading and matching it against pillar strength. The IAPUM state: "*Caution is required with this approach.*" SCT agrees with the premise of this statement. The approach adopted in SCT (2020) is based on field measurements of abutment load, consideration of subsidence behaviour and a range of other considerations developed over 30 years of SCT working in the underground coal industry. It has been found to be conservative when matched to the UNSW pillar strength estimates. The approach takes account of several other effects not included in the UNSW approach. Nevertheless, integration with the UNSW approach is helpful because of the broad industry acceptance of the UNSW approach and the links to a probability-based assessment.

Other considerations relevant to the discussion include:

- The proposed pillar mining system is flexible and can be easily modified to respond to changes in loading and other circumstances allowing for more responsive adaptive management systems.

- WCL's plan to undertake a comprehensive subsidence monitoring program, even though surface subsidence is expected to be largely imperceptible in a bushland setting and only reliably measurable with high accuracy survey techniques.

- WCL's plan to initially mine in areas where it will be possible to determine the effectiveness of the mining system, the ability to detect goaf edge abutment loading and immediate surface subsidence without impacting swamps or infrastructure and other built features.

The IAPUM states in the opening section of their report that:

> *The crux of the matter relates to coal pillar system design in a multi-seam mining environment and the risk of the catastrophic loss of a swamp presented by vertical surface subsidence.*

SCT concurs with this statement, but there is some additional information that is relevant to the discussion.

- The probability of "catastrophic loss of a single swamp" is assessed as "very rare", but this probability exists irrespective of whether the project goes ahead.

- The potential for pillar instability in existing Bulli Seam goaf areas to cause further subsidence hinges on whether these goaf areas have collapsed or not. All available information indicates that these goaf areas have indeed collapsed but there is not yet definitive proof for half of the fourteen goaf areas relevant to project.

There is evidence available in seven of the fourteen Bulli Seam goaf areas relevant to the project that confirms these seven areas have collapsed. This evidence is available directly through measurement of surface subsidence, borehole measurements and indirectly from underground experience of goaf edge abutment loading in underlying seams. In all seven of the goaf areas where evidence is available, the Bulli Seam pillars are confirmed as having been extracted or collapsed. The potential for further subsidence in these areas is limited to residual movements. Over the 80-90 years since mining was completed, any residual movements are expected to have occurred.

Pillars were extracted using similar mining techniques in the other seven Bulli Seam goaf areas, but there has not been any subsequent mining in seams below these areas or other investigations to confirm their status. The proposed mining is expected to provide the opportunity to confirm these pillars have also been extracted and subsidence has already occurred. It is noted that three (#8, 9 and 11) of the seven Bulli Seam goaf areas not yet confirmed as collapsed do not have substantial areas of swamps above them.

3. Review of IAPUM Response to Specific IPC Questions

The IAPUM response to questions asked of it by the IPC are reviewed in this section.

3.1 Question 1

In terms of the SCT report and Dr Hebblewhite's peer review, are the risk and extent of the predicted subsidence impacts in the catchment reasonable? This needs to be considered in two scenarios:

> i. *that all the overlying Bulli Seam pillars have collapsed; and*
> ii. *that some of the pillars have not collapsed.*

SCT concurs with the conclusions reached in relation to Question 1, especially given the limited information provided to the IAPUM. As the IAPUM states:

> *There is nothing particularly unique or abnormal about what is being proposed and that has not been done before and, apart from the matters noted already, the SCT report addresses the extent of the impacts adequately.*

By way of clarification, the 100mm blanket limit on incremental vertical subsidence was for the express purpose of providing a conservative limit suitable to use in a probability assessment recognising that SCT does not have or claim to have expertise relating to swamps. Notwithstanding the merits of such an approach, the concept of providing a swamp-specific limit for each swamp was outside the scope of the probability assessment requested by the IESC.

3.2 Question 2

Is it likely that the Applicant will be able to develop a Mine Plan and Principal Hazard Management Plan that meets the requirements of the Resources Regulator and limits the level of subsidence to 100mm?

The 100mm limit was intended as a conservative guide to estimating the risk of vertical subsidence causing catastrophic loss of a single swamp. Given the experience of the IAPUM in determining swamp impacts, a higher value is accepted as more appropriate to use as a general performance indicator and for the development of Principal Hazard Management Plans for subsidence.

3.3 Question 3

Beyond a 100mm target what is likely to be the worst-case local subsidence scenario if residual pillars in the Bulli Seam collapse?

The IAPUM indicate 1150mm of subsidence may be possible if failure is confined to remnant pillars in the Bulli Seam and, in the very unlikely scenario of pillar failure in the Wongawilli Seam, subsidence of up to 1300mm may be possible.

The Bulli Seam mining height across most of the Russell Vale East area is approximately 2.2m. On the assumption that there are still standing pillars capable of supporting the 250-300m of overburden strata that would subsequently need to collapse to give rise to surface subsidence, a value of subsidence equal to 1150mm (50% of seam thickness) appears quite high. Even total extraction from longwall mining only causes 55%-65% of mining height. A maximum value of additional subsidence from collapse of standing pillars in Bulli Seam goaf areas is considered likely to be limited to less than 1m and probably significantly less than 1m if the collapse area is narrower than the overburden depth.

It should be recognised that the original figure that forms the basis for Figure 1 presented in the IAPUM report is slightly misleading in that the panel width (W) relates to the width of individual panels. This width is normalised when divided by overburden depth (H). However, the maximum subsidence normalised by dividing by mining height relates to the subsidence across multiple panels of width (W), not just a single panel as drawn. It is very unusual to see surface subsidence above a single panel when the panel width is less than one third of overburden depth. The guidelines from the Reynolds Inquiry (Reynolds 1977) take advantage of this geometry to control subsidence below stored waters.

3.4 Question 4

Dr Gang Li has made comments and raised concerns relating to the local subsidence impacts and mine stability due to the possible existence of un-collapsed "marginally stable pillars". Are these concerns adequately addressed by the approach proposed by the Applicant and the guidance given in the Resource Regulator's 'Letter to Commission from Resources Regulator on 16 October, 2020'?

SCT concurs with the IAPUM.

3.5 Question 5

We note that the Resources Regulator has recommended that the applicant undertake investigations to identify and define the existence and distribution of any marginally stable pillars in the overlying Bulli Seam. Are there proven non-invasive methods available to determine the subsurface presence of voids either from existing surface access points or from underground prior to development commencing in sections of the mine which may undercut areas identified as 'unconfirmed' with respect to pillars in the Bulli Seam?

SCT concurs with the IAPUM.

It would not be practical or necessary to drill holes across the entire area of Bulli Seam goafs. Other methods are likely to be more effective.

Mining conditions in the Wongawilli Seam are expected to provide clearer evidence of the presence of goaf edges in the Balgownie and Bulli Seams above. The presence of standing pillars in the Bulli Seam does not cause a sharp change in vertical stress, whereas mining below a goaf edge does cause a sharp change in vertical stress under the increased abutment loads generated by a large area of extracted pillars. The proposed method of confirming the collapse of pillars in the Bulli Seam from mining conditions encountered in the Wongawilli Seam is considered a practical and robust approach.

3.6 Question 6

To what extent should the status of any voids in sections of the old Bulli workings be determined before mining commences or is it appropriate to do this by measurement (and observation) of abutment stresses once mining commences?

SCT has had the opportunity to review detailed mine plans and recording tracings of the Bulli Seam mining and to inspect areas in the Bulli Seam, Balgownie Seam and Wongawilli Seam workings where there is interaction between seams. SCT concurs with the IAPUM assessment and response.

All currently available information indicates that the Bulli Seam goaf areas have almost certainly collapsed. Deteriorated mining conditions below the goaf edge when mining in the Wongawilli Seam will provide unequivocal confirmation of this expectation.

3.7 Question 7

Is the claimed stability of the pillars in the current application likely to be realised given the ground conditions expected in the poorer quality coal remaining in the Wongawilli Seam above that part of the Wongawilli Seam that is proposed to be mined?

As discussed in Section 2, the IAPUM refers to a description of the Wongawilli Seam roof strata being "weak coal/shale roof in a thick seam environment" (SCT 2019) contrasting with field monitoring data from AMIRA (1995) that supports the finding that Wongawilli Seam pillars are observed to generate confinement consistent with strong roof and floor conditions. These two observations are not in conflict. Field monitoring experience supports the strength of Wongawilli Seam pillars as being consistent with pillars in strong roof and floor conditions despite the roof material comprising "weak coal/shale roof in a thick seam environment".

The stability of the Wongawilli Seam pillars will be critical to the maintenance of productive roadway conditions during mining. The pillars are large enough not to collapse suddenly. Any potential for them to become heavily loaded will become evident through rib and potentially roof deterioration. Such deterioration will significantly impact mining productivity. The mining system is flexible enough to allow modification to the layout as part of the ongoing adaptive mine management system proposed. There will be significant value to the mine in ensuring that pillars do not become heavily loaded and productive mining conditions are maintained.

3.8 Question 8

Could any of the above matters be reasonably addressed through conditioning, and if so, how?

In SCT's experience, management of subsidence outcomes is most convincingly managed by measuring subsidence effects and, in systems where it is possible to measure impacts, measurement of impacts on the surface features of interest.

Empirical evidence (Holla and Barclay 2000) confirms that an increase of 100mm of subsidence would be expected to cause tensile strains of up to approximately 0.5mm/m.

Conditioning on the basis of incremental subsidence is easiest to do because subsidence can be measured precisely, unambiguously and accurately across large areas and at specific points using a range of reliable technologies. Derivative effects such as tilt and strain tend to be more difficult to measure. The systems required to make these derivative measurements also tend to be more intrusive.

Actual levels of tilt and strain for most areas of any swamps are likely to be less than the maximum predictions based on Holla and Barclay (2000). Elevated tensile strains are only expected around the fringes of subsided areas. Mills and Wilson (2017) present measurements and observations of incremental and cumulative subsidence effects from longwall mining in two seams. These measurements provide understanding of the mechanics of multi-seam subsidence. More recent monitoring in three seams confirms the earlier understanding developed for two seams.

This understanding indicates that except directly above stacked goaf edges – one goaf edge directly above another in an overlying seam – the levels of permanent tilt and strain in multi-seam mining are similar or less than for single seam mining despite the greater vertical subsidence. Cumulative values for tilt and strain are not increments from each seam. General softening of the overburden with each episode of subsidence means the cumulative tilts and strains are also softened. Tilt and strain are much higher over stacked goaf edges, but there are no stacked goaf edges at Russell Vale East due to the irregular mining layouts in the three seams.

Measurements of incremental subsidence available from Longwall 11 in the Balgownie Seam and Longwalls 4, 5 and 6 in the Wongawilli Seam are consistent with this softening behaviour. Maximum incremental tensile strain at the shallower northern end of Longwall 11 were measured as 8mm/m after incremental vertical subsidence of 1.3m. Incremental tensile strain over Longwalls 4, 5 and 6 were in the range of 3-6mm/m after incremental vertical subsidence of 1.8m. Actual tensile ground strains are expected to be no more than 60% of those predicted in earlier reports.

If you have any queries or require further clarification of any of the issues raised, please don't hesitate to contact me.

Yours sincerely

Ken Mills
Principal Geotechnical Engineer

4. References

AMIRA 1995, Gale W.J. & Mills K.W. Coal Pillar Design Guidelines P351 Report to AMIRA, January 1995.

Holla, L. and Barclay, E. 2000, 'Mine Subsidence in the Southern Coalfield, NSW, Australia' NSW Department of Mineral Resources, ISBN 0 7313 9225 6.

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SCT 2019. "Russell Vale Colliery: Subsidence Assessment for Proposed Wongawilli Seam at Russel Vale East" SCT Report UMW4609, dated 3 October 2019.

SCT 2020 "IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area" SCT Report WCRV5111 REV4, dated 12 June 2020.

APPENDIX C

Peer Review of SCT Response to IAPUM Advice

B.K. HEBBLEWHITE B.E.(Min.) PhD
Consultant Mining Engineer

B K Hebblewhite Consulting
ABN 85 036 121 217

5 Plant St
BALGOWLAH NSW 2093
AUSTRALIA
Mobile: +61 (0) 417 267 876
Email: hebble@bigpond.com

29 November 2020

Report No. 2003/03.6
Peer Review – Response to IAPUM Advice – Russell Vale Colliery

Supplementary Summary Report

Attn: Mr David Holmes, Principal Environmental Consultant - Approvals & Policy, Umwelt Australia Pty Ltd
Cc: Mr Devendra Vyas, Project Manager, Wollongong Coal Ltd

Introduction

The Independent Advisory Panel on Underground Mining (IAPUM) was asked by the Independent Planning Commission (IPC) to provide advice on eight specific questions which related to a number of issues raised during the NSW *Environmental Planning and Assessment Act 1979* assessment process for the Russell Vale Colliery Revised Underground Expansion Project. The IAPUM provided a report dated November 2020 containing a discussion of issues related to the project, and specifically containing responses to these eight questions, as listed below:

> *1. In terms of the STC report and Dr Hebblewhite's peer review, are the risk and extent of the predicted subsidence impacts in the catchment reasonable? This needs to be considered in two scenarios:*
> *(i) that all the overlying Bulli Seam pillars have collapsed; and*
> *(ii) that some of the pillars have not collapsed.*

2. Is it likely that the Applicant will be able to develop a Mine Plan and Principal Hazard Management Plan that meets the requirements of the Resources Regulator and limits the level of subsidence to 100mm?

3. Beyond a 100mm target what is likely to be the worst-case local subsidence scenario if residual pillars in the Bulli Seam collapse?

4. Dr Gang Li has made comments and raised concerns relating to the local subsidence impacts and mine stability due to the possible existence of un-collapsed "marginally stable pillars". Are these concerns adequately addressed by the approach proposed by the Applicant and the guidance given in the Resource Regulator's Letter to Commission from Resources Regulator on 16 October 2020?

5. We note that the Resources Regulator has recommended that the applicant undertake investigations to identify and define the existence and distribution of any marginally stable pillars in the overlying Bulli Seam. Are there proven non-invasive methods available to determine the subsurface presence of voids either from existing surface access points or from underground prior to development commencing in sections of the mine which may undercut areas identified as 'unconfirmed' with respect to pillars in the Bulli Seam?

6. To what extent should the status of any voids in sections of the old Bulli workings be determined before mining commences or is it appropriate to do this by measurement (and observation) of abutment stresses once mining commences?

7. Is the claimed stability of the pillars in the current application likely to be realised given the ground conditions expected in the poorer quality coal remaining in the Wongawilli Seam above that part of the Wongawilli Seam that is proposed to be mined?

8. Could any of the above matters be reasonably addressed through conditioning, and if so, how?

Wollongong Coal, together with their consultants – Umwelt and SCT Operations – have reviewed the IAPUM report, and specifically the IAPUM response to the eight questions, including a number of recommendations made by IAPUM to IPC as well as questions raised seeking further information or clarification.

The purpose of this supplementary letter report is to provide a brief, over-arching independent comment on the responses prepared by Wollongong Coal, through both Umwelt and SCT. I can confirm that I had the opportunity to participate in an online discussion with these three parties (Wollongong Coal, Umwelt and SCT) on 25th November, comprising a discussion of the IAPUM Report. I have subsequently been provided with the following two documents:

- SCT Report WCRV5269, dated 27 November 2020, titled: "*Response to Advice from Independent Advisory Panel for Underground Mining"* (received 29.11.2020).

- Umwelt Draft Report, dated November 2020, titled: *"Response to IAPUM Advice"* (received 29.11.2020).

I do not intend to deal with all of the detailed points raised in either the IAPUM Report or the above two responses. I will offer some brief summary observations and an independent professional opinion with regard to these responses.

I confirm that my role as an independent peer reviewer in relation to this project has been undertaken and presented in line with the NSW Department of Planning and Environment's Peer Review Guideline (draft) (2017).

For the purposes of transparency, I make the following declarations:

- I have had no direct involvement in the planning or design of the Russell Vale Colliery Extension Project, other than as providing independent peer review.
- I have been involved in a number of projects involving collaborative work (both of a research and consulting nature) with SCT Operations, over many years, both as an independent consultant, and also through my role at UNSW.
- I am appointed as a member of the Independent Advisory Panel on Underground Mining (IAPUM), subject to appointment to specific projects as required from time to time. Under Conflict of Interest provisions of the IAPUM, I am excluded from any IAPUM role in relation to the Russell Vale Project, by reason of my previous and current independent peer review responsibilities.

Summary Comments

Firstly, I wish to concur with opinions expressed in all of the reports under consideration, that being - that the issue being reviewed, associated with subsidence effects and impacts due to multi-seam mining – is a particularly technically complex issue, and will never be resolved in a totally definitive or black and white form of resolution. It involves considerable degrees of uncertainty, together with some significant levels of interaction between the different seams and surface features. The situation is further complicated by the age of some of the earlier higher seam workings and a lack of detail in relation to some of the mining conditions that may exist after many years.

Having said this, I believe that the earlier studies undertaken by SCT on behalf of Wollongong Coal have addressed the issues involved with an appropriate level of investigation and analysis. I believe that this analysis provides a significant degree of confidence in their design approaches and their recommendations for dealing with the ongoing uncertainties, where they exist.

It is noted by both SCT and Umwelt that the IAPUM was not provided with all of the background documentation for the project. This has led to IAPUM rightly raising some concerns, simply by way of lack of information. Nevertheless, on the basis of other information available to them, IAPUM has drawn some quite appropriate conclusions in many of their responses to the IPC questions raised.

I would particularly like to draw attention to just a few specific issues that I wish to offer further comment on.

Firstly, is the issue of the small group of potentially marginally stable pillars in one section of the old Bulli Seam bord and pillar workings. These are discussed and highlighted in section 2.1.1 of the Umwelt response and the associated mine plan provided, where the pillars in question are shaded in a blue ellipse.

It is important to understand and I seek to emphasise that any potential for future instability of these pillars is considered to be totally independent of any proposed new Wongawilli Seam workings. Even if no Wongawilli Seam workings were to proceed in this region, there is a small risk associated with future failure of these pillars, but it is totally independent of the Russell Vale Expansion Project. The second point to make about these pillars, is that it is understood that there are no significant swamp areas on the surface above these pillars.

The second issue that I wish to add a comment on relates to the mining conditions likely to be experienced beneath the old Balgownie Seam goaf areas or longwall panels. This is one of the technical issues that cannot be totally defined in advance. IAPUM is right to raise some concerns about the anticipated levels of stress that might act on Wongawilli Seam pillars beneath these goaf areas. However, SCT has also drawn on considerable experience of previous multi-seam mining conditions and monitoring and observations, to support their expectation of some degree of stress reduction or shadowing on these underlying pillars, resulting in lower levels of pillar loading. The reality of pillar loading levels will only be known once mining commences in the area.

The important points to make in response to this issue, as has been stated by SCT in their response report, is that firstly, there is no practical, comprehensive and reliable method of pre-determining the state of the overlying goaf areas and hence the underlying stress levels. Observation in the development headings within the Wongawilli Seam will provide the best means of assessing abutment loading conditions and degrees of stress protection or otherwise. Secondly, the proposed bord and pillar mining system is an extremely flexible type of mining where changes can be made to panel layouts at quite short notice, in response to observed conditions. In particular, detailed panel layouts (and pillar dimensions in particular) will be able to be modified in response to these abutment stress observations at the time. This, together with a formalised geotechnical observation and monitoring regime, should be a key feature of the ongoing, risk-based operational adaptive management plan to be adopted by Wollongong Coal. Such an adaptive management plan is critical to the success of this proposed mining system and is also critical to managing the extent of any potentially adverse impacts as a result of mining.

The third point I would like to briefly comment upon is to simply endorse the recommendation of the IAPUM regarding the increase in the threshold level of acceptable incremental vertical subsidence to 300mm, from the more conservative 100mm currently adopted, when considering significant swamp impacts.

Beyond these specific issues where I have chosen to add further reinforcement to what has already been said by both SCT and Umwelt, I am comfortable that the responses by both SCT and Umwelt have adequately and appropriately addressed the issues raised by IAPUM, and this should provide further confidence to the IPC in considering this proposed project, going forward.

Bruce Hebblewhite

Disclaimer

Bruce Hebblewhite is employed as a Professor within the School of Minerals & Energy Resources Engineering, at The University of New South Wales (UNSW). In accordance with policy regulations of UNSW regarding external private consulting, it is recorded that this report has been prepared by the author in his private capacity as an independent consultant, and not as an employee of UNSW. The report does not necessarily reflect the views of UNSW and has not relied upon any resources of UNSW.

APPENDIX D

Summary of Subsidence Monitoring for Russell Vale Underground Expansion Project

SCT Operations Pty Ltd
ABN 23 078 328 953
www.sct.gs

HEAD OFFICE
Cnr Kembla & Beach Streets Wollongong NSW 2500 Australia
PO Box 824 Wollongong NSW 2520 Australia
Telephone +61 2 4222 2777 Fax: +61 2 4226 4884
Email: sctnsw@sct.gs

BRISBANE OFFICE
Telephone 0428 318 009 (international +61 428 318 009)
Email: p.cartwright@sct.gs

BENDIGO OFFICE
Telephone +61 3 5443 5941
Email: s.macgregor@sct.gs

29 November 2020

Gabrielle Allan
Manager – Planning and Assessment NSW
Umwelt (Australia) Pty Ltd
75 York St
TERALBA NSW 2284

WCRV5268_Rev1

Dear Gabrielle

SUMMARY OF SUBSIDENCE MONITORING FOR RUSSELL VALE UNDERGROUND EXPANSION PROJECT

1. INTRODUCTION

Wollongong Coal Limited (WCL) is proposing to mine the Wongawilli Seam in the Russell Vale East (RVE) area of Russell Vale Colliery (RVC) located approximately 9km northwest of Wollongong as part of the Russell Vale Revised Underground Expansion Project (UEP). Umwelt Australia Pty Ltd (Umwelt) are the lead environmental consultant managing the UEP approval process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the NSW *Environmental Planning and Assessment Act 1999* (EP&A Act).

WCL commissioned SCT Operations Pty Ltd (SCT) to assist Umwelt by preparing a consolidated summary of subsidence monitoring for the UEP to inform both the EPBC Act and EP&A Act approval assessment processes.

Umwelt have specifically requested:

1) A description of the ongoing subsidence monitoring program within Wonga East (RVE) area.
2) A description of the proposed subsidence monitoring program for the UEP.
3) A description of any additional subsidence monitoring that may be required in order to identify and differentiate any additional subsidence from Bulli Seam goaf areas from impacts associated with the UEP.
4) Plans showing the location of monitoring and, as relevant, key features such as the seven Bulli Seam goaf areas yet to be confirmed as collapsed.
5) A description of the process for confirming the status of the Bulli Seam goaf areas yet to be confirmed as subsided (noting specifically that this is an existing risk not related to, or exacerbated, by the project).
6) A description of any specific subsidence management measures to be implemented for the UEP.
7) A description of the process for reviewing and validating subsidence predictions.

This letter report provides our preliminary advice and recommendations for these items in consideration of the recommended conditions of approval issued by the NSW Department of Planning, Industry and Environment (DPIE) for the UEP and the NSW regulatory process for underground mining under the *Workplace Health and Safety (Mine and Petroleum Sites) Regulation 2014*.

2. ADVICE AND RECOMMENDATIONS

This advice has been compiled based on our site knowledge and experience from previous site visits in recent years. No specific surface inspections have been undertaken to assess the status of vegetation and other features that may impact the practicality of the suggested monitoring.

2.1 Description of the ongoing subsidence monitoring program

The existing subsidence monitoring program (SMP) for Russell Vale East was prepared in 2015 as required by the Extraction Plan (EP) for Longwall 6 (365m) under MOD2 to the Russell Vale Preliminary Works Project (10_0046).

This existing SMP covers all of Longwall 6 and Longwall 7 based on the mining plan layout being assessed for the UEP application at that time. That is, the Preferred Project Report (PPR) layout with Longwalls 1-3 east of Mt Ousley Road, Longwalls 6 and 7 west of Mt Ousley Road and east of Cataract Creek, and Longwalls 9-11 west of Cataract Creek. Ultimately, only the first 365m of LW 6 was approved.

The EP for Longwall 6 (365m) includes subsidence management plans for Groundwater, Stream, Biodiversity, Upland Swamp, Heritage, Built Features Electricity Transmission Lines and Public Safety over the total length of Longwalls 6 and 7. The monitoring in the SMP for Longwalls 6 and 7 overlaps with that in several of these management plans including the Built Features and Electricity Transmission Lines plans. The subsidence management plans and SMP include reporting and trigger action response plan (TARP) details to manage the impacts from subsidence.

The existing SMP is based on conventional ground measurements of subsidence effects and visual inspections of impacts. No airborne or satellite-based survey techniques are included. Under this SMP, WCL are responsible for surveys on the conventional monitoring lines established along the centrelines (longitudinal) of Longwalls 6 and 7 with three main cross-panel (transverse) lines and a line along the edge of Mt Ousley. The lines generally have pegs at approximately 20m spacings. Other measurements include valley closure across Cataract Creek, crack-meters at the closure slot in Mt Ousley Road, tilt meters on powerline towers and measurements by fixed prism shots of the geometry of the bridge at the Picton Road interchange.

The frequency of surveys is generally pre and post mining for each longwall panel or more frequent based on the likelihood of movements and level of consequence.

For the mining of the first 365m of Longwall 6, additional short lines along the edge of upland swamp CCUS4 were installed and regularly surveyed.

Review of the monitoring of Mt Ousley Road conducted by Roads and Maritime Services (RMS) under the Built Features Management Plan (BFMP) for Longwalls 6 and 7 is overseen by a technical committee of experts. The monitoring includes continuous measurements at the closure slot, weekly pavement inspections and periodic inspections and measurements of other infrastructures sensitive to subsidence movements.

This SMP was prepared on the basis of the expected subsidence behaviour from longwall mining with forecasts for maximum incremental subsidence effects of 2.1m vertical subsidence, tilt of 38mm/m, strain of 23mm/m and 290mm of valley closure across Cataract Creek.

No changes are proposed to Longwall 6 relative to that which was approved under MOD2 to the Russell Vale Preliminary Works Project (10_0046) and EPBC2014/7259. The extraction of the remaining 25 metres approved for mining and the removal of the longwall mining equipment would be undertaken in accordance with the existing approved SMP. This would include the post mining survey of subsidence effects.

The existing SMP is not considered appropriate for the first workings development or bord and pillar mining method proposed by the Revised Preferred Project (RPP) plan with the expected low-magnitude subsidence movements and low risk of significant impacts and consequences.

2.2 Description of the proposed subsidence monitoring program for UEP

With the reduced subsidence effects and impacts expected from the proposed mining method and mining plan layout, a shift from the existing conventional monitoring techniques in the difficult surveying environment above RVE, is recommended. A full-time (continuous) high accuracy ground based system, backed up by accurate aerial or satellite based remote sensing on a regular basis, is considered a better way to measure the expected low-magnitude movements from the proposed Wongawilli Seam mining and possibly larger movements from the collapse of any marginally stable pillars remaining in the Bulli Seam.

The basis of the recommended monitoring for ground and some built features involves the installation of a series of continuous GNSS (GPS) units at single points over the mining panels and on specific infrastructure with regular Interferometric Synthetic Aperture Radar (InSAR) deformation monitoring. The use of airborne LIDAR (Light Detection and Ranging) is also available however is not recommended because, without extensive survey control points on the ground, LIDAR is expected to produce surveys with a tolerance of ±200mm, resulting in up to potentially 400mm difference between two surveys.

These proposed methods are expected to provide more accuracy than the existing conventional monitoring where overall survey control and peg to peg accuracy is reduced by surface constraints and limits on vegetation clearing. The suggested methods are also expected to be cost-effective as the need for conventional ground surveys is reduced. The actual cost would depend on the number of GNSS units deployed and the frequency of InSAR data processing. The number of GNSS units and the frequency of InSAR surveys would be confirmed during preparation of the SMP under the EP for the RPP.

Some existing systems for the monitoring on Mt Ousley Road and closure across Cataract Creek would be retained. These include closure slot monitoring on the pavement. The review of the monitoring of the Picton Road interchange bridge would be conducted in consultation with asset owner (RMS). Some periodic ground surveys at base of the powerline towers are also likely to be retained.

The GNSS units can record the 3D position (XYZ coordinates) continuously to less than ±10mm accuracy. The units could be programmed to provide a record of positioning data on say a daily basis, tracking trends and be set to alert at any exceedance of trigger levels or thresholds.

InSAR could provide deformation updates (changes to the surface topography) at weekly intervals, if required, or longer intervals, depending on mining progress. For example, on a two-monthly, six-monthly or annual timeframe.

2.3 Description of any additional subsidence monitoring

This section describes additional subsidence monitoring that may be required in order to identify and differentiate any additional subsidence from Bulli Seam goaf areas from impacts associated with the UEP.

The proposed GNSS and InSAR survey techniques are expected to be able to identify the subsidence effects in all areas above and adjacent to the proposed Wongawilli Seam first workings, including Bulli Seam goaf areas yet to be confirmed as collapsed.

Once monitoring is established, any additional subsidence effects above Bulli Seam goaf areas over or in close proximity to the active Wongawilli Seam operations are likely to be attributed to the mining of the Wongawilli Seam regardless of the timing of the additional subsidence. It is not considered possible to unequivocally separate those subsidence effects that may involve interaction between the proposed and previous mining and those that may have occurred coincidentally. However, it could be concluded that any observed subsidence levels significantly in excess of that which could reasonably be expected from mining in the Wongawilli Seam are attributable to additional subsidence effects from Bulli Seam goaf areas.

Subsidence impacts are expected to be able to be assessed and quantified based on subsidence movements measured by the proposed survey techniques.

2.4 Plans showing the location of monitoring

This section describes the location of monitoring and, as relevant, key features such as the seven Bulli Seam goaf areas yet to be confirmed as collapsed.

Figure 1 shows the concept of the GNSS units installed for routine monitoring of three continuous miners (CM) forming first workings in the Wongawilli Seam and the Bulli Seam goaf areas yet to be confirmed as collapsed where swamps are located above the proposed workings. The configuration shown assumes one CM unit is operating west of Longwall 6, one CM unit is mining east of Longwall 4 and one CM unit is mining at the eastern edge of the proposed mine plan area. It is recognised that three of the seven goaf areas (#8, 9 and 11) not confirmed as collapsed do not have any substantial areas of swamps above them and would not necessarily be monitored with a GNSS unit but would still be covered by the proposed InSAR technique.

The number of the GNSS units in operation at any one time, the timing of their installation and the locations would be based on consideration of the number of CM units operating, mining sequence and direction, and proximity to sensitive surface features. The timing and location of units would be especially important when mining towards sensitive surface features (i.e. upland swamps, specifically those swamps above Bulli Seam goaf areas not yet confirmed as collapsed) to provide early warning of any increasing subsidence prior to mining below the goaf edges and allow time for any adaptive management practices that may be required to manage impacts.

The GNSS units are flexible with regard to their location but do require a degree of 'open sky' to access visible satellites. The units are portable and reusable so they can be leap-frogged forward as panels advance, moved to the next panel or returned to previous installation points if required.

Similar units are currently installed and operating successfully at a number of mine sites in NSW and Queensland.

2.5 Process for confirming status of Bulli Seam goaf

This section describes the process for confirming the status of the Bulli Seam goaf areas yet to be confirmed as subsided. Any risk associated with potential subsidence in these areas currently exists and is not related to, or exacerbated, by the project.

As shown in Figure 1, it is intended to monitor subsidence movements above areas where it is possible there may be:

- remnant standing pillars remaining in the Bulli Seam
- the pillars have not yet been confirmed as collapsed
- and the overburden strata is not yet confirmed as fully subsided.

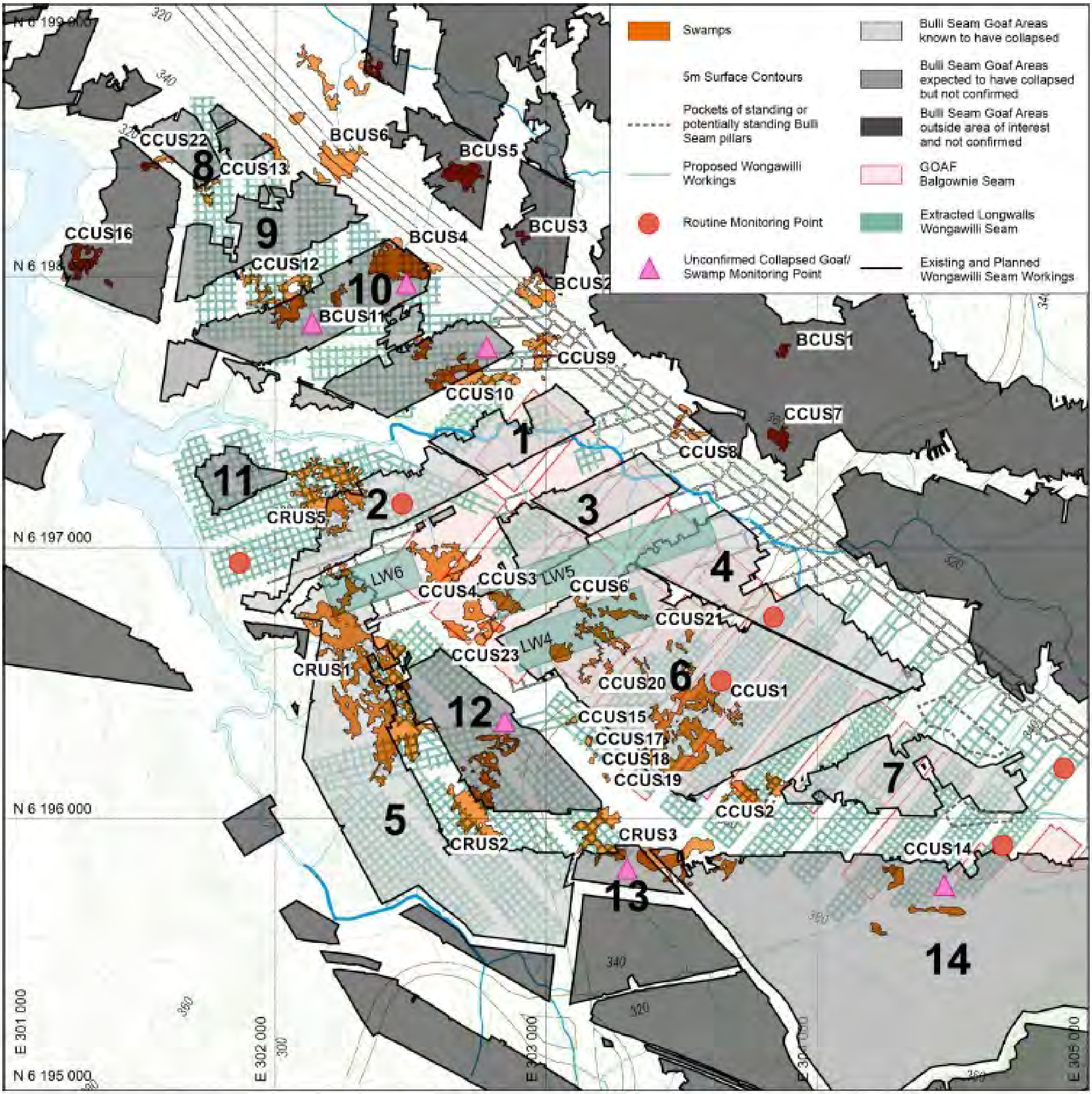


Figure 1: Concept of GNSS monitoring points relative to existing goaf areas and swamp locations.

Underground geotechnical mapping of changes to the observed vertical and horizontal stress conditions, around the edges of the areas shown as goaf on the original Bulli Seam mine plans and record tracings, is expected to be a strong indicator of the status of these areas.

As benchmarks, there are several examples, but three in particular, of areas still currently accessible in RVE where the interaction of an overlying goaf edge with tell-tale signs and impacts of changes to the vertical (and horizontal) stress were experienced.

Evidence of an example from another local mine where the same situation occurred of mining first workings in the Wongawilli Seam up to and then below a Bulli Seam pillar extraction area with significant changes in mining conditions, is also available.

2.6 Subsidence management measures

This section describes specific subsidence management measures to be implemented for the UEP.

The proposed subsidence monitoring survey techniques are expected to provide early warning of the potential for any subsidence effects and impacts greater than forecast.

The proposed mining method is flexible compared to longwall mining and easily adaptable to unexpected or unfavourable mining conditions.

In this case, the use of adaptive management practices including TARPs would allow for immediate changes to the mining layout in response to changes in mining conditions, risk profiles and potential impacts.

Coordinated managements plans for environmental monitoring and inspections that include TARPs associated with regular subsidence observations are expected to be effective in managing the actual subsidence impacts and any consequences.

2.7 Validation processes

This section describes the process for reviewing and validating subsidence predictions.

In addition to incident reporting (e.g. a TARP exceedance), the draft (unpublished) "Guidelines for the Preparations of Extraction Plans" issued by the Department of Planning & Environment, NSW Trade & Investment – Division of Resources and Energy, require subsidence impact reporting on a bi-monthly (every two months), six-monthly and annual basis.

The SMP required under an EP for the RPP is expected to include, amongst other things, provisions to ensure the mine operator manages risks to health and safety associated with subsidence as required by Clause 67 of *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014.*

Clause 67 (2), requires monitoring of subsidence to be conducted, including monitoring of its effects on relevant surface and subsurface features, and any investigation of subsidence and any interpretation of subsidence information is carried out only by a component person.

On this basis, it is suggested that subsidence effects and impacts are reviewed and validated for compliance with forecast by a component person and reported at the end of a panel (or significant milestone in mining of the underground layout) and/or annually as a minimum.

If you have any queries or would like further clarification of any of these issues, please don't hesitate to contact us.

Yours sincerely

Stephen Wilson
<u>Mine Planner</u>

Ken Mills
<u>Principal Geotechnical Engineer</u>

3. REFERENCES

SCT 2019. "Russell Vale Colliery: Subsidence Assessment for Proposed Workings in Wongawilli Seam at Russel Vale East" SCT Report UMW4609 - 3 October 2019.

SCT 2020 "IESC 2019-108: Quantitative Assessment of Risk of Pillar Failure in Russell Vale East Area" SCT Report WCRV5111_REV4 – 12 June 2020.

APPENDIX E

Predicted Subsidence Impacts at Swamps from Balgownie and Bulli Seam Workings

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

Environmental & Social Consultants

Newcastle | Perth | Canberra | Brisbane | Sydney | Orange

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au

ATTACHMENT 2 – PRESENTATION TO BCD

WOLLONGONG COAL

Russell Vale Colliery
Revised Underground Expansion Project (UEP)

BCD Presentation
May 2021

Outline

- Conceptual Ecohydrological Model
- Impact Pathway Considerations
- IAPUM Advice
- Applicability of Offsets Policy
- Approach to monitoring and TARPs

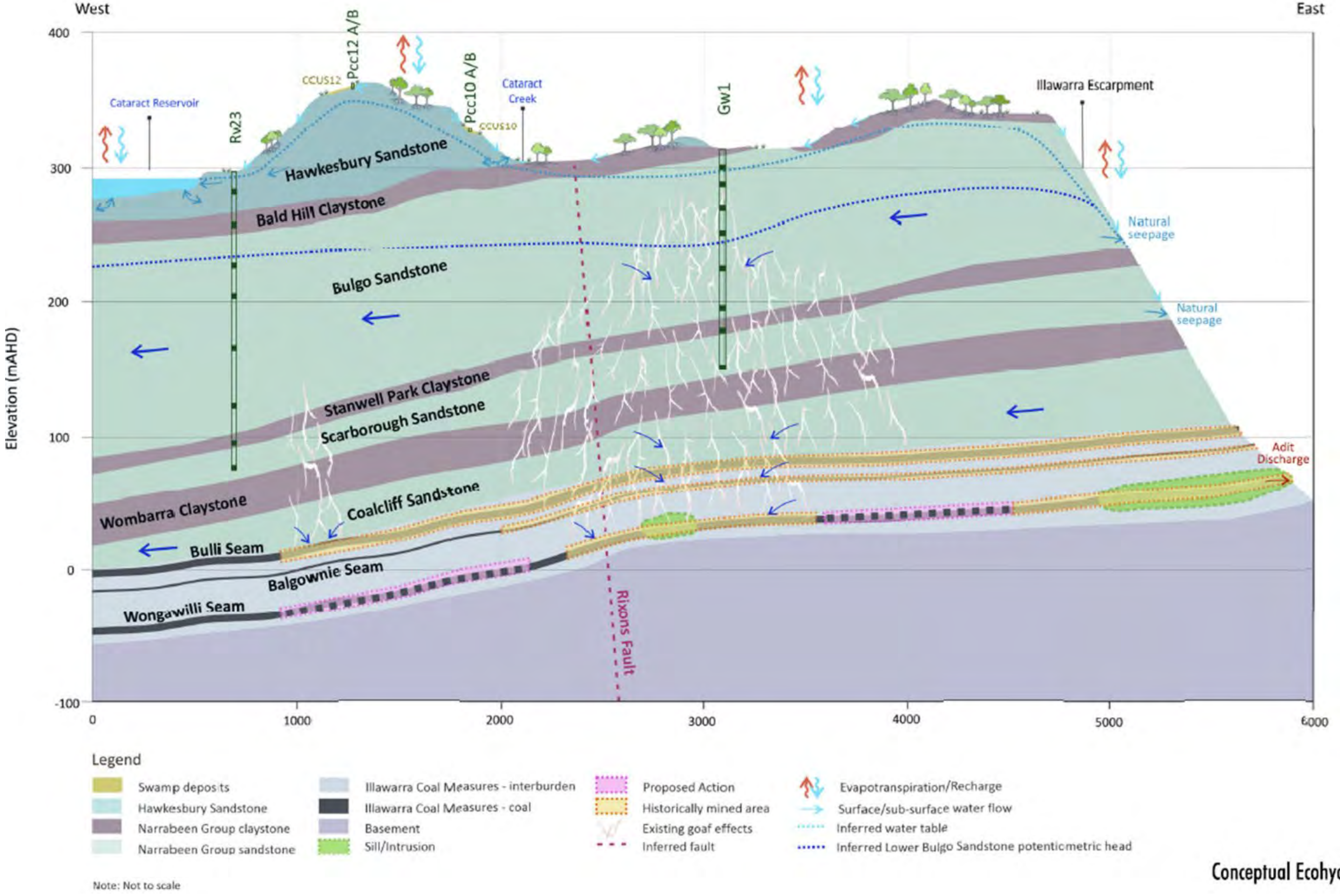


FIGURE 8.5

Conceptual Ecohydrological Model

Impact pathway considerations

Significant difference between what is proposed and potential impacts on swamps from longwall mining

- Longwall mining has potential to impact:
  - underlying water table through goaf fracturing,
  - Integrity of low permeability barrier at base of swamp (perched)
  - Significant terrain changes within swamps that can affect surface run-off, erodibility and drainage
- Proposed action, with no longwall mining, is significantly different:
  - No additional goaf as no secondary extraction (i.e. no longwall mining and no pillar extraction)
  - Incremental near surface depressurisation effects limited to areas of depressurisation caused by former longwall mining (LWs 4, 5 and 6). The increased drawdown predicted is associated with delayed recovery due to extended period dewatering and larger void
  - Potential surface expression of subsidence (<100mm) unlikely to have any significant impacts of swamps
  - Very minor tensile strain impacts predicted – consideration of cumulative impacts

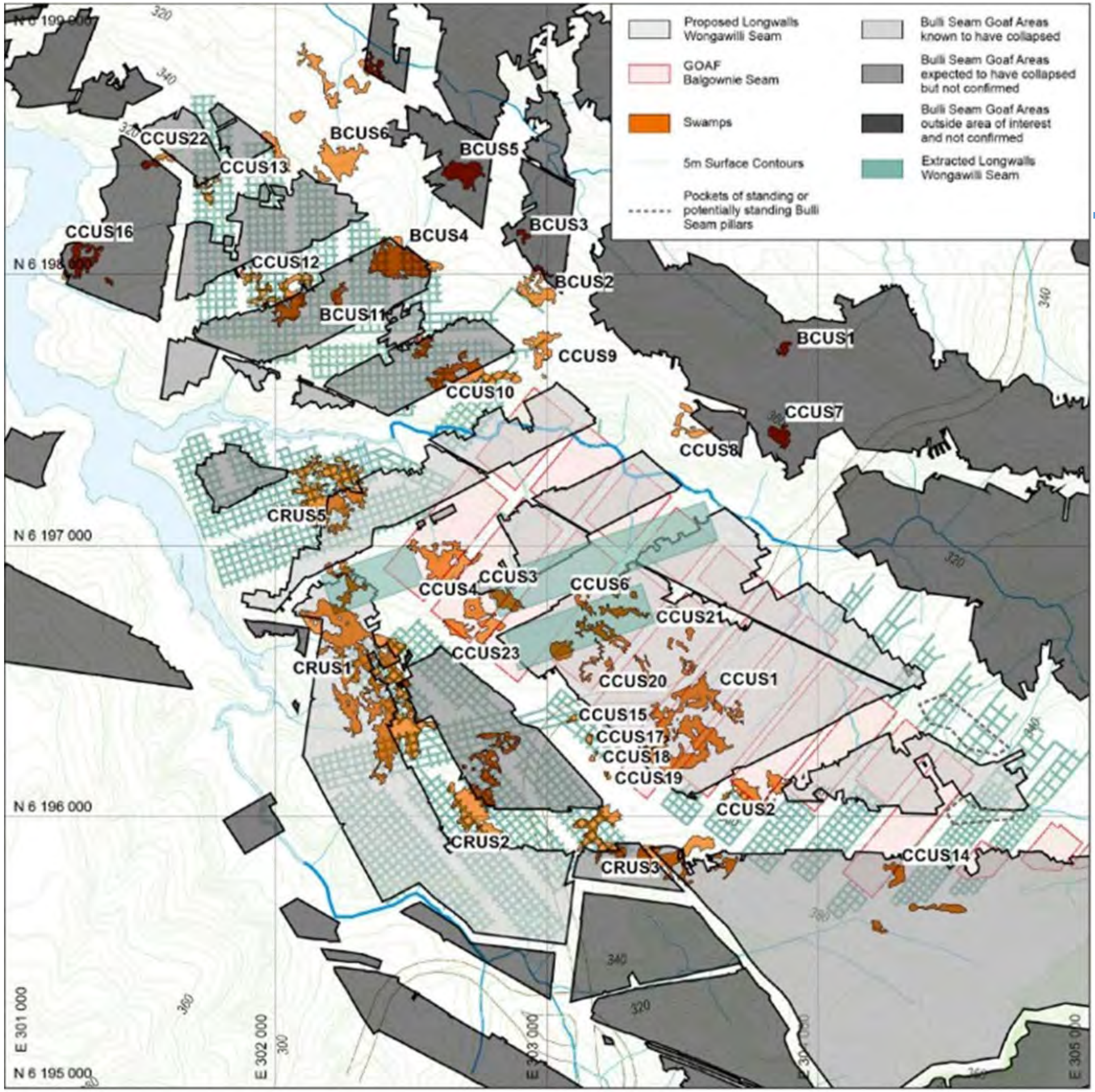


Figure 2: Location of Upland Swamps relative to historic and proposed mining.

Swamps – IAPUM Advice

Pg 7

"Based on experience in the Sydney Basin Biogeographic Region, the Panel associates catastrophic loss with a reduction in the capacity for a swamp to retain its water table and soil moisture that is so severe as to cause the swamp flora species to be replaced by species representative of dry heath or woodland. This process is exacerbated by bushfires since dry swamps and their organic-rich sediments are susceptible to very hot burns, as evident by the fires in the Western Coalfield late last year (see, for example Keith et al. (2020)). The Panel is not aware of this degree of consequence having been experienced over the workings of Russell Vale Colliery in the more than 130 years that the mine has been in operation."

Swamps – IAPUM Advice

Rather, it appears that in the area of this proposal (the Wonga East area of Russell Vale Colliery), mining operations in the Bulli and Balgownie Seams have not resulted to date in adverse consequences for swamps that can be linked unequivocally to mining impacts. Three reasons postulated for this outcome in previous approval processes (e.g. DoP (2014)) are:

1. *The magnitude of the subsidence impacts, principally tensile cracking, are not sufficient to cause a significant change in swamp moisture content.*
2. *Loss of swamp water through tensile cracks is compensated for by (high) rainfall on the escarpment.*
3. *If the swamps have had vertical drainage increased due to undermining, the mix of flora species in the swamps has changed over the decades to adapt to the modified soil moisture conditions and gone unnoticed due to a lack of monitoring; the sub-communities may have altered (for example, from cyperoid heath to banksia thicket) but still are within the Coastal Upland Swamp Ecological Community.*

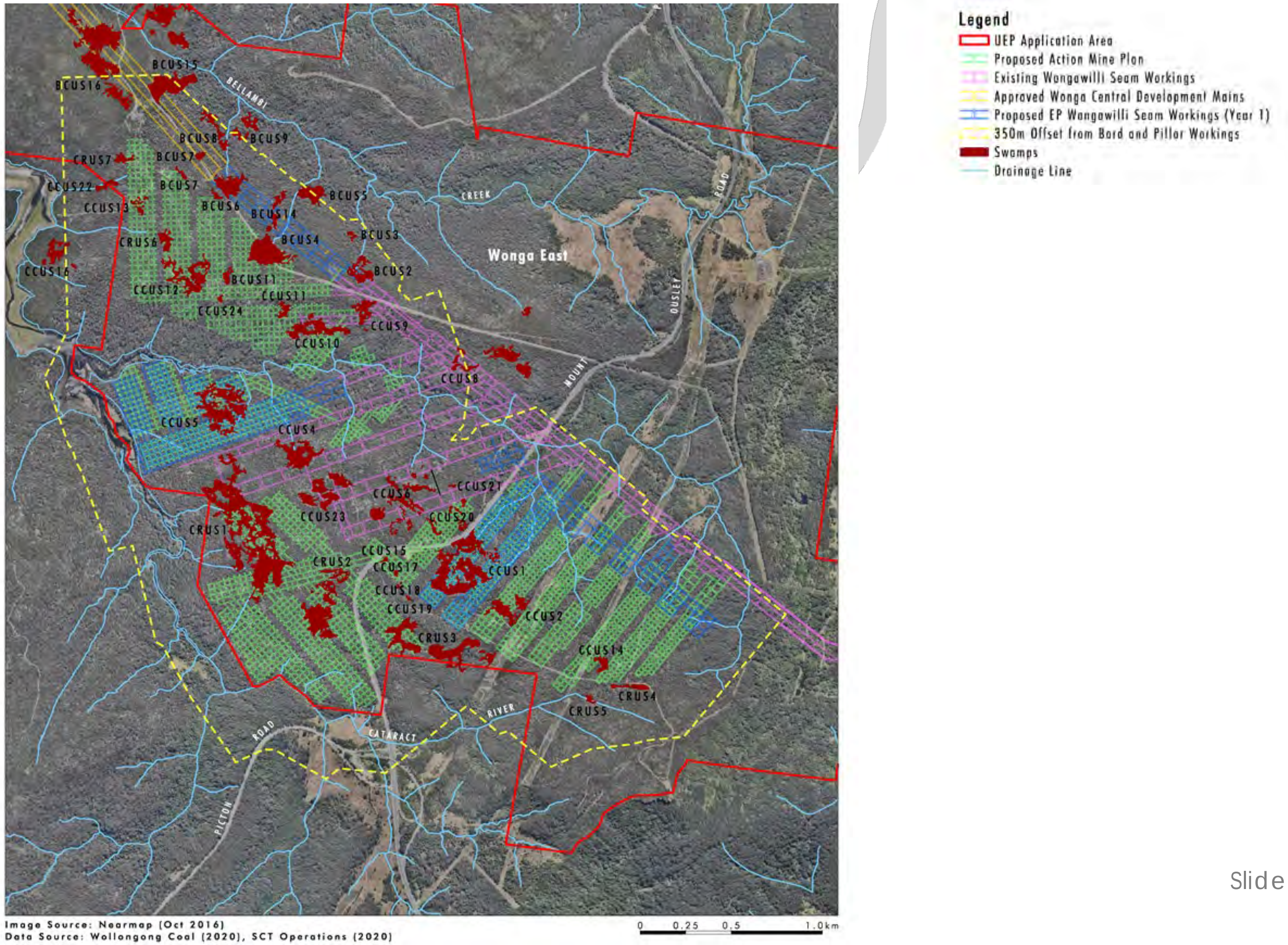
Swamps – IAPUM Advice

Pg 12

"It is concluded that:

- *even allowing for those swamps overlying goaves where it is yet to be 'proven' that vertical subsidence has not been impeded by marginally stable pillars and, therefore, would be less than estimated in Table 3, the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible……..*
- *…..based on historical performance, the failure of standing pillars in the Bulli Seam is extremely unlikely to result in catastrophic loss of a swamp (noting that the values for these swamps in Table 3 would need to be reduced accordingly if they are in fact located over pillars that are still standing). "*

Coastal Upland Swamps within 350 m of Proposed Bord and Pillar Workings



Swamps

- Critical issue is retention of vegetation communities which are consistent with listing criteria
- Swamps vary in size and level of impact from previous mining
- Specific baseline vegetation and hydrological monitoring undertaken will be informed by risk profile for swamp – noting that predicted impacts from mining indicate extremely low risk of adverse impact
- Existing reference swamps available and will be used in program
- Monitoring from all swamps across mining domain will be to inform triggers and investigations – deviations from trends observed

Application of Swamp Offset Policy

- Offset policy developed for longwall mining – not really relevant to proposed bord and pillar mining
- Impacts from longwall mining more likely but difficult to predict with any accuracy.
- No credible impact pathway from proposed mining
- ‘Primary monitoring’ has limited application as being definitive of impacts from proposed monitoring.
- Swamp characteristics and duration of piezometer data in swamps
- ‘Secondary’ monitoring - vegetation extensive: 2 years of baseline vegetation monitoring data is available at 12 Swamps over proposed mining area (including CCUS1 and CCUS5) + reference swamps

Key impact pathway/monitoring/trigger considerations

- No material changes to swamp terrain
- No predicted impacts to rock bars
- Variability within swamps and generally dry nature of upper and edge areas
- Increased loss to underlying sandstone via tensile cracking near impossible to detect against natural (existing) variability
- Ephemeral nature of swamps (existing monitoring indicates unsaturated conditions approximately 47% of the time) means triggers are reliant on interpretation of changes in water levels following rainfall events – large statistical uncertainty and highly unlikely to be indicative of impact from mining
- Nature of subsidence development means any impacts will only be observable after undermining has occurred, but subsidence monitoring would be the lead indicator of changes.
- Any impacts are unlikely to extend to entire swamp area

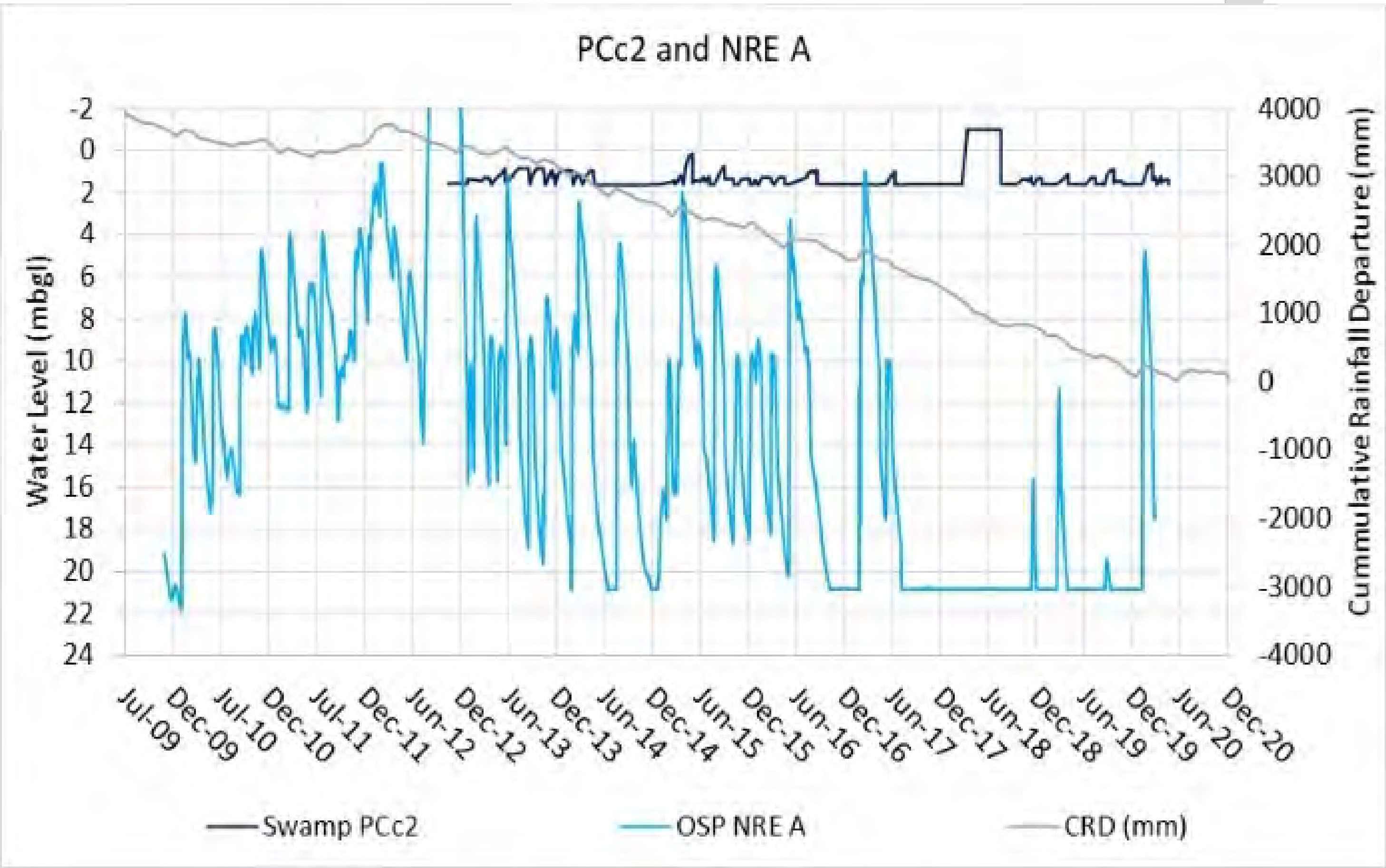
Limitations of Primary Monitoring

- Swamps are perched systems with little to no reliance on underlying water table – no ‘baseflow’ contribution
- Swamps are ephemeral in nature and do not have persistent water tables that can be monitored to reliably identify new impact from mining
- Potential impacts limited to ‘faster’ loss of saturation due to tensile cracking - significant statistical analysis required to identify any departures from existing conditions and large variability in data preclude definitive conclusions from data
- Rainfall recharge in eastern areas of escarpment likely to far outweigh any losses to underlying low permeability strata – particularly given existing observations regarding water levels in swamps

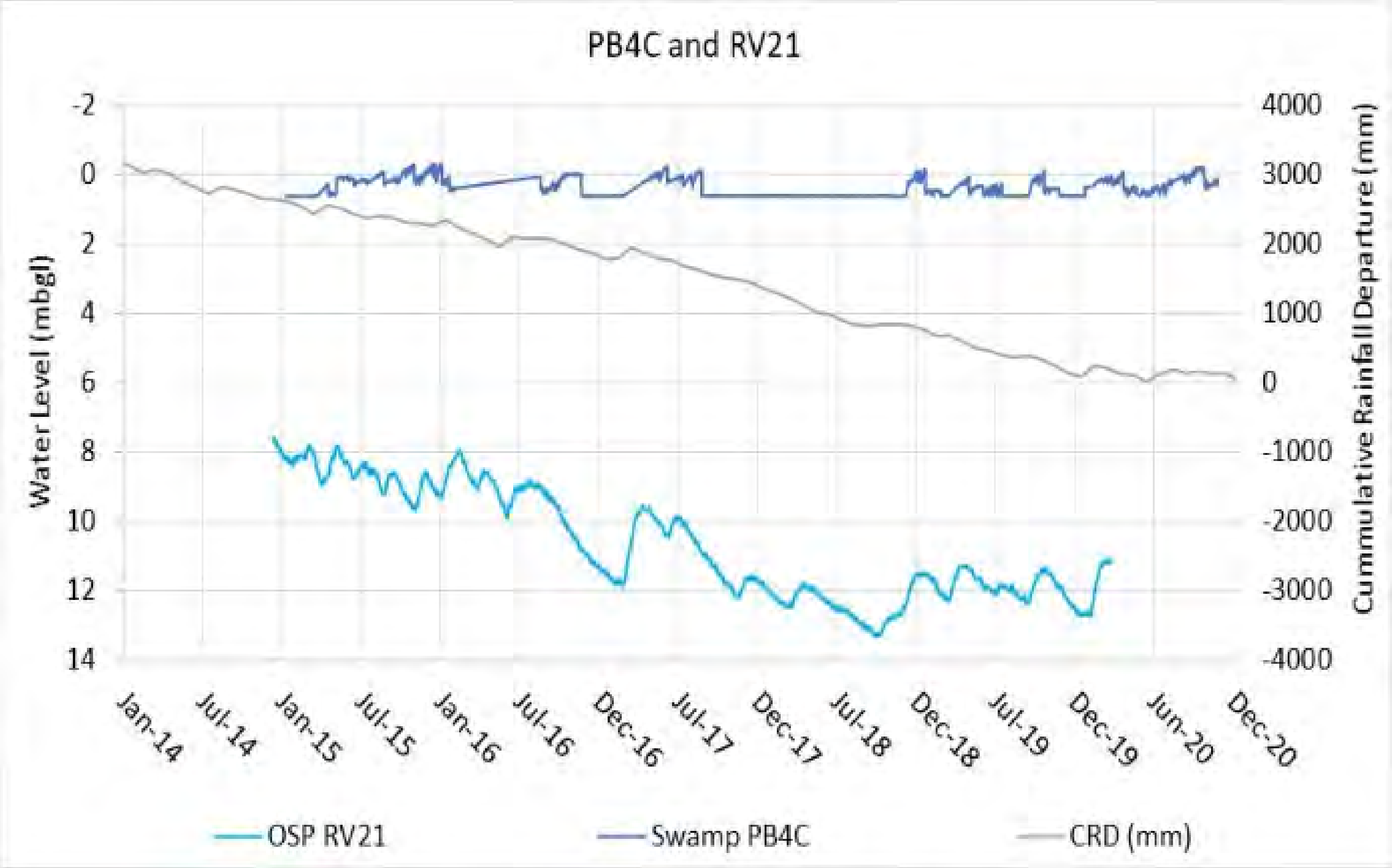
Impact Indicators - GW

- Lead indicators will include subsidence monitoring – Subsidence Monitoring and performance of the bord and pillar mine method to minimise potential for subsidence impacts
- Potential groundwater indicators include:
  - Lower water levels than expected following rainfall event (large natural and spatial variability)
  - Faster reduction in water levels (large natural and spatial variability)
  - Reduced outflows from swamps (not present or diffuse for many swamps and volumes miniscule and highly variable in others)
  - Faster loss of soil moisture within swamps (large natural and spatial variability – trend analysis possible but data is complicated and a delayed indicator)
  - All swamp groundwater monitoring is a lagging indicator and limited use for adaptive management (other than informing future mine planning)

CCUS2


PCc2 and NRE A
Water Level (mbgl)
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
Cummulative Rainfall Departure (mm)
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
Jul-09
Dec-09
Jul-10
Dec-10
Jul-11
Dec-11
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Swamp PCc2
OSP NRE A
CRD (mm)

BCUS4



PB4C and RV21
Water Level (mbgl)
-2
0
2
4
6
8
10
12
14
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
Cummulative Rainfall Departure (mm)
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Dec-16
Jul-17
Dec-17
Jul-18
Dec-18
Jul-19
Dec-19
Jun-20
Dec-20
OSP RV21
Swamp PB4C
CRD (mm)

Swamps Specific Water Balances

- Swamps are typically dry for large periods of time – behave like an ephemeral system with saturation occurring after rainfall.
- Large degree of uncertainty in any swamp specific water balance(SSWB) due to variable depth, assumptions regarding leakage, variable evaporation rates across swamps, extrapolation of piezo data to large swamp area
- Limited to no reliance on ‘baseflow’ contribution from underlying water table
- SSWB would have limited utility for use as triggers due to uncertainties and nature of potential impacts
- SSWBs will be *considered* as part of investigation toolkit if monitoring indicates potential impact however usefulness is considered unlikely in most circumstances

Summary

- Given limited impact pathways and large variability in baseline data, groundwater monitoring within swamps has limited utility as a predictor of impacts.
- At best – observed changes in monitoring is an indicator of a *potential* impact which warrants further investigation
- Lagging indicator
- Limited utility as a trigger for adaptive management, however can inform future mine planning to avoid similar impacts in future

Impact Indicators - vegetation

- Vegetation Monitoring
  - Long period of baseline data and established statistical analysis processes
  - Lagging indicator but directly evidence of an impact to swamps
  - Can be supplemented by premining delineation of swamp extents and BAM plots to inform any future offsetting considerations.
  - Nature of subsidence impacts means impacts may vary across swamp. Catastrophic failure of entire swamp ‘hardly credible’.

Proposed Monitoring and TARPS

- Except in unlikely event of significant pillar failure, almost impossible for observed changes in monitoring data to be linked to mining without further investigation
- Limited ability to implement mitigation measures if impacts observed
- Combination of subsidence, vegetation and groundwater monitoring likely to be required to identify any impacts and attribute to mining
- In absence of credible impact pathway – presumption should be that single monitoring point observed changes are 'natural'.
- Statistical thresholds used to identify unlikely changes which warrant further investigation.

Proposed Monitoring and TARPS

- Subsidence monitoring to detect levels of subsidence higher than predicted which may alter assumptions about negligible impacts
- Vegetation monitoring to detected changes in swamp communities (species richness, health, extent)
- Groundwater monitoring to inform investigations of causal factors behind any changes in vegetation and as a trigger for increased monitoring if indicative of ‘potential’ impact.
- Adaptive Management TARPs
- Performance Measure TARPs

Subsidence monitoring

- 100mm adopted as performance measure for CCUS1,CCUS6,CCUS20 and CCUS21 due to pre-existing mining impacts.
- 100 mm adopted as investigation/adaptive management trigger for other swamps.
- Informed through GNSS and subsidence monitoring within swamps and leading up to swamps – high frequency and broad spatial coverage.

Subsidence monitoring

GNSS accuracy expected to be at least +/- 10mm (+/- 5mm achieved at Metropolitan Colliery)

- +/- 10mm for subsidence monitoring (reported accuracy of sub-mm). Accuracy improved through repeated survey.
- Baseline ahead of mining established through both GNSS (single point measurements over proposed mining area) and subsidence monitoring (whole area) with triggers established around impact predictions. Combination of methods provide broader, more accurate and timely coverage than conventional ground based survey.

Subsidence monitoring

- GNSS provide early warning (daily readings) of above expected subsidence
- Amended pillar design and avoidance of further mining under sensitive surface areas have high effectiveness – informed through TARP.
- May not be necessary to avoid mining below any remnant pillars if risk assessment indicates high degree of confidence that pillar failure would not result in performance measures being exceeded (noting that pillar failure will almost certainly occur at some point in the future if project does not proceed)

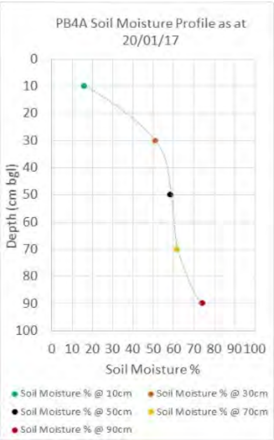
Groundwater Monitoring - Swamps

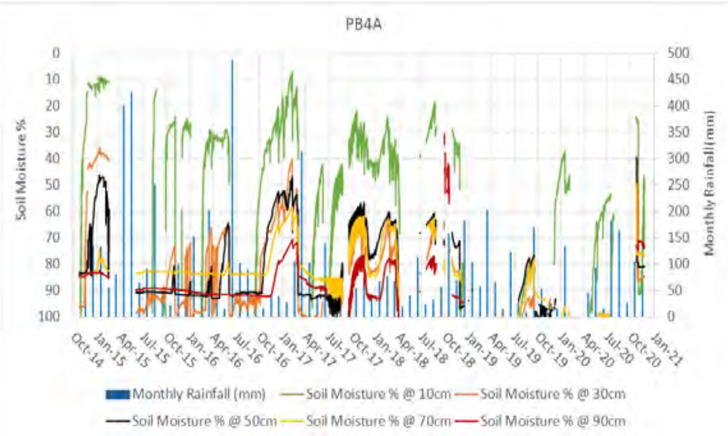
- Shallow Swamp Piezometer: Existing piezometers indicate the swamps are often unsaturated, and the occurrence of groundwater varies between and within the swamp clusters. Some swamps, particularly those in the middle of a large swamp cluster, show a good response to rainfall events. Monitoring will be conducted at all monitoring points, and site specific water level triggers assigned for the more saturated monitoring locations to enable analysis of any changes in conditions during mining, to inform adaptive management practices.
- Paired bores: Used to assess potential interactions between swamp aquifers and water table within underlying sandstone aquifer. Not used as triggers other than for GW drawdown purposes.
- Moisture Probes: Assist in investigation of any observed changes to vegetation or water levels. Not used as triggers due to the variability within and between swamp clusters, but potential for use as a trigger in subsequent EPs if able to be used to detect trend changes relative to other sites.
- Water Quality Data – Swamp Piezometers: Assist in identifying any changes in groundwater quality within the swamp which may indicate an impact. Additional sampling can also be undertaken to inform environmental tracer studies if considered warranted.
- ***Water Quality Data – Shallow sandstone bores***: Inform environmental tracer studies if required.

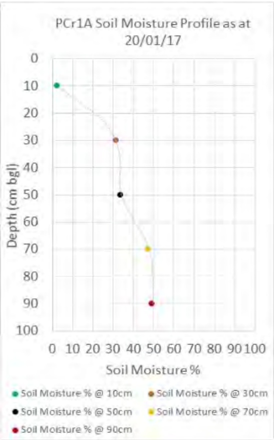
Swamp Water Characteristics

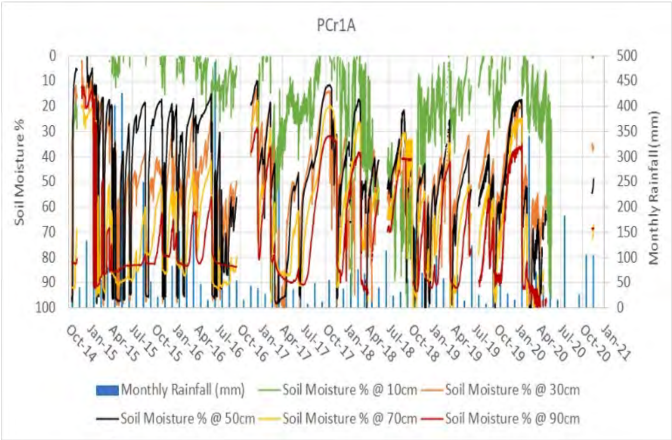
Monitoring of the soil moisture and water level within swamp deposits is conducted in RVE UEP at swamps BCUS4, CCUS10, CCUS12, CCUS4, CCUS5 and CRUS1. It is noted that there are currently no monitoring sites at swamps CCUS1, CCUS14, CCUS20, CCUS21, CRUS2 and CRUS6. Additional monitoring sites for these locations have been proposed.

Soil moisture is measured with Odyssey SM probe which measures the dielectric constant of moist soil to determine the moisture content. Probes are typically 1 m deep with five sensors typically at 10, 30, 50, 70 and 90 cm below surface. The data shows a good correlation between increasing moisture content in response to rainfall events, with the highest rainfall generally occurring within the summer to autumn months from February to March. Some data gaps are visible intermittently in the graphs. These are due to instrument error related to the age of equipment; the swamp soil moisture probes were replaced across the site in November 2020 to enable ongoing monitoring.

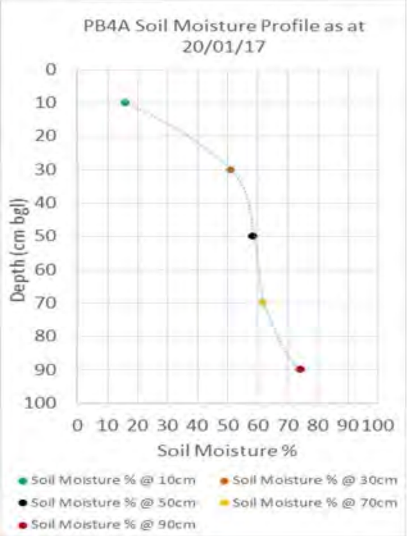


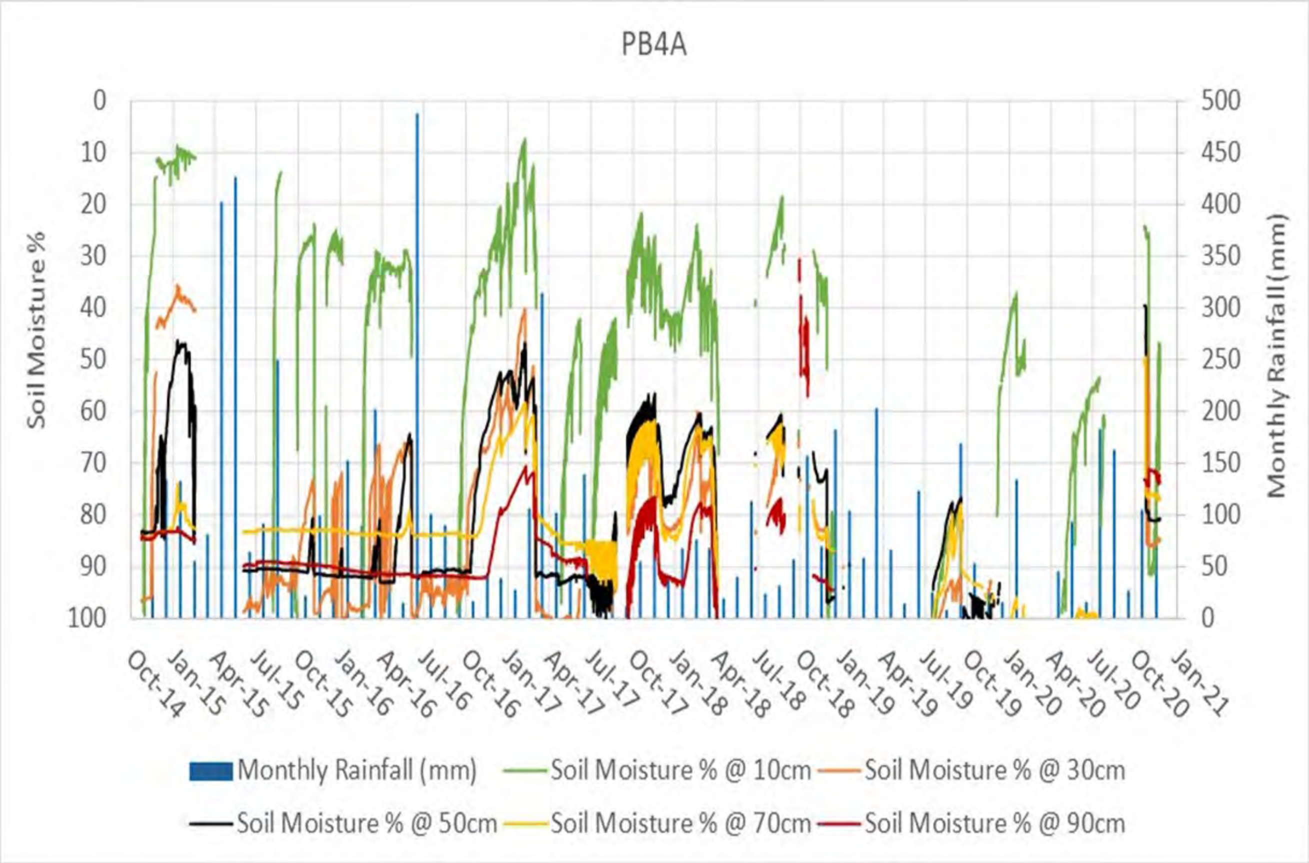




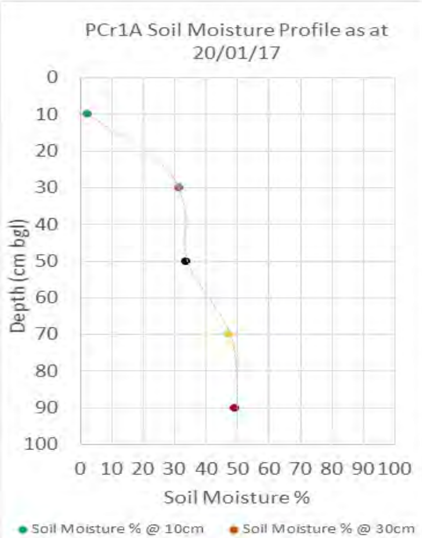


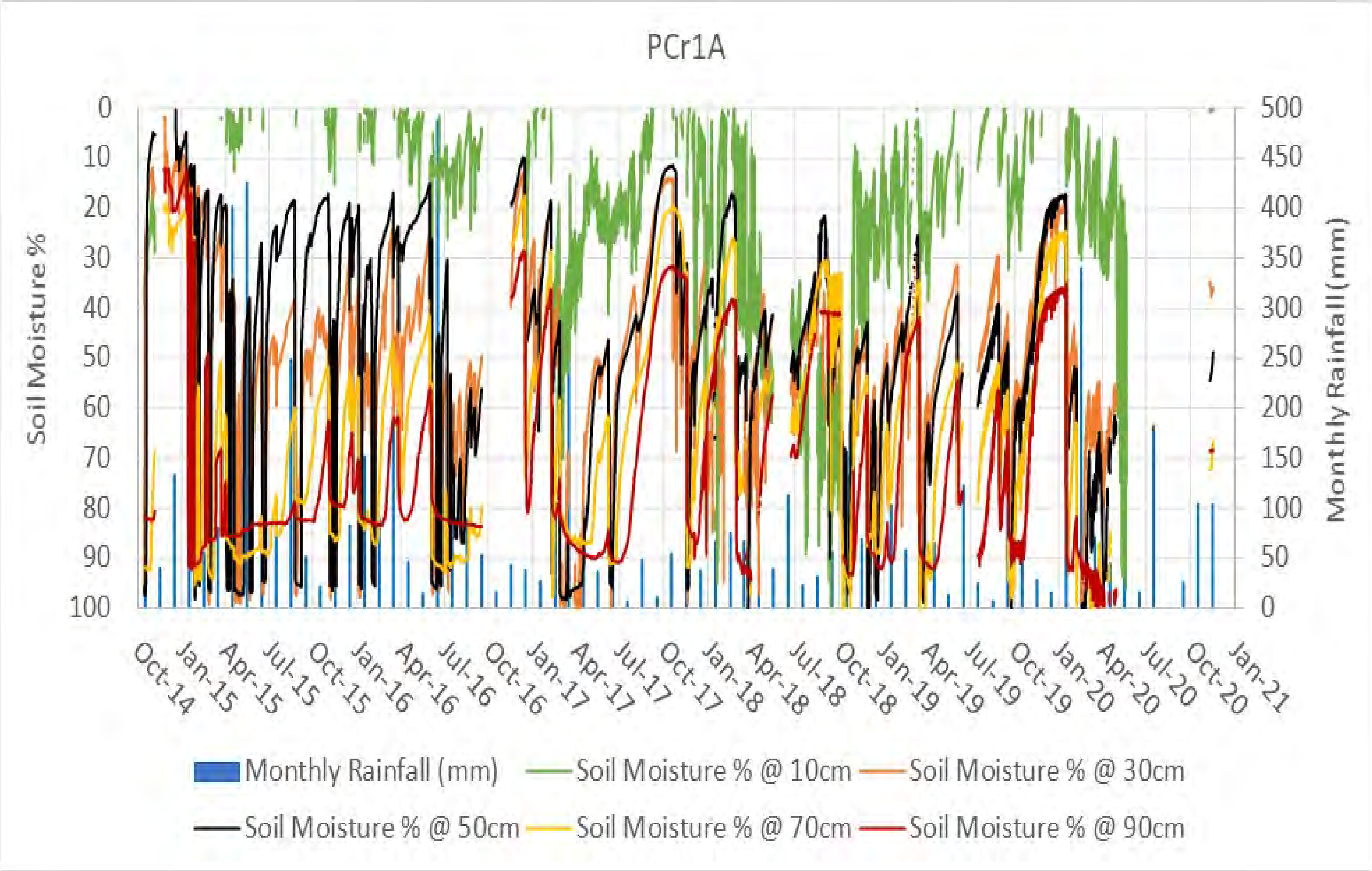
Soil Moisture – BCUS4





Soil Moisture – CRUS1



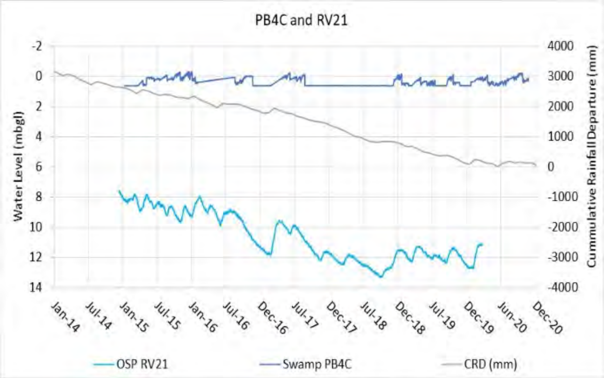


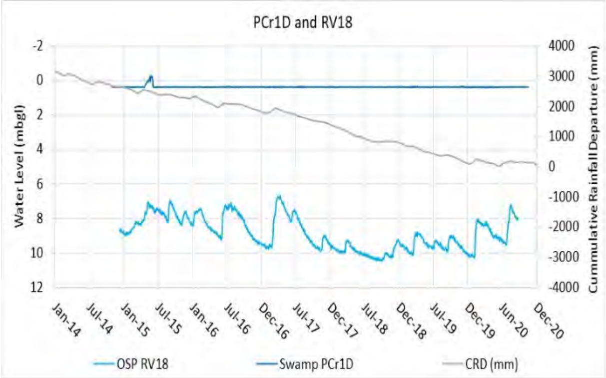
Swamp Water Characteristics

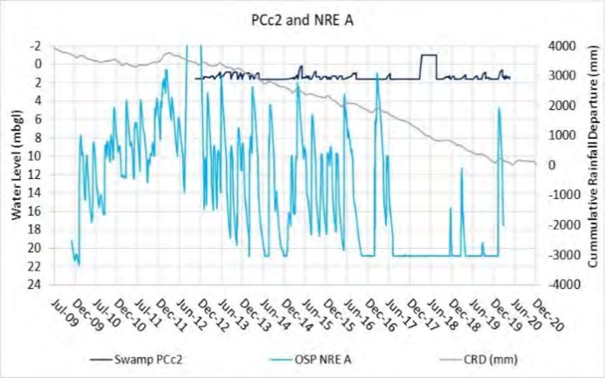
Water level trends for site monitoring piezometers show a good correlation to rainfall trends, with water levels in the swamps rising to at or near surface generally in response to rainfall (i.e. over 100 mm/month). Across the RVE swamp monitoring network the available manual dipped water levels indicate unsaturated conditions approximately 47% of the time. For periods when the swamps are saturated, the median (50th percentile) of readings indicates water present around 0.57 m below surface.

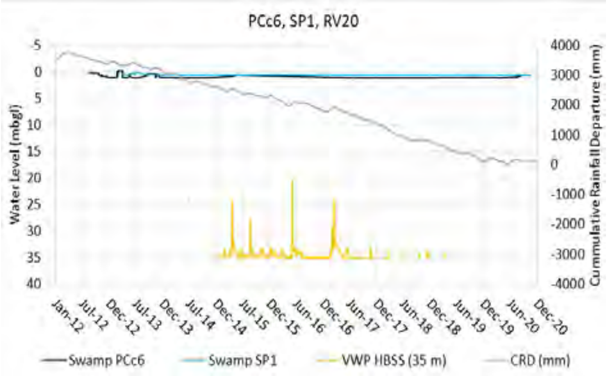
The swamps are recharged from rainfall and shallow surface flow; however, the site data also shows variability in the response to rainfall between the different swamp monitoring. Dry bore conditions generally correspond to low rainfall periods (i.e. below 10th percentile of monthly rainfall, 20 mm rainfall per month), and appears to be more prevalent for monitoring points at the edge of swamp clusters. Other factors such as the slope aspect and localised disturbance (i.e. tracks and historical subsidence impacts) also influences water level and soil moisture conditions.

The swamps at site are generally perched, meaning they are hydraulically separated from the lower Hawkesbury Sandstone regional water table. There are existing paired bores within the underlying Hawkesbury Sandstone at swamps CRUS1 (PCr1D and RV18), BCUS4 (PB4C and RV21), CCUS2 (PCc2 and NRE A) and CCUS6 (PCc6, SP1, RV20). The baseline data for the open standpipes show that the water heads in the Hawkesbury Sandstone are generally 1.5 m to 28.9 m below surface.









Swamp Triggers

Swamp Trigger Site	Trigger Level			
	Field pH[1]	Field EC (µS/cm)[2]	Standing Water Level[3] (mbTOC)	Standing Water Level (mbgl)
PB4A	3.8 – 6.3	193	2.64	1.29[3]
PCc10A			2.22	0.56[3]
PCc10B			2.57	0.90[3]
PCc12A			2.37	0.70[3]
PCc2			2.56	1.60[3]
PCc4C			2.98	1.05[3]
PCc5B			2.70	1.13[3]
PCr1B			2.26	0.68[3]
PCc1A*			-	0.57[4]
PCc1C*			-	0.57[4]
PCc6B*			-	0.57[4]
PCc14A*			-	0.57[4]
PCc20*			-	0.57[4]

Notes:

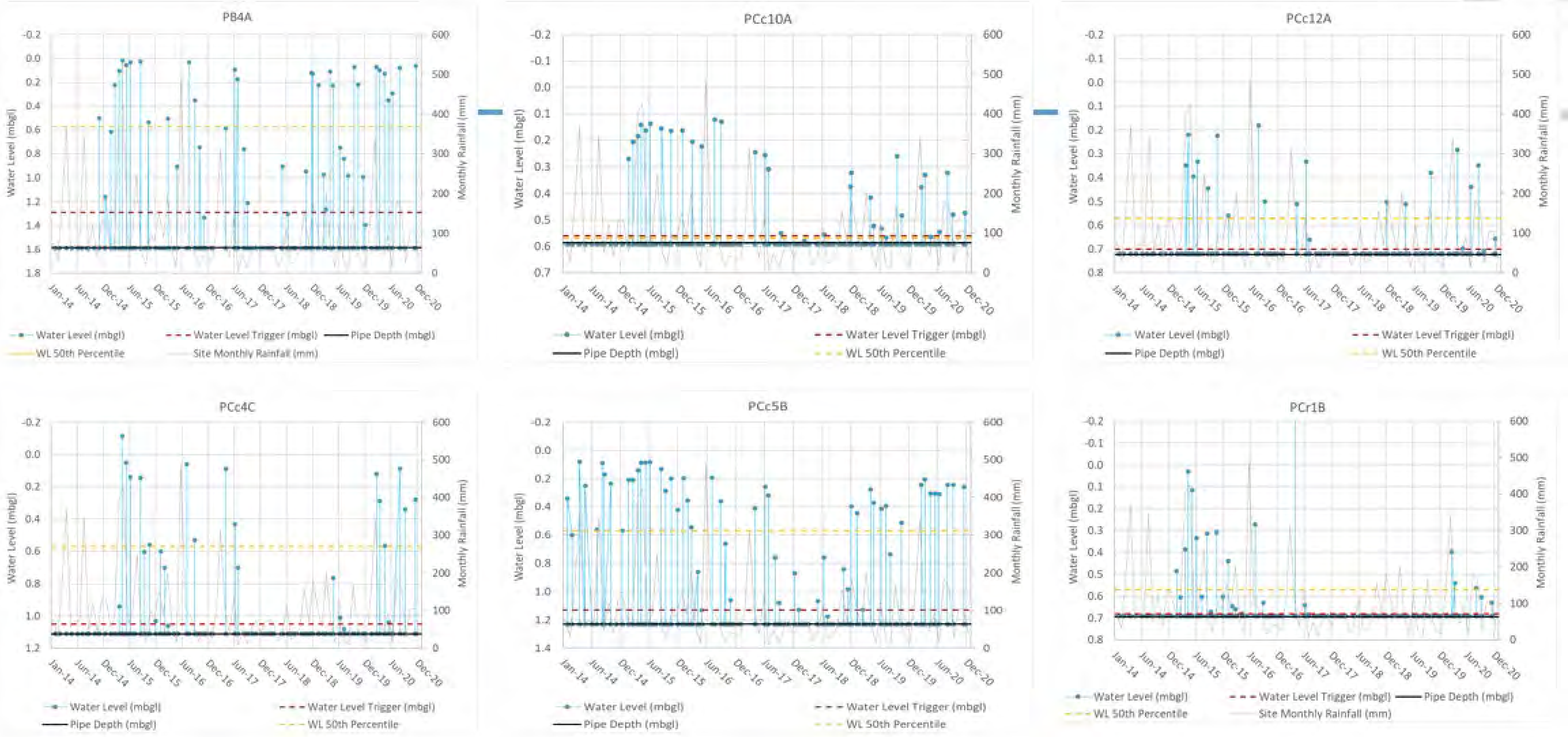
1. pH trigger based on 5th and 95th percentile baseline data for RVE swamps. Trigger criteria of consecutive readings (based on criteria level) recorded outside trigger level for prescribed trigger bores

2. EC trigger based on 95th percentile baseline data for RVE swamps. Trigger criteria of consecutive readings (based on criteria level) recorded outside trigger level for prescribed trigger bores

3. Standing water level (water depth) trigger based on individual bore 95th percentile baseline depth to groundwater (below groundwater level and top of casing). Trigger criteria of consecutive manual readings recorded outside trigger level (based on criteria level) and not related to natural rainfall trends – as indicated by monthly rainfall of less than 20 mm

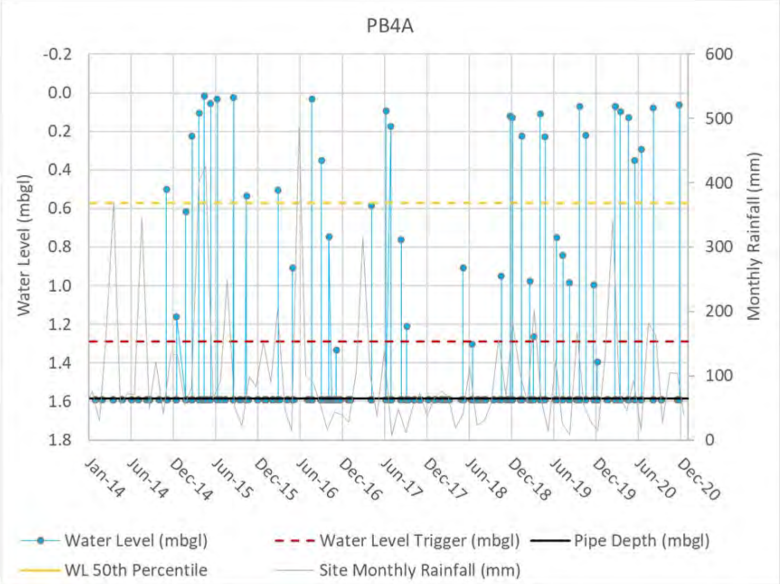
4. Standing water level (water depth) trigger based on 50th percentile baseline data for RVE swamps water level (below groundwater level and top of casing). Trigger criteria of two consecutive manual readings recorded outside trigger level (based on criteria level) and not related to natural rainfall trends – as indicated by monthly rainfall of less than 20 mm

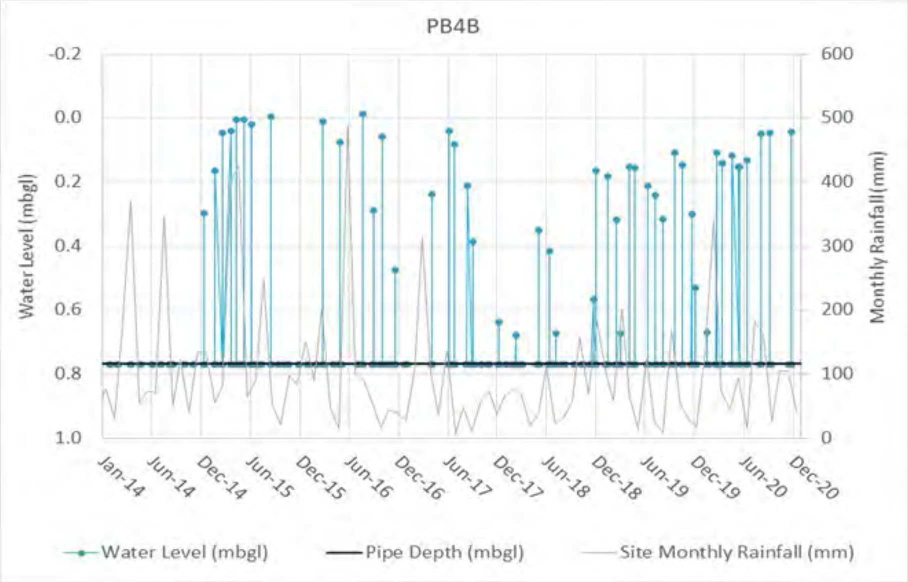
* proposed swamp piezometer

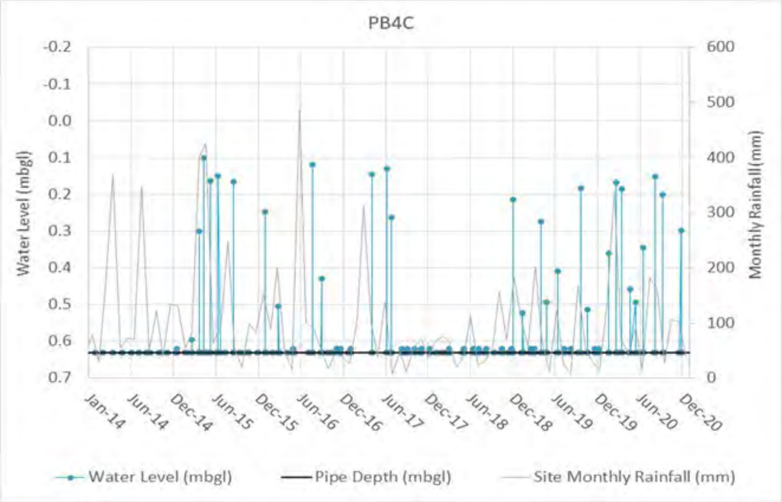


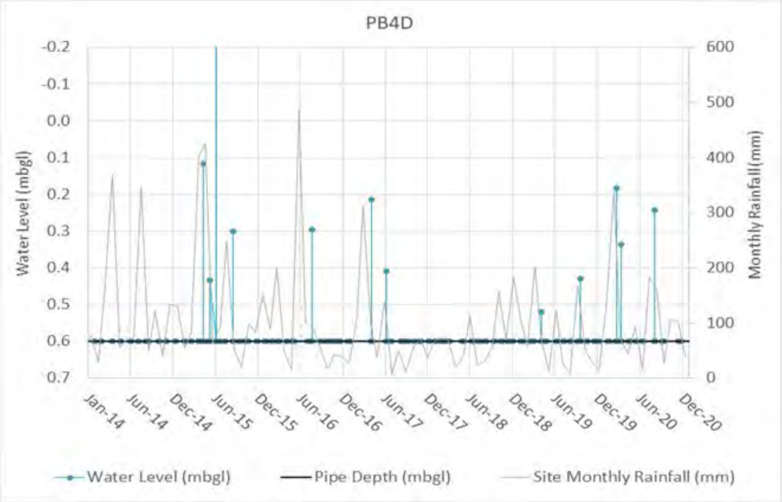
Graphs showing manual recorded water levels in swamp piezometers with individual site trigger and default trigger for new sites

BCUS4

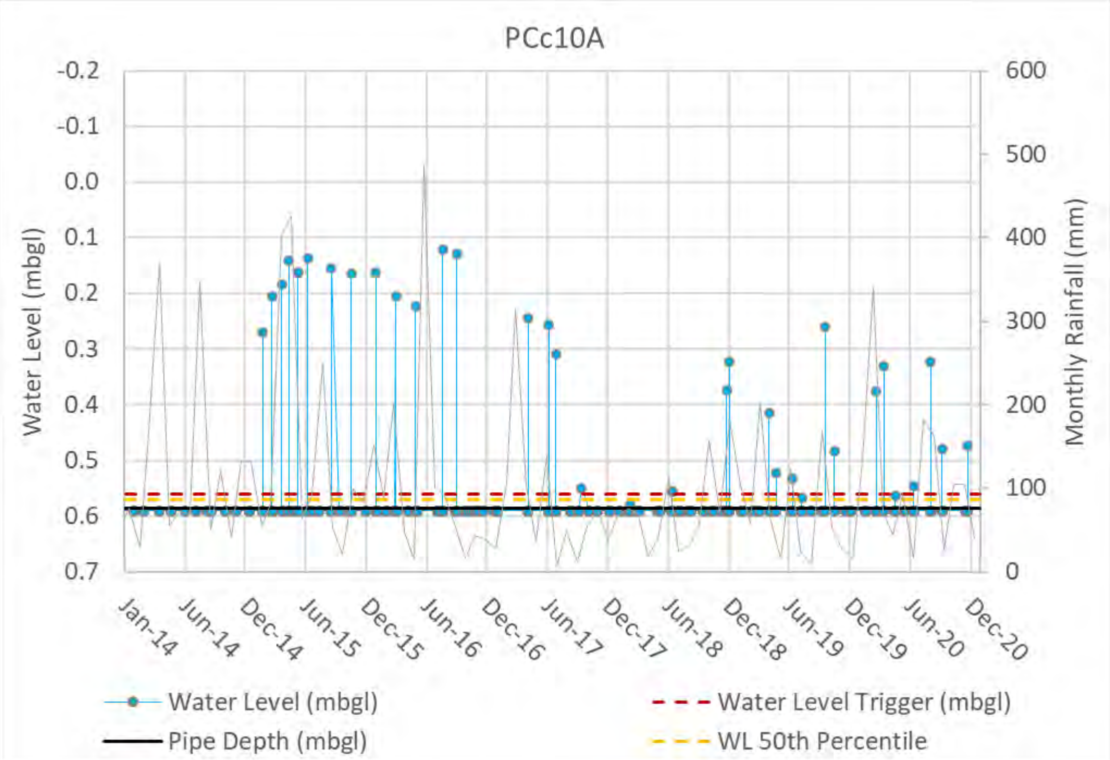

PB4A
Water Level (mbgl)
Monthly Rainfall (mm)
Water Level (mbgl)
Water Level Trigger (mbgl)
Pipe Depth (mbgl)
WL 50th Percentile
Site Monthly Rainfall (mm)

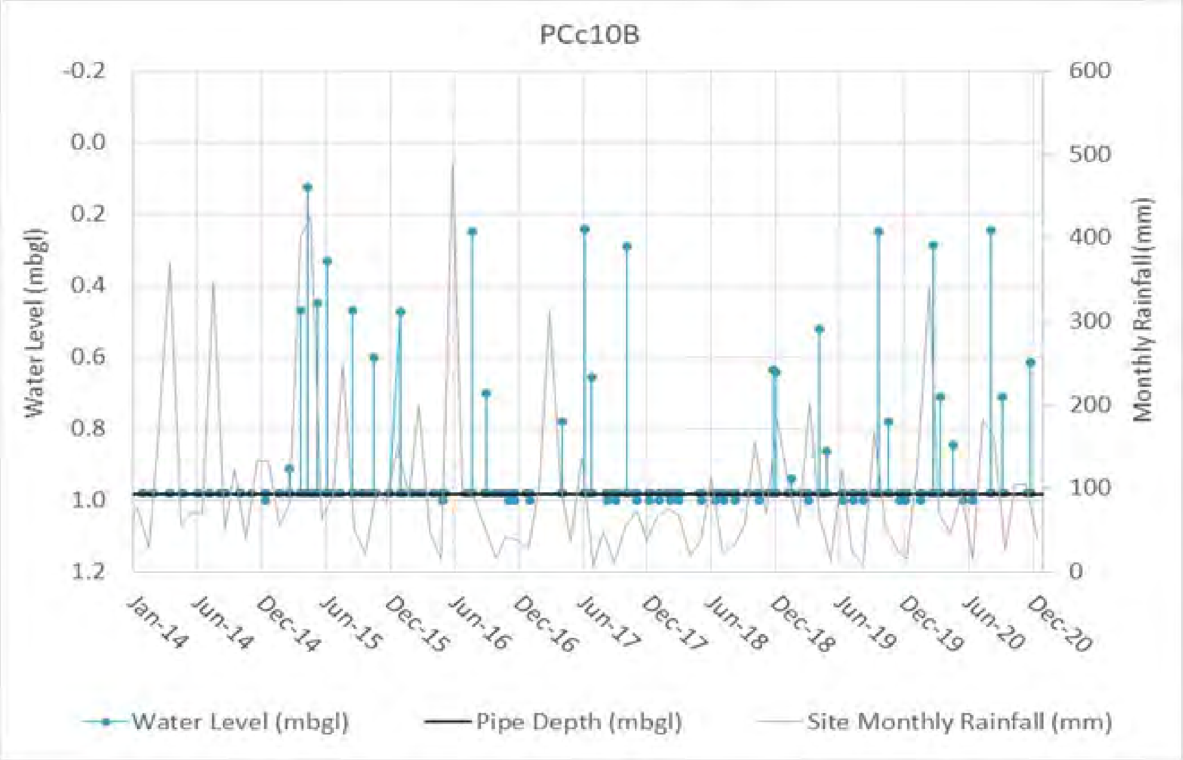

PB4B
Water Level (mbgl)
Monthly Rainfall (mm)
Water Level (mbgl)
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)


PB4C
Water Level (mbgl)
Monthly Rainfall (mm)
Water Level (mbgl)
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)


PB4D
Water Level (mbgl)
Monthly Rainfall (mm)
Water Level (mbgl)
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)

CCUS10


PCc10A
Water Level (mbgl)
Monthly Rainfall (mm)
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
600
500
400
300
200
100
0
Jan-14
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Water Level (mbgl)
Water Level Trigger (mbgl)
Pipe Depth (mbgl)
WL 50th Percentile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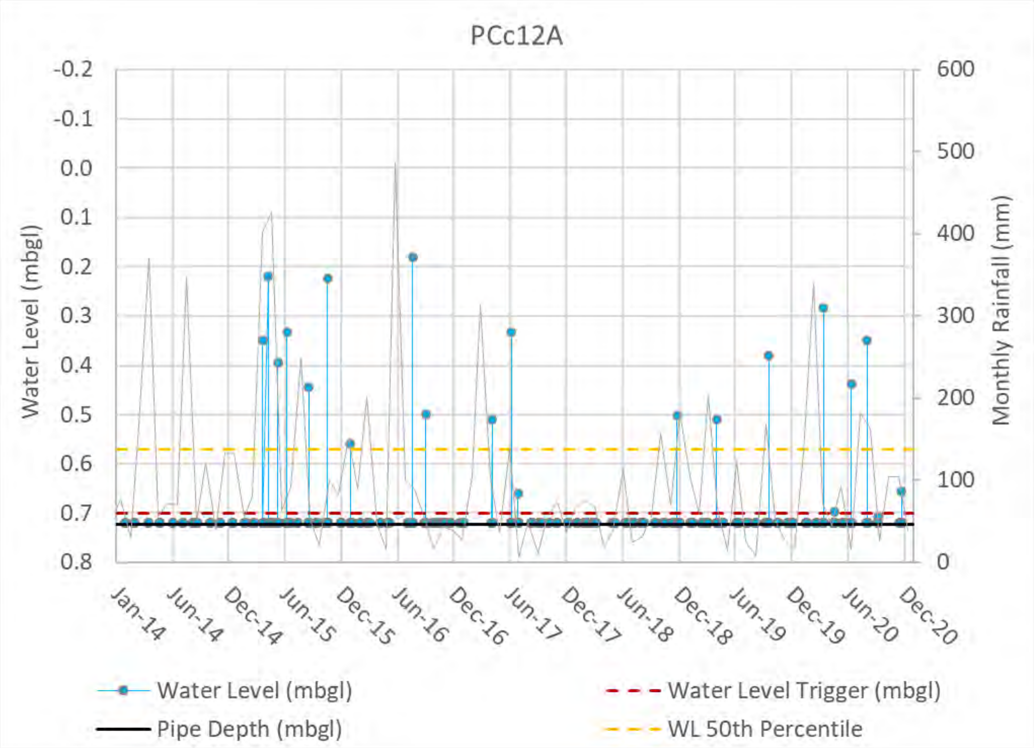
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)

CCUS12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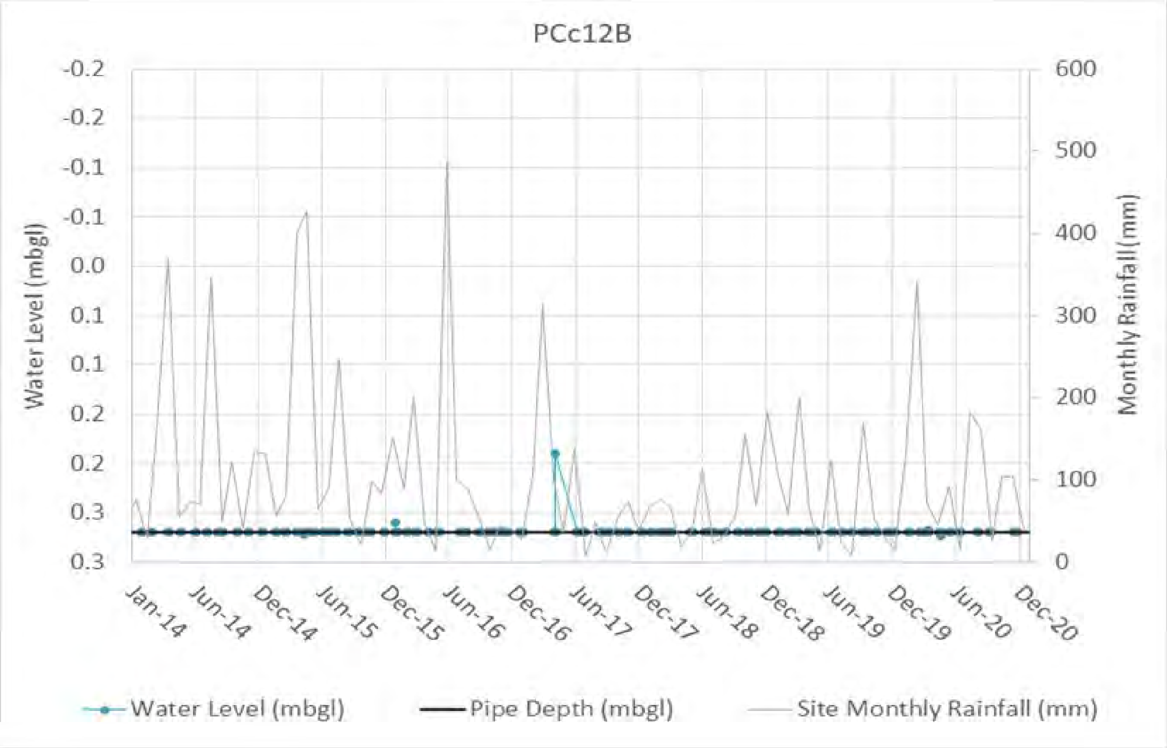
Pipe Depth (mbgl)
WL 50th Percentile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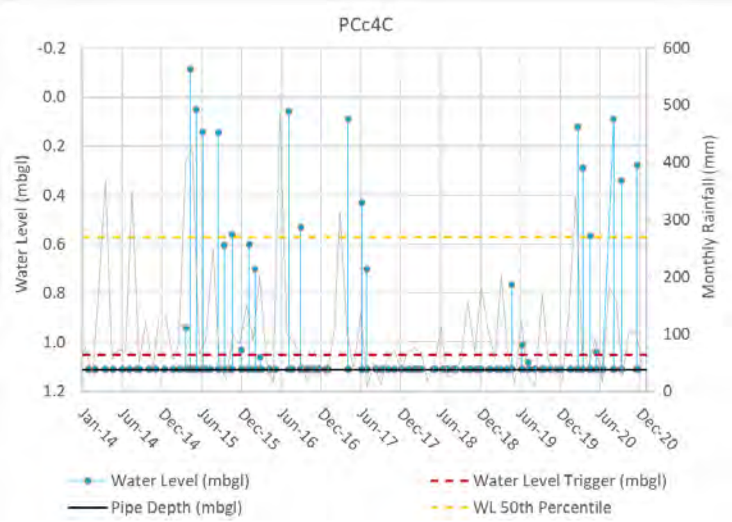
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)

CCUS4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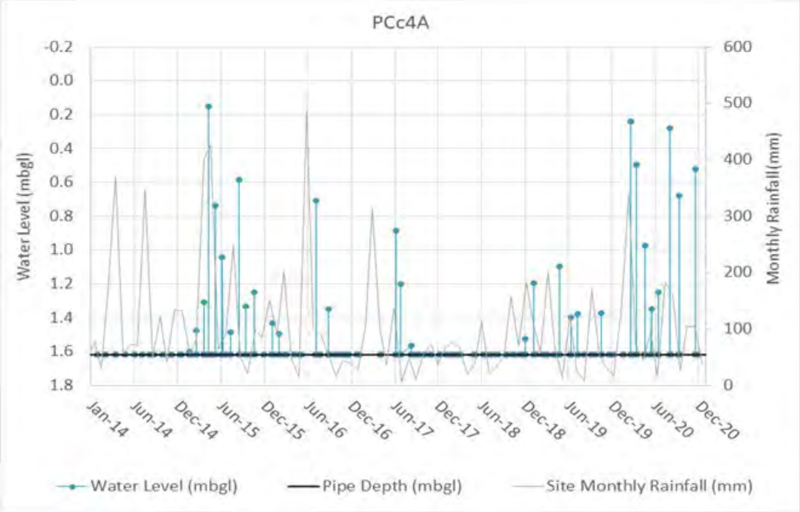
Pipe Depth (mbgl)
WL 50th Percentile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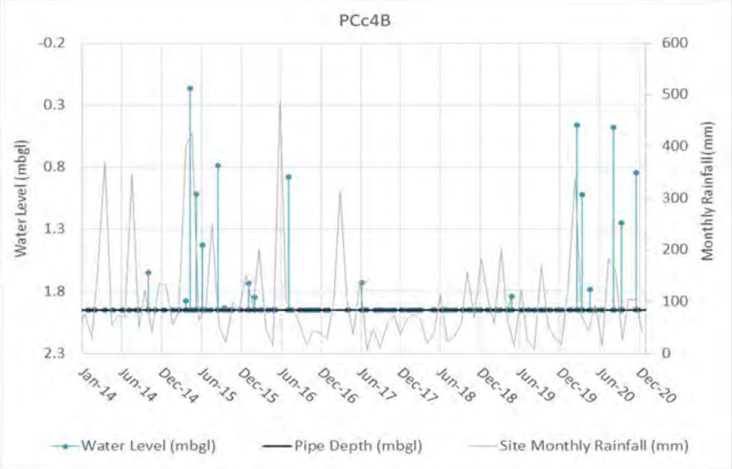
Site Monthly Rainfall (mm)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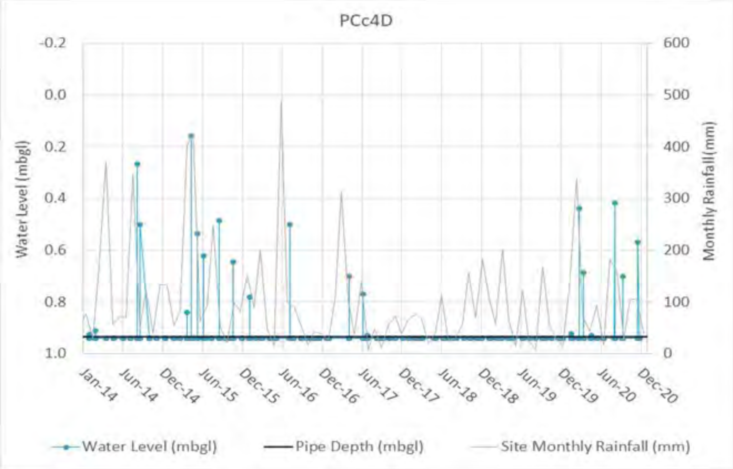
Water Level (mbgl)
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)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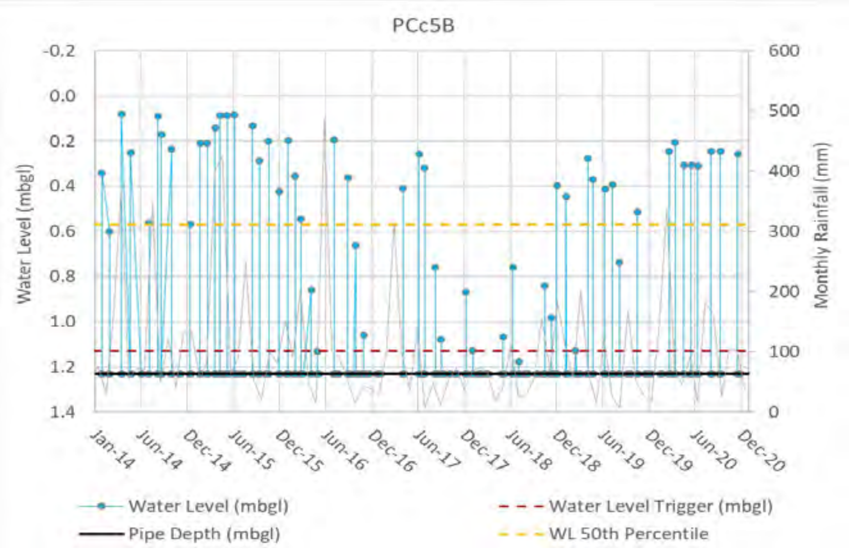
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)

CCUS5



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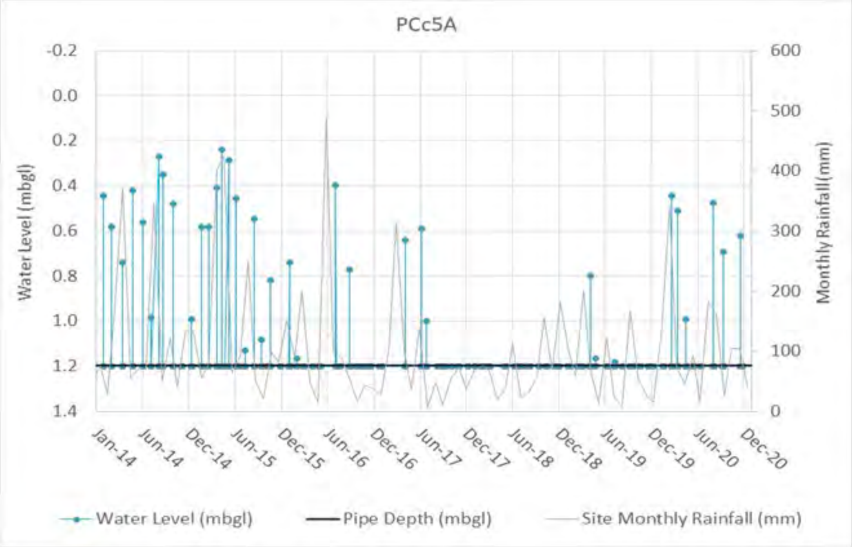

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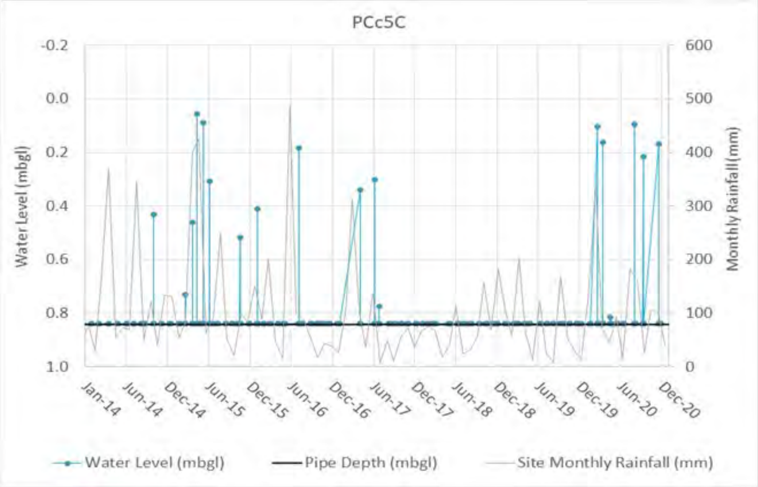

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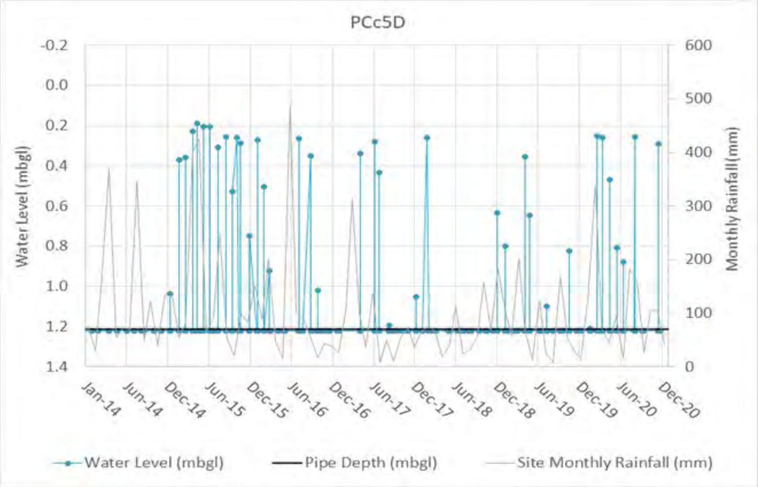

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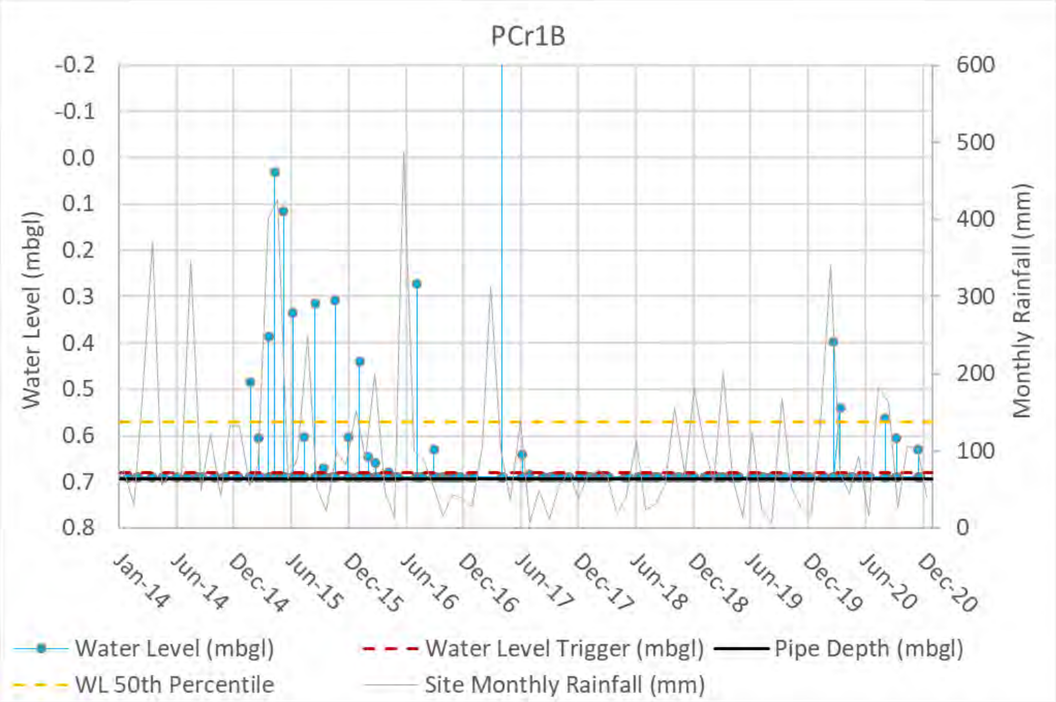

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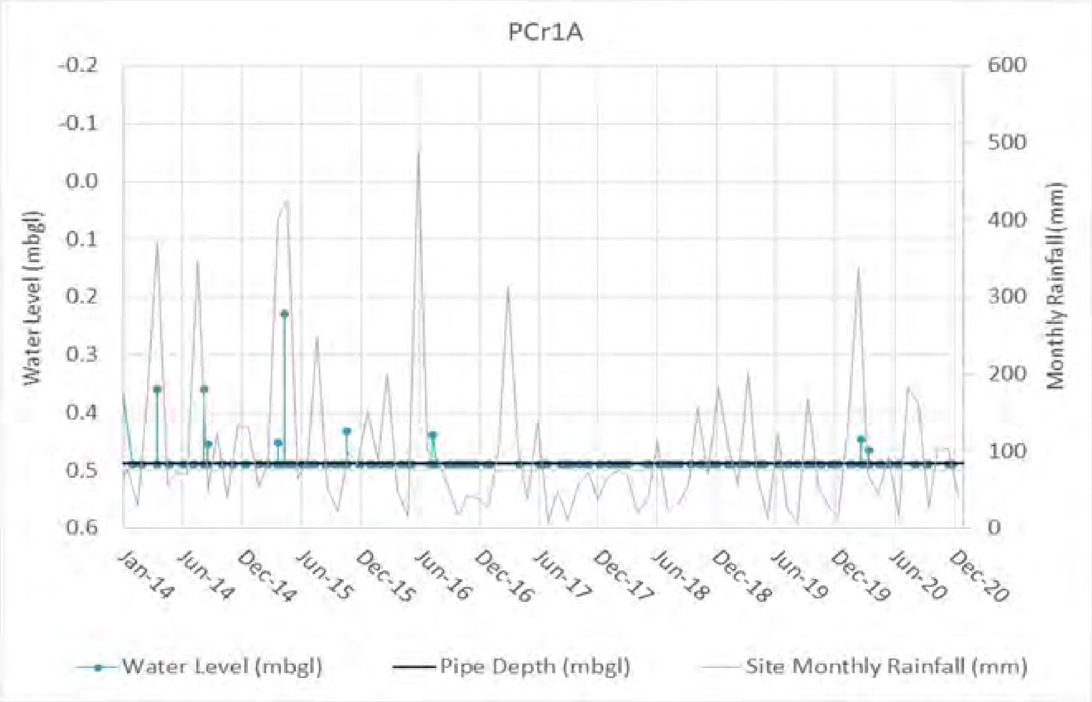
WL 50th Percentile
Site Monthly Rainfall (mm)



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Dec-20
Water Level (mbgl)
Pipe Depth (mbgl)
Site Monthly Rainfall (mm)

Swamp Ecological Monitoring

- LiDAR analysis and Field Inspection: Provide baseline and periodic mapping of swamp extent and swamp sub-communities.
- BAM Plots (Impact sites): Provide baseline for any offsetting requirements in unlikely event of observed impacts attributable to mining. For small swamps without permanent transects, BAM sites also provide quantitative data to assess vegetation changes that may be observed in photo points (e.g. dieback in specific plants, changes in extent of woody vegetation species).
- Vegetation Transects: Quantitative data for statistical analysis of changes in TSR and Species Composition at impact sites relative to observed changes in control sites (including yet to be impacted sites (non-impact sites)). Trigger for further investigation (GW, moisture, veg transect). Baseline against which changes can be assessed.
- Photo Points (impact sites): Provide baseline condition assessment of swamp (when coupled with BAM Plot and transect) prior to any potential impacts. Trigger for further investigation (GW, moisture, veg transect). Enable visual assessment of vegetation condition to be assessed and detect an senescence/dieback.
- Photo-points (non-impact sites): Provide qualitative control for comparison to impact sites to assess whether any changes observed at impacts sites are also observed at control sites.

Ecohydrological Monitoring

- subsidence monitoring, including review of historical LIDAR/ DInSAR/ GNSS data;
- observation of underground mining conditions;
- groundwater monitoring;
- soil moisture monitoring;
- observational monitoring, including photo points; and
- water quality and flow monitoring.

ATTACHMENT 3 – RESPONSE TO MAY 2021 BCD COMMENTS

Briefing Note

To:	Chris Page, BCD
cc:	Calvin Houlison, BCD
From:	David Holmes
Author:	David Holmes/ Claire Stephenson
Date:	04 June 2021
Subject:	Applicability of "Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence" to bord and pillar mining approved under MP09_0013

Purpose

To provide further information on the Coastal Uplands Swamps (Upland Swamps) in the Russell Vale East Area (RVEA) and the nature of predicted impacts from the proposed bord and pillar workings approved under development consent MP09_0013 and the applicability of the *Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence* (Upland Swamp Offset Policy) to the monitoring of proposed mining.

As indicated in a meeting between BCD, Wollongong Coal, Umwelt and Biosis on 24 May 2021, Umwelt and Biosis are of the view that the application of the Primary Monitoring requirements under the Upland Swamps Offset Policy is not appropriate for the monitoring of impacts associated with the proposed bord and pillar mining approved under MP08_0013. The primary reasons for this are:

- predicted subsidence effects from the proposed bord and pillar mining is unlikely to have any impacts which could have a significant impact on swamp integrity, even having regard to pre-existing cumulative impacts associated with past mining and
- the hydrology of the Upland Swamps in the RVEA is distinct compared to other areas in that they are shallow (<2 m deep) and often record dry piezometric water levels. These conditions do not lend themselves to the setting of water level monitoring triggers that are indicative of impacts.

Key messages

- The Upland Swamp Offset Policy was developed to provide policy guidance for monitoring of impacts from longwall mining. The policy was not developed to manage impacts from long term stable bord and pillar workings.
- The approved Russell Vale East bord and pillar workings have been designed to be long term stable and do not result in any goaf related subsidence effects; the predicted vertical subsidence associated with the Project is due to compression of pillars.
- There is a high degree of confidence that the approved mining will be long term stable (<1:1,000,000 risk of failure) and will not result on any goaf effects (e.g. vertical fracturing above mining area).

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- The predicted levels of vertical subsidence are up to 100mm. The IAPUM considered that 'the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible'.

- Predicted impacts from the proposed mining system on upland swamps have a significantly higher degree of certainty than those from longwall mining.

- The 'Primary Monitoring' requirements in the Upland Swamp Offset Policy are based on the assumption that swamps remain permanently (or almost permanently) saturated with connectivity to the groundwater table, and changes in hydrology within swamps can be detected relatively quickly through the monitoring of shallow groundwater levels.

- The long-term monitoring of Upland Swamps in the Russell Vale East Area indicates that these swamps are largely ephemeral in nature and are dry for more than 40% of the time.

- There is also limited-to-no hydraulic connectivity between the swamps and the groundwater table within the Hawkesbury Sandstone (underlying strata).

- The monitoring data for swamps within the RVEA shows high variability in soil moisture and piezometric water levels within and between the swamps. The trends are greatly influenced by external factors including climatic conditions and local features (i.e. slope aspect and vegetation). Due to this variability, the piezometric monitoring data would not provide a clear indicator of potential impacts due to mining. Accordingly, the Primary Monitoring framework required under the Upland Swamp Offset Policy is not considered to be appropriate as a predictor of potential impacts to Upland Swamps in the Russell Vale East Area.

- Given the low levels of predicted impacts from the proposed mining methods (and high degree of confidence in these predictions), near-real time subsidence monitoring using a combination of GNSS units and DInSAR is proposed as the most effective means for informing operational decisions which may impact Upland Swamps.

- Adaptive management measures will be primarily informed by subsidence monitoring and associated TARPs.

- The subsidence monitoring will be supported by ecological monitoring and a comprehensive groundwater monitoring framework. The network includes vibrating wire piezometers, open standpipes within the Triassic Hawkesbury Sandstone and Bulgo Sandstone, as well as the shallow piezometers and moisture probes within the swamps.

- As no direct impact pathways to the swamps are likely with the application of the bord and pillar mine method, no changes in upland swamps are expected beyond that observed historically or as a result of natural variability.

- The focus of TARPs based around groundwater and vegetation monitoring will be the investigation of potential causes or influences of any observed changes in environmental conditions within swamps (including water levels, moisture levels and vegetation) within proximity of workings. The monitoring framework and data analysis will be informed by BACI design principles.

- The vegetation monitoring will be consistent with the Secondary Monitoring requirements in the Upland Swamp Offset Policy and will also include baseline BAM plots prior to any potential new mining related impacts that will inform any offsetting requirements in the unlikely event that an impact attributable to the proposed mining is observed.

- TARP Triggers for vegetation will be based on the existing longwall mining (LW6) monitoring and statistical analysis framework which is based on BACI design principles.

- Conservative investigation triggers for water levels in swamps with standpipe piezometers will be utilised and supplemented by a review and analysis of soil moisture and vegetation monitoring.

1.0 Background

Feedback from the Biodiversity and Conservation Division (BCD) of the NSW Department of Planning, Industry and Environment (DPIE) has indicated that it expected the monitoring framework under the Upland Swamp Offset Policy to be implemented. While the Upland Swamp Offset Policy has been specifically developed for longwall mining, BCD has stated that the proposed application of the Upland Swamp Offset Policy is based on the development consent MP08_0013 setting a performance criteria for impacts on Upland Swamps of:

> *'Negligible environmental consequences including negligible change to the structural integrity of the bedrock base or any controlling rockbar of the swamp.'*

As indicated in a meeting between BCD, Wollongong Coal, Umwelt and Biosis on 24 May 2021, Umwelt and Biosis are of the view that the application of the Primary Monitoring requirements under the Upland Swamps Offset Policy is not appropriate for the monitoring of impacts associated with the proposed bord and pillar mining approved under MP08_0013. The primary reasons for this are:

- predicted subsidence effects from the proposed bord and pillar mining is unlikely to have any impacts which could have a significant impact on swamp integrity, even having regard to pre-existing cumulative impacts associated with past mining and

- the hydrology of the Upland Swamps in the RVEA do not lend themselves to the setting of water level monitoring triggers that are indicative of impacts.

These issues are discussed further below. A copy of the presentation provided at the 24 May 2021 meeting is attached and includes relevant reference material regarding groundwater monitoring.

2.0 Predicted Impacts from Bord and Pillar Mining

The proposed bord and pillar mine design is based on well understood mining practices and principles. There is a high degree of confidence that pillars will be long term stable (<1:1,000,000 risk of failure) and will not result on any goaf effects (e.g. vertical fracturing above mining area).

The proposed bord and pillar mining is predicted to have vertical subsidence of up to 100mm. This subsidence is effectively limited to the area immediately over the proposed bord and pillar workings. The IAPUM considered that 'the catastrophic loss of a swamp due to only 100 mm of incremental vertical subsidence is hardly credible'.

In the absence of any vertical subsidence, there is no credible impact pathway between the approved mining and Upland Swamps (other than the unlikely event of a pillar failure or a localised area of incremental water table drawdown which is associated with the prolonged duration of mining rather than the particular mining methods proposed).

Material subsidence effects further afield are unlikely and would be limited to circumstances of a pillar failure.

The monitoring of vertical subsidence and comparison with subsidence predictions is proposed as 'Primary Monitoring' method to inform operational decisions. Consistent with requirements set in discussions with DAWE/OWS, a vertical subsidence limit will be applied to all Upland Swamps. This low level of vertical subsidence is unlikely to have any significant impacts on swamps, either through impacts to the integrity of the water holding capacity of the swamps or through terrain effects (e.g.

changes to surface flows and increased erosivity). Based on the advice of the IAPUM, vertical subsidence effects of up to 300mm are considered unlikely to have any impact on upland swamps.

A combination of groundwater (including soil moisture) monitoring as well as vegetation monitoring will be adopted as 'Secondary Monitoring' measures to inform the need for a further investigation into any potential changes to swamps observed following mining.

A conservative zone of *potential* impact of 350m from the proposed bord and pillar mining area has been proposed through discussions with the Commonwealth Department of Agriculture, Water and Environment (DAWE) and Office of Water Science. This zone has been defined for the purposes of establishing monitoring networks and frequency. The 350m zone is based on a 45^{o} angle of draw using depth of cover over the proposed bord and pillar workings. This 350m zone is not an area where impacts are expected, rather it defines the area in which impacts *could* occur if subsidence impacts higher than predicted occur. The 45^{o} angle of draw is also highly conservative, even in the event of a significant pillar failure event. Subsidence effects outside this area immediately surrounding the proposed bord and pillar mining area would only occur in the unlikely event of a pillar failure or there is an underprediction of subsidence effects. The extension of monitoring into this area is proposed only as a precautionary approach and both monitoring frequency and the monitoring methods within this area are proposed on a risk-based approach which considers the characteristics of the swamp (size, ecological significance), pre-existing subsidence impacts and likelihood of impacts in unlikely event of increased subsidence effects.

3.0 Coastal Upland Swamps in the Russell Vale East Area

The long-term monitoring of Coastal Upland Swamps in the Russell Vale East Area indicates that:

- there is limited-to-no hydraulic connectivity between the aquifers within the swamps and aquifer systems within the underlying sandstone strata
- the swamps are ephemeral in nature and an analysis of data collected over more than eight years indicates the swamps are dry for almost 50% of the time and become saturated only after rainfall events.

Additionally, despite previous mining below swamps in this area, there has been no observed loss of swamps. This was considered by the IAPUM in its advice on the Project where it stated:

> *Rather, it appears that in the area of this proposal (the Wonga East area of Russell Vale Colliery), mining operations in the Bulli and Balgownie Seams have not resulted to date in adverse consequences for swamps that can be linked unequivocally to mining impacts. Three reasons postulated for this outcome in previous approval processes (e.g. DoP (2014)) are:*
>
> 1. *The magnitude of the subsidence impacts, principally tensile cracking, are not sufficient to cause a significant change in swamp moisture content.*
> 2. *Loss of swamp water through tensile cracks is compensated for by (high) rainfall on the escarpment.*
> 3. *If the swamps have had vertical drainage increased due to undermining, the mix of flora species in the swamps has changed over the decades to adapt to the modified soil moisture conditions and gone unnoticed due to a lack of monitoring; the sub-communities may have altered (for example, from cyperoid heath to banksia thicket) but still are within the Coastal Upland Swamp Ecological Community.*

The ephemeral nature of these swamps is shown in the monitoring data presented in the 24 May 2021 meeting (see attached).

As the swamps exhibit regular periods where there is no saturation, the reduction in groundwater levels cannot be used as a primary indicator as periods of no saturation are observed already. Any use of groundwater levels to indicate potential for mining related impacts would be limited to the potential changes to the duration and depth of saturation following rainfall events. However, each swamp (and bore site) behaves differently in these circumstances and a review of the data indicates the relationship is complex and multivariate within and between swamps in terms of seasonality and influence of the swamp setting (i.e. slope aspect and vegetation types). Due to this complex relationship, any statistical approach to the use of water levels as an indicator of impact would have a high degree of uncertainty, which effectively precludes it being used as a primary monitoring method for informing operational decisions.

While groundwater and soil moisture monitoring alone will not detect potential impacts due to bord and pillar mining, it is considered an important element of the ecohydrological assessment approach. This approach will utilise the groundwater and soil moisture data in concert with vegetation, surface water, climatic and subsidence monitoring in order to assess and report on the swamp condition and changes over time. This suite of data can then be used in determining potential causes of any observed changes in swamp vegetation or groundwater, particularly in circumstances where subsidence monitoring does not indicate levels of subsidence that are likely to have an impact on swamps.

There is a long history of vegetation monitoring of swamps in the RVEA. Additional baseline monitoring in the form of swamp extent, BAM plots and pre-impact transects and photo monitoring points are proposed for all swamps within 350m of proposed bord and pillar workings. Similar baseline monitoring will be undertaken in reference sites. Due to the extensive use of reference sites and the long duration of vegetation monitoring at these reference swamps, a shorter period of baseline vegetation monitoring at potentially impacted sites is not considered to be essential as comparisons with changes at reference sites (rather than long periods of baseline data from the impact site) can be used to ascertain whether any changes in observed vegetation condition are due to factors outside of natural variability. This baseline data will be used to inform the maximum predicted offset liability. Any actual offset requirements will be determined but comparing post impact monitoring values with the pre-mining baseline data, particularly the BAM data.

Vegetation monitoring in swamps outside the area where subsidence impacts are not predicted will be undertaken on a reduced frequency relative to swamps which directly overly bord and pillar workings. Monitoring frequency will be increased at all sites where subsidence monitoring indicates higher than predicted subsidence impacts with the increased frequency dependent on the magnitude of observed subsidence (e.g. monitoring frequency for areas with observed impacts of less than, say, 50mm will remain less than for areas directly over the proposed bord and pillar working unless there is a causative impact reason for increased frequency).

Swamps in the RVEA, but outside 350m of actual bord and pillar mining undertaken, will be considered as reference swamps for biodiversity and groundwater monitoring purposes where statistical analysis of baseline data indicates this is appropriate having regard to BACI design principles. The inclusion of these additional, and proximate sites in the reference data pool will improve the statistical evaluation of any observed changes against natural variability. It is not essential that these sites have not been previously undermined as the assessment of potential impacts is relative to the mining proposed, rather than historical mining; indeed, the inclusion of previously undermined sites provides arguably better analogue sites for comparison.

4.0 TARPs

4.1 Water and biodiversity monitoring

Hydrology, hydrogeology and biodiversity TARPs in the Upland Swamp Monitoring Plan have been set based historical observations of data collected. Except for piezometer water level monitoring, triggers are set at levels which would be unlikely to occur from natural variability alone but are not necessarily outside historically observed data. Exceedances of these triggers will result in an investigation into the potential for mining to have caused these changes. Soil moisture monitoring is not proposed for use as a triggers due to the multivariate nature of factors contributing to soil moisture and site specific nature of the triggers.

The previously defined TARPS applied for the longwall mining are less conservative than the triggers proposed. Previously approved triggers for swamp piezometers was:

> *Piezometer becomes, or stays, dry (where it has not done so previously) or the rate of water level reduction increases where the effect is not related to climatic variability.*

These triggers are subjective and open to differences in interpretation and would not provide an early indicator of changes as review of the site data indicated the piezometers are often unsaturated. More conservative and quantifiable triggers based on statistical analysis of swamp piezometer water level readings and excluding dry readings was applied to enable early detection of potential changes.

The Proposed water level piezometer triggers have been set based on a conservative analysis of water levels observed after a defined period of rainfall. An exceedance of these triggers is likely under natural variability and is not indicative of an impact caused by mining. However, any trigger exceedances will result in an investigation of the potential for the exceedance to have been caused by mining will be undertaken. This investigation may include consideration of:

- proximity (spatial and temporal) of observed impact to bord and pillar mining
- observed vertical subsidence in the area around the observed change
- groundwater monitoring results (swamp and hardrock)
- swamp soil moisture monitoring results and
- observations in reference swamps.

In the absence of any clear indication that mining is a potential contributing factor in any observed change (e.g. higher than predicted subsidence or changes in underground conditions which may indicate a causative factor), the presumption will be that any observed changes are attributable to natural or historical conditions and will not require precautionary changes to underground operations.

Water and vegetation triggers will not result in any adaptive management measures being implemented in the absence of clearly or likely evidence of a link to the active mining being undertaken.

4.2 Subsidence TARPs

TARPs related to subsidence monitoring are contained in the overarching Extraction Plan, rather than the subplans. The subsidence monitoring TARPs are based on both subsidence predictions and the 300mm vertical subsidence performance measure.

Observed vertical subsidence higher than predicted subsidence impacts will require a temporary cessation of second workings (bord and pillar development) in the area where the exceedance was observed; first workings can continue unless there is an indication from underground conditions that these may be contributory to the observed subsidence impacts.

A review of the subsidence monitoring will be undertaken initially to ascertain whether the observation is anomalous or an indication of actual impacts. If the observations indicate subsidence predictions have been exceeded, a review of potential causal factors will be undertaken and potential mitigation measures to prevent a recurrence.

Potential adaptive management measures that can be implemented in the event of higher than predicted subsidence impacts include a review of mine design including aspects such as:

- pillar design and layout
- avoidance of mining below features potentially sensitive to higher subsidence impact (e.g. upland swamps, cliffs, transmissions towers, Mt Ousley road and sensitive heritage items)
- increased underground support.

The recommencement of mining operations in the area and implementation of these adaptive management measures will be discussed with relevant agencies and stakeholder prior to implementation.

Attachment 4 – WCL Responses to BCD Submission dated 23 May 2022

<table>
<tr><th>BCD Comment</th><th>WCL Response</th></tr>
<tr><td>Condition of Approval C10(g)(iv) Page 17
This condition requires a BMP which establishes baseline data for the existing habitat on the site, including vegetation condition and threatened species habitat.
Table 8 describes monitoring methods, including “Photo-point monitoring”. How will vegetation data (including baseline data) be collected and analysed for non-swamp vegetation, noting that a Briefing Note sent to BCD, dated 4/6/2021, described the use of BAM plots for baseline data to inform offsetting requirements?
BAM plots are mentioned in the SMP but not the BMP. Please clarify when and how BAM plots will be used.</td><td>In the context of the Russell Vale Colliery, the detailed monitoring of non-swamp vegetation data (including baseline data) is not considered necessary due to the low potential for surface impacts resulting from the bord and pillar mining method.
BAM plots are only used to inform potential offsetting requirements for swamps in the event that other monitoring indicates there has been a more than negligible impact. BAM plots are completed prior to undertaking second workings within a certain distance of each swamp (subject to various criteria).
As per Section 3.2 of the BMP, there are two BC Act and EPBC Act listed plant community types that are potential groundwater dependent ecosystems and therefore considered to be subject to collection of baseline data via BAM plots. These include Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions and Coastal Upland Swamp in the Sydney Basin Bioregion. However, only Coastal Upland Swamps have been recorded within the UEP area to date.
Table 12 of the BMP outlines the biodiversity performance measures and proposed monitoring, and in turn the required offsets, in line with Condition C4 of the approval and Section 7.5.3 of the BMP. As no other plant community types listed under the BC Act and/or EPBC Act have been recorded within the UEP area, no further BAM plots to inform offsetting are considered necessary.
As BAM plots are only used for swamps, they have not been described in the BMP.</td></tr>
</table>

BCD Comment	WCL Response
Threatened Frogs Habitat mapping and occupancy of frogs needs to be done more accurately in the possibly impacted areas. Likelihood of detection needs to be considered for all monitoring proposals – frog breeding periods will mean tadpoles are present at different times. Consider using eDNA monitoring techniques for screening streams (note this should not be used as a replacement for normal monitoring, for further advice, consult BCD). The BMP should discuss how monitoring data is to be collected in accordance with current Threatened Frog Survey Guidelines: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/nsw-survey-guide-for-threatened-frogs-200440.pdf	Frog breeding periods and survey periods are as follows: • Giant Burrowing Frog – February to May, aural-visual surveys or tadpole surveys. • Red-crowned Toadlet – year-round following rain, aural-visual surveys. • Littlejohn's Tree Frog – July to November, aural-visual surveys or tadpole surveys. • Stuttering Frog – September to March, aural-visual surveys. The above breeding period is considered in all Giant Burrowing Frog monitoring undertaken at RVC. Giant Burrowing Frog monitoring ceased in 2022, and will recommence if impacts to swamp water quality are detected or if subsidence TARPs level 3 are triggered (i.e. greater than 100 mm of subsidence at Coastal Upland Swamps). No monitoring for Red-crowned Toadlet has been included in the BMP as habitat for this species within the study area is widespread and potential indirect impacts from subsidence are unlikely to affect the species. Littlejohn's Tree Frog and Stuttering Frog are now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2017). Suitable habitat is limited and targeted surveys undertaken between August 2013 and February 2016 did not detect these species in the UEP area. Additionally, any potential indirect impacts from subsidence are unlikely to affect the species. There is a negligible risk of any impact to threatened frogs within the UEP area from the bord and pillar mining method. Potential indirect impacts are limited to subsidence (such as surface cracking) and hydrological changes affecting surface water regimes or near-surface groundwater, which are in turn considered to have a low likelihood of occurring under the bord and pillar mining method. eDNA monitoring techniques are not considered to be required at this stage as no further frog monitoring is proposed under the revised BMP.

BCD Comment	WCL Response
Littlejohn's Tree Frog Habitat is not limited to tributaries only. It is unclear what remediation will be worthwhile if monitoring detects an impact. Further information required.	Noted. The *Russell Vale Colliery – Underground Expansion Project: Preferred Project Report – Biodiversity* (Biosis 2014a) report identified 13 fauna species listed under the EPBC Act and/or BC Act, that have the potential to occur or are known to occur in the Extraction Plan area, of which nine fauna species 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 mining was provided in Table 11 of the BMP. Further, species with a low likelihood of occurrence are not represented on Figure 6 and are not addressed further in the BMP. The additional monitoring data collected since 2014 (since the Preferred Project Report was completed) indicates lower likelihood of occurrence of the Littlejohn's Tree Frog. It is noted that the species was referenced in the indirect impacts section with a footnote regarding its low likelihood of occurrence. As no clear impact pathway exists for the species due to absence of known habitat, potential remediation measures have not been identified in the BMP. Potential remediation options would only be investigated in the unlikely event that habitat for the species is detected and impacts to habitat (Coastal Upland Swamps / aquatic environments) associated with mining are higher than anticipated (i.e. subsidence TARPs level 3 are triggered, greater than 100 mm of subsidence at Coastal Upland Swamps).
Red-crowned Toadlet Red-crowned toadlet is a localised species that appears to be largely restricted to the immediate vicinity of suitable breeding habitat. Due to this tendency for discrete populations to concentrate at particular sites, a relatively small, localised disturbance may have a significant impact on a local population if it occurs on a favoured breeding or refuge site. Mining impacts (e.g. changes to soil moisture) could adversely impact this species.	Noted. The level of monitoring necessary to identify all potential points within swamps is not commensurate with the minimal risk posed by the proposed bord and pillar mining method.

BCD Comment	WCL Response
Giant Burrowing Frog (Section 6.4.2) Giant burrowing frogs only breed February to May and therefore tadpoles are only present during that time. Only a 245 metre section of a tributary of Cataract River has been identified as habitat when other similar areas of habitat exist. Section 6.4.2 states that "giant burrowing frog monitoring is not required within the stage 2 EP area as no habitat is considered to be present". Based on information provided in the BMP, adequate surveys have not been carried out for this species to be able to exclude Stage 2 areas as non-habitat. Consider using eDNA screening as part of the monitoring program.	eDNA monitoring techniques are not considered to be required, as surveys conducted to date have been successful in detecting the species. Potential indirect impacts to this species are considered to be negligible. Monitoring for Giant Burrowing Frog has been discontinued in the 2022 monitoring program. Monitoring is only to recommence if impacts to swamp water quality are detected or if subsidence TARPs level 3 are triggered (i.e. greater than 100 mm of subsidence at Coastal Upland Swamps).
Section 3.4, Page 39 and Section 6.4.2, Page 69 Overall, it is not clear that adequate survey has been done to determine whether certain threatened species occur within the Stage 2 Extraction Plan area and thus whether baseline data requirements in accordance with CoA 10(g)(iv) are met. The Preferred Project Report identified a number of threatened species which have potential to occur and may be impacted by subsidence. Further monitoring has occurred, but no detail is provided.	There is a long period of monitoring within the UEP area, commencing largely in 2012, that has been used to assess the likelihood of occurrence for threatened species. All threatened species considered to have a moderate or greater likelihood of occurrence within the UEP area have been assessed against potential predicted subsidence and all species have consequently been assessed as being at negligible risk from subsidence related impacts. The project does not present a risk to any of the threatened species identified which would warrant additional levels of precautionary investigation/ monitoring for presence. There are no additional threatened species being considered as having a moderate or greater likelihood of occurrence under the Stage 2 EP, that were not already considered under the approved Stage 1 EP. However, several species have been discounted on the basis of further field investigations, which have not identified habitat for the species. The available baseline data has been presented within Appendix B (Likelihood of Occurrence) of the 2022 BMP. This is considered to address the requirements of CoA C10(g)(iv).
Figure 6, Page 46 It is unclear why swamps in Stage 2 do not contain habitat for giant dragonfly? None of the swamps mapped in Stage 2 are mapped as habitat.	Suitability of swamps within the Stage 2 EP area will be confirmed during detailed field assessment as part of Stage 2 baseline monitoring, which is being currently undertaken. Any additional swamps identified as providing habitat for the Giant Dragonfly will be incorporated into the BMP. Note that there was an error in Figure 6 of the BMP, whereby the following impact swamps were not mapped as habitat but are considered to be Giant Dragonfly habitat: BCUS4, CCUS10. The map will be updated for the final BMP.

BCD Comment	WCL Response
Figure 11a All swamp monitoring sites should be identified in a Table with co-ordinates or provide BCD with an excel file of latitude/longitude or easting/northing for each identified swamp. A shapefile of all swamps should be provided. We could not find the following swamps: ACUS, BCUS12, BCUS13. WACUS, WCUS, S22, S33, S15A.	These are control sites that are removed from the UEP. The control sites are shown on Figure 13 of the USMP. Labels will be added to this figure to allow for easier identification of the specific swamps. A table with the coordinates of all sites and a shapefile is provided.
A table is required that clearly demonstrates whether all swamps potentially affected by the mining are monitored and what monitoring takes place in those swamps (ie water level, soil moisture, vegetation quadrat, giant dragonfly) and their choice of accompanying reference swamps for comparison in a rigorous BACI design. If a swamp is within the defined mining footprint and is not monitored, a justification for this is required.	A table with a list of swamps within 350 m of the second workings is provided, as well as associated monitoring undertaken at each swamp. This table has been incorporated into the USMP.
Rationale should be provided underlying the choice of swamps for dragonfly monitoring and the justification for not monitoring all swamps that could potentially be affected by the mining (bearing in mind cumulative impacts form previous mining in the area).	As per the USMP, "Giant Dragonfly monitoring has and will continue to be undertaken at swamps identified as providing known breeding habitat as part of previous monitoring and considered to be potentially at risk of impacts from the UEP." As described above, suitability of swamps within the Stage 2 EP area will be confirmed during detailed field assessment as part of Stage 2 baseline monitoring, which is being currently undertaken. Any additional swamps identified as providing habitat for the Giant Dragonfly will be incorporated into the BMP. Swamps not included in the current monitoring program are either not relevant to Stage 1/Stage 2 secondary extraction or have not had previous records of breeding. Text within Section 4.3.3 of the USMP will be revised to include more detail regarding this matter.

BCD Comment	WCL Response
Attached document: Analysis of RV East flora data for Biosis, prepared by The Analytical Edge Statistical Consulting, Page 150 This document analyses vegetation data in terms of total species richness (TSR). This document states: "*TSR is not a good metric to reflect the complex nature of community composition and species turnover, since some species may become locally extinct or invade a region, yet the TSR can remain stable.*" We agree with this conclusion which clearly indicates that community composition data should be the focus for any BACI Assessment. The Plan does not include the use of community composition data as a means of identifying impact (or lack thereof) in a rigorous BACI design. This needs rectification.	Given the initial baseline monitoring (2021 and 2022) undertaken in the UEP area included undertaking BAM plots, which are followed by seasonal capture of TSR data, the indicator of harm to swamps will involve a combination of data inputs including; observation and transect monitoring data, soil moisture data, exotic species capture and seasonal weather data. Having a focus on community composition risks setting triggers which are inconsistent with natural swamp succession processes which are prone to seasonal variability. Based on the bord and pillar mining methodology and low potential for impacts, the focus is on the swamp functionality (not risks to individual species), therefore TSR is a consistent statistical indicator of change. The bord and pillar mining method does not increase risks of exotic species invasion.
All piezometer, soil moisture, vegetation quadrat, flow, pool level and water quality data should be provided to BCD so an independent analysis can be conducted and the appropriateness/rigour of the proposed BACI design tested.	Reports are made available to DPE on an annual basis. A copy of the statistical analysis approach for swamps is included with the USMP and this method has been approved for longwall mining which has higher risk of actual impacts. No impacts predicted here due to different mining methods and high confidence in risk control effectiveness due to engineering controls. Stage 2 presents even lower risk than the existing approved Stage 1 method.

ATTACHMENT 5 – WATERNSW RESPONSE

PO Box 398, Parramatta NSW 2124
Level 14, 169 Macquarie Street
Parramatta NSW 2150
www.waternsw.com.au
ABN 21 147 934 787

27 April 2022

Contact: Ravi Sundaram
Telephone: 0428226152
Our ref: *D2022/31435*

Jessie Evans, Director Resource Assessments, DPE
Email: Jessie Evans@DPIE.nsw.gov.au

Dear Jessie

Russell Vale Colliery Underground Expansion Project – Stage 2 (PC27-PC34) Extraction Plan

WaterNSW appreciates the opportunity to review the updated extraction plan (EP) which now include Stage 2 (PC27-34) of underground mining expansion project. WaterNSW has previously provided feedback on the Stage 1 (PC07-08 and 21 -25) (our reference - D2021/116712). Both Stage 1 and Stage 2 mining areas are located within the Metropolitan Special Area and the Upper Nepean Catchment (specifically within the upper catchment of the Cataract Reservoir).

WaterNSW has an important statutory role "*to protect and enhance the quality and quantity of water in declared catchment areas*". It also has a set of 'Mining Principles' which underpin WaterNSW decision making in relation to managing mining impacts in the declared Sydney catchment area and on catchment infrastructure.

Wollongong Coal Limited (WCL) has consulted with WaterNSW in preparing several key management plans required under the approval including Water Management Plan, Land Management Plan, Swamp Monitoring Program, and the Public Safety Management Plan. The EP has addressed feedback provided by WaterNSW to these plans.

Proposed mining in the Wongawilli seam in the Stage 2 area underlie parts of the previously mined Bulli and Balgownie seam workings area. The subsidence assessment has comprehensively addressed the pillar stability and pillar failure issues, and the potential risk of 'pillar run' for proposed extraction in a multi-seam area where overlying seams have been extracted previously.

Subsidence assessment predicts:

- vertical subsidence to be less than 100mm and generally imperceptible over most of the area, and
- the impacts, and consequences to natural, surface, and sub-surface features to be negligible and imperceptible in the undeveloped bushland setting over most of the Stage 2 extraction area.

WaterNSW considers that:

- The mining method and mine design adopted by WCL to the proposed mining in Stage 2 is likely to result in negligible impacts on water resources, biodiversity, and catchment environmental values.
- The proposed monitoring and management measures are appropriate for the planned mining method and subsidence predictions.
- The underground mine water balance monitoring system is expected to be effective as a guide to any unexpected inflows and inrush events from previously mined overlying seams and from Cataract Reservoir.
- The Trigger Action Response Plans (TARPs) for water and swamp monitoring including stream and swamp triggers developed based on baseline monitoring of performance indicators and anticipated subsidence effects are reasonable and appropriate.

WaterNSW does not have any concerns to the approval of the updated EP as:

- It has taken into consideration WaterNSW Mining Principles;
- Poses low risk to overlying catchment values and water resources; and
- Is likely to meet the performance measures set in the development consent.

Please contact Dr. Ravi Sundaram if you would like to discuss any of the above matters further.

Yours sincerely

Daryl Gilchrist
Manager, Catchment Protection

Russell Vale East Stage 2 Extraction Plan

Biodiversity Management Plan Response to Request for Information

FINAL REPORT

Prepared for Umwelt on behalf of Wollongong Resources Pty Ltd

9 September 2022

Biosis offices

NEW SOUTH WALES

Albury

Phone: (02) 6069 9200

Email: albury@biosis.com.au

Newcastle

Phone: (02) 4911 4040

Email: newcastle@biosis.com.au

Sydney

Phone: (02) 9101 8700

Email: sydney@biosis.com.au

Western Sydney

Phone: (02) 9101 8700

Email: sydney@biosis.com.au

Wollongong

Phone: (02) 4201 1090

Email: wollongong@biosis.com.au

VICTORIA

Ballarat

Phone: (03) 5304 4250

Email: ballarat@biosis.com.au

Melbourne

Phone: (03) 8686 4800

Email: melbourne@biosis.com.au

Wangaratta

Phone: (03) 5718 6900

Email: wangaratta@biosis.com.au

Document information

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- Wollongong Resources Pty Ltd.
- Umwelt: Matthew Copeland, David Holmes.

Biosis staff involved in this project were:

- Astrid Mackegard (mapping).

Contents

Tables

Figures

1. Introduction

Biosis was engaged by Umwelt on behalf of Wollongong Resources Pty Ltd (WRPL, formerly Wollongong Coal Limited) to prepare a Biodiversity Management Plan (BMP) (Wollongong Coal 2021) to inform the Russell Vale East (RVE) Underground Expansion Project (UEP) Extraction Plan (EP).

Biosis has received a request for information from the NSW Department of Planning and Environment (DPE) regarding survey methodology and results for threatened frogs in the RVE area, as undertaken by Biosis. The request for information is detailed in Table 1 below.

Table 1 Request for information from DPE

Consultation	Biosis' response
Giant Burrowing Frog Monitoring	
The BMP describes 13 surveys undertaken along a 245 m section of a tributary of Cataract River below swamp CRUS2. The BMP states that detailed surveys indicate that other tributaries are unlikely to support the species, and the species is not present within the Stage 2 extraction area. **NSW Biodiversity Conservation Division (BCD) has provided the attached advice. The department has reviewed WRPLs response to similar advice in Appendix E – Attachment 4 of the Biodiversity Management Plan.** **Appendix B of the 2022 BMP details the year of the most recent record, the number of records, and the distance of the records from the Study Area. The data included in Appendix B does not sufficiently justify the exclusion of the Giant Burrowing Frog from baseline data collection surveys prior to mining in the Stage 2 EP area.** **The preferred project report biodiversity assessment (Umwelt 2019) draws a conclusion regarding the potential for impact on the Giant Burrowing Frog stating:** **"Although often associated with upland swamps, this association is not direct, rather that upland swamps are associated with minor drainage lines that provide suitable breeding pools and burrowing habitat for this species (DECC 2007). SCT (2018) predicts that the imperceptible levels of subsidence resulting from the revised UEP mine plan will not result in perceptible impacts to creeks. As such, the Giant Burrowing Frog is considered at negligible risk of impact."**	Noted. Refer to discussion below regarding adequacy of survey effort.
The department acknowledges to low risk of impact. However, conditions C4-C6 of MP09_0013 provide for biodiversity impact offsetting if WCL exceeds the performance measures. If required, offsets must be undertaken in accordance with the Biodiversity Offsets	Noted. The Biodiversity Assessment Method (BAM) was originally released in 2017 (OEH 2017) and has since been updated in 2020 (DPIE 2020a). Threatened frog surveys undertaken prior to the

Consultation	Biosis' response
Scheme (BOS). The BOS requires a suitable baseline dataset collected in accordance with the Biodiversity Assessment Method.	initial BAM release (OEH 2017) were not undertaken in line with the BAM, however methodology had been designed to meet the requirements of *Threatened species survey and assessment guidelines: field survey methods for fauna - Amphibians* (DECC 2009). Giant Burrowing Frog Surveys undertaken in 2021 were conducted in line with the BAM (DPIE 2020a), including: • *NSW Survey Guide for Threatened Frogs: A Guide for the Survey of Threatened Frogs and their Habitats for the Biodiversity Assessment Method* (DPIE 2020b). • *Survey guidelines for Australia's threatened frogs* (DEWHA 2010). • *Threatened species survey and assessment guidelines - Field survey methods for fauna - Amphibians 2009* (DECC 2009). • *Environmental Impact Assessment Guideline: Giant Burrowing Frog* (NPWS 2001a). • *Environmental Impact Assessment Guideline: Red-crowned Toadlet* (NPWS 2001b). All future threatened frog surveys will also be undertaken in line with BAM and relevant survey guidelines.
To justify the exclusion of the Giant Burrowing Frog from the baseline dataset, the department requires the following:	Refer to individual items below.
• **Maps demonstrating the survey effort conducted for the Giant Burrowing Frog other than at CRUS2.**	Map detailing survey type and sites for each species is provided in Figure 1.
• **Survey data associated with the mapped survey effort.**	Survey data from prior reports provided herein.
• **Detailed outline of any other criteria used for each swamp to justify the exclusion of the species from further survey.**	An assessment of habitat suitability for the species is provided in Section 2.1 below, as per the BMP. There is a long period of monitoring within the UEP area, commencing largely in 2012, that has been used to assess the likelihood of occurrence for threatened species. The monitoring within Cataract Creek and Bellambi Creek and downstream of BCUS2 and BCUS3 (refer to Figure 1 and Section 2.1 below) support the assessment that suitable habitat for the Giant Burrowing Frog does not occur within Stage 2. Similarly, the monitoring within CCUS1, CCUS2, CCUS4, CCUS23, CRUS1 and CRUS3 support the conclusion that the Giant Burrowing Frog is not present in the areas potentially impacted by Stage 1. As an additional commitment by WRPL since the preparation of the Stage 2 BMP, an additional round

Consultation	Biosis' response
	of Giant Burrowing Frog monitoring will be undertaken at CRUS2 to confirm presence in spring 2022 and autumn 2023. Mining in Stages 1 and 2 will not impact on CRUS2 or the tributary where Giant Burrowing Frog has been observed.
Frog Species Monitoring	
Threatened frog monitoring listed in Appendix B- Attachment 1 of the Biodiversity Monitoring Plan includes: • **Two transects for *Litoria littlejohni* and *Heleioporus australiacus.*** • **Four transects for *Mixophyes balbus.***	Appendix E of the BMP includes the prior BCD EES Response regarding the BMP, which includes a letter dated 19 November 2021 from Wollongong Resources Pty Ltd, to Department of Planning and Environment, as well as Appendix B *DPIE NSW – RFI Attachment B Request for clarifications,* Attachment 1. Attachment 1 states that Biosis has undertaken: • 2 x Giant Burrowing Frog transects. • 2 x Littlejohn's Tree Frog transects. • 4 x Stuttering Frog transects. The above threatened frogs, as well as Red-crowned Toadlet were surveyed for in 2012 (Biosis 2012), 2013 (Biosis 2013, Biosis 2014b), 2014-2015 (Biosis 2016). Red-crowned Toadlet has also been surveyed for in 2016 (2017) and Giant Borrowing Frog in 2021 (2022). More information is provided below on these and other surveys undertaken to date.
The department requests more information including:	Refer to individual items below.
• **Maps of the transect locations referenced and any other survey transects completed for threatened frog species.**	Map detailing survey type and sites for each species is provided in Figure 1.
• **Details of survey effort at the monitoring transect locations, and any other locations including date, number of days/hours.**	Survey data from prior reports provided herein.
• **Detailed outline of any other criteria used for each swamp to justify the exclusion of the above species from further survey.**	An assessment of habitat suitability for the species is provided in Section 2.1 below, as per the BMP. The Russell Vale Colliery – Underground Expansion Project: Preferred Project Report – Biodiversity (Biosis 2014a) report identified 13 fauna species listed under the EPBC Act and/or BC Act, that have the potential to occur or are known to occur in the EP area, of which nine fauna species are considered susceptible to subsidence impacts. An assessment of the likelihood of occurrence of these species, based on additional monitoring data collected since 2011, and the risk of impact from mining was provided in Table 11 of the Stage 2 BMP. There is a long period of monitoring within the UEP area that

Consultation	Biosis' response
	has been used to assess the likelihood of occurrence for threatened species. Species with a low likelihood of occurrence are not represented on Figure 6 and are not addressed further in the BMP. This includes Littlejohn's Tree Frog and Stuttering Frog, which are now considered a low likelihood of occurrence based on the results of additional monitoring (reported herein). No monitoring for Red-crowned Toadlet has been included in the BMP as habitat for this species within the study area is considered to be widespread and potential indirect impacts from subsidence are unlikely to affect the species. There is a negligible risk of any impact to threatened frogs within the UEP area from the bord and pillar mining method. Potential indirect impacts are limited to subsidence (such as surface cracking) and hydrological changes affecting surface water regimes or near-surface groundwater, which are in turn considered to have a low likelihood of occurring under the bord and pillar mining method. Potential remediation options for threatened species with a low likelihood of occurrence would only be investigated in the unlikely event that habitat for the species is detected and impacts to habitat (Coastal Upland Swamps / aquatic environments) associated with mining are higher than anticipated (i.e. subsidence TARPs level 3 are triggered, greater than 100 mm of subsidence at Coastal Upland Swamps).

2. Project background

2.1. Threatened frogs

Threatened frogs identified previously as having a moderate or greater likelihood of presence within the RVE locality and potentially susceptible to subsidence include:

- Giant Burrowing Frog *Heleioporus australiacus*.
- Littlejohn's Tree Frog *Litoria littlejohni*.
- Stuttering Frog *Mixophyes balbus*.
- Red-crowned Toadlet *Pseudophryne australis*.

Giant Burrowing Frog is known to inhabit ephemeral and intermittent streams in the locality. Habitat for the Giant Burrowing Frog within the study area consists of small sections of upper tributaries above the Stage 1 and future stages workings. Despite extensive survey across the RVE area, GBF has only been identified along a 245 metre section of a tributary of Cataract River below swamp CRUS2 only. This area is outside the Stage 1 and Stage 2 mining areas and potential impacts from mining in these two areas do not have a feasible causal pathway to have any impact on CRUS2 and the downstream catchment where the Giant Burrowing Frog has been observed. Additional baseline survey within the Stage 1 and Stage 2 mining areas is therefore not considered to be warranted. As the Giant Burrowing Frog has not been observed in the Stage 1 and Stage 2 mining areas or in catchments immediately downstream of these areas, the absence of this species in any post-mining monitoring in these areas would not be indicative of any adverse impacts on this species from mining. Other than below CRUS2, this species is assumed **not** to be present for the purposes of offsetting requirements in the unlikely event that the proposed mining does impact on swamps or creeks.

Littlejohn's Tree Frog is known to inhabit ephemeral and intermittent streams in the locality. The species is however considered a low likelihood of occurrence in the Stage 1 and Stage 2 mining areas based on the results of additional monitoring (detailed herein) since the Preferred Project Report (Biosis 2014a). Suitable habitat is limited in the study area and targeted surveys undertaken have not detected the species. This species is assumed **not** to be present for the purposes of offsetting requirements in the unlikely event that the proposed mining does impact on swamps or creeks.

Stuttering Frog is known to inhabit streams in the locality. The species is rare in the locality. Stuttering Frog is considered a negligible likelihood of occurrence based on the results of additional monitoring (detailed herein) since the Preferred Project Report (Biosis 2014a). Targeted surveys undertaken between August 2013 and February 2016 did not detect the species in the study area. 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 it 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 which occur irrespective of the proposed mining. This species is assumed **not** to be present for the purposes of offsetting requirements in the unlikely event that the proposed mining does impact on swamps or creeks.

The Red-crowned Toadlet is fairly common in preferred ridgetop habitat and first order ephemeral creeks below ridges (DECC 2007) and has been recorded, using drainage lines, sheltering under bushrock on ridgetops and in depressions along fire trails (Biosis pers. obs.). Habitat for this species within the study area has not been mapped, as it is widely distributed and common. Targeted surveys for the Red-crowned Toadlet have been undertaken by Biosis as a part of the ecological monitoring program for Wonga East (Biosis 2013) and the species was recorded. This species is therefore assumed to be present for the purposes of offsetting requirements in the unlikely event that the proposed mining does impact on swamps or creeks. However, given the wide diversity in habitat of this species and the nature of subsidence impacts that may (unlikely) occur, this species is not predicted to be adversely impacted even if higher than predicted levels of subsidence were to occur.

2.2. Threatened frog surveys of relevance

A summary of Biosis' projects involving threatened frog surveys at RVE is detailed in Table 2 below.

Table 2 Current and prior projects in relation to threatened frog surveys or habitat assessment

Matter	Notes	Project mentions or includes survey of threatened frogs of relevance			
		Giant Burrowing Frog	Littlejohn's Tree Frog	Stuttering Frog	Red-crowned Toadlet
***Wonga East Lease Area Ecological Monitoring Program Annual Monitoring Report Year 1 (2011)* (Biosis 2012); Project no. 11853**	Terrestrial flora and fauna monitoring for RVE in 2011, including targeted threatened frog survey.	✓	✓	✓	✓
***Wonga East and V-Mains Ecological Monitoring Program. Autumn 2011 through to autumn 2013* (Biosis 2013); Project no. 14511**	Terrestrial flora and fauna monitoring for RVE in 2012, including targeted threatened frog survey.	✓	✓	✓	✓
***Russell Vale East and V Mains 2013 Ecological Monitoring Program* (Biosis 2014b); Project no. 16940**	Terrestrial flora and fauna monitoring for RVE in 2013-2014, including targeted threatened frog survey. Non-breeding Habitat: • Auditory and quadrat survey: Auditory surveys at fixed points throughout each swamp identified as suitable habitat. This will be followed by a Visual Encounter exhaustively checked and all frog species will be recorded. • In addition, non-standardised transect surveys will be undertaken. Call recognition surveys conducted	✓	✓	✓	✓

Matter	Notes	Project mentions or includes survey of threatened frogs of relevance			
		Giant Burrowing Frog	Littlejohn's Tree Frog	Stuttering Frog	Red-crowned Toadlet
	simultaneously to detect those species that are hard to see. Breeding Habitat: • Standardised transects in breeding habitat conducted in areas considered to be suitable breeding habitat for the various frog species. • Tadpole counts undertaken as part of the breeding habitat monitoring transects. Acoustic Surveys: • Use of Song meters to collect auditory data during favourable breeding conditions.				
Russell Vale East terrestrial ecological monitoring program: Annual Report 2015 **(Biosis 2016); Project no. 20492**	Terrestrial flora and fauna monitoring for RVE in 2015-2016, including targeted threatened frog survey. Breeding Habitat Monitoring: • Standardised transects conducted in areas considered to be suitable breeding habitat for the various frog species. • Tadpole counts. Acoustic Surveys: • Use of Song Meters to collect auditory data during favourable breeding conditions.	✓	✓	✓	✓
Russell Vale East Terrestrial ecological monitoring program Annual report for 2016 **(Biosis 2017); Project no. 23086**	Terrestrial flora and fauna monitoring for RVE in 2016-2017, including targeted threatened frog survey. Acoustic Surveys: • Use of Song Meters to collect auditory data during favourable breeding conditions. • The results of these surveys were assessed by comparing impact and control sites with a presence/absence approach.	✗	✗	✗	✓
Russell Vale East	Terrestrial flora and fauna	✓	✗	✗	✗

Matter	Notes	Project mentions or includes survey of threatened frogs of relevance			
		Giant Burrowing Frog	Littlejohn's Tree Frog	Stuttering Frog	Red-crowned Toadlet
***Terrestrial Ecological Monitoring Program 2021* (Biosis 2022); Project no. 34919**	monitoring for RVE in 2021-2022, including targeted threatened frog survey. Giant Burrowing Frog survey included searches along a tributary below swamp CRUS2.				

3. Survey method and effort

The survey methodology to identify and/or discount habitat for these species is detailed below and in Figure 1.

3.1. Biosis (2012) – Project no. 11853 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Threatened frog auditory and habitat survey

Creekline surveys consisted of 50 metre nocturnal stream searches for 30 person-minutes at fixed locations. Upland swamp surveys consist of area and stream searches at fixed locations. Each site had three replicates.

Sites surveyed within RVE (Figure 1) include; CC-F1, CC-F2, CC-F3, CRS-F1, CRS-F2, CRS-F3, CRS-F1 and CRS-F2, and CRS-F3.

Threatened frog breeding habitat assessment

A diurnal assessment of threatened frog habitat in the Cataract River tributaries was completed in winter 2011. This area was mapped as potential habitat by ERM (2011). Those areas considered to contain suitable Littlejohn's Tree Frog or Giant Burrowing Frog breeding pools were mapped.

One day of threatened frog habitat assessment was conducted by two zoologists in the Cataract River Tributaries down-swamp from Cataract River Swamp (CRHS1). A total of three tributaries were walked and areas containing suitable breeding pools for Littlejohn's Tree Frog, Giant Burrowing Frog, Red-crowed Toadlet and Stuttering Frog were mapped. The sites assessed are identified in Table 3 below.

Table 3 Threatened frog habitat assessment sites

Location Description	Coordinates
Walked down from CRS-F3 monitoring point down towards Cataract River (245 m transect)	CRWP-7 – CRWP-8
Second western tributary at Cataract River Swamp	CRWP-6 – CRWP-5
Walked down from CRS-F1 monitoring point down towards Cataract River	CRWP-1 – half way between CRWP-3 and CRWP-3
Upstream from fire road 7C/Bellambi Creek crossing	BCWP1 – BCWP2

3.2. Biosis (2013) – Project no. 14511 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Surveys were undertaken between 25-28 February 2013.

Threatened frog auditory monitoring

Auditory monitoring surveys for the Red-crowned Toadlet have been undertaken at two locations within RVE, where locations were chosen based on suitable breeding habitat along two ephemeral creeks located below ridgelines above Longwalls (Figure 1). Two control sites were also established in the Cordeaux catchment where the species has previously been observed or heard. Surveys were undertaken at two fixed-point locations for four hours across four nights (equal to 32 hours of survey).

Surveys were undertaken using a passive acoustic monitoring device (SM2+ Song Meter (Wildlife Acoustics)), to monitor the presence of Red-crowned Toadlet breeding males calling within the area above Longwall 4 and Longwall 5 at RVE and at control sites. Data was then analysed using Audacity by scanning the spectrogram for the characteristic signature of the Red-crowned Toadlet.

The survey methodology has been designed to meet the requirements of the guidelines outlined in the *Threatened species survey and assessment guidelines: field survey methods for fauna - Amphibians* (DECC 2009).

Audio strip transects (and quadrats) have also been incorporated into both the threatened frog breeding and non-breeding habitat monitoring (targeting Giant Burrowing Frog, Littlejohn's Tree Frog and Stuttering Frog) which can be particularly effective for species that are hard to see, either because they blend in with their habitat, or because their habitat may be inaccessible (for example in the thick vegetation of upland swamps). This technique used a combination of both call-playback of the male advertisement call and set listening periods to estimate relative abundances of calling males, species composition, breeding habitat and microhabitat use.

Sites surveyed within RVE (Figure 1) include LW5A-F1 and LW5A-F2.

Threatened frog breeding habitat monitoring

An initial diurnal habitat assessment was undertaken across RVE. All areas of potential habitat were mapped and used to inform the location and extent of future monitoring. Potential habitat identified by topography maps and aerials along streams was ground-truthed and all suitable breeding pools were marked using a GPS.

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.

Transects are surveyed by zoologists familiar with the target species, counting all amphibians seen and/or heard along the transect. The timing of surveys has taken into consideration the seasonal movements of each species, with monitoring undertaken in both the breeding season, to detect calling males and higher period of activity for adult frogs and following the breeding season to target tadpoles and metamorphs.

Active Visual Encounter Surveys (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 was undertaken along transects in those areas assessed to contain suitable habitat for each of the species.

The location of any individuals detected during the targeted nocturnal surveys, or any other significant incidentals is recorded using a GPS.

Sites surveyed that are within RVE (Figure 1) that were considered controls for this survey include the following transects; CC(1)-T, CC(2)-T, CCUS4-T, CRUS1(1)-T, CRUS1(2)-T, CRUS2-T.

Control sites (not mapped) include WAC-T and WACT-T.

Sites surveyed that are not within RVE (not mapped) include; DC13, LA4, LC7, NDC, ND2, ND1, SC7(1), SC7(2), SC7A (rep 1), SC7A, SC8, WC11, WC15 and WC10.

Threatened frog non-breeding habitat monitoring

A combination of both randomised transects and permanent quadrat survey techniques have been established within the non-breeding habitat of upland swamps throughout RVE.

Quadrat surveys for threatened frogs in upland swamps are conducted within a 25 metre by 25 metre (625 metre square area centralised around a fixed point. An initial listening period is followed by active searching by zoologists familiar with the target species of all natural features including rocks, vegetation and leaf litter within the transect for 25 person minutes. The length of the initial listening period varies depending on the target species. Five minutes is allocated to those habitats suitable for Littlejohn's Tree Frog, whereas a 30 minute listening period is 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 quadrat is recorded. An inventory of incidental species, namely non-threatened frogs, is also recorded.

Between fixed quadrat survey points, randomised transects are surveyed by walking a specific distance through a randomly chosen route. This design allows for detection of threatened and non-threatened species across habitat gradients of RVE.

Sites surveyed within RVE (Figure 1) include; CCUS1, CCUS2, CCUS3, CCUS4, CRUS1, CRUS2, and CRUS3; which are associated with quadrats; CCHS1-V2-S, CCHS1-V3-S, CRHS3-V1-S, CRHS3-V3-S, CRHS2-V2, CRHS2-V3, CCHS3-V1, CCHS3-V2, CCHS4-V2, CCHS4-V3, and CCHS2-V2.

Control sites (not mapped) include; 33 and 15A(1).

3.3. Biosis (2014b) – Project no. 16940 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Surveys were undertaken 9-18 December 2013, 24 January-2 February 2014.

Threatened frog auditory monitoring

See Biosis (2013) above (Section 3.2).

In addition to the above methodology, data was then analysed using a call recogniser built in Song Scope bioacoustics software (Wildlife Acoustics). Confirmed Red-crowned Toadlet calls were sourced from previous Biosis recordings combine with David Stewarts Nature Sounds (2002) and were annotated into a call library to be used in the recogniser. The final recogniser had a total training value of 71.5 +-6.36 %, which indicates an adequate power of detection for the species. Recordings from the field were then run through the recogniser to detect potential Red-crowned Toadlet calls. An ecologist then reviewed these calls to confirm their identity.

Sites surveyed within RVE (Figure 1) that differ to Biosis (2013) include LW6A-F1 instead of LW5A-F2.

Control sites (not mapped) include FT6FA and WC11.

Threatened frog breeding habitat monitoring

See Biosis (2013) above (Section 3.2).

Threatened frog non-breeding habitat monitoring

See Biosis (2013) above (Section 3.2).

3.4. Biosis (2016) – Project no. 20492 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Monitoring for Stuttering Frog along Cataract Creek was completed between 2012 and the summer of 2014/2015. Given that no individuals were detected over three years of monitoring, this component of the threatened frog program ceased during the 2015/2016 monitoring.

Threatened frog auditory monitoring

See Biosis (2013) (Section 3.2) and Biosis (2014b) (Section 3.3) methods above.

Threatened frog breeding habitat monitoring

See Biosis (2013) above (Section 3.2).

Sites surveyed within RVE (Figure 1) that differ to Biosis (2013) include; BCUS2(1), BCUS2(2), CCUS4, CRUS1(1), CRUS1(2) and CRUS2.

3.5. Biosis (2017) – Project no. 23086 (Red-crowned Toadlet)

Threatened frog auditory monitoring

See Biosis (2013) (Section 3.2) and Biosis (2014b) (Section 3.3) methods above.

As per the recommendations outlined in the *Russell Vale East Terrestrial Ecological Monitoring Program Annual Report for 2015* (Biosis 2016), two additional sites were established downstream from the existing impact sites within RVE, in an attempt to identify whether or individuals were still present along the ephemeral drainage lines (Figure 1).

Sites surveyed within RVE (Figure 1) that differ to Biosis (2013) and Biosis (2014b) include LW5A-F1 and LW6A-F1 additional sites.

3.6. Biosis (2022) – Project no. 34919 (Giant Burrowing Frog)

Targeted surveys for Giant Burrowing Frog tadpoles were undertaken over two days along a tributary below swamp CRUS2 (Figure 1). The initial survey was undertaken in line with the previous survey methodology undertaken in the area to detect the species, see Biosis (2013) above and according to the methodology outlined in the BMP (Wollongong Coal 2021), developed following consultation with the NSW BCD.

The 2021 surveys were undertaken by Luke Stone (Senior Aquatic Ecologist), assisted by Zoe Goold (Project Zoologist) and Rosie Gray (Research Assistant) on 13 and 21 October 2021. Active VES for adults, tadpoles and egg mass were undertaken using spotlighting and call detection along a set transect identified as containing suitable habitat the species.

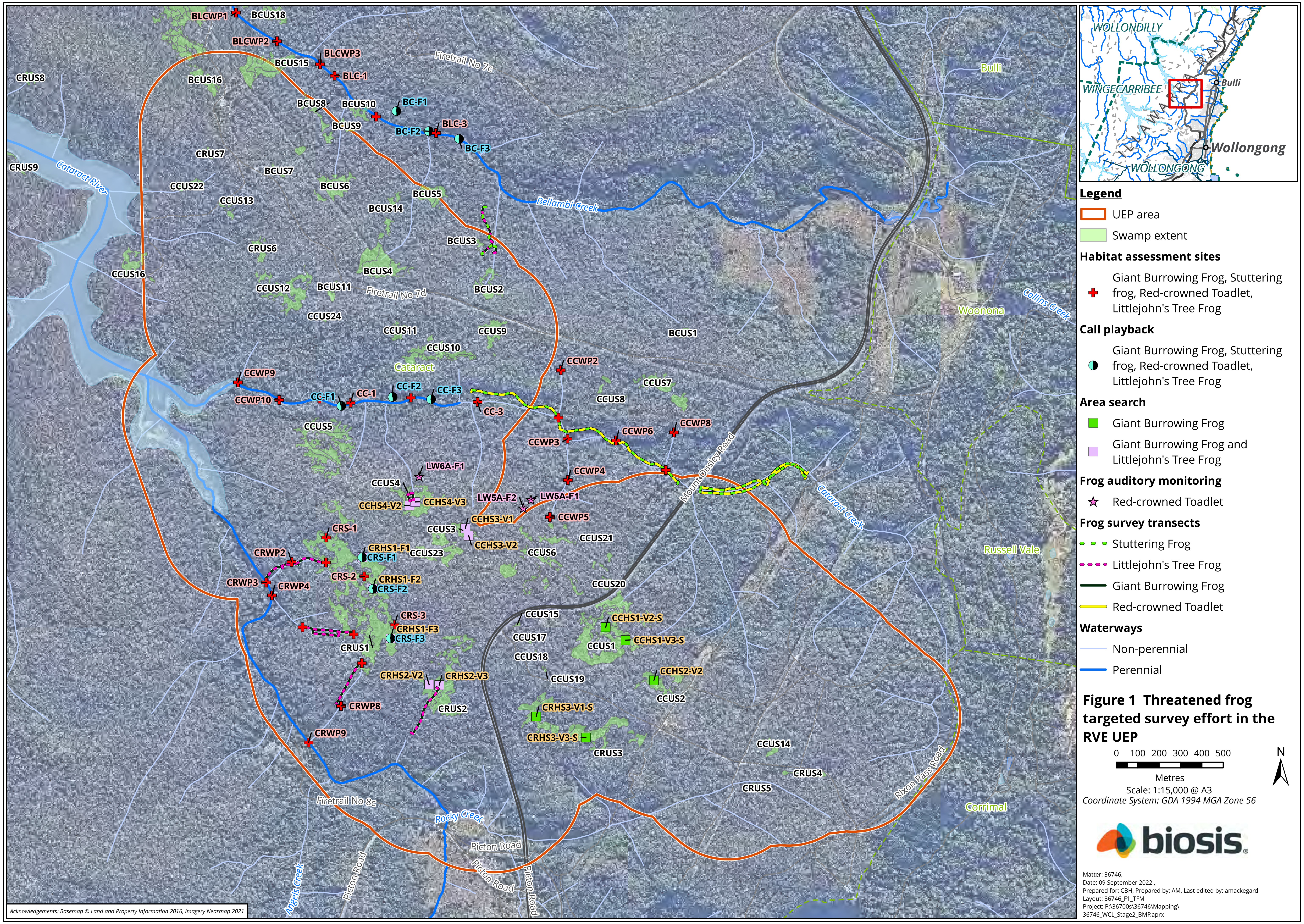

Figure 1 Threatened frog targeted survey effort in the RVE UEP

4. Timing of survey

Recommended survey periods for threatened frogs surveyed at RVE are outlined in Table 4.

Table 4 Recommended survey periods for threatened frogs surveyed at RVE

Species	EPBC Act	BC Act	Recommended survey period
Heleioporus australiacus **Giant Burrowing Frog**	VU	VU	September-May
Litoria littlejohni **Littlejohn's Tree Frog**	VU	VU	July-November
Mixophyes balbus **Stuttering Frog**	VU	EN	September-March
Pseudophryne australis **Red-crowned Toadlet**	-	VU	Year-round

Surveys were conducted with the following timing:

- Biosis (2012) – Project no. 11853 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet):
  - Frog surveys were conducted in creeklines and upland swamps in autumn and spring. The remaining surveys were undertaken in winter 2011 during the active period for frogs (Table 4).
- Biosis (2013) – Project no. 14511 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet):
  - Surveys were undertaken during optimal conditions for each of the targeted species and during the active period for most species (Table 4) between 25-28 February 2013.
  - The survey period is not within the recommended survey period for Littlejohn's Tree Frog, however the species was consistently detected at control sites during this period (see Section 5.2, Table 8).
- Biosis (2014b) – Project no. 16940 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet):
  - Surveys were undertaken during optimal conditions for each of the targeted species and during the active period of most species (Table 4) between the 9-18 December 2013 above Longwall 5, and 24 January to 2 February 2014 above Longwall 6.
  - The survey period is not within the recommended survey period for Littlejohn's Tree Frog, however the species was consistently detected at control sites during this period (see Section 5.3).
- Biosis (2016) – Project no. 20492 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet):
  - Monitoring along Cataract Creek was completed between 2012 and the summer of 2014/2015 (see Section 5.4), during optimal conditions for each of the targeted species and during the active period of the species (Table 4).

- Biosis (2017) – Project no. 23086 (Red-crowned Toadlet):
  - Surveys were undertaken during optimal conditions for the targeted species and during the active period of the species (Year-round, Table 4) between February to April 2017.
- Biosis (2022) – Project no. 34919 (Giant Burrowing Frog):
  - Surveys were undertaken in CRUS2 during optimal conditions for each of the targeted species and during the active period of the species (September – March, Table 4) on 13 and 21 October 2021.
  - As the species was detected during the initial nocturnal survey, the second survey was undertaken under diurnal conditions, focusing on describing pools where the species was detected, to better record detailed habitat descriptions. Species observations were also collected during this survey, although water surface visibility was hampered due to tannin staining and glare. As the primary focus of the surveys are to determine the ongoing presence of the species within the previously identified area of habitat this is not considered a major limitation. Diurnal survey was required to ensure the most appropriate recording of habitat conditions could be collected, including the collection of photographs of the pools occupied by the species.

5. Results

5.1. Biosis (2012) – Project no. 11853 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

The results of this survey are shown in Table 5 and Table 6 below.

Table 5 Species detected at newly established sites during the autumn and spring surveys 2011

Location	Common Name	Scientific Name	Total Count over 3 Replicates
Impact Creekline			
Cataract Creek	Lesueur's Tree Frog	*Litoria lesueuri*	1
	Leaf Green Tree Frog	*Litoria nudidigita/Litoria phyllochroa*	35
	Leaf Green Tree Frog	*Litoria phyllochroa*	33
Reference Creeklines			
Bellambi Creek	Lesueur's Tree Frog	*Litoria lesueuri*	-
	Leaf Green Tree Frog	*Litoria nudidigita/Litoria phyllochroa*	37
	Leaf Green Tree Frog	*Litoria phyllochroa*	17
Flying Fox Creek #3	Common Eastern Froglet	*Crinia signifera*	32
	Jervis Bay Tree Frog	*Litoria jervisiensis*	1
	Leaf Green Tree Frog	*Litoria nudidigita/Litoria phyllochroa*	10
	Peron's Tree Frog	*Litoria peronii*	1

Table 6 Results of diurnal threatened frog habitat assessment

Location Description	Habitat Notes
Walked down from CRS-F3 monitoring point down towards Cataract River (245 m transect)	Width: 0 – 1.5 metres Depth: 0 – 0.25 metres Defined creekline with very little water present. Only one suitable breeding pool present however, the surrounding terrain is steep. Around CRWP-8, creekline vegetation consists of mesic species with bare ground. **No tadpoles observed in diurnal surveys.**
Second western tributary at Cataract River Swamp	Width: 0 – 2 metres Depth: 0 – 0.2 metres Slow flowing rocky stream. Several sections stagnant with no water flow apparent for some time. Mossy/rainforest environment. **Possible Stuttering Frog habitat. Not considered to be potential Littlejohn's Tree Frog or Giant Burrowing Frog habitat. No tadpoles observed in diurnal surveys.**

Location Description	Habitat Notes
Walked down from CRS-F1 monitoring point down towards Cataract River	Width: 0 – 5 metres Depth: 0 – 0.25 metres Fast flowing rocky stream with few breeding pools present. Stream widens and becomes slightly deeper toward CRWP-2. Although there are a few breeding pools present, the terrain is very steep and minimal overhanging vegetation. **Considered to be sub-optimal habitat for Littlejohn's Tree Frog. No tadpoles observed in diurnal surveys. Red-crowned Toadlet may be heard from adjacent ephemeral drainage lines.**
Upstream from fire road 7C/ Bellambi Creek crossing	Width: 1.5 – 6 metres Depth: 0.1 – 2 metres Fast Flowing rocky stream. From BCWP1 and upstream, vegetation turns into Moist Gully Gum Forest. **Not ideal vegetation type for Littlejohn's Tree Frog however structurally suitable with flat slope, deep permanent pools present and fringing vegetation. No tadpoles observed in diurnal surveys.**

5.2. Biosis (2013) – Project no. 14511 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Threatened frog auditory monitoring

The Red-crowned Toadlet was recorded calling at Site F1 on 25-27 of February 2013 and at Site 2 on 25 of February 2012.

Table 7 Summary of Red-crowned Toadlet auditory monitoring, including numbers of calls and calling time for each site

Site	Date	Calls (24 hour time)
LW5A-F1	25 February 2013	1 adult calling at 19:54
	26 February 2013	3 adults calling between 18:08 and 19:35
	27 February 2013	3 adults calling between 17:23 and 19:04
	28 February 2013	Nil - Heavy rain precluded analysis of calls
LW5A-F2	25 February 2013	5 adults calling between 16:14 and 17:54
	26 February 2013	-
	27 February 2013	-
	28 February 2013	Nil - Heavy rain precluded analysis of calls

Threatened frog breeding habitat monitoring

Following the commencement of the threatened frog breeding habitat monitoring program in winter 2012, no adult Littlejohn's Tree Frog, Giant Burrowing Frog or Stuttering Frog adults have been detected at RVE.

Despite no records of Littlejohn's Tree Frog located in suitable habitats at RVE, the species was recorded at 12 of the 14 control sites surveyed within the same seasons. All three lifecycle stages (adult, tadpole and egg mass) were recorded at four sites; adults and tadpoles at six sites; and adults only at an additional two sites. A summary of the results is provided in Table 8 below.

The Giant Burrowing Frog was recorded, as tadpoles only, at only one site (CRUS2 transect) during the winter and summer targeted surveys. A total of 17 tadpoles were observed over three breeding pools located along the 245 metre long transect.

Of the transects surveyed as part of the breeding habitat monitoring program at RVE, the CRUS2 transect is considered to be of highest habitat value for both the Giant Burrowing Frog and Littlejohn's Tree Frog and was ranked "good" in habitat assessments (although Littlejohn's Tree Frog has not been recorded).

Finally, no records of the Stuttering Frog have been recorded following the spring and summer targeted surveys for this species along two transects of Cataract Creek.

Threatened frog non-breeding habitat monitoring

Seven swamps potentially impacted by mining in RVE and two control sites were also monitored for non-breeding individuals in seasons where each frog is most active, and therefore easiest to detect. No threatened frog presence was recorded at any of the non-breeding habitat monitoring survey sites within RVE.

Table 8 Summary of results of threatened frog species surveys 2012-2013 (maximum number of recorded individuals is displayed)

Species	Control														Pre-impact and impact sites														
	SC8	SC7(1)	SC7(2)	SC7A (rep 1)	SC7A	NDC	ND2	ND1	LA4	DC13	WC11	WC15	LC7	WC10	CC(1)-T	CC(2)-T	CCUS2	CRUS1	CRUS1(1)-T	CRUS1(2)-T	CRUS2	CRUS2-T	CRUS3	WAC-T	WACT-T	CCUS1	CCUS3	CCUS4	CCUS4-T
Littlejohn's Tree Frog																													
Adults	4	9	14	8	15	4	3	1	-	9	6	2	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tadpoles	4	-	70	86	185	7	-	2	-	19	2	4	-	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Egg Mass	4	-	4	-	-	-	-	-	-	4	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Breeding Pools	3	4	6	-	10	7	2	2	-	4	1	2	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Giant Burrowing Frog																													
Adults	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tadpoles	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-
Egg Mass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Breeding Pools	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-
Stuttering Frog																													
Adults	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tadpoles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Egg Mass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pools	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

5.3. Biosis (2014b) – Project no. 16940 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Threatened frog auditory monitoring

The Red-crowned Toadlet was recorded calling at LW5A-F1 on 13 and 16 December 2013, however there were no records detected at LW5A-F2. This is the second season that the threatened species has been recorded calling in this ephemeral drainage line, following data collected at the same point in February 2013 (specific details provided in Biosis (2013). There has been no indication of a change in habitat at LW5A-F2 and the lack of calls is likely to be a result of environmental factors rather than longwall mining.

Song Meter data collected at LW6A did not detect the species this season despite being recorded at the control site (WC11A) within this same timeframe. This is the first season of monitoring at this site collecting pre-mining data. Data collected from the summer 2013/2014 auditory monitoring program are provided in Table 9 below.

Table 9 Summary of Red-crowned Toadlet auditory monitoring, including numbers of calls and calling time for each site

Site	Date	Calls (24 hour time)
LW5A-F1	9/12/2013	-
	10/12/2013	-
	11/12/2013	-
	12/12/2013	-
	13/12/2013	1 adult calling at 19:54
	14/12/2013	-
	15/12/2013	-
	16/12/2013	1 adult calling within 0:50:52 and 1:15:44
	17/12/2013	-
	18/12/2013	-
LW5A-F2	9/12/2013	-
	10/12/2013	-
	11/12/2013	-
	12/12/2013	-
	13/12/2013	-
	14/12/2013	-
	15/12/2013	-
	16/12/2013	-
	17/12/2013	-
	18/12/2013	-

Site	Date	Calls (24 hour time)
LW6A-F1	24/1/2014	-
	25/1/2014	-
	26/1/2014	-
	27/1/2014	-
	28/1/2014	-
	29/1/2014	-
	30/1/2014	-
	31/1/2014	-
	1/2/2014	-
	2/2/2014	-

Threatened frog breeding habitat monitoring

Following the commencement of the threatened frog breeding habitat monitoring program in winter 2012, no adult Littlejohn's Tree Frog or Stuttering Frog adults have been detected at RVE.

Despite no records of Littlejohn's Tree Frog located in suitable habitats at Russell Vale East, the species was recorded at 12 of the 14 control sites surveyed within winter 2013. All three lifecycle stages (adult, tadpole and egg mass) were recorded at four sites; adults and tadpoles at six sites; and adults only at an additional two sites.

No records of the Stuttering Frog have been recorded following the spring 2013 and summer 2013/2014 targeted surveys along two transects of Cataract Creek.

The Giant Burrowing Frog was recorded, as adults, metamorphs and tadpoles at only one monitoring site (CRUS2 Tributary) during the summer 2013/2014 targeted surveys. A total of 17 tadpoles (including 11 metamorphs) were observed within one breeding pool located along the 245 metre long transect on the first replicate conducted for the season on 13 January 2014. The second replicate completed on the 21 January 2014 detected nine tadpoles (including 3 metamorphs) within the same breeding pool. One adult was also identified to be calling from a burrow upstream of the known breeding pools. This is the first time an adult and metamorphs have been detected within this monitoring transect. The species was first detected as tadpoles in winter 2012 when ecological monitoring commenced.

Table 10 Summary of Giant Burrowing Frog observations at CRUS2-Trib in summer 2013/2014 monitoring season

Date recorded	Life Stage	Habitat	Number recorded
13/1/2014	Tadpoles	In water	8
	Metamorphs	In water	8
	Metamorphs	On Ground	1
21/1/2014	Tadpoles	In water	6
	Metamorphs	In water	3
	Adult	Calling	1

Of the transects surveyed CRUS2 is considered to be of highest habitat value for both the Giant Burrowing Frog and Littlejohn's Tree Frog and was ranked "good" in habitat assessments (although Littlejohn's Tree Frog has not been recorded).

Threatened frog non-breeding habitat monitoring

A total of seven sites were also monitored for non-breeding individuals in seasons where each frog is most active, and therefore easiest to detect. No threatened frog presence was recorded at any of the survey sites.

5.4. Biosis (2016) – Project no. 20492 (Giant Burrowing Frog, Littlejohn's Tree Frog, Stuttering Frog and Red-crowned Toadlet)

Threatened frog auditory monitoring

The Red-crowned Toadlet was again not recorded at either of the two impact sites (LW5A-F1 and LW6A-F1) during summer 2015/2016 auditory monitoring despite having been detected at the control sites. The site inspection again confirmed that the surface fracture intersecting the LW5A drainage line, first detected in 2014, is still present. The fracture is located approximately 30 meters upstream of the monitoring point and remains to be approximately eight meters long, two meters wide and one and a half meters deep. For the second consecutive year, no Red-crowed Toadlet were detected at LW5A-F1 downstream which may be a result of disrupted surface flows down the drainage line.

Data for the 2015 monitoring period is summarised in Table 11.

Table 11 Summary of Red-crowned Toadlet auditory monitoring, including numbers of calling adults and calling time for each site

Site status	Site	Date	Calls (24 hour time)
Impact	LW5A-F1	4/02/2016	-
		5/02/2016	-
		6/02/2016	-
		7/02/2016	-
		8/02/2016	-
	LW6A-F1	4/02/2016	-
		5/02/2016	-
		6/02/2016	-
		7/02/2016	-
		8/02/2016	-
Control	FT6FA	4/02/2016	2 adults calling between 18:43 and 22:00
		5/02/2016	2 adults calling between 18:05 - 22:00
		6/02/2016	1 adult calling between 18:01 - 22:00
		7/02/2016	1 adult calling between 19:07 - 21:42
	WC11	4/02/2016	1 adult calling between 20:25 – 21:42
		5/02/2016	1 adult calling between 20:22 - 21:40

Site status	Site	Date	Calls (24 hour time)
		6/02/2016	1 adult calling between 20:17 - 22:00
		7/02/2016	-

Threatened frog breeding habitat monitoring

During 2015, no Littlejohn's Tree Frogs were detected in RVE. Since the commencement of the program in winter 2012 this species has not yet been detected at any of monitoring sites at RVE. The species was however recorded at seven control sites surveyed within winter 2015. All three lifecycle stages (adult, tadpole and egg mass) were recorded at each site.

The Giant Burrowing Frog was again recorded as adult, metamorphs and tadpoles at the CRUS2 tributary monitoring site during 2015. Throughout the monitoring year of 2015 Giant Burrowing Frog tadpoles were recorded in three breeding pools in CRUS2. Giant Burrowing Frog tadpoles were recorded across all three monitoring seasons during 2015, with the largest numbers of tadpoles being observed during autumn (117) and at the end of winter/early spring (119). Metamorphs were only recorded during the two monitoring seasons completed in summer 2015/2016. Three adults were detected along the transect during the December 2015 monitoring survey, observed on the warmest evening of the month (minimum temperature of 20.4˚C) the night before a rainstorm. This is the third year where metamorphs and adult frogs have been detected at CRUS2. Data for the 2015 monitoring period is summarised in Table 12, Table 13 and Table 14.

Table 12 Summary of Giant Burrowing Frog observations at CRUS2-Trib in 2015 monitoring program (autumn 2015 – summer 2015/2016)

Date recorded	Life stage	Habitat	Number recorded	Breeding pool
09/04/2015	Tadpoles	In water	3	Pool 12
	Tadpoles	In water	19	Pool 13
	Tadpoles	In water	49	Pool 14
21/05/2015	Tadpoles	In water	4	Pool 12
	Tadpoles	In water	16	Pool 13
	Tadpoles	In water	26	Pool 14
21/12/2015	Adult	On Ground	1	On banks of transect
	Adult	On Ground	1	Pool 14
	Adult	On Ground	1	Pool 16
	Metamorphs	In water	2	Pool 12
	Tadpoles	In water	2	Pool 12
	Tadpoles	In water	11	Pool 13
	Tadpoles	In water	16	Pool 14
18/02/2016	Tadpoles	In water	2	Pool 13
	Tadpoles	In water	57	Pool 14
	Metamorphs	In water	1	Pool 12
	Metamorphs	In water	2	Pool 14

Table 13 RVE threatened frog breeding habitat 2015 data

Species	Life Stage	BCUS2(1) (07/05/2015)	BCUS2(1) (14/05/2015)	BCUS2(1) (20/08/2015)	BCUS2(1) (11/08/2015)	BCUS2(2) (07/05/2015)	BCUS2(2) (14/05/2015)	BCUS2(2) (20/08/2015)	BCUS2(2) (11/08/2015)	CCUS4 (09/04/2015)	CCUS4 (21/05/2015)	CCUS4 (19/08/2015)	CCUS4 (09/09/2015)	CRUS1(1) (09/04/2015)	CRUS1(1) (21/05/2015)	CRUS1(1) (19/08/2015)	CRUS1(1) (09/09/2015)	CRUS1(2) (09/04/2015)	CRUS1(2) (21/05/2015)	CRUS1(2) (19/06/2015)	CRUS1(2) (09/09/2015)	CRUS2 (09/04/2015)	CRUS2 (21/05/2015)	CRUS2 (19/08/2015)	CRUS2 (09/09/2015)	CRUS2 (21/12/2015)	CRUS2 (18/02/2016)
Giant Burrowing Frog	Adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
	Eggmass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tadpoles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	71	46	59	60	29	59
	Metamorph	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3
	Number of Breeding pools	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	5	3
Littlejohn's Tree Frog	Adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Eggmass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tadpoles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Metamorph	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Number of Breeding pools	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stuttering Frog	Adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Eggmass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tadpoles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Metamorph	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Number of Breeding pools	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 14 Control threatened frog breeding habitat 2015 data

Species	Life Stage	SC6	SC7A	SC7(1)	SC7(2)	SC8	NDC	ND1	ND2	WC10	WC11
		10/08/2015	10/08/2015	10/08/2015	28/07/2015	5/08/2015	3/08/2015	8/09/2015	3/08/2015	4/08/2015	12/08/2015
Giant Burrowing Frog	Adult	-	-	-	-	-	-	-	-	-	-
	Eggmass	-	-	-	-	-	-	-	-	-	-
	Tadpoles	11	-	-	-	-	-	-	-	-	7
	Metamorph	-	-	-	-	-	-	-	-	-	-
	# Breeding pools	10	-	-	-	-	-	-	-	-	4
Littlejohn's Tree Frog	Adult	7	19	6	14	1	8	7	-	11	4
	Eggmass	7	18	9	7	4	-	11	-	13	2
	Tadpoles	5	5	-	5	3	3	4	-	1	2
	Metamorph	-	-	-	-	-	-	-	-	-	-
	# Breeding pools	12	16	8	9	4	6	10	-	12	4

The species was first detected as tadpoles in winter 2012 when ecological monitoring commenced with the first adult frog and metamorphs detected in the summer surveys of 2013/2014. During the period of monitoring, adults continue to be detected on warm nights following or prior to thunderstorms during the summer and autumn months. Following this the highest numbers of tadpoles also continue to be observed during the autumn and winter months. As tadpole abundance declines in summer, metamorph abundance increases with peak metamorph abundances during summer. Metamorph detection was comparably low in 2015 when compared to 2014 (Figure 2).

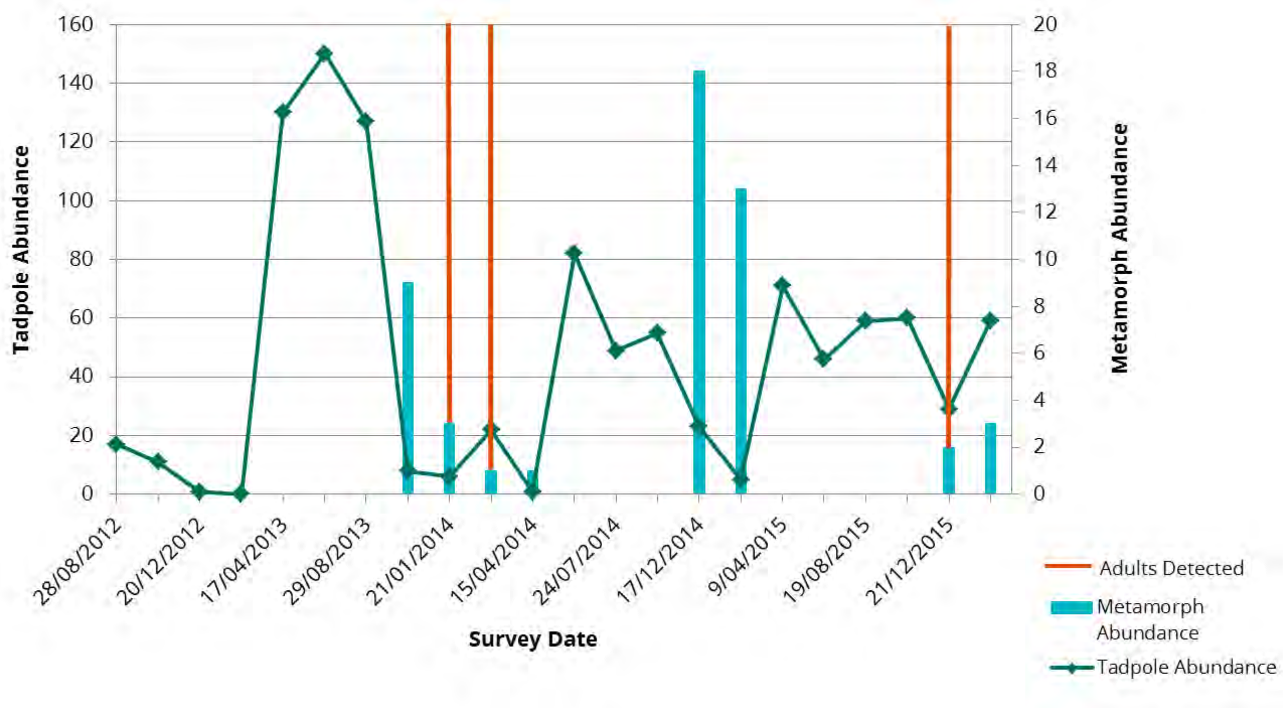

Figure 2 **Giant Burrowing Frog observations at CRUS2-Trib across time since monitoring commenced (spring 2012 – summer 2015/2016)**

Of the seven transects surveyed at RVE as part of the breeding habitat monitoring program, the CRUS2 transect is considered to be of highest habitat value for both the Giant Burrowing Frog and Littlejohn's Tree Frog. However, Littlejohn's Tree Frog has not been recorded at this site to date.

5.5. Biosis (2017) – Project no. 23086 (Red-crowned Toadlet)

Threatened frog auditory monitoring

Due to the two previous years of auditory monitoring resulting in the apparent absence of the Red-crowned Toadlet from the impact sites (LW5A-F1 and LW6A-F1), additional monitoring sites were established for the 2016/2017 monitoring period. These sites were located within the impact area of Longwalls 5 and 6 in an attempt to determine if the species may have relocated to more suitable habitat downstream of the initial monitoring sites. Analysis of the recordings resulted in the presence of the Red-crowned Toadlet at the additional site downstream from LW6A-F1, where habitat was thought to be more suitable. In addition to this, during the setup of the original monitoring site at LW5A-F1, a qualified zoologist identified the presence of the Red-crowned Toadlet, as the species is known to call back to clapping and ambient noises created from using tools during installation of the songmeter.

Data collected from the summer 2013/2014 auditory monitoring program are provided in Table 15 below. Trends in call activity at these sites from the beginning of monitoring are represented in Table 16.

Table 15 Summary of Red-crowned Toadlet auditory monitoring, including numbers of calling adults and calling time for each site

Site	Site status	Date	Calls (24 hour time)
LW5A-F1	Impact	23/02/2017 - 03/03/2017	One individual recorded during the installation of the Songmeter
LW6A-F1	Impact	23/02/2017 - 09/04/2017	-
LW5A-F1 Additional Site	Impact	24/02/2017 - 5/03/2017	-
LW6A-F1 Additional Site	Impact	24/02/2017 - 09/04/2017	At least two individuals calling between 16:18 – 16:21
FT6FA	Control	23/02/2017 - 14/05/2017	At least two individuals calling between 19:36 – 19:39
WC11	Control	23/02/2017 - 01/03/2017	At least two individuals calling between 16:59 – 17:46

Table 16 Summary of Red-crowned Toadlet auditory monitoring, including all monitoring years

Treatment	Site	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
RVE	LW5A-F1	Present	Present	Absent	Absent	Present
	LW6A-F1	Absent	Absent	Absent	Absent	Absent
	LW5A-F1 - Additional	-	-	-	-	Absent
	LW6A-F1- Additional	-	-	-	-	Present
Control	FT6FA	Present	Present	Present	Present	Present
	WC11	Present	Present	Present	Present	Present

5.6. Biosis (2022) – Project no. 34919 (Giant Burrowing Frog)

The spring 2021 surveys have focussed on identifying the continued presence of the species within mapped habitat along the CRUS2 transect. Giant Burrowing Frog tadpoles were identified at pools 12 and 13 along transect CRUS2 during the spring surveys.

A summary of the Giant Burrowing Frog tadpoles recorded from transect CRUS2 since monitoring commenced in 2012 is summarised in Table 17 (Biosis 2022). While the spring surveys cannot be directly compared to any previous surveys during spring, the 2021 results broadly align with results of previous surveys which show greatest detection during winter and lowest levels of detection during summer and demonstrate the ongoing presence of this species in this waterway.

Table 17 Giant Burrowing Frog records summary from CRUS2 transect

Survey date	Round	Adults	Metamorphs	Tadpoles
28/08/2012	Winter	-	-	17
30/08/2012	Winter	-	-	11
17/04/2013	Autumn	-	-	130
27/05/2013	Autumn	-	-	50
27/08/2013	Winter	-	-	100
29/08/2013	Winter	-	-	127
20/12/2013	Summer	-	-	1
13/01/2014	Summer	-	9	8
21/01/2014	Summer	1	3	6
19/03/2014	Autumn	1	1	22
15/04/2014	Autumn	-	1	82
24/07/2014	Winter	-	-	49
29/07/2014	Winter	-	-	55
17/12/2014	Summer	-	18	23
13/01/2015	Summer	-	13	5
9/04/2015	Autumn	-	-	71
21/05/2015	Autumn	-	-	46
19/08/2015	Winter	-	-	59
9/09/2015	Winter	-	-	60
21/12/2015	Summer	3	2	29
18/02/2016	Summer	-	3	59
13/10/2021	Spring	-	-	21
21/10/2021	Spring*	-	-	18

**diurnal habitat survey*

Previous monitoring has been undertaken in winter, autumn and summer and has predominantly encountered tadpoles at pools 12, 13 and 14. A detailed breakdown of detection per pool is provided in Table 18. The monitoring data indicate that pools 12 and 13 represent the most permanent habitat for Giant Burrowing Frog tadpoles. Pool 14 has also reliably recorded relatively high number of tadpoles, although there is a greater number of zero counts for this pool. Indicating that habitat conditions are less permanent or utilisation is less frequent, but that abundances tend to be greater when tadpoles are present. The 2021 results are consistent with these findings.

Table 18 Giant Burrowing Frog tadpole detection in identified pools along the CRUS2 transect

Year	Season	CRUS2-P10	CRUS2-P11	CRUS2-P12	CRUS2-P13	CRUS2-P14	CRUS2-P15	CRUS2-P16
2012	Winter	-	-	15	8	5	-	-
2013	Autumn	-	-	130	20	30	-	-
2013	Summer	-	-	1	-	-	-	-
2013	Winter	-	2	102	50	73	-	-
2014	Autumn	1	-	22	59	-	12	10
2014	Summer	-	-	-	37	-	-	-
2014	Winter	-	-	-	104	-	-	-
2015	Autumn	-	-	7	35	75	-	-
2015	Summer	-	-	2	16	16	-	-
2015	Winter	-	-	16	34	69	-	-
2016	Summer	-	-	-	2	57	-	-
2021	Spring	-	-	19	20	-	-	-

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Contact

Dr Caragh Heenan

Consultant Zoologist

cheenan@biosis.com.au

+61 418 540 494

APPENDIX B – FLORA AND FAUNA

Threatened flora, ecological communities and fauna

The following table includes a list of the threatened flora species that have potential to occur within the EP area. The list is based on database searches outlined in Section 3.3.1.

Table 14 Endangered Ecological communities predicted to occur within 5 km of the EP area

Scientific name	BC Act status	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	Endangered	Endangered	No. Restricted to coastal floodplains. Not recorded within EP area.
Coastal Upland Swamp in the Sydney Basin Bioregion	Endangered	Endangered	Yes. Community occurs within the EP area and is susceptible to subsidence.
Illawarra and south coast lowland forest and woodland ecological community	Endangered	Critically Endangered	No. Not recorded within EP area.
Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No. Not recorded within EP area.
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Endangered	Critically Endangered	No. Restricted to within 2 km of the coast or adjacent to a large salt water body. Suitable habitat not present within EP area.
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within EP area.
Subtropical and Temperate Coastal Saltmarsh.	Endangered	Vulnerable	No Restricted to coastal areas under regular or intermittent tidal influence. Suitable habitat not present within EP area.
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	Endangered	Critically Endangered	No Restricted to Cumberland lowlands. Not recorded within EP area.
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Endangered	No Found on basalt and basalt-like substrates. Suitable habitat not present within the EP area.

Table 15 Threatened flora recorded or predicted to occur within 5 km of the EP area

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Acacia baueri subsp. *aspera*	-	-	VU	1999	3	2,894	No *Acacia baueri* ssp. *baueri* occurs in damp heaths associated with sandstone woodland and often occurs in small depressions on rocky outcrops. Targeted and opportunistic surveys in the EP area have not recorded this species. The EP area does not contain many rocky outcrops, and suitable habitat for this species within the EP area is limited.
Acacia bynoeana	Bynoe's Wattle	VU	EN	#	-	-	No Species commonly found in sandstone and gravel based soils, occasionally on rock platforms. Potential habitat is present. Not recorded within the EP area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Allocasuarina glareicola	-	EN	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	EN	#	-	-	No Perennial terrestrial orchid found in grassy Sclerophyll woodland on clay loam or sandy soils. Suitable habitat not present.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Chorizema parviflorum - **endangered population**	Eastern Flame Pea (*Chorizema parviflorum* Benth. in the Wollongong and Shellharbour Local Government Areas)	-	E2	1995	1	8,748[5]	No Endangered population present in the Illawarra region. Potential habitat present within the EP area. Not recorded within the EP area. Negligible risk of impact from subsidence.
Cryptostylis hunteriana	Leafless Tongue Orchid	VU	VU	#	-	-	Yes Moderate likelihood of occurrence. One confirmed record greater than 10 km from the EP area.
Cynanchum elegans	White-flowered Wax Plant	EN	EN	1991 #	1	3,628	No Known from ecotone between dry rainforest and grassy woodland communities on coastal plain. Suitable habitat not present.

[5] Only detected within 5-10 km search, included due to potential habitat present.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Epacris purpurascens var. *purpurascens*	-	-	VU	2015	5	3,720	No *Epacris purpurascens* var. *purpurascens* is found within a wide range of habitat, usually associated with moisture, most of which have a strong shale influence. It is not considered to be a swamp specialist. This habitat is considered to be at negligible risk of impact. Further opportunistic surveys in the EP area have not recorded this species.
Genoplesium baueri	Bauer's Midge Orchid	EN	EN	#	-	-	No Grows in dry sclerophyll forest and moss gardens over sandstone. Potential habitat is present. Not recorded within the EP area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Gossia acmenoides **- endangered population**	Scrub Ironwood (*Gossia acmenoides* population in the Sydney Basin Bioregion south of the Georges River)	-	E2	2017	4	5,682[5]	No Endangered population present in the Sydney Basin. Potential habitat present within the EP area. Not recorded within the EP area. Negligible risk of impact from subsidence.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Haloragis exalata subsp. *exalata*	Square Raspwort	VU	VU	#	-	-	No Requires protected and shaded damp situations in riparian habitats. Outside known distribution.
Leucopogon exolasius	Woronora Beard-heath	VU	VU	2019	8	8,112[5]	No Occurs in a wide range of habitat types, including woodland, rocky hillsides and creeks. Potential habitat is present. Not currently recorded within the EP area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Melaleuca biconvexa	Biconvex Paperbark	VU	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	VU	#	-	-[5]	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 EP 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	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Persoonia hirsuta	Hairy Geebung	EN	EN	1992 #	1	1,380	No Occurs in dry sclerophyll forest and woodland with a shrubby understory. Potential habitat is present. Not recorded within the EP area. Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Persoonia nutans	Nodding Geebung	EN	EN	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Pomaderris adnata	Sublime Point Pomaderris	-	EN	2020	69	5,621[5]	No Potential habitat present within the EP area. Not recorded within the EP area. Negligible risk of impact from subsidence.
Pterostylis gibbosa	Illawarra Greenhood	EN	EN	#	-	-	No Occurs on soils derived from Permian sedimentary rocks of the Berry formation at an altitude of 10 to 20 m. Outside known altitudinal range.
Pterostylis saxicola	Sydney Plains Greenhood	EN	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 60 m. Outside known altitudinal range.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Pultenaea aristata	Prickly Bush-pea	VU	VU	2017 #	99	Species is present within EP area	Yes Occurs in open habitats, including upland swamps and adjacent woodland, where drainage is impeded. Previously located within EP area. Fracturing of bedrock may result in changes in hydrology and result in impacts to the species.
Rhodamnia rubescens	Scrub Turpentine	-	CE	2020	15	1,414	No Species recorded within the EP area. Negligible risk of impact from subsidence.
Senna acclinis	Rainforest Cassia	-	EN	1988	1	2,069	No Marginal habitat present. Species occurs near rainforest margins with negligible risk of impact from subsidence.
Solanum celatum	-	-	EN	1900	1	9,451[5]	No Potential habitat present within the EP area. Not recorded within the EP area. Negligible risk of impact from subsidence.
Syzygium paniculatum	Magenta Lilly Pilly	VU	EN	#	-	-	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.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to EP area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Thelymitra kangaloonica	Kangaloon Sun Orchid	CE	CE	#	-	-	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	VU	#	-	-	No Species occurs in in a range of terrestrial environments with negligible risk of impact from subsidence.
Xerochrysum palustre	Swamp Everlasting	VU	-	#	-	-	No Suitable habitat present. Species occurs in a range of environments with negligible risk of impact from subsidence.

Table 16 Threatened fauna recorded or predicted to occur within 5 km of the EP area

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet 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	CE	CE	#	-	-	No Potential foraging habitat present in the study area. Not recorded within the locality. Not reliant on

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							sensitive environments susceptible to impact from subsidence.
Artamus cyanopterus cyanopterus	Dusky Woodswallow	-	VU	2017	3	198	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	EN	2000#	1	3,579	No Found in terrestrial freshwater wetlands and, rarely, estuarine habitats. Suitable habitat not present.
Calidris canutus	Red Knot	EN	-	#	-	-	No Occurs in marine environments. Suitable habitat not present. Not recorded within the locality.
Calidris ferruginea	Curlew Sandpiper	CE	EN	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present. Not recorded within the locality.
Callocephalon fimbriatum	Gang-gang Cockatoo	EN	VU	2020	69	307	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	VU	2009	6	2,353	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Circus assimilis	Spotted Harrier	-	VU	2014	1	3,943	No

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							Potential habitat present in the study area though rarely recorded near the coast. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Daphoenositta chrysoptera	Varied Sittella	-	VU	2019	4	198	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Dasyornis brachypterus	Eastern Bristlebird	EN	EN	2021#	57	Species is recorded within study area	No Potential habitat is present. Not reliant on sensitive environments susceptible to impact from subsidence.
Glossopsitta pusilla	Little Lorikeet	-	VU	2020	9	2,642	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.
Haematopus longirostris	Pied Oystercatcher	-	EN	2019	1	4,145	No Found in estuarine habitats. Suitable habitat not present.
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	VU	2014	2	4,086	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.
Hieraaetus morphnoides	Little Eagle	-	VU	2020	8	198	No Potential foraging habitat present in the study area. Not recorded within the study area. Not reliant on

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							sensitive environments susceptible to impact from subsidence.
Hirundapus caudacutus	White-throated Needletail	VU	-	2010#	3	3,698	No The species has been recorded roosting in trees in forests and woodlands, though little is known about the species. The species does not breed in Australia and nearby sightings are likely vagrants.
Ixobrychus flavicollis	Black Bittern	-	VU	2015	3	1,447	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present.
Lathamus discolor	Swift Parrot	CE	EN	2017#	6	3,858	No Potential foraging habitat in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Lophoictinia isura	Square-tailed Kite	-	VU	2018	5	3,161	No Breeding habitat for this species includes large eucalypts in preferred vegetation types located along or near watercourses. Marginal habitat is present within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	-	VU	2004	1	4,506	No Eucalypt woodland vegetation is present in the study area, though sightings are rare east of the Great Dividing Range. Not reliant on sensitive environments susceptible to impact from subsidence.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Neophema chrysogaster	Orange-bellied Parrot	CE	CE	#	-	-	No Potential foraging habitat in the study area. Not recorded within the locality. Not reliant on sensitive environments susceptible to impact from subsidence.
Ninox strenua	Powerful Owl	-	VU	2019	34	Species is recorded within study area	No Potential habitat present in 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. Not recorded within the locality.
Pandion cristatus	Eastern Osprey	-	VU	#	-	-	No Breeding habitat for this species consists of dead trees or artificial structures that are located within 100 m of a floodplain, with a preference for coastline, therefore the habitat is absent in the study area. Not recorded within the locality.
Petroica boodang	Scarlet Robin	-	VU	2003	1	2,875	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Petroica phoenicea	Flame Robin	-	VU	1967	1	4,454	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Petroica rodinogaster	Pink Robin	-	VU	2015	1	4,377	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Pezoporus wallicus wallicus	Eastern Ground Parrot	-	VU	2013	1	4,937	No The Eastern Ground Parrot occurs in low heathlands and sedgelands, generally below one metre in height and very dense. Habitat within the study area is largely limited to MU 44 Upland swamp: Sedgeland-Heath Complex. This vegetation community is severely restricted and highly fragmented within the study area. ERM (ERM 2013) assessed that this species could potentially occur in the Wonga West area, but was unlikely to occur within the Wonga East area. This species is considered unlikely to occur within the study area.
Ptilinopus regina	Rose-crowned Fruit-Dove	-	VU	2019	1	4,437	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Rostratula australis	Australian Painted Snipe	EN	EN	#	-	-	No Found in terrestrial freshwater wetlands and estuarine habitats. Suitable habitat not present. Not recorded within the locality.
Sternula nereis nereis	Fairy Tern	VU	-	#	-	-	No Occurs in marine environments. Suitable habitat not present. Not recorded within the locality.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Thinornis rubricollis	Hooded Plover	VU	CE	#	-	-	No Occurs in marine environments. Suitable habitat not present. Not recorded within the locality.
Tyto novaehollandiae	Masked Owl	-	VU	2014	5	512	No Potential habitat present in the study area. Not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Tyto tenebricosa	Sooty Owl	-	VU	2017	16	103	No Potential habitat present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Mammals							
Cercartetus nanus	Eastern Pygmy-possum	-	VU	2020	13	1,040	No Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive environments susceptible to impact from subsidence.
Chalinolobus dwyeri	Large-eared Pied Bat	VU	VU	#	-	-	Yes The likelihood of occurrence for the Large-eared Pied Bat has been downgraded to a low likelihood of occurrence since the Preferred Project Report (Biosis 2014a). Although targeted surveys detected a single possible record, the study area does not support suitable roosting habitat.
Dasyurus maculatus	Spotted-tailed Quoll	EN	VU	2013	2	455	No Potential habitat is present in the study area. Species not recorded. Not reliant on sensitive

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							environments susceptible to impact from subsidence.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	VU	2010	4	1,019	No Potential habitat is present in the study area. Species not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	EN	EN	#	-	-	No Potential habitat is present in the study area. Not recorded within the locality. Not reliant on sensitive environments susceptible to impact from subsidence.
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	-	VU	2019	1	4,227	No Potential habitat is present in the study area. Species not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Miniopterus australis	Little Bent-winged Bat	-	VU	2019	2	4,227	No Potential foraging habitat is present in the study area, and roosting habitat in the form of hollow-bearing trees are present, however it does not support suitable roosting habitat in the form of cliffs. Species not recorded within the study area.
Miniopterus orianae oceanensis	Large Bent-winged Bat	-	VU	2019	21	351	No The study area does not support suitable roosting habitat. Not recorded within the locality.
Myotis macropus	Southern Myotis	-	VU	2019	8	349	Yes Southern Myotis is considered to be rare in the local area (DECC 2007). The species forages along

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							waterways, including disturbed waterways in urban environments, and is more common in more highly productive environments. Therefore there is a low likelihood of occurrence for this species. Potential foraging habitat is present in the study area, and roosting habitat in the form of hollow-bearing trees are present, however it does not support suitable roosting habitat in the form of cliffs. The species may be susceptible to changes in water quality or natural flow regimes (DECC 2007).
Petauroides volans	Greater Glider	VU	-	2016#	24	694	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Petaurus australis	Yellow-bellied Glider	-	VU	2015	4	618	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Petaurus norfolcensis	Squirrel Glider	-	VU, E2	2016	3	3,583	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	EN	#	-	-	No Thought to be locally extinct in Southern Coalfield (DECC 2007). Not recorded within the locality.
Phascolarctos cinereus	Koala	EN	VU	2018#	6	2,199	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it 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 within the locality. Not reliant on sensitive environments susceptible to impact from subsidence.
Pteropus poliocephalus	Grey-headed Flying-fox	VU	VU	2020#	95	387	No Potential habitat is present in the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Scoteanax rueppellii	Greater Broad-nosed Bat	-	VU	2020	2	3,448	No Potential habitat is present in the study area. Species not recorded within the study area. Not reliant on sensitive environments susceptible to impact from subsidence.
Reptiles							
Hoplocephalus bungaroides	Broad-headed Snake	VU	EN	2021#	16	894	Yes Potential habitat is not present within the study area. Subsidence may result in fracturing of rocky outcrops, however the species is considered a low likelihood of occurrence.
Varanus rosenbergi	Rosenberg's Goanna	-	VU	2001	1	2,970	Yes Potential habitat is not present within the study area. Subsidence may result in fracturing of rocky outcrops, however the species is considered a low likelihood of occurrence.
Frogs							

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Heleioporus australiacus	Giant Burrowing Frog	VU	VU	2020#	29	Species is recorded within study area	Yes Known to inhabit ephemeral and intermittent streams and upland swamps in the locality. Habitat for the Giant Burrowing Frog within the study area consists of small sections of upper tributaries above the future stages workings; identified along a 245 m section of a tributary of Cataract River below swamp CRUS2 only. Habitat within the Stage 2 EP area has been assumed for the purposes of offsetting. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Litoria aurea	Green and Golden Bell Frog	VU	EN	2016	34	2,759	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	VU	2019#	42	958	Yes Known to inhabit ephemeral and intermittent streams in the locality. The species is now considered a low likelihood of occurrence based on the results of additional monitoring (Biosis 2016) since the Preferred Project Report (Biosis 2014a). Suitable habitat is limited in the study area and targeted surveys undertaken between August 2013 and February 2016 did not detect the species in the study area. Habitat within the Stage 2 EP area has been assumed for the purposes of offsetting. Subsidence can result in impacts to breeding habitat for this species through draining of pools.

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
Mixophyes balbus	Stuttering Frog	VU	EN	#	-	-	Yes Known to inhabit streams in the locality. Species rare in locality. Stuttering Frog is now considered a negligible likelihood of occurrence based on the results of additional monitoring (Biosis 2016) since the Preferred Project Report (Biosis 2014a). Targeted surveys undertaken between August 2013 and February 2016 did not detect the species in the study area. 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 it 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. Subsidence can result in impacts to breeding habitat for this species through draining of pools.
Pseudophryne australis	Red-crowned Toadlet	-	VU	2019	29	Species is recorded within study area	Yes The Red-crowned Toadlet is fairly common in preferred ridgetop habitat and first order ephemeral creeks below ridges (DECC 2007) and has been recorded, using drainage lines, sheltering under bushrock on ridgetops and in depressions along fire trails (Biosis pers. obs.). Habitat for this

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							species within the study area has not been mapped, as it is widely distributed and common. Targeted surveys for the Red-crowned Toadlet have been undertaken by Biosis as a part of the ecological monitoring program for Wonga East (Biosis 2013) and the species was recorded. Preferred habitat for this species is considered to be at limited risk of impact, however 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.
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

Scientific name	Common name	EPBC Act status	BC Act status	Most recent record	No. of records	Distance of closet record to study area (m)	Does the species occur in, and is it reliant on, sensitive environments susceptible to impact from subsidence?
							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.
Invertebrates							
Austrocordulia leonardi	Sydney Hawk Dragonfly	-	EN (FM Act)	#	-	-	No Inhabits freshwater streams, but not recorded within the locality. Observations restricted to areas further north. Subsidence may result in impacts to aquatic environments.
Petalura gigantea	Giant Dragonfly	-	EN	2008	2	Species is recorded within study area	Yes Species recorded in the study area during surveys. Suitable habitat is present. Subsidence may result in impacts to Coastal Upland Swamps.

APPENDIX C – TARPS

Biodiversity TARPs

Table 17 Current TARP trigger levels for the aquatic biodiversity monitoring program

Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/ Frequency	Purpose	Level	Action/ Reporting	Responsibility	Timing
Aquatic biodiversity	Monitoring of water quality and aquatic macroinvertebrate at five impact sites in Cataract Creek and Cataract River. Monitoring of water quality and aquatic Macroinvertebrates at four control sites.	A comprehensive visual inspection and photographic record of each monitoring site will be collected each time a site is visited. Physico-chemical water quality parameters, including temperature, conductivity, pH, oxidation, dissolved oxygen and turbidity. Physicochemical properties of waterways are compared to	Minimum 12 months of baseline monitoring prior to mining. Monitoring during mining. A minimum of one year of monitoring post-mining. Macroinvertebrate monitoring is undertaken in spring and autumn.	To determine if subsidence effects resulting from mining result in impacts to aquatic habitats or threatened species. Inform stakeholders of baseline assessment and monitoring. Identify, investigate and report on impacts to aquatic ecology.	Within prediction (Level 1):			
					Negligible environmental consequences for creeks, as illustrated by no significant changes in water quality or data collected during macroinvertebrate sampling.	Continue monitoring. Report negligible impact in six monthly reports.	Russell Vale Colliery (Environmental Manager)	Six monthly reporting in accordance with EP approval.
					Within prediction (Level 2):			
					Negligible environmental consequences for creeks, as illustrated by a short term (1 year) reduction in aquatic habitat, as shown by:	Continue monitoring. Review frequency and location of monitoring and determine if additional	Russell Vale Colliery (Environmental Manager)	Six monthly reporting in accordance with EP approval Monitoring plan reviewed within one month of potential

Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/ Frequency	Purpose	Level	Action/ Reporting	Responsibility	Timing
		ANZECC AMRANZ (2000) guidelines. Condition of aquatic habitats based on AUSRIVAS method. Upper and lower limits of aquatic habitat will be established using OE50TaxaScores and SIGNAL2 scores.			▪ Water quality data exceeding upper or lower limits of baseline monitoring. ▪ Change in OE50Taxa Score. ▪ Change in AUSRIVAS Band.	monitoring is required. Inform BCD, and DCCEEW of potential impact. Report potential impact in six monthly reports.		impact being identified. BCD, and DCCEEW notified of potential impact within one week of potential impact being identified.
					Exceeding prediction (Level 3):			
					Reduction in aquatic habitat at impact sites only for an extended timeframe (>2 years), as shown by: ▪ Water quality data exceeding upper or lower limits of baseline monitoring.	Engage ecologist to investigate and report on the cause of trigger exceedances and advise of potential impacts. Inform BCD and DCCEEW of investigation outcomes.	Russell Vale Colliery (Environmental Manager)	BCD, and DCCEEW notified of potential impact within one week of impact being identified. Investigation initiated within one week of impact being identified. Investigation results reported to

Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/ Frequency	Purpose	Level	Action/ Reporting	Responsibility	Timing
					▪ Change in OE50Taxa Score. ▪ Change in AUSRIVAS Band.	Review monitoring program, including frequency and location, and modify if necessary. Develop and implement impact mitigation and remediation measures in consultation with BCD and DCCEEW. Develop a monitoring plan to determine the success of mitigation / remediation measures. If mitigation /Remediation measures are		BCD and DCCEEW within one week of completion. Monitoring plan reviewed within one week of impact being identified. Commence preparation of mitigation/ action and monitoring plan within one week of impact being identified, if required. Monthly updates of investigation progress to BCD and DCCEEW, if required.

Aspect	Monitoring				Trigger			
	Location	Parameters	Timing/ Frequency	Purpose	Level	Action/ Reporting	Responsibility	Timing
						unsuccessful or not feasible, determine whether offsets will be required. An offset strategy/offset management plan will be developed in consultation with BCD and DCCEEW. Report in annual reviews and six monthly reports to inform relevant agencies of results of monitoring.		Six monthly reporting in accordance with EP approval.

Other biodiversity related EP TARPs

In addition to the specific EP Biodiversity TARP, the TARPs as below as noted to also be relevant to the assessment of potential impacts on threatened species, threatened populations or EECs contained in other EP specific management plans are listed with reference to the EP specific plan to avoid duplication:

- Subsidence – Extraction Plan subsidence monitoring program (RVC EC PLN 003) as prepared in accordance with Condition C10(g)(i).
- Upland Swamps - Extraction Plan Upland swamps monitoring program (RVC EC PLN 008) as prepared in accordance with Condition C10(g)(v).
- Surface water and groundwater – Extraction Plan Water Management Plan (RVC EC PLN 010) as prepared in accordance with Condition C10(g)(iii).
- Land management including cliffs, rock outcrops and slabs and steep slopes – Extraction Plan Land Management Plan (RVC EC PLN 035) as prepared in accordance with Condition C10(g)(vi).

APPENDIX D – THREATENED FISH SURVEY DATA

Table 18 Collated fish data collected from Cataract Creek by Biosis between 2013 and 2020

Site	Date	Effort (seconds)	Native species					Exotic species			
			Silver Perch *Bidyanus bidyanus*	Broad-finned Galaxias *Galaxias brevipinnis*	Mountain Galaxias *Galaxias olidus*	Galaxias species *Galaxias spp.*	Murray Cod *Maccullochella peelii*	Macquarie Perch *Macquaria australasica*	Eel-tailed Catfish *Tandanus tandanus*	Goldfish *Carassius auratus*	Eastern Gambusia *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[6]	0	0	0	0	1	0	0	8	0
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

[6] Three fyke nets set over five hours at the confluence of Cataract Creek and the Cataract River

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

Site	Date	Effort (seconds)	Native species						Exotic species		
			Silver Perch *Bidyanus bidyanus*	Broad-finned Galaxias *Galaxias brevipinnis*	Mountain Galaxias *Galaxias olidus*	Galaxias species *Galaxias spp.*	Murray Cod *Maccullochella peelii*	Macquarie Perch *Macquaria australasica*	Eel-tailed Catfish *Tandanus tandanus*	Goldfish *Carassius auratus*	Eastern Gambusia *Gambusia holbrooki*
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
Cataract River downstream	9/11/2020	4,093	0	16	0	0	2	1	0	0	0
Cataract Creek downstream	10/11/2020	1,656	0	29	0	34	1	0	0	0	0