Centennial Coal

CENTENNIAL COAL
CLARENCE COLLIERY
ANNUAL REVIEW

January 2018 to December 2018

March 2019

Annual Review Title Block

Name of Operation	Clarence Colliery
Name of Operator	Clarence Colliery Pty Ltd
Development Consent/ Project Approval #	DA 504-00
Name of holder of development consent / project approval	Centennial Coal Company Limited
Mining Lease #	CCL705, ML1353, ML1354, ML1583, ML1721, (A307, A416, A451, EL5072)
Name of Holder of Mining Lease	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
Water License #	WAL36479
Name of Holder of Water License	Coalex Pty Ltd & Clarence Coal Investments Pty Ltd
MOP/RMP Start Date	1/1/2018
MOP/RMP End Date	31/10/2022
Annual Review Start Date	1/1/2018
Annual Review End Date	31/12/2018

I, Andrew Myors , certify that this audit report is a true and accurate record of the compliance status of Clarence Colliery for the period 1 January 2017 to 31 December 2018 and that I am authorized to make this statement on behalf of Clarence Colliery Pty Ltd

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion) in an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

b) *The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (intention to defraud by false or misleading statement – maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents –maximum penalty 2 years imprisonment or $22,000,or both).*

Name of Authorised Reporting Officer	ANDREW MYORS
Title of Authorised Reporting Officer	DIRECTOR
Signature of Authorised Reporting Officer	A.J.Myors
Date	22/3/19

Contents

Tables

Figures

Appendices

Appendix No	Appendix Name
1	Regional Location Plan
2	Development and Extraction 2018 Plan
3	2019 Proposed Workings Plan
4	Combined Monitoring Points Plan
5	Pit Top Monitoring Locations Plan
6	Aerial View of Surface Facilities Plan
7	Surface Disturbance and Rehabilitation 2018 Plan
8	2018 Rehabilitation Monitoring Report
9	2018 Noise Monitoring Report

1. STATEMENT OF COMPLIANCE

Table 1 provides a statement of compliance with the relevant approvals during the reporting period.

Table 1. Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
DA504-00	No
Mining Lease (ML) 1353	Yes
ML 1354	Yes
ML 1583	Yes
ML 1721	Yes
CCL 705	Yes
Authorisation (A) 307	Yes
A416	Yes
A451	Yes
Exploration Lease (EL) 5072	Yes
Environmental Protection Licence (EPL) 726	No
Water Access Licence (WAL) 36479	Yes
Subsidence Management Plan (SMP) Approvals	Yes
Statement of Commitments	Yes

Table 2 provides a list of conditions that were not complied with during the reporting period.

Table 2. Non-Compliances

Relevant Approval	Condition No.	Condition summary	Compliance Status	Comment	Section in Annual Review
EPL 726	M2.1	Requirement to monitor concentration of pollutants discharged		DDG1 Bottle Broken	Section 11
DA504-00	S3 C14	Implementation of Air Quality Monitoring Program			
EPL 726	L2.4	Water Concentration Limits		Cobalt, Nickel, Zinc and Copper Exceedance	Section 11
EPL 726	L2.4	Water Concentration Limits		Chloride concentration Exceedance	Section 11
EPL 726	L2.4	Water Concentration Limits		PH outside range	Section 11
EPL726	L5.1	Noise Limits		Noise Exceedance Night	Section 11 Table 47
DA504-00	S3 C15	Noise Limits			

Note: Compliance Status Key for Table 3

Risk Level	Colour Code	Description
High		Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium		Non-compliance with: • Potential for serious environmental consequences, but is unlikely to occur; or • Potential for moderate environmental consequences, but is likely to occur.
Low		Non-compliance with: • Potential for moderate environmental consequences, but is unlikely to occur; or • Potential for low environmental consequences, but is likely to occur.
Administrative		Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

2. INTRODUCTION

Clarence Colliery is an underground coal mining operation located within the NSW Western Coalfields (**Figure 1**). Clarence Colliery Pty Ltd (Clarence) is a wholly owned subsidiary of Centennial Coal Company Limited, which is a wholly owned subsidiary of Banpu Public Company and has been appointed as the management entity for the Clarence Joint Venture. The Clarence Joint Venture is comprised of a number of wholly owned subsidiaries being Coalex Pty Ltd (51% share), Clarence Coal Investments Pty Ltd (29% share) and Centennial Clarence Pty Ltd (5% share). The remaining 15% share in the Clarence Joint Venture is held by SK Networks Resources Australia Pty Ltd. Operations at Clarence Colliery commenced in 1979. Coal is extracted from the Katoomba Seam using the bord and pillar partial extraction method, supplying coal to both domestic and export markets.

Clarence Colliery is located approximately 15 kilometres east of Lithgow, to the north of Chifley Road (continuation of the Bells Line of Road) and the Main Western Rail Line. Newnes Junction village is located approximately 900 metres to the south-east of the site and contains a small number of residential dwellings. Clarence Village is also located approximately 1.5 kilometres to the south-west of the site.

A number of extractive industries are also located in close proximity to Clarence Colliery including the Hanson Quarry, located immediately to the west and the disused Rocla Quarry located to the south-east of the site respectively. The Newnes Kaolin Project is an approved quarry, which is proposed to be established to the south-east of the site. Land to the east of the site is protected under the Blue Mountains National Park, one of the eight protected areas making up the World Heritage Listed Greater Blue Mountains Area (UNESCO 2013). The Newnes State Forest is located to the north and west of Clarence Colliery. Clarence Colliery is located within the Hawkesbury-Nepean Catchment and discharges water to the Wollangambe River which eventually drains to the Colo River.

The principal components of the existing operations include:

- Construction and operation of pit top facilities:
    - Mine administration and bath house building;
    - Store and workshop building;
    - Water treatment plant;

  - Rail loop and load out facilities;
  - Conveyor systems to transfer coal from the underground mine to the pit top facilities including the load out on the rail loop;
  - Run-of-Mine stockpile area;
  - Ventilation facility;
  - Washed coal stockpile area;
  - Coal Handling and Preparation Plant (CHPP);
  - Various water management structures include storage and leachate dams and irrigation area which forms part of the water management on site;
  - Sewage treatment plant; and
  - A downcast ventilation shaft located on the Newnes Plateau.
- Underground coal mine for extraction from the Katoomba and Lithgow Seams using board and pillar techniques,
- Construction and operation of reject emplacement areas (REAs) I-VI and associated water management infrastructure;
- Extraction of up to 3 million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal;
- Transport of up to 200,000 tonnes per annum (tpa) of coal products by road in total, with a maximum 100,000 tpa transported to the west, via the Darling Causeway and the Great Western Highway haulage route.

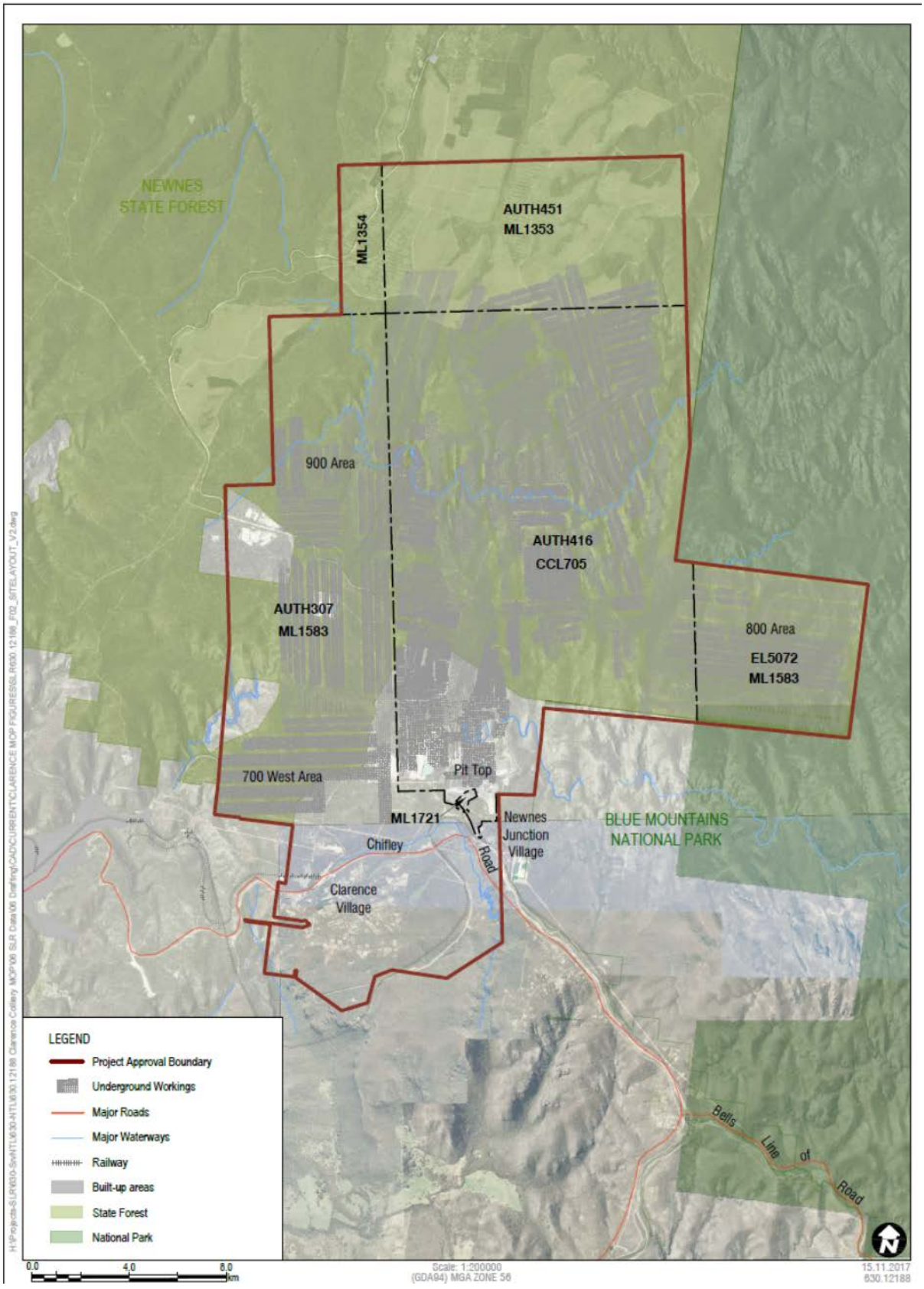


Figure 1. ***Regional Context***

Table 3 provides the names and contact details of the key personnel who are responsible for the environmental management of the operation.

Table 3. Environmental Management Contact Details

Name	Position	Phone
Kyle Egan	Mine Manager	02 6353 8033
Natalie Gardiner	Environment & Community Coordinator	02 6353 8039
Enquiries and Complaints Line	Daytime Contact	02 6353 8000
	Afterhours Contact	02 6353 8010

3. APPROVALS

Table 4 includes a list of all of the environmental approvals held by Clarence Colliery under the *Environmental Planning and Assessment Act 1979* (EP&A Act), *Mining Act 1992*, *Protection of the Environment Operations Act 1997* (POEO Act), *National Parks and Wildlife Act 1974* (NPW Act)/ *Threatened Species Conservation Act 1995* or *Biodiversity Conservation Act 2016*, *Water Act 1912*, *Water Management Act 2000*, *Radiation Control Act 1990*, and any changes made to these approvals during the reporting period.

Table 4. Approvals held by Clarence

Name	Description	Issued By	Issue and Expiry Date	Changes during reporting period (Y/N)
Development Consents				
IRM.GE.76	Original development consent	Blaxland Shire Council	Approved 15/06/1976 - Perpetuity	N
	Modification to amend the REAs	Lithgow City Council	Approved 21/07/1993 - Perpetuity	N
174/93	Extension underground coal mining and surface REAs	Lithgow City Council	Approved 15/02/1994 - Perpetuity	Y
DA504-00	Extension of the Clarence Underground Coal Mine.	Department of Planning & Environment (DPE)	19/12/2005-31/12/2026	N
Licenses				
Environmental Protection Licence	EPL726	Environment Protection Authority (EPA)	12/08/2016-Renewed Annually 1st of January	Y
Radiation Management Licence	RML5078394	EPA	08/02/2017-08/02/2020	Y
Dangerous Goods Licence	NDG020999	WorkCover Authority NSW	05/03/2015- Perpetuity	N
Bore Licence CLRP1	10BL161964	Department of Primary Industries Water' (DPI Water)	13/08/2003-Perpetuity	N
Bore Licence CLRP2	10BL161965	DPI Water	13/08/2003-Perpetuity	N
Bore Licence CLRP3	10BL602213	DPI Water	10/12/2007-Perpetuity	N
Bore Licence CLRP4	10BL161962	DPI Water	13/08/2003-Perpetuity	N
Bore Licence CLRP5, CLRP7, CLRP10	10BL602211	DPI Water	10/12/2007-Perpetuity	N
Bore Licence CLRP6	10BL602212	DPI Water	10/12/2007-Perpetuity	N

Name	Description	Issued By	Issue and Expiry Date	Changes during reporting period (Y/N)
Bore Licence CLRP 12	10BL604063	DPI Water	07/06/2010-Prepetuity	N
Bore Licence CLRP 11, 13, 14	10BL604099	DPI Water	05/07/2010-Perpetuity	N
Bore Licence CLRP 15, 16	10BL604098	DPI Water	05/07/2010-Perpetuity	N
Bore Licence - CLRP 17, 20	10BL605316	DPI Water	30/01/2013-Perpetuity	N
Bore Licence CC114	10BL602819	DPI Water	09/03/2009-Perpetuity	N
Bore Licence CC115	10BL602820	DPI Water	09/03/2009-Perpetuity	N
Bore Licence HV1, HV2, HVU1, HVU2	10BL603337	DPI Water	07/09/2009-Perpetuity	N
Bore Licence	10BL605494	DPI Water	12/12/2013-Perpetuity	N
Bore Licence CLRP18, 22	10BL605612	DPI Water	11/08/2014-Perpetuity	N
Bore Licence	10BL156676	DPI Water	12/05/1995	N
Bore Licence	10BL161963	DPI Water	13/08/2003	N
Surface Licence Main Dam	10WA118714	DPI Water	1/8/2013-30/06/2024	Y
Water Supply Works	10WA10715	DPI Water	1/7/2011	N
Water Access Licence	10AL122285	DPI Water	1 July 2018- Perpetuity	Y
WAL 36479	10WA118758	DPI Water	23/10/2014 - Perpetuity	Y
Surface Authority	10SA001409	DPI Water	30/9/2007 – 30/9/2017	Y
Joint Water Supply Works	10WA103852	DPI Water	1/7/2011-29/09/2027	N
Threatened Species Licence	C0003012	Office of Environment and Heritage (OEH)	22/9/2017 - 22/9/2022	N
Section 95 (2) Certificate	C0002449	OEH	2/2/2017 -2/2/2022	N
Authorisations				
Authorisation 307	A307	Department of Planning and Environment – Division of Resources and Geoscience (DRG)	21/05/2015-24/08/2019	N
Authorisation A416	A416	DRG	21/05/2015-24/08/2019	N
Authorisation A451	A451	DRG	27/03/2015-24/08/2019	N
Exploration Licence	EL5072	DRG	31/7/1996 – 31 July 2022	Y
Statutory Approval				
Reject Emplacement Area II	Section 126	Department of Primary Industries (DPI)	Approved 19/06/1992	N
Reject Emplacement Area III	Section 126	DPI	Approved 07/10/1993	N
Reject Emplacement Area IV	Section 100	DPI	28/03/2011-01/07/2015	N- Note:

Name	Description	Issued By	Issue and Expiry Date	Changes during reporting period (Y/N)
Reject Emplacement Area IV extension	Section 100	DPI	18/09/2013-01/09/2017	Renewal not required- REA IV no longer receiving reject material
Reject Emplacement Area VI	Section 100	DPI	11/08/2014-04/08/2020	Y
Leases				
Consolidated Coal Lease	CCL705	DRG	20/12/2005 - 20/12/2026	N
Mining Lease	ML1353	DRG	21/7/2015-21/07/2036	N
Mining Lease	ML1354	DRG	21/7/2015-21/07/2036	N
Mining Lease	ML1583	DRG	9/07/2006 - 9/07/2027	N
Mining Lease	ML1721	DRG	7/12/2015 - 7/12/2036	N
Mining Operations Plan				
Mining Operations Plan	N/A	DRG	01/01/2018 – 31/10/2022	Y
Subsidence Management Plans				
SMP	900 Area	DRG	22/01/2014 – 31/01/2023	Y
SMP	800 Area	DRG	1/11/2013 – 30/10/2021	Y
SMP	700 West Area	DRG	18/06/2012 - 01/06/2021	N
Access Agreement				
Access Agreement	Q648-100	State Rail Authority	10/07/1981-Life of Loop	N
Occupation Permit				
Occupation Permit	PB54303	Forestry Corporation of NSW	21/12/2012 - Renewed Annually	N

3.1. Changes to Approvals during the Reporting Period

3.1.1. Development Consent / Project Approval

Consent 174/93

During the reporting period, Clarence submitted an application to modify the 1994 development consent (Consent 174/93). The application sought approval to:

- Relocate an approved intersection from immediately west of the train loading facility (as proposed in the 1993 EIS) to the eastern side of the Clarence Colliery rail loop;
- Facilitate additional vegetation clearing (approximately 340 m^2) required to construct the intersection; and

- Extend the current Project Site Boundary to encompass the additional vegetation clearing required for the construction of the intersection.

The Consent 174/93 was modified on 8 February 2018 to allow relocation of the REA V access and to allow associated vegetation clearing.

IRM.GE.76

Clarence Colliery is currently seeking a modification to IRM.GE.76 to facilitate the removal of fines and to commence the re-profiling of Reject Emplacement Area 3 in accordance with a High Risk Activity notification submitted to the Department. Following the recovery of all available fine coal/CCR material, the final landform will be built through the emplacement of compacted coarse coal reject. When the final landform is achieved, REA III will be capped, rehabilitated and decommissioned.

3.1.2. Mining Authorisations

An extension of Exploration Licence (EL) 5072 from 15th November 2015 to 31st July 2022 was granted during the reporting period.

3.1.3. Environment Protection Licence

During the Reporting period EPL 726 was varied by notice on two occasions.

On 20th September 2018, the EPA varied the licence to include a Pollution Reduction Program (PRP) relating to discharges from licence discharge point 2.

In response to the variation, Clarence advised it did not support the PRP as attached. As a result, the EPA and Clarence entered into further discussions regarding the salinity levels of the discharge into the Wollangambe River, along with options to cease the discharge from LDP2 into the Wollangambe River. As a result of further discussions, the EPA and the licensee reached agreement on a PRP to address salinity and on 23 November 2018 the EPA received comments from the licensee that included the agreed wording of PRP condition U2. By this subsequent Notice issued on the 28 November 2018 the EPA amended condition U2.

U2 Discharges into the Wollangambe River

U2.1 By 31 December 2019, the licensee is to lodge an application under Section 5.15 of the Environmental Planning and Assessment Act 1979 which seeks approval to carry out, as State Significant Infrastructure, the construction and operation of infrastructure designed for the purpose of transferring to the Coxs River treated groundwater which would otherwise be discharged via LDP002 into the Wollangambe River. The transferred water is to have a conductivity (EC) limit of 350 microsiemens per centimetre (us/cm) (90th percentile).

U2.2 If the infrastructure referred to in Condition U2.1 is authorised to be carried out, under the Environmental Planning and Assessment Act 1979, as State Significant Infrastructure, the licensee is required to construct and operate the infrastructure no later than 18 months after the date on which the State Significant Infrastructure approval was granted.

In the event that there is a legal challenge to the State Significant Infrastructure approval which is finally determined in favour of the licensee, it is required to construct and operate the infrastructure no later than 18 months after the appeal rights are exhausted.

3.1.1. Other Approvals

MOP Amendments

A new MOP covering the period 18th January 2018 to 31st October 2022 was submitted to DRG in November 2017. The new MOP was approved by DRG on 12th February 2018.

The Section 100 associated with REA VI was extended until August 2020.

The 800 SMP Area Variation 4 was submitted on the 13th March 2017 and was approved on 8th June 2017. The main components of this variation included:

- Developing a set of mains to the north off 808 panel (808 Mains) at 38-43 cut through. Two panels will then diverge off the 808 Mains, namely the 804a and the 806a panels, both in an east – west orientation;
- Extraction off the 808 Mains;
- Reducing the 806 panel to 36 cut through (just outbye of a projected fault);
- Reducing the 804 panel to 36 cut through (just outbye of a projected fault).
- Development and extraction of the 822 panel; and
- An extension to the 800 SMP approval expiry out to 30 October 2021.

SMP Variations

A variation to the SMP Approval CL999 (900 Area) was issued 25th January 2019 approving Variation 4 (CL1294), authorising an extension to the expiration of the approval out to 31 January 2023.

A variation was also sought to the SMP Approval CL960 for:

- Reducing the 818 panel to 24 cut through;
- Relocation of the 820 panel to the south;
- Development and extraction of a new panel known as the 819 panel;
- Modify the 820 panel from a Five Heading Enhanced FCT layout to a Four Heading FCT up to 23 cut through;
- Development and extraction of the 818 Mains;
- Development and extraction the 818A panel;
- 800 South Mains have varied in their orientation; and
- 822 panel has had to be relocated to the south.

This approval was granted on 15th February 2018.

3.2. Annual Review Requirements

The Annual Review has been developed to satisfy the reporting requirements of the approvals listed in Table 5.

Table 5. Annual Review Requirements

Approval	Condition No.	Requirement	Where addressed in Annual Review
Development Consent	Schedule 5 Condition 5	The applicant shall prepare and submit and AEMR to the Secretary and the relevant agencies. This report must a) Identify the standards and performance measures that apply to the development	Section 6
		b) Describe the works carried out in the last 12 months	Section 4.3
		c) Describe the works that will be carried out in the next 12 months	Section 12
		d) Include a summary of the complaints received during the past year, and compare this to the complaints received in previous years	Section 9.3
		e) Include a summary of the monitoring results for the development during the past year	Section 6
		f) Include an analysis of the monitoring results against the relevant: -impact assessment criteria -monitoring results from previous years and -predications in the EIS	Section 6
		g) Identify any trends in the monitoring results over the life of the development	Section 6
		h) Identify any non-compliance during the previous year and	Section 11
		i) Describe what actions were are being taken to ensure compliance	Section 11
	Schedule 3 Condition 7	Water Balance b) provide for the annual recalculation of the water balance and reporting of the review in the AEMR	Section 7.2
	Schedule 3 Condition 12	Water Management Plan c) Report the results of this review in the AEMR including d) the results of monitoring e) details of the review of each sub plan f) amendments to the sub plan and g) details of the measures undertaken/proposed to address any identified issues	Section 7.3
	Schedule 3 Condition 23	Greenhouse Gas -report on these investigations in the AEMR	Section 6.4
ML1721	3f	The leaseholder must prepare and submit a rehabilitation report to the satisfaction of the minster. The report must i. Provide a detailed review of the progress of rehabilitation against the performance measures established in the approved MOP ii. Be submitted annually on the grant anniversary date (or at such times as agreed by the minister); and iii. Be prepared in accordance with any relevant annual guidelines published on the departments website (Note rehabilitation report replaces AEMR)	This Report-Section 8
ML1583	3	1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed	This Report-

Approval	Condition No.	Requirement	Where addressed in Annual Review
		by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General. 2) The AEMR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of a) the accepted Mining Operations Plan; b) development consent requirements and conditions; c) Department of Environment and Conservation and Department of Planning and licences and approvals; d) any other statutory environmental requirements; e) details of any variations to environmental approvals applicable to the lease area. and f) where relevant, progress towards final rehabilitation objectives. 3) After considering an AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice. 4) The lease holder shall, as and when directed by the Minister, co-operate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies.	Section 8
ML1353	2 (31)	a) The registered holder shall each years once operation have commenced, submit for the ministers approval an "Annual environmental Management report" relating to the operations of the registered holder on the subject area b) The date by which the report must be submitted will be determined by the minister after consulting with the registered holder c) The report shall comprise i) A plan showing short, medium and long term mining plans ii) A rehabilitation report (in respect of open cut operations_ and/or a surface environmental management report (in respect of underground operations) iii) A review of the performance in terms of Environmental Protection authority and Department of Water Resources licence and approval conditions (related to the clean Air Act 1961, the Clean Waters Act 1970, the noise Control Act 1975, the Environmentally Hazardous Chemical Act 1985, the Pollution Control Act 1970 and the Water Act1912) applicable to the subject area iv) A review of performance in terms of Development Consent Conditions for the subject area v) A listing of any variations obtained to approvals applicable to the subject area during the previous reporting year	This Report-Section 8
CCL705	3	1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General. 2) The AEMR must be prepared in accordance with the Director-	This Report-Section 8

Approval	Condition No.	Requirement	Where addressed in Annual Review
		General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of a) the accepted Mining Operations Plan; b) development consent requirements and conditions; c) Department of Environment and Conservation and Department of Infrastructure, Planning and Natural resources licences and approvals; d) any other statutory environmental requirements; e) details of any variations to environmental approvals applicable to the lease area. and f) where relevant, progress towards final rehabilitation objectives. 3) After considering an AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice. 4) The lease holder shall, as and when directed by the Minister, co-operate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies.	

The Consolidation of Annual Reporting dates for the Centennial Coal Annual Environmental Management Report (AEMR)/ Annual Review was accepted by the DRG. The accepted new due date is the 31 March (1/2/2018- MCV17/734#1 OUT 18/1814). It is noted that the DPE was consulted regarding the nominated submission date of 31 March and the Secretary considered it acceptable for the Annual Review to be submitted on the 31 March (19/9/2017).

4. OPERATIONS SUMMARY

4.1. Mining Operations

During 2018, the following mining activities took place:

- Extraction of the 808 panel continued throughout the year (first and last quarter 2018);
- Development and extraction of the 808 mains panel;
- Development of the 804 panel in quarter 1 (as a spare unit);
- Development of the 801S mains panel;
- Development of the 820 panel commenced from mid year;
- Development of the 822 mains panel lead ins;
- Development of the 908 panel continued throughout the year;
- Development of the 910 panel continued throughout the year;
- Development and extraction of the 819 panel in quarter 2;
- Development of the 701 panel in quarter 1;
- Development of the 709 panel in quarter 1 and 2;

A production summary is presented in Table 6.

Table 6. Production Summary

Material	Approved Limit (and source)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock/ Overburden	NA	0	0	0
ROM Coal	3,000,000T	2,616,951	1,772,124	2,419,223
Coarse reject	250,000T*	106,860	90,220	96,769
Fine reject (Tailings)	NA	12,120	0	0
Saleable product	N/A	2,509,807	1,681,904	2,322,454

*Approval limit of 250,000T coarse reject applies to emplacement within REA 6 only.

4.2. Other Operations

Table 7. Operations Summary

Limits	Approved Limit (and source)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast
Transport (rail)	Limits based on total extraction	2,436,189T	1,614,743	2,230,000
Transport (road)	200,000T DA 504-00*	198,198T	173,052	150,000

*100,000 to the West as per approved haulage route

4.3. Exploration

During the reporting period Clarence Colliery sought approval to drill four exploration boreholes (i.e. CLRP 23, 24, 25 and 26) within A307 and ML1583 for the 700 South Area Exploration Program. Three of the proposed holes are located wholly within the Newnes State Forest, and within Forestry Management Zone 4 (FMZ4 – General Management).

The drilling program was completed in Q2 2018 and all drill sites have been rehabilitated. The program provided important information for the geological model to assist mine planning and design.

During 2018 planning was undertaken for a larger drilling program, 900 north which will include 13 boreholes across three MLs and an Exploration Authorisation. It is anticipated that the program will commence in May 2019.

4.4. Significant Activities during Reporting Period

4.4.1. Wollangambe Environmental Monitoring Program

In 2016 the Wollangambe Environmental Monitoring Program was established following the completion of remediation works in the Wollangambe River, following the overtopping of a temporary coal fines holding cell in 2015. During the reporting period the Wollangambe Environmental Monitoring Program has continued in accordance with EPL 726.

Two Environmental Monitoring Program Reports were submitted to the EPA during the reporting period in March and December 2018 respectively. Figure 2 below illustrates the results of Petrographic analysis since the commencement of the program and the coal proportion in the sediment has decreased over time and all monitoring sites show levels less than 0.7%.

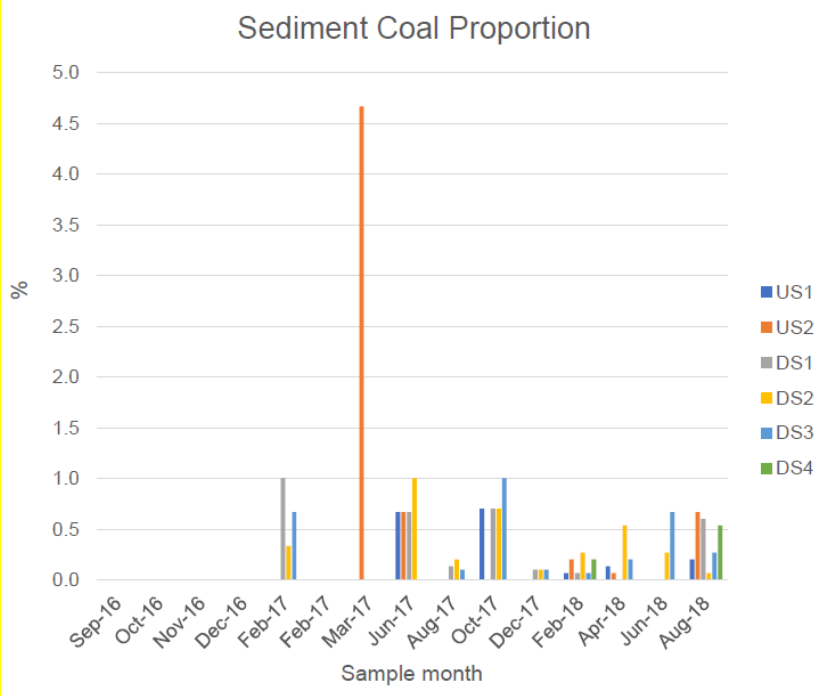


Figure 2. ***Wollangambe River Petrographic Analysis Results***

The macroinvertebrate assemblage data comprises presence-absence data for taxa identified to the taxonomic levels specified in AusRivAS (generally to Family level). It was concluded that the variations in the various stream-health and macroinvertebrate indices shown in Autumn 2017 are expressions of normal seasonal variation. For aquatic ecology monitoring in Autumn 2018, the period between the last aquatic ecology

sampling in October 2017 through to the April 2018 sampling period was characterised by long dry spells punctuated by short periods of low intensity rainfall and a few heavy rainfall events, and for the March to April 2018 period leading up to sampling, the daily average LDP discharge was reduced to around 6ML/day. Comparisons of individual site Streamhealth indices against study Mean ± Standard Deviations (X ± SD) indicated the most index results were within the site X ± SD ranges with individual exceptions for all sites except US1.

Mountain galaxias were the only fish caught in traps or observed in Autumn 2018 and were caught at four sites. A total of 15 were caught. Mountain galaxias have been found or sighted at all sites and it is concluded that there is no physical barrier for this species to travel between sites. For the Autumn 2018 survey no tadpoles or frogs were observed during the systematic site searches. From frog call recordings overnight for the Autumn 2018 survey sites, only one call - Red Crowned Toadlet, *Pseudophryne australis was* recorded - at site DS3.

The aquatic ecology monitoring results indicate that the Wollamgambe River within the study area provides good aquatic habitat for a range of macroinvertebrate species and provides fish passage and habitat for native fish species.

All four monitoring reports to date are published on the Centennial website and the Final monitoring period was conducted in February 2019. A final report will be submitted to the EPA by April and published on the website.

4.4.2. Water Treatment Plant Operations

During 2018, the Water Treatment Plant (WTP) operation has been continually upgraded in terms of infrastructure, process controls and operational management process. Some of the improvements but are not limited to; moving of the pH dosing system closer to the WTP to facilitate better process control (removing lag time), upgrading Citec and PLC (management system), reinstating the settling pond and increased flocculent dosing installation of curtains on the booms to settle out more solids prior to release, installation of a turbidity monitor at LDP2, a change from H_2SO_4 to HCL for pH modification and, additional laboratory trials of plant improvement options.

4.4.3. Reject Management Strategy Update

During 2017, Clarence identified opportunities to re-use and/or sell both coarse coal reject and fines coal. During 2018, a number of contracts were secured that enabled Coal fines to be included in the shipments. In addition due to low ash ROM there was higher volumes of coarse coal reject incorporated into saleable product which has reduced the need to emplace the material within REA VI and extended the life of the REA, with forward projections showing that there is sufficient capacity remaining in REA VI for 2019. Notwithstanding the construction of REA V Stage 1 has commenced with the Rail crossing constructed in 2018 and works commencing in Q2 2019 for Stage 1 of the REA 5.

Clarence continues to investigate options for reject emplacement including at other centennial rehabilitation sites needing material for successful closure, thereby resolving a life of mine REA scenario for the mine. Whilst this process has been slow, Clarence is confident that with both the REA VI and the REA V, there is likely to be more than five years capacity. However, this will depend upon marketing, coal quality and mine planning into the future.

4.5. Next Reporting Period

For the 2019 Reporting period, Clarence is forecast to produce approximately 2.4 MT of ROM Coal. Whilst REA 5 is expected to be completed and REA3 works commenced additional long term planning will continue for the reject management strategy.

In addition the 900N Exploration program is scheduled to commence in Quarter 2 2019.

5. ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 8. Actions from previous Annual Review

Action Required	Requested By	Action Taken	Where addressed in Annual Review
Provide the Department a response by the 1st June 2018 to; a) What action is being undertaken to address the unreliable piezometers; and b) On what basis is the +/- 25mm margin of error allowed as noted in Section 6.8.2 of the Annual Review? Condition 1 of Schedule	DPE	a) The extent of the monitoring provides for significant redundancy and is the safeguard against a small number of unreliable piezometers. This redundancy means that the groundwater system is currently (and will in future) continue to be adequately monitored. There is no need for additional piezometers to be installed to account for a small number of unreliable instruments. b) The +/- 25mm is pre-2005 and refers to those partial extraction areas that pre-dated the DA504-00 (ML1583). This period essentially spans 1998 - 2005 and includes mining activities within CCL705. During this time, extraction applications were approved under Section 138 (2) (e) of the Coal Mines Regulation Act 1982. 609A and D line were the subject of these earlier approvals. All panels (most certainly since 2005) are designed so as not to exceed 100mm subsidence, noting that the upper limit of subsidence induced by partial pillar extraction is 100mm. The End of Year Subsidence report is available on the Centennial Coal Website for further detail in regards to subsidence management.	Not applicable – the response to DPE satisfied the request for further information.
In future Annual Reviews; i) Ensure that trends are provided over the life of the development; ii) And ensure all graphs are clear and provided in colour.		The trends in water quality monitoring results are only shown since the change in the EPL limits (June 2017) as many of the analytes were not required to be tested prior to this date and discharge limits have changed. Weather is based on a reporting period (Calendar year 2018) The only graphs which refer to longer time periods relate to consent conditions such as; dust, Noise, Complaints, pH and TDS. All graphs are presently as clearly as practicable and are in colour.	Section 6 and Section 7

6. ENVIRONMENTAL PERFORMANCE

In accordance with Schedule 5, Condition 3 of DA 504-00 Clarence operates in accordance with an approved Environmental Monitoring Program. This program was approved by the former NSW Department of Planning on 6 November 2007 (S02/0280).

Clarence operates in accordance with various management plans which outline monitoring requirements. The following table provides a summary of requirements for Clarence as specified under the consent.

Table 9. Summary of Monitoring Requirements

Monitoring Type	Overview of Monitoring Requirements	Requirement of Approval / Management Plan	Annual Review Section
Air quality	3 x DGs - Monthly 1 x HVAS – operating over two months of a calendar year.	Western Region Air Quality & Greenhouse Gas Management Plan EPL 726	Section 6.1
Blasting Monitoring	Not undertaken at Clarence	Not required	Section 6.3
Greenhouse Gas	Not required	Western Region Air Quality & Greenhouse Gas Management Plan	Section 6.4
Heritage	As required	Western Region Aboriginal and Cultural Heritage Management Plan	Section 6.5
Meteorological Monitoring	1 weather station - Continuous	DA 504-00 and EPL 726	Section 6.6
Noise	Annual at 1 location	Western Region Noise Management Plan and EPL 726	Section 6.7
Rehabilitation	Annual	Clarence Mining Operations Plan 2018-2022 (Rehabilitation Plan)	Section 8
Subsidence Management Plan	Groundwater Flora Fauna Subsidence	SMP Approval- 800 Area Environmental Monitoring Program 900 Area Environmental Monitoring Program	Section 6.8
Water	Surface Water Volume & Quality - Groundwater Depth – Bi-monthly	Clarence Water Management Plan EPL 726	Section 7

6.1. Air Quality

Development Consent DA 504-00 specifies dust criteria for Clarence Colliery but does not nominate dust monitoring locations. Condition M2.2 of EPL 726 specifies the monitoring requirements. Current dust monitoring consists of:

- Three dust deposition gauges, collected monthly; and

- Co-located PM_{10} and total suspended particulate (TSP) real-time monitors, operating over two months of a calendar year.

Table 10. Description of Air Quality Monitoring

Monitor Point Reference	Description / Location
DG1	Located south-east of Clarence Operations
DG2	Located on the northern side of Clarence Operations
DG3	Located south-east of Clarence Operations
HVAS 1	Located south-east of Clarence Operations

Key dust mitigation measures for Clarence Colliery operations include:

- Signage to display speed limits on all unsealed roads in the surface facilities area;
- A water truck on unsealed areas during use or windy conditions; and
- Water sprays (sprinkler system) on the coal product stockpile during dry and windy conditions.

Dust monitoring data indicated that monthly dust deposition results for 2018 ranged from 0.1 at Depositional Dust Gauge 1 to 10.9 g/m^2/month at Depositional Dust Gauge 3. Depositional dust gauge results for 2018 are shown in Table 13 below. The results are all below the annual average air quality criteria of 4 g/m^2/month. One sample at DG2 could not be analysed due to a broken dust gauge bottle suspected to be a result of vandalism.

Table 11. Air Quality Environmental Performance

Dust Monitor	Approval criteria	EIS / EA Predictions*	Performance during the reporting period	Trend compared to previous years
DG1	2 g/m^2/month Max Annual Average Increase 4 g/m^2/month Total Annual Average	It is predicted that incremental and cumulative annual average dust deposition rates at all surrounding receivers will be well below the criterion of 2 g/m^2/month (incremental increase in dust deposition) and below 4 g/m^2/month (cumulative dust deposition)	The annual average for DG1 was 1.24 g/m^2/month which is below the prescribed annual average. The maximum increase in annual deposited dust levels has therefore not exceeded 2 g/m^2/month	Results for 2018 are slightly elevated from previous years due at least in part to state wide dust storms after the drought. Annual Average: 2017-0.79 g/m^2/month 2016-0.7 g/m^2/month 2015-0.8 g/m^2/month
DG2	2 g/m^2/month Max Annual Average Increase 4 g/m^2/month Total Annual Average		The annual average for DG2 was 1.60 g/m^2/month which is below the prescribed annual average. The maximum increase in annual deposited dust levels has therefore not exceeded 2 g/m^2/month	Results for 2018 are slightly elevated from previous years due at least in part to state wide dust storms after the drought. Annual Average: 2017-0.67 g/m^2/month 2016-0.6 g/m^2/month 2015-0.9 g/m^2/month
DG3	2 g/m^2/month Max Annual Average Increase 4 g/m^2/month Total		The annual average for DG3 was 2.06 g/m^2/month which is below the prescribed annual average. The	Results for 2018 are slightly elevated from previous years due at least in part to state wide dust storms after

Dust Monitor	Approval criteria	EIS / EA Predictions*	Performance during the reporting period	Trend compared to previous years
	Annual Average		maximum increase in annual deposited dust levels has therefore not exceeded 2 g/m^2/month	the drought. Annual Average: 2017 - 1.89 g/m^2/month 2016 - 0.7 g/m^2/month 2015 - 2.4 g/m^2/month
HVAS pM10	30 µg/m^3 Annual Average	The maximum PM_{10} increments as a result of the Project alone are anticipated to fall well within the respective EPA criteria at all nearby receivers.	7.04 µg/m^3	Results are not significantly different from previous years: Annual Average: 2017-1.23 µg/m^3 2016-2.96 µg/m^3 2015-2.18 µg/m^3
	50 µg/m^3 24 Hour Average		26 µg/m^3 (Max 24 Hour result)	(Max 24 Hr result) Results are not significantly different from previous years: Max 24 Hour result: 2017- 20 µg/m^3 2016- 5.13 µg/m^3 2015- 5.1µg/m^3
HVAS TSP	90 µg/m^3 Annual Average	Total suspended particulate (TSP) concentrations are predicted to be well below the EPA criterion of 90 µg/m^3 at all identified sensitive receiver locations during construction and operation	9.61 µg/m^3	Results are not significantly different from previous years: Annual Average: 2017- 6.8 µg/m^3 2016 - 12.15 µg/m^3 2015 - 7.02 µg/m^3

*SOURCE: November 2013 Environmental Assessment Clarence Colliery Reject Emplacement Area VI Section 75W Modification to Development Consent DA 504-00

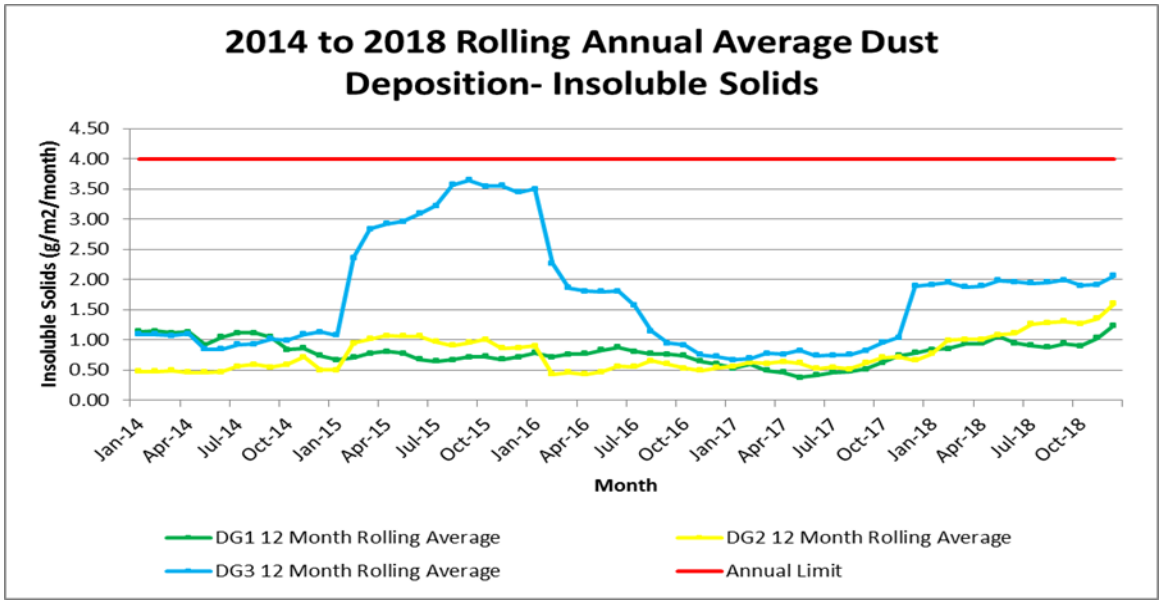


Figure 3. ***Dust Depositional Gauge – Rolling Annual Average (excluding anomalous results DG 1 Feb and March 2015 and DG2 March 2015)***

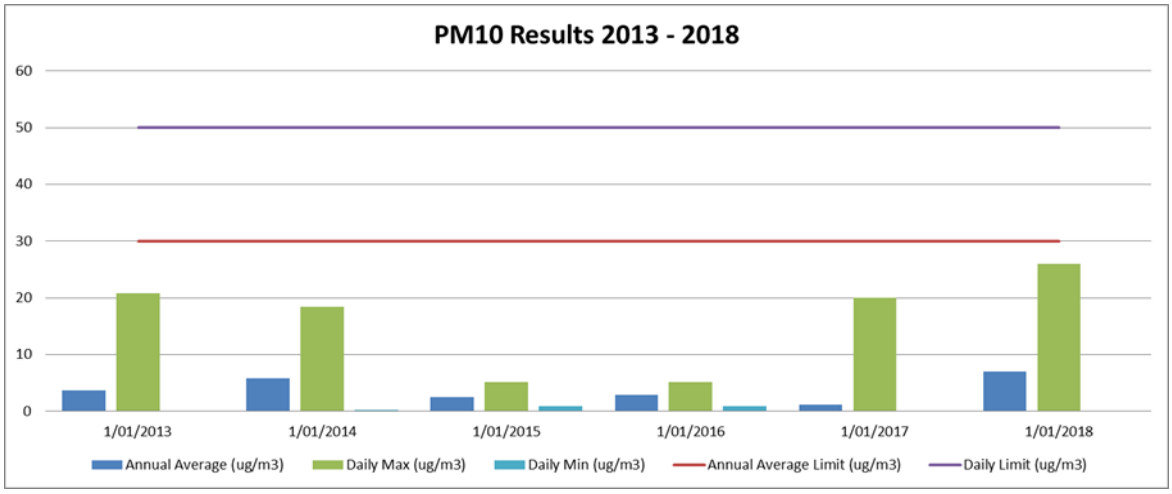


Figure 4. ***High Volume Air Sampler – PM10 2013-2018***

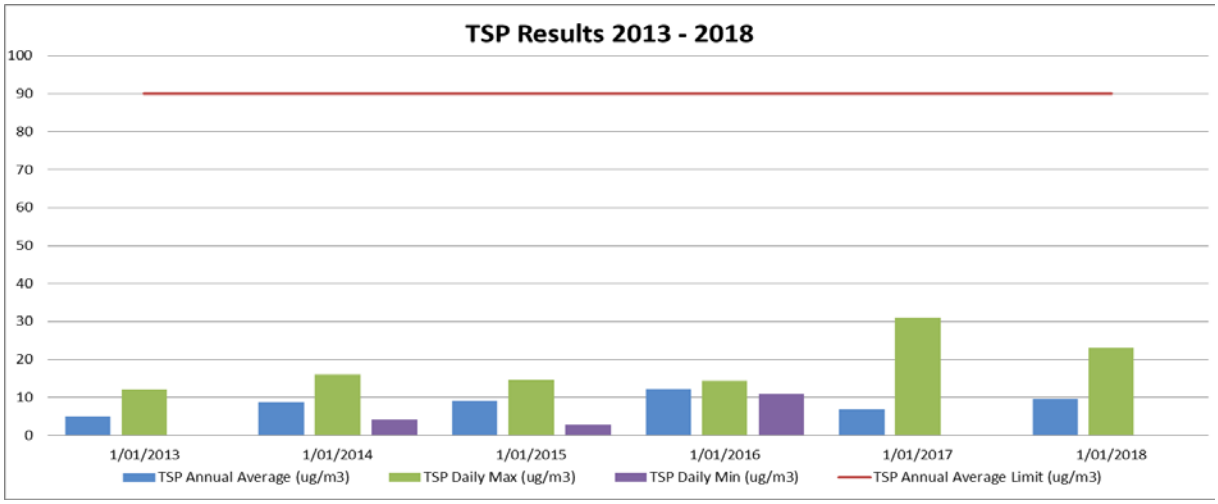


Figure 5. ***High Volume Air Sampler – TSP 2013-2018***

6.1.1. Air Quality Monitoring Data Interpretation

The Environmental Assessment (2013) concluded that the proposed development, including the alternate truck routes and REA VI operation, would have no significant additional impact on air quality. No impact has been observed from the operation of Clarence Colliery. Annual average insoluble solids were below 4g/m^2/month for all depositional dust gauges during 2018. Monitoring for TSP and PM_{10} also showed results well below the Development Consent criteria during 2018. Results are generally consistent with previous years.

6.2. Biodiversity

Biodiversity Management within Clarence Operational area is restricted during operational activities due to the absence of intact vegetation and the impracticality of conducting surveys or management actions within an active CHPP. Management activities are restricted to:

- Bushfire management;
- Erosion management;
- Surface water management;
- Access management;
- Pre-clearance surveys; and
- Waste management.

Once activities in an operational area have ceased, rehabilitation measures can be implemented to restore biodiversity values in accordance with the MOP.

In accordance with Schedule 3, Condition 12A, Clarence has provided a suitable offset for the clearing of 4.1 hectares of Newnes Plateau Narrow-leaved Peppermint- Silvertop Ash layered open forest and the loss of related biodiversity values including threatened species. This offset is part of the Western Region Biodiversity Offset Strategy. The Western Region Biodiversity Offset Strategy identifies retirement 204 ecosystem biodiversity offset credits by Clarence. Clarence's biodiversity offset requirements will be satisfied with the retirement of land utilising a Conservation Agreement in perpetuity under the *Biodiversity Conservation Act 2016*.

The Conservation Agreement will be placed on a land parcel held by Centennial adjacent to the Capertee National Park. This proposal was endorsed by OEH in February 2018. DPE have received quarterly updates on the status of the Strategy and that the Conservation Agreement is yet to be finalised with the Biodiversity Conservation Trust. The area is located at Airly and is presented below.

- Centennial updated the Western Region Biodiversity Offset Strategy, as described within the Voluntary Undertaking with DPE on 27/6/2017.
- Centennial received conditional endorsement of the Western Region Biodiversity Offset Strategy from OEH on 1 February 2018. Centennial has addressed OEH comments, and provided a revised Western Region Biodiversity Offset Strategy for approval.
- Centennial provided a final report to DPE on the Voluntary Undertaking on 29 March 2018. The final report requested no further reports were required to satisfy the Voluntary Undertaking. A response was received from DPE on 3 April 2018 accepting no further reports are required.
- Centennial resubmitted the Western Region Biodiversity Offset Strategy for review and approval by DPE.

The retirement of Clarence biodiversity offset is satisfied by land at Carinya Lot 163 (located between the Airly State Forest, Capertee National Park and Mugii Mrum-ban State Conservation Area, making a substantial contribution in connectivity between the existing biodiversity conservation areas. Centennial has applied for a Conservation

Agreement to secure the land and is concurrently discussing with National Parks inclusion of the land in the Capertee National Park. Centennial commenced management of the land as a biodiversity offset in 2018 and installed a fence separating the land from adjacent grazing land.

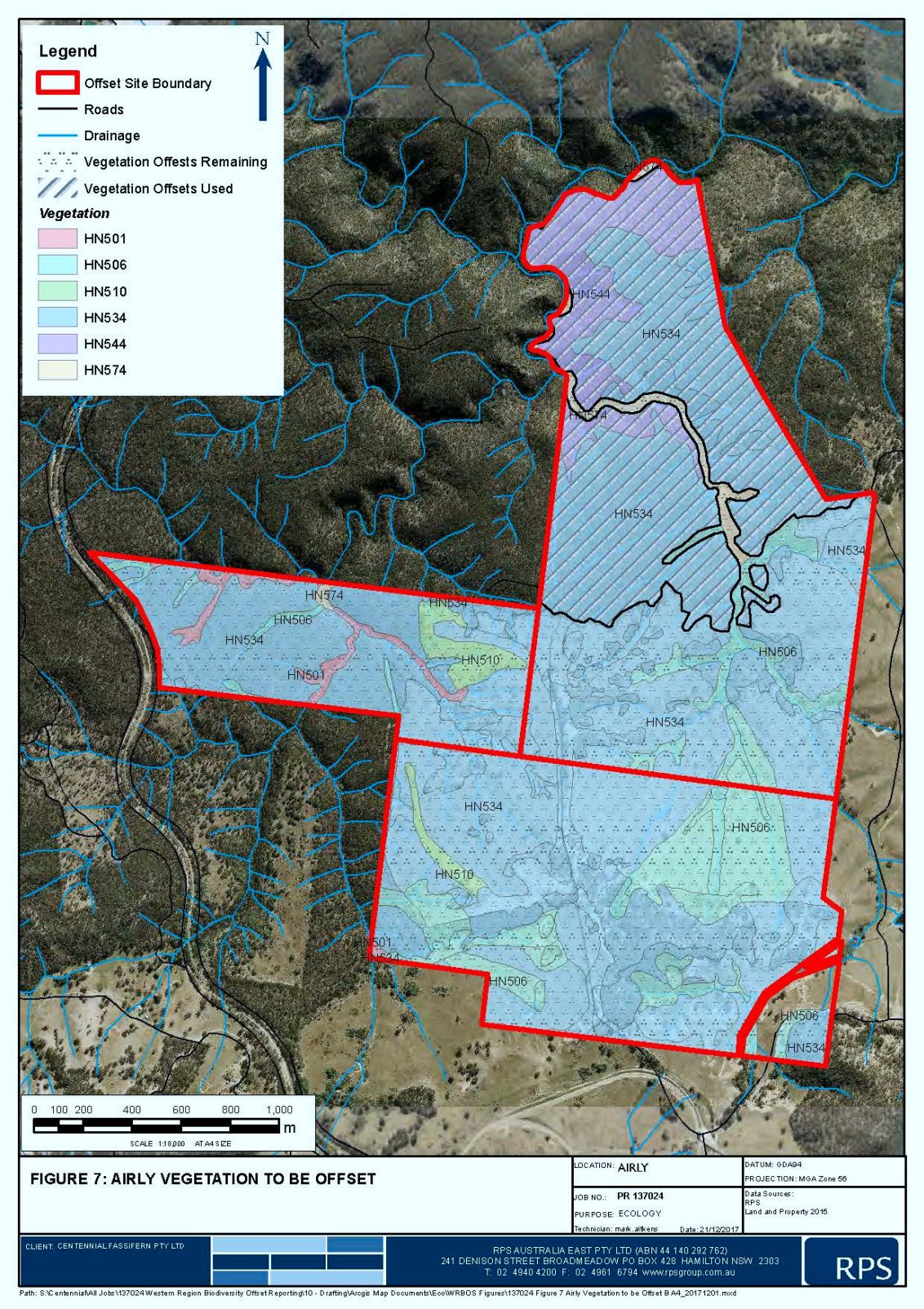


Figure 6. ***Biodiversity Offsets Clarence***

Biodiversity monitoring is undertaken in accordance with SMP requirements. Monitoring for flora and fauna is summarised in the following sections.

6.2.1. Flora

Flora monitoring at pagoda, heath and wet gully sites within the Clarence Colliery Outbye, Eastern and 700 Western SMP Areas was undertaken by Roger Lembit of Gingra Ecological Surveys.

Eastern SMP and 700 Western SMP Area

A total of six sites in the Eastern SMP Area (with two control sites) and two sites in the Clarence 700 West area (with one control site) were monitored.

Table 12. Heath/Pagoda Flora Monitoring Sites (Eastern /700 West SMP Areas)

Site	Location	Type	Easting (GDA)	Northing (GDA)
Clarence Eastern SMP Area				
PAG_01	Gorilla Rock	Impact	246753	6300035
PAG_02	Gorilla Rock	Impact	246755	6299924
PAG_03	Waratah East	Impact	247251	6300707
PAG_04	Waratah East	Impact	247043	6300784
PAG_05	Waratah North	Control	247962	6303960
PAG_06	Waratah North	Control	247888	6303910
BNS_01	Bungleboori North Swamp	Impact	245582	6302273
BNS_02	Bungleboori North Swamp	Impact	246290	6303633
Clarence 700 West SMP Area				
CLW_01	Heath	Impact	241774	6295584
CLW_02	Swamp		242596	6295527
CLW_03	Happy Valley Swamp		241923	6296954
CLW_04	Hanging swamp		241904	6298016
CLW_05	Pine Swamp		240804	6300186
CLW_06	Heath—Paddys Creek Ridge	Control	240472	6299171

Plant condition at swamp sites may be affected by hydrological changes or presence of insect predators. Plant health was generally good within the six swamp plots covered in this section of the report Plant condition at swamp sites may be affected by hydrological changes, disease caused by pathogens such as fungi or insects, and the effects of drought and extreme weather. Plant health was generally good within the six swamp plots covered in this section of the report.

The dry weather during 2018 had an impact on the health of swamp plants with many recorded instances of plant disease in spring 2018. At CLW_02, there was leaf dieback on *Grevillea acanthifolia* plants. At CLW_04 a few *Acacia longi*folia plants had died.

At the control site in Bungleboori North Swamp (BNS_02) several species were affected by dieback. These included *Leptospermum grandifolium, Gleichenia dicarpa, Banksia marginata and Baumea rubiginosa*. Branch dieback of *Leptospermum grandifolium* was also evident at BNS_01.

There was a significant decline in species richness within two plots, CLW_05 and BNS_01. Species richness within the other plots was similar to levels recorded in autumn 2018.

Logging of the pine plantation in the catchment of plot BNS_01 a few years ago caused an increase in water yield and the waterlogging of the swamp. The relatively dry conditions from November onwards has caused drying of the swamp, with no standing water observed in spring 2018.

Species richness at the other four Clarence West swamp plots was affected by the 2013 State Mine Fire. Increased water levels at Pine Swamp, plot CLW_05, resulted from the fire and logging of pine trees in the catchment area to the north-west of the Swamp. Pine Swamp has dried significantly over the past year and limited areas of standing water were observed in autumn 2018, although the surface soil remained saturated. There was also a large patch of browned off vegetation near the southern edge of the plot.

Some of the Clarence West swamp sites have been subject to disturbance prior to any impact of mining with the establishment of a pine plantation in the catchment of some swamps being a notable factor.

Radiata Pine (Pinus radiata) is present within BNS_01 and in autumn 2018 the cover/abundance score was 1 (rare). No other exotic plant species were recorded at BNS_01 in spring 2018. The exotic grass Yorkshire Fog (Holcus lanatus) was present at CLW_05 with a cover/abundance score of 2 (uncommon). The exotic daisy, Catsear (Hypochaeris radicata) was not recorded, having been present in autumn 2017 with a cover/abundance score of 1 (rare). At CLW_03, Blackberry (Rubus anglocandicans) was present with a C/A score of 1 (rare). Catsear (Hypochaeris radicata) was also recorded as uncommon. Catsear (Hypochaeris radicata) was not recorded at CLW_02, having previously been recorded as rare.

There has been a decline in weed abundance across the Clarence West swamp plots since the initial impact of the October 2013 bush fire.

Outbye SMP Area

Four vegetation monitoring quadrats were established within the heath vegetation in the Outbye SMP Area. There were also two control sites.

Table 13. Heath/Pagoda Flora Monitoring Sites (Outbye SMP Area)

Site	Location	Easting (MGA)	Northing (MGA)
CLAO 01	Above 307 south of Bungleboori Creek	245023	6297763
CLAO 02	Above 307 south of Bungleboori Creek	245092	6297707
CLAO 03	Above 402, north of Bungleboori Creek (completed June 2009)	245504	6298627
CLAO 04	Adjacent to 602, north of Bungleboori Creek (completed April 2009)	245294	6299168

There were relatively few instances of plant disease was observed within the Outbye plots in autumn 2018 with only one plot affected.

At CLAO_01 Eucalyptus stricta and Allocasuarina nana plants had borer damage, Banksia marginata plants had leaf tip dieback and Isopogon anemonifolius plants had leaf discoloration.

There was a slight increase in species richness recorded in autumn 2018, with the average species richness being 34.75, a higher level than previously recorded across these plots. In spring 2018 the average was 31.0, a figure within the range of pre-fire records.

The pattern of species richness over the past 60 months is consistent with a normal post fire response; an initial increase then a stabilisation, with seasonal fluctuations in response to rainfall and temperature, followed by a decline. The dry conditions prevailing in 2018 may have contributed to this decline.

No exotic species were recorded at any of the Clarence Outbye sites in spring 2018.

There are no clear long term trends indicating a change in abundance of the more common shrub or ground layer species present at each site.

800 SMP Area

There are eight sites in the Clarence 800 Area located in the section of Newnes State Forest which is bordered by Blue Mountains National Park. Locations are shown in Table 16.

Table 14. 800 SMP Area Flora Monitoring Sites

Site	Location	Type	Easting	Northing
CLAE_01	Gully N of Dumbano Fire Trail dam	Impact	248971	6295894
CLAE_02	Heath ridge	Impact	247495	6295216
CLAE_03	Heath ridge	Impact	247271	6295388
CLAE_04	Secret Swamp	Impact	247203	6296462
CLAE_05	Secret Swamp	Impact	247159	6296404
CLAE_06	Olearia Swamp	Impact	247648	6296165
CLAE_07	Olearia Swamp	Impact	247701	6296288
CLAE_08	Olearia Swamp	Impact	247789	6296830

There were signs of plant disease at 3 of the 5 swamp plots surveyed within the Clarence 800 area. At CLAE_04 *Xyris gracilis* plants had drought associated leaf dieback. At CLAE_06 *Gleichenia dicarpa* plants had frond dieback and *Pultenaea divaricata* plants had branch tip dieback. At CLAE_08 *Pultenaea divaricata* plants also had branch tip dieback and Olearia quercifolia plants had leaf dieback. At the gully site, CLAE_01, *Banksia marginata* plants were suffering from drought associated dieback and leaf yellowing.

There were also several instances of dieback at the heath sites. At CLAE_02 a *Pultenaea subspicata* plant was dead and a *Banksia spinulosa* plant had a dead branch due to borer damage. At CLAE_03 Conesticks (*Isopogon anemoni*folius) plants had leaf discoloration and there was a dead stem on a *Phyllota squarrosa* plant.

Species richness figures for the Clarence 800 Area sites showed a generally declining trend in species richness after an initial increase is consistent with a normal post-fire recovery sequence.

There have only been two records for an exotic species at the 800 area sites since monitoring commenced. Fleabane (Conyza sp.) was recorded as rare at CLAE_08 in summer 2010 and Yorkshire Fog (Holcus lanatus) was recorded as rare at CLAE_08 in autumn 2012. Disturbance associated with damage by feral pigs was recorded in proximity to this site in April 2009.

There have been no subsequent records of exotic species at any of the 800 area sites. The bare ground layer evident at the sites following the bush fire has not led to any new weed occurrences, even in the Olearia Swamp sites which had been affected previously by feral pigs or in the Secret Swamp area where there are old trail bike tracks and associated erosion and sedimentation.

900 SMP Area

Two sites were established along an arm of Paddys Swamp in the Clarence 900 SMP Area in November 2014. This area was affected by the October 2013 bushfire. The two sites are presented in **Table 17**.

Table 15. 900 Area Flora Monitoring Sites

Site	Location	Type	Easting	Northing
PSB_01	Paddys Swamp Branch	Impact	241338	6298523
PSB_02	Paddys Swamp Branch	Impact	241404	6298617
PS_03	Paddys Swamp (lower)	Impact	241822	6299156

There are a range of disturbance factors already operating in the vicinity of the two sites in the upper catchment (PSB_01 and PSB_02). This includes drainage works associated with the abandoned sand mine 600 metres to the south, a trail bike track to the north of PSB_01 and the impacts of the 2013 bush fire. Site PS_03 is located in the main section of Paddys Swamp, in an area substantially free of past disturbance, other than bush fires.

Species richness at PSB_01 in autumn 2018 was at the low end of the range of previous records, whilst at the other two plots species richness was below the previously recorded range. This is considered to be due to the dry weather in 2018 and a cold winter with severe frosts. There is a declining trend of species richness at PSB_02. This may be a normal post fire decline, due to growth of the dominant shrub and ground layer species out-competing smaller, less common plants.

In terms of plant health Empodisma minus plants at PSB_01 had drought associated stem dieback. There were no other records of plant disease at the Paddys Swamp plots in spring 2018.

One exotic species, Catsear (Hypochaeris radicata) has regularly been recorded at PSB_01 and in autumn 2018 this species was ranked 1 (rare), a lower same ranking than in autumn and spring 2017. Catsear was also recorded at Site PSB_02 in spring

2014 but has not subsequently been recorded at the site. This is a response to time since fire.

Discussion of Flora results

Plant condition in spring 2018 showed a drought effect at many of the plots. Including both swamp and heath sites. This follows the autumn survey when there were several records of plant dieback due to water stress. There were some records made of plant damage caused by insects, but records of fungal infections. At swamp sites browsing by wombats was found to be affecting grasses and sedges, with tracks more obvious and spots where resting wombats had smothered swamp vegetation. It is likely that these impacts have been concentrated in these swamps due to the relatively dry conditions in the surrounding woodland.

There were very few records of exotic plant species with occurrences being related to sites with a known history of disturbance factors unrelated to mining.

The bush fire affected sites have now largely stabilised with species richness and cover following a natural pattern of post-fire dynamics. This indicates that ecosystem function across the study area is normal.

There were no anomalous results for spring 2018 relating to sites which lie over or in proximity to recently mined areas, nor were there any indications of residual effects of subsidence in areas undermined previously. The patterns of species richness, species composition and plant disease relate strongly to bush fire impacts and relatively dry seasonal weather conditions with no indication of a mining effect.

Rapid Assessment Flora Results

In accordance with the Statement of commitments in DA 504 -00, A small swamp 400 m south of the Clarence Colliery office, consistent with the Newnes Plateau Hanging Swamp ecological community is monitored on a an Annual basis using a Rapid Assessment Methodology (RAM) described in Blick *et al* 2013. The Surveys were conducted by Gingra Ecological Surveys on 9th April 2018.

In April 2018 the swamp vegetation was observed to be in good condition, showing a strong and normal response in terms of recovery from the October 2013 bush fire and to rainfall conditions in the 12 months prior to this rapid assessment.

The swamp vegetation is particularly dense, with a diverse range of species present. Species sensitive to disturbance or drying such as Gleichenia dicarpa, Banksia marginata and Comesperma retusum were all observed to be in good condition.

Swamp hydrology is consistent with that in undisturbed swamps in similar topographic locations on the Newnes Plateau. There are no signs of nutrification or sediment movement. Swamp organic material is plentiful and shows no sign of physical disruption.

There are no indications of an impact of nearby mine operation activities, including the proximity of the reject emplacement area.

6.2.2. Fauna

Fauna monitoring at Clarence Colliery was undertaken by Biodiversity Monitoring Services. Fieldwork for the 700 Area (Eastern, Western and Outbye), 800 Area (Eastern Portion) and 900 Area was completed.

In 2008 sites were established within both the Outbye and 700 SMP Areas and in 2009 sites were established to commence baseline surveys within the ‘800 Area’ to identify impacts (if any) of mining induced subsidence on native fauna.

Two additional sites were established in 2014 to commence baseline surveys within the 900 Area to identify impacts (if any) of mining induced subsidence on native fauna.

Fauna monitoring undertaken uses the methods of setting traps including Elliot traps, tomahawk cage traps, glider traps and pitfall traps, additional monitoring includes spotlighting, hair funnels, remote cameras, bird surveys, call broadcasting, herpetological searches, bat call detection, animal track recognition and opportunistic observations.

A set of criteria that is used to monitor and compare fauna populations within the SMP Areas over time includes:

- Species richness of faunal groups;
- Diversity indices of faunal groups;
- Capture rates of individual species;
- Population status of species;
- Contribution to the faunal assemblages by threatened species, species dependent upon woodland and by species declining in the Central West;
- Habitat complexity scores; and
- Comparisons between Treatment and Control sites.

700 Western SMP Area

Six long term fauna monitoring sites have been established within the Western SMP Area including:

- CLW01 – Control site, not undermined, pagoda landscape;
- CLW02 – Undermined November 2009, swamp landscape;
- CLW03 – Undermined October 2010, swamp landscape;
- CLW04 – Control site, not undermined, swamp landscape;
- CLW05 – Control site, not undermined, swamp landscape; and
- CLW06 – Undermined November 2011, pagoda landscape.

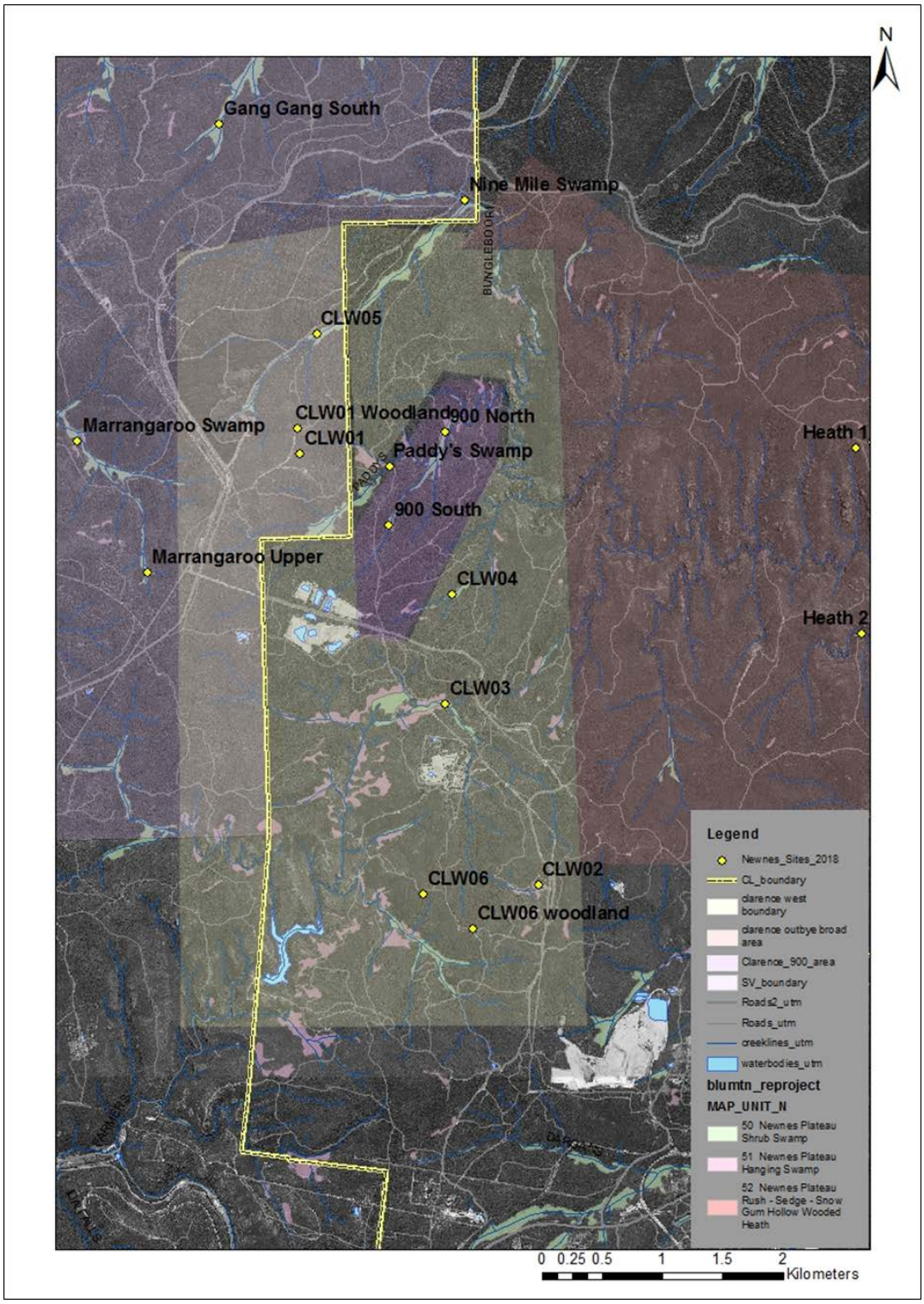


Figure 7. ***Location of Fauna Monitoring Sites in 700 Western SMP Area***

The configuration of survey sites established in 2006 adequately samples the two major environments within Clarence Colliery Western SMP Application Area i.e. pagoda and wetland (swamp). These sites provide the best possible data for the long-term monitoring of terrestrial vertebrates. The survey techniques used have been successful in locating a wide range of species, including new records for the Newnes Plateau region. Pagoda habitat mainly comprises low heath that is characteristic of pagoda and hilltop environments on Newnes Plateau.

At this stage 25 threatened species are known to occur within the area, and several species that have been located are considered as being of conservation concern in this region e.g. Beautiful Firetail, Rufous Fantail, Long-nosed Bandicoot. The area should be

considered heavily disturbed by recreational activities, particularly trail bikes and 4WDs. This must be brought into consideration when assessing any changes.

The major influence upon the fauna populations (and vegetation) within Clarence West has been the State Mine fire that burnt out all the sites in the area in 2013. At this stage, the data obtained provides an important baseline for monitoring the recovery from fire by fauna in the future. It also provides important data to compare the rates of recovery within areas that have been previously mined and those still to be mined or used as controls.

The results from the survey of the Clarence Colliery Western SMP Area in 2018 show that the assemblages found are typical of that found throughout Newnes Plateau and are similar to that obtained in the remainder of Clarence Colliery. Bird, native non-bat mammal and amphibian species richness' were the highest they have been since surveys began. Overall bird numbers were good. Reptile richness was down on 2016 and 2017, but is within the bounds of expected fluctuations. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. There is now sufficient data accumulated to provide annual population estimates for all groups of fauna.

Thirteen threatened species were located during 2018, including Eastern Pygmy-possum, Greater Glider, Yellow-bellied Sheath-tailed Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Gang-gang Cockatoo, Little Lorikeet, Varied Sittella, Dusky Woodswallow, Scarlet Robin, Flame Robin and Blue Mountains Water Skink. This is an increase in the diversity of threatened species since the surveys began, though a number of species have been listed since surveys began. The State Mine fire appears to have affected the fauna and habitats within the CLW area, as it had with other Clarence areas. Many measured habitat and diversity parameters started low in early 2014 and have increased since then. The number of woodland-dependant birds recorded has dropped over 2017-2018, which could be due to the dry conditions experienced.

Table 16. Biodiversity indices over time (700 Western SMP Area)

Group	Diversity index	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Birds	**Simpson's**	0.86	0.95	0.91	0.92	0.94	0.96	0.94	0.94	0.95	0.97	0.96	0.95	0.95
	Species richness	40	72	64	59	63	49	72	62	71	73	69	76	76
***Native Mammals**	**Simpson's**	0.70	0.71	0.70	0.82	0.82	0.79	0.77	0.76	0.84	0.86	0.82	0.81	0.85
	Species richness	12	13	11	12	14	12	15	13	14	15	13	11	15
Reptiles	**Simpson's**	NA	0.82	0.86	0.81	0.76	0.75	0.84	0.63	0.82	0.86	0.93	0.73	0.82
	Species richness	0	10	10	10	6	5	10	3	9	9	12	9	7
Amphibians	**Simpson's**	-	-	-	-	0.39	0.40	0.11	0.42	0.57	0.49	0.74	0.78	0.57
	Species richness	1	3	3	4	2	2	5	4	8	4	7	7	9

Statistical analyses have shown no impact by undermining with the impacts of fire and climatic changes stronger drivers of habitat and diversity parameters. Given the low levels of subsidence from previous mining at Clarence Colliery, the risk of adverse impacts on fauna within this area is considered to be low. Mining commenced in the CLW Area in November 2009, and would now be affecting all of the impact survey sites. At present, there appears to be no evidence of subsidence impacts upon the fauna diversity at CLW Area.

Outbye SMP Area

Three sites have been established within the Outbye SMP Area including:

- *Heath North (Site 1)* – Sandstone Plateau Tea Tree – Dwarf Sheoak – Banksia Rock Heath Sandstone Plateau and Ridge Scribbly Gum Silvertop Ash Shrubby Woodland;
- *Gully (Site 2)* –Shrubland and Newnes Sheltered Peppermint /Brown Barrel Shrubby Forest; and
- *Heath South (Site 3)* - Blue Mountains Sydney Peppermint /Silvertop Ash Shrubby Woodland.

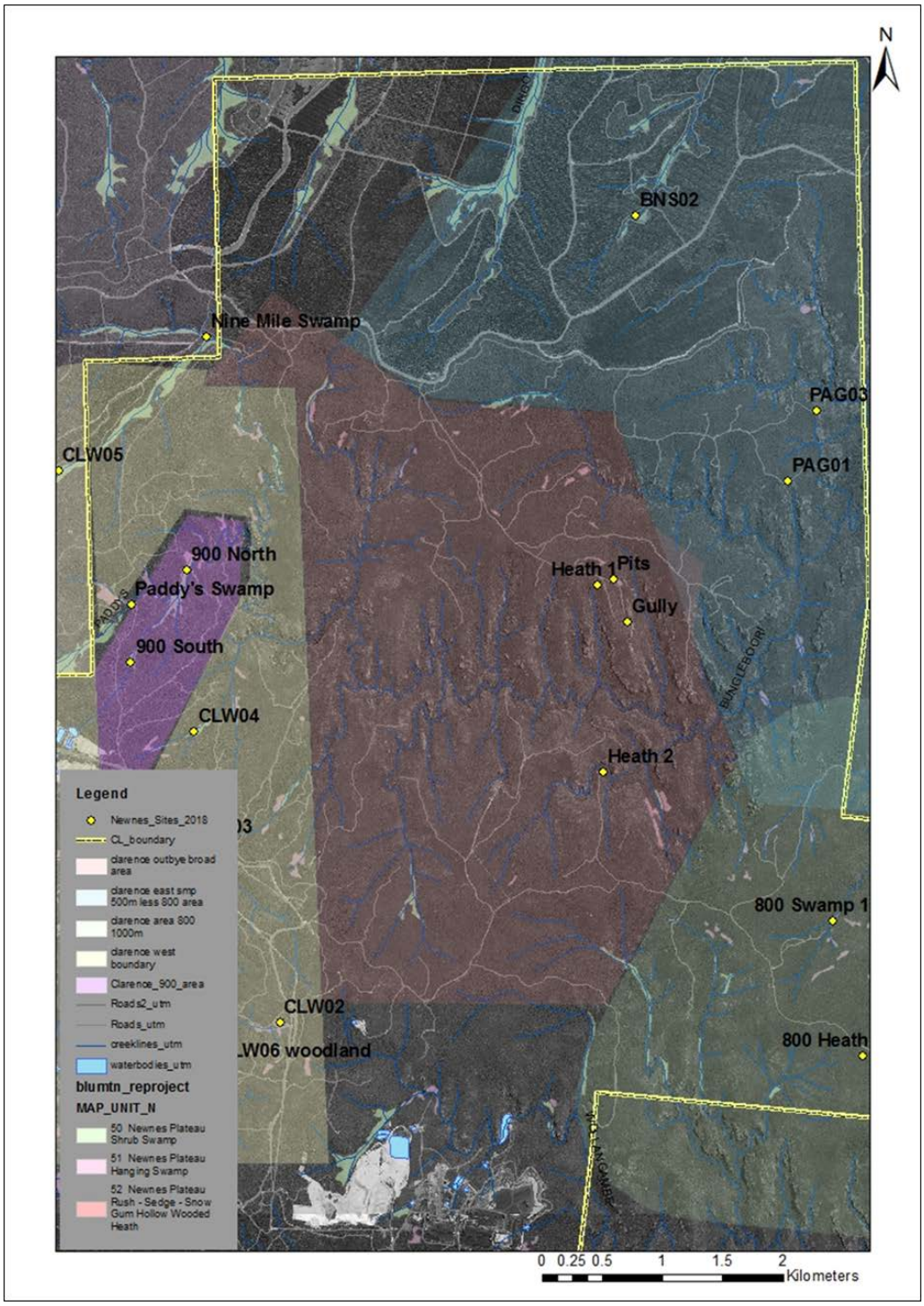


Figure 8. ***Location of Fauna Monitoring Sites in Outbye SMP Area***

The results from the survey of the Clarence Colliery Outbye Area in 2018 show that the assemblages found are typical of that found throughout Newnes Plateau and are similar to that obtained in the remainder of Clarence Colliery. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Overall bird numbers were good. Bird, mammal, reptile and amphibian diversities have all fallen slightly since last year, but still typical for the long term. The proportions of woodland-dependent and declining birds have been depressed the last two years, indicating the dry conditions may have affected the suitability of the habitat for this largely mobile fauna group. The dry conditions may have also been the cause of decreased reptile numbers this year. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. There is now sufficient data accumulated to provide annual population estimates for all groups of fauna

Eight threatened species were located during 2018, as well several bird species dependent upon woodland habitats. Threatened species included Greater Glider, Yellow-bellied Sheath-tailed Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Gang-gang Cockatoo, Scarlet Robin and Flame Robin. This is an increase in the diversity of threatened species since the surveys began, though numbers found typically vary.

At present, there appears to be no evidence of potential impact from subsidence on the fauna populations of the Outbye Area. Analysis of the data shows that, for both the Eastern SMP and Outbye SMP Areas, there are no significant changes in Simpson's Index of Diversity, population numbers, species richness, trapping rates and woodland-dependent birds. Comparison between data from impact and control areas show no significant differences and Bray-Curtis Similarity Indices are relatively high.

Overall it is difficult to relate changes in fauna populations over the years to any quantifiable parameter, including mining activities. The assessment of the data from Clarence Eastern SMP and Outbye SMP Areas shows that mining activities do not appear to be a significant factor in determining changes in fauna populations at Newnes Plateau.

Table 17. Biodiversity indices over time (Outbye SMP Area)

Group	Diversity index	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Birds	**Simpson's**	0.94	0.92	0.88	0.96	0.96	0.91	0.95	0.97	0.95	0.96	0.93
	Species richness	45	51	41	48	49	47	47	49	47	53	50
***Native Mammals**	**Simpson's**	0.36	0.23	0.39	0.29	0.52	0.47	0.86	0.81	0.80	0.77	0.69
	Species richness	7	8	9	8	13	8	9	7	6	9	8
Reptiles	**Simpson's**	0.67	0.64	0.70	0.67	0.30	0.54	0.37	0.21	0.36	0.28	0.26
	Species richness	9	7	8	6	5	7	9	5	9	11	9
Amphibians	**Simpson's**	-	-	-	-	-	-	-	-	-	0.81	0.18
	Species Richness	2	2	2	1	1	1	3	4	4	4	2

*Bats not included

Eastern SMP Area

The three sites are surveyed in the Eastern SMP area:

- *BNS02 (Bungleboori North 1)* – a swamp community/Blue Mountains Sandstone Plateau Forest within the pine forest east of Waratah Ridge Road.;
- *PAG01/02* –This site samples Pagoda Complex and Blue Mountains Sandstone Plateau Forest vegetation, as well as habitats unique to the cliffline environment; and
- *PAG03/04* – a pagoda and steep hill overlooking Bungleboori Creek, similar to PAG01/02.

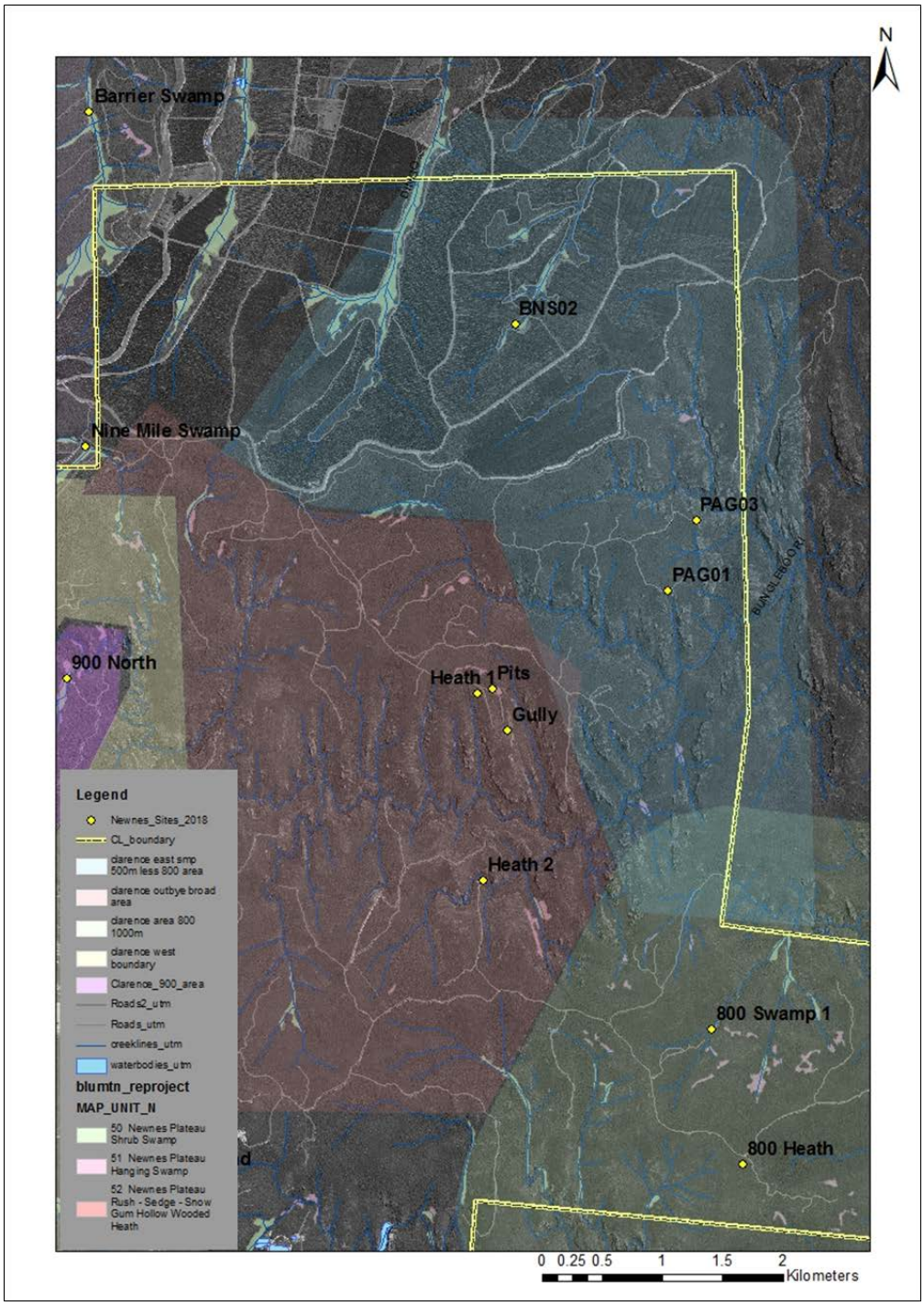


Figure 9. ***Location of Fauna Monitoring Sites in 700 Eastern SMP Area***

The results from the survey of the Clarence Colliery Eastern Area in 2018 show that the assemblages found are typical of that found throughout Newnes Plateau and are similar to that obtained in the remainder of Clarence Colliery. Native non-bat and reptile species richness trend downwards over time, but the decline does not look to be associated with mining activity (from a statistical standpoint). Other diversities have varied but remained neutral over time. Despite the dry conditions in 2017 and 2018, species richness was up on the last few years, and bird richness was the highest since monitoring began. Mammal trapping rates are recovering post fire, but levels are still down. Antechinus species have been captured again for the first time since the fire. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. There is now sufficient data accumulated to provide annual population estimates for all groups of fauna.

Eight threatened species were located during 2018, as well as several bird species dependent upon woodland habitats. Threatened species included Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Gang-gang Cockatoo, Little Lorikeet, Varied Sittella, Scarlet Robin and Flame Robin. Their locations are shown in Figure 5-8. The number of threatened species is highly variable through time, but current levels are good. Woodland-dependent and declining species were under-represented in 2017 and 2018. Either the burning of the area, clearing of the pine around BNS02, or the current dry conditions may have discouraged these rarer species, though it has also led to some species uncommon to the Plateau turning up. The State Mine fire affected the pagoda fauna and habitats within the CLE Area, with some measured parameters falling between spring 2013 and 2014.

Table 18. Biodiversity indices over time (Eastern SMP Area)

Group	Diversity index	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Birds	**Simpson's**	0.92	0.84	0.91	0.95	0.95	0.93	0.96	0.95	0.96	0.96	0.93	0.94	0.97	0.96
	Species richness	63	50	51	46	54	42	57	53	56	51	54	54	67	68
***Native Mammals**	**Simpson's**	0.58	0.42	0.47	0.64	0.78	0.74	0.73	0.51	0.51	0.78	0.76	0.76	0.72	0.81
	Species richness	11	13	8	8	11	8	10	8	8	8	7	7	9	10
Reptiles	**Simpson's**	0.81	0.78	0.77	0.80	0.73	0.76	0.82	0.74	0.75	0.72	0.74	0.76	0.81	0.82
	Species richness	13	11	14	8	10	9	10	7	6	5	6	5	8	8
Amphibians	**Simpson's**							0.56	0.25	NA	0.14	0.67	0.56	0.70	0.51
	Species richness	1	2	2	2	2	2	3	2	1	2	2	3	3	2

As extraction in the Eastern SMP Area was completed in 2009, it is evident from the above analyses that there have been no significant differences in the indices measured over the years. At present, there is no evidence of potential effects from subsidence on the fauna diversity at CLE.

The assessment of the data from Clarence Eastern SMP and Outbye SMP Areas shows that mining activities do not appear to be a significant factor in determining changes in fauna populations at Newnes Plateau

800 Area (Eastern Portion)

Three sites were established in the 800 Area during 2009 and fauna surveys have continued through 2018. The sites are:

- 800 Swamp 1 is located within a Newnes Plateau Shrub Swamp community;
- 800 Swamp 2 Site is located within Exposed Blue Mountains Sydney Peppermint – Silver-top Ash Shrubby Woodland, Newnes Plateau Hanging Swamp community; and
- 800 Heath Site is located within a montane heath vegetation community.

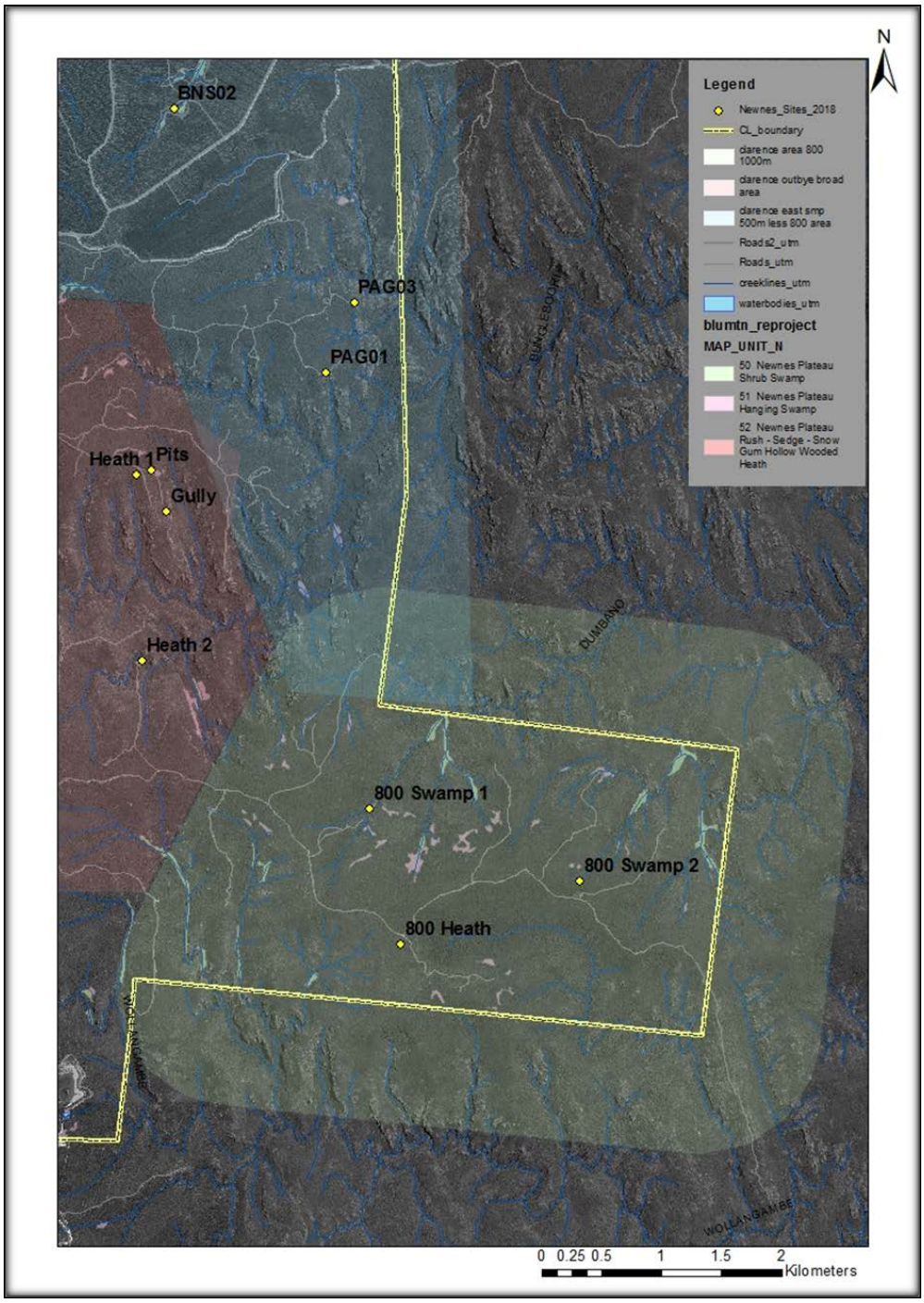


Figure 10. ***Location of Fauna Monitoring Sites in 800 SMP Area***

The results from the survey of the Clarence Colliery 800 Area in 2018 show that the assemblages found are typical throughout Newnes Plateau and are similar to that obtained in the remainder of Clarence Colliery.

Native non-bat mammal and reptile diversities have increased since the fire. Other fauna groups have remained relatively stable over time considering the impact of the State Mine fire on the habitat in the 800 Area. Seven threatened species were located during 2018, as well as several bird species dependent upon woodland habitats. Threatened species included Eastern False Pipistrelle, Eastern Bentwing-bat, Gang-gang Cockatoo, Little Lorikeet, Varied Sittella, Scarlet Robin and Flame Robin. Threatened species and woodland dependent birds appear to have remained quite stable over the years, with the exception of a decline in 2013 and a lull in 2017-2018. The State Mine fire definitely affected the fauna and habitats within the Clarence 800 area, with many measured parameters falling between spring 2013 and 2014. Dry conditions over the last few years has also impacted fauna and their habitats.

Table 19. Biodiversity indices over time (800 SMP Area)

Group	Diversity index	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Birds	**Simpson's**	0.95	0.86	0.93	0.93	0.96	0.95	0.95	0.91	0.92	0.75
	Species richness	40	38	39	48	51	53	39	40	50	51
***Native Mammals**	**Simpson's**	0.76	0.71	0.67	0.65	0.61	0.84	0.83	0.78	0.82	0.78
	Species richness	7	7	9	8	11	8	8	6	9	9
Reptiles	**Simpson's**	0.78	0.82	0.73	0.76	0.83	0.84	0.90	0.88	0.83	0.83
	Species richness	5	6	8	6	10	7	3	9	14	10
Amphibians	**Simpson's**	0.63	0.67	0.25	NA	-	0.29	0.41	0.29	0.66	0.73
	Species Richness	4	3	4	1	2	2	3	3	3	3

*Bats not included

Bird Simpson's has declined since 2017, and species richness is within the natural level of fluctuation. Mammal Simpson's has increased since 2013, yet species richness remains average. Reptile richness is down on 2017 yet numbers are still relatively good over the long-term. Amphibian Simpson's has increased since 2013 and species richness remains average. The effects of the fire were felt mainly in spring when diversity indices dropped from 2013 to 2014. Mammal trapping rates have remained low since the fire. There were sufficient numbers and diversities of these fauna groups to be able to calculate a set of diversity indices that form part of the baseline monitoring database. There is now sufficient data accumulated to provide annual population estimates for all groups of fauna. Weather conditions during the surveys were ideal (with regard to temperature) for recording fauna.

At this stage there is no evidence to suggest any impact due to undermining, though power of analyses are low due to the small number of sites included in each treatment. Data from these sites will contribute towards analysis of fauna recovery from high intensity fire.

Given the low levels of subsidence from previous mining at Clarence Colliery, and the predicted low levels (30–100mm) of subsidence for 800 Area, the risk of adverse impacts on fauna within this area is considered to be low. Mining (first workings only) commenced in 800 Area in July 2012, and are now affecting two of the survey sites. The monitoring of recovery from fire within those sites mined and un-mined will be an important tool in the on-going assessment of mining activities.

900 Area

, Clarence Colliery commenced the monitoring of fauna populations within the area 900 SMP Area, particularly within swamps considered as TEC's in spring 2014 at two sites:

- Site A North is a monitoring site within a Newnes Plateau Shrub Swamp, Newnes Plateau Hanging Swamp community; and
- Site B South is within an area encompassing both Newnes Plateau Shrub Swamp, Tableland Mountain Gum /Snow Gum /Daviesia Montane Open Forest communities.

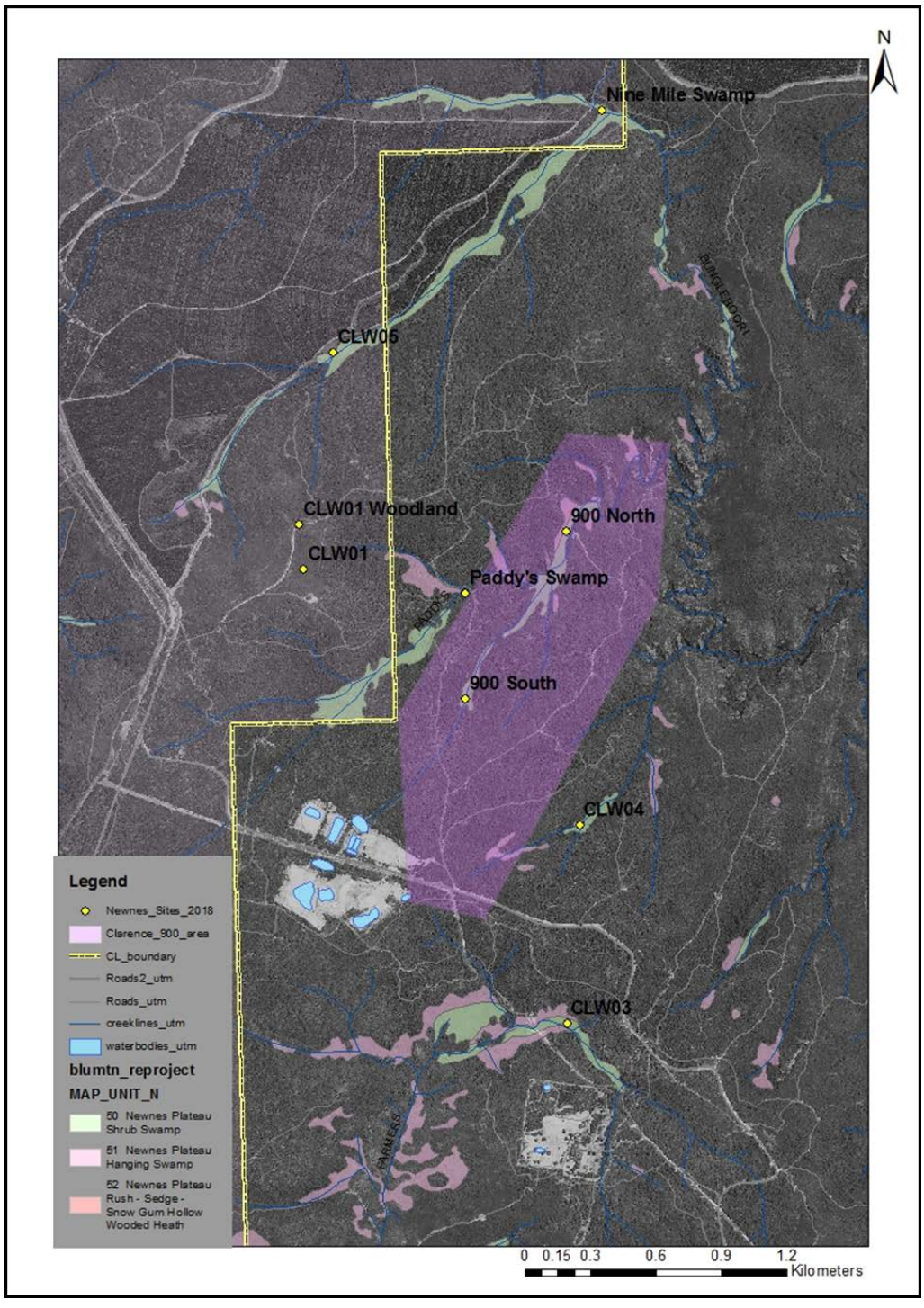


Figure 11. ***Location of Fauna Monitoring Sites in 900 SMP Area***

The results from the survey of the Clarence Colliery 900 Area in 2018 show that the assemblages found are typical of that found throughout Newnes Plateau and are similar to that obtained in the remainder of Clarence Colliery. The timing of the survey was successful, in terms of the number of individuals and diversity of species within the main fauna groups surveyed. Species richness was up for all groups but native mammals. Bird Simpson's was stable. Mammal Simpson's was stable, and trapping rates are still on the rise after the State Mine fire. Reptile Simpson's was down on last year, but up since the fire. Amphibian Simpson's was up on last year and the fire. Weather conditions during the surveys were ideal (with regard to temperature) for recording fauna, though overcast conditions during the summer surveys may have hindered the target searches for Blue Mountains Water Skink and Giant Dragonfly.

Ten threatened species were located during 2018, as well several bird species dependent upon woodland habitats. Threatened species included Yellow-bellied Sheath-tailed Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Bentwing-bat, Gang-gang Cockatoo, Powerful Owl, Varied Sittella, Dusky Woodswallow, Scarlet Robin and Flame Robin. Their locations are shown in Figure 5-8. This is an increase in the diversity of threatened species since the surveys began. As we did not survey the 900 Area pre fire, the increases we are seeing across the board are likely a result of the habitat recovering post fire and animals moving back into the Area. The State Mine fire appears to have affected the fauna and habitats within the surrounding Clarence areas. Many measured parameters started low in spring 2014 and have increased since then.

Table 20. Biodiversity indices over time (900 SMP Area)

Group	Diversity index	2014	2015	2016	2017	2018
Birds	**Simpson's**	0.967	0.966	0.960	0.965	0.957
	Species richness	40	51	50	59	62
***Native Mammals**	**Simpson's**	0.786	0.856	0.729	0.799	0.747
	Species richness	5	7	7	12	6
Reptiles	**Simpson's**	NA	0.911	0.750	0.671	0.538
	Species richness	1	7	4	9	5
Amphibians	**Simpson's**	NA	0.167	0.333	0.286	0.417
	Species Richness	1	2	2	2	4

At this stage, the data obtained cannot be used to monitor any effects from underground mining as none of the 900 Area sites have been undermined. It does however, provide an important baseline for monitoring the recovery from fire by fauna in the future. It also provides important data to compare the rates of recovery within areas that have been previously mined and those still to be mined or used as controls.

Given the low levels of subsidence from previous mining at Clarence Colliery, and the predicted low levels (30mm) of subsidence for 900 Area, the risk of adverse impacts on fauna within this area is considered to be low. The monitoring of recovery from fire within those sites mined and un-mined will be an important tool in the on-going assessment of mining activities..

Discussion/overview

The Clarence Colliery Lease Extension Environmental Impact Statement (October 2000) predicated the overall impact on flora and fauna to be negligible. The results presented in Section 6.2 show trends in plant species richness, plant condition and weed distribution which are consistent with previous annual reports. Subsidence impact to flora and fauna is therefore consistent with predicted impacts.

6.3. Blasting

No blasting activities are undertaken at Clarence Colliery.

6.4. Greenhouse Gas

Clarence undertakes monitoring of greenhouse gas emissions for reporting under the National Greenhouse and Energy Reporting (NGER) Program. Under the Program Clarence reports on:

- Greenhouse gas emissions;
- Energy production; and
- Energy consumption.

Of the six greenhouse gases identified in the Kyoto Protocol, Clarence Colliery produces one of these, carbon dioxide (CO_2).

Scope 1 emissions refer to direct emission sources from Clarence. Scope 2 emissions refer to indirect emissions from consumption of energy or heat produced by another organisation.

Table 21. Greenhouse Gas Emissions from Site

Emissions Summary (CO_2-eT) 2017	Total
Electricity	39,127
Diesel	2,469
Petroleum Based Oils and Greases (PBOG)	116
SF6	0
Fugitives -	11,532
TOTAL	**53,244**

Table 22. Greenhouse Gas Emissions 2011 - 2018 (CO_2 –e T)

Scope (CO_2-e T)	2012	2013	2014	2015	2016	2017	2018
Scope 1	8,925	9,289	9,876	12,116	11,655	12,700	14,117
Scope 2	33,007	38,380	39,287	39,121	41,523	41,193	39,127

6.5. Heritage (Aboriginal and non-Aboriginal)

6.5.1. Aboriginal

Clarence undertakes management of Aboriginal Heritage aspect and artefacts in accordance with the Western Region Aboriginal Cultural Heritage Management Plan.

During the 2018 reporting period no artefacts were undermined and no post mining surveys were conducted. Previously site C-OS-04 (45 -1-2699) was subject to a Phase 2 post mining inspection in 2017 however no artefacts were located during the inspection with RAPS. The Phase 3 post mining inspections were delayed in consultation with RAPS as a result of the identification of a large heritage site in the 900 North Due diligence studies. The Phase 3 inspections were delayed until early 2019 when the 900N site was inspected by 6 representatives of 5 Registered Aboriginal Parties. Detailed results of the inspections will be reported in the 2019 Annual Return however as per previous inspections at 45 -1-2699 due to the amount of leaf litter and ground covers

which limited surface exposure to less than 5%, the previously recorded artefacts could not be ground-truthed.

6.5.2. Non Aboriginal

Clarence undertakes management of non-aboriginal heritage in accordance with the Western Region Historic Heritage Management Plan.

There are four heritage items and two archaeological sites listed in the Lithgow City Council Local Environment Plan 2014 (LEP) Schedule 5 – Environmental Heritage which are within the Clarence Lease Boundary.

There are no heritage items within the Clarence Lease Boundary which are listed on the Commonwealth Heritage Register, on the NSW State Heritage Register (SHR), or the s170 registers (state owned items). There are no unlisted heritage items in the Clarence Lease Boundary.

During the reporting period no surface works or additional impacts occurred.

6.6. Meteorological Monitoring

Meteorological monitoring is undertaken at the Clarence Automated Weather Station. The weather station is required under M5.1 of EPL726 and Schedule 3, Condition 17 of DA 504-00. Figure 15 depicts monthly rainfall as well as monthly minimum and maximum temperatures.

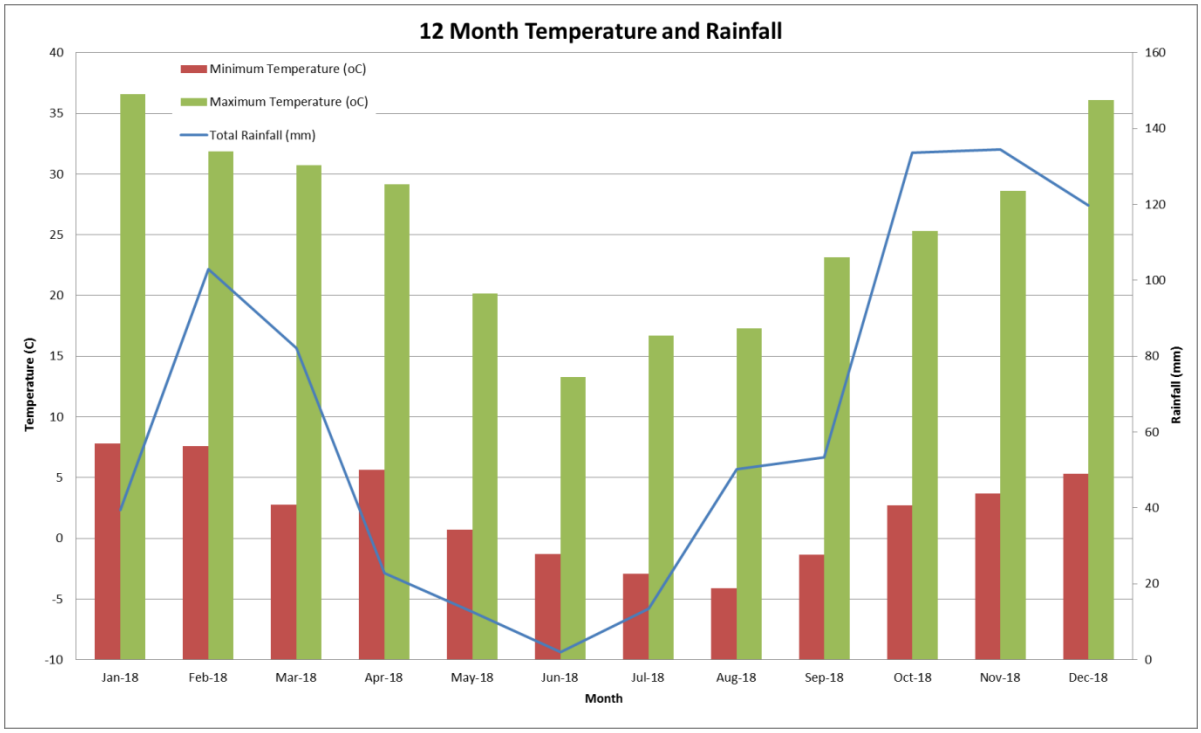


Figure 12. ***2018 Temperature and Rainfall trends***

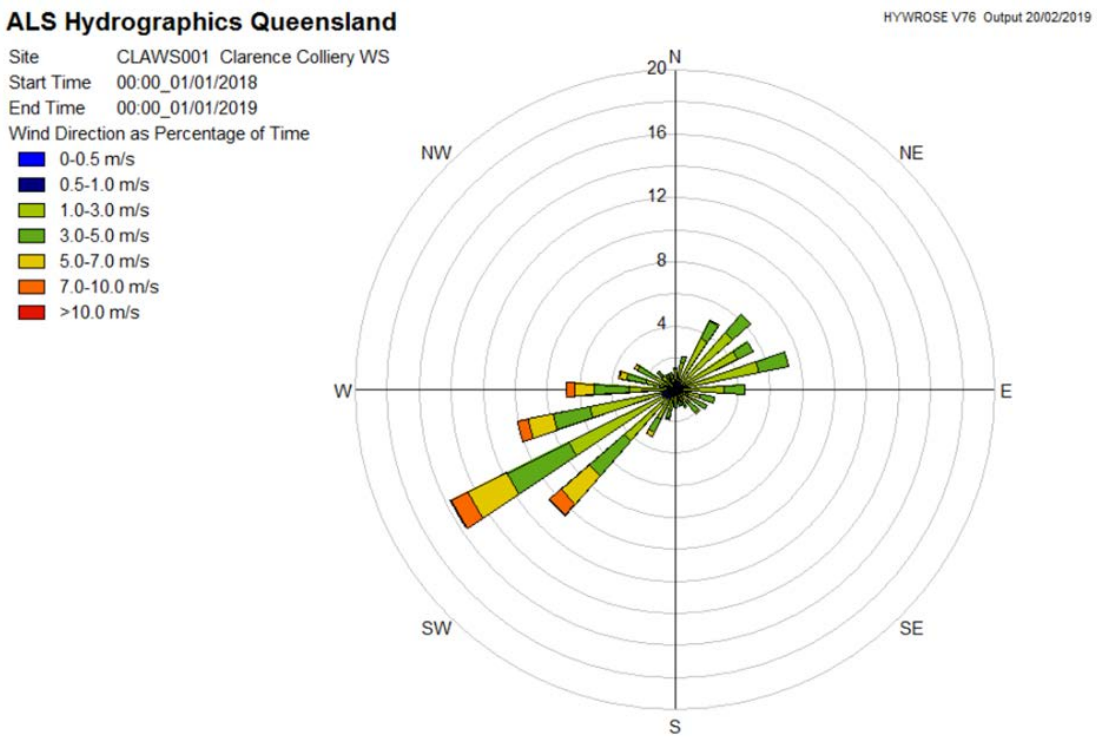


Figure 13. ***2017 Wind rose plot for Clarence.***

Results obtained from the weather station show the predominant wind direction is south-westerly. The most significant rainfall events occurred during October and November 2018 with the driest month being June 2018.

6.7. Noise

Clarence operates in accordance with the Western Region Noise Management Plan.

Key noise mitigation measures for Clarence Colliery include:

- Maintaining all plant and equipment to manufactures specifications.
- Operate mobile plant in a quiet, efficient manner and regular training of operators.
- Installation of frequency modulated reversing alarms or “quakers” on mobile plant to replace reversing alarms.
- Installing acoustic enclosures around processing plants.
- Switching off vehicles and plant when not in use.

In accordance with DA504-00 and EPL 726 noise monitoring is undertaken annually at M1. Clarence Annual monitoring (attended) was undertaken on 27 March 2018 which demonstrates compliance with the criteria specified in the consent. A summary of the results are provided below and the report has been attached.

Table 23. Noise Environmental Performance

Noise Monitoring location	Time of day	Approval criteria dB(A) $L_{Aeq(15min)}$	Performance during the reporting period (actual) dB(A) $L_{Aeq(15min)}$	Trend compared to previous years dB(A) $L_{Aeq(15min)}$
M1	Day	38	35	2017-BD 2016-33 2015-36
	Evening	36	30	2017-30 2016-33 2015-45
	Night	35	N/M #	2017-42 2016-35 2015-45

*SOURCE: November 2013 Environmental Assessment Clarence Colliery Road Haulage Modification Section 75W Modification to Development Consent DA 504-00

NM – Not measured as Weather conditions exceeded consent parameters.

Figures 14 – 16 show the results of the 2018 Monitoring and Trends since 2013.

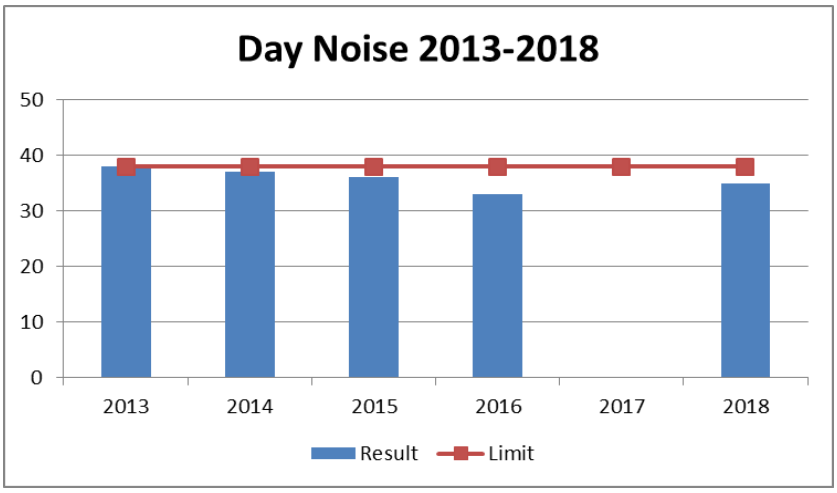


Figure 14. ***2013 to 2018 Day Noise***

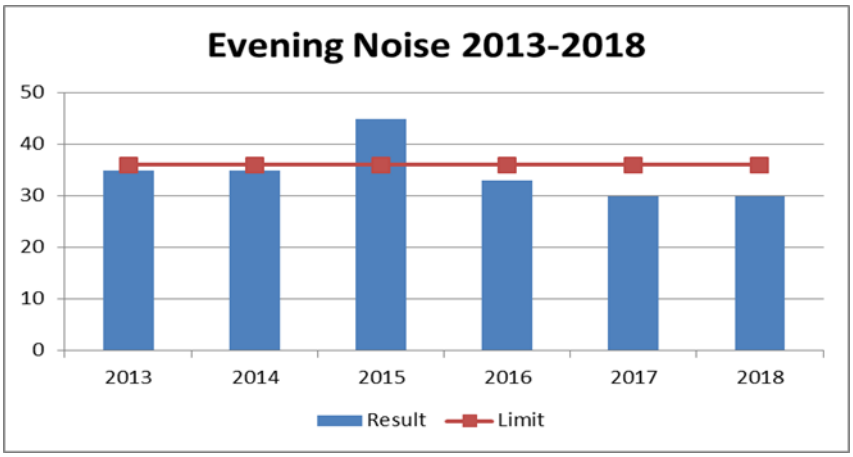


Figure 15. ***2013 to 2018 Evening Noise***

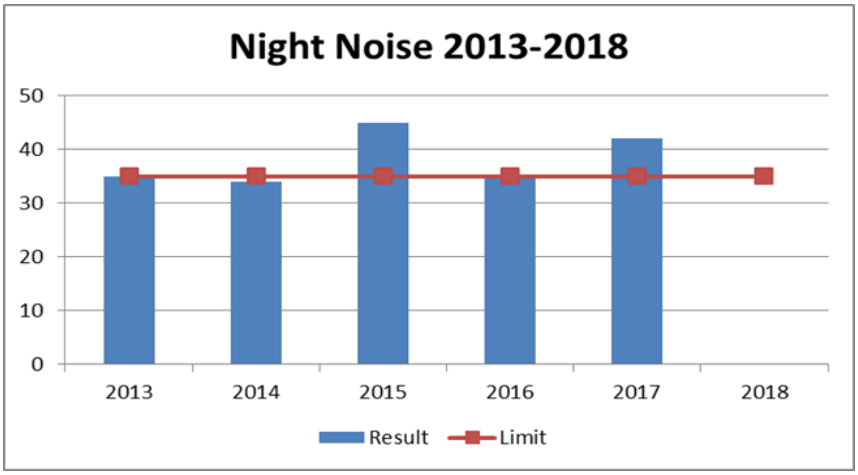


Figure 16. ***2013 to 2018 Night Noise***

Results obtained for the day and evening monitoring during the March noise Monitoring indicates the noise levels recorded are similar in 2018 than previous years.

Following the March Monitoring the Department of Planning & Environment issued a Show Cause Notice requiring additional monitoring and a review of the noise attenuation undertaken to date. The monitoring was undertaken on the 11 September 2018 by an independent consultant Global Acoustics which, included an expanded noise monitoring program with two attended noise monitoring locations being conducted simultaneously instead of a single attended site as required by the conditions of DA504-00. This monitoring was conducted to provide validation of noise experienced at the closest sensitive receptors in comparison to the approved monitoring point. This monitoring approach was formulated after review of various models and discussions with DPE. This noise monitoring was targeted to enhanced noise conditions whereby;

- Plant was fully operational, noting that the coal washing is currently undertaken only 2-3 days per week based on lower production volumes;
- Winds were generally from the North West (in a direction from the operations such that a differential could be recorded between the monitoring site and the sensitive receptors);
- Avoidance of conditions outside parameters of valid measurement (avoiding temperature inversions and winds >3m/s).

This program is therefore a worst case scenario sampling regime with a particular emphasis on gaining an understanding of the experienced noise levels at receptors when compared to the recorded noise levels at the approved monitoring points.

The results identified that the noise levels experienced at the nearest residence are lower than those recorded at the monitoring point with LAeq values recorded between 3 -6 Dba lower than that experienced at the monitoring point.

This was the case for both meteorological variables as, during high wind conditions experienced in the day sampling period a wind speed of >3.2m/s was recorded and a drop of 4 dba was recorded between the monitoring point and the residence. Although this was outside the applicable Consent meteorological criteria and hence no exceedance was relevant, the residence location was still within the Consent limits.

Similarly under temperature inversion conditions recorded during the evening outside the meteorological criteria of the Consent, the residence noise LAeq was 34dba and under the Consent level of 36 dba for evening. The results are contained in Table 7 below.

Table 24. Summary of results of the Comparative noise investigations September 2018 between the Monitoring Point and Residences

Location Description	Start Time	Wind Speed	Wind Direction	VTG	LAeq Criterion	Criterion Applies?	Clarence LAeq	Notes
Top of hill	12:15	3.2	279	-2.0	38	No	42	Day
Residence						No	38	
Top of hill	18:55	1.5	243	3.0	36	No	40	Evening
Residence						No	34	
Top of hill	21:00	2.4	292	-1.0	36	Yes	**43**	Breeze affected the total LAeq.
Residence						Yes	**40**	
Top of hill	21:40	3.4	296	-1.0	36	No	*44/45*	*Breeze affected.*
Residence						No	*40-42*	
Top of hill	22:00	3.4	289	0.5	35	No	*43*	Breeze affected.
Residence						No	*38/39*	

As shown in Table 7 one exceedance was recorded during the validation sampling undertaken where, at 9pm the meteorological conditions were within criteria. Global acoustics noted that the result was breeze affected and the Clarence weather station recorded a wind speed of 2.4m/s during the period. The results determined that the LAeq was 43dba at the monitoring location and 40 dba at the residence, 4 dba above the Consent criteria. It was determined that the operations were, at a worst case scenario for noise operation with the all mobile and fixed plant operational at the same time. In addition, the wind direction was directly from the operations to the noise monitoring locations and the wind speed was just under the maximum applicable speed for relevant sound levels.

Based on these results another study was undertaken to further investigate the differential values between the Monitoring Location and Sensitive receptors by Recognition Research. This study was to identify a differential value for Dba adjustment at residences based on monitoring data in accordance with Condition 15 of Development Approval DA 504-00 which states

"*Where it can be demonstrated that direct measurement of noise from the development is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable*"

The Recognition Research study identified that;

- noise levels at the sensitive receptors are mostly related to wind-in-vegetation-noise from elevated wind speeds, animal noises (insects and frogs), road and rail traffic namely the Main Western Rail Line and Chifley Road, contribute to received sound levels at these locations,
- Attended sound levels at the residential receiver indicated that the contribution sound levels from the Colliery did not exceed the limit conditions,
- The statistical difference between LA90,15-minutes at the Monitoring Point and the Residence C3 is calculated to be 7 dB (lower at the receiver) with light winds in the westerly to northerly quadrants due to the exposed nature of the monitoring point.

Based on this study Clarence will be seeking an EPL amendment with the EPA to acknowledge the differential in Noise exposure and corresponding noise monitoring results between the Monitoring Point and Sensitive receptors.

6.8. Subsidence Monitoring

Subsidence monitoring continued throughout the reporting period in accordance with the Subsidence Management Plans listed in Table 5. These plans require that the preparation and submission of Subsidence Management Status Report (SMSR) complies with the provisions of:

- Condition 17 of the SMP Approval for 900 Area dated 21st January 2014 (due to expire on 31st January 2019);
- Condition 17 of the SMP Approval for 800 Area dated 1st November 2013 (now due to expire on 30th October 2021); and
- Condition 17 of the SMP Approval for 700 West (700W) dated 18th June 2012 (now due to expire on 1st June 2021).

SMSR Reports continue to be sent every 4 months with data updated as results become available and an Endo f Year report which summarises the results of all SMSRs in a single report. Subsidence reports completed over the reporting period in accordance with SMP requirements are listed below.

Table 25. Subsidence Reporting

Report	Report Period	Date Issued
2017 End of Year Report	2017 Calendar Year	14/3/2017
February 2018 Subsidence Management Status Report (SMSR)	1st November 2016 to 28th February 2017	22/3/2017
June 2018 Subsidence Management Status Report (SMSR)	1st March to 30th June 2018	31/7/2017
November 2017 Subsidence Management Status Report (SMSR)	1st July to 31st to October 2017	30/11/2018

The reports are distributed to numerous Departments, agencies and stakeholders including but not limited to; Sydney Catchment Authority, Office of Environment and Heritage, NSW Department of Primary Industries – Water, NSW Department of Industry – Division of Resources and Energy, Division of Resources and Mining, NSW Department of Planning & Environment - Central Coast Coordination and Resources Regulation Division, Division of Resources and Geoscience, NSW Dams Safety Committee, Boral, Endeavour Energy and Forestry Corporation of NSW. As such, the SMSR and End of Year Subsidence Management Report is only summarised here.

6.8.1. Subsidence Performance Measures

Development Approval DA504-00 defines the subsidence impact criteria in Schedule 3, Condition 1. These criteria have been presented in Table 26.

Table 26. Subsidence Impact Assessment Criteria

Level of Extraction	Subsidence	Tilt	Horizontal Strain (compressive and tensile)
First Workings	20mm	1.0mm/m	1.0mm/m
Partial Extraction	100mm	3.0mm/m	2.0mm/m

6.8.2. Relevant SMP Monitoring

The following subsidence monitoring was undertaken in 2018.

- Survey of surface subsidence monitoring lines
- Surface subsidence management inspections
- Underground roof monitoring (Tell-Tales)
- Underground geotechnical audits.
- Visual inspections of underground conditions and stability.
- Regular measurement of roadway widths and intersection heights
- Underground panel audits.
- Eight Geokon “4300BX” vibrating wire borehole stress cells (
- Anchor extensometers
- Two-monthly downloads and reporting of multi-level groundwater piezometers (CLRP1, CLRP2, CLRP3, CLRP6, CC114, CC115, CLRP11, CLRP12, CLRP13, CLRP14, CLRP15, CLRP16, CLRP19 and CLRP20) and open hole piezometers (CLRP4, CLRP5, CLRP7, CLRP8, CLRP10 and CC113).
- Post-mining inspection of powerlines.
- Quarterly surface inspections.
- Ongoing flora monitoring
- Ongoing fauna monitoring
- Underground panel audits.

6.8.3. Subsidence Performance Summary

During 2018, subsidence and environmental monitoring has been carried out generally in accordance with the relevant Subsidence, Infrastructure, Public Safety and Environmental Monitoring Programs required under the various SMP and HRA Notifications. Mining systems have been implemented as planned.

No subsidence impacts have been observed by the management of Clarence Colliery in the reporting period. No surface cracking has been detected and there has been no adverse impacts detected on surface water, upper aquifers, swamps, flora or fauna.

During the 2018 reporting period there has been no need for early response or emergency procedures to ensure adequate management of potential subsidence impacts.

7. WATER MANAGEMENT

Clarence holds a water access licences (WAL36479) permitting the extraction of groundwater from the coal measures encountered during the process of mining. The extraction bore entitles the Mine to extract an annual entitlement of 6,623 ML of groundwater for the period. This underground mine water is treated in the Water Treatment plant prior to be discharged at LDP002.

Table 27 identifies the water take under the water licences. It is important to note that Table 27 reports on the Financial year not the calendar year.

Table 27. Water Take

License #	Water Sharing Plan, source and management zone (as applicable)	Entitlement	Passive take / inflows	Active pumping	TOTAL
WAL36479	Sydney Basin Richmond Groundwater Source	6,623 ML	0	4843.3 ML	4843.3 ML

Between the January 2018 and October 2017 Lithgow City Council extracted approximately 996ML from Main Dam under 10WA103852.

7.1. Surface Water Monitoring

7.1.1. Surface Water Monitoring Results

There is an established surface water quality monitoring program for Clarence. Monitoring requirements adhere to the latest version of EPL 726 (November 2018). Surface water quality is required to be monitored at 5 locations as detailed in Table 28 and shown on Plans 4 and 5. Water quality is required to be monitored on a monthly basis (during discharge). The water is tested for a range of analytes however Schedule 3, Condition 4 Table 2 in DA504-00 only specify Water discharge concentration limits for two parameters, pH and Total Suspended Solids (TSS). EPL 726 however, specifies an additional 21 parameters that must be monitored with corresponding discharge concentration limits.

Table 28. Summary of Surface Water Monitoring Locations

Monitoring Point Reference	Description / Creek Catchment
LDP001	Discharge from the ventilation fan to Main Dam (not currently used).
LDP002	Discharge from the Water Treatment Plant via drainage channel to Main Dam. The Polishing Lagoon also discharges from this point however only after high rainfall events.
LDP003	Discharge from Leachate Dam 1 to Main Dam.
LDP004	Discharge from Leachate Dam 2 to the Wollangambe River downstream of Main Dam.
Point 9	Wollangambe River downstream of LDP002 (and main dam)

Of the 5 monitoring points, LDP01 is no longer used and no discharges have been required since 2014 at LDP03 or LDP04. Also the data from the reporting period can be compared to previous years from the tables below.

Table 29. Surface Water Quality: pH 2014-2018

Discharge point	2018			2017			2016	2015	2014	EPL Limit	Comments
	Min	Avg	Max	Min	Avg	Max	Avg	Avg	Avg		
LDP001	No discharges									6.0-8.5	No longer used
LDP002	7.4	8.24	8.9	6.2	7.4	8.4	7.4	7.08	7.2	6.0-8.5	
LDP003	No discharges									6.0-8.5	Only discharges during extreme weather events
LDP004	No discharges									6.0-8.5	Only discharges during extreme weather events

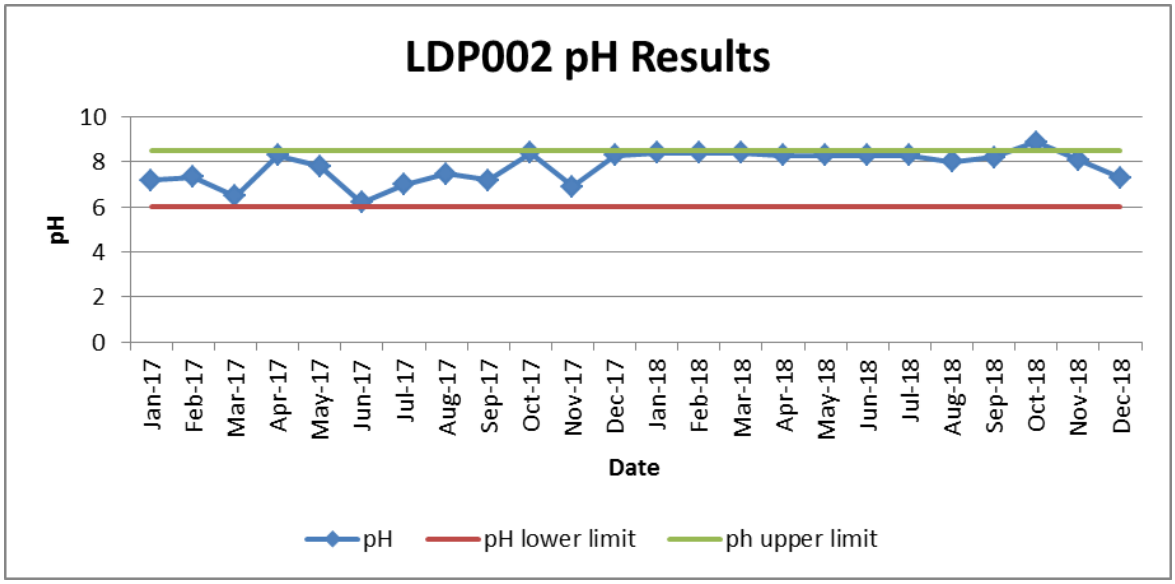


Figure 17. ***LDP002 pH 2018***

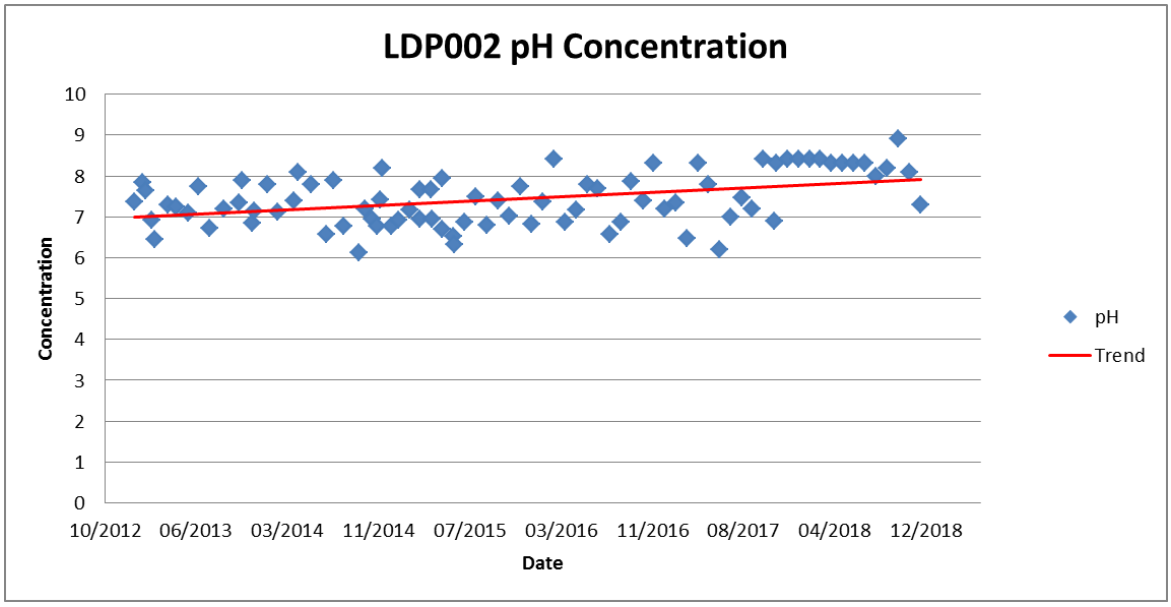


Figure 18. ***LDP002 pH Trends 2013 to 2018***

Figures 17 and 18 demonstrate that pH at LDP002 during 2018 is generally consistent with previous years data. This is a reflection of the operation of the WTP which has an output pH set point. Only one exceedance was recorded in the last reporting period due to a minor plant issue.

Table 30. Surface Water Quality: Total Suspended Solids 2014-2018

Discharge point	2018			2017			2016	2015	2014	EPL Limit	Comments
	Min	Avg	Max	Min	Avg	Max	Avg	Avg	Avg		
LDP001	No discharges									30	No longer used
LDP002	5	6	15	<5	5.4	10	<5	6.35	7.3	30	
LDP003	No discharges									30	No discharges
LDP004	No discharges									30	No discharges

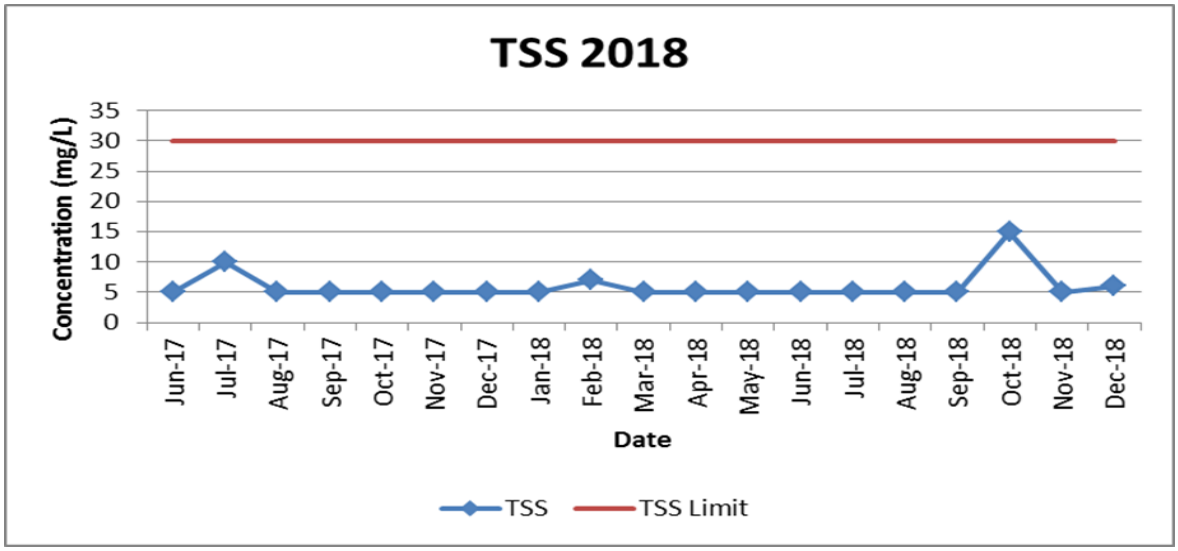


Figure 19. ***2013 to 2018 TSS Trends***

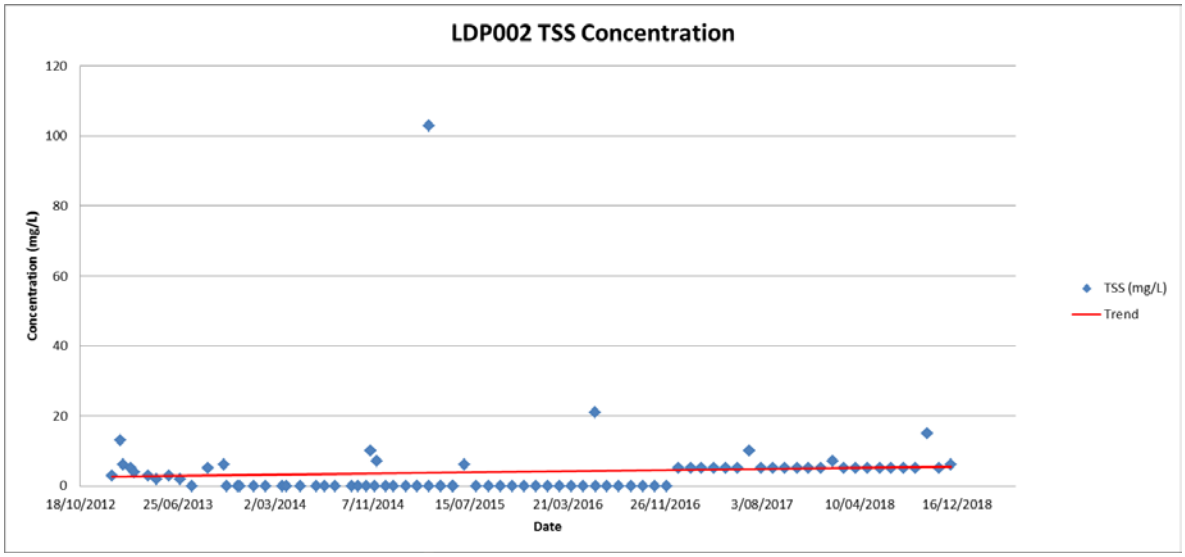


Figure 20. ***2013 to 2018 TSS Trends***

The TSS levels in LDP002 are generally at or below the detection limit (<LOR) which results in a relatively low TSS average in 2018 (6 mg/L). These results are consistent with previous years with all averages being less than 8mg/L (limit 30mg/L).

The average annual results for LDP002 are summarised in Table 33 as reported in the 2018 Annual Return. Graphs presented following the table provide a graphical comparison to the EPL Limits. Water quality results below detection limit have been graphed at the detection limit. Non-compliances are discussed in Section 11.

Table 31. LDP002 Water Quality

Pollutant	Unit of Measure	No. of Samples required by licence	No. of Samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL Limit
pH	pH units	12	12	7.30	8.24	8.90	6.0 - 8.5
Conductivity	microsiemens per centimetre	12	12	300	326	350	Monitor only
Sulfate	milligrams per litre	12	12	81	127	159	250
Fluoride	milligrams per litre	12	12	0.1	0.1083	0.2	1
Filterable iron	milligrams per litre	12	12	0.05	0.0508	0.06	0.3
Chloride	milligrams per litre	12	12	2	6.5	33	3
Arsenic (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001	0.013
Total suspended solids	milligrams per litre	12	12	5	6	15	30
Zinc (dissolved)	milligrams per litre	12	12	0.005	0.011	0.025	0.008
Boron	milligrams per litre	12	12	0.013	0.051	0.06	0.1
Cadmium (dissolved)	milligrams per litre	12	12	<0.0001	<0.0001	<0.0001	0.0002
Chromium (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001	0.001
Cobalt (dissolved)	milligrams per litre	12	12	0.001	0.0034	0.005	0.0025
Copper (dissolved)	milligrams per litre	12	12	0.001	0.0011	0.002	0.0014
Lead (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001	0.0034
Lithium (dissolved)	milligrams per litre	12	12	0.017	0.0187	0.022	0.1
Manganese (dissolved)	milligrams per litre	12	12	0.003	0.0237	0.052	0.5
Mercury (dissolved)	milligrams per litre	12	12	<0.00004	<0.00004	<0.00004	<0.00004
Nickel (dissolved)	milligrams per litre	12	12	0.005	0.010	0.014	0.008
Nitrogen (total)	milligrams per litre	12	12	<0.10	<0.10	<0.10	<0.1
Oil and Grease	milligrams per litre	12	12	5.00	5.08	6.00	<5
Phosphorus (total)	milligrams per litre	12	12	0.01	0.02	0.02	0.02
Selenium (total)	milligrams per litre	12	12	0.0002	0.00021	0.0003	0.005
Silver (dissolved)	milligrams per litre	12	12	<0.00001	<0.00001	<0.00001	0.00005

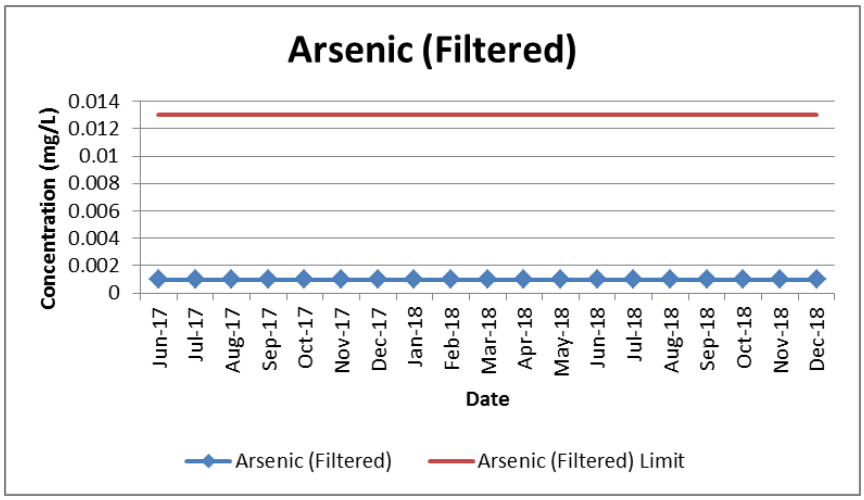


Figure 21. ***Arsenic June 2017- December 2018***

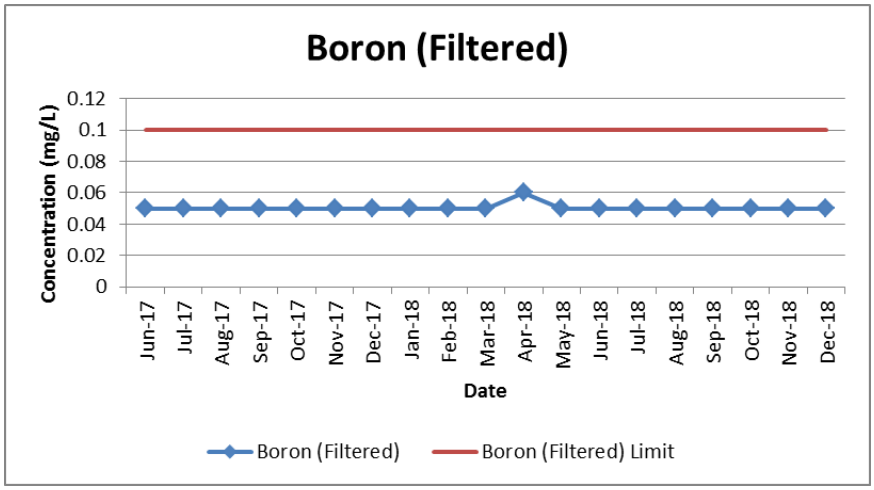


Figure 22. ***Boron June 2017- December 2018***

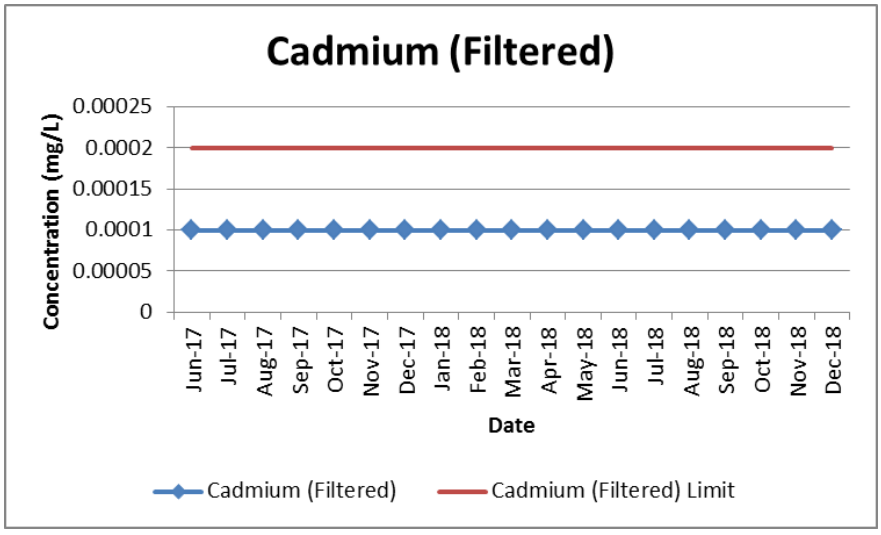


Figure 23. ***Cadmium June 2017- December 2018***

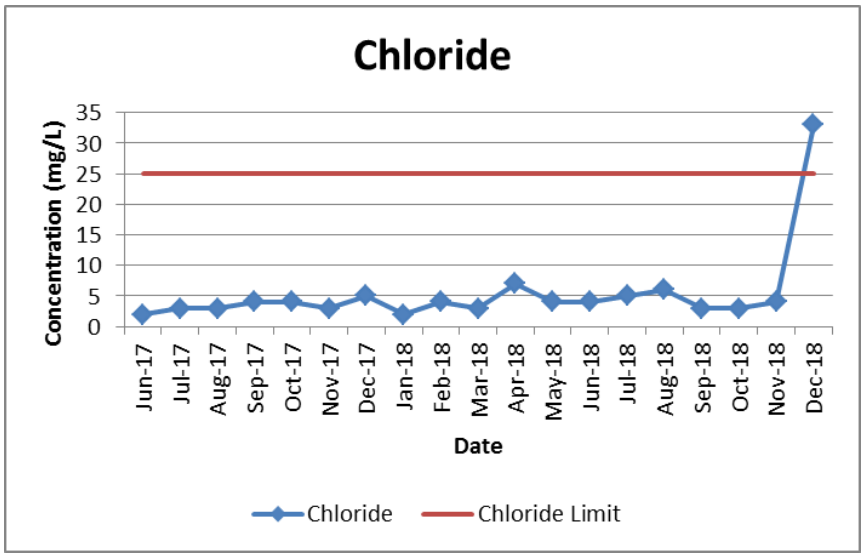


Figure 24. ***Chloride June 2017- December 2018***

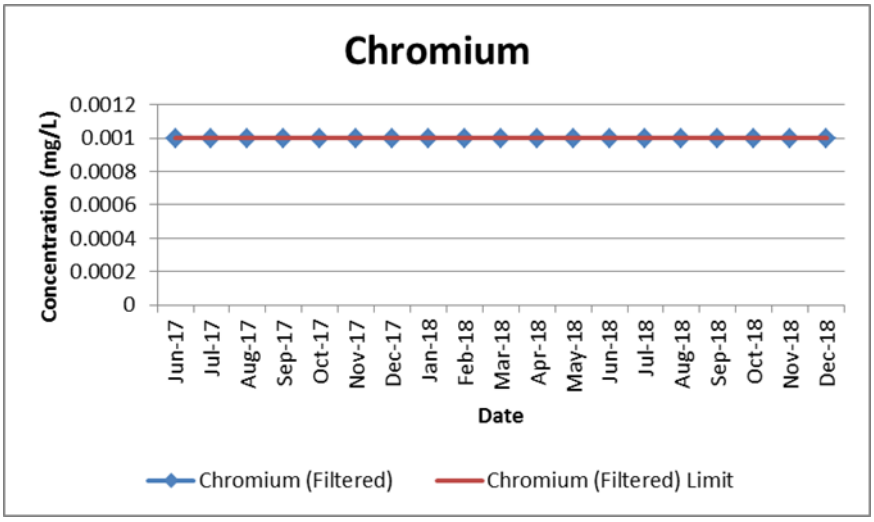


Figure 25. ***Chromium June 2017- December 2018***

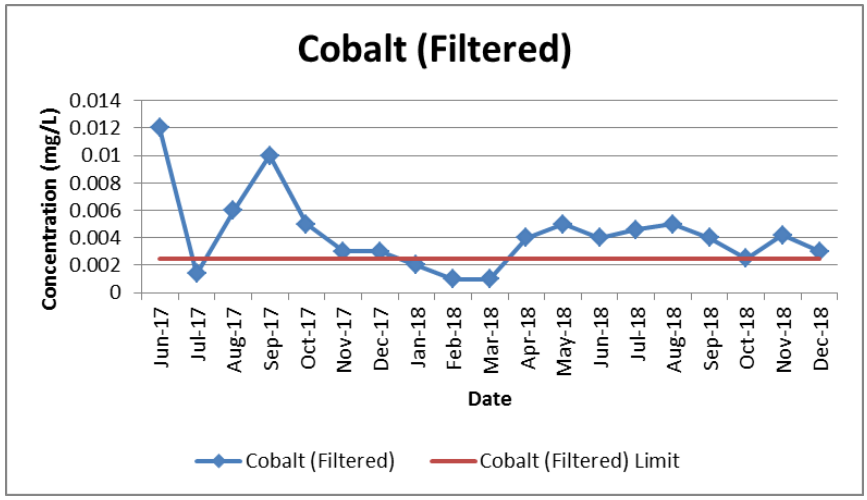


Figure 26. ***Cobalt June 2017- December 2018***

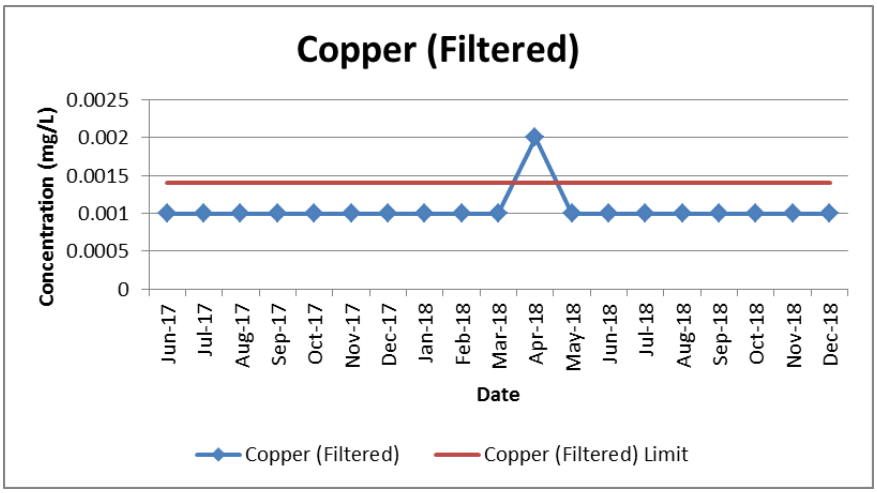


Figure 27. ***Copper June 2017- December 2018***

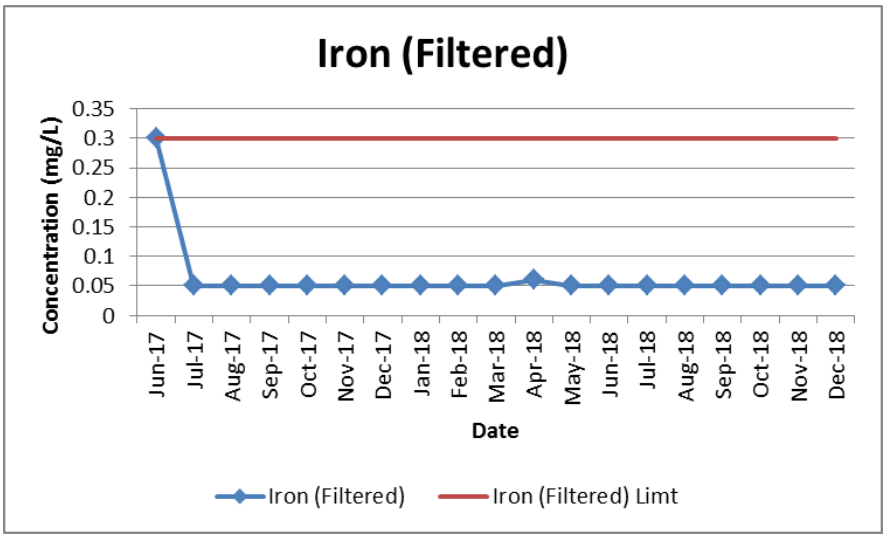


Figure 28. ***Iron June 2017- December 2018***

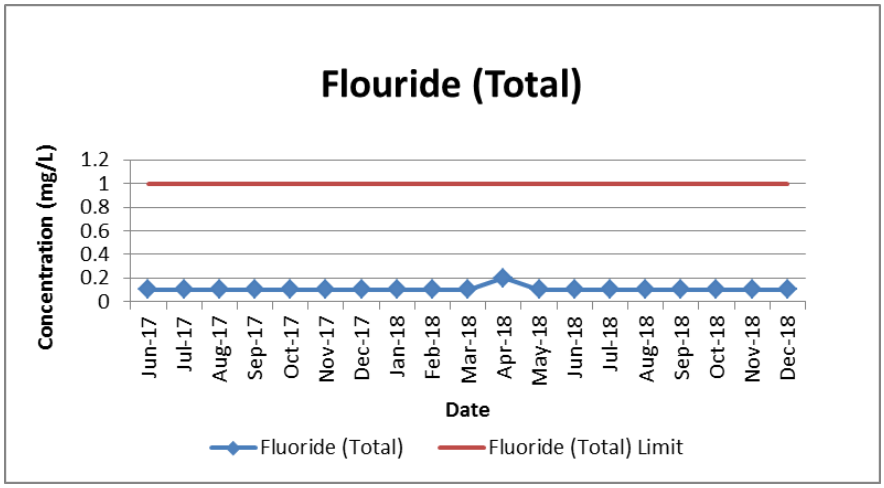


Figure 29. ***Fluoride June 2017- December 2018***

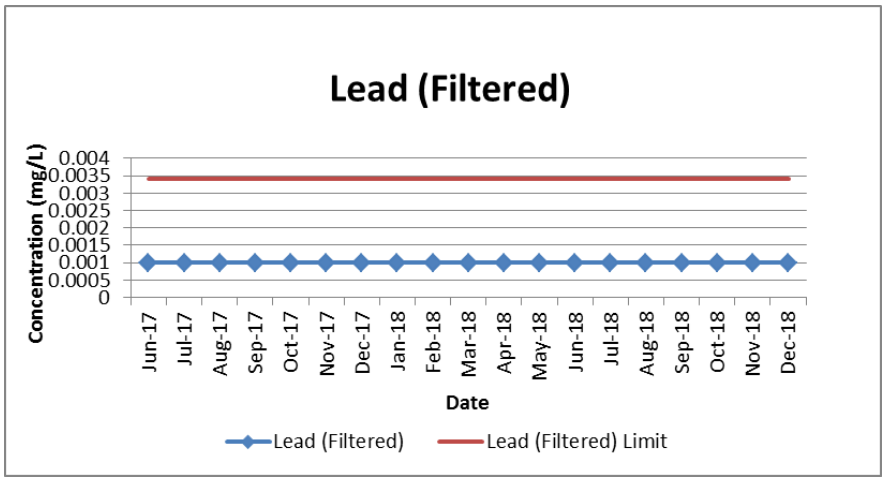


Figure 30. ***Lead June 2017- December 2018***

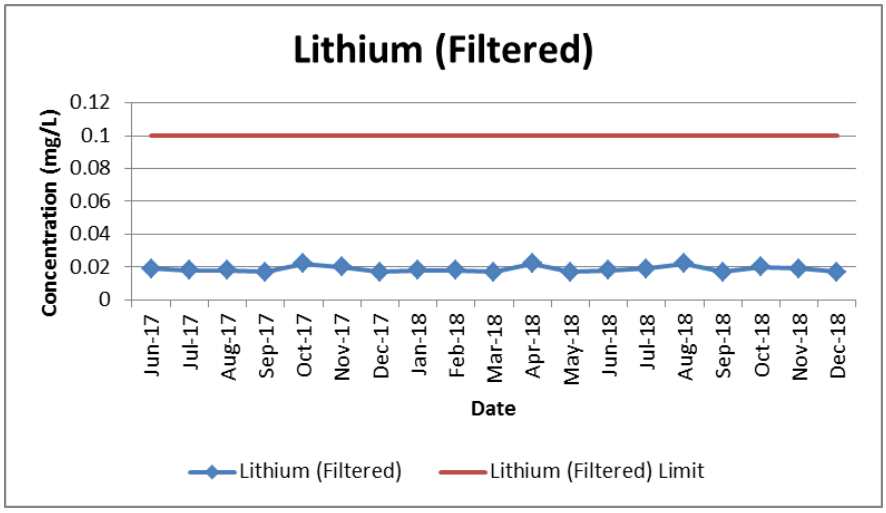


Figure 31. ***Lithium June 2017- December 2018***

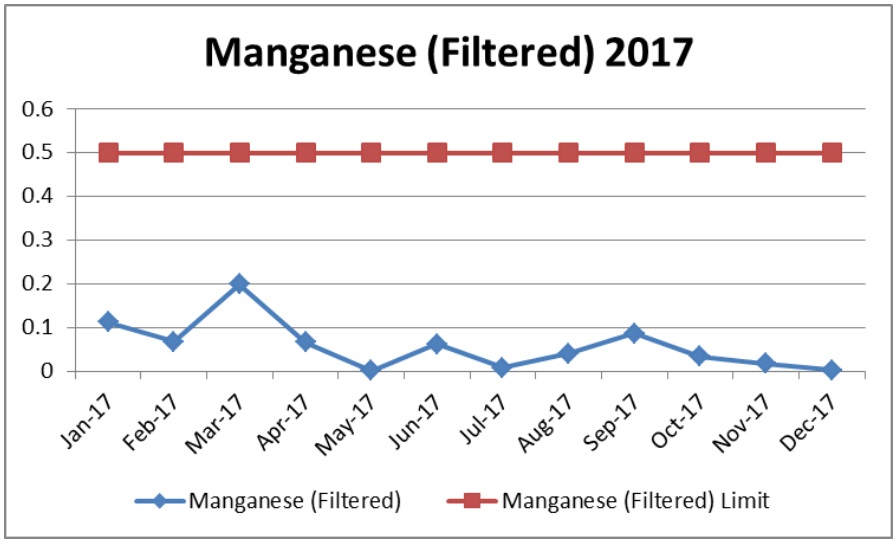


Figure 32. ***Manganese June 2017- December 2018***

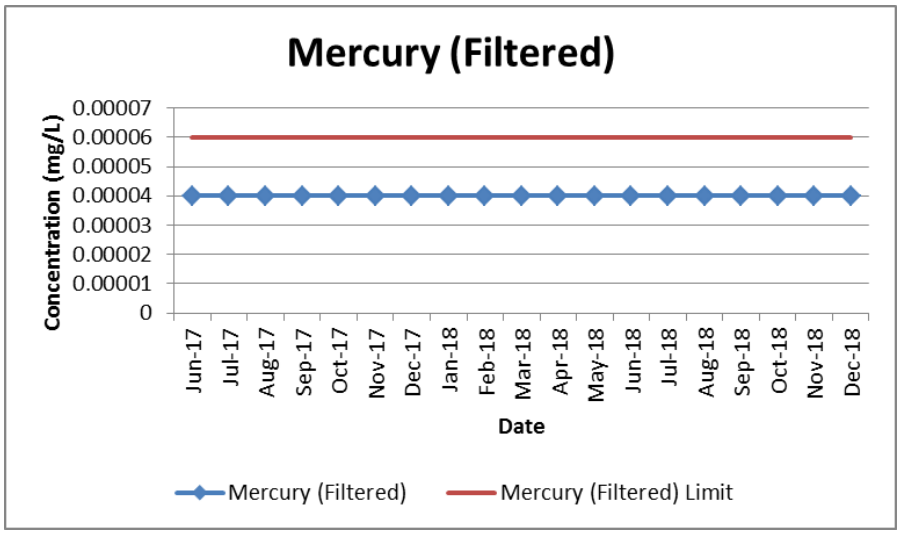


Figure 33. ***Mercury June 2017- December 2018***

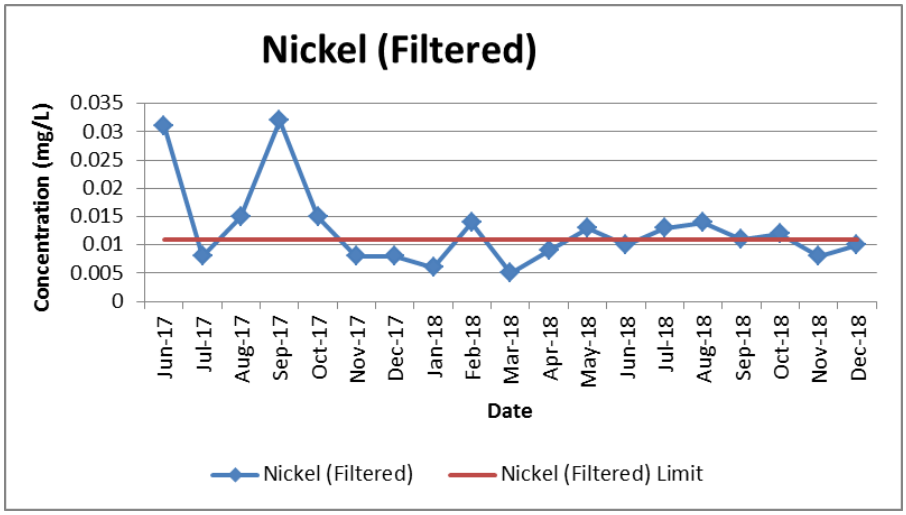


Figure 34. ***Nickel June 2017- December 2018***

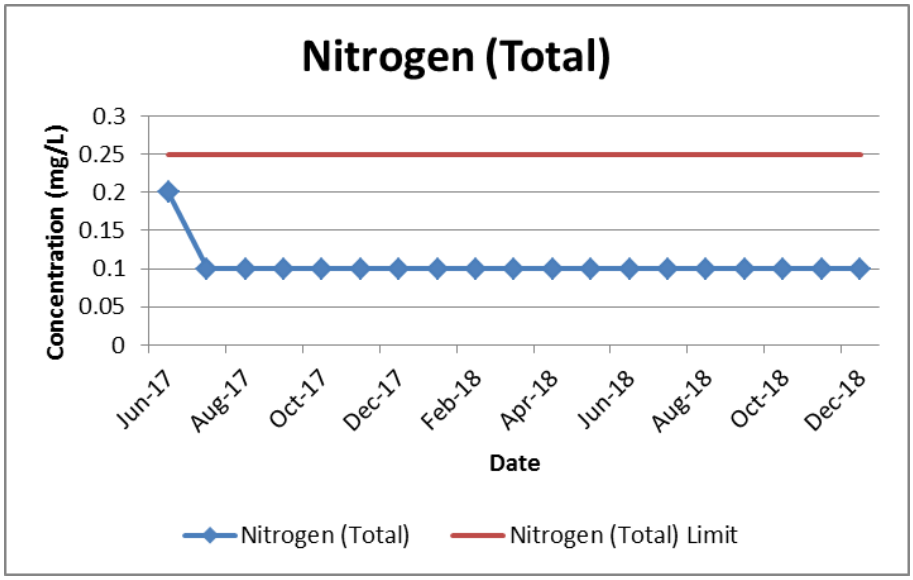


Figure 35. ***Nitrogen June 2017- December 2018***

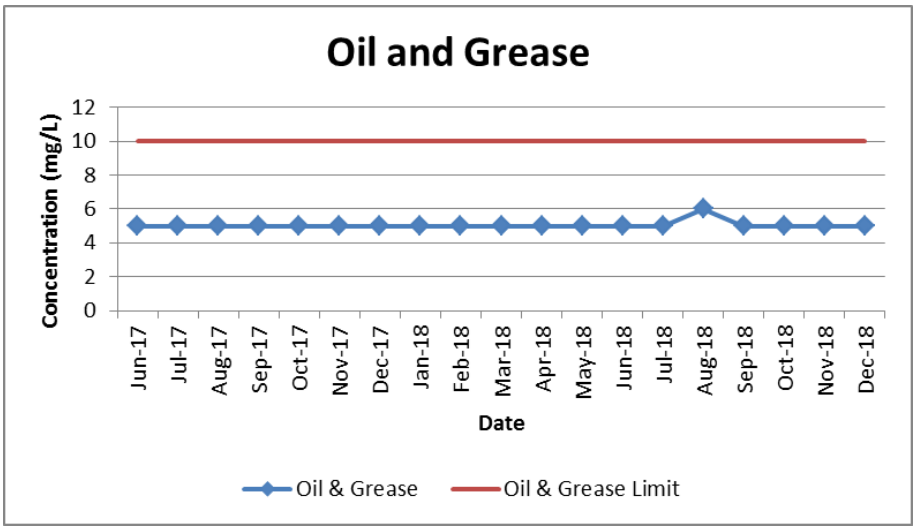


Figure 36. ***Oil and Grease June 2017- December 2018***

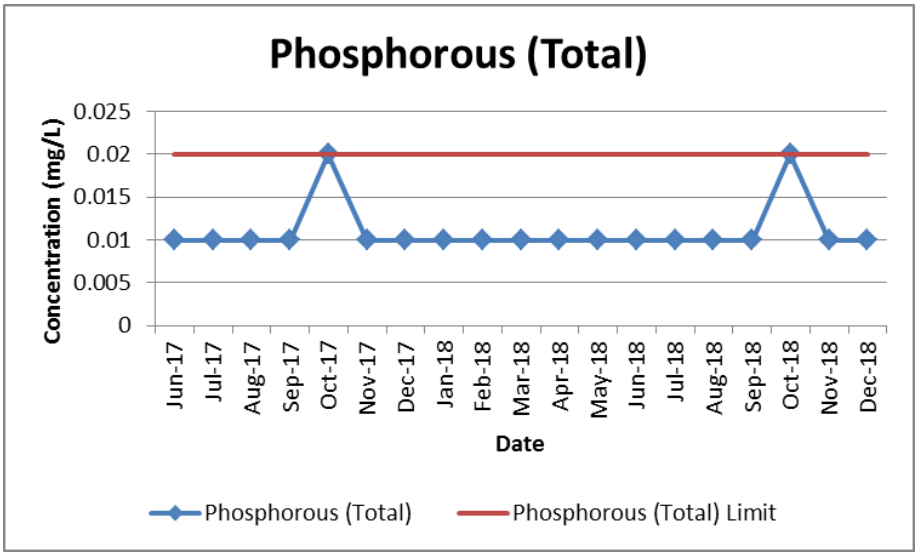


Figure 37. ***Phosphorus June 2017- December 2018***

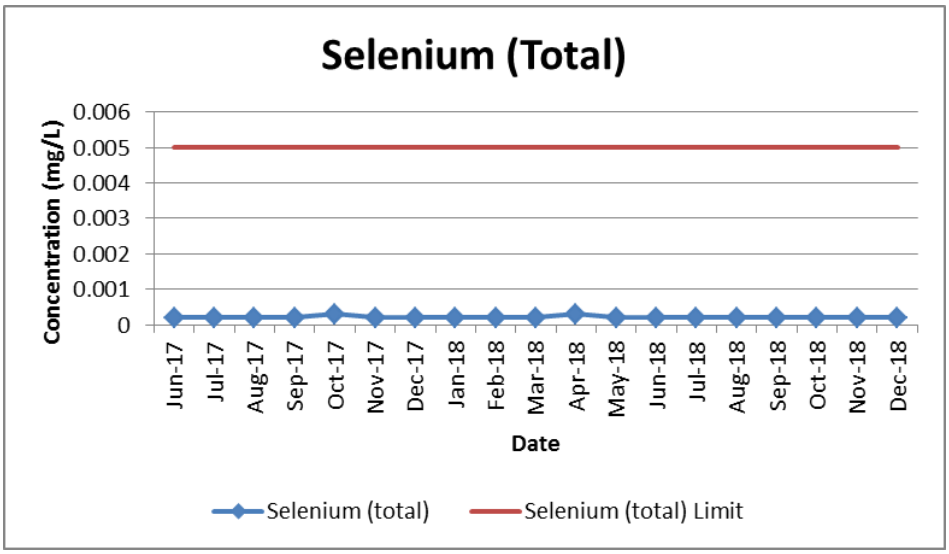


Figure 38. ***Selenium June 2017- December 2018***

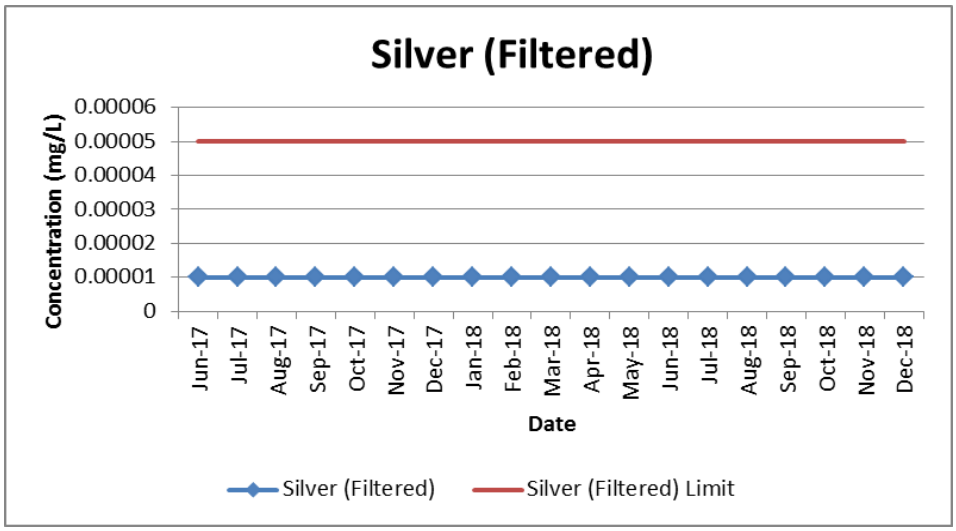


Figure 39. ***Silver June 2017- December 2018***

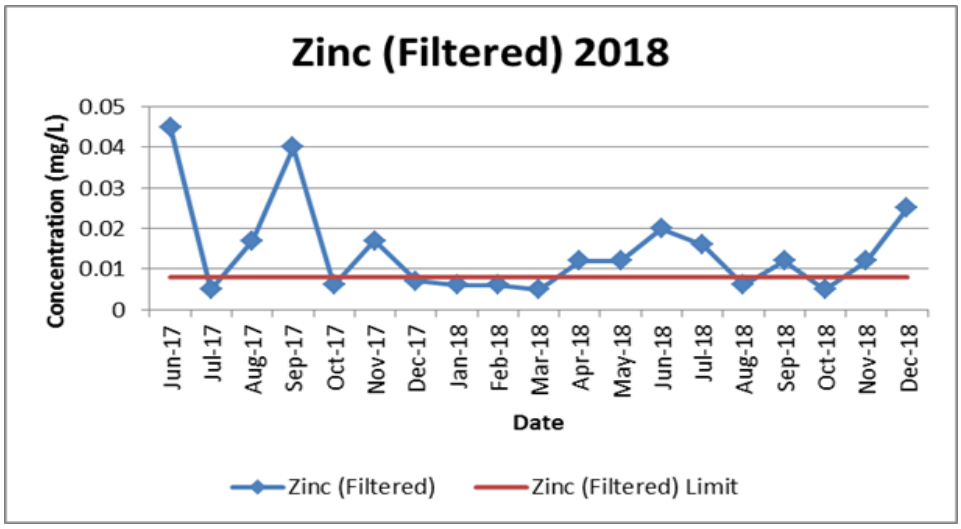


Figure 40. ***Zinc June 2017- December 2018***

The operation of the water treatment plant has been steady throughout 2018 with elemental trends being stable. Exceedances have been recorded for metals/metalloids and are further discussed in Section 11. While the exceedances have been observed for cobalt, nickel and zinc a general decreasing trend can be shown which reflects the modifications to the water treatment plant system which have been implemented by Clarence to address the non-compliances.

The 2000 EIS reflected the licence at the time of preparation and included limits for TSS, pH and oil grease. The predicted impact on water quality in the region will be neutral. These parameters were within the limits.

Point 9 Water Quality Monitoring

Point 9 is located downstream of LDP002 in the Wollangambe River. The requirement to undertake water quality monitoring at this point was introduced into EPL 726 in March 2017. The EPL sets out the parameters which must be monitored on a monthly basis which are the same analytes as LDP002 however as this is not a discharge point, there are no limits and the requirements are to monitor only. Table 34 summarises the results of the Water Quality Monitoring at Point 9 for 2018.

Table 32. Point 9 Water Quality

Pollutant	Unit of Measure	No. of Samples required by Licence	No. of Samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value
Arsenic (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001
Boron	milligrams per litre	12	12	<0.05	<0.05	<0.05
Cadmium (dissolved)	milligrams per litre	12	12	<0.0001	<0.0001	<0.0001
Chloride	milligrams per litre	12	12	2	6.1	31
Chromium (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001
Cobalt (dissolved)	milligrams per litre	12	12	0.002	0.0052	0.013
Conductivity	microsiemens per centimetre	12	12	227	326	399
Copper (dissolved)	milligrams per litre	12	12	<0.001	0.001	0.002
Filterable iron	milligrams per litre	12	12	<0.05	0.062	0.19
Fluoride	milligrams per litre	12	12	<0.1	<0.1	<0.1
Lead (dissolved)	milligrams per litre	12	12	<0.001	<0.001	<0.001
Lithium (dissolved)	milligrams per litre	12	12	0.015	0.019	0.022
Manganese (dissolved)	milligrams per litre	12	12	0.036	0.069	0.159
Mercury (dissolved)	milligrams per litre	12	12	<0.00004	<0.00004	<0.00004
Nickel (dissolved)	milligrams per litre	12	12	0.015	0.026	0.045
Nitrogen (total)	milligrams per litre	12	12	0.1	0.12	0.2
Oil and Grease	milligrams per litre	12	12	<5	5	5
pH	pH	12	12	5	7. 3	9.3
Phosphorus (total)	milligrams per litre	12	12	<0.01	0.013	0.05
Selenium (total)	milligrams per litre	12	12	<0.0002	<0.0002	<0.0002
Silver (dissolved)	milligrams per litre	12	12	<0.00001	<0.00001	<0.00001
Sulfate	milligrams per litre	12	12	80	121.3	144
Total suspended solids	milligrams per litre	12	12	5	6.25	20
Zinc (dissolved)	milligrams per litre	12	12	0.021	0.040	0.054

LDP002 Discharge Volumes

The volume of Water discharged is required to be monitored daily at the licenced discharge points in accordance with EPL 726. Table 33 provides the discharge volume results for the Annual Review period.

Table 33. LDP Discharge Volumes

Discharge Point	Frequency of Monitoring	No. of Measurements made	Lowest result (kL)	Mean result (kL)	Highest result (kL)	EPL Limit (kL/day)	Comments
LDP001	Daily During Discharge	0	0	0	0	No limit applied	LDP001 no longer used
LDP002	Daily During Discharge	365	0	12,482	19,646	25,000	Measured constantly
LDP003	Daily During Discharge	0	0	0	0	No limit applied	No discharges prior to 2014
LDP004	Daily During Discharge	0	0	0	0	No limit applied	No discharges prior to 2014

The 2000 EIS reflects the licence requirements at the time of preparation. 18ML per day with average discharge of 14ML was described. Additionally the EIS did not predict the volume of water pumped from the underground workings will decrease or increase. The average result obtained throughout the 2018 reporting period is consistent but slightly lower than this prediction (12.5ML).

7.2. Water Balance

Section 5.8 of the Clarence Water Management Plan provides details of the water balance for the sites. The following schematic provides an overview.

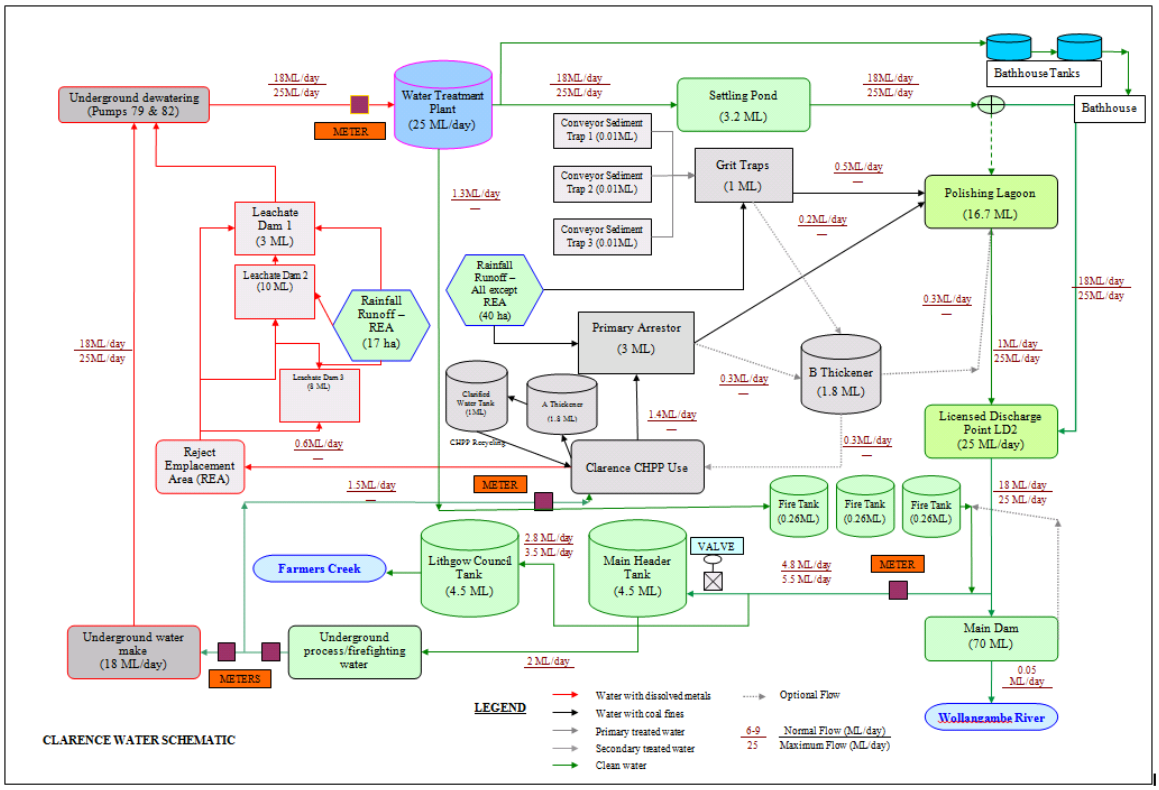


Figure 41. *Clarence Water Schematic*

The following sections provide a brief summary of the water management process at Clarence. Additional detail is available in the Water Management Plan located on the Centennial Coal website.

Extraction and Dewatering

- Dewater underground workings via boreholes;
- All underground water is fed directly into the Water Treatment Plant for removal of dissolved metals and pH adjustment if required; and
- A small portion of water is added to the underground sump from Leachate Dam 1.

Transfer

- Leachate water and surface water runoff from the REAs is transferred to Leachate Dam 1 (REA I, REA III), Leachate Dam 2 (REA II, REA IV) or Leachate Dam 3 (REA VI). Water from the Leachate Dams is released underground (gravity fed) into the underground into underground water storages.
- Surface water runoff from all areas other than the REA passes through a series of control structures prior to collection in the Polishing Lagoon. From the Polishing Lagoon, water is pumped to the WTP for treatment or directed into Leachate Dam and returned underground to the mine water storage.
- All water released off site through LDP002, LDP003 or LDP004 is collected in the Main Dam located on the Wollangambe River. Water from the Main Dam is pumped to the Main Header Tanks for use as process water (e.g. underground process water, washery make-up water) and as a permanent supply of water for firefighting purposes. It is however important to note that no releases from LDP003 or LDP004 have occurred since before 2014.
- The CHPP receives up to approximately 2.5 ML/day (typically 1.5 ML/day) of process water from the Main Header Tank (recycled from the Main Dam).
- Treated water is also used by Lithgow City Council to supplement the Farmers Creek Reservoirs and then treated for Councils mains water. During the extended drought period in 2018 this water was essential for the community.

Discharge Off-site

- Treated underground water plus all surface water runoff is released off-site through LDP002.

The following table provides for the annual recalculation of the water balance as compared to the prediction in the Water Management Plan.

Table 34. Water Balance 2018

Component	Normal Flow (ML/Day)	Actual Average Flow (ML/Day) in 2018
Underground water make	18	14.4
Discharge from LDP002	18	12.5
Discharge from LDP003	Only during large rainfall events	0
Discharge from LDP004	Only during large rainfall events	0
Underground Inflow	Not Specified- Rea Runoff 0.6ML	0.7
Supply to Lithgow City Council	2.8	0.4[#]
CHP Use	1.4	0.5
Underground process/fire fighting water/surface use*	2	1.9

*Main Dam Flow to Fire Tanks

[#]Average calculated for entire year (not transfer peiod described in Section 7)

7.3. Water Management Plan Review

As required under Schedule 3, Condition 12, the following provides a review of the Water Management Plan.

General comments:

- The system described continues to operate at Clarence.

Erosion and Sediment Control Plan:

- The management measures described in the Erosion and Sediment Control Plan continue to be adopted at Clarence Colliery. The water management system is supported by a maintenance program to operate effectively. This is demonstrated by the sites low TSS levels in discharges
- There are no outstanding areas requiring rehabilitation.
- Subsidence levels observed continue to be within predictions not posing any additional sediment control risk.

Surface Water Monitoring Program:

- Since the revisions of the EPL in 2017 monitoring requirements have changed at Clarence Colliery.

Groundwater Monitoring Program:

- The described monitoring program continues to be undertaken by Clarence Colliery.

Surface and Groundwater Response Plan:

- The surface water monitoring trigger action response plan has been reviewed and is being implemented by Clarence.
- There were no triggers for swamp piezometers during the reporting period.

A revised Water Management Plan has been prepared by Clarence Colliery and was submitted for consultation in Quarter 2 2017 to contemporise the document to reflect more modern approval and licencing requirements. Following submission of the document a detailed clean water diversion project was commenced which continues into 2019. The project is to improve the capture and diversion of clean water through the site and will necessitate a full review of the water balance. Additional surveys of water management structure sizing were also undertaken to facilitate this review. The Water Management Plan will therefore have a complete review and incorporate these findings.

7.4. Groundwater Monitoring

Groundwater monitoring sites and the relevant SMP area are outlined in **Table 37**. A summary of results is presented herein.

Table 35. Groundwater Piezometers at Clarence

Piezometer	Installed	Area
CLRP1	2004	Eastern Area SMP, within 330 Area
CLRP2	2004	Eastern Area SMP, above 611E panel
CLRP3	2006	Eastern Area SMP, above 612 panel
CLRP4	2008	South of mining areas
CLRP5	2008	700 Area SMP, north of 700 area panels
CLRP6	2008	700 Area SMP, above 702/704 panels
CLRP7	2008	700 Area SMP, south of 700 area panels
CLRP10	2008	700 Area SMP, above 706 panel
CC113	2008	700 Area SMP, south of 700 area panels
CLRP8	Existing bore	Clarence Township. Piezo installed 2009
CC114	2009	800 Area SMP Application Area
CC115	2009	800 Area SMP Application Area

Piezometer	Installed	Area
HV1	2009	Happy Valley Swamp (700 Area SMP)
HV2	2009	Happy Valley Swamp (700 Area SMP)
HVU1	2009	Happy Valley Upper Swamp (700 Area SMP)
HVU2	2009	Happy Valley Upper Swamp (700 Area SMP)
CLRP11	2010	700 West SMP Application Area
CLRP12	2010	700 West SMP Application Area
CLRP13	2010	800 Area SMP Application Area
CLRP14	2011	800 Area SMP Application Area
CLRP15	2011	Lithgow No.2 Dam
CLRP16	2011	Lithgow No.2 Dam
CLRP17	2013	800 Area SMP Application Area
CLRP18	2014	900 Area SMP Application Area
CLRP19	2013	800 Area SMP Application Area
CLRP22	2014	900 Area SMP Application Area

All sites are downloaded every 2 months. Following download, data is analysed for any trends or potential mining related impacts and presented in in the Subsidence Management Status Report (SMSR) submitted to numerous stakeholders every 4 months. At the time of the preparation of the Annual Review the latest SMSR report was submitted in November – summarising the results until 31st October 2018.

7.4.1. Open Hole Piezometers

CLRP4, CLRP5, CLRP7, CLRP8 and CLRP10

The piezometers continued the broadly level trends they have showed over time. Groundwater levels in all of these Peizometers declined slightly from historically high levels which were related to the wetter conditions between late 2010 and early 2013. Minor noisy data and distinct small negative spikes in the record for CLRP8, in Clarence Village, appear to be related to localised pumping of groundwater for domestic use. CLRP7 also shows sporadic spikes related to groundwater sampling.

Extraction aprox 150 m east of CLRP10, commenced in April 2009 and this piezometer was directly undermined by panel 706 (1st workings only) in September 2011 and continued in the 700 area until January 2014.To date there is no evidence of any mining-related impacts on any of these piezometers, based on the continuing uniform results of the piezometers. The results from these piezometers are presented below.

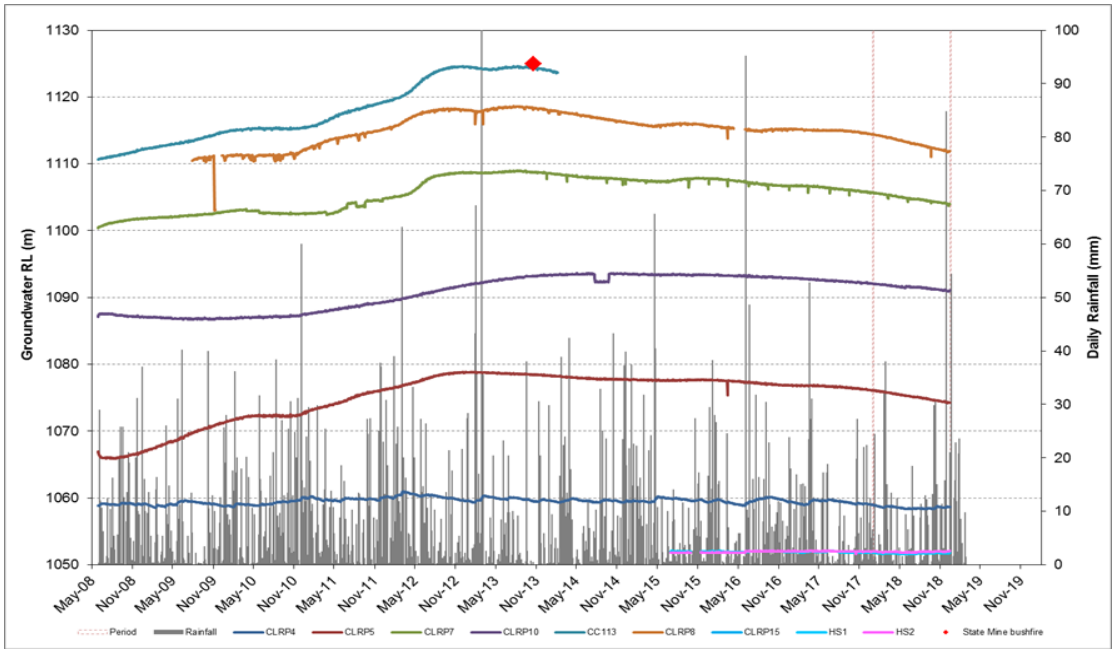


Figure 42. ***Open Hole Piezometer Results.***

7.4.2. Multi-level Piezometers

Only piezometers that are being monitored post mining or in the close vicinity of mining activities are reported. Long term background monitoring (in the northern 900 Area for example) are not reported.

CLRP1

All piezometers within CLRP1 continue to record data (**Figure 47**).

Most trends observed previously continued in the 2018, and there are no indications of any abnormal trends in the available data.

Pillar removal was carried out in Panel 330 immediately to the north of this bore in late 2004. This resulted in a significant depressurisation of the Katoomba seam, as measured by piezometer 1. In December 2013, first workings in panel 803 were developed over 10km to the east. There was no evidence of any permanent mining-related impacts in the three piezometers higher up in the bore (including the two in the Banks Wall Sandstone), although piezometer 2 just above the roof of the seam did show partial depressurisation followed by near-complete recovery. Since that time there have been no further indications from the data recorded to the present of any mining-related impacts. Pillar extraction occurred in Panel 803 during July 2014, with no apparent impact. Pressures recorded in the two Banks Wall Sandstone piezometers remained above pre-mining levels. Mining occurred in the 800 area in May 2018, 2½ km east of the hole, with no discernible impact on groundwater pressures.

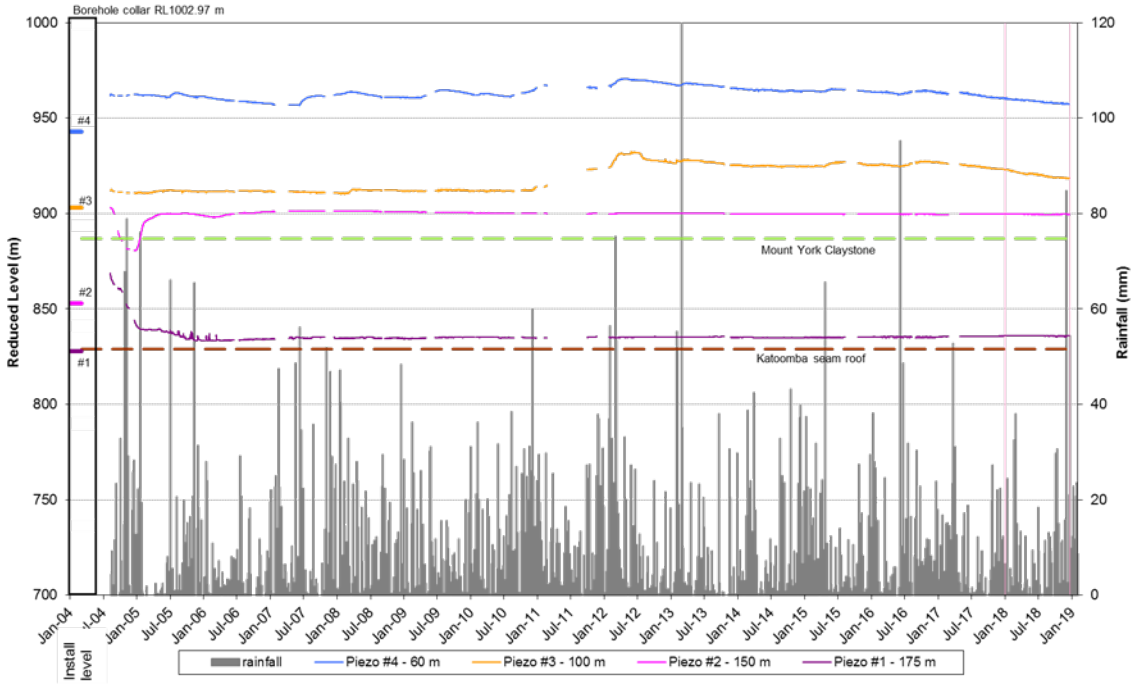


Figure 43. ***CLRP 1 Piezometer Data.***

CLRP2

The previous groundwater level trend, established over many years, has continued in piezometers 2 and 3 **(Figure 44).** These two instruments show very similar trends, suggesting that they are in close hydrogeological continuity. The very slowly rising trend observed in Piezo 4 since early 2015 previously levelled off to a constant pressure trend, and then started declining very slowly. All pressures in the operating piezometers remained above pre-mining levels. During the period, first workings occurred in the 800 area, 6 km south of the piezometer, and in the 900 area, 4 km to the southwest. Total depressurisation occurred in piezometer 1 in the coal seam in August 2007 after mining below the borehole, as would be expected. The other three piezometers continue to show no negative impact from mining.

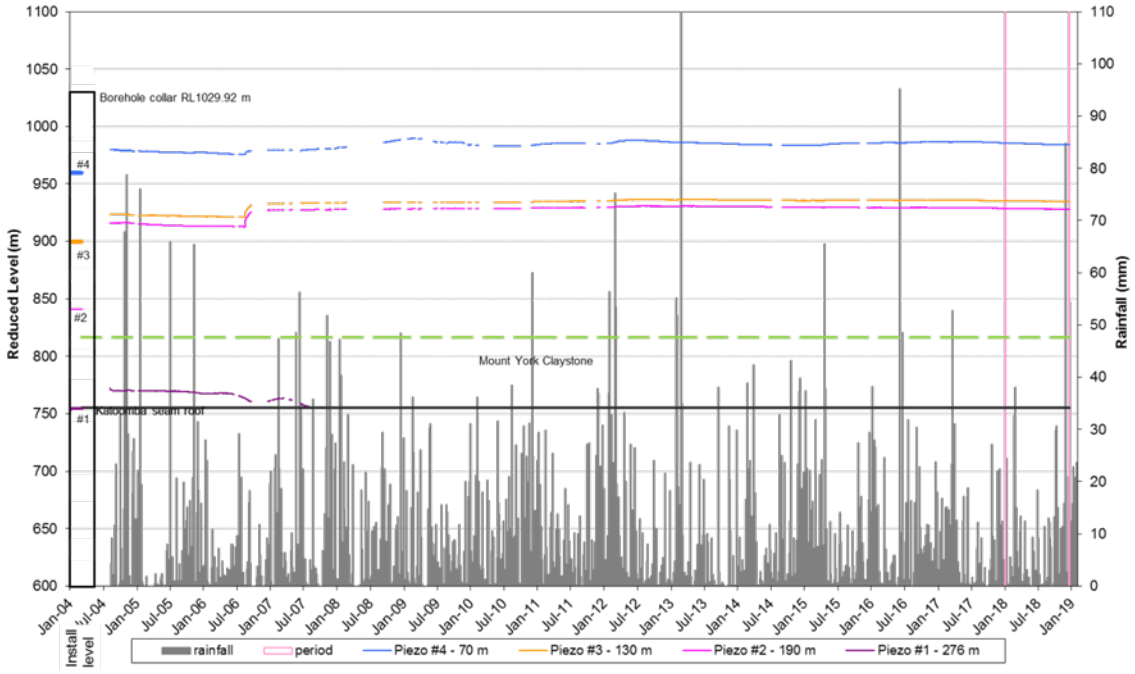


Figure 44. ***CLRP 2 Piezometer Data.***

CLRP3

The data show a continuation of the level, steady trends recorded previously. During 2018, first workings and pillar extraction occurred in the 800 area, 4 km south of the piezometer; first workings and pillar extraction occurred in the 900 area, 4 km to the west. This borehole was undermined shortly after it was installed in 2006, with no mining-related impacts evident in the. (**Figure 45**).

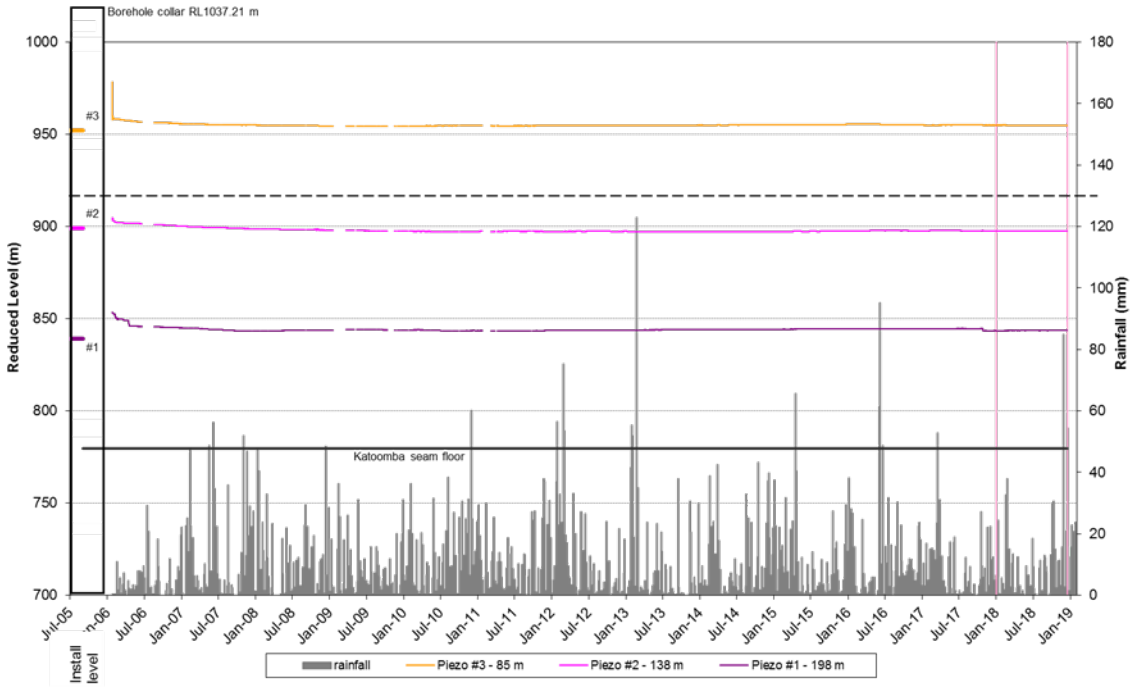


Figure 45. ***CLRP 3 Results.***

CLRP15

Consitent vibrating wire piezometer data are only available up to 20 December 2016 after which it was damaged by a lighting strike and subsequently repaired however the data is is sporbadidic until February 2018. A single datum was recorded from each of piezometers 1, 2, and 4, when the installation was serviced on 15 May 2018.

While the dataset is not considered entirely reliable, variations observed may be due to instrumental problems, or possibly adjustments in the grout envelope. The behaviour is unrelated to mining activity, given the distance to mining, nature of mining.

In addition to the multilevel piezometer array, a conventional aquifer piezometer was installed in an open hole at the same site. The data showed a constant groundwater level, just above the FSL of Lithgow # 2 Dam, until mid-June 2014. At that time the data suddenly showed a rise in water level of some 20 m, followed by continued flat trends at the new level, through to the current period. The reason for the change in pressure remains unclear, although caving into the hole is suspected. Two separate slug tests showed no impact on the water level, indicating the presence of substantial, water-charged voids at depth, with an effectively infinite capacity; this is consistent with caving. However, the level trends, both before and after the baseline reset, are consistent, and suggest that the water level in this hole is controlled by the water in the reservoir, with flow towards the reservoir.

Since CLRP15 is located between the reservoir and the mine workings, the presence of a flow direction towards the dam is significant. This situation represents the normal pre-mining hydrogeological regime, and indicates that mining has had no impact on the groundwater regime between the dam and the mine workings.The period when mining occurred within the DSC Notification Area around Lithgow # 2 Dam is shown by a horizontal purple line. First workings in 707 panel were about 250 m east of the borehole at the end of July 2012, and continued in the local area until September 2013. The previous and current level trends and evidence of flow towards the reservoir indicate that there is no recognisable impact from mining. Results presented in **Figure 46** also includes the data from the open hole piezometer (shown in light blue) situated next to the multi-level piezometer.

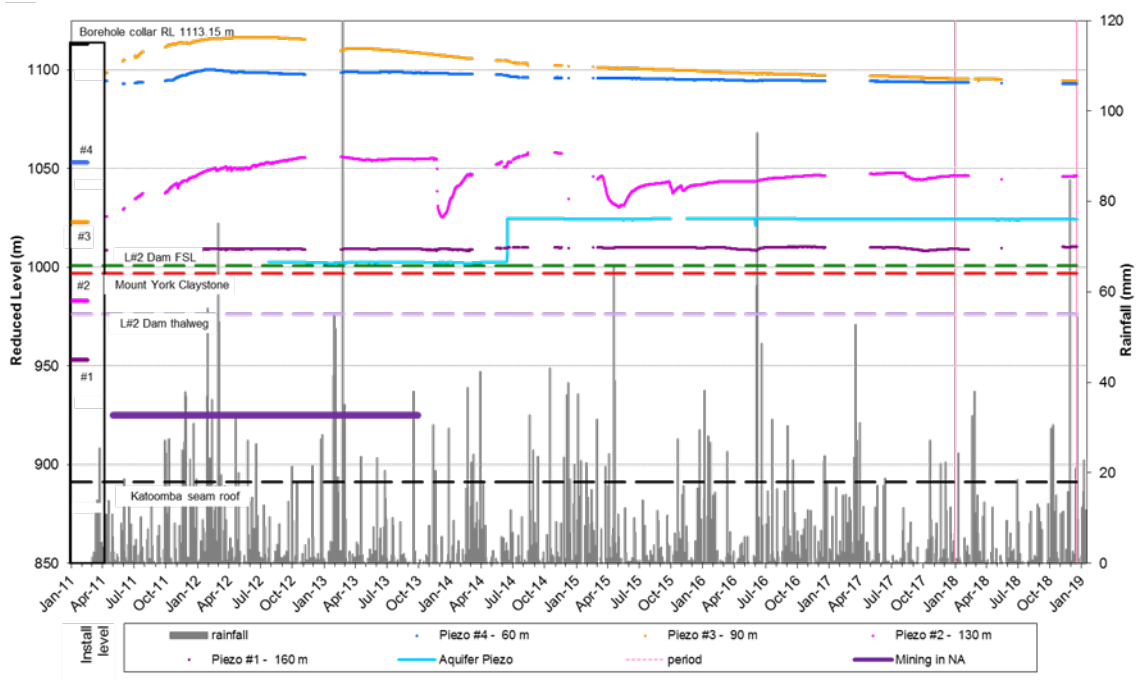


Figure 46. ***CLRP 15 Results.***

CLRP16

Piezo 2, located just above the level of the reservoir thalweg at the dam, shows a broadly level pressure trend over time, and generally lies at about the dam full supply level. Piezometer 1, located in the cover sequence approximately 35 m above the level of the mine workings, showed a slowly declining trend in recent periods, following a more complex trend. The head measured by piezometer 1 remains well above the values seen in the overlying piezometer. The discrepancy between the absolute values may possibly be explained by the piezometer's location adjacent to a significant topographic scarp, as has been observed in piezometers at CLRP3 and CC114.The overall pressure trend does not appear to be natural, and it is possible that there are instrumental effects in these data. As borehole CLRP15 is closer to the workings, and has not shown this effect, it is highly unlikely to be due to mining impacts.

The period when mining occurred within the DSC Notification Area around Lithgow # 2 Dam is shown by a horizontal purple line. Pillar extraction in 716 panel was more than 1 km northeast of the borehole in August – September 2013. Pillar extraction in 700 Panel occurred over 1.8 km m the east during March 2014. Mining in the 900 area during the current period was over 5 km to the north. There is no evidence of mining impact in the groundwater record. Results from the piezometer are presented in **Figure 47.** The solid purple line indicates when mining within the Lithgow No.2 Dam Notification Area took place.

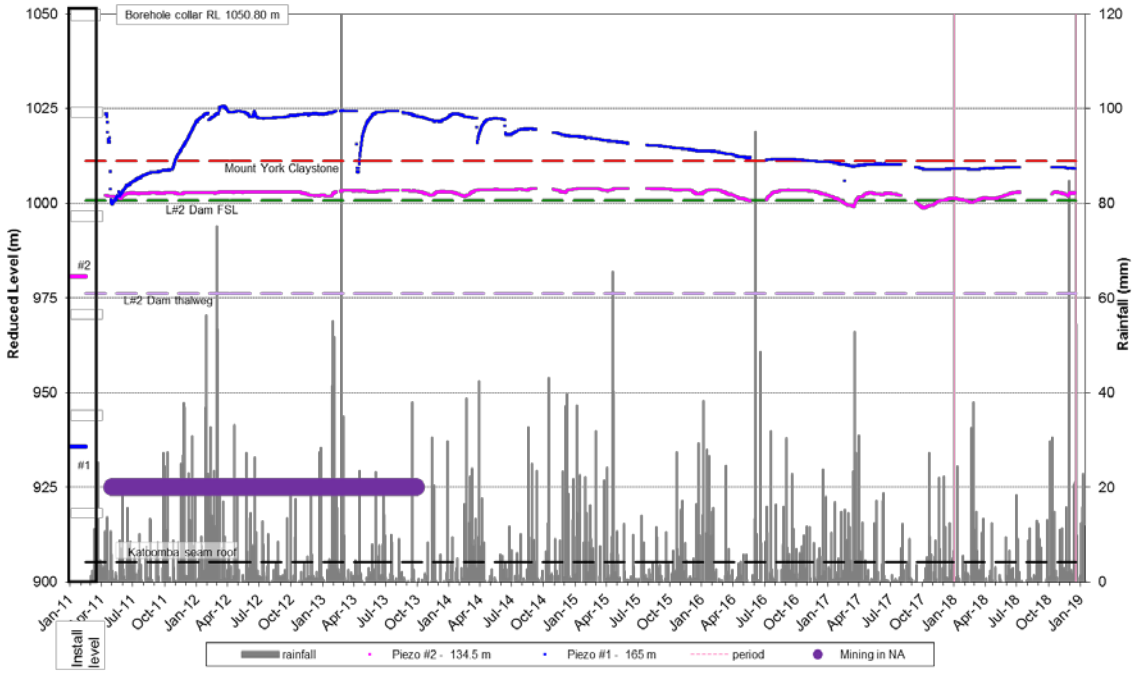


Figure 47. ***CLRP* 16 *Results.***

CC114

Previous trends continued in all piezometers. Piezo 4 has drifted between slightly positive and negative pore pressures and currently shows negative values. Negative pressures indicate that the piezometer is dry, which had previously been ascribed to lower-than-average rainfall. However, it is likely the topographic location of this installation, analogous to CLRP3, situated on the edge of the deeply-incised Wollangambe Creek gorge. The elevated, exposed nature of the upper section may allow easy drainage of groundwater. Piezometer 3 has previously displayed variable data, in which high frequency variations are superimposed on a more slowly changing trend. The lower frequency trend more closely resembles that seen in piezometer 4. It may be that the Piezometer 3 reflects the actual groundwater pressure head, with some instrumental anomalies superimposed on it. The topographically induced depressurisation of piezo 4

results in the pressure head in 3 lying above that in 4 for most of the record. In December 2017, piezometer 3 pressures declined below piezometer 4 for the first time since June 2009. The local topographic base level lies at c. RL 960 m, defined by the thalweg of adjacent stream lines, which is between the installation depths for Piezometers 3 and 4. As well, there may be some degree of isolation between Piezometers 3 and 4, with an aquiclude present between them due to the claystone unit between the two instruments noted in the geological log. There are no abnormal trends in the available data. During the period, first workings and pillar extraction occurred in the 800 area, 2 km to the east. There is no indication of mining impact. Results for CC114 are shown in **Figure 48**.

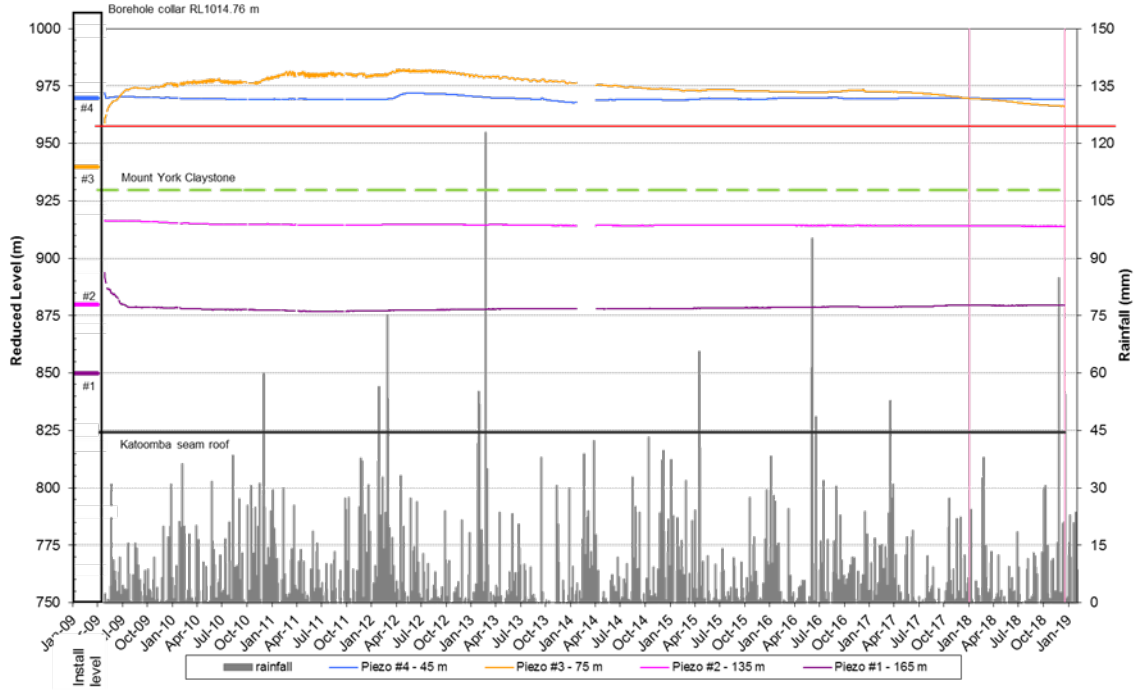


Figure 48. ***CC114 Results.***

CC115

CC115 was damaged by bushfire, and consequently data were temporarily lost after October 2013. The installation was repaired on 23 March 2014. The repairs included an upgrade of data logger to a Campbell Scientific model. Coherent data are available for piezometer 1 up to 24 February 2017, after which the data are corrupt. This may be problem with the data logger or the vibrating wire piezometer. A service visit on 15 May 2018 identified that the multiplexer module needs to be replaced. This should be followed up by a further service. In the current period, data are available for the three active channels up to 4 October 2018.

Trends in the available data are broadly consistent with those seen previously, although at lower absolute levels than before the new data logger was installed. The difference in pressure heads are 30 – 50 m, which is highly unlikely to be a real groundwater phenomenon. The most likely reason is a calibration difference between the old and new data loggers. All piezometers showed trends consistent with previous behaviour.

Piezometer 1 is located c. 13 m above the Katoomba seam working horizon. Previous data showed steady pressure trends throughout almost the entire data record, but suddenly declined asymptotically by 11 m after reconnection. The steep decline seen in previous data slowed to an asymptotic curve, which levelled off, before commencing a slowly rising trend, which again levelled off before the piezometer stopped recording. Piezometers 2, 3, and 4 showed broadly level trends. Piezometers 2 and 3 continue to show very similar pressures, suggesting that the piezometers may be hydro geologically connected. During the period, 2, 3, and 4 showed generally level trends; the variations are within the range of movements seen previously. Persistent negative values in piezometer 4 are unlikely to indicate a dry hole; instead, they are almost certainly an artefact of the reduction in pressures resulting from the change of data logger. All

piezometers show very minor perturbations in trend in late May 2016. These consist of drops in pressure head of a few meters over this time, followed by recovery. The perturbations coincide with mining directly under the site (see below). There are no indications of any abnormal effects in the data, indicated by the consistent trends in these records, and subject to the comments above about calibration.

In late May 2016, the borehole was directly undermined in Panel 812. The small but distinct drop and recovery in the piezometers are mining impacts. It is notable that pressure has totally or partially recovered in each piezometer. No instruments showed a drop to negative values, and the upper strata has not been affected by development of a permeability connection to the workings. The movements are mining-induced, and according to expectations. They have not had a significant or permanent impact on the groundwater system. Piezometer 1, which lies closest to the mining horizon, has shown slowly rising pressure trends for the past year, indicating that there is no permeability connection between the mining horizon and this installation level. During the current period, mining in the 800 area consisted of first workings 1 – 2 km from the borehole. Results are presented in **Figure 49**.

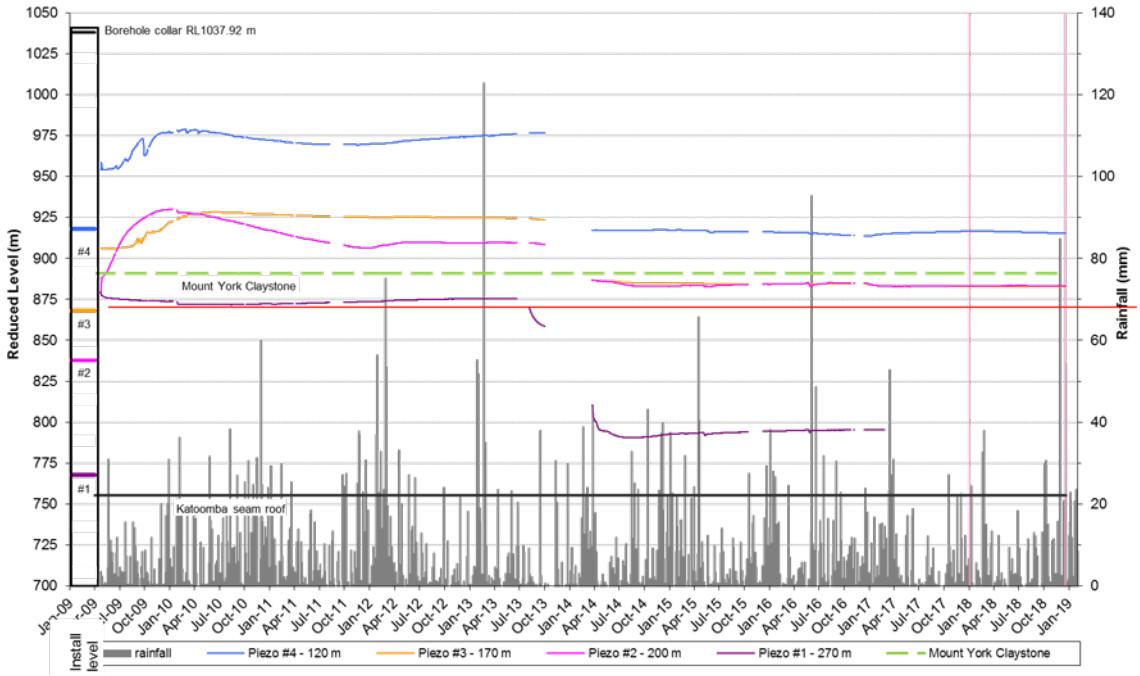


Figure 49. ***CC115 Results.***

CLRP17

The data show steady trends with positive groundwater pressures. The two available piezometers show very steady, level positive pressure trends. Piezometer 2, installed 107 m above the working horizon, showed a single stepwise change in level of 4.4 m upwards on 25 January 2018. After the change, the previously level pressure trend continued, at the elevated value. There was no corresponding change in piezometer 3, higher in the cover sequence. It is very unlikely to be a groundwater effect, due to the sudden and singular nature of the change. The jump is also unlikely to be due to beam flexing above mine workings, as undermining occurred some four months previously. An instrumental effect is suspected.

Pillar extraction occurred directly under the piezometer in the first half of September 2017 and current workings are 600 m to the south east. The consistent, regular, level pressure trends since over time indicate that there has been no discernible mining impact on the groundwater system. Monitoring results for piezometric height at CLRP17 is presented in **Figure 50**.

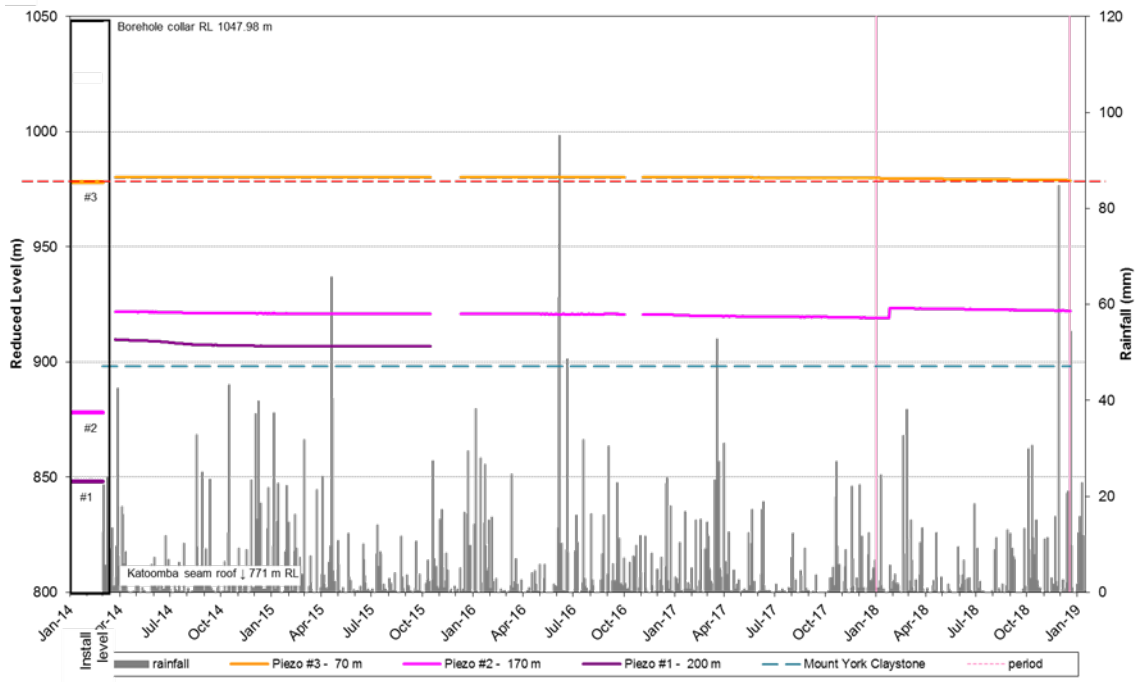


Figure 50. ***CLRP17 Results.***

CLRP19

The data previously showed a very slow decline in pressure in piezometer 1 and 3, and similarly slow increases in pressure in piezometer 2, which subsequently has maintained a very level pressure trend (**Figure 51**). Previous pressure trends continue in the current data. Piezometer 1, installed approximately 100 m above the working horizon but below the Mount York Claystone, the pressure trend was initially level, with a head that lay near the top of the Mount York Claystone which suggests that this is a confined aquifer.As this piezometer is installed in a low permeability unit, pressures can take some time to dissipate, possibly explaining that the slow decline may have been due to gradual stabilisation of the borehole after installation.

Pillar extraction took place immediately below the piezometer in March 2016. Current mining extraction occurs 1 km to the southwest. The data shows no impact from mining. Monitoring results for piezometric height at CLRP19 is presented in **Figure 51**.

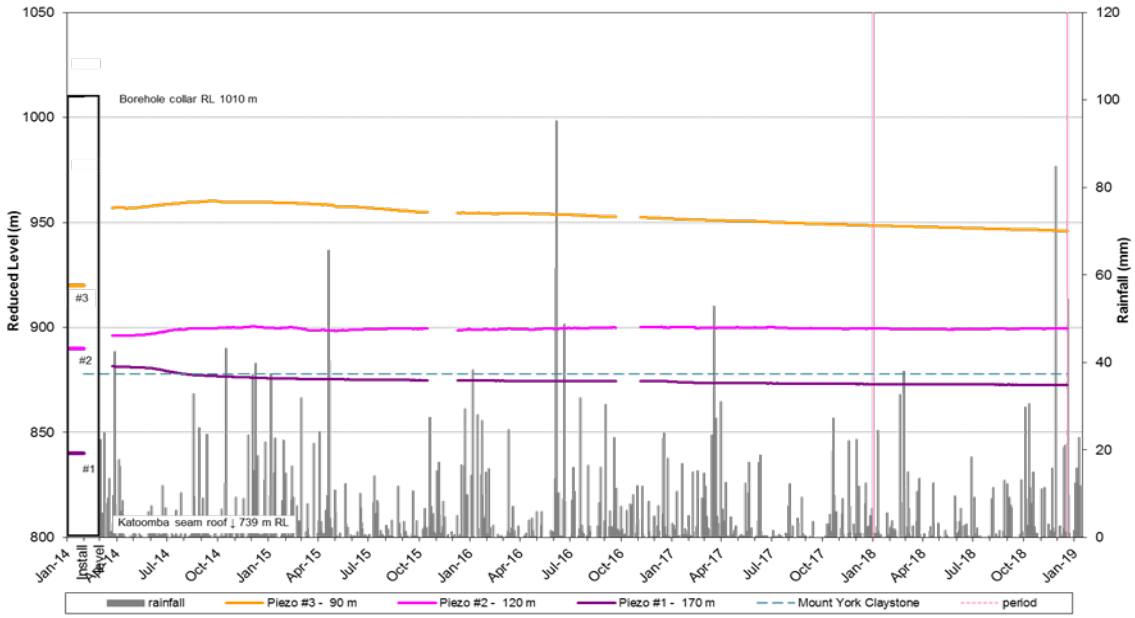


Figure 51. ***CLRP19 Results.***

CLRP14

The data for the period continue previous trends. Piezometers 1 and 2 continue the generally level trends displayed previously, and Piezometer 4 maintains a slowly declining trend. The lowest piezometers show similar stable pressure trends. The similarity of pressure previously observed in piezometers 1 and 2 suggested that the instruments are in hydrogeological continuity. Since early 2014 these pressures started to diverge. Data from more recent periods show the trends converging again.

The uppermost piezometer 4 shows a very slowly declining trend. Piezometer 4 commenced producing more stable data, although, for a few days after 19 August 2014, the pressure head varied by up to 1 m daily. The cause of this anomalous behaviour is unclear, but it is transient, unprecedented, and likely to be non-significant.

Mining in the 800 area has occurred previously under the piezometers; during the current period, first workings were 1 km southeast. The available data record shows no mining impact. Results are presented in **Figure 52**.

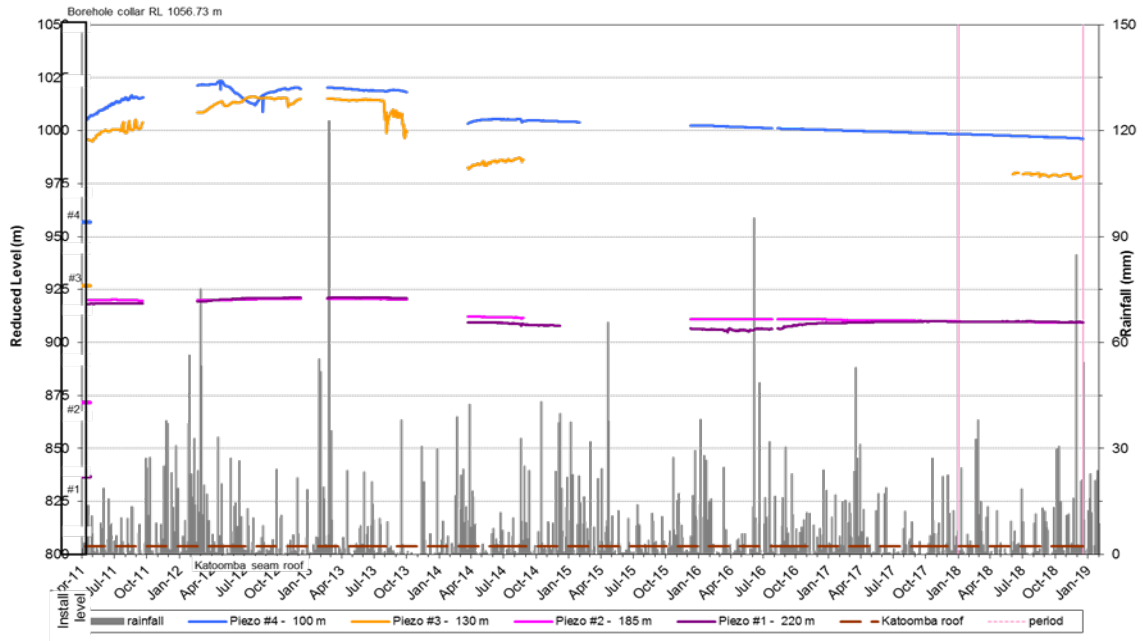


Figure 52. ***CLRP14 Results.***

CLRP22

Trends observed previously continue in the current data. Piezometer 1, installed had stabilised after a very slowly rising pressure trend, with a pressure head that lies near the top of the Mount York Claystone (the regional aquiclude). The coincidence suggests that this is a confined aquifer with no significant leakiness or formation damage in the cap rock, which is controlling pressure in the underlying aquifer. Piezometer 2, installed approximately 100 m above the Mount York Claystone, showed a level trend.

The nearest mining during the period was about 0.5 km south of the installation. There is no indication in the current data of any mining impact. The data record shows no mining impact. Results are presented in **Figure 53**.

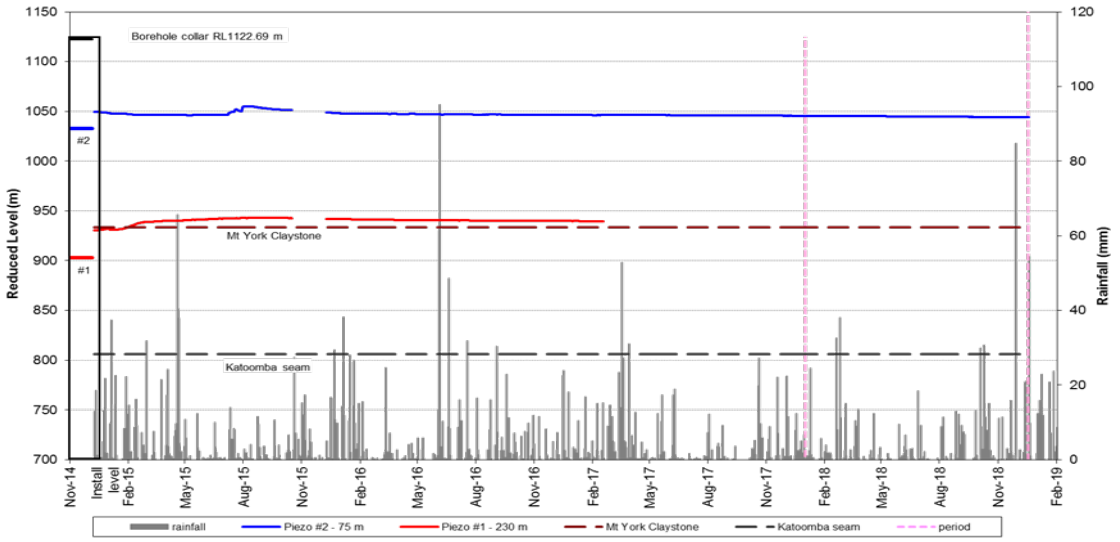


Figure 53. *CLRP22 Results.*

CLRP13

Piezometers 1, 2 and 3 showed small drops in pressure before recovering and continuing previous trends. Piezometer 4 continued its previous stable trend. Piezometer 5 declined in level by 4.1 m and stabilised at RL 992.3 m by the end of the 2018. Pillar extraction commenced directly underneath CLRP13 in Panel 820 between during July. (**Figure 58).**

Prior to undermining on 22 July 2018, piezometer 1 was reading a pressure of RL 876.3 m and dropped to RL 873.8 m before recovering on the and remaining stable at RL 875.4 m on 26 August 2018, 0.9 m below the pressure prior to mining. Piezometers 2 and 3 showed a similar pattern of partial depressurisation but fully recovered to pre-mining levels by the end of the review period. Piezometer 5 showed a delayed depressurisation compared to piezometers 1, 2 and 3. The pressure dropped to RL 992.2 m from RL 996.3 m between 4 August and 5 October 2018 and has yet to recover to pre-undermining levels however previous data for Piezometer 5 has been variable and future readings will be closely monitored. Piezometer 4 has shown no effects of undermining which is installed 30 m below piezometer 1. The data record shows no mining impact.

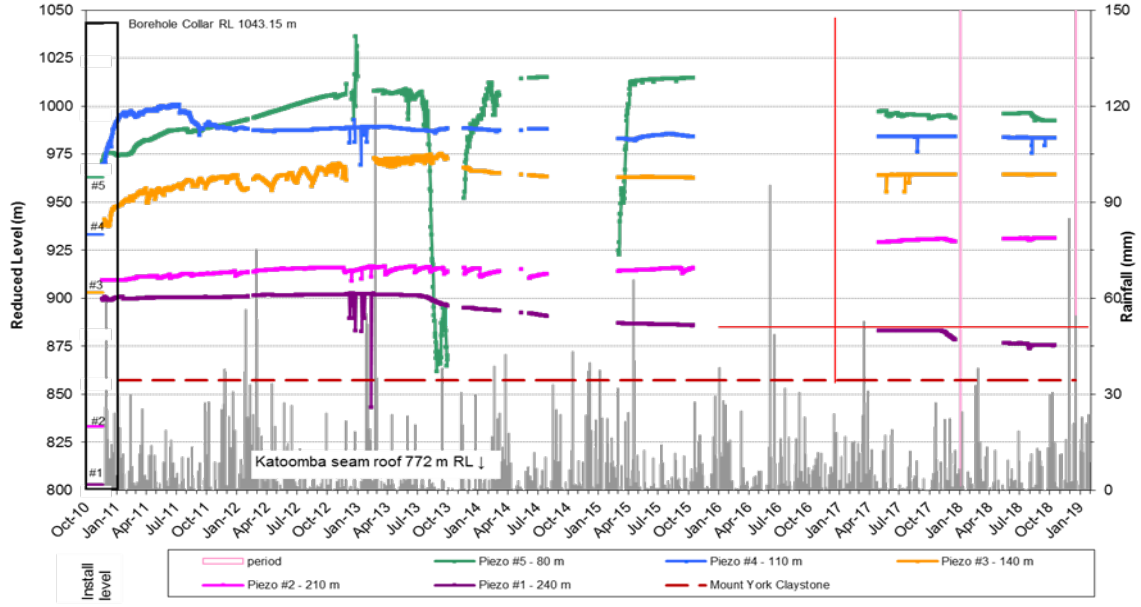


Figure 54. *CLRP13 Results.*

Swamp Piezometers

Happy Valley Upper Swamp

- **HVU1 Upstream**
- **HVU2 downstream**

The behaviour shown up until the State Mine bushfire was typical of a periodically waterlogged swamp in the upper part (HUV1), and a permanently waterlogged swamp in the lower part. Data from HUV1 for the period after the bushfire may be a unique dataset from the Newnes Plateau, and offer an insight into the impact of severe bushfire on the swamp. After the fire, the swamp has continued to show the highly variable groundwater pattern typical of a Type A (periodically waterlogged) swamp, as it had before the fire.

Groundwater levels during the period showed typical responses to rainfall, with distinct spikes related to significant rain (figure 2). By the end of the period, the groundwater level was 0.23 m below surface

Happy Valley Upper Swamp was undermined in March 2010, when partial pillar extraction was carried out in panel 704. In April 2011, partial pillar extraction occurred in panel 708, c. 300 m west of the swamp. In January 2011, first workings were driven in panel 712, c. 700 m west of the swamp. In September 2011, first workings occurred in panel 706 immediately west of HVU2. In November and December 2013, pillar extraction occurred in Panel 700, approximately 700 m west-southwest of the swamp. During the current period, first workings occurred in the 900 area, 4½ km north of the swamp, and first workings occurred in the 800 areas, 5 – 6 km east of the swamp.

Up to the time of the State Mine bushfire, there was no evidence from the data of any impact on the groundwater levels in the swamp that could be attributed to the mining. Continuing monitoring showed groundwater level behaviour that is typical for these swamps in areas that have not been undermined. Changes in the measured groundwater levels appeared to be due solely to prevailing weather conditions. In HUV1, data after the State Mine bushfire continue to show behaviour typical of a periodically waterlogged swamp, with no discernible mining impact.

Happy Valley Swamp

- HV1 upper section
- HV2 lower section

There are no new data from HV1 and HV2, as they were destroyed by the State Mine bushfire. The behaviour shown up until that time was typical of a permanently waterlogged swamp.

Mining impacts:

HV1 was undermined by first workings (710 panel) in September 2010, with partial pillar extraction in October 2010. The swamp was further undermined by first workings in panel 712 in June – July 2011, with subsequent pillar extraction under the swamp in September 2011. HV2 was undermined by first workings in panel 714 in July 2012 with subsequent partial pillar extraction in September 2012. Pillar extraction in panel 716 occurred over 500 m south-southwest of HV2 in August and September 2013, and pillar extraction in panel 700 occurred over 1.8 km south in November – December 2013. During 2018, first workings and pillar extraction occurred in the 900 area, c. 3 -4 km north of the swamp.

Up to the time of the State Mine bushfire, there was no recognisable response to mining in the groundwater record.

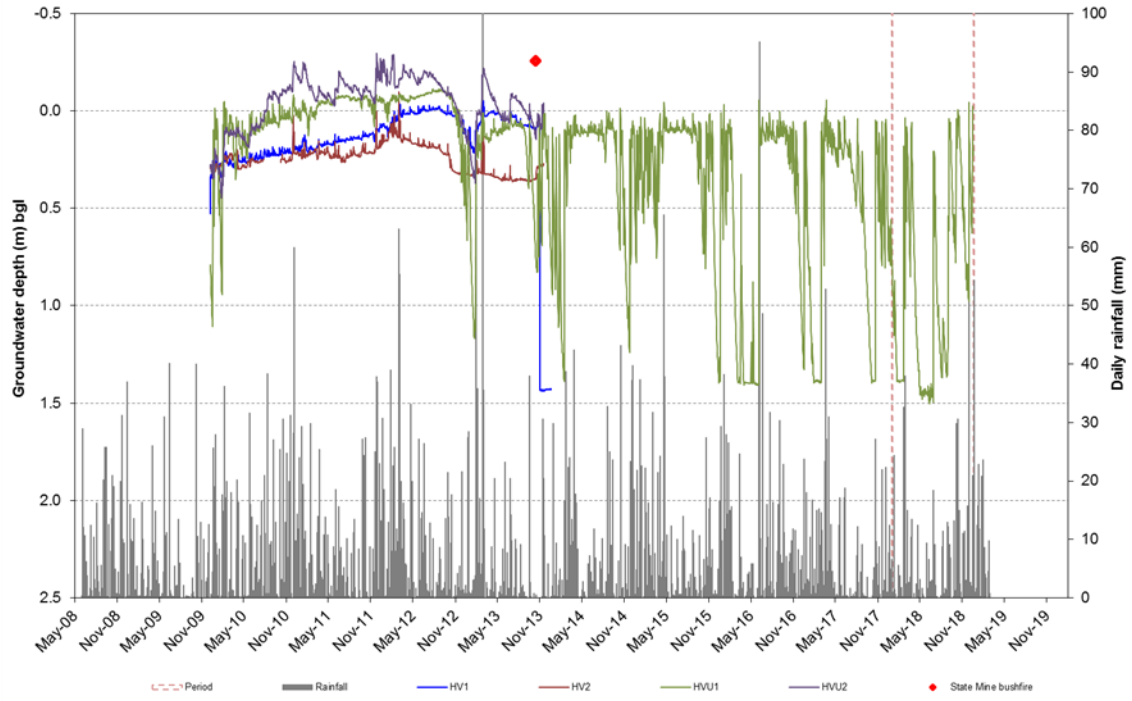


Figure 55. ***Happy Valley Swamp Results.***

7.4.3. Conclusions

The 2000 EIS predicted that the depth of mining and subsidence protection measures will limit subsidence impacts to negligible levels. Furthermore, as outlined in the EIS, the proposed protection zones would ensure that the sensitive areas of vegetation on the plateau are protected from subsidence impacts and as such the groundwater monitoring data supports the EIS predictions.

8. REHABILITATION

Rehabilitation at Clarence is undertaken in accordance with an approved Mining Operations Plan (MOP). The MOP is consistent with commitments from the 2000 Clarence Environmental Impact Statement and subsequent 2013 Modification 2 Environmental Assessment and the 2013 Modification 3 Environmental Assessment.

As defined in Sections 4.2 and 4.3 of the MOP (2018-2022), the key objective of site rehabilitation at Clarence is to achieve an optimum post-mining land capability suitable for supporting the natural bushland environment which surrounds the site. The entire site will be returned to a natural woodland environment, consistent with bushland surrounding the site which is dominated by ‘Sydney Montane Dry Sclerophyll Forest’ communities (DEC, 2006).

Restoration of all disturbed surface lands will provide a landform largely consistent topographically with the pre-mining and surrounding landscape.

8.1. Progressive Rehabilitation and Completion

8.2. Buildings & Infrastructure

During the reporting period no buildings were constructed or removed from the colliery.

8.3. Rehabilitation Trials and Research

Clarence Colliery engaged SLR to devise a detailed Rehabilitation Trial Program which were planned to commence 2018 but were delayed due to a combination of operational constraints – specifically REA 5 intersection works, lack of available space for topsoils and subsoils to be stripped from REA 5 and the prolonged drought conditions experienced into Spring. The trials are planned to conducted on areas of REA 2 and REA 4 where some rehabilitation has not achieved the standards The results of the proposed trials will be used to identify suitable methods for the rehabilitation of REA 3.

The trail was presented during HRA presentations to government agencies and feedback was received from and has been considered in the final rehabilitation trial design:

- Department of Planning and Environment - Resources Regulator (the Resources Regulator) suggested that two transects be treated with erosion control products and no cover crop application.
- Environment Protection Authority suggested that a suitable irrigation system be used for the trial areas, to minimise dependence upon rainfall.

8.3.1. Rehabilitation Monitoring

The Rehabilitation monitoring across the site was conducted 13th and 15th February 2019 and reports on the progression of rehabilitation since the previous monitoring undertaken during December 2017.

This monitoring program expanded the sites from 7 in 2017 to a total of nine woodland monitoring sites for the 2018 period, consisting of:

- Six rehabilitation sites including four historic (existing) sites and two new sites (established to increase sites density and improve data coverage and representativeness); and
- Three analogue sites.

This expansion of monitoring followed the recommendations of the 2017 program with the aim to remove results bias from poor transect placement, the historic monitoring sites located within REA IV (coded ‘RHB4’) was relocated– effectively acting as a new monitoring site.

Each monitoring site consisted of a standardised 50m long transect, with a nested 10m x 30m plot and 1m x1m quadrats, as depicted in **Figure 56**. To facilitate repeated measurements over time, all sites were permanently located with metal star pickets at the start and end points of the 50m line, and their geographical coordinates recorded using a GPS (±3m accuracy).

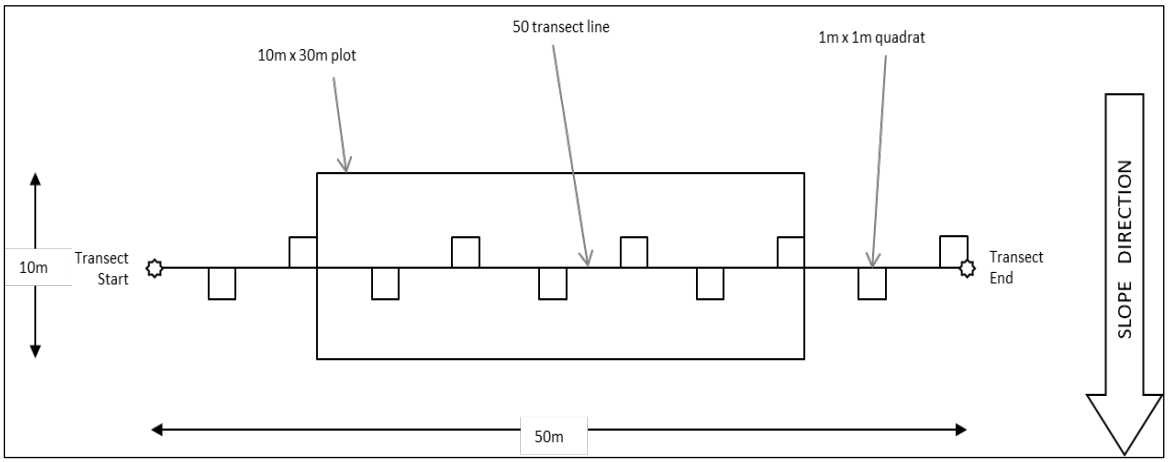


Figure 56. ***Monitoring site layout***

At each monitoring site data are collected using a combination of methodologies and tools developed to assess the performance of the establishing / existing ecosystems. The monitoring includes the following components: Landscape Function Analysis (LFA), vegetation dynamics, habitat complexity, disturbance assessment and photographic monitoring.

An overview of the monitoring program is presented in the following table

Table 36. Rehabilitation monitoring program – Monitoring sites

Site Code	Type	Rehabilitation Establishment	Slope (deg)	Coordinates (GDA94 Zone 56)	
				Easting	**Northing**
RHB 1	Rehabilitation (existing)	2002	12	244291	6294105
RHB 2	Rehabilitation (existing)	1996	12	244563	6293796
RHB 3a	Rehabilitation (existing)	2002	17	244665	6294303
RHB3b	Rehabilitation (new)	2002	22	244752	6294210
RHB 4a	Rehabilitation (new)	2015	17	244412	6293568
RHB 4b	Rehabilitation (new)	2016	20	244299	6293670
ANA 1	Analogue	N/A	3	244632	6293686
ANA 2	Analogue	N/A	12	244659	6294391
ANA 3	Analogue	N/A	10	244521	6294450

Despite recent rainfall received in the four months preceding the field surveys, the locality remained in a drought-affected condition following over 18 months of enduring dry weather in the region. It is also noted that this 2018/2019 monitoring event occurred five years following the state mine bushfire which proceeded through Clarence in October 2013.

Soils in the rehabilitation consisted of sandy loams to sandy clay loams. Characterisation of the growing media was undertaken which indicated that rehabilitation soils were strongly acidic, non-saline, not sodic to moderately sodic and generally with poor fertility and organic matter content; which was consistent with soils sampled in adjacent native woodland. Overall, soils were assessed as being conducive to the establishment and growth of native vegetation, and no key limitation were identified that could constrain the rehabilitation.

Rehabilitated landforms were overall stable, particularly in areas of older rehabilitation across REA I and II. Some low to moderately severe active erosion processes were recorded in more recent rehabilitation within REAs III and IV where vegetation was less established, including some localised gully channels on slopes and within diversion drains that may need to be repaired.

Protective ground cover was generally satisfactory across both REAs I and II where no large bare patches were identified. Ground cover performance was more variable across REA III with a number of localised bare areas recorded which may require improvement works. At REA IV, ground cover protection was excellent where logs/woody debris were installed and direct seeding of primary coloniser species undertaken, however ground cover remained poor in areas where revegetation was undertaken solely using tubestock plantings, but should naturally improve over time as vegetation further establishes.
Driven by the ground cover and soil surface condition, landscape functionality (as assessed through the landscape function analysis tool) was variable across the rehabilitation sites. Landscape function scores within REAs I and II were within analogue range and therefore these areas were considered as trending towards the analogue sites in terms of landscape functionality. Rehabilitation within REAs III and IV remained generally less functional at the time of the monitoring due to poorer ground cover and vegetation establishment and localised active erosion processes in these areas.

Rehabilitation sites generally showed excellent performance in terms of native species assemblages in all vegetation layers, with a range of native ground covers, shrubs and trees recorded at all monitoring sites. Flora species establishing in the rehabilitation were generally well aligned with those recorded at the nearby analogue sites.

A total of 104 species were recorded at the monitoring sites during the floristics assessments, including 95 native species and 9 exotic species (i.e. 91.3% native species). Although total species diversity showed some variance between the rehabilitation monitoring sites, most sites showed levels of native biodiversity comparable to or exceeding analogue values. Tree stem densities remained unsatisfactory and below analogue benchmarks at all rehabilitation sites in during the monitoring. However, in most areas a moderate to high density of young eucalypt seedlings occurred, which indicated a good potential for stem densities to increase over time. In other areas supplementary infill plantings may need to be undertaken to increase tree densities to satisfactory levels.

Vegetation condition was assessed as satisfactory with good tree health and tree growth recorded. Despite some residual fire impact symptoms still noticeable, the rehabilitated communities overall have showed excellent resilience and recovery from the 2013 bushfire event. With only localised exceptions, good structural complexity and vegetation stratification was generally achieved across REAs I, II and III. Given the younger age of the rehabilitation at REA IV, the litter cover and/or tree layers were not yet established, and overall habitat potential remained limited in for the period.

Good incorporation of surface logs / woody debris was generally undertaken throughout the rehabilitated REAs (with the exception of some sections within REA IV), however no other artificial structures were observed (e.g. boulders, arboreal nest boxes, etc) to provide additional supplementary habitat.

Weed diversity and population levels remained generally low (<5% cover) and were not considered a barrier to successful native vegetation establishment. However, four species of invasive weeds were noted as occurring at the site (albeit at relatively low levels) for which an ongoing control effort will need to be maintained, particularly Pampas Grass. No evidence of impact from vertebrate animal pests was evident across the site.

In summary, the results from the 2018/2019 monitoring campaign highlighted variable performance in rehabilitation condition across the site. Although some localised areas require some maintenance or improvement works to be implemented, the rehabilitation at Clarence generally showed positive signs of progress towards the defined objectives and criteria and towards the successful establishment of woodland communities commensurate with locally occurring native ecosystems.

8.4. Next Reporting Period

During 2018 a comprehensive review of the rehabilitation status of the mine was undertaken during the preparation of the 2018 MOP Amendment A. This included a detailed review of the existing mining footprint, this is reflected in the observed variation between 2018 and 2017 (refer Table 39). During this review it was identified athat current rehabilitation areas had been included in the disturbance footprint and therefore the total disturbance area has been reduced. There was only minor physical change to rehabilitation or disturbance areas in 2018.

The additional disturbance projected in 2019 reflects the commencement of Stage 1 REA V construction (including Leachate Dam 4). The current rehabilitation status of the site is as of December 2018 presented below.

Table 37. Rehabilitation Status

Mine Area Type	Previous Reporting Period 2018	This Reporting Period 2019	Next Reporting Period 2020
A. Total mine footprint[2]	95.2	95.7	99.2
B. Total active disturbance[3]	69.8	73.7	75.3
C. Land being prepared for rehabilitation[4]	0	1.90	0
D. Land under active rehabilitation[5]	25.4	22.0	23.9
E. Completed rehabilitation[6]	0	0	0

[2] **Total Mine Footprint:** includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in the DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.
[3] **Total Active Disturbance:** includes all areas requiring rehabilitation
[4] **Land being prepared for rehabilitation:** includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE MOP/RMP Guidelines)
[5] **Land under active rehabilitation:** includes areas under rehabilitation and being managed to achieve relinquishment – includes 'ecosystem and land use establishment' and 'ecosystem and land use sustainability (as defined under the DRE MOP/RMP Guidelines)
[6] **Completed rehabilitation**: requires formal sign off from DRE that the area has successfully net the rehabilitation land use objectives or completion criteria

In 2018 a review of site disturbance and rehabilitation data was undertaken. This increase to disturbance and reduction to rehabilitation resulted from:

- Alignment of the REA3 footprint with the official High Risk Activity (HRA) Notification boundaries; and

- Some areas on REA2 and REA4 that were previously captured as rehabilitation, was captured as disturbance in 2018. These areas will be rehabilitated in 2018 as part of the planned rehabilitation trials.

Forecast 2019 areas reflect increased disturbance associated with Stage 1 REA 5 construction works (3.5 hectares), along with subsequent reductions to disturbance/increase to active rehabilitation following REA2 and REA4 rehabilitation trials (1.9 hectares).

The predicted 2018 disturbance area presented in the approved MOP (95.2 hectares) incorrectly captured total rehabilitation (25.4 hectares). This was identified during preparation of MOP Amendment A and was discussed with RR during a meeting 21 February 2019. The amended disturbance area presented in MOP Amendment A is 73.7 hectares. The minor change to rehabilitation have resulted from refinements to site rehabilitation and disturbance data as outlined above. Subsequently, all activities in 2018 align with the predictions in the approved MOP.

9. COMMUNITY

9.1. Community Consultation and Engagement

During the reporting CCC meetings were held on the following dates:

- 26th February 2018,
- 25th June 2018,
- 24th September 2018, and
- 17th December 2018.

Minutes are available on the Centennial Coal Clarence Website (https://data.centennialcoal.com.au/domino/centennialcoal/cc205.nsf/Published.xsp?site=Clarence&type=Community%20Consultative%20Committee&date=All)

9.1.1. Aboriginal Cultural Heritage

Consultation with Registered Aboriginal Parties was undertaken was undertaken in accordance with the Western Region Cultural Heritage Management Plan, via the Western Region Cultural Heritage Sub-committee. Meeting were held on the following dates:

- 2nd May 2018; and
- 7th November 2018.

The RAP representatives were consulted on the mine development, exploration activities, results of Archaeological surveys and anticipated timing for post mining archaeological inspections.

9.1.2. Local Community

The community of the nearby locality of Newnes Junction have been consulted with in relation to the construction of the REA V road crossing across Clarence Loop Road. This consultation has included direct contact with residents to advise of the proposed works

and, information about the scope of works and project schedule has been provided via letter box drops. Consultation will be ongoing as the project continues.

9.2. Community Sponsorships

During the reporting period, Clarence (in conjunction with other Centennial sites) supported the following community groups via either in-kind or financial sponsorship (or a combination of both):

- Portland Central School;
- Lithgow Show Society;
- Lithgow State Mine Railway;
- Centennial Coal Charity Golf Day;
- Ironfest;
- Rydal Village Association;
- St Joseph's Primary School Portland;
- Dargans Creek Reserve Trust;
- Lithgow PCYC;
- Wallerawang Lidsdale Progress Association Inc;
- Lithgow Hockey Association;
- Kye Cameron;
- Mingaan Wiradjuri Aboriginal Corporation;
- Portland Development Association;
- Clarence Dargan Rural Fire Brigade;
- Lithgow City Council;
- Hartley Historic Site Advisory Committee;
- Lithgow High School;
- Lauren Core;
- Australian Roof Bolting & Coal Shovelling Titles 2016;
- Lithgow Chamber of Commerce;
- Portland Central School;
- Rydal A, H & P Society;
- Mining Museum;
- Wallerawang Public School; and
- Cooerwull Public School.

Additionally sporting sponsorships were provided to the following groups/events:

- Lithgow Junior Lazers Basketball;
- Lithgow Senior Lazers Basketball;
- Lithgow City Womens Bowling Club;
- Lithgow Workmen's Club - Mens Bowling Club;
- Blackheath Junior Cricket Club;
- Lithgow District Junior Cricket Association Inc;
- Lithgow Seniors District Cricket Association Inc;
- Western Wildfires - Over 60's cricket team;
- Lithgow Golf Club;
- Lithgow Hockey Association Inc.;
- Central Tablelands Mountain Bike Club;
- Lithgow Croquet Club;
- Lithgow Flash Dragons Dargon Boat Club;
- Lithgow Little Athletics;
- Lithgow Small Arms Rifle Club;
- Lithgow Valley Archer Inc;
- Parkrun Lithgow;
- Portland District Motor Sports Club;

- Lithgow District Car Club;
- Lithgow District Netball Association;
- Rugby League;
- Lithgow District Storm JRLFC;
- Lithgow Workmen's Club RLFC;
- Mid West Cup New Era Cup (previously Centennial Coal Cup);
- Wallerawang Warriors Junior Rugby League;
- Blue Mountains and Greater West Rugby Sevens Carnival; and
- Portland District Olympic Swimming Pool Association.

9.3. Community Complaints

The following table provides a summary of community complaints throughout the reporting period.

Table 38. 2018 Community Complaints Details

Date Complaint was Logged	Type of Complaint	Comments / Actions taken
9/07/2018	A complaint was received regarding a truck driving west on Bells Line of Road. The truck was over the centre line forcing the complainant to take evasive action. As no identification details were recorded it could not be determined if the truck was from a company that sources coal from Clarence or, whether the truck was undertaking haulage for any purpose unrelated to the sites activities.	Although the origin of the truck could not be determined, a notice was distributed to all contractors and independent haulage companies reminding them of their obligation to safety and responsible driving behaviours.

Table 39. Complaints History

Year	Air	Water	Noise	Waste	Other	Total
2018	0	0	0	0	1	1
2017	0	0	1	0	1	2
2016	0	0	0	0	1	1
2015	0	0	0	0	1	1
2014	0	0	0	0	0	0

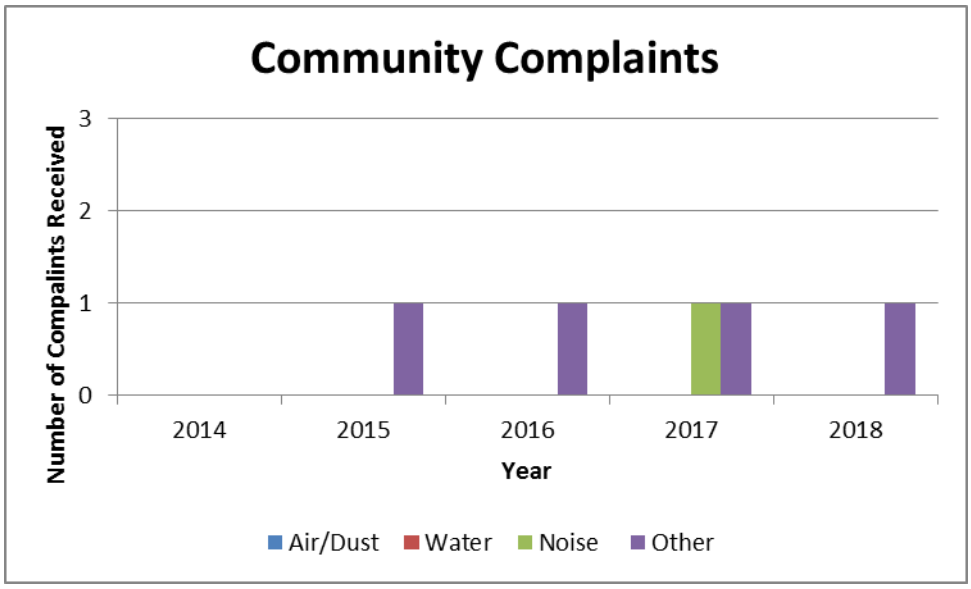


Figure 57. *Annual Community Complaints*

The single complaint received during 2018 was not directly attributable to Clarence Colliery's operations.

10. INDEPENDENT AUDIT

Following the completion of the 5 yearly Independent Environmental Audit in 2016, Clarence developed an Actions Plan aimed at addressing all of the recommendations and findings of the Audit. The following table refers to only ongoing or outstanding actions, any actions that have been completed and reported in the 2017 Annual review are not included in Table 42 below.

Table 40. Audit Actions and Update

Reference in Audit Report	Recommendation	Action Description / Comments	Action Due Date
REC 06 CLR IEA 2016	Revise the WMP to reflect actual on-site water flows and management and to reflect findings of and responses to the recent assessment of water management at Clarence.	The Clarence WMP is currently being reviewed and updated to align with the recently developed Western Region WMP.	Ongoing- Draft Water Management Plan prepared in 2017 and submitted for consultation. Clarence is currently addressing feedback and has identified areas for improvement in Water balances due to a clean water diversion project, and plans submission of the document for approval by the Department in 2019
REC 07 CLR IEA 2016 .	Further assess and implement recommendations of the independent review of Clarence's surface water management	Refer REC 06 Action.	Ongoing.
REC 09 CLR IEA 2016	Reshape and rehabilitate REAIII promptly and effectively with local native vegetation.	Detailed engineering assessments are underway at REAIII, with the findings to inform a HRA Application and the final landform design, as well as a revision of the Clarence MOP.	HRA and DA modification submitted in 2018, awaiting DA mod approval.
REC 11 CLR IEA 2016	Undertake a compliance assessment of the new lighting installed at REAVI with AS4282	A consultant was commissioned in May 2018 and the Report determined that Clarence is compliant with AS4282	Completed Quarter 3 2018
REC 12 CLR IEA 2016	Investigate ways to reduce greenhouse gas emissions and report on these in the AEMR.	Engineering investigations include replacing outdated conveyor drives with a more efficient system where possible. Feasibility review of solar PV system install at Admin Building scheduled.	Ongoing.
REC 14 CLR IEA 2016	Ensure records are maintained to demonstrate the DPE has been immediately notified of all incidents and provided with a written report within 7 days.	Environment & Approvals Business Management Framework sets out correspondence documentation and filing standards.	Ongoing.
REC 20 CLR IEA 2016	Include discussion of the additional surface and groundwater monitoring requirements in the next revision of the WMP.	Refer REC 06 action.	Ongoing- Draft Water Management Plan prepared in 2017 and submitted for consultation. Clarence is currently addressing feedback and has identified areas for improvement in Water balances due to a clean water diversion project, and plans submission of the document for approval by the Department in 2019
REC 25 CLR	Reshape and rehabilitate REAIII promptly and effectively with	Refer REC 9 Action.	HRA and DA modification submitted in 2018, MOP amendment submitted in

Reference in Audit Report	Recommendation	Action Description / Comments	Action Due Date
IEA 2016	local native vegetation once stop works order has been lifted		2019 to facilitate the lifting of notices.
REC 27 CLR IEA 2016	Confirm with the DPE whether consultation with the Soil Conservation Service is required during topsoil stripping and stockpiling associated with REAV.	Soil Conservation Service was consulted for the preliminary REA 5 works and continued into 2019 for proposed works. .	Clarification sought from the Department in March 2019.
REC 28 CLR IEA 2016	Develop a detailed rehabilitation plan for REAV and REAVI within 6 months of commencement of REAV and submit to the DRG, Soil Conservation Service and Council for approval.	Clarence are required to update the MOP prior to commencement of REAV, and propose this will be completed with sufficient rehabilitation detail.	A MOP amendment has been prepared in 2018 (lodged March 2019) and a Rehabilitation trial has been devised in consultation with relevant agencies.
REC 29 CLR IEA 2016	Confirm with the DPE whether consultation with the Soil Conservation Service is required during topsoil stripping and stockpiling associated with REAV.	Soil Conservation Service was consulted for the preliminary REA 5 works and continued into 2019 for proposed works. .	Clarification sought from the Department in March 2019

11. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

Incidents and non-compliances are summarised in the following tables for the reporting period.

Table 41. Incident/Non-Compliance No 1 - Summary

Nature of the incident/non-compliance	EPL L2.4- Metal/Metalloid monitoring results exceed limits for discharge at LDP02
Date of incident/ non-compliance (if known; if not known state not known)	The results of the exceedances are below: 28th February 2018: Nickel 0.014 mg/L 19th April 2018: Zinc 0.012 mg/L, Cobalt 0.004 mg/L, Copper 0.02mg/L 17th May 2018: Nickel 0.013 mg/L, Zinc 0.012 mg/L, Cobalt 0.005 mg/L 28th June 2018: Zinc 0.02 mg/L, Cobalt 0.004 mg/L 18th July 2018: Nickel 0.013 mg/L, Zinc 0.016 mg/L, Cobalt 0.0046 mg/L 16th August 2018: Nickel 0.014 mg/L, Cobalt 0.005 mg/L 17th September 2018: Nickel 0.011 mg/L, Zinc 0.012 mg/L, Cobalt 0.004 mg/L 17th October 2018: Nickel 0.012 mg/L 14th November 2018: Zinc 0.012 mg/L, Cobalt 0.0042 mg/L 12th December 2018: Zinc 0.025 mg/L.
The location of the incident/ non-compliance (include a figure if appropriate), if known	Discharge Monitoring point identified as LDP002
Detail the cause of the incident/non-compliance	Variation in feed water quality, trials of Water treatment plant improvements, lag for pH modification on discharge, carry over of colloidal material and re-solubilisation of metals. .
Detail action that has been, or will be, taken to mitigate any adverse effects of	The Water treatment plant is continuing to be improved with changes in processes, plant control systems, increased flocculent

the incident/ non-compliance	capture and changes to plant infrastructure. trials have been conducted and consultants advice sought on a regular basis
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	Moved pH dose tank and system close to WTP to facilitate better process control (remove lag time), Upgrading Citec and PLC (management system), reinstating settling pond & increased floc dosing to settle out more solids prior to release, Installed turbidity monitor at LDP2, Change from H_2SO_4 to HCL, Laboratory trials of plant improvement options.

Table 42. Incident/Non-Compliance No 2 - Summary

Nature of the incident/non-compliance	EPL L2.4- Chloride concentration recorded at LDP02 of 33mg/L
Date of incident/ non-compliance (if known; if not known state not known)	12/12/2018
The location of the incident/ non-compliance (include a figure if appropriate), if known	Discharge and Monitoring point identified as LDP002
Detail the cause of the incident/non-compliance	The Chloride concentration increase is attributed to the change from H_2SO_4 to HCL for pH correction. The exceedance occurred in the initial the commissioning phase.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	The results are a minor exceedance of the limits and no adverse effects are expected. Water quality and aquatic ecology monitoring continue downstream of the discharge point.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	Trials of the Water Treatment plant processes are being undertaken to reduce the dosing of HCL required.

Table 43. Incident/Non-Compliance No 3 - Summary

Nature of the incident/non-compliance	EPL L2.4- pH recorded above pH range limits at 8.9 at LDP002.
Date of incident/ non-compliance (if known; if not known state not known)	17/10/2018
The location of the incident/ non-compliance (include a figure if appropriate), if known	Discharge and monitoring point identified as LDP002
Detail the cause of the incident/non-compliance	Water Treatment Plant process control failure due to time lag in water quality changes and process response time.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	Due to the minor nature of the exceedance no adverse effects are expected.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	The Water Treatment Plant has been subject to numerous upgrades including installation of new dosing tanks closer to the plant to remove time lag and upgrades to the plant control and automation systems. It is expected that these upgrades will ensure no further exceedances.

Table 44. Incident/Non-Compliance No 4 - Summary

Nature of the incident/non-compliance	EPL M2.2- Dust monitoring was not completed and analysed for the month of November 2018 at Dust Gauge 2 DA 504-00 S3 C14 Implementation of Air Monitoring Program
Date of incident/ non-compliance (if	Between 1/11/2018 -29/11/2018

known; if not known state not known)	
The location of the incident/ non-compliance (include a figure if appropriate), if known	Dust Deposition Gauge identified as DM2
Detail the cause of the incident/non-compliance	Broken dust gauge likely caused by vandalism.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	The dust bottle is in a secure location however no additional practical measures can be implemented to avoid vandals throwing rocks.. Dust results were collected for the month at the 2 other monitoring locations.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	No additional practical measures can be implemented to avoid vandals.

Table 45. Incident/Non-Compliance No 5 - Summary

Nature of the incident/non-compliance	EPL L5.1-A noise exceedance in the evening period was recorded. The result was 43dB (EPL Limit and Consent Criteria is 36dB). DA504-00 S3 C15 Noise Limits
Date of incident/ non-compliance (if known; if not known state not known)	13/9/2018
The location of the incident/ non-compliance (include a figure if appropriate), if known	Sandham Road (M1)
Detail the cause of the incident/non-compliance	The Noise exceedance recorded followed monitoring undertaken in March 2018 which recorded noise levels within compliance. The purpose of the monitoring was to ascertain the difference between the monitoring location and sensitive receptors. The exceedance was identified as a breeze affected result and additional investigations conducted in November determined that the background noise in the location exceed the limits without contributions from the operations.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	Additional investigations were undertaken to determine the background noise levels and difference in noise levels experienced from the operations at residences. The study identified that the residences are subject to background noise levels higher than the limits and that the monitoring point receives operational noise levels 7 dba higher than the nearest residence. No complaints were received during the period as higher contributions are received from other sources (i.e. Bells Line of Road and natural background noise).
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	The November monitoring determined that the monitoring point should be either moved to better discern the operational noise from other sources or that a correction factor derived statistically as 7 dba be applied. If the correction factor was applied, this monitoring result would be considered compliant. Further discussions will be held with EPA.

Table 46. Summary of Reportable Incidents and Regulatory Actions

Compliance Type	Agency(ies)	Number	Issue	Response
Incidents	Not relevant	0	N/A	Not relevant
Caution Notices		1	Noise exceedance that occurred in 2017.	Clarence committed to a number of additional investigations and monitoring which were completed in 2018 including; • Extensive paired attended and unattended monitoring to determine the noise levels experienced at the sensitive receivers. This work identified a drop of approx. 7 dba between the monitoring point and receptors and that the background noise was the dominant driver of exceedances.
Show Cause	EPA	1	Water quality exceedance- Show Cause	Clarence committed to a number of Water treatment Plant upgrades which were completed in 2018 including; • reinstating settling pond and increased flocculent dosing to settle out more solids prior to release; • Moving acid dose tank and system to facilitate better process control (remove lag time for pH correction) • Trialing hydrochloric acid in the pH correction process as opposed to Sulphuric Acid. • Upgrading water treatment plant telemetry system to facilitate better controls over the process • Installing turbidity monitor at LDP2 to better improve measurement capabilities and response to discharge water quality.
Penalty Notices	Not relevant	0		Not relevant
Prosecutions	Not relevant	0		Not relevant

There have been no incidents causing or threatening material harm during the reporting period. Clarence has consulted with EPA in regards to non-compliances with LDP002 water quality criteria.

12. ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

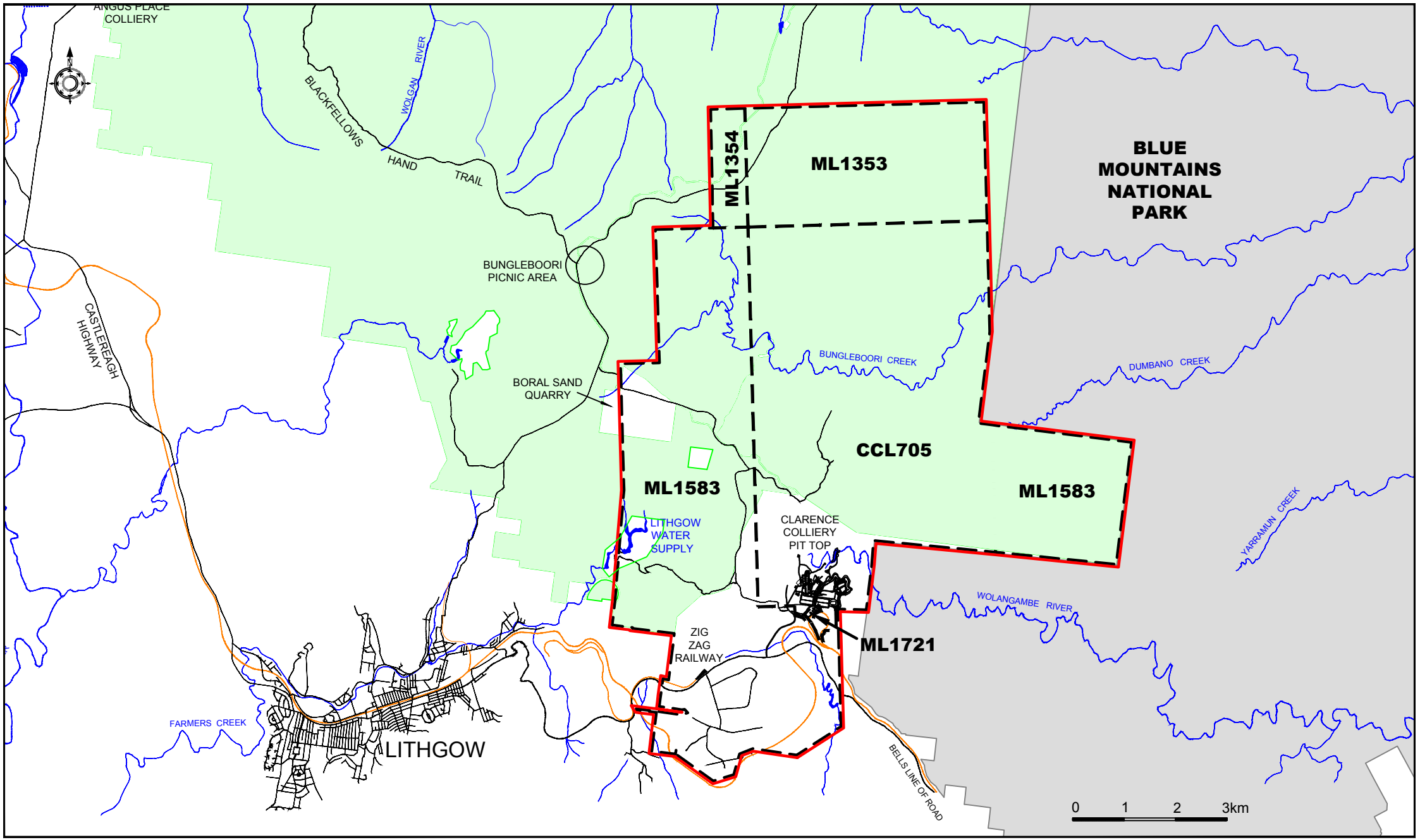
Clarence propose to undertake the following activities during 2018:

- Commence the removal of reject from REA 3 and re-profiling for rehabilitation (pending all approvals are in place);
- Commence rehabilitation trials at REA 4 2019 (pending all approvals are in place);
- Obtain approval for the MOP Amendment A;
- Undertake Construction of REA V;
- Continue to refine the operation of the water treatment plant; and
- Commence the 900 North Drilling Program
- Preparation and submission of EIS for Cox's River pipeline route as per EPL PRP.

APPENDICES

Regional Location Plan

Appendix 1



NEWNES STATE FOREST

BLUE MOUNTAINS NATIONAL PARK

PLAN 1-LOCATION PLAN

RAIL LINE

ROAD/TRACK

RIVERS/CREEKS

MINING LEASE BOUNDARY(S)

PROJECT BOUNDARY

CL1645-1

Development and Extraction Plan 2018

Appendix 2

N

MGA GRID
ZONE 56

UNDERGROUND
MINE
ENTRANCES

LEGEND

JANUARY	JULY
FEBRUARY	AUGUST
MARCH	SEPTEMBER
APRIL	OCTOBER
MAY	NOVEMBER
JUNE	DECEMBER

PARTIAL EXTRACTION SEQUENCE(S)

FIRST WORKINGS

NOTE: The workings and scale shown on this plan are indicative only
Mine workings pre 2005 - refer to hard copy Mine Working Plan (in I.S.G.format)
Current mine workings - refer to digital mine working plan

DATE	26/03/2019
REFERENCE	N:\Shared\Plans\Environmental\AEMR\2019\Plan 2- Devlopment and Extraction Workings_CL1645-2.dwg
SCALE	AS SHOWN

PLAN 2
DEVELOPMENT AND EXTRACTION WORKINGS FOR 2018

Centennial Coal
Clarence

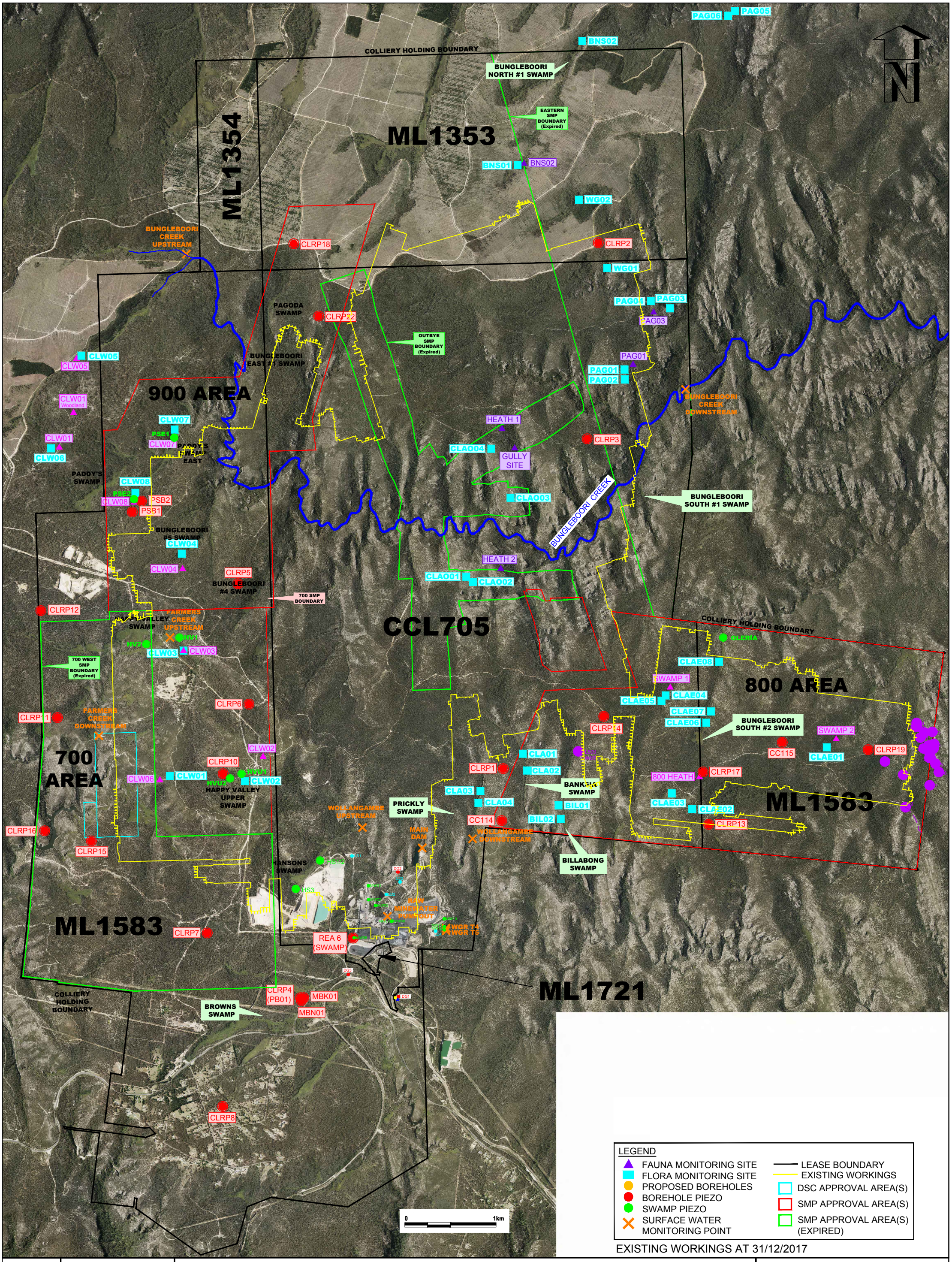
DRG. No. CL1645-2

Proposed Development and Extraction Workings for 2019

Appendix 3

Combined Surface Monitoring Points

Appendix 4



LEGEND

- FAUNA MONITORING SITE
- FLORA MONITORING SITE
- PROPOSED BOREHOLES
- BOREHOLE PIEZO
- SWAMP PIEZO
- SURFACE WATER MONITORING POINT
- LEASE BOUNDARY
- EXISTING WORKINGS
- DSC APPROVAL AREA(S)
- SMP APPROVAL AREA(S)
- SMP APPROVAL AREA(S) (EXPIRED)

EXISTING WORKINGS AT 31/12/2017

DATE	26/03/2019
REFERENCE	N:\Shared\Plans\Environmental\AEMR\2019\Plan 4- Combined Surface Monitoring Points_CL1645-4.dwg
SCALE	AS SHOWN

PLAN 4
COMBINED SURFACE MONITORING POINTS

Centennial Coal
Clarence

DRG. No. CL1645-4

Pit Top Monitoring Locations

Appendix 5

MGA GRID ZONE 56

N

WOLLANGAMBE UPSTREAM

MAIN DAM

LDP1

DG2

LDP3

LDP2

RAW MINEWATER

LDP4

COLLIERY HOLDING BOUNDARY

DG3

DG1

0 200m

SCALE - metres

DATE	26/03/2019
REFERENCE	
N:\Shared\Plans\Environmental\AEMR\2019	
SCALE	AS SHOWN

CLARENCE COLLIERY PIT TOP MONITORING LOCATIONS

- DUST MONITORING SITE(S)
- TSP & PM10 MONITORING SITE
- WATER MONITORING SITE(S)
- WEATHER STATION
- NOISE MONITORING SITE

Clarence Colliery

DRG. No. CL1645-5

Aerial View of Surface Facilities

Appendix 6

DATE	26/03/2019
REFERENCE	
N:\Shared\Plans\Environmental\AEMR\2019	
SCALE	AS SHOWN

PLAN 6

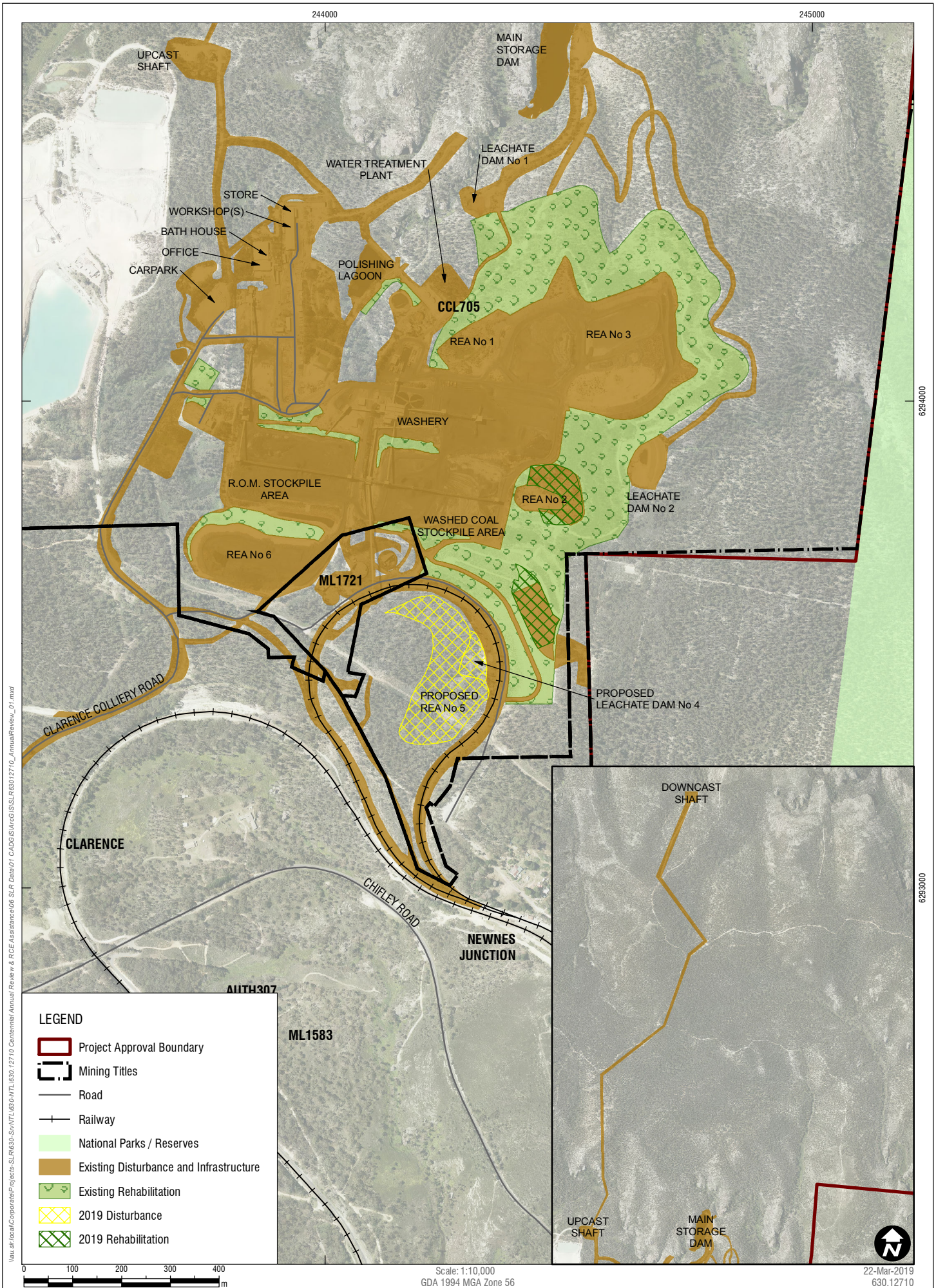
AERIAL VIEW OF SURFACE FACILITIES

Clarence Colliery

DRG. No. CL1645-6

Surface Disturbance and Rehabilitation 2018

Appendix 7



Sheet Size : A4

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Surface Disturbance and Rehabilitation 2018

Plan 7

2018 Rehabilitation Monitoring Report

Appendix 8

KORU ENVIRONMENTAL

Centennial Coal

Rehabilitation Monitoring 2018

Clarence Colliery

Rehabilitation Monitoring 2018 – Clarence Colliery

Prepared for

Clarence Colliery Pty Ltd
P/O Box 92
Lithgow NSW 2790
ABN 19 001 680 584

Prepared by

Matthieu Catteau - B. Env. Mgmt (Hons 1)
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DOCUMENT CONTROL

Document ref.	Date	Version	Checked by
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P2018-008_v02	26 March 2019	Final	

Table of Content

List of Figures

List of Tables

List of Graphs

Executive Summary

This report presented the findings of the 2018 rehabilitation monitoring program conducted at Clarence Colliery by Koru Environmental on behalf of Clarence Colliery Pty Ltd to satisfy the requirements of the mining operations plan (MOP) for the operation.

Monitoring methods were slightly amended in 2018 to reflected changes in rehabilitation performance indicators and completion criteria defined in the revised MOP (2018-2022). The changes in methods were aimed to improve the relevance and adequacy of collected datasets whilst allowing for an accurate assessment of rehabilitation performance to be undertaken against defined objectives. However, the change in monitoring methods implied that some of the data collected in previous monitoring campaigns could not be directly compared and analysed against the 2018 results.

In total, the 2018 monitoring included the assessment of nine permanently established monitoring sites (transects), comprising six sites in rehabilitated reject emplacement areas (REAs I, II, III and IV) and three analogue sites in areas of undisturbed native woodland used to define performance benchmark values for the rehabilitation. To complement the transect-based monitoring, a high-level walkover inspection of all rehabilitation areas was also undertaken aimed at identifying key issues or deficiencies requiring treatment across the site.

Field surveys were undertaken between 13th and 15th February 2019. Despite recent rainfall received in the four months preceding the field surveys, the locality remained in a drought-affected condition following over 18 months of enduring dry weather in the region. It is also noted that this monitoring event occurred five years following the state mine bushfire which proceeded through Clarence in October 2013.

Soils

Soils in the rehabilitation consisted of sandy loams to sandy clay loams. Characterisation of the growing media was undertaken for the first time in 2018 which indicated that rehabilitation soils were strongly acidic, non-saline, not sodic to moderately sodic and generally with poor fertility and organic matter content; which was consistent with soils sampled in adjacent native woodland. Overall, soils were assessed as being conducive to the establishment and growth of native vegetation, and no key limitation were identified that could constrain the rehabilitation.

Landform stability and erosion

Rehabilitated landforms were overall stable, particularly in areas of older rehabilitation across REA I and II. Some low to moderately severe active erosion processes were recorded in more recent rehabilitation within REAs III and IV where vegetation was less established, including some localised gully channels on slopes and within diversion drains that may need to be repaired.

Ground cover and landscape function

Protective ground cover was generally satisfactory across both REAs I and II where no large bare patches were identified. Ground cover performance was more variable across REA III with a number of localised bare areas recorded which may require improvement works. At REA IV, ground cover protection was excellent where logs/woody debris were installed and direct seeding of primary coloniser species undertaken, however ground cover remained poor in areas where revegetation was undertaken solely using tubestock plantings, but should naturally improve over time as vegetation further establishes.

Driven by the ground cover and soil surface condition, landscape functionality (as assessed through the landscape function analysis tool) was variable across the rehabilitation sites. Landscape function scores within REAs I and II were within analogue range and therefore these areas were considered as trending towards the analogue sites in terms of landscape functionality. Rehabilitation within REAs III and IV remained generally less functional at the time of monitoring due to poorer ground cover and vegetation establishment and localised active erosion processes in these areas.

Native woodland community establishment

Rehabilitation sites generally showed excellent performance in terms of native species assemblages in all vegetation layers, with a range of native endemic ground covers, shrubs and trees recorded at all monitoring sites. Flora species establishing in the rehabilitation were generally well aligned with those recorded at the nearby analogue sites.

A total of 104 species were recorded at the monitoring sites during the floristics assessments, including 95 native species and 9 exotic species (i.e. 91.3% native species). Although total species diversity showed some variance between the rehabilitation monitoring sites, most sites showed levels of native biodiversity comparable to or exceeding analogue values.

Tree stem densities remained unsatisfactory and below analogue benchmarks at all rehabilitation sites in 2018. However, in most areas a moderate to high density of young eucalypt seedlings occurred, which indicated a good potential for stem densities to increase over time. In other areas supplementary infill plantings may need to be undertaken to increase tree densities to satisfactory levels.

Vegetation condition was assessed as satisfactory with good tree health and tree growth recorded. Despite some residual fire impact symptoms still noticeable, the rehabilitated communities overall have showed excellent resilience and recovery from the 2013 bushfire event.

Habitat complexity and potential

With only localised exceptions, good structural complexity and vegetation stratification was generally achieved across REAs I, II and III. Given the younger age of the rehabilitation at REA IV, the litter cover and/or tree layers were not yet established, and overall habitat potential remained limited.

Good incorporation of surface logs / woody debris was generally undertaken throughout the rehabilitated REAs (with the exception of some sections within REA IV), however no other artificial structures were observed (e.g. boulders, arboreal nest boxes, etc) to provide additional supplementary habitat.

Weeds and feral animals

Weed diversity and population levels remained generally low (<5% cover) and were not considered a barrier to successful native vegetation establishment. However, four species of invasive weeds were noted as occurring at the site (albeit at relatively low levels) for which an ongoing control effort will need to be maintained, particularly Pampas Grass.

No evidence of impact from vertebrate animal pests was evident across the site.

Conclusion

In summary, the results from the 2018 monitoring campaign highlighted variable performance in rehabilitation condition across the site. Although some localised areas require some maintenance or improvement works to be implemented, the rehabilitation at Clarence generally showed positive signs of progress towards the defined objectives and criteria and towards the successful establishment of woodland communities commensurate with locally occurring native ecosystems.

1. Introduction

1.1 Background

Clarence Colliery (Clarence) is an underground coal mining operation located within the New South Wales (NSW) Western Coalfields, approximately 10 kilometres (km) east of Lithgow. Coal is extracted from the Katoomba Seam using the board and pillar partial extraction method, supplying coal to both domestic and export markets.

Clarence currently operates under three development consents: IRM.GE.76 and DA 174/93 granted by the former Greater Lithgow County Council, and DA 504/00 granted in 2005 by the (now) NSW Department of Planning and Environment under the *Environmental Planning and Assessment Act 1979*. The latter allows Clarence to extract up to three million tonnes of run of mine coal per year until 31 December 2026.

Monitoring of rehabilitated areas at Clarence commenced in 2012 and has been implemented annually by AECOM until 2017. Monitoring is implemented to satisfy the requirements of:

- The current Mining Operations Plan 2018-2022 (MOP); and
- Relevant conditions contained within the development consents.

It is noted that some changes to the rehabilitation performance indicators and completion criteria were made in the latest version of the MOP. This provided an opportunity to improve the rehabilitation monitoring program, and monitoring methods were revised and (slightly) amended from those implemented in previous years. The revised methods aimed to improve the relevance and adequacy of collected datasets whilst ensuring that they adequately addressed the rehabilitation objectives and criteria defined for Clarence. Furthermore, this change also allowed for maintaining consistency in monitoring methods between Centennial mine sites in the region. However, the application of different methods implied that some of the data collected in previous monitoring campaigns could not be directly compared and analysed against the 2018 results. Historic rehabilitation monitoring data remain however relevant and valuable in terms of documenting rehabilitation performance and progress over time.

Finally, it is important to note that this 2018 monitoring event was the fifth since the State Mine Bushfire proceeded through Clarence site 17 October 2013, impacting both rehabilitation and analogue sites. The monitoring results provide a good indication on the resilience and recovery rate of the rehabilitated vegetation communities at Clarence, and how they compare to the resilience observed in analogue sites.

1.2 Report Scope and Structure

This report presents the findings of the 2018 annual rehabilitation monitoring program conducted in February 2019 by Koru Environmental Pty Ltd on behalf of Clarence Colliery Pty Limited – a Centennial Coal company. Assessments included the study of nine long-term monitoring transects as well as a high-level walkover inspection of all rehabilitated areas to record the general condition of the rehabilitation and detect potential maintenance issues. This document is structured as follows:

- **Section 2** – highlights rehabilitation requirements and objectives for Clarence;
- **Section 3** – outlines the revised rehabilitation monitoring methodology adopted in 2018;
- **Section 4** – presents the 2018 results from the long-term (transect-based) monitoring assessments;
- **Section 5** – presents the results of the 2018 rehabilitation walkover inspection;
- **Section 6** – summarises current rehabilitation condition across the site; and
- **Section 7** – outlines the recommendations suggested to improve rehabilitation performance.

2. Post-Mined Lands Rehabilitation

2.1 Rehabilitation Planning and Management

Rehabilitation planning and activities at Clarence are undertaken in accordance a MOP approved by NSW Resources Regulator. The current MOP (Jan 2018 – Oct 2022) (SLR, 2017) also fulfils the function of Rehabilitation Management Plan (RMP) for the site, and was prepared to meet relevant requirements of development consents.

Reject material from the washing activities at Clarence is placed onto Reject Emplacement Areas (REAs), which are progressively rehabilitated as they reach capacity. Rehabilitation activities start with the shaping and capping of the REA. The cap typically consists of approximately 0.5m to 0.8m of sandstone subsoil covered by compacted clay. The capped area is then topped with a minimum of 100mm of topsoil or suitable alternative before revegetation activities are undertaken.

There are currently six approved REAs at Clarence:

- REAs I, II and IV are closed and fully rehabilitated.
- REAs VI is the only two areas currently receiving rejects whilst REA III is in care and maintenance. Both REAs are planned to be fully rehabilitated and closed during the term of the current MOP.
- Construction and rejects emplacement are planned to begin within REA V during the term off the current MOP.

2.2 Post-Mining Land Use Goals

Post-mining land use and landscape goals are outlined in Section 4.2 of the MOP (2018-2022).

The conceptual long term mine rehabilitation objective is to provide a low maintenance, geotechnically stable and safe landform that is commensurate with the surrounding area. The intended post-mining land use for the areas disturbed by the operations will be of native woodland commensurate with the adjacent native vegetation – i.e. consistent with 'Sydney Montane Dry Sclerophyll Forest' native local communities.

It is anticipated that preliminary options will be reviewed in more detail at the commencement of the detailed closure planning stage which, will be no later than five years from permanent mine closure. It is recognised that there may be opportunities for infrastructure (such as roads and buildings) to remain to service future industries, as well as other potential re-use and/or recycling opportunities for the site.

2.3 Rehabilitation Objectives

Rehabilitation objectives for Clarence are defined in Table 12 (p.42) of the MOP (2018-2022). Key objectives include:

- Integration of rehabilitated areas of native vegetation with undisturbed native vegetation to provide consolidated areas and wildlife corridors where possible.
- Creation of a stable landform with self-sustaining vegetation compatible with the surrounding native communities.
- Control of noxious weeds and feral animals.
- Rehabilitation areas to be clean and tidy and not present a hazard to persons or native fauna.

To achieve these objectives, rehabilitation planning has been undertaken in the MOP and mining 'domains' defined, each of which requiring a different rehabilitation methodology to successfully achieve the intended post-mining land use.

Relevant to this rehabilitation monitoring program is the 'secondary' woodland rehabilitation domains, i.e. areas of rehabilitation where the intended final land use of native woodland has been or is being re-established. Rehabilitation commitments and objectives for this domain are reproduced in **Table 1**.

Table 1 Secondary domains rehabilitation objectives

Domain	Rehabilitation Objectives
Rehabilitation – Woodland	• All infrastructure removed or made safe. • All hazardous materials and contaminated materials removed. • Stable landform that is non-polluting. • Drainage structures will be designed and constructed where required in accordance with the Blue Book. • Class V Land and Soil Capability. • Ecosystem health satisfying completion criteria. • Ecosystem structure satisfying completion criteria. • Ecosystem composition satisfying completion criteria.

2.4 Current Rehabilitation Status

At the time of the 2018 rehabilitation monitoring program implementation, a total of approximately 40.0 hectares (ha) of native woodland rehabilitation had been completed at Clarence across REAs I, II, III and IV.

Rehabilitation activities on REA II were completed in 1996, while REA I and III were rehabilitated in 2002. The rehabilitation of REA IV started in late 2012 with final completion in late 2016.

3. Methodology

3.1 Long-term (Transect-based) Monitoring

3.1.1 Monitoring Sites

A total of nine woodland monitoring sites were assessed during the 2018 program of works, consisting of:

- Six rehabilitation sites including four historic (existing) sites and two new sites (established to increase sites density and improve data coverage and representativeness); and
- Three analogue sites.

Analogue sites are a central component of the rehabilitation monitoring program, they are used to derive target benchmarks against which rehabilitation performance can be assessed, particularly with reference to species diversity, assemblages and vegetation structure. The analogue sites are located in nearby areas of undisturbed native vegetation representative of local vegetation type and condition, and generally mapped as '*Exposed Blue Mountains Sydney Peppermint - Silver-top Ash Shrubby Woodland*' (DEC, 2006).

Furthermore, it is noted that following recommendations made in the 2017 rehabilitation monitoring report (AECOM, 2018) and with the aim to remove results bias from poor transect placement, the historic monitoring sites located within REA IV (coded 'RHB4') was relocated in 2018 – effectively acting as a new monitoring site.

Each monitoring site consisted of a standardised 50m long transect, with a nested 10m x 30m plot and lm xlm quadrats, as depicted in **Figure 1**. To facilitate repeated measurements over time, all sites were permanently located with metal star pickets at the start and end points of the 50m line, and their geographical coordinates recorded using a GPS (±3m accuracy).

The suite of monitoring sites assessed in 2018 is presented in **Table 2**, with their location mapped in **Figure 2**.

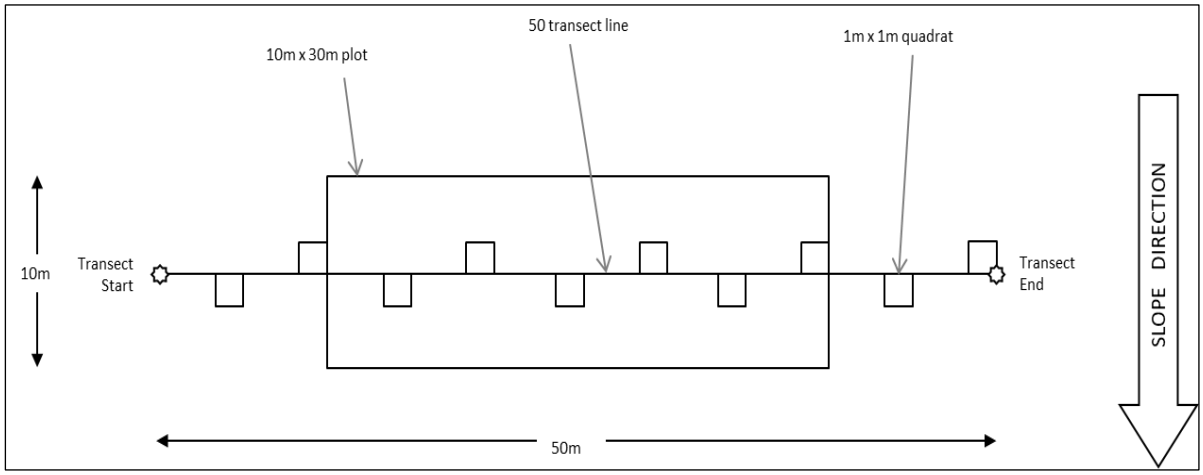


Figure 1 Monitoring site layout

Table 2 Clarence rehabilitation monitoring program – 2018 monitoring sites

Site Code	Type	Rehabilitation Establishment	Slope (deg)	Coordinates (GDA94 Zone 56)	
				Easting	Northing
RHB 1	Rehabilitation (existing)	2002	12	244291	6294105
RHB 2	Rehabilitation (existing)	1996	12	244563	6293796
RHB 3a	Rehabilitation (existing)	2002	17	244665	6294303
RHB3b	Rehabilitation (new)	2002	22	244752	6294210
RHB 4a	Rehabilitation (new)	2015	17	244412	6293568
RHB 4b	Rehabilitation (new)	2016	20	244299	6293670
ANA 1	Analogue	N/A	3	244632	6293686
ANA 2	Analogue	N/A	12	244659	6294391
ANA 3	Analogue	N/A	10	244521	6294450

KORU ENVIRONMENTAL

N W E S

0 30 60 120
metres

1:4,836 (when printed at A4)

MAP SIZE:	A4 Portrait	**PROJECT REF:**	P2018-008
DATUM:	GDA 1994	**CREATED BY:**	mcatteau
PROJECTION:	MGA Zone 56	**DATE CREATED:**	27-Feb-2019

LEGEND

- Rehabilitation areas

Monitoring sites

- 50m transect start
- 50m transect end
- Transect line

Clarence Colliery
Rehabilitation Monitoring 2018

FIGURE 2

Rehabilitation Areas and Monitoring Sites Locations

3.1.2 Field Data Collection

At each of the monitoring sites, the metrics and attributes listed in **Table 3** were assessed and recorded.

Table 3 Monitoring metrics and assessment methods

Metric	Sampling area	Methods
Site attributes	General area surrounding transect	• For each monitoring site the vegetation community type, age of rehabilitation, slope, transect geographical coordinates and transect orientation were recorded.
Photographic monitoring	50m transect line	• Photographs were taken from start the transect with the end of transect in centre background, and from the end of the transect looking in.
Soil monitoring	10m x 50m plot	• A composite soil sample (made up of 5-6 x sub-samples) was collected and sent to a NATA-accredited laboratory for analysis of soil chemistry. • Whilst collecting the sub-samples with a hand shovel, the thickness of the growing media layer was assessed and confirmed.
Erosion	10m x 50m transect area	• Erosion was assessed in accordance with the guidelines in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009) for sheet, rill, gully and tunnel erosion. • Where rills and gullies were present, their location, width and depth were recorded along the 50m transect line.
Landscape function	50m transect line	• The Landscape Function Analysis (LFA) monitoring tool was implemented strictly as per Tongway and Hindley (2004); including landscape organisation characterisation and soil surface assessments.
Ground cover protection and floristics	1m x 1m quadrats	• The percentage cover live vegetation (projected), organic litter, rocks >100mm and bare ground were visually estimated. • All ground cover species (grasses, forbs, sub-shrubs, etc.) were identified (where possible) and recorded, and assigned a percentage cover score.
Vegetation community composition and structure	10m x 30m plot	• All trees and shrub species were identified and recorded. • A count was undertaken of all tree stems (long-lived canopy tree species only i.e. eucalypts) to determine the overall stem density. • Tree stems were categorised in DBH classes (diameter at breast height) using the following classes: <5cm, 5-9cm, 10-20cm, 20-30cm, 30-50cm, >50cm. • The height range of both the mid-storey (shrubs and small trees) and over-storey (eucalypts) vegetation layers was estimated and recorded.
	At 10 points along 50m transect	• At every 5 metres, the foliage percent cover (FPC) of both over and mid-storey vegetation (i.e. trees and shrubs) directly overhead were estimated to the nearest 5%, using for reference the estimation charts provided in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009).
Community health and resilience	10m x 30m plot	• The condition of each recorded tree (long lived eucalypts only) was assessed as healthy, sick or dead. • The number of tree species with second generation seedlings (i.e. <5cm DBH) and the number of species bearing reproductive material (i.e. flowers/fruits) was recorded. Regeneration status for the site was assessed as follows: - Active: second generation seedlings present. - Potential: no seedlings but reproductive material present. - Nil: no seedlings or reproductive material present.
Habitat complexity	10m x 50m plot	• Habitat complexity was assessed at the start (0m), centre (25m) and end (50m) of the 50m transect line as per the guideline defined in Tongway and Hindley (2004). Individual scores from the three assessment points were averaged to determine the habitat complexity score for the site. • The presence and abundance of ground logs/woody debris, large rocks or other artificial habitat features was quantified and recorded. • The number of hollow-bearing stems in live trees was counted and recorded.

3.2 Walkover Inspection

The walkover inspection is intended as a complement to the long-term (transect-based) monitoring, and consisted of a high-level assessment of all rehabilitated lands across the site with the objective to identify any potential issues / deficiencies requiring maintenance treatments.

While covering the rehabilitated areas on foot (ensuring optimum geographical coverage within the available time allocation), opportunistic sightings and assessments were made identifying the following factors where relevant:

- Stability of slopes and landforms – including presence and severity of active erosion areas (e.g. rill, gully and tunnel erosion);
- Function and condition of existing erosion and sediment control structures and landform features, including water management structures (e.g. drains), water ponding areas, etc. (where applicable);
- Visual assessment of ground protection and vegetation cover, vegetation health and growth rates;
- Areas of significant weed incursion;
- Evidence of presence/impact of vertebrate pests; and
- Any other disturbance factors or features, such as presence of mine waste, track disturbance, damaged fences etc.; and

GPS points (±3m accuracy) and geo-referenced photographs were taken of all observations made during the assessment. By collecting geo-located photos, areas can be re-visited in the future and photo-monitoring continued to demonstrate the evolution of the site condition over time.

3.3 Works Implementation

3.3.1 Monitoring Dates

Field data collection took place between 13th and 15th February 2019, and was conducted by Matthieu Catteau (Principal Rehabilitation Scientist) from Koru Environmental.

Monitoring activities were supervised by Brett Campbell of Centennial Coal.

3.3.2 Weather Conditions

It is important to first note that that an official state of drought was declared for the state of NSW in early August 2018 by the NSW Department of Primary Industries (DPI) as a result of the very dry conditions enduring since late 2016, and that at the time of the 2018 monitoring the locality remained in a drought affected condition (as per drought update report dated 22 February 2019).

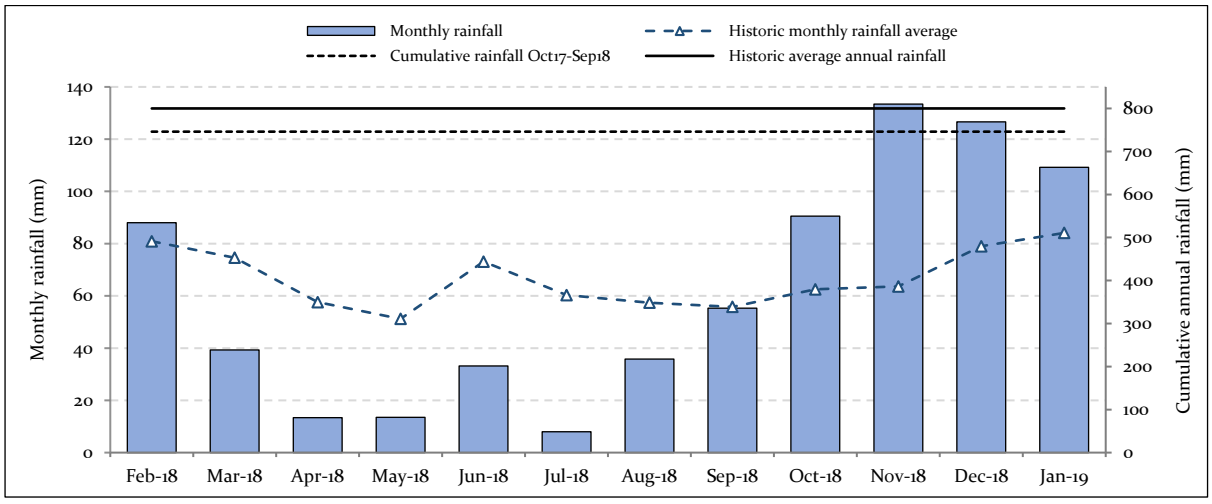
For further reference, weather data for the 12 months leading to the 2018 monitoring event (i.e. from February 2018 to January 2019) have been presented graphically in **Graph 1** (rainfall) and **Graph 2** (temperature), together with historical data ranges included for comparison purposes (data from BoM stations Lithgow (Cooerwull) No. 063226).

Recent data showed that the locality received significant rainfall in the four months leading to the monitoring event (i.e. above monthly seasonal averages between October 2018 and January 2019). Thanks to this recent rainfall events, total rainfall received during the last 12 months was only slightly below annual average (746mm v.sm 800mm). However, conditions were very dry during between March and September 2018 which may have exacerbated the long-term effects of the drought.

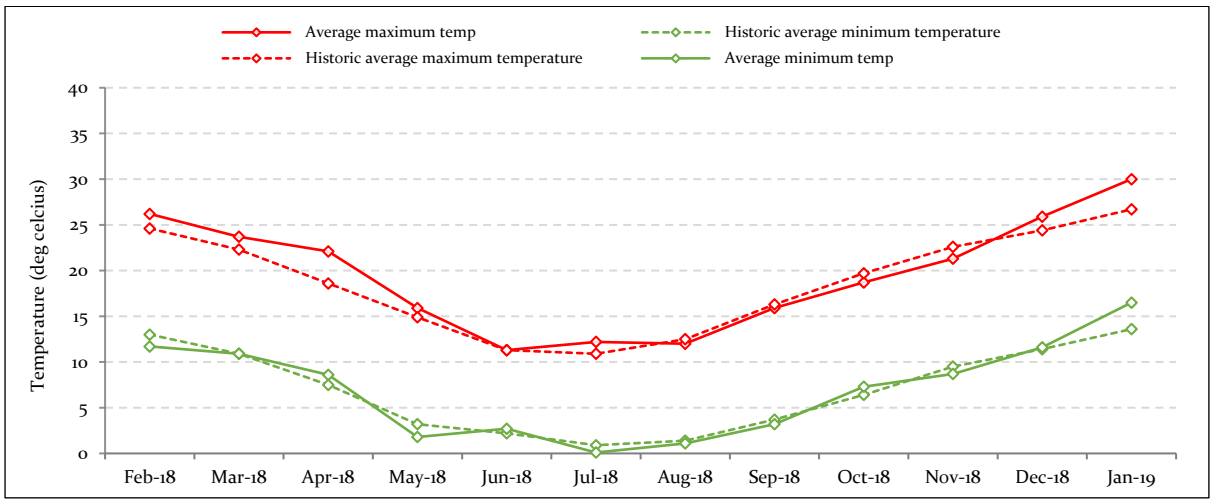
In addition, the locality experienced unseasonably hot summer and autumn 2018 and summer 2019 seasons, with average maximum temperature well above seasonal averages for the region.

Overall and notwithstanding the recent rainfall, the dry conditions of the past two years have likely influenced the condition and state of local vegetation and hence the results and observations collected during the 2018 rehabilitation monitoring program, including:

- Conditions poorly conducive to seed germination and therefore establishment (or survival) of new seedlings / plants;
- Increased water / heat stress impacts on shrubs and trees, leading to restricted plant growth and vigour and potentially to plant dieback;
- Lack of reproductive material or structure on plants, in cases leading to impossible or uncertain identification of observed specimens;
- Detrimental impacts on ground cover plant growth and vigour, potentially exacerbating grazing impacts from herbivores (with herbivory impacts further affecting positive species identification);
- Detrimental impacts on total species diversity, vegetation structure and foliage cover; and
- Reduced erosive forces/potential and sediment movement as a function of the poor rainfall and general absence of significant rainfall events (i.e. significant erosion may not have occurred over the past 12-18 months).



Graph 1 Local rainfall data (Feb18-Jan19)



Graph 2 Local temperature data (Feb18-Jan19)

3.4 Data Analysis and Interpretation

Field collected data were analysed with the view to provide an accurate assessment of current rehabilitation performance against the rehabilitation completion criteria defined in the MOP. For reference, criteria defined for the 'rehabilitation – woodland' domain have been reproduced in **Table 4**, which also indicates the associated monitoring component / metrics metric used to undertake compliance assessment. (Note that for legibility purposes some criteria have been reworded or grouped where relevant).

Table 4 MOP completion criteria for woodland rehabilitation

Completion criteria	Monitoring metric
Landform	
Final landform is consistent with surrounding landforms	Walkover inspection
Slopes are generally less than 10 degrees and no more than 14 degrees without approval	Site attributes (slope) Walkover inspection
Erosion control structures installed at intervals commensurate with the slope of the landform and direct water into stable areas or sediment control basins	Walkover inspection
Landforms are stable	Erosion assessments Walkover inspection
Growing media	
Soil analysis undertaken to determine potential constraints to rehabilitation	Soil monitoring
Topsoil or alternative dressing media spread at depth of 100-300mm	Soil monitoring
Ecosystem establishment and sustainability	
Minimum of 60% protective ground cover, and no bare surfaces >20m^2 or >10m in length down slope	Ground cover protection Walkover inspection
Evidence of nutrient cycling processes (i.e. presence of litter, cryptograms, etc.)	Ground cover protection
A mixture of native trees, shrubs and grasses representative is present	Vegetation composition
Dominant species aligned with those in local native woodland communities	Vegetation composition
Total woody species richness within 20% of analogue sites	Vegetation composition
>75% of trees are healthy and growing	Vegetation health
Established species survive and/or regenerate after disturbance	Community resilience
Evidence of natural regeneration potential (2nd generation seedlings or reproductive structures on plants)	Community resilience
Weed cover <15%	Vegetation composition
Animal pests do not occur in substantial numbers or visibly affect the development of planted species	Walkover inspection
Habitat features or structures suitable for fauna habitat are incorporated	Walkover inspection
Presence of a range of structural habitats (eucalypts, shrubs, ground cover, developing litter layer)	Vegetation structure
Habitat complexity score >4.0	Habitat complexity

4. Results – Long-term Monitoring

Note: in the following section, the monitoring results showed in blue font indicate an acceptable rehabilitation performance for the specific metric/attribute (i.e. meeting completion criteria and/or commensurate to analogue benchmarks (within 20%)); whilst red font indicates otherwise.

4.1 Photographic Monitoring

With the view to assist in the interpretation of the results presented in the following sections, photographs taken from the permanent photo points are provided below which show the condition of each monitoring site at the time of the 2018 monitoring event.

Site (date)	View from start of transect (0m)	View from end of transect (50m)
RHB 1 (14/02/19)		
RHB 2 (15/02/19)		
RHB 3a (13/02/19)		

RHB 3b (15/02/19)		
RHB 4a (14/02/19)		
RHB 4b (14/02/19)		
ANA 1 (15/02/19)		

ANA 2 (13/02/19) ***[Note: start photo from 2017 monitoring event]***		
ANA 3 (13/02/19)		

4.2 Soils

This section provides a summary of results for key soil performance indicators, i.e. those most likely to limit or restrict vegetation establishment and growth or to promote erosion. Detailed laboratory soil analyses results are included in **Appendix A** for additional reference.

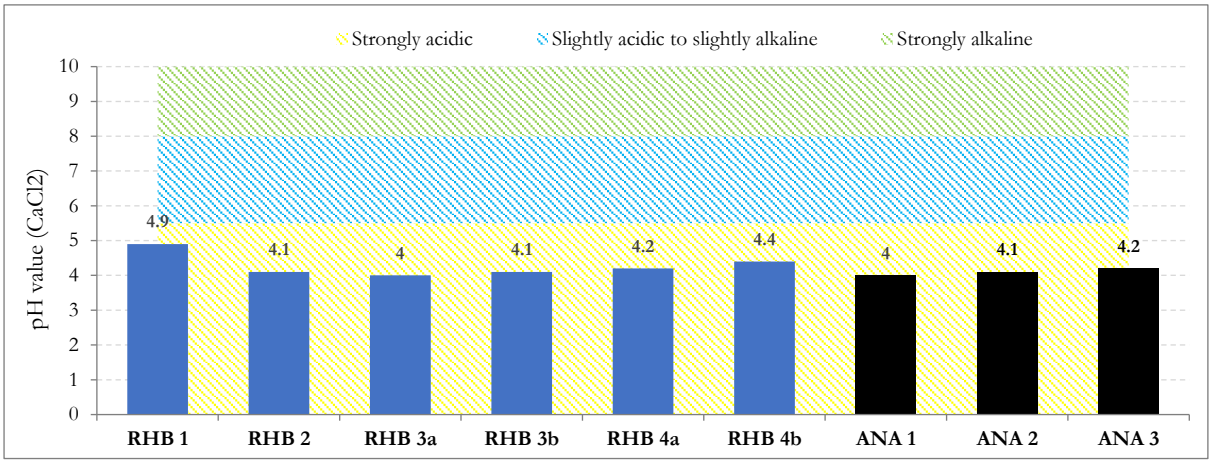
4.2.1 Soil Type and Cover

Soils across the rehabilitation areas were similar in texture and consisted of sandy loams (RHB 1, RHB 3b, RHB 4a and RHB 4b), sandy clay loams (RHB 2) or clayey sands (RHB 3a) – i.e. very low clay content, which was consistent with those recorded at the analogue sites. These soil types are typically associated with moderate to poor coherence but good infiltration rates.

Soil cover was estimated as satisfactory and >100mm at all rehabilitation monitoring sites.

4.2.2 Soil Acidity

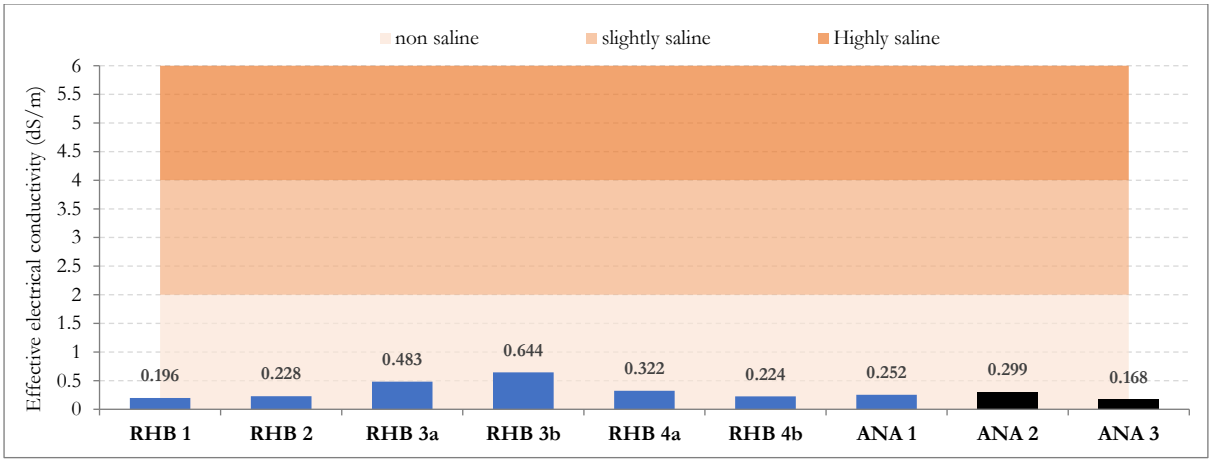
The laboratory analyses results indicated minimal variance in soil acidity levels between the monitoring sites (inclusive of rehabilitation and analogue areas) – all soils returning strongly acidic with pH ($CaCl_2$) levels comprised between 4.0–4.9 (**Graph 3**). Such acidity levels are typical of soils naturally occurring in the region and consequently are adequate for the establishment and growth of endemic native woodland species.



Graph 3 Soil acidity levels (pH $CaCl_2$)

4.2.3 Soil Salinity

Soil electrical conductivity (EC) levels are presented in **Graph 4**, noting that the results reported in the laboratory report (**Appendix A**) were converted to effective EC (eEC) to account for soil types (as per the guidelines in Hazelton & Murphy, 2007). The results showed that all samples had very low eEC levels (<1.0 dS/m), indicating that soil salinity was not an issue at the site.



Graph 4 Soil salinity levels

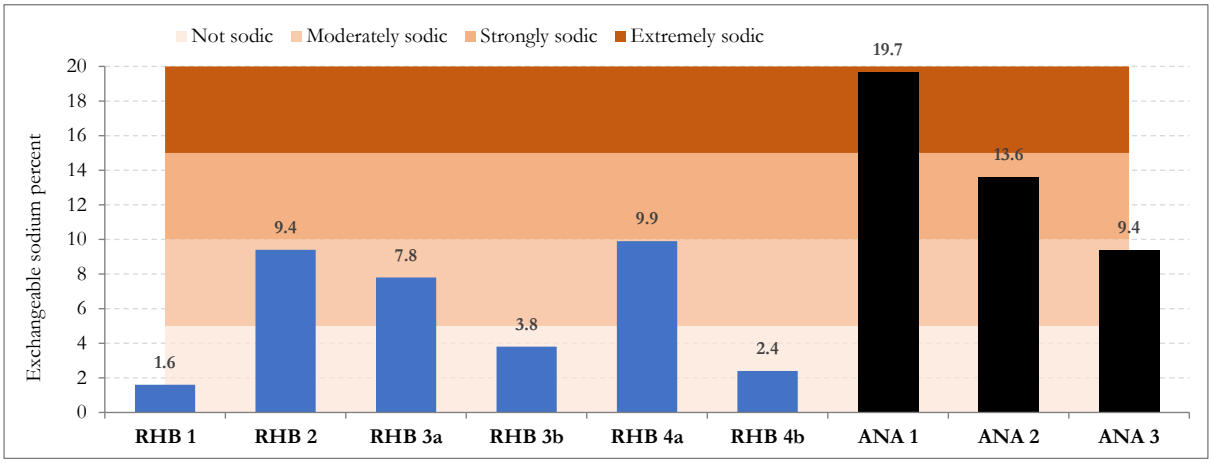
4.2.4 Soil Sodicity and Dispersion

As shown in **Graph 5**, soil sodicity levels were highly variable between the monitoring sites:

- Three of the six samples from the rehabilitation sites were not sodic (RHB 1, RHB 3b and RHB 4b), whilst the other three samples were moderately sodic (RHB 2, RHB 3a and RHB 4a).
- The samples collected from the analogue sites were moderately to extremely sodic, and soil sodicity was on average greater in analogue areas than across the rehabilitation.

Results from the analogue sites highlighted that natural soil profiles contain high proportions of sodium, therefore the sodicity occurring within the rehabilitation should not be a barrier to vegetation establishment and growth. Indeed, soil sodicity in the local soils is buffered by the very low pH levels, soil sodicity being mainly an issue in alkaline soils or soils with higher clay content.

In addition, the testing results showed that all samples returned an Emerson Class number of 3 or 4 (refer to **Appendix B**), which implied that the soils may slake but are unlikely to disperse. This means that the existing sodicity levels are unlikely to have a detrimental impact on soil stability, which correlates well with the generally good slope stability and minimal erosion recorded in the rehabilitation.



Graph 5 Soil sodicity levels

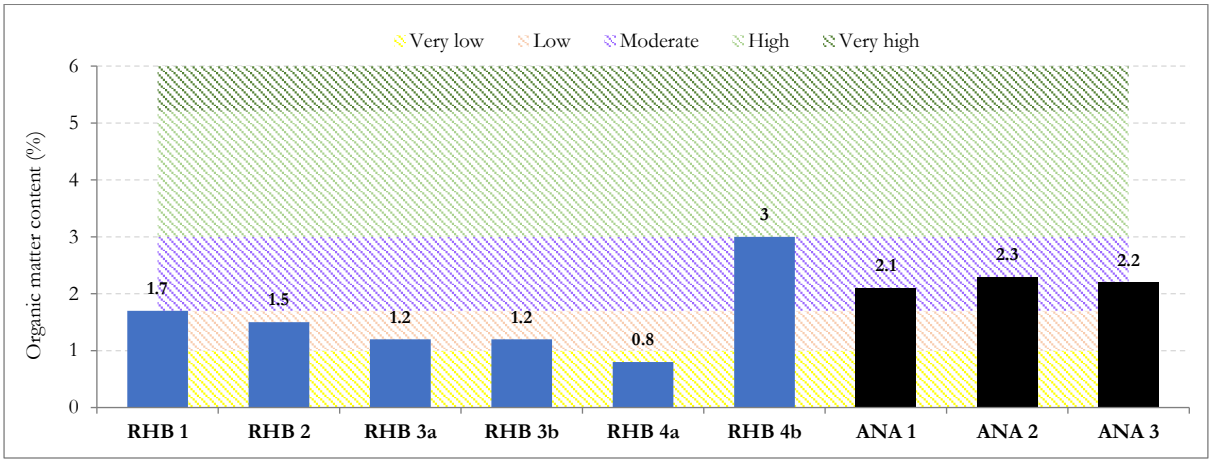
4.2.5 Soil Organic Matter

Testing results for organic matter (OM) content are presented in **Graph 6**. The levels of OM in soils are a key indicator of soil structure stability, water holding capacity and overall soil fertility (through the storage of nutrients and food source for soil microbes).

The results indicated that OM levels at the analogue sites were moderate (2.1-2.3%), comparing to the generally low to very low levels recorded at the rehabilitation sites (<1.7%). The exception being for RHB 4b which returned moderately high levels of soil OM (3%), reflecting the good ground cover and vegetative performance at this location.

The somewhat limited levels of soil OM at the analogue sites were likely explained by the 2013 bushfire which entirely removed the litter layer and surface organic matter.

Generally, the lower levels of OM in the rehabilitation was a function of the younger and less matured/developed soil profiles in these locations. Soil OM should gradually increase over time has communities further establish and litter is returned and accumulates on the ground.



Graph 6 Soil organic matter

4.3 Erosion

Erosion monitoring results are summarised in **Table 5**, which shows that superficial but active sheet erosion processes were occurring at most monitoring sites except RHB 1 and RHB 4b where excellent ground cover protection and soil stability was achieved (refer to **Section 4.4**).

Erosion processes at RHB 2, RHB 3a and RHB 3b were of low severity and resultant soil loss was generally minimal. The rehabilitation and soil profile in these areas were relatively well-established and overall slope and landform stability were satisfactory. A localised residual rill channel of low severity (<20cm deep) was also noted at RHB 3a, however the erosion feature has showed no obvious degradation over the past five monitoring events and is considered stabilised.

Sheet erosion severity and soil losses were significantly greater at RHB 4a as a function of the very poor ground cover protection, steeper slope gradients and high erodibility of the substrate (i.e. consisting of a sandy loam). The slopes and landform within the broader area remained generally satisfactory at the time of the 2018 monitoring and the installed erosion controls (jute mesh, small rock strips, etc.) provided good soil anchoring. However, this should also be placed in context of the relative lack of frequent rainfall events during the past 2 years, and slope stability at REA IV should be regularly and closely monitored until the existing vegetation establishes further.

In all cases surface water and sediments adequately reported into erosion control structures including contour banks and diversion drains, in turn feeding into sediment basins.

Table 5 Erosion monitoring results

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Sheet erosion	0	1	1	1	2	0	0	0	0
Rill erosion	0	0	0	0	0	0	0	0	0
Gully erosion	0	0	0	0	0	0	0	0	0
Tunnel erosion	0	0	0	0	0	0	0	0	0
Total score	**0**	**1**	**1**	**2**	**0**	**0**	0	0	0
Erosion status	**Stable**	**Stable**	**Stabilised**	**Stable**	**Active**	**Stable**	Stable	Stable	Stable

4.4 Ground Cover Protection

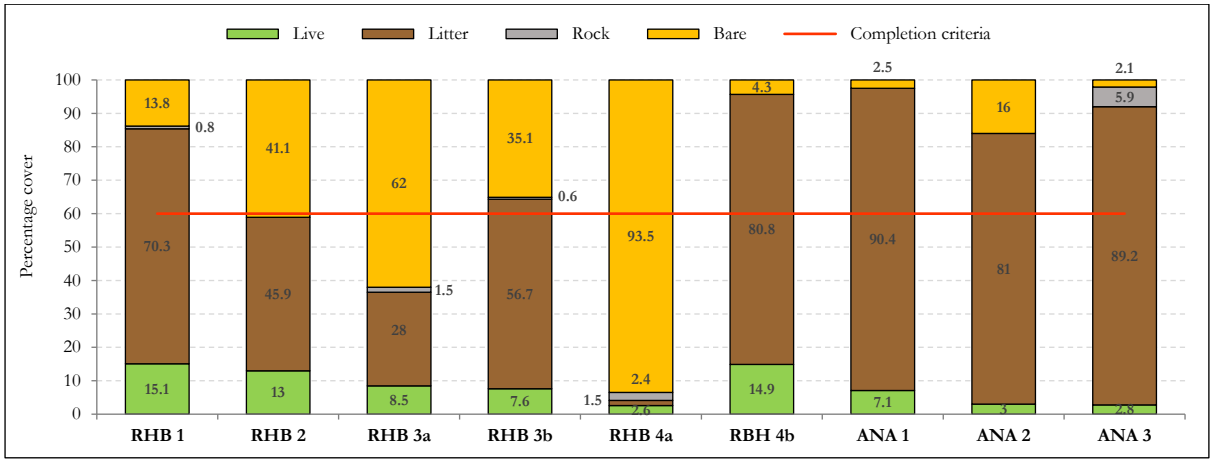
The ground cover assessments results have been presented in **Graph 7**, which highlights variable performance between the monitoring sites. Overall, the results showed that ground protection at the rehabilitation sites was consistently dominated by organic litter, typically with only low to very low levels of live vegetation. This however was consistent with the condition observed in analogue areas and is characteristic of the natural condition of local native vegetation communities.

The ground cover completion criterion (i.e. minimum 60% cover) was achieved at three of the six rehabilitation sites (RHB 1 and RHB 3b and RHB 4b), whilst protective cover remained unsatisfactory at the other three monitoring sites (RHB 2, RHB 3a and RHB 4a) where moderate to high levels of exposed bare ground remained.

Ground cover performance was particularly poor at RHB 4a (>90% bare ground) where revegetation was implemented solely using tubestock plantings and with no prior ground cover enhancements (i.e. seeding with ground cover species or spread of logs/coarse woody debris).

At most sites where ground cover protection was limited a satisfactory diversity and densities of shrubs and trees generally occurred, therefore it is expected that ground cover should gradually improve with time as vegetation further establishes and foliage canopy increases (i.e. leading to higher rates of litter

return to the surface). However, this would be accelerated through the incorporation / spread of organic matter on the soil surface (e.g. mulch, compost, bio-solids, straw, etc.), which would have the added benefit of minimising the risks of soil erosion associated with exposed surfaces.



Graph 7 Ground cover protection monitoring results 2018

4.5 Landscape Function

It is noted that the LFA methodology and resultant scores do not automatically define poor, moderate of good performance condition for the systems assessed. Rather, the significance of the index scores comes from comparing rehabilitated sites with analogue sites and developing a range of benchmark values for each indicator.

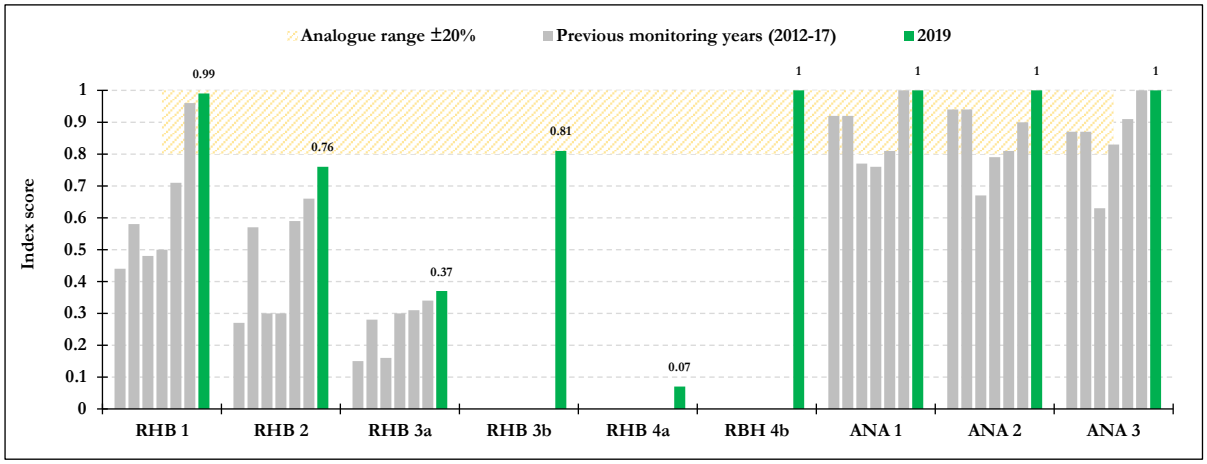
4.5.1 Landscape Organisation

A patch is a long-lived feature or ground obstruction (e.g. perennial ground vegetation, log, large rock, created furrow, etc.) collecting/retaining valuable resources such as topsoil and organic matter in situ, which can then be used by biota. In contrast, an inter-patch is an area where such resources are freely transported downslope with surface runoff and lost from the local system, such as bare ground.

The landscape organisation index (LOI) is calculated by the length of the patch divided by the length of the transect to provide a percentage (or index) of the transect which is occupied by the functional patch areas (Tongway and Hindley, 2004). Typically, LOI scores are therefore correlated to the protective ground cover performance at a monitoring site.

The 2018 LOI scores are presented in **Graph 8**, alongside previous years scores which have been included for comparison purposes.

- Landscape organisation performance was excellent and within range of the analogue sites (i.e. within 20%) at RHB 1, RHB 3b and RHB 4a, reflecting the good ground cover in these locations.
- At RHB 2 the LOI score was only slightly below the analogue range for an overall satisfactory performance.
- With high levels of exposed bare ground at RHB 3a and RHB 4a, landscape organisation remained poor in 2018.
- All sites where previous years values were available recorded another successive increase in LOI index score since the 2013 fire, highlighting a sustained recovery and good resilience of the systems from the disturbance.

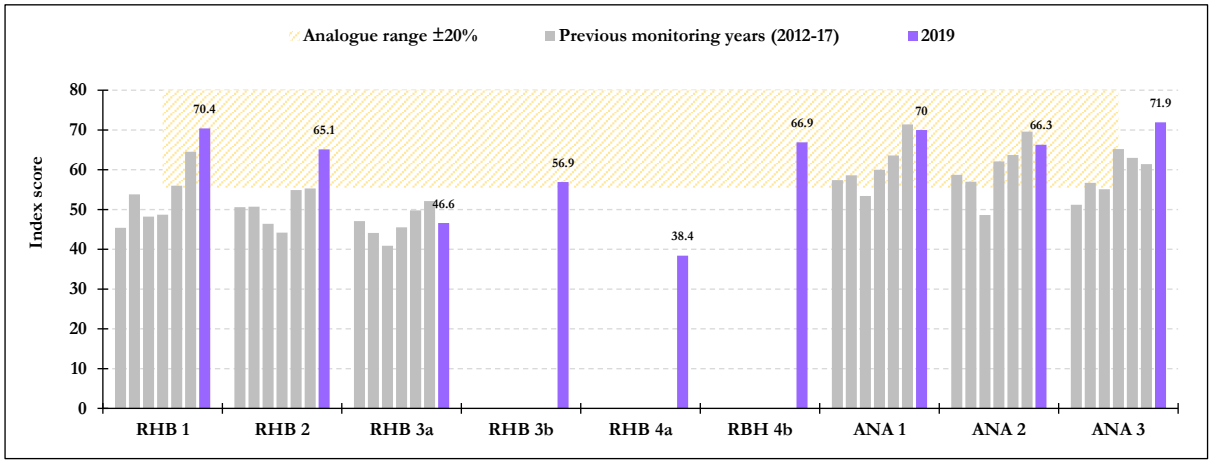


Graph 8 LFA – Landscape organisation index scores

4.5.2 Soil Surface Stability

Soil surface stability is calculated from a range of condition indicators/attributes including vegetation, litter and cryptogram cover, surface crusting, erosion, deposited materials, surface resistance to disturbance and the slake test. The 2018 soil surface stability index scores are presented in **Graph 9**, alongside previous years scores which have been included for comparison purposes.

Distinct improvement in stability scores were observed for RHB 1 and RHB 2, whilst a slight decrease was recorded at RHB 3a. With a component of perennial ground vegetation, high levels of trapped litter and minimal erosion processes, soil surface stability in 2018 was within analogue benchmarks at RHB 1, RHB 2, RHB 3b and RHB 4b. Stability remained however lower at RHB 3a and RHB 4a due to poor ground cover and active sheet erosion.



Graph 9 LFA – Soil surface stability index scores

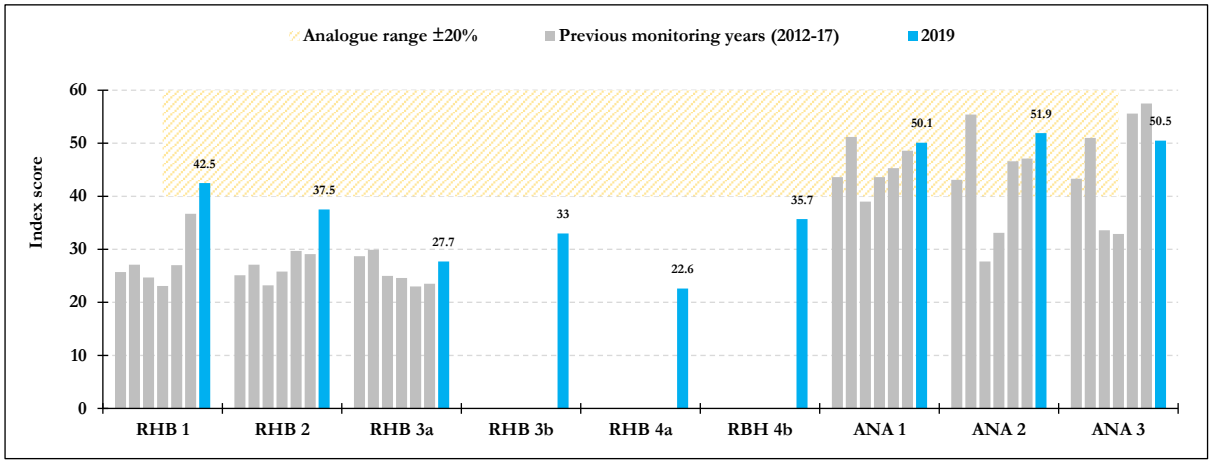
4.5.3 Soil Surface Infiltration

Soil surface infiltration potential is calculated from a range of condition indicators/attributes including vegetation and litter cover, litter decomposition, soil surface roughness, surface resistance to disturbance and the slake test. The 2018 soil surface infiltration index scores are presented in **Graph 10**, alongside previous years scores which have been included for comparison purposes.

Positively, all previously monitored sites recorded a significant increase in infiltration scores in 2018. However and with the exception of RHB 1 which achieved a good performance, infiltration potential at

the rehabilitation sites still compared negatively against analogue values; although it is noted that index score for RHB 2 and RHB 4b were only slightly below benchmarks (i.e. <5%).

The difference in soil infiltration potential between rehabilitation and analogue areas was likely due to the greater levels of litter (and in a more advanced state of decomposition) and less compacted surfaces at the analogue sites which promotes easy water infiltration through the soil profile. In contrast, the soil surface at the rehabilitation sites was typically harder and compacted, leading to lower infiltration rates.

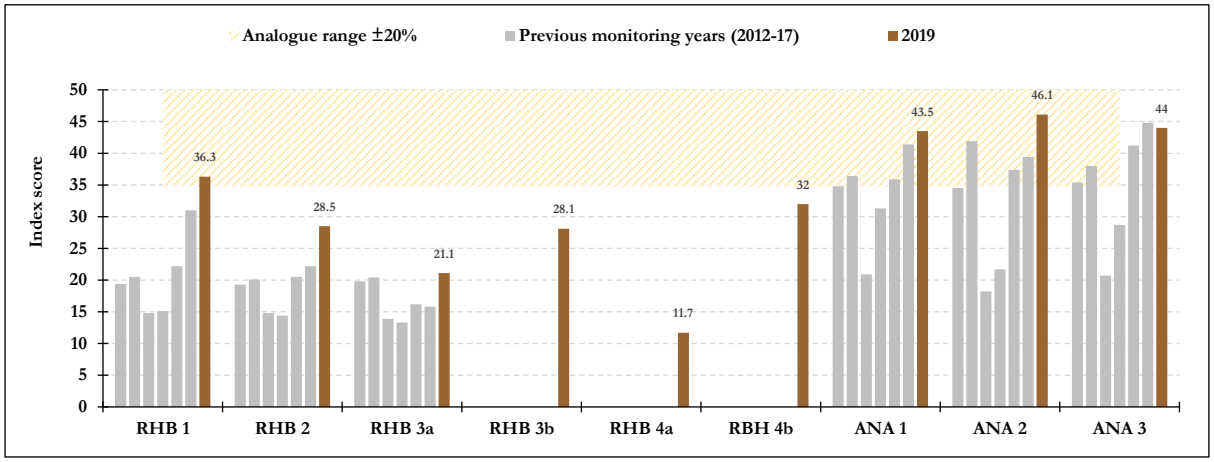


Graph 10 LFA – Soil surface infiltration index scores

4.5.4 Soil Surface Nutrient Cycling

Soil surface nutrient cycling is calculated from a range of condition indicators/attributes including vegetation cover, litter decomposition, cryptogram cover and soil surface roughness. The 2018 nutrient cycling index scores are presented in **Graph 11**, alongside previous years scores which have been included for comparison purposes.

Consistently with the infiltration score (which is driven by a similar set of attributes), all previously monitored sites recorded a significant increase in nutrition in 2018. In-situ soil nutrient cycling was within analogue benchmarks at RHB 1 and just slightly below benchmarks at RHB 4b (<5% from benchmark). The lower levels of ground litter at the other four monitoring sites translated into nutrient index scores still comparing negatively against analogue values in 2018.



Graph 11 LFA - Soil surface nutrient cycling index scores

4.5.5 Overall Soil Surface Condition

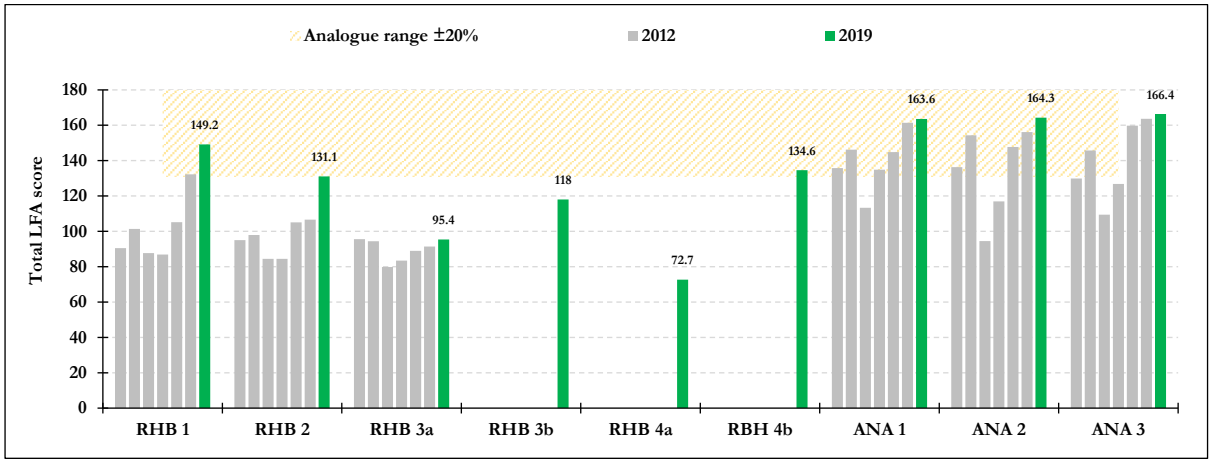
The sum of the soil stability, infiltration and nutrient cycling indices provides an indicator of the overall functionality of the landscape at each of the monitoring site – this has been presented in **Graph 12.**

The results showed that the three analogue sites were the most functional sites, which was based on the excellent ground cover levels, thick and decomposing litter layer, well established mid and upper vegetation layers, absence of erosion and mature soil profiles.

Three of the rehabilitation sites (RHB 1, RHB 2 and RHB 4b) were within 20% of the analogue values and therefore can be considered as trending towards the analogue sites in terms of landscape functionality. In comparison, RHB 3b showed moderate total landscape function whilst RHB 3a and RHB 4a were the least functional sites (respectively), which was a function of the poorer ground cover, vegetation establishment and active erosion processes in these areas.

As noted in the 2017 monitoring report (AECOM, 2018), all LFA scores now exceed their pre-fire levels, which indicates that the fire may in fact have been beneficial in terms of promoting/inducing germination and vegetation growth.

Finally, it is expected that LFA scores should keep improving over time in the rehabilitation as vegetation further establishes, greater levels of organic matter are returned to the ground and soil profiles mature and develop.



Graph 12 LFA – Sum of soil surface condition index scores

4.6 Vegetation Community Establishment

4.6.1 Community Composition

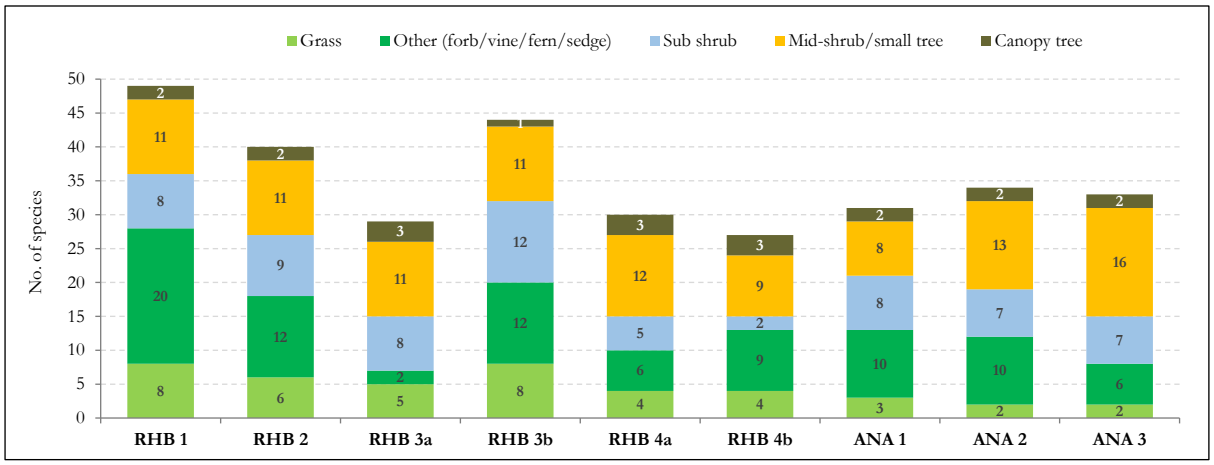
Vegetation community composition performance recorded in 2018 have been summarised in **Table 6** and **Graph 13**. Detailed floristics monitoring results have been provided in **Appendix B** for further reference.

A total of 104 species were recorded at the monitoring sites during the floristics assessments, including 95 native species and 9 exotic species (i.e. 91.3% native species).

Total species diversity was variable between the monitoring sites and ranged from moderate to high, with the most diverse site being RHB 1 (49 species) and the least diverse RHB 3a (28 species). Species assemblages were largely dominated by native species in all vegetation layers, and at all rehabilitation sites except RHB 4b the total recorded native biodiversity was comparable or exceeded analogue values.

Table 6 Floristics performance summary

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Total species diversity	49	40	28	44	29	27	31	34	33
Total native species	42	40	27	42	29	24	31	34	33
Total exotic species	7	0	1	2	0	3	0	0	0
Ground cover species (grasses + sub-shrubs + others)	36	27	15	32	15	15	21	19	15
Average ground cover species per m^2	8.2	7.0	3.9	6.8	2.2	4.2	6.2	5.0	3.6
Small trees & mid-shrub species	11	11	10	11	11	9	8	13	16
Canopy tree species	2	2	3	1	3	3	2	2	2
Total shrub / tree species	13	13	13	12	14	12	10	15	18



Graph 13 Vegetation community composition – Life forms

Ground layer

As previously noted, ground vegetation was sparse at all monitoring sites (inclusive of analogue sites) which is typical of local native woodland communities. Ground cover species diversity (grasses, others and sub-shrubs) in the rehabilitation ranged from 15 to 32 species, and was moderate at RHB 3a, RHB 4a and RHB 4b (15 species) and high at RHB 1, RHB 2 and RHB 3b (>25 species). This compared very positively against the analogue sites where species diversity ranged from 14-21 species. Average ground cover species diversity per m^2 was high and within analogue benchmarks at all but one rehabilitation site (i.e. RHB 4a where the live ground cover had not yet successfully established).

It is noted that the greater biodiversity in the ground stratum recorded at RHB 1 was to some extent driven by a higher number of exotic species (7 species, most of all monitoring sites), which establishment was promoted by the nearby irrigation system installed just uphill from the monitoring transect (resulting in wetter/moister conditions and favouring exotic species). However, this site also recorded the greatest diversity of native species.

Native ground cover species assemblages showed a high level of similarity between the rehabilitation sites. A range of native grasses, forbs and sub-shrubs consistently occurred which were commensurate with those recorded at the analogue sites and/or characteristic of native local woodland communities. The most abundant or commonly recorded species included:

- Grasses: *Austrostipa pubescens* (Tall Speargrass), *Microlaena stipoides* (Weeping Grass) and *Rytidosperma spp*. (Wallaby Grasses).
- Forbs: *Dampiera stricta* (Blue Dampiera), *Lomandra spp*. (Mat-rushes) and *Patersonia sericea* (Silky Purple-flag).
- Sub-shrubs: *Amperea xiphoclada* (Broome Spurge), Billarderia *scandens* (Hairy Apple Berry), *Lomatia silaifolia* (Crinkle Bush), *Mirbelia platylobioides* (Large-flowered Mirbelia), *Monotoca scoparia* (Prickly Broom-heath), *Phyllota squarrosa* (Dense Phyllota) and *Platysace linearifolia* (Narrow-leaved Platysace).

Mid-storey layer

A diverse native mid-storey occurred at all rehabilitation sites (9–12 species), with diversity levels comparable to the analogue sites (8–16 species). Species assemblages showed a high level of similarity between the rehabilitation sites, where the shrub layer was typically dominated by *Acacia terminalis* (Sunshine Wattle) and *Leptospermum trinervium* (Paperbark Tea-tree). Other frequently recorded species (generally occurring more sparsely) included *Acacia obtusifolia* (Blunt-leaf Wattle), *Banksia spp*. (Banksias), *Daviesia latifolia* (Hop Bitter-pea), *Epacris pulchella* (Wallum Heath), *Persoonia levis* (Broad-leaved Geebong) and *Petrophile pedunculata* (Conesticks). All recorded species consisted of native endemic shrubs well aligned to local communities.

Canopy layer

Canopy tree species (i.e. eucalypts) were successfully established (or establishing) at all rehabilitation sites, with a diversity comprised between 1 and 3 species which was similar to the analogue sites. At all rehabilitation monitoring sites the tree layer was typically (and largely) dominated by *Eucalyptus sieberi* (Silver-top Ash) and *E. sclerophylla* or *E. rossii* (Scribbly Gums), which is well characteristic of local surrounding communities at the analogue sites.

4.6.2 Community Structure

Vegetation community structure monitoring results are summarised in **Table 7**.

Table 7 Vegetation structure monitoring results

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Mid storey height range (m)	1–3	1.5–3.5	1–1.5	1–1.5	1–1.5	2–3	1–2	1–3	1–3
Mid storey FPC (%)	26.5	18.5	2.0	9.5	11.0	36.0	13.0	10.5	3.5
Canopy height range (m)	5–7	5–11	5–10	4–6	1.5–2.5	1–3	9–18	8–15	9–16
Canopy FPC (%)	12.0	8.0	9.0	12.0	1.0	0.0	28.5	29.5	23.5
No. trees in plot <5cm DBH	8	16	13	42	14	7	13	48	24
No. trees in plot 5-9cm DBH	5	2	2	6	0	1	4	7	3
No. trees in plot 10-14cm DBH	4	3	2	0	0	0	4	2	2
No. trees in plot 15-19cm DBH	0	1	1	0	0	0	4	3	3
No. trees in plot 20-29cm DBH	0	1	0	0	0	0	1	4	2
No. trees in plot 30-49cm DBH	0	0	0	0	0	0	2	4	2
No. trees in plot >50cm DBH	0	0	0	0	0	0	2	1	0
>5cm DBH tree stem density / ha	300	230	165	200	0	35	560	695	395

Tree stem densities

For a realistic and accurate assessment of tree establishment performance, tree stem densities have been assessed on the basis of stems >5cm DBH only. This was to remove the bias created by the potentially high number of eucalypt seedlings which may not grow into mature trees, and which in their current size provided limited structural complexity to the vegetation communities. The presence and abundance of young seedlings (<5cm DBH) can be assessed separately as an indicator of community resilience.

Monitoring results from the analogue sites indicated that tree densities (>5cm DBH) in native local communities were generally comprised between ~395-695 stems/ha. It can therefore be considered that tree densities of ≥320 stems/ha (i.e. 20% of lower analogue site value) represent a realistic benchmark and satisfactory performance for rehabilitated areas.

In this regard, tree densities across all rehabilitation sites remained unsatisfactory at the time of the 2018 monitoring (i.e. all sites ≤300 stems/ha). However, at most sites a moderate to high density of young eucalypt seedlings also occurred, which indicated a good potential for stem densities to increase over time and ultimately achieve satisfactory levels (assuming successful establishment and growth of existing seedlings).

The exception was at RHB 4b where total tree densities (including seedlings) were low. Eucalypts in that location were established through tubestock plantings, and supplementary infill plantings may be required to increase tree densities. In comparison, eucalypt tubestock plantings at RHB 4a were established at higher densities, and assuming good seedling survival and growth tree density at this location should achieve satisfactory levels in the future.

Tree growth

Having regard to the relatively young ecological age of the rehabilitated communities, tree size remained limited across the rehabilitation with most individuals occurring within the 5-9cm and 10-14 cm DBH classes and reaching heights comprised between 5-10m. In comparison, the analogue sites contained several trees within the 20-29cm, 30-49cm and >50cm DBH classes and reaching heights to 18m.

It is further noted that tree growth and size in the rehabilitation were negatively affected by the 2013 bushfire (and comparatively more than at the analogue sites where trees were better established and therefore more resilient). A high proportion of the trees assessed at the rehabilitation sites consisted of coppicing individuals or re-sprouting from lignotubers, leading to smaller DBH sizes compared to pre-fire (where trees consisted of larger, single-stemmed individuals).

However, as the soil analyses results highlighted no apparent limitations to the existing growing media which could constrain vegetation growth, tree growth should continue over time.

Mid and Canopy Foliage Cover

As a direct reflection of lower stem densities and smaller trees, canopy FPC in the rehabilitation remained relatively limited (≤12%) and well below the analogue benchmarks (~24-30%). However, this should naturally increase over time as trees further establish/mature and community structure improves.

The mid-storey FPC was satisfactory (i.e. within or exceeding analogue range) at most rehabilitation sites except RHB 3a. The following key points were noted:

- Mid-storey performance was excellent at RHB 1, RHB 2 and RHB 3b where the majority of the foliage cover was provided by *Leptospermum spp*., which was consistent with analogue areas.
- Despite a currently poor and unsatisfactory mid-storey cover, a good diversity of shrub species was present at RHB 3a. The establishment of shrubs in this location may currently be restricted by the poor canopy cover, but may improve with time as (and if) the canopy closes out. This will need to be monitored.

- The recorded mid-storey at RHB 4a was provided by shrubs established through tubestock plantings. Tubestock survival will need to be monitored to ensure adequate mid-storey performance is maintained.
- Despite a very high total FPC, the mid storey at RHB 4b was very largely dominated by primary colonising acacias (reflecting the young age of the rehabilitation) which will rapidly senesce and likely lead to a decrease in mid-storey FPC in future monitoring years. However, a good diversity of other local shrubs also occurred which establishment and cover may be promoted as acacias recede.

4.6.3 Community Health and Resilience

The 2018 monitoring results for community health and resilience are summarised in **Table 8**.

Table 8 Community health and resilience monitoring results

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Percent healthy trees	85	100	90	95	95	100	100	100	100
No of tree species with fruits	0	0	0	0	0	0	0	0	1
No. tree species with seedlings	2	1	2	1	n/a	n/a	2	2	2
Regeneration status	Active	Active	Active	Active	**n/a**	**n/a**	Active	Active	Active

Established (or establishing) trees generally showed good health condition across all rehabilitation sites (>85% individuals assessed as healthy). Naturally, some individuals continued to display some residual impact symptoms from the 2013 bushfire, however trees generally showed good resilience and recovery.

Positively, active natural regeneration was evidenced at all older rehabilitation sites across REA I, REA II and REA III, where the germination and establishment of new seedling may have been promoted by the bushfire. This indicates an excellent capacity of the rehabilitated communities to recover from disturbance and self-sustain.

Rehabilitation was too young across REA IV for natural regeneration to occur or reproductive structures to be present on young tree seedlings.

4.6.4 Habitat Complexity

Table 9 presents the findings of the 2018 habitat complexity assessments.

Table 9 Habitat complexity monitoring results

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Litter cover (%)	70.3	45.9	28.0	56.7	1.5	80.8	90.4	81.0	89.2
Native ground cover present	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shrub layer present	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tree layer present	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Cumulative length of log (m)	16	45	22	38	0	>400	16	39	15
No. hollow stems	0	0	0	0	0	0	4	2	6
Habitat complexity score[#]	4.33	4.67	3.33	4.67	1.33	7.0	8.67	7.33	7.33

[#] *Based in assessment method in Tongway and Hindley (2004)*

Total habitat complexity scores were satisfactory and meeting the defined MOP completion criterion (i.e. ≥4.0) at four of the six rehabilitation sites (RHB 1, RHB 2, RHB 3b and RHB 4b). The criterion was however not met at RHB 3a and RHB 4a, reflecting the poorer ground cover and vegetation growth at these sites.

A satisfactory litter layer (within analogue range) was recorded for RHB 1 and RHB 4b, however litter accumulation remained more limited at the other sites.

Good levels of structural complexity (i.e. with native ground cover, shrub layer and tree layer) occurred at most monitoring sites with the exception of the REA IV monitoring sites where the tree layer had not yet established due to the young rehabilitation age.

Generally, excellent incorporation of surface logs had been undertaken throughout the rehabilitation, with the exception of the southern section of REA IV where revegetation was implemented solely using tubestock plantings (RHB 4a). The lack of surface logs / woody debris in this area not only restricted its future habitat potential, but also limited surface anchoring to provide additional surface protection against erosion. In contrast, the lower two contours and northern section of REA IV (RHB 4b) contained extremely high volume of logs / fallen trees, potentially excessive in places. It is recommended that a better management of logs/tree resources is implemented in future rehabilitation activities to ensure that all surface logs are evenly spread across all areas.

As a function of the young ecological age of the communities, arboreal hollows were missing from rehabilitation sites when compared to the mature analogue sites. Such features require very long timeframes to develop naturally, however the installation of arboreal nest boxes on mature trees in the rehabilitation could be an effective way to provide substitution for this key ecological resource.

4.7 Weeds

Weed performance as recorded in 2018 at the monitoring sites has been summarised in **Table 10**.

The results showed that weed species diversity and total weed cover levels were generally not problematic across the rehabilitation, with all monitoring sites recording less than 5% weed cover (i.e. well below the allowable MOP target of 15% weed cover).

Weed incursion is therefore considered as currently not being a barrier to native vegetation establishment in the rehabilitation.

Table 10 Weed diversity and cover levels

Monitoring metric	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
# non-invasive species	7	0	1	2	0	3	0	0	0
Non-invasive species cover	4.5	0	0.1	0.2	0	0.3	0	0	0
# invasive weed species	0	0	0	0	0	0	0	0	0

However, it is noted that four species of invasive weeds were recorded at the site during the walkover inspection (refer to **Section 5**), namely *Hypericum perforatum* (St John's Wort), *Cortaderia sp.* (Pampas Grass), *Echium plantagineum* (Paterson's Curse) and *Rubus fruiticosus* (Blackberry). Although their prevalence remained consistently low, these species represent a potential long-term threat to community integrity and rehabilitation success should they spread, and an ongoing control effort will need to be maintained. Details on these species and suggested control mechanisms are provided in **Table 11**.

Table 11 Recorded invasive weed species and recommended control mechanisms

Species	Description	Control Mechanisms
Blackberry	Prickly scrambling shrub forming dense thickets and potentially spreading quickly. Dense thickets reduce native habitat for fauna and flora, represent a fire hazard and can harbour vermin. The plant is classified as a weed of national significance.	• Physical control is usually unsuccessful because the entire root system must be removed. • Spray the plants with suitable registered herbicide when plants are healthy and actively growing. Successive treatments will likely be required for well-established plants.
Pampas Grass	Very tall, clumpy grass with fluffy flower heads. It competes with native vegetation, represents a fire hazard and can potentially harbour vermin.	• Where possible, undertake physical removal of young plants ensuring that the entire root system is removed. • For mature plants: remove plants seed heads (then bag, remove from site and dispose of correctly), followed by foliar spraying of plants using a registered herbicide. • Avoid control in summer to protect wildlife (i.e. some native species may use the plants for shelter or nesting resources.
Paterson's Curse	Winter annual herb with showy purple flowers. Dense infestations can degrade natural environment, compromising habitat values by crowding out and suppressing native vegetation	• Small infestations or isolated plants can be effectively controlled through physical removal of plants (by hand or using a hoe or shovel). • Alternatively, spot spray the plants with a registered herbicide when actively growing, ideally when the plants are in early flower and before seed set (i.e. mid-late spring).
St John's Wort	Herb or small shrub with bright yellow flowers, potentially poisonous to herbivore species.	• Spot spray with registered herbicide when the plants are actively growing, in early flower and before seed set (late spring/early summer). • Successive spraying treatment will likely be required to suppress the species. • Hand-weeding is not an effective way to control St John's wort as the entire root system must be removed to stop new plants from growing.

4.8 Animal Pests

No evidence of impact from vertebrate animal pests was evident across the site. Some rabbit scats were noted in some locations however their population levels and associated impacts are likely to be minimal.

5. Results – Walkover Inspection

Areas inspected during the walkover assessment, together with recorded observations are shown in **Figure 3**. A summary of observations types is provided in **Table 12**, which also includes suggested management actions / responses and links to associated photographs included below.

Table 12 Walkover inspection observations summary

No.	Photo	Observation description	Action required
1	**Photo 1**	**Erosion** – low severity erosion in drainage structures at REA IV, evidenced through rocks being washed down and exposing the geotextile fabric.	• Implement regular visual inspections of the drains (particularly following significant rainfall events) to ensure structure integrity and stability are maintained.
2	**Photo 2**	**Erosion** – severe gullying within the diversion drain at REA IV, with gully channel near 1 metre deep at its most severe.	• Repair the diversion drain structure.
3	**Photo 3**	**Erosion** – failed outside batter of diversion drain at REA IV, with sediments actively washing into adjacent natural bushland.	• Repair the diversion drain structure.
4	**Photo 4**	**Erosion** – localised area of moderately severe and frequent gullying within REA III. The erosion has exposed large amounts of carbonaceous material to the surface, and the capping depth was observed as inadequate (<20cm).	• Given its location on the perimeter of the REA, consider re-working the area when rehabilitation works in the adjacent area are undertaken, including the reconstruction of a cap of sufficient depth.
5	**Photo 5**	**Weed incursion** – severe weed infestation along the length of the installed irrigation pipe within REA I, dominated by including Thistles, Blackberry Nightshade and Pampas Grass. Weed growth likely promoted by nutrient rich water.	• Remove the weed infestation through chemical control, targeting Pampas Grass as the highest priority. • The use of the irrigation system must be suspended during and following herbicide applications to prevent chemical drift and leaching.
6	**Photo 6**	**Weed incursion** – Pampas Grass (isolated plant or small cluster of plants). Recorded in all REAs.	• Control the species as per the mechanisms suggested in **Table 11** of this report.
7	N/A	**Weed incursion** – Blackberry (isolated plant) (REA II).	• Control the species as per the mechanisms suggested in **Table 11** of this report.
8	**Photo 7**	**Weed incursion** – St John's Wort rapidly establishing in contour bank trough in REA IV.	• Control the species as per the mechanisms suggested in **Table 11** of this report.
9	N/A	**Weed incursion** – Paterson's Curse (isolated plants on top of REA IV landform).	• Control the species as per the mechanisms suggested in **Table 11** of this report.
10	**Photo 8**	**Vegetation establishment** – several areas across REA III showed overall poor vegetative performance, typically with high levels of exposed bare ground and limited shrub/tree establishment. In some locations tubestock plantings were previously established but did not survived.	• Consider further soil investigations / testing to determine growing media suitability in the area (including assessments of capping depth). • Ameliorate substrate as required to remedy any identified deficiencies. • Generally, these areas would greatly benefit from the incorporation /spread of organic matter onto the soil surface • Following soil enhancements, revegetate areas using a combination of direct seeding and/or planting methods.
11	**Photo 9**	**Community structure and composition** – in all REAs some localised areas were noted where excellent establishment and growth of mid storey shrubs was achieved (particularly acacias or Tea	• Undertake supplementary infill plantings of tubestock using endemic eucalypt species. • In areas of very dense and thick mid-storey, plantings may need to be preceded by selective

No.	Photo	Observation description	Action required
		Trees, and sometimes occurring at very high densities), but canopy eucalypts densities were inadequate (sparse to lacking).	thinning of the shrub layer (through cut and lay or mulching in situ).
12	**Photo 10**	**Community structure and composition** – localised area within REA II showing excellent shrub and tree establishment and growth, but generally very poor species diversity (Silver-top Ash only in the canopy layer and Tea-trees very largely dominant in the mid-layer).	• Consider improving community composition and species diversity in the mid and upper layers through localised patch plantings of shrubs and supplementary tubestock plantings of eucalypts.
13	**Photo 11**	**Good performance** – areas within REA I, II and IV showing good establishment of woodland communities, typically with a diversity and densities of native shrubs and trees and good vegetation growth. In REA IV the ground cover remained sparse but should rapidly increase as litter is returned to the surface.	• Nil action required. Continue the implementation of the monitoring program to demonstrate ongoing progress of vegetation community
14	**Photo 12**	**Good performance** – well established woodland rehabilitation in REA I, II and III showing excellent performance, typically with a high diversity of native shrubs and trees, good vegetation growth and high structural complexity.	• Nil action required.

1. Low severity erosion in drainage structures
2. Severe gullying in diversion drain
3. Failed outside batter of diversion drain
4. Frequent gullying of moderate severity (exposing coal rejects)
5. Weed infestation along irrigation pipeline
6. Weed incursion - Pampas Grass
7. Weed incursion - Blackberry
8. Weed incursion - St John's Wort
9. Weed incursion - Paterson's Curse
10. Poor vegetation establihsment / bare area
11. Unsatisfactory tree densities
12. Poor species diversity
13. Good establishing woodland
14. Excellent established woodland

KORU ENVIRONMENTAL

N W E S

0 30 60 120
metres

1:4,433 (when printed at A4)

MAP SIZE:	A4 Portrait	**PROJECT REF:**	P2018-008
DATUM:	GDA 1994	**CREATED BY:**	mcatteau
PROJECTION:	MGA Zone 56	**DATE CREATED:**	28-Feb-2019

LEGEND

- Rehabilitation areas
- Walkover_tracks
- Weed infestation

Action priority

- Maintenance required
- Monitoring required
- Acceptable (no action required)

Clarence Colliery
Rehabilitation Monitoring 2018

FIGURE 3

2018 Walkover Inspection Observations

Photo 1 Low severity erosion in rock drain structure (REA IV)

Photo 2 Severe gully erosion channel within diversion drain (REA IV)

Photo 3 Failed batter of diversion drain causing sedimentation into adjacent bushland (REA IV)

Photo 4 Gullying and poor capping depth (REA III)

Photo 5 Severe weed infestation along irrigation pipeline (REA I)

Photo 6 Pampas Grass incursion (REA I)

Photo 7 St John's Wort incursion (REA IV)

Photo 8 Example of area with poor vegetation establishment performance (REA III)

Photo 9 Example of area showing good shrub establishment but lacking canopy eucalypt species (REA IV)

Photo 10 Area with good shrub and tree establishment and growth but poor species diversity (REA II)

Photo 11 Excellent woodland vegetation establishment in young rehabilitation area (REA IV)

Photo 12 Excellent mature woodland rehabilitation with good structural complexity (REA II)

6. Progress Against Completion Criteria

A high-level assessment of rehabilitation progress against the MOP completion criteria (as relevant to the information and data collected under the scope of this monitoring program) is provided in **Table 13**. A separate assessment is provided for each REA based on the associated transect-based data and observations made during the walkover inspection.

Table 13 Rehabilitation progress against completion criteria

Completion criteria	Progress / status in 2018	Compliance status			
		REA I	REA II	REA III	REA IV
Landform establishment					
Final landform is consistent with surrounding landforms	Rehabilitated REAs and landforms have been constructed as per approved mine plans and generally integrate with surrounding landforms.	**Yes**	**Yes**	**Yes**	**Yes**
Slopes are generally less than 10 degrees and no more than 14 degrees without approval	Slope angles were adequate and below 14 degrees across most of REA I and REA II. However, steep slope gradients have been established in REAs III and IV which were comprised between 17-22 degrees.	**Yes**	**Yes**	**No**	**No**
Erosion control structures installed at intervals commensurate with the slope of the landform and direct water into stable areas or sediment control basins	Contour banks, rock-lined drains and/or diversion drains have been installed at adequate intervals throughout REAs II, III and IV to break linear slopes and slow or re-direct surface water runoff into sediment basins. Particularly, good densities of erosion structures were installed across REA IV were steeper landforms and slope angles have been established. No erosion control structures were installed within REA I, however these were deemed unnecessary as a function of gentler topography and shorter slope lengths.	**Yes**	**Yes**	**Yes**	**Yes**
Landforms are stable	REAs I and II were assessed as very stable with vegetation well established and no signs of active erosion processes recorded. Active erosion processes (sheet and gully erosion) were recorded across both REAs III and IV, which were therefore not fully stable at the time of the 2018 monitoring.	**Yes**	**Yes**	**No**	**No**
Growing media development					
Soil analysis undertaken to determine potential constraints to rehabilitation.	Soil characterisation and testing results from samples collected at the six rehabilitation monitoring sites in 2018 identified no key limitations to the growing media. Soil properties in the rehabilitation were similar to those in analogue areas and generally conducive to the establishment and growth of native vegetation.	**Yes**	**Yes**	**Yes**	**Yes**
Topsoil or alternative dressing media spread at depth of 100-300mm	Adequate levels of topsoil (consisting of sandy loams or sandy clay loams) were generally present across REAs I, II and IV. Localised areas with insufficient topsoil and capping depth were observed within REA III.	**Yes**	**Yes**	**No**	**Yes**

Ecosystem establishment and sustainability					
Minimum of 60% protective ground cover, and no bare surfaces >20m^2 or >10m in length down slope	Protective ground cover was generally satisfactory across both REAs I and II where no large bare patches were identified. A number of localised bare areas were recorded within REA III where improvement works may be required. At REA IV, ground cover protection was excellent where logs/woody debris were installed and direct seeding of primary coloniser species undertaken. Ground cover remained very poor in 2018 in areas where revegetation was undertaken solely using tubestock plantings, but should naturally improve over time as vegetation further establishes and litter is returned to the ground.	**Yes**	**Yes**	**No**	**No**
Evidence of nutrient cycling processes (i.e. presence of litter, cryptograms, etc.)	Active in-situ nutrient cycling occurred in all areas of successful vegetation establishment, which was however inconsistent across rehabilitation areas. Based on litter cover and LFA nutrient cycling index scores, nutrient cycling was satisfactory at REA I, but inconsistent at REAs II, III and IV.	**Yes**	**No**	**No**	**No**
A mixture of native trees, shrubs and grasses is present	Rehabilitation sites generally showed excellent performance in terms of native species assemblages in all vegetation layers, with a range of native endemic ground covers, shrubs and trees recorded at all monitoring sites.	**Yes**	**Yes**	**Yes**	**Yes**
Dominant species aligned with those in local native woodland communities	Flora species establishing in the rehabilitation very largely comprised of local native endemic species and generally fully aligned with those recorded at the nearby analogue sites.	**Yes**	**Yes**	**Yes**	**Yes**
Total woody species richness within 20% of analogue sites	Total woody species richness was consistently within analogue range at all rehabilitation monitoring sites and comprised between 12-14 species (analogue range 10-18 species).	**Yes**	**Yes**	**Yes**	**Yes**
>75% of trees are healthy and growing	Established or establishing trees showed satisfactory health condition across all rehabilitation sites, with >85% of trees assessed as healthy and displaying active growth.	**Yes**	**Yes**	**Yes**	**Yes**
Established species survive and/or regenerate after disturbance	Rehabilitation areas have showed excellent resilience and recovery from the 2013 bushfire event. Naturally, some individuals continued to display some residual fire impact symptoms, particularly in terms of growth habit (e.g. coppicing), but generally showed good recovery. In addition, the fire even promoted species germination in places and vegetative and landscape function performance at most monitoring sites in 2018 exceeded pre-fire levels.	**Yes**	**Yes**	**Yes**	**Yes**
Evidence of natural regeneration potential (2nd generation seedlings or reproductive structures on plants)	Active natural regeneration was evidenced across all older rehabilitated areas at REAs I, II and III with second-generation seedlings present.	**Yes**	**Yes**	**Yes**	**n/a**

	Condition indicator not applicable to REA IV given the younger age of the rehabilitation (<5 years).				
Weed cover <15%	Weed cover was minimal at all monitoring sites (<5%). However, a significant weed infestation was recorded within REA I which establishment was promoted by the installation and use of the irrigation pipeline. Four species of invasive weeds were recorded across the site, Pampas Grass being the most problematic. Current population levels remained relatively low in 2018 however ongoing vigilance and control will be required.	**No**	**Yes**	**Yes**	**Yes**
Animal pests do not occur in substantial numbers or visibly affect the development of planted species	Animal pests were not an issue at the site. No evidence of impact was recorded.	**Yes**	**Yes**	**Yes**	**Yes**
Habitat features or structures suitable for fauna habitat are incorporated	Logs / dead trees have been spread across the surface at adequate densities throughout REAs I and II and III, but inconsistently throughout REA IV (where extremely high volumes of were installed on some contours but entirely lacking in other areas). No other habitat structures observed (e.g. boulders, arboreal nest boxes, etc).	**Yes**	**Yes**	**Yes**	**No**
Presence of a range of structural habitats (eucalypts, shrubs, ground cover, developing litter layer)	With the exception of locally deprived areas, good structural complexity and vegetation stratification was generally achieved across REAs I, II and III. Given the younger age of the rehabilitation at REA IV, the litter cover and/or tree layers were not yet established, and overall habitat potential remained limited in 2018.	**Yes**	**Yes**	**Yes**	**No**
Habitat complexity score >4.0	Habitat complexity scores consistently achieving target benchmark at the monitoring sites within REAs I and II, but inconsistent at REAs III and IV. Habitat complexity scores excepted to naturally increase with time as vegetation further establishes and communities mature.	**Yes**	**Yes**	**No**	**No**

7. Recommendations

The following recommendations are a summary of what has been provided / discussed throughout this report. Recommendations are made with the view to improve rehabilitation performance at Clarence and ensure that rehabilitated communities progress towards a natural state commensurate to local native vegetation communities.

Landform stability and erosion

- Repair the identified area of localised gully erosion at REA III when rehabilitation works are implemented in the adjacent area. This should include an assessment of capping depth in the broader area, and reconstruction of a cap of sufficient depth as required.
- Repair the severe erosion within the diversion drains at REA IV. Having regard to the recurring erosion issues within the drains, different materials or construction methods (etc.) may need to be considered.
- Carefully and regularly monitor slope stability across REA IV until the landform is deemed fully stabilised. Particularly, systematic visual inspections of the area should be undertaken post-localised heavy rainfall events (i.e. >25mm in a 24hr-period).

Ground cover protection

- In the identified areas of REA III and IV showing high levels of exposed surfaces and limited vegetative ground cover, consider incorporating organic matter on the ground surface with the view to enhance ground cover protection and soil organic matter, promote vegetation establishment and provide additional protection against soil loss and erosion. This can be in the form of brush material from local native plants (ideally when bearing fruits), wood chips, compost, bio-solids, etc.

Community composition and structure

- Undertake infill plantings of eucalypt tubestock in areas of insufficient tree densities or poor tree species diversity. Plantings should ideally be undertaken in late Spring and use local endemic species that are known to succeed at the site.
- In areas where eucalypt densities need to be increased and where a thick shrub layer occurs, prior selective thinning of the mid-storey may need to be first implemented to reduce competition with young eucalypt seedlings.

Habitat potential

- Where it can be done with minimal to no impact on establishing vegetation (e.g. along the perimeter or along access tracks), consider incorporating surface logs throughout the areas of REA IV where logs have not been installed.
- Where feasible, consider installing artificial arboreal nest boxes on mature trees in areas of older and well-established rehabilitation to provide substitution for tree hollows and improve habitat value.

Weed management

- Control and remove the weed infestation along the irrigation pipeline in REA I.
- Continue the ongoing implementation of the weed control program across the site, specifically targeting Pampas Grass (highest priority), Blackberry, St John's Wort and Paterson's Curse.

8. References

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APPENDIX A

SOIL LABORATORY ANALYSIS RESULTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1904935**	Page	: 1 of 6
Client	: **SPRINGVALE COAL PTY. LTD.**	Laboratory	: Environmental Division Sydney
Contact	: Mr Matthieu Catteau	Contact	: Customer Services ES
Address	: 1 Donald Street Lithgow NSW 2790	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: CLARENCE REHAB MONITORING 2018	Date Samples Received	: 18-Feb-2019 08:52
Order number	:	Date Analysis Commenced	: 19-Feb-2019
C-O-C number	: ----	Issue Date	: 26-Feb-2019 15:53
Sampler	: Matthieu Catteau		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED021 (Bicarbonate Extractable K (Colwell) by ICP-AES): All samples from workorder ES1904935 required dilution prior to analysis due to matrix interferences. Limit of reporting values have been adjusted accordingly.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ANA1	ANA2	ANA3	RHB R1	RHB R2
			Client sampling date / time	15-Feb-2019 00:00	13-Feb-2019 00:00	13-Feb-2019 00:00	14-Feb-2019 00:00	15-Feb-2019 00:00
Compound	CAS Number	LOR	Unit	ES1904935-001	ES1904935-002	ES1904935-003	ES1904935-004	ES1904935-005
				Result	Result	Result	Result	Result
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	4.0	4.1	4.2	4.9	4.1
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.2	4.9	4.9	5.6	4.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	18	13	12	14	24
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	16.2	5.3	5.1	3.9	4.8
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Olive Brown (2.5Y 4/3)	Olive Brown (2.5Y 4/4)	Olive Brown (2.5Y 4/4)	Light Olive Brown (2.5Y 5/6)	Olive Brown (2.5Y 4/4)
Texture	----	-	-	Sandy Loam	Clayey Sand	Sandy Loam	Sandy Loam	Sandy Clay Loam
Emerson Class Number	EC/TC	-	-	4	3	3	3	4
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	1.3	0.1
Exchangeable Magnesium	----	0.1	meq/100g	0.2	<0.1	<0.1	0.5	0.1
Exchangeable Potassium	----	0.1	meq/100g	0.1	<0.1	<0.1	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.4	0.2	0.2	2.1	0.4
Exchangeable Sodium Percent	----	0.1	%	19.7	13.6	9.4	1.6	9.4
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	<200	<200	<200	<200	<200
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	20	<10
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	1.01	<1.00	<1.00	<1.00	<1.00
ø Iron	7439-89-6	1.00	mg/kg	612	524	456	474	211
ø Manganese	7439-96-5	1.00	mg/kg	1.21	1.65	2.10	<1.00	1.20
ø Zinc	7440-66-6	1.00	mg/kg	1.11	<1.00	<1.00	<1.00	2.24
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.1	<0.1	<0.1	0.2	<0.1
EK058G: Nitrate as N by Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ANA1	ANA2	ANA3	RHB R1	RHB R2
				Client sampling date / time	15-Feb-2019 00:00	13-Feb-2019 00:00	13-Feb-2019 00:00	14-Feb-2019 00:00	15-Feb-2019 00:00
Compound	CAS Number	LOR	Unit		ES1904935-001	ES1904935-002	ES1904935-003	ES1904935-004	ES1904935-005
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser - Continued									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		0.2	0.5	0.2	0.6	0.2
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.3	0.5	0.2	0.8	0.2
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		680	200	400	300	540
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		680	200	400	300	540
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		57	91	96	108	82
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	7	<5
EP004: Organic Matter									
Organic Matter	----	0.5	%		2.1	2.3	2.2	1.7	1.5
Total Organic Carbon	----	0.5	%		1.2	1.4	1.3	1.0	0.9

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	RHB R3A	RHB R3B	RHB R4A	RHB R4B	----
			Client sampling date / time	13-Feb-2019 00:00	15-Feb-2019 00:00	14-Feb-2019 00:00	14-Feb-2019 00:00	----
Compound	CAS Number	LOR	Unit	ES1904935-006	ES1904935-007	ES1904935-008	ES1904935-009	--------
				Result	Result	Result	Result	----
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	4.0	4.1	4.2	4.4	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	4.6	4.5	4.9	5.4	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	21	46	23	16	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	4.9	3.3	7.4	3.7	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Olive Brown (2.5Y 4/4)	Light Olive Brown (2.5Y 5/6)	Olive Brown (2.5Y 4/4)	Dark Olive Brown (2.5Y 3/3)	----
Texture	----	-	-	Clayey Sand	Sandy Loam	Sandy Loam	Sandy Loam	----
Emerson Class Number	EC/TC	-	-	3	4	4	3	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.1	0.2	0.1	0.8	----
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	0.1	<0.1	0.3	----
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.2	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	----
Cation Exchange Capacity	----	0.1	meq/100g	0.3	0.4	0.3	1.5	----
Exchangeable Sodium Percent	----	0.1	%	7.8	3.8	9.9	2.4	----
ED021: Bicarbonate Extractable Potassium (Colwell)								
Bicarbonate Extractable K (Colwell)	----	10	mg/kg	<200	638	<200	<200	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	----
ED092: DTPA Extractable Metals								
ø Copper	7440-50-8	1.00	mg/kg	<1.00	<1.00	<1.00	<1.00	----
ø Iron	7439-89-6	1.00	mg/kg	181	345	85.8	618	----
ø Manganese	7439-96-5	1.00	mg/kg	3.73	2.90	1.06	2.77	----
ø Zinc	7440-66-6	1.00	mg/kg	<1.00	2.74	<1.00	2.23	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	RHB R3A	RHB R3B	RHB R4A	RHB R4B	----
				Client sampling date / time	13-Feb-2019 00:00	15-Feb-2019 00:00	14-Feb-2019 00:00	14-Feb-2019 00:00	----
Compound	CAS Number	LOR	Unit		ES1904935-006	ES1904935-007	ES1904935-008	ES1904935-009	--------
					Result	Result	Result	Result	----
EK058G: Nitrate as N by Discrete Analyser - Continued									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		0.1	0.3	0.4	0.4	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.1	0.3	0.4	0.4	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		260	400	210	720	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		260	400	210	720	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		44	86	92	134	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		<5	<5	<5	<5	----
EP004: Organic Matter									
Organic Matter	----	0.5	%		1.2	1.2	0.8	3.0	----
Total Organic Carbon	----	0.5	%		0.7	0.7	<0.5	1.8	----

APPENDIX B

FLORISTICS MONITORING RESULTS

Ground Cover Species

Value indicates avergae percentage cover score. An 'x' indicates that the species was not recorded within the 1m x 1m quadrat assessment zones, but the species occurred within the 10m x 30m plot

Scientific name	Common name	Type	Life from	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Acacia gunnii	Ploughshare Wattle	Native	Sub-shrub	<0.1	x	<0.1	x			0.1		
Amperea xiphoclada	Broom Spurge	Native	Sub-shrub	x	<0.1	x	0.2	0.1		<0.1	x	
Aristida jerichoensis	Jericho Wiregrass	Native	Grass	0.2	1		<0.1					
Asteraceae sp. 1		Native	Herb	<0.1					<0.1			
Asteraceae sp. 2		Native	Herb					<0.1				
Austrostipa pubescens	Tall Speargrass	Native	Grass	0.7	0.7	0.4	0.2			<0.1		
Austrostipa scabra	Speargrass	Native	Grass	0.1								
Billarderia scandens	Hairy Apple Berry	Native	Vine	0.1	<0.1		<0.1		0.2	<0.1	0.1	<0.1
Boronia microphylla	Small Leaved Boronia	Native	Sub-shrub		x		<0.1			0.6	0.1	<0.1
Bossiaea heterophylla	Variable Bossiaea	Native	Sub-shrub	0.1			<0.1					
Brachyloma daphnoides	Daphne Heath	Native	Sub-shrub									x
Caustis flexuosa	Old Man's Beard	Native	Sedge	0.1		0.3					0.2	0.3
Chenopodium sp.		Exotic	Herb	<0.1								
Cirsium vulgare	Spear Thistle	Exotic	Herb	0.2								
Conyza sp.	Fleabane	Exotic	Herb	3					0.1			
Cyperus sp.		Native	Sedge				<0.1					
Dampiera stricta	Blue Dampiera	Native	Herb		<0.1		<0.1	0.1		0.3	<0.1	
Dianella caerulea	Blue Flax-lily	Native	Herb							0.2	0.2	0.2
Entolasia stricta	Wiry Panic	Native	Grass	0.4	1.8	5.2	2	0.5	8	0.1	<0.1	0.5
Eragrostis brownii	Brown's Lovegrass	Native	Grass				<0.1					
Euchiton sphaericus	Star Cudweed	Native	Herb	0.3								
Fabaceae sp.		Native	Herb								0.1	
Gahnia sp.		Native	Sedge				0.1	0.1	<0.1	<0.1		
Gamochaeta sp.	Cudweed	Exotic	Herb	<0.1								
Gonocarpus tetragynus	Common Raspwort	Native	Herb		0.1					0.1		
Grevillea laurifolia	Laurel-leaf Grevillea	Native	Sub-shrub		1.4			1				
Hibbertia obtusifolia	Hoary Guinea Flower	Native	Sub-shrub								x	
Hovea linearis	Common hovea	Native	Sub-shrub			<0.1	0.1				<0.1	x
Hybanthus vernonii	Erect Violet	Native	Sub-shrub				0.1					

Hypochaeris radicata	Catsear	Exotic	Herb	0.3			<0.1		0.1			
Juncus sp. 1		Native	Sedge	<0.1								
Juncus sp. 2		Native	Sedge		<0.1		0.2					
Lachnagrostis filiformis	Blown Grass	Native	Grass	3								
Lepidosperma laterale	Variable Saw-sedge	Native	Sedge	0.3	0.2					0.1		
Lomandra filiformis	Wattle Mat-rush	Native	Herb	<0.1	0.1		<0.1			<0.1	0.1	0.1
Lomandra glauca	Pale Mat-rush	Native	Herb	0.2	0.1		<0.1	<0.1		<0.1	0.1	0.2
Lomandra longifolia	Spiny-head Mat-rush	Native	Herb		2		0.2		0.7			
Lomandra sp.		Native	Herb					0.1		0.8		
Lomatia silaifolia	Crinkle Bush	Native	Sub-shrub	0.5	x	<0.1	x		<0.1	0.1	0.5	<0.1
Microlaena stipoides	Weeping Grass	Native	Grass	0.3	0.2	0.7	1.7	<0.1	2.4			
Mirbelia platylobioides	Large-flowered Mirbelia	Native	Sub-shrub	0.1	<0.1	0.1	x			0.2		
Monotoca scoparia	Prickly Broom-heath	Native	Sub-shrub	0.6	0.1	x	<0.1	x	<0.1	0.5	0.2	x
Opercularia ?aspera	Coarse Stinkweed	Native	Herb		<0.1		<0.1					
Oxalis ?exilis	Shady Wood-sorrel	Native	Herb	0.2								
Patersonia sericea	Silky Purple-flag	Native	Herb	0.4	0.2	0.3	0.5	<0.1	<0.1	0.5	0.1	0.1
Phyllota squarrosa	Dense Phyllota	Native	Sub-shrub	x	0.5	<0.1	0.1	x		<0.1		
Platysace linearifolia	Narrow-leaved Platysace	Native	Sub-shrub	0.3	0.1	0.1	0.5	x		0.6	0.5	0.1
Pteridium esculentum	Bracken Fern	Native	Fern		0.1		<0.1				0.3	
Poa sieberiana	Tussock Grass	Native	Grass					0.2	2.3			
Poaceae sp. 1		Native	Grass	0.5			<0.1					
Poaceae sp. 2		Exotic	Grass			<0.1	<0.1					
Poaceae sp. 3		Native	Grass						0.3			
Pomax umbellata	Pomax	Native	Sub-shrub									x
Rytidosperma monticola	Wallaby Grass	Native	Grass	0.4								
Rytidosperma pallidum	Red-anther Wallaby Grass	Native	Grass		3.6	0.9	<0.1			2.2	0.1	0.9
Rytidosperma sp.	Wallaby Grass	Native	Grass		0.1			<0.1				
Schizaea bifida	Forked Comb Fern	Native	Fern		<0.1							
Solanum nigrum	Black-berry Nightshade	Exotic	Herb	0.7								
Sonchus olaceraceus	Common Sowthistle	Exotic	Herb	0.1								
Unknown herb 1		Native	Herb	0.5								
Unknown herb 2		Native	Herb	0.1					<0.1			
Unknown herb 3		Native	Herb								<0.1	

Unknown shrub 1		Native	Sub-shrub				<0.1					
Unknown shrub 2		Native	Sub-shrub									<0.1
Verbena incompta	Purpletop	Exotic	Herb						<0.1			
Veronica sp.	Speedwell	Native	Herb	0.8								
			Total species	***36***	***27***	***15***	***32***	***15***	***15***	***21***	***19***	***16***

Mid-storey Shrubs and Tree Species

Letter indicates species abundance within the 10m x 30m plot relative to their stratum: 'R' = rare, 'S' = sparse, 'C" = common and 'A' = abundant

Scientific name	Common name	Type	Life from	RHB 1	RHB 2	RHB 3a	RHB 3b	RHB 4a	RHB 4b	ANA 1	ANA 2	ANA 3
Acacia dealbata	Silver Wattle	Shrub	Native						C			
Acacia ?mearnsii	Black Wattle	Shrub	Native		S							
Acacia obtusifolia	Blunt-leaf Wattle	Shrub	Native		C	R	C	A	A			R
Acacia rubida	Red-stemmed Wattle	Shrub	Native		R							
Acacia terminalis	Sunshine Wattle	Shrub	Native	C	C	C	S	A	A	S	A	C
Acacia ulicifolia	Prickly Moses	Shrub	Native					R	R		R	R
Banksia ericifolia	Heath-leaved Banksia	Shrub	Native			R					R	R
Banksia marginata	Silver Banksia	Shrub	Native		R						R	R
Banksia spinulosa	Hairpin Banksia	Shrub	Native	R			R			S	R	R
Callicoma serratifolia	Butterwood	Shrub	Native		R							
Callistemum sp.	Bottlebrush	Shrub	Native					R				
Cassinia ?aculeata	Common Cassinia	Shrub	Native						S			
Casuarina ?littoralis	Black She-oak	Shrub	Native					S				
Daviesia ?genistifolia	Broom Bitter-pea	Shrub	Native			R						
Daviesia latifolia	Hop Bitter-pea	Shrub	Native			R		C	C		C	C
Daviesia sp.		Shrub	Native				R					
Epacris pulchella	Wallum Heath	Shrub	Native	C	S	R	C				C	C
Eucalyptus mannifera	Brittle Gum	Tree	Native		R							
Eucalyptus ?radiata	Narrow-leaved Peppermint	Tree	Native					R	R		S	
Eucalyptus rossii	Inland Scribbly Gum	Tree	Native							C		
Eucalyptus sclerophylla	Scribbly Gum	Tree	Native	S		S		C	S			C
Eucalyptus sieberi	Silver-top Ash	Tree	Native	C	C	C	A		S	S	A	C

Eucalyptus sp.		Tree	Native			R		R				
Hackea dactyloides	Finger Hakea	Shrub	Native	S			R	S		C		R
Hackea sericea	Needlebush	Shrub	Native	R				A	A			R
Isopogon anemonifolius	Broad-leaved Drumstick	Shrub	Native	S			S			C		S
Leptospermum arachnoides	Spidery Tea-tree	Shrub	Native	R								
Leptospermum ?polygalifolium	Lemon-scented Tea-tree	Shrub	Native					A				
Leptospermum trinervium	Paperbark tea-tree	Shrub	Native	A	A	S	C		R	A	A	A
Leucopogon lanceolatus	Lance-leaved Beard Heath	Shrub	Native								R	
Persoonia levis	Broad-leaved Geebung	Shrub	Native	R	R	R	R				R	R
Persoonia myrtilloides	Myrtle Geebong	Shrub	Native			R		R			R	R
Petrophile pedunculata	Stalked Conesticks	Shrub	Native	S		R	R			S		S
Polyscias sambucifolia	Elderberry Panax	Shrub	Native		R				R			
Pomaderris andromedifolia	Pomaderris	Shrub	Native		C			S				
Pultenaea scabra	Rough Bush-pea	Shrub	Native								S	S
Telopea speciosissima	Waratah	Shrub	Native	R						R	R	
Unknown shrub 1		Shrub	Native				C			R		
			Total species	***13***	***13***	***13***	***12***	***14***	***12***	***10***	***15***	***18***

KORU ENVIRONMENTAL

END OF REPORT

Noise Monitoring Report -March 2018

Appendix 9

Clarence Colliery

March 2018

Environmental Noise Monitoring

Prepared for

Centennial Coal Pty Ltd

Global Acoustics

Noise and Vibration Analysis and Solutions

Global Acoustics Pty Ltd
PO Box 3115 | Thornton NSW 2322
Telephone +61 2 4966 4333
Email global@globalacoustics.com.au
ABN 94 094 985 734

Clarence Colliery

March 2018
Environmental Noise Monitoring

Reference: 17460_R01
Report date: 5 April 2018

Prepared for

Centennial Coal Pty Ltd
Locked Bag 1002.
Wallerawang NSW 2845

Prepared by

Global Acoustics Pty Ltd
PO Box 3115
Thornton NSW 2322

Prepared:	Robert Kirwan Acoustic Consultant	QA Review:	Amanda Borserio Acoustic Consultant

Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

EXECUTIVE SUMMARY

Global Acoustics was engaged by Centennial Coal Pty Limited (Centennial) to conduct additional noise monitoring for the Clarence Colliery (Clarence) in accordance with Development Consent DA504-00 and the Centennial Coal Western Region Noise Management Plan (CCWRNMP).

Environmental noise monitoring described in this report was undertaken during the day, evening and night of 27 March 2018. Figure 1 shows the monitoring location included in this survey.

The survey purpose is to quantify and describe the existing acoustic environment around Clarence and compare results with relevant limits. Attended monitoring was conducted in accordance with relevant Environment Protection Authority (EPA) requirements and Australian Standard AS 1055 'Acoustics, Description and Measurement of Environmental Noise'. The duration of each measurement was 15 minutes.

Operational Noise Assessment

Activities from Clarence complied with the relevant development consent noise limits during monitoring.

Criteria may not always be applicable due to meteorological conditions at the time of monitoring.

Low Frequency Noise Assessment

A low-frequency assessment was carried out in accordance with the EPA 'Noise Policy for Industry' (NPfI, 2017). Low-frequency modifying factors, where applicable, did not result in any exceedances of Clarence noise limits during the March 2018 survey.

Global Acoustics Pty Ltd

Table of Contents

Appendices

1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by Centennial Coal Pty Limited (Centennial) to conduct additional noise monitoring for Clarence Colliery (Clarence) operations in accordance with Development Consent DA504-00 and the Centennial Coal Western Region Noise Management Plan (CCWRNMP).

Environmental noise monitoring described in this report was undertaken during the day, evening and night of 27 March 2018. Figure 1 shows the monitoring location.

The survey purpose was to quantify and describe the existing acoustic environment around Clarence and compare results with relevant limits.

1.2 Monitoring Locations

There is one monitoring location listed in the CCWRNMP. This is detailed in Table 1.1 and shown in Figure 1. It should be noted that the figures show the actual monitoring position, not the location of the residence.

Table 1.1: CLARENCE MONITORING LOCATIONS

Report Descriptor	Monitoring Location
M1	End of Sandham Road

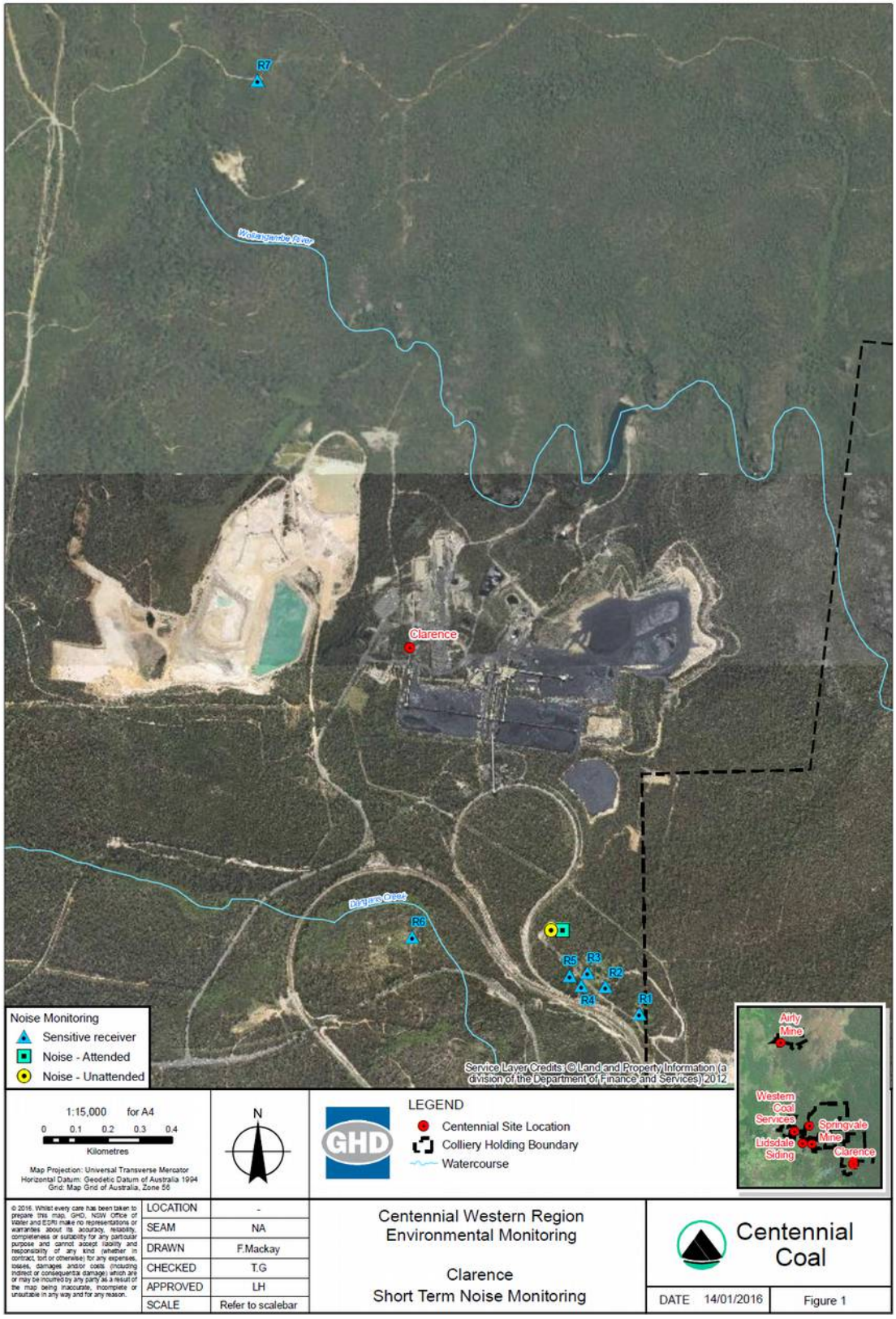

Figure 1: Noise Monitoring Location (Source: CCWRNMP)

1.3 Terminology & Abbreviations

Some definitions of terms and abbreviations, which may be used in this report, are provided in Table 1.2.

Table 1.2: TERMINOLOGY & ABBREVIATIONS

Descriptor	Definition
L_A	The A-weighted root mean squared (RMS) noise level at any instant
L_{Amax}	The maximum A-weighted noise level over a time period or for an event
L_{A1}	The noise level which is exceeded for 1 per cent of the time
L_{A10}	The noise level which is exceeded for 10 percent of the time, which is approximately the average of the maximum noise levels
L_{A50}	The noise level which is exceeded for 50 per cent of the time
L_{A90}	The level exceeded for 90 percent of the time, which is approximately the average of the minimum noise levels. The L_{A90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes
L_{Amin}	The minimum A-weighted noise level over a time period or for an event
L_{Aeq}	The average noise energy during a measurement period
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise
SPL	Sound pressure level (SPL), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals
Hertz (Hz)	Cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together
VTG	Vertical temperature gradient in degrees Celsius per 100 metres altitude. Estimated from wind speed and sigma theta data
IA	Inaudible. When site only noise is noted as IA, there was no noise from the source of interest audible at the monitoring location
NM	Not Measurable. If site only noise is noted as NM, this means some noise from the source of interest was audible at low-levels, but could not be quantified
Day	This is the period 7:00am to 6:00pm
Evening	This is the period 6:00pm to 10:00pm
Night	This is the period 10:00pm to 7:00am

2 CONSENT AND CRITERIA

All monitoring reported in this document has been carried out in accordance with the Clarence Development Consent (DA504-00) and the CCWRNMP and Clarence Environment Protection Licence number 726.

2.1 Development Consent and Project Specific Criteria

The sections of the Development Consent relating to noise are reproduced in Appendix A.

Noise impact assessment criteria are outlined in Schedule 3, Condition 15 of the Clarence development consent. Impact assessment criteria for Clarence are detailed in Table 2.1.

Table 2.1: $L_{Aeq,15min}$ IMPACT ASSESSMENT CRITERIA

Descriptor	Day	Evening	Night
M1	38	36	35

Noise criteria detailed above apply under prevailing meteorological conditions (wind speeds up to 3 m/s) except under conditions of temperature inversions.

2.2 Environment Protection Licence

Environment Protection Licence number 726 apply to Clarence operations. The sections of the EPLs relating to noise are reproduced in Appendix A.

To avoid disturbance to residents, particularly during the night period, suitable monitoring locations where noise levels are likely to be higher than those measured at the residence are chosen to take a conservative approach, as the direct measurement of noise 1 metre from the dwelling facades or within 30 metres of the residence is often impractical due to access requirements and the presence of dogs, air conditioners and other noise sources at the residences.

2.3 Modifying Factors

The EPA 'Noise Policy for Industry' (NPfI, 2017) was approved for use in NSW in October 2017, and supersedes the EPA's Industrial Noise Policy (INP, 2000). Assessment and reporting of modifying factors is to be carried out in accordance with Fact Sheet C of the NPfI.

NPfI modifying factors, as they are applicable to mining noise, are described in more detail below.

2.3.1 Tonality and Intermittent Noise

As defined in the Noise Policy for Industry:

> *Tonal noise contains a prominent frequency and is characterised by a definite pitch.*
>
> *Intermittent noise is noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.*

There were no intermittent noise sources from site during the survey. In addition, there is no equipment on site that is likely to generate tonal noise as defined in the NPfI.

2.3.2 Low Frequency Noise

As defined in the Noise Policy for Industry:

> *Low frequency noise is noise with an unbalanced spectrum and containing major components within the low-frequency range (10 – 160 Hz) of the frequency spectrum.*

The NPfI contains the current method of assessing low frequency noise, which is a 2 step process as detailed below:

> *Measure/assess source contribution C-weighted and A-weighted L_{eq},T levels over the same time period. The low frequency noise modifying factor correction is to be applied where the C-A level is 15 dB or more and:*
>
> • *where any of the 1/3 octave noise levels in Table C2 are exceeded by* ***up to and including*** *5 dB and cannot be mitigated, a 2 dBA positive adjustment to measured A weighted levels applies for the evening/night period; and*
>
> • *where any of the 1/3 octave noise levels in Table C2 are exceeded by* ***more than*** *5 dB and cannot be mitigated, a 5 dBA positive adjustment to measured A weighted levels applies for the evening/night period and a 2 dBA positive adjustment applies for the daytime period.*

Table C2 and associated notes from the NPfI is reproduced below:

Table C2: One-third octave low-frequency noise thresholds.

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:

- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for

wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.

- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.
- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

3 METHODOLOGY

3.1 Overview

Noise monitoring was conducted at the locations in accordance with relevant NSW Environmental Protection Agency requirements and Australian Standard AS1055 'Acoustics, Description and Measurement of Environmental Noise.'

Meteorological data was sourced from the Bureau of Meteorology Mount Boyce weather station. This allowed correlation of atmospheric parameters and measured noise levels.

3.2 Attended Noise Monitoring

Attended monitoring is preferred to the use of noise loggers when determining compliance with prescribed limits as it allows the most accurate determination of the contribution, if any, to measured noise levels by the source of interest, in this case Clarence.

If the exact contribution of the source of interest cannot be established, due to masking by other noise sources in a similar frequency range, but site noise levels are observed to be well below (more than 5 dB lower than) any relevant criterion, a maximum estimate of the potential contribution of the site might be made based on other measured site-only noise levels, for example, L_{A10}, L_{A50} or L_{A90}. This is generally expressed as a 'less than' quantity, such as <20 dB or <30 dB.

The terms 'Inaudible' (IA) or 'Not Measurable' (NM) may also be used in this report. When site noise is noted as IA, no site noise was audible at the monitoring location. When site noise is noted as NM, this means some noise was audible but could not be quantified. If site noise was NM due to masking but estimated to be significant in relation to a relevant criterion, we would employ method (e.g. measure closer and back calculate) to determine a value for reporting.

Therefore, all sites noted as NM in this report are due to one or more of the following reasons:

- site noise levels were extremely low and unlikely, in many cases, to be even noticed;
- site noise levels were masked by another relatively loud noise source that is characteristic of the environment (e.g. breeze in foliage or continuous road traffic noise) that cannot be eliminated by moving closer; and/or
- it was not feasible or reasonable to employ methods such as move closer and back calculate. Cases may include, but are not limited to, rough terrain preventing closer measurement, addition/removal of significant source to receiver shielding caused by moving closer, and meteorological conditions where back calculation may not be accurate.

A measurement of $L_{A1,1minute}$ corresponds to the highest noise level generated for 0.6 second during one minute. In practical terms this was quantified by measuring or estimating the highest noise level emitted from a site noise source during the entire measurement period (i.e. the highest level of the worst minute during the 15 minute measurement).

3.3 Modifying Factors

Years of monitoring have indicated that noise levels from mining operations, particularly those measured at significant distances from the source are relatively continuous and broad spectrum. Given this, noise levels from Clarence at the monitoring locations are unlikely to be intermittent or tonal.

Assessment of low-frequency modifying factors is necessary when application of the maximum correction could potentially result in an exceedance of the relevant site-only L_{Aeq} criterion. Low-frequency analysis is therefore undertaken for measurements in this report where:

- meteorological conditions resulted in criteria being applicable;
- contributions from Clarence were audible and directly measurable, such that the site-only L_{Aeq} was not "NM" or less than a maximum cut off value (e.g. "<20 dB" or "<30dB");
- contributions from Clarence were within 5 dB of the relevant L_{Aeq} criterion, as 5 dB is the maximum penalty that can be applied by low-frequency modifying factors; and
- Clarence was the dominant low-frequency noise source.

All measurements meeting these conditions were evaluated for possible low frequency penalty applicability in accordance with the NPfI.

3.4 Monitoring Equipment

The equipment used to measure environmental noise levels is detailed in Table 3.1. Monitoring equipment used meets the requirements of AS 1259.1-1990: Acoustics – Sound Level Meters and AS IEC 61672.1-2004: Electroacoustics – Sound level meters – Specifications. Calibration certificates are provided in Appendix B.

Table 3.1: MONITORING EQUIPMENT

Model	Serial Number	Calibration Due Date
Rion NA-28 sound level analyser	960042	10/10/2019
ND9 acoustic calibrator	N452838	30/06/2019

3.5 Operational Information

The control room at Clarence confirmed the CHPP, dozers and all conveyors were operating. A train also arrived at 10pm for loading.

4 RESULTS

4.1 Attended Noise Monitoring

Noise levels measured during the attended survey are provided in Table 4.1.

Table 4.1: MEASURED NOISE LEVELS – MARCH 2018

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB
M1	27/3/18 14:13	58	49	40	38	40	36
M1	27/3/18 21:44	49	42	39	36	37	32
M1	27/3/18 22:13	51	46	42	39	40	37

Notes:

1. *Levels in this table are not necessarily the result of activity at Clarence.*

Table 4.2 compares measured $L_{Aeq,15min}$ levels from Clarence with impact assessment criteria.

Table 4.2: $L_{Aeq,15min}$ GENERATED BY CLARENCE AGAINST IMPACT ASSESSMENT CRITERIA – MARCH 2018

Location	Start Date and Time	Wind Speed m/s[1]	VTG °C/100m[6]	Criterion dB	Criterion Applies?[2]	Clarence $L_{Aeq,15min}$ dB[3,4]	Exceedance[4,5]
M1	27/3/18 14:13	2.6	-2.0	38	Yes	35	Nil
M1	27/3/18 21:44	2.7	0.5	36	No	<30	NA
M1	27/3/18 22:13	2.5	0.5	35	No	NM	NA

Notes:

1. *Criterion may or may not apply due to rounding of meteorological data values;*
2. *Noise emission limits do not apply during the following meteorological conditions: wind speeds greater than or equal to 3 metres per second or temperature inversion conditions;*
3. *Estimated or measured $L_{Aeq,15min}$ attributed to Clarence;*
4. *Bolded results in red indicate exceedance of criteria;*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable; and*
6. *NA denotes sigma theta data was not available from the BOM weather station. VTG is unknown.*

4.2 Low Frequency Noise Assessment

Measured Clarence only noise levels were assessed for the applicability of low frequency modifying factors in accordance with the EPA's NPfI.

None of the measurements satisfied the conditions outlined in Section 3.3. Therefore no further assessment was undertaken.

4.3 Atmospheric Conditions

Atmospheric condition measurement data, collected with each noise measurement, are shown in Table 4.3.

Table 4.3: MEASURED ATMOSPHERIC CONDITIONS AT 1.8 METRES – MARCH 2018

Location	Start Date and Time	Temperature Degrees	Wind Speed m/s	Wind Direction Degrees	Cloud Cover Eighths
M1	27/3/18 14:13	16	1.1	30	0
M1	27/3/18 21:44	12	1.4	40	8
M1	27/3/18 22:13	13	1.1	60	8

5 SUMMARY OF COMPLIANCE

Global Acoustics was engaged by Centennial Coal Pty Limited (Centennial) to conduct additional noise monitoring for the Clarence Colliery (Clarence) in accordance with Development Consent DA504-00 and the Centennial Coal Western Region Noise Management Plan (CCWRNMP).

Environmental noise monitoring described in this report was undertaken during the day, evening and night of 27 March 2018. Figure 1 shows the monitoring location included in this survey.

5.1 Operational Noise Assessment

Activities from Clarence complied with the relevant development consent noise limits during monitoring.

Criteria may not always be applicable due to meteorological conditions at the time of monitoring.

5.2 Low Frequency Noise Assessment

A low-frequency assessment was carried out in accordance with the EPA NPfI. Low-frequency modifying factors, where applicable, did not result in any exceedances of Clarence noise limits during the March 2018 survey.

Global Acoustics Pty Ltd

APPENDIX

A DEVELOPMENT CONSENT AND ENVIRONMENT PROTECTION LICENCES

A.1 DEVELOPMENT CONSENT

NOISE

Noise Impact Assessment Criteria

15. The Applicant shall ensure that the noise generated by the development, excluding train-loading and rail operations, does not exceed the noise impact assessment criteria presented in Table 6 at any residence on privately owned land.

Table 6: Noise impact assessment criteria dB(A) $L_{Aeq\ (15\ min)}$

Location	Day	Evening	Night
Residences on privately owned land	38	36	35

Notes:

(a) For the purpose of these noise criteria, 5dB(A) must be added to the measured level if the noise is substantially tonal or impulsive in character.

(b) The noise criteria do not apply where the Applicant and the affected landowner have reached a negotiated agreement in regard to noise, and a copy of the agreement has been forwarded to the Secretary and EPA.

(c) Noise from the development is to be measured at the most affected point or within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the development is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.

(d) The noise criteria apply under prevailing meteorological conditions (winds up to 3m/s), except under conditions of temperature inversions. Noise impacts that may be enhanced by temperature inversions must be addressed by:

- *documenting noise complaints received to identify any higher level of impacts or patterns of temperature inversions; and*
- *where levels of noise complaints indicate a higher level of impact then actions to quantify and ameliorate any enhanced impacts under temperature inversion conditions shall be developed and implemented.*

A.2 ENVIRONMENT PROTECTION LICENCE

L5 Noise limits

L5.1 Noise generated from the premises, excluding train loading and rail operations, must not exceed the noise limits specified in the table below.

Location	Day (LAeq 15 min)	Evening (LAeq 15 min)	Night (LAeq 15 min)
Any residence on privately owned land not subject to an agreement with the licensee	38	36	35

Note: For the purposes of condition 5.1:

a) Day is defined as:

i. the period from 7am to 6pm Monday to Saturday; and

ii. the period from 8am to 6pm Sundays and Public Holidays.

b) Evening is defined as: the period from 6pm to 10pm.

c) Night is defined as:

i. the period from 10pm to 7am Monday to Saturday; and

ii. the period from 10pm to 8am Sundays and Public Holidays.

d) The morning shoulder period is a subset of the night period between 6am to 7am Monday to Saturday.

L5.2 To determine compliance with condition L5.1, noise from the premises is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of the residence where the residence is more than 30 metres from the residential boundary to determine compliance with the noise levels in condition L5.1

L5.3 To determine compliance with condition L5.1, the modification factors in Section 4 of the NSW Industrial Noise Policy (EPA, 2000/2001) must be applied, as appropriate, to the noise levels measured by any monitoring equipment.

L5.4 The noise limits stipulated by condition L5.1 apply under all meteorological conditions except for the following:

a) wind speeds greater than 3 metres per second at ground level; and

b) temperature inversions as outlined in Section 5 of the NSW Industrial Noise Policy (EPA, 2000/2001).

APPENDIX

B CALIBRATION CERTIFICATES

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Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2013

Calibration Certificate

Calibration Number C17510

Client Details	Acoustic Research Labs Pty Ltd Level 7, Bld 2, 423 Pennant Hills Road Pennant Hills NSW 2120
Equipment Tested/ Model Number :	Rion NA-28
Instrument Serial Number :	00960042
Microphone Serial Number :	07714
Pre-amplifier Serial Number :	60062

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	22.4°C	**Ambient Temperature :**	22.8°C
Relative Humidity :	50.7%	**Relative Humidity :**	50.1%
Barometric Pressure :	99.7kPa	**Barometric Pressure :**	99.67kPa

Calibration Technician : Jason Gomes
Calibration Date : 10/10/2017
Secondary Check: Riley Cooper
Report Issue Date : 11/10/2017
Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	*Pass*	17: Level linearity incl. the level range control	*Pass*
13: Electrical Sig. tests of frequency weightings	*Pass*	18: Toneburst response	*Pass*
14: Frequency and time weightings at 1 kHz	*Pass*	19: C Weighted Peak Sound Level	*Pass*
15: Long Term Stability	*Pass*	20: Overload Indication	*Pass*
16: Level linearity on the reference level range	*Pass*	21: High Level Stability	*Pass*

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.

As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation test performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.16dB*	*Temperature*	*±0.05°C*
12.5kHz	*±0.2dB*	*Relative Humidity*	*±0.46%*
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.017kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

PAGE 1 OF 1

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Sound Calibrator
IEC 60942-2004
Calibration Certificate

Calibration Number C17306

Client Details	Acoustic Research Labs Pty Ltd Level 7, Bld 2, 423 Pennant Hills Road Pennant Hills NSW 2120
Equipment Tested/ Model Number :	ARL ND9
Instrument Serial Number :	N452838

Atmospheric Conditions

Ambient Temperature :	22.5°C
Relative Humidity :	37.4%
Barometric Pressure :	100.27kPa

Calibration Technician :	Lucky Jaiswal	**Secondary Check:**	Riley Cooper
Calibration Date :	30/06/2017	**Report Issue Date :**	03/07/2017

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
5.2.2: Generated Sound Pressure Level	*Pass*	5.3.2: Frequency Generated	*Pass*
5.2.3: Short Term Fluctuation	*Pass*	5.5: Total Distortion	*Pass*

	Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
Measured Output	94.0	1000.0	94.0	1000.12

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2004 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed..

Least Uncertainties of Measurement -

Specific Tests		Environmental Conditions	
Generated SPL	*±0.11dB*	*Temperature*	*±0.05°C*
Short Term Fluct.	*±0.02dB*	*Relative Humidity*	*±0.46%*
Frequency	*±0.01%*	*Barometric Pressure*	*±0.017kPa*
Distortion	*±0.5%*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

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PAGE 1 OF 1

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