umwelt

Inspired people | Dedicated team
Quality outcomes

CC
Castlereagh Coal

CULLEN VALLEY MINE
ANNUAL REVIEW

1 JANUARY 2017 –
31 DECEMBER 2017

March 2018

CULLEN VALLEY MINE ANNUAL REVIEW

1 JANUARY 2017 – 31 DECEMBER 2017

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

Project Director:	Luke Bettridge
Project Manager:	Luke Bettridge
Report No.	3968_R35_Annual Review
Date:	March 2018

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	**Date**	**Name**	**Date**
FINAL	Luke Bettridge	28 March 2018	Graham Goodwin (Manildra)	29/03/2018

Table of Contents

Figures

Tables

Plates

Appendices

Annual Review Title Block

Name of operation:	Cullen Valley Mine
Name of operator:	Shoalhaven Coal Pty Ltd
Development consent:	DA-200-5-2003
Name of holder of development consent:	Shoalhaven Coal Pty Ltd
Mining leases:	See Table 3.1
Name of holder of mining leases:	Shoalhaven Coal Pty Ltd
Water licence:	See Table 3.1
Name of holder of water licence:	Shoalhaven Coal Pty Ltd
MOP start date:	31 December 2015
MOP end date:	31 December 2018
Annual Review start date:	1 January 2017
Annual Review end date:	31 December 2017

I, Graham Goodwin, certify that this audit report is a true and accurate record of the compliance status of Cullen Valley Mine for the period 1 January 2017 to 31 December 2017, and that I am authorised to make this statement on behalf of Shoalhaven Coal Company Pty Limited.

Note.

a) The Annual Review is an 'environmental audit' for the purposes of section 122B(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 report officer:	Graham Goodwin
Title of authorised report officer:	Mining Engineering Manager
Signature of authorised report officer:	
Date:	29 March 2018

1.0 Statement of compliance

This Annual Review has been prepared to provide a summary of the performance of the Cullen Valley Mine (CVM) operations over the period 1 January 2017 to 31 December 2017 (referred to hereafter as the reporting period). The compliance of the operation with relevant approvals was managed during the reporting period by CVM and the compliance status is summarised in **Table 1.1**.

The statement of compliance status in **Table 1.1** is based on compliance information provided by CVM. Umwelt (Australia) Pty Limited has relied on this information in combination with other information sources such as; environmental monitoring documentation, discussions with the CVM, site inspection(s) and our general understanding of the operation. In preparing this report Umwelt has not sought to undertake a full compliance audit, including secondary verification of the collated documentary evidence with relevant government agency staff, construction personnel or operational staff, site records etc.

It is noted that an Independent Environmental Audit (IEA) was undertaken during the 2016 reporting period (i.e. previous reporting period). The IEA identified non-compliances with the EPL, Development Approval and the 2003 Environmental Impact Statement mitigation measure commitments. Each of the actions to address the non-compliances identified by the IEA have been actioned. Further details regarding the status of the non-compliances identified by the IEA can be found in **Appendix 1.** A copy of the 2016 IEA is located on the CVM website.

Table 1.1 below provides a statement of compliance for the reporting period and has identified non-compliances with statutory approvals as detailed by the IEA.

It was determined that a total of 2 non-compliances relating to odour occurred during the reporting period. The non-compliances recorded during the reporting period have been ranked according to the risk matrix included in **Table 1.2** and a brief description of each is provided in **Table 1.3**.

Table 1.1 Statement of Compliance

Relevant approval	All conditions complied with?
Development Approval DA-200-5-2003	No – refer to **Table 1.3**
Environment Protection Licence EPL 10341	No – refer to **Table 1.3**
Authorisation 324	Yes
Authorisation 420	Yes
Exploration Licence (EL) 5712	Yes
EL 6007	Yes
EL 8618	Yes
EL 8619	Yes
Mining lease(ML) 1455	Yes
ML 1488	Yes

Relevant approval	All conditions complied with?
ML 1556	Yes
ML 1557	Yes
WAL 27898	Yes
Water Supply Work Approval (80WA 706148)	Yes

Table 1.2 Compliance Status Key for Table 1.3

Risk Level	Colour Code	Description
High	**Non-compliant**	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	**Non-compliant**	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-compliant**	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 non-compliance	**Non-compliant**	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)

Source: Annual Review Guideline (NSW Government, 2015).

Table 1.3 Non compliances recorded during the 2017 Report Period

Relevant Approval	Condition #	Description (Summary)	Compliance Status	Comment and Proposed Action	Where addressed in Annual Review
Development Approval DA-200-5-2003	Condition 27 Schedule 4	Odour complaints associated with sub-surface heating areas at CVM.	**Non–compliant**	Non-compliant due subsurface heating complaints received by CVM during the report period (refer to **Section 9.2**). Shoalhaven Coal has implemented a combination of inspection, management measures and remediation works during 2017 to manage and treat subsurface heating, refer to **Section 6.9**.	**Section 6.9**
EPL 10341	L6.1	Odour complaints associated with sub-surface heating areas at CVM.	**Non-compliant**	See comments for Development Approval non-compliance in this table.	**Section 6.9**

2.0 Introduction

The CVM is located near the village of Cullen Bullen and approximately 30 kilometres (km) north-west of Lithgow in New South Wales (NSW) (refer to **Figure 2.1**).

Underground mining commenced at Cullen Valley Mine (CVM), formerly Tyldesley Colliery around 1904 and continued up until the 1960's when the workings were abandoned. Open cut operations were conducted on the site between 1948 and 1953. Modern open cut operations began at CVM after 19 August 1999 when the Lithgow Coal Company was granted Mining Lease (ML) 1455 by the then Minister for Mineral Resources. Mining commenced on site in May 2000 following a four month construction phase.

Following the identification of additional open cut coal reserves, a further Environmental Assessment and Development Application was lodged for an extension of the mine in April 2003 (i.e. DA-200-5-2003). The lease extension area lies along the western side of Tyldesley Hill adjacent to the main railway line. Approval of the Development Application was granted by the then Department of Planning and Infrastructure (DP&I) on 19 August 2004.

CVM has previously supplied coal under contract to the Mount Piper Power Station. However, with the failure of the mine to secure a supply contract in 2007, it was proposed to place the operation on a care and maintenance program until such time as sufficient contracts were awarded that would make the operation of the mine viable once again. Coalpac Pty Ltd purchased the Lithgow Coal Company Pty Ltd, which owned the CVM, in January 2008 and the previous plans to place the mine on care and maintenance were discarded. Recommencement of the open cut mining operations occurred in February 2008. Mining of the available approved area at CVM was completed in early December 2012. Any remaining stockpiled ROM coal was transported to the Invincible Colliery during February 2013 and processed through the Invincible Coal Crushing Plant. The CVM was then placed under care and maintenance.

Shoalhaven Coal purchased the mine from Coalpac's administrators in May 2015 and continues to operate the mine under a care and maintenance arrangement.

2.1 Mine contacts

The Mining Engineering Manager is responsible to the regulatory authorities for all aspects of environmental compliance. The Mining Engineering Manager's contact details are summarised in **Table 2.1**.

Table 2.1 Key Personnel Responsible for Environmental Management of CVM during the Report Period

Name	Contact details
Graham Goodwin Mining Engineering Manager	Invincible Colliery Castlereagh Highway Cullen Bullen, NSW 2790 0418 830 598 Graham.Goodwin@manildra.com.au
Cullen Valley Mine Website (Copies of approvals, licences, management plans, monitoring and other information relating to the operation)	http://www.castlereaghcoal.com.au/

2.2 Annual review requirements

Condition 5 of Schedule 6 of the CVM Extension Development Approval-200-5-2003 requires an Annual Review (AR) to be prepared and submitted to the Department of Planning and Environment (DPE) and relevant agencies. This report has been prepared in accordance with the *NSW Government Annual Review Guidelines* (NSW Government, 2015) and details the operational and environmental management activities at CVM during the reporting period. The reporting obligations contained in the Development Approval along with an explanation of where each requirement is addressed within this document are provided in Table 2.2.

Table 2.2 Development approval (200-5 2003) conditions for the annual review

Conditions		Addressed in Section
Schedule 4 – Specific Environmental Conditions Noise		
4.	The applicant shall: a) Investigate ways to reduce the noise generated by the development; b) Implement best practice noise mitigation measures at the development; and c) Report on these investigations and the implementation of any new noise mitigation measures at the development of the AEMR.	Noise management measures are discussed in **Section 6.5**
6.	**Noise Monitoring** Within 3 months of the date of this consent, unless otherwise approved by the DEC, the applicant shall establish a continuous noise monitoring system adjacent to the meteorological weather station required under this consent. This system must be capable of recording LAmax, LA1, LA90 and LAeq noise levels in 15-minute statistical intervals. Unless otherwise agreed, the results of this monitoring must be reported to the DEC on a monthly basis and included in the AEMR.	Results of noise monitoring are included in **Section 6.5**
Schedule 4 – Specific Environmental Conditions Waste Minimisation		
58.	**Waste Minimisation** The applicant shall: a) Monitor the amount of waste generated by the development; b) Investigate ways to minimise waste generated by the development; c) Implement reasonable and feasible actions to minimise waste generated by the development; and d) Report on waste monitoring and minimisation in the AEMR, to the satisfaction of the Director-General.	**Section 0**
Schedule 4 – Specific Environmental Conditions Greenhouse Gas		
60.	(e) report on greenhouse gas monitoring and minimisation in the AEMR	**Section 6.14**
Schedule 6 – Environmental Management, Monitoring, Auditing and Report Annual Report		
5.	The Proponent shall submit an AEMR to the Director- General and relevant agencies. This report must:	This document
	(a) identify the standards and performance measures that apply to the project;	Relevant sections throughout **Section 6.0**

Conditions		Addressed in Section
	(b) include a detailed summary of the complaints received during the past year, and compare this to the complaints received in the previous 5 years;	**Section 9.2**
	(c) include a detailed summary of the monitoring results for the project during the past year;	Relevant sections throughout **Section 6.0**
	(d) include a detailed analysis of these monitoring results against the relevant: • impact assessment criteria/limits; • monitoring results from previous years; and • predictions in the EA;	Relevant sections throughout **Section 6.0**
	(e) identify any trends in the monitoring results over the life of the development;	Relevant sections throughout **Section 6.0**
	(f) identify any non-compliance during the previous year;	**Section 11.0**
	(g) describe what actions were, or are being, taken to ensure compliance.	**Section 11.0**

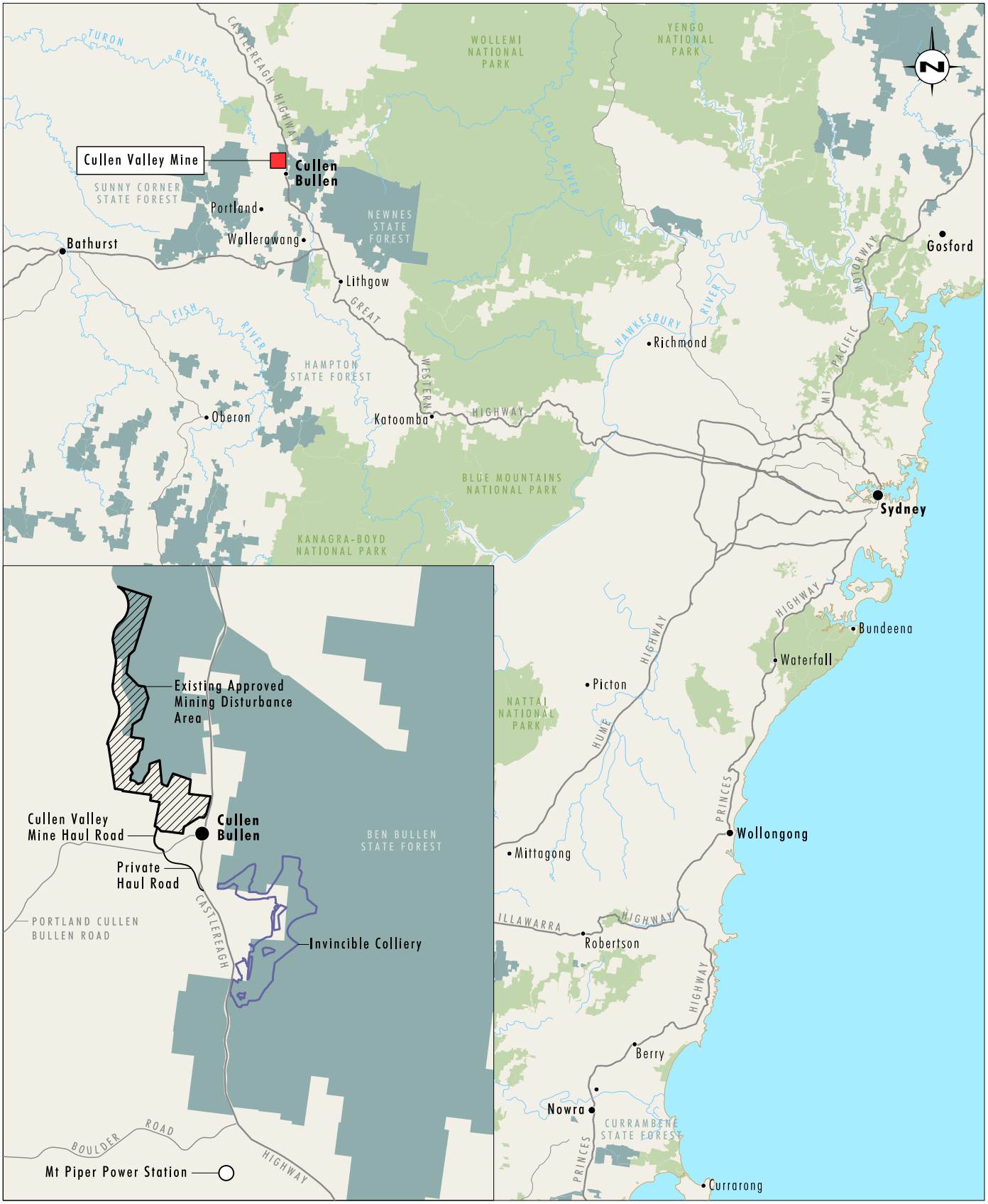


FIGURE 2.1

Locality Plan
Cullen Valley Mine

3.0 Approvals

The operations of CVM during 2017 were regulated by a range of leases, licences and approvals from both State and Local authorities. The current approvals, licences and leases associated with the CVM are listed in **Table 3.1**.

Table 3.1 Environmental approvals held by CVM

Approval	Date Granted	Expiry Date	Status
Development Approval (DA-200-5-2003)	19 August 2004	19 August 2025	Current
Environment Protection Licence (EPL) 10341	10 December (anniversary date)	Annually	Current
Authorisation 324	25 August 1983	9 April 2016	Tenement Relinquishment Pending
Authorisation 420	12 January 1990	9 April 2016	Tenement relinquished 12 Oct 2017
Exploration Licence (EL) 5712	10 April 2000	10 April 2019	Current
EL 6007	8 October 2002	7 October 2018	Current
EL 8618	12 July 2017	12 July 2023	Current
EL 8619	12 July 2017	12 July 2023	Current
ML 1455	19 August 1999	18 August 2020	Current
ML 1488	21 June 2001	20 June 2022	Current
ML 1556	20 September 2004	19 September 2025	Current
ML 1557	20 September 2004	19 September 2025	Current
Water Supply Work Approval 80WA706148	16 January 2012	5 July 2025	Current

Care and maintenance activities at CVM are undertaken in accordance with an approved Care and Maintenance (C&M) MOP (Sedgman, 2015) for the site. The C&M MOP (Sedgman, 2015) was reviewed during 2017, with the updated revision submitted and approved by DRG. This updated C&M MOP approves activities up to 31 December 2018. During late 2017 Castlereagh Coal identified an opportunity to recommence the progressive rehabilitation of CVM using Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM) from various infrastructure construction projects in Sydney. This material will be used to meet the rehabilitation obligations (i.e. the filling of the voids and the progression of the final landform). This activity has been detailed in a revised Cullen Valley MOP (Castlereagh Coal, 2018) which was approved by the NSW Trade and Investment – Division of Resources and Geoscience (DRG) on 6 March 2018.

3.1 Status of management plans

In accordance with the DA-200-5-2003, CVM is required to implement a range of environmental management plans. **Table 3.2** identifies the environmental management strategy and plans and the approval status of each as at the end of the reporting period.

During the reporting period CVM revised the Flora and Fauna Management Plan (Umwelt, 2017a) and Water Management Plan (Umwelt, 2017b) and submitted these to DP&E for approval. No comment on the draft management plans has been received. In accordance with the requirements of the Protection of the Environment Operations Act (1997), CVM also reviewed and updated the Pollution Incident Response Management Plan (PIRMP). The updated PIRMP has been placed on the Castlereagh Coal website.

Table 3.2 Status of DA-200-5-2003 management plans

Management Strategy / Plan	Approved	Modified Plan Submitted	Approved	Approval Agency
Environmental Management Plan (Coalpac, 2012c)	Yes	N/A	N/A	DP&E
Flora and Fauna Management Plan (Coalpac, 2012a)	Yes	N/A	N/A	DP&E
Flora and Fauna Management Plan (Umwelt,2017a)	N/A	29 June 2017	Pending	DP&E
Water Management Plan (Umwelt,2017b)	N/A	31 August 2017	Pending	DP&E
Species Management Plan (Clandulla Geebung) (Coalpac, 2012f)	Yes	N/A	N/A	DP&E
Environmental Monitoring Program (Coalpac, 2009)	Yes	N/A	N/A	DP&E
Blast Management Plan (Coalpac, 2012d)	Yes	N/A	N/A	DP&E
Fire Management Plan (Coalpac, 2012e)	Yes	N/A	N/A	DP&E
Cullen Valley C&M MOP (Sedgman, 2015)	Yes	N/A	N/A	DRG
CVM and Invincible Colliery Pollution Incident Response Management Plan (PIRMP) (Umwelt, 2017c)	N/A	N/A	N/A	EPA

4.0 Operations summary

4.1 Mining operations

No production occurred during the reporting period. A summary of the production figures and mining activity for 2017 and the forecast production for 2018 are summarised in **Table 4.1**. It is noted that the CVM has been on care and maintenance since 2013 and therefore there has been minimal activity at the operations since this time. The production summary is included in **Table 4.1** below.

Table 4.1 Production summary

Material	Approved limit (specify source)	2016 Previous reporting period (actual)	2017 This reporting period (actual)	2018 Next report period (forecast)
Waste rock / overburden	Not specified	0	0	0
Coal works / Coal mining	0-2 Mtpa Coalworks (EPL) 0.5-2 Mtpa Mining for Coal (EPL) 1 Mtpa (DA)	0	0	0
Coarse reject	Not specified	0	0	0
Fine reject (tailings)	Not specified	0	0	0
Saleable coal	Not specified	0	0	0

4.1.1 Waste rock/overburden

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the reporting period. Therefore, no waste rock or overburden was produced.

4.1.2 ROM Coal

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the reporting period. Therefore, no coal was handled or produced.

4.1.3 Coarse reject

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the reporting period. Therefore, no coal reject material was produced.

4.1.4 Fine reject (tailings)

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the reporting period. Therefore, no tailings were produced.

4.1.5 Saleable coal

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the reporting period. Therefore, no coal was produced for sale.

4.2 Other operations

During the reporting period the works undertaken included erosion and sediment control works to repair surface water drainage lines (refer to **Section 6.8**) as well as works to treat subsurface heating which included the excavation and compaction of surface material (refer to **Section 6.9**).

There was no exploration undertaken during the reporting period.

4.3 Next report period

There are no coal mining operations proposed during the 2018 reporting period at CVM. To assist with the progressive rehabilitation of CVM, during the 2018 reporting period CVM propose to receive Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM) to assist in developing the final landform for CVM. The receipt of the VENM/ENM has been detailed in a revised Cullen Valley MOP (Castlereagh Coal, 2018) which was approved by the NSW Trade and Investment – Division of Resources and Geoscience (DRG) on 6 March 2018.

5.0 Actions required from previous annual review

DPE provided comment on the 2016 CVM Annual Review in correspondence provided to CVM on 21 April 2017. DPE requested the inclusion of additional information in future CVM Annual Reviews and updates to information which was located on the CVM website. These requirements and where they are addressed in this Annual Review are detailed in **Table 5.1** below.

Table 5.1 DPE requirements following review of CVM 2016 annual review

DPE Requirements	Works Undertaken	Where addressed in this Document
Annual Reviews to provide further detail of complaints received during the reporting period including the date the complaint was received, the cause of the complaint and actions taken to address the complaint.	2017 Annual Review has been updated to include further information regarding community complaints which have been received.	**Section 9.2**
CVM complaints register on the Castlereagh Coal website is to be updated on a quarterly basis.	CVM complaints register updated on a quarterly basis	Noted
'Groundwater Bores – pH' graph to be modified prior publishing the Annual Review on the CVM website to extend the scale on the y axis to show the actual groundwater quality for pH.	The requested graph was updated in the CVM 2016 Annual Review prior to the Annual Review being published on the CVM website.	Noted
The significant change in groundwater pH quality recorded in bores BHW1 and CP114 and increased sulphate and hardness in bore CP115 identified in the review will be addressed in separate correspondence. Refer to **Section 11**.	Further groundwater sampling and analysis was undertaken in May 2017 by Shoalhaven Coal. The results of the sampling undertaken in May 2017 as well as groundwater sampling undertaken in December 2017 are detailed in **Section 6.4.2.**	**Section 6.4.2**

There were no specific actions identified from DRG for inclusion within this Annual Review following the submission of the 2016 Annual Review.

6.0 Environmental performance

In accordance with the *Annual Review Guidelines* (2015), this section describes the environmental monitoring and management measures undertaken at CVM during the reporting period.

To facilitate the implementation and effectiveness of control strategies for identified environmental risks, a number of management plans have been developed in consultation with various government authorities and other stakeholders as relevant. See **Section 3.1** for further information.

A range of environmental monitoring is required to be undertaken by the Project Approval, EPL and CVM management plans. **Figure 6.1** shows the CVM environmental monitoring locations.

6.1 Summary of performance against EIS predictions

CVM has been the subject of two Environmental Impact Statements (EIS) in the last 20 years of operations. The results of environmental monitoring conducted during the report period are compared to the predictions of these EIS's.

The Feldmast Coal Project for open cut and underground operations to the north-east and north-west of Cullen Bullen was assessed in the EIS dated February 1997 (International Environmental Consultants, 1997). The CVM Lease Extension Project involved expanded operations further to the north-west of the original mining area adjacent to the Wallerawang-Gwabegar Railway line and was assessed in the EIS dated April 2003 (International Environmental Consultants, 2003).

Environmental monitoring undertaken includes noise, air quality, water quality and biodiversity. Below is a summary of predictions from the two EIS's completed for the site. **Table 6.1** provides a summary of CVM environmental performance against the EIS predictions for the reporting period. It is noted that modelling undertaken for the respective EIS's assumed mining operations were being undertaken. As noted previously, CVM is in care and maintenance and there were no mining operations during the reporting period.

6.1.1 Noise predictions

The Feldmast EIS (1997) predicted that with construction of the noise bund, noise from open cut operations was expected to result in an increase in existing background levels measured at the Hillcroft property (Hillcroft) of no more than 5 dB(A). The construction of a private access road between the mine and Mudgee Road to bypass Cullen Bullen was completed during the construction phase and was expected to minimise truck noise. The bypass around Cullen Bullen and noise bund were constructed, significantly reducing traffic and noise impacts on the town and nearby properties.

In the 2003 EIS and approved extension to mining operations, noise exceedances of 2-4 dB(A) were predicted to occur at Red Springs during temperature inversion conditions. Noise exceedances of 4-7 dB(A) were also predicted at Hillcroft during temperature inversion conditions. At Forest Lodge, exceedances of 1 dB(A) (calm), 5dB(A) (south wind) and 5dB(A) (temperature inversion) were predicted in Years 9 and 10 of the extension operations. Exceedances of 3 dB(A) (calm), 10dB(A) (south wind) and 5dB(A) (temperature inversion) were also predicted during years 9 and 10 at the 25 acre allotments to the north of the mine. *NB: These are exceedances of the 35 dB(A) criteria.*

6.1.2 Air quality predictions

The Feldmast EIS (1997) predicted annual average TSP concentrations from background levels plus mine emissions to be 48 µg/m^3 at the closest residences to the mine, which is well below the 90 µg/m^3 annual average goal. Predicted PM_{10} concentrations were 24 µg/m^3 (background plus mine emissions) and this is well below the annual average goal of 50 µg/m^3. $PM_{2.5}$ concentrations from mine emissions were predicted to be 0.5 µg/m^3 at the closest residence.

Modelling of dust deposition in the worst case scenario predicted that no long-term adverse air quality impacts were expected at the closest residential area as a result of mine operations. Episodic short term impacts were predicted where there are large exposed areas or large waste stockpiles, however, the potential for impacts was considered to be small.

The 2003 EIS predicted that nearby residences and those in Cullen Bullen were unlikely to experience unacceptable long-term impacts on air quality from the mine extension operations. It was predicted that short-term impacts could occur if emissions from the mine extension operations were combined with elevated levels from other sources.

6.1.3 Water quality predictions

Given the water management system which contains and treats water within storage ponds prior to discharge, the Feldmast EIS (1997) predicted that EPA discharge criteria would be met. All water within the Lithgow Seam was proposed to be drained within the mining area. Groundwater systems below the Lithgow Seam were expected to be unaffected by the project.

The 2003 EIS predicted that the water management system for containment and reuse of all runoff from disturbed areas would ensure that EPA licence criteria for surface water quality would be met. The project was expected to use underground water within the old Tyldesley underground workings which collects subsurface water contained within the coal measures. Groundwater systems below the Lithgow Seam were expected to be unaffected by the project.

6.1.4 Groundwater predictions

During the 2017 report period, a review of the groundwater regime in the vicinity of CVM was undertaken which resulted in the development of a standalone CVM Water Management Plan (Umwelt, 2017b). For the purposes of this report, the results of the 2017 groundwater monitoring have been compared to the groundwater trigger levels contained in the CVM Water Management Plan (Umwelt, 2017b).

6.1.5 Biodiversity predictions

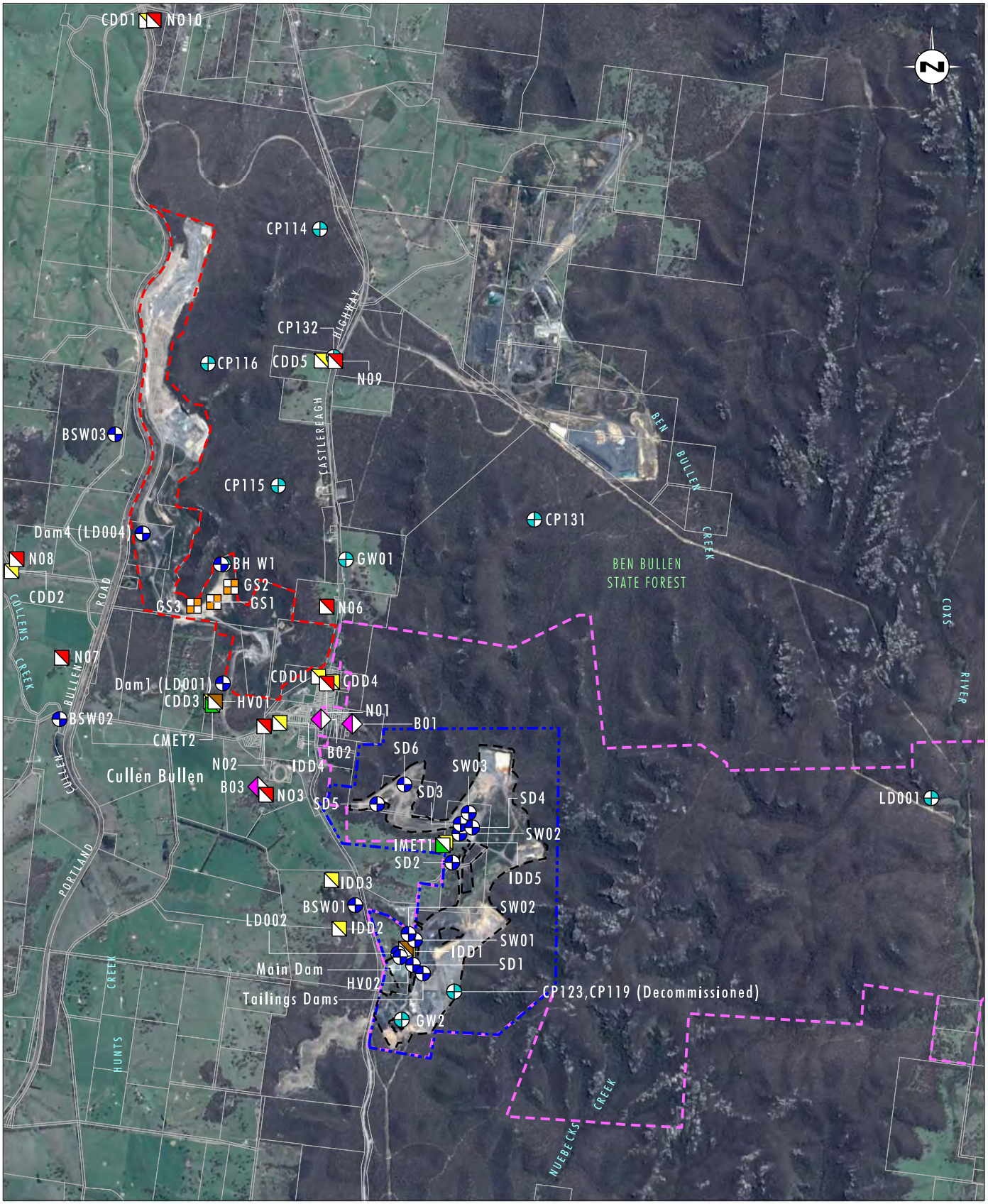
Only one threatened plant species, Capertee Stringybark, was found to occur in the study area during the Feldmast EIS (1997). The EIS predicted that no local population of Capertee Stringybark would be placed at risk of extinction as a result of the proposed mining operations. The 2003 EIS made similar predictions and concluded that there would not be a significant effect on Capertee Stringybark as a result of the expansion.

The 1997 EIS predicted that the mining operations were unlikely to cause a significant impact on threatened fauna species found in the study area. Similarly, the 2003 EIS predicted that the expansion was unlikely to have a significant impact on threatened fauna.

A summary of the environmental performance of CVM during the current report period as compared to predictions made in the EIS's is provided in **Table 6.1**.

Table 6.1 Summary of environmental performance during 2017

Aspect	Development Approval criteria / EA prediction	Performance during the report period	Trend / key management implications	Proposed additional management actions
Noise	Refer to **Section 6.1.1**	Noise performance is compliant with Development Approval criteria and conforms to EIS predictions. Refer to **Section 6.5**	No noise exceedance recorded during 2017. Historic trends are shown In **Section 6.5**	No further action required. The NMP will be reviewed should mining operations recommence.
Air Quality	Refer to **Section 6.1.2**	Air Quality monitoring was compliant with Development Approval criteria and conforms with EIS predictions. Refer to **Section 6.3**	A comparison to historic trends for air quality are shown in **Section 6.3** and **Appendix 2**	No further action required.
Water Quality	Refer to **Sections 6.1.3** and **6.1.4**	Surface water quality performance is compliant with Development Approval criteria and conforms with EIS predictions. Refer to **Section 6.4.1**. Groundwater monitoring has been compared to trigger levels developed during 2017 in **Section 6.4.2**.	A comparison of Surface Water Quality results to historic trends are shown in **Section 6.4.2** and **Appendix 3.** Groundwater monitoring is generally in accordance with previous monitoring undertaken and is discussed in **Section 6.4.2** and **Appendix 4**.	No further action required.
Biodiversity	Refer to **Section 6.1.5**	Progressing towards satisfactory completion The 2010 and subsurface heating areas, were found not be regenerating as successfully as the other areas. It is expected that the 2010 Rehabilitation Areas will passively regenerate over time.	The revised Biodiversity Monitoring Program commenced in 2016 and will be continued in 2017.	Biodiversity monitoring will continue to be undertaken during 2018.



Legend

- Existing Approved Mining Disturbance Area - Cullen Valley
- Existing Approved Mining Disturbance Area - Invincible
- Invincible Project Approval Boundary
- EPL Boundary
- Blast Monitoring Point
- Depositional Dust Monitoring Point
- Meteorological Station
- HVAS Monitor
- Noise Monitoring Point
- Surface Water Monitoring Point
- Groundwater Monitoring Point

FIGURE 6.1

Environmental Monitoring Locations
Cullen Valley Mine and Invincible Colliery

6.2 Meteorological monitoring

Meteorological monitoring is undertaken at CVM. The CVM weather station is located at the training centre adjacent the compensatory habitat area (see **Figure 6.1**). A summary of monthly meteorological monitoring results is provided in **Table 6.3.**

6.2.1 Rainfall

CVM received 459.4 mm of rainfall over 123 rain days during the report period. The highest rainfall occurred during March (99.8 mm), while September had the lowest rainfall (2.4 mm). A summary of monthly rainfall data is provided in **Table 6.3**.

6.2.2 Temperature

Air temperature is measured at 2 m and 10 m above ground level to account for temperature inversions. The maximum temperature recorded during the report period was in February (42°C @ 2m, 40°C @10m) and the lowest temperature occurred in July (-11.3°C @ 2m, -9.6°C @10m). The minimum and maximum monthly temperature data is provided in **Table 6.3**.

6.2.3 Humidity

The highest humidity recorded during the report period at CVM occurred during March and October (95.9%) and the lowest was during July (6.0%) as shown in **Table 6.3**.

6.3 Air quality

6.3.1 Environmental management measures

CVM's Environmental Management Plan (Coalpac, 2012c), which includes an Air Quality Management Plan (AQMP), which sets out air quality criteria, mitigation measures and monitoring procedures for the management of dust.

The air quality monitoring network at CVM consists of five dust deposition gauges (i.e. CDD1 to CDD5) and one High Volume Air Sampler (HVAS) measuring particulate matter <10µm (PM_{10}) (see **Figure 6.1**). Air quality monitoring equipment and weather stations are calibrated and maintained as required.

6.3.2 Performance criteria

The air quality impact assessment criteria specified in DA 200-5-2003 are provided in **Table 6.2**.

Table 6.2 Air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulate (TSP) matter	Annual average	90 µg/m^3
Particulate matter <10µm (PM_{10})	Annual average	30 µg/m^3
	24 hour average	50 µg/m^3
Deposited dust	Annual average (maximum total)	4 g/m^2/month
	Annual average (maximum increase)	2 g/m^2/month

Table 6.3 CVM weather station summary

Month	Rainfall (mm)	Cumulative Rainfall (mm)	No of rain days	Air temp @ 2m (°C)		Air temp @ 10m (°C)		Humidity (%)	
				Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January	34.8	34.8	14	9.3	38.8	10.4	36.9	9.8	93.8
February	14.6	49.4	10	1.2	42.0	2.8	40.0	10.9	93.8
March	99.8	149.2	17	4.0	31.3	5.1	29.7	15.6	95.9
April	20.2	169.4	9	-1.6	23.3	-0.9	22.2	22.4	93.7
May	27.0	196.4	10	-5.7	19.8	-4.4	19.1	18.9	93.7
June	13.8	210.2	14	-7.3	17.7	-5.7	17.5	24.7	95.3
July	8.8	219	7	-11.3	20.5	-9.6	19.8	6.0	92.6
August	28.8	247.8	11	-7.4	20.3	-5.9	19.8	15.1	92.9
September	2.4	250.2	2	-7.8	30.1	-5.8	29.1	9.0	90.8
October	70.4	320.6	7	-2.0	29.1	-0.5	27.4	12.7	95.9
November	61.6	382.2	13	0.8	30.5	1.7	28.6	18.3	94.3
December	77.2	459.4	9	5.9	35.2	6.7	33.2	12.8	94.7
Total	**459.4**	-	**123**	-	-	-	-	-	-

6.3.3 Environmental outcomes

Deposited dust is monitored on a monthly basis at 5 representative locations around the mine site (dust deposition gauges CDD1 to CDD5). The annual average criterion for deposited dust (4g/m^2/month) was not exceeded at any of the dust deposition gauges during the reporting period. The increase in annual average dust levels was less than the criterion of 2 g/m^2/month at all gauges. The deposited dust monitoring results for 2017 are shown in **Table 6.4**.

Table 6.4 Deposited dust monitoring results

	Total Insoluble Solids (g/m^2/month)				
Date	**CDD1**	**CDD2**	**CDD3**	**CDD4**	**CDD5**
January 2017	0.8	1.0	0.6	0.7	0.6
February 2017	0.6	0.3	0.5	0.8	1.6
March 2017	0.2	0.1	0.3	0.1	0.2
April 2017	0.9	0.1	0.3	0.5	0.6
May 2017	0.2	7.6	1.3	1.0	1.1
June 2017	0.3	12.9*	0.1	0.2	0.9
July 2017	0.3	5.2	0.7	0.4	0.5
August 2017	0.5	13.8*	0.7	0.5	5.4
September 2017	0.7	7.7	0.6	0.9	1.3
October 2017	<0.1	2.9	0.3	0.5	0.9
November 2017	0.2	0.2	0.3	0.6	1.2
December 2017	0.7	6.1	0.8	0.8	0.8
Annual Average 2017	**0.5**	**1.3**	**0.5**	**0.6**	**1.3**

Note*: These results have been excluded from the annual average calculations as the dust gauges were contaminated.

Monitoring of particulate matter is conducted on a 24-hour basis (collected every 6 days) using a HVAS. Total suspended particulates are estimated from the PM_{10} concentrations. The annual average criteria for PM_{10} (30 µg/m^3) and TSP (90 µg/m^3) were not exceeded during the reporting period. The 24 hour maximum allowable limit for PM_{10} (50µg/m^3) was not exceeded during the reporting period. The PM_{10} monitoring results for the reporting period are shown in **Table 6.5**.

Table 6.5 Particulate matter (PM_{10}) and Total Suspended Particulates (TSP) results

	PM_{10} (µg/m^3)	TSP (µg/m^3)
Annual Average 2017	7.8	24.5*

Note*: Total suspended particulates are estimated from the PM_{10} concentrations

6.3.4 Trends in data

Annual averages for dust deposition during 2017 are compared with monitoring data from the previous five years in **Table 6.6** below. Graphs of the long term dust deposition results included in **Appendix 2**. The annual averages for particulate matter recorded at CVM during 2017 are within the range of results recorded in the previous four years and are well below criteria limits.

Table 6.6 Annual averages for dust deposition 2012 -2017

	Total Insoluble Solids (g/m2/month)				
Year	CDD1	CDD2	CDD3	CDD4	CDD5
2013	0.7	0.6	0.7	0.6	1.2
2014	0.6	0.6	0.6	0.7	2.9
2015	0.2	2.7	0.4	0.8	0.6
2016	0.2	0.6	0.4	0.6	0.8
2017	0.5	1.3	0.5	0.6	1.3

A graph of the PM_{10} and TSP monitoring data is shown in **Appendix 2**.

6.3.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM EMP (Coalpac, 2012c).

6.4 Water management

CVM's Environmental Management Plan (Coalpac, 2012c), which includes a Water Management Plan (WMP). During the reporting period, a standalone Water Management Plan (Umwelt, 2017b) was prepared for the CVM was submitted to DPE for approval (refer to **Section 3.1**). The 2017 WMP sets out water quality criteria, mitigation measures and monitoring procedures for the management of surface water and groundwater.

6.4.1 Surface water quality

6.4.1.1 Environmental management measures

The surface water management system at CVM is a closed loop system that utilises a series of settlement dams. The CVM Water Management System (WMS) incorporates a range of infrastructure to manage clean water runoff from upslope undisturbed catchments, dirty water runoff from disturbed catchments and mine water (i.e. groundwater extracted from former underground workings or water that has come into contact with coal). Whilst CVM is on care and maintenance, mine water is only utilised for dust suppression. Where mine water is utilised for dust suppression it is captured and managed within the dirty water management system. The fundamental principle of the WMS is to minimise interaction of clean water, dirty and mine water and to capture dirty water for re-use and provide controls to treat captured dirty water to a standard acceptable for discharge off-site.

As the site is currently in care and maintenance, water is also sourced from the mine's pollution control dams as required. The Tyldesley Mine underground workings are also used to store excess water from the WMS surface water storages. The primary source of water for site use (when required) is from the abandoned and flooded Tyldesley Mine underground workings via the Tilley's Bore (GW01) in accordance with Water Access Licence WAL27898. When required, water is pumped from the workings via the Tilley's Bore to two 500,000 L tanks at CVM. Site water is transferred between site dams through gravity fed water mains.

During the reporting period, the CVM Water Management Plan (Umwelt, 2017b) was developed to address the findings of the 2016 Independent Environmental Audit (SLR, 2016).

The CVM Water Management Plan (Umwelt, 2017b) included further information regarding the erosion and sediment control management across CVM.

CVM operates under EPL 10341. This EPL 10341 provides water quality criteria and water quality monitoring requirements for discharges to water from the two CVM Licensed Discharge Points (LDP's) being LDP 001 and LDP 004, refer to **Figure 6.1**. Further discussion regarding water management and erosion and sediment control measures is included in **Section 7.0**.

6.4.1.2 Performance criteria

Water may be discharged from LDP 001 and LDP 004 at CVM in accordance with EPL and Development Approval requirements. **Table 6.7** presents the discharge criteria for the site.

Table 6.7 Water quality concentration limits for LDP 001 and LDP 004 during discharge

Pollutant	Concentration limit
Oil & Grease	10 mg/L
pH	6.5 – 8.5
Total suspended solids (TSS)	30 mg/L

6.4.1.3 Environmental outcomes

Water quality monitoring is conducted monthly at LDP 001 and LDP 004 regardless of the discharge status. This is undertaken for due diligence to monitor the water quality within the respective dams. There were no discharge events from LDP 001 and LDP 004 during the reporting period. The results of the monthly due diligence monitoring undertaken at Dam 1 and Dam 4 are included in **Appendix 3**.

6.4.1.4 Trends in data

The monthly water quality results in Dam 1 and Dam 4 during 2017 are compared with monitoring data from 2016 in **Appendix 3.** As noted above, during the 2017 report period there was no discharge from EPL Points LDP001 and LDP004.

The pH results for Dams 1 and 4 during the reporting period ranges between 6.5 and 8.0, as shown in **Appendix 3**. This range is generally consistent with that recorded during the 2016 reporting period (i.e. 6.8 to 8.4).These levels are within the EPL discharge criteria in the event that CVM were required to discharge water from EPL Points LDP 001 and LDP 004. There were no discharges during the reporting period.

Oil and grease was below detection limits in Dam 1 and Dam 4 during the reporting period.

Results of TSS monitoring in Dam 1 were elevated during April and May 2017, but were below the EPL discharge criteria for remaining months. Dam 4 was below EPL TSS criteria for all months. As noted previously, these water quality results are for due diligence/site management purposes as there was no discharge from EPL Points LDP 001 and LDP 004 during the report period.

6.4.1.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the WMP (Umwelt, 2017b).

6.4.2 Groundwater quality

6.4.2.1 Environmental management measures

CVM is located on the western escarpment of the Sydney Basin. Aquifers in this area are typically limited to the Lithgow Seam and the Marangaroo Sandstone which underlies the Lithgow Seam. Despite their proximity, there is little observed horizontal movement between these aquifers in the Marangaroo Sandstone and the Lithgow Seam (AGE, 2012).

Past open cut and highwall mining at CVM has targeted the Irondale, Lidsdale and Lithgow seams. Underground mining in the area has been largely limited to the Lithgow seam. The Lithgow Seam can be seen in the highwalls faces at CVM (some of which are now covered by emplaced overburden). Outcrop areas north of the open cut workings represent local recharge points for the Lithgow seam.

Figure 6.2 shows the general dip in the strata of the Lithgow seam to the east - northeast and the location of underground workings in the Lithgow seam in the area. The open cut workings in the southern parts of the CVM are hydraulically connected to the former Tyldesley Colliery workings which extend to the east of the southern part of CVM (refer to **Figure 6.2**). The water in the Tyldesley Colliery workings is sourced from groundwater inflows (i.e. recharge areas) located up-dip, ingress from areas at CVM where the open cut operations are hydraulically connected to the Tyldesley workings, and infiltration through subsidence cracking associated with pillar extraction and pillar failure in the former workings. Water quality in these workings is monitored at GW01 (East Tyldesley Bore) (refer to **Figure 6.2**).

As can be seen from **Figure 6.2**, the CVM pit is located up-dip of the Lithgow seam groundwater monitoring bores of CP 116, CP 115 and CP 132 and operates as a recharge point for the Lithgow seam in this area. As mining at CVM extended to the base of the Lithgow Seam and as CVM represents an up-dip recharge point of this aquifer, the open cut at CVM do not intercept any natural groundwater aquifers. Therefore, there are limited depressurisation impacts associated with the CVM open cut pits and any impacts would be associated with interactions with the recharge regime; these impacts are expected to be limited due to the low recharge rates and the generally benign nature of the overburden emplaced adjacent to the outcropping coal seams (Umwelt, 2017b).

During 2017, the CVM WMP (Umwelt, 2017b) was developed to include additional information as required by correspondence from DPE, in response to an anomalous groundwater monitoring result recorded during the 2016 round of groundwater sampling. Shoalhaven Coal received a Show Cause notice in regards to groundwater quality on 21 April 2017 in regards to groundwater sampling undertaken during 2017. Shoalhaven Coal completed a groundwater report to address the requirements of the show cause notice with the report submitted to DPE on 29 May 2017. An anomalous groundwater monitoring result for pH was, on investigation attributed to a non-compliance with the sampling procedure and the nature of the tested bore (BHW1) which was installed to monitor groundwater depth only. This bore has subsequently been removed from the CVM groundwater quality monitoring program. Further explanation of the groundwater results obtained during 2017 groundwater sampling was also provided to DPE who subsequently issued Shoalhaven Coal a Warning Letter and Voluntary Undertaking on 13 June 2017. The warning letter was in relation to the groundwater monitoring results reporting accuracy and that the results were not investigated prior to the submission of the Annual Review.

As part of the Voluntary Undertaking Shoalhaven Coal committed to refine the WMP to include a review of the existing groundwater monitoring network and development of Trigger Action Response Plans (TARPS). The updated WMP and TARP's were to identify clear action(s) to be undertaken in the event of monitoring results being recorded which are outside defined trigger levels. Subsequently and as detailed in the Voluntary Undertaking, CVM developed the CVM WMP (Umwelt, 2017b). The preparation of the CVM WMP (Umwelt, 2017b) involved:

- a full review of the existing groundwater monitoring network to determine the suitability of the existing monitoring network.

- a review of the monitoring methods undertaken by specialist groundwater monitoring consultants for future groundwater monitoring.

- defining specific groundwater monitoring and reporting requirements.

- The development of Groundwater TARP's to ensure any anomalous monitoring results in the future are actioned in a timely and consistent manner.

DPE have not yet provided comment on the CVM WMP (Umwelt, 2017b) as at the end of the 2017 reporting period.

6.4.2.2 Performance criteria

There are no pollutant concentration limits for groundwater specified in the Development Approval or EPL. The CVM WMP (Umwelt, 2017b) includes a trigger values against which groundwater monitoring results are compared. For the purposes of this Annual Review, the groundwater results obtained during the reporting period have been compared to these trigger values.

The CVM WMP (Umwelt, 2017b) has reviewed the location and target seam for each groundwater monitoring bore and considers the CP115, CP116 and GW01 groundwater monitoring bores are suitable to assess any potential offsite groundwater impacts associated with the operation of CVM. These bores are located down dip of CVM and are also located within appropriate seams. **Table 6.8** shows the range of historical values for key analytes from the groundwater monitoring impacts bores CP115, CP116 and GW01. Results outside of these ranges may be triggers for further investigation. The results of CP115, CP116 and GW01 are also compared to reference bores which are bores that are considered to be representative of background groundwater quality (refer to **Section 6.4.2.4**).

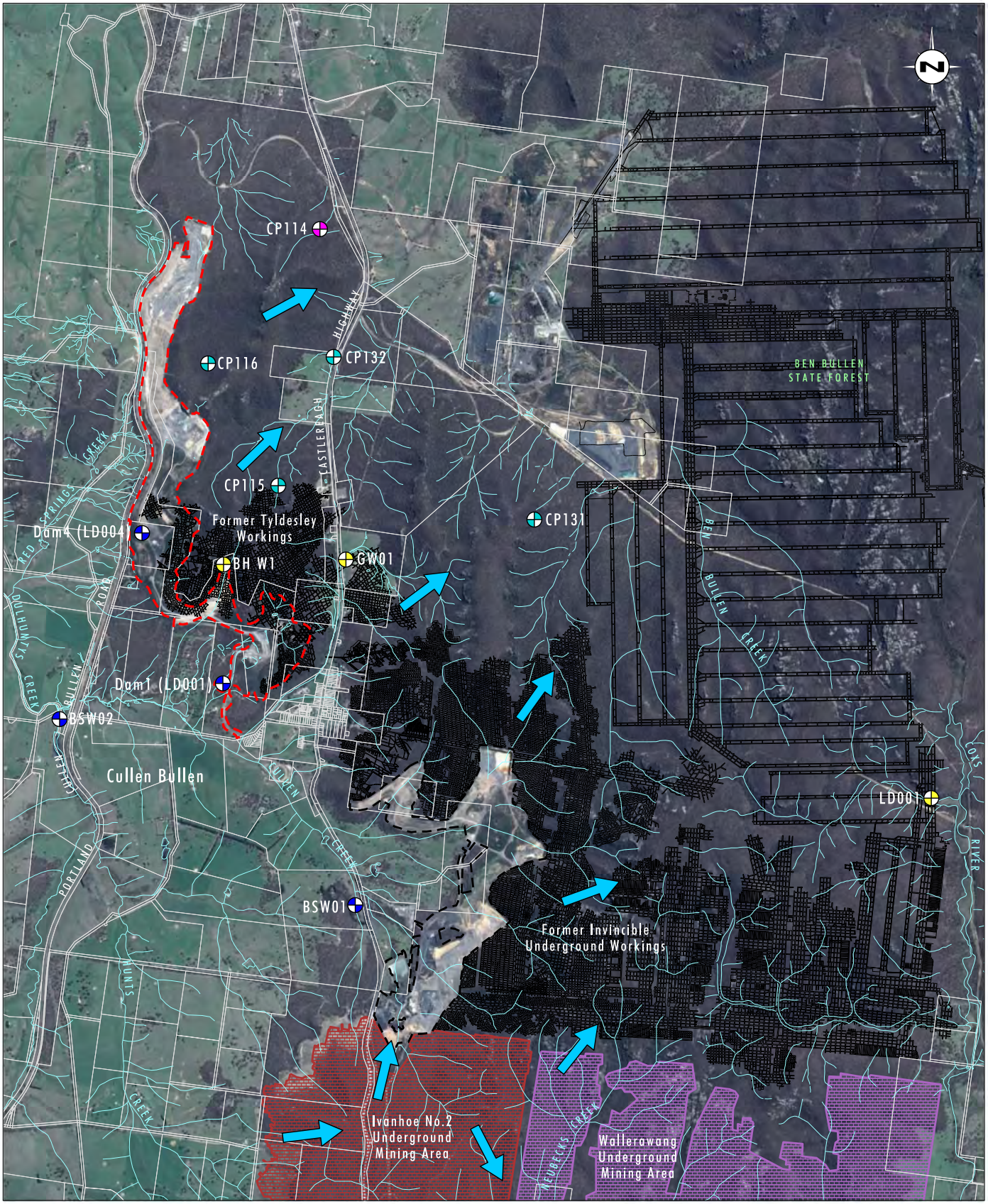


Image Source: Google Earth - CNES/Astrim (2016)
Data Source: LPI (2016), Sedgman (2014)

0 0.5 1.0 2.0km
1:50 000

Legend

- Open Cut Mining Disturbance Area - Cullen Valley
- Existing Mining Disturbance Area - Invincible
- Direction of Coal Seam Dip
- Former Invincible Underground Workings
- Invincible Project Approval Boundary
- Wallerawang Underground Mining Area
- Groundwater Monitoring Point (Lithgow Seam)
- Groundwater Monitoring Point (Marangaroo Sandstone)
- Groundwater Monitoring Point (Underground Workings)
- Surface Water Monitoring Point (Invincible)

FIGURE 6.2

Hydrology Context
Cullen Valley Mine

Table 6.8 Groundwater quality and level triggers as defined in CVM WMP (Umwelt, 2017b)

Bore	Groundwater Level (mAHD) Trigger Range	Analyte			
		pH	EC (us/cm)	Sulphate (mg/L)	Hardness (mg of $CaCO_3$/L)
CP116	890 - 894	Range 5.82 - 7.2	Upper limit 840	Upper limit 140	Upper limit 210
CP115	892 - 896	Range 6.26 - 7.3	Upper limit 970	Upper limit 380	Upper limit 376
GW01[1]	N/A as bore is located in workings	Range 6.14 - 6.82	Upper limit 939	Upper limit 338	Total Alkalinity[2] Upper limit 100 mg of $CaCO_3$

[1] Baseline data for GW01 has been obtained from 11 groundwater monitoring events over an 11 month period from 2016-2017. The trigger level ranges may be modified over time to be consistent with those seen in other bores.

[2] GW01 has not been monitored for Hardness as part of groundwater quality baseline monitoring. Total Alkalinity has been used as a proxy for Hardness, and will be utilised as a trigger for this bore until sufficient baseline data for hardness has been obtained for this bore to develop a trigger value.

Baseline groundwater monitoring programs and associated trigger levels when developed in accordance with ANZECC recommendations require the utilisation of 24 contiguous monthly samples (ANZECC, 2000). The trigger levels for groundwater monitoring at CVM have been developed utilising the existing groundwater data set which is a limited data set of between nine and eleven annual groundwater samples at each location over the period 2011 – 2017. It is therefore intended that the groundwater trigger levels for the CVM groundwater bores will be refined as further data becomes available. The trigger action response plan, as detailed in the CVM WMP (Umwelt, 2017b) defines a process for reviewing results which have been obtained which are outside of the groundwater trigger levels as detailed in **Table 6.8**. Section 5.7.1 of the CVM WMP (Umwelt, 2017b) states:

> *'Monitoring results observed outside groundwater quality and level triggers identified in Table 5.3 do not necessarily reflect an environmental impact associated with CVM, as variances within the CVM bores may be influenced by natural environmental variations and /or localised land use activities (not associated with CVM activities).'*

Monitoring results observed outside groundwater quality and level triggers identified in **Table 6.8** do not necessarily reflect an environmental impact associated with CVM, as variances within the CVM bores may be influenced by natural environmental variations and/or localised landuse activities (not associated with CVM activities).

6.4.2.3 Environmental outcomes

During the reporting period, groundwater monitoring was conducted on three occasions (refer to **Table 6.9**). A discussion of the 2017 groundwater monitoring results is included in **Section 6.4.2.4**.

Table 6.9 Reporting period groundwater monitoring

Sampling Date	Overview of Sampling
May 2017	This in conjunction with the data collected from the November 2016 Annual Groundwater Monitoring (RCA, 2016) was utilised to review the validity of the anomalous groundwater monitoring result from borehole BHW1 recorded during 2016. Monitoring completed during May 2017 focussed on a restricted set of bores and analytes and did not constitute a full suite of monitoring as would usually be completed as part of Annual Groundwater Monitoring.
November 2017	The groundwater samples of 9 November 2017 were not collected in accordance with Australian Standard groundwater sampling requirements or the approved management plan procedure. The corresponding results were determined as being anomalous following an investigation. The monitoring contractor did not utilise the agreed sampling procedure as defined in the CVM WMP (Umwelt, 2017b) due to equipment unavailability. Instead a sampling procedure which utilised low-flow equipment which did not purge the required volume of water from the bores prior to the collection of the sample was used during sampling (i.e. 4 bore volumes were not removed using this technique). Through comparison with previous results, it was determined the result was likely to be anomalous. Groundwater sampling was re-conducted using the approved sampling procedure in December 2017. Consequently, the November 2017 groundwater quality monitoring results has been excluded from the results and discussions below. All monitoring results (excluding the 9 November 2017 sample which has been determined to be anomalous) are included in **Appendix 4**. During the November 2017 monitoring round connectivity issues were noted in loggers BHW1 and CP114. These loggers were removed and sent to the manufacturer for data retrieval. New loggers were re-installed within bores BHW1 and CP114.
December 2017	Groundwater sampling undertaken on 13 December 2017 was undertaken in accordance with the Annual Groundwater sampling program required by the CVM WMP (Umwelt, 2017b). During the December groundwater monitoring event, connectivity issues were noted with the loggers contained in bores CP115, CP131 and CP132. Data was successful downloaded from logger CP115; however, no data could be downloaded from logger CP131 (historically this bore is dry) and the data obtained from logger CP132 was corrupted for the month of December 2017. Bore LD001 was downloaded successfully; however, the logger ceased recording in September 2017. It is also noted that all bore were dipped manually for groundwater levels on a monthly basis during November and December 2017. An investigation following the data logger issues encountered during late 2017 identified the typical lifespan of the logger (i.e. Schlumburger Diver water level logger) is seven years. The loggers contained within CP115, CP116, LD001, CP131 and CP132 are approximately seven years old. Replacement loggers are currently on order and will be replaced in 2018.

A summary of the groundwater logger data coverage for the 2017 period is presented in **Table 6.10**.

Table 6.10 Groundwater logger data coverage

Logger	Last Successful Field Download	2017 Data Coverage	Logger replaced
CP114	November 2016.	1st January – 5th October. Monthly manual dip reading undertaken November and December.	Yes
CP115	December 2017. Connectivity issues noted.	1st January – 13th December.	To be replaced 2018
CP116	December 2017.	1st January – 13th December	To be replaced 2018
LD001	December 2017. Logger ceased logging prior to download.	1st January – 7th September. Monthly manual dip reading undertaken October - December.	To be replaced 2018
CP115	December 2017. Connectivity issues noted.	1st January – 13th December.	To be replaced 2018
CP116	December 2017.	1st January – 13th December	To be replaced 2018
LD001	December 2017. Logger ceased logging prior to download.	1st January – 7th September. Monthly manual dip reading undertaken October - December.	To be replaced 2018
CP131	November 2017.	1st January – 9th November. Monthly manual dip reading undertaken November and December.	To be replaced 2018
CP132	November 2017	1st January – 9th November. Monthly manual dip reading undertaken November and December.	To be replaced 2018
BHW1	November 2016.	No data from data logger. Monthly manual dip reading undertaken in May, November and December.	Yes

6.4.2.4 Trends in Data

The groundwater monitoring program at CVM consists of:

- impact bores – bores with the potential to identify potential groundwater impact from CVM specifically CP115, CP116 and GW01; and

- reference bores - bores that are considered to be representative of background groundwater quality (i.e. are unlikely to be impacted by CVM operations), specifically CP114, CP131, CP132 and LD001. These bores provide a baseline for comparison with bores CP115, CP116 and GW01.

The collection of groundwater samples from CP114 and CP 116 was hampered by the bailer becoming increasingly lodged inside the bore casing. As a result, groundwater samples were collected from CP114 and CP 116 when the last three pH and electrical conductivity field readings were within 10% (i.e. four bore volumes were not able to be purged from these bores). The bailer was unable to be removed from CP116. The groundwater monitoring contractor has been asked to attempt to remove the bailer. It is anticipated that this will be undertaken during April / May 2018 with groundwater samples to be collected at this time.

Standing Water Level

The standing water level in the impact bores during the reporting period are within the trigger level range, as shown in **Table 6.11**.

Table 6.11 Impact bores standing water levels and triggers

Bore	Groundwater Level (mAHD) Trigger Range	May 2017 Groundwater Level (mAHD)	December 2017 Groundwater Level (mAHD)	Complied with Trigger Level
CP116	890 - 894	893.0	893.0	Yes
CP115	892 - 896	894.4	894.2	Yes
GW01	N/A as bore is located in workings	N/A	N/A	N/A

The long term standing water level trend in both impact bores (CP116 and CP 116) has been almost identical since monitoring commenced in February 2012. Since February 2012 the standing water level has gradually increased until November 2016 after which time it has gradually declined, as shown graphically in **Appendix 4**.

The reference bores however show greater variability in the long term standing water level trends, as shown graphically in **Appendix 4.**

pH

The pH results for the impact bores during the reporting period were within the trigger level range, with the exception being the December 2017 results for CP116 and CP115, as shown in **Table 6.12**. CP116 had a pH reading 0.01 pH units below the baseline range of 5.82. While CP115 had a pH reading 0.3 pH units below the trigger value range of 6.26. The decrease in pH values appears to be consistent with the longer term trend observed across both impact and reference bores. As such, these results are considered to be reflective of a wide regional trend and not the results of CVM activities, as shown as shown graphically in **Appendix 4**.

Table 6.12 Impact bore pH levels and triggers

Bore	pH Trigger Range	May 2017 pH Level	December 2017 pH Level	Complied with Trigger Level
CP116	5.82 – 7.2	6.20	5.81	No
CP115	6.26 – 7.3	6.26	5.96	No
GW01	6.14 – 6.82	Not sampled	6.23	Yes

The impact and reference bores typically display a decreased in pH from the November 2016 and May 2017 monitoring rounds, which is consistent with the long term trend (2011-2017) for both reference and impact bores. The exception being LD001 which has increased slightly on the November 2016 result (i.e. increase of approx. 0.5 pH units).

The long term pH trend across both impact and reference bores is typically one of declining pH value, with occasional isolated spikes and drops depending on the bore in question, as shown graphically in **Appendix 4**.

Given the restricted dataset of baseline monitoring completed, the December 2017 CP115 value is possibly within the range of likely expected values for the bore and are not necessarily indicative of groundwater impact. However, in accordance with Table 5.1 of the CVM WMP (Umwelt, 2017b), CP115 will be monitored on a 6-monthly basis and further sampling during June and December 2018 will provide an opportunity to further assess pH variances for this bore.

The December 2017 CP116 value was only 0.01 pH unit below the trigger range, no further action is proposed at this time. The December 2017 values represent a minor increase on trigger levels as detailed in the CVM WMP (Umwelt, 2017b). An analysis of water licenses in the region completed during May 2017 identified that there were no registered bore users in the area down-dip of CVM and thus there are no users which would be impacted by these results.

Electrical Conductivity

The Electrical Conductivity (EC) in the impact bores during the reporting period are below the trigger level, as shown in **Table 6.13**.

Table 6.13 Impact bores electrical conductivity levels and triggers

Bore	Electrical Conductivity (µS/cm) Trigger Level	May 2017 Electrical Conductivity Level (µS/cm)	December 2017 Electrical Conductivity Level (µS/cm)	Complied with Trigger Level
CP116	Upper limit 840	361	313	Yes
CP115	Upper limit 970	77	670	Yes
GW01	Upper limit 939	Not sampled	629	Yes

The long term trend in EC values across the reference bores is mixed. LD001 has shown minor variability (±20 µS/cm) around 130 µS/cm. CP114 exhibits a steady decline from 350 µS/cm to 223 µS/cm, with occasional small spikes and stable periods before returning to a steady decline. CP132 declined initially, until April 2014 after which the EC values rose until May 2017 and have subsequently declined, as shown graphically in **Appendix 4**.

The long term trend in EC values in the impact bores however shows greater variability than the reference bores. There also does not appear to be consistent trend for the impact bores, as shown graphically in **Appendix 4**.

Sulphate

The sulphate levels in the impact bores during the reporting period are below the trigger level, as shown in **Table 6.14**.

Table 6.14 Impact bores sulphate levels and triggers

Bore	Sulphate (mg/L) Trigger Level	May 2017 Sulphate Level (mg/L)	December 2017 Sulphate Level (mg/L)	Complied with Trigger Level
CP116	Upper limit 140	40	46	Yes
CP115	Upper limit 380	338	356	Yes
GW01	Upper limit 338	Not sampled	287	Yes

The long term trend in sulphate values for the reference bores LD001 and CP114 is consistently 17 mg/L ±5 mg/L. CP132 shows greater variability with results ranging between 17 mg/L at February 2011 and 103 mg/L at May 2017 with up to 70 mg/L of variation between consecutive samples, as shown graphically in **Appendix 4**.

The results for the impact bores show very different trends. CP116 initially declined, before spiking in November 2015, after which it dropped back to levels comparable to pre November 2015 (i.e. approximately 25 mg/L) and has since increased slightly. While CP115 typically increased from 100 mg/L in February 2011 to 380 mg/L in April 2014, after which it has remained relatively stable around a value of 350 mg/L, as shown graphically in **Appendix 4**.

As discussed within the groundwater study completed for CVM in 2017 (Umwelt, 2017e), the recorded sulphate levels are all well within the ANZECC criteria for drinking water for domestic stock which provide:

> *No adverse effects to stock are expected if the concentration of sulphate in drinking water does not exceed 1000 mg/L. Adverse effects may occur at sulphate concentrations between 1000 and 2000 mg/L, especially in young or lactating animals or in dry, hot weather when water intake is high. These effects may be temporary and may cease once stock become accustomed to the water. Levels of sulphate greater than 2000 mg/L may cause chronic or acute health problems in stock.*

As the sulphate results from CP115 are stable and within ANZECC guidelines, there is no indication of any environmental harm associated with these results. In accordance with the CVM WMP (Umwelt, 2017b) Shoalhaven Coal will continue to monitor sulphate levels however no specific investigation of sulphate levels is required to be undertaken.

Hardness

The hardness levels in the impact bores during the reporting period are below the trigger level, with the exception of the December 2017 result for CP115, as shown in **Table 6.15**. CP115 had a hardness level 11mg/L above the upper limit of 376 mg/L. An analysis of water licenses in the region completed during May 2017 identified that there were no bore users in the area down-dip of CVM and therefore there are no groundwater bores which would be impacted by increased hardness levels if it were to occur.

Table 6.15 Impact bores hardness levels and triggers

Bore	Hardness (mg/L) Trigger Level	May 2017 Hardness Level (mg/L)	December 2017 Hardness Level (mg/L)	Complied with Trigger Level
CP116	Upper limit 210	118	128	Yes
CP115	Upper limit 376	360	387	No
GW01	Total Alkalinity[2] Upper limit 100 mg of $CaCO_3$	Not sampled	84	Yes

The long term trend in hardness values for the reference bores is mixed. LD001 shows little change throughout. CP114 shows small variability around 100 mg/L before a result of 350 mg/L in December 2017. CP 114 is a reference bore as defined in the CVM WMP (Umwelt, 2017). Sampling of CP114 will be undertaken in April 2018 to confirm whether the hardness values have returned to the historic range. Sampling of EC will also be undertaken. The resampling of this bore is as per the requirements of the CVM WMP (Umwelt, 2017) which requires resampling of impact bores when a result spike cannot be attributed to non-compliance with sampling procedures, or similar trends are observed in surrounding bores. Whilst CP114 is a reference bore and the CVM WMP (Umwelt, 2017) TARP process applies to 'impact' bores, Shoalhaven Coal will resample the reference bore and advise DPE of the April 2018 sample result.

While CP132 initially was consistent around a level of 150 mg/L (April 14 to Nov 15), before spiking at 200mg/L on November 2016 and declining to 50 mg/L in December 2017, as shown graphically in **Appendix 4**. Sampling of CP 132 will be undertaken in April 2018 to confirm whether the hardness values have returned to the historic range.

The impact bores also show different long term trends in hardness. CP116 has declined from 210 mg/L before stabilising in April 2014 around a level of 100-125mg/L. The long terms trend for CP115 shows an overall increasing trend, from 210 mg/L in February 2011 to 380mg/L in December 2017, as shown graphically in **Appendix 4**.

Given the restricted dataset of baseline monitoring completed, the December 2017 CP115 value is possibly within the range of likely expected values for the bore and are not necessarily indicative of groundwater impact. However, in accordance with Table 5.1 of the CVM WMP (Umwelt 2017b), CP115 will be monitored on a 6-monthly basis and further sampling during 2018 will provide an opportunity to further assess hardness variances for this bore. The December 2017 value represents a minor increase on trigger levels as detailed in the CVM WMP (Umwelt, 2017b). An analysis of water licenses in the region completed during May 2017 identified that there were no registered bore users in the area down-dip of CVM and thus there are no users which would be impacted by this result.

Other Analytes (not required for trigger level assessment as described in the WMP)

Nitrate

Results for December 2017 round of monitoring together with the long terms trend show that both impact reference bores have very low levels of nitrate, the majority of which are less than the laboratory detection limit, as shown graphically in **Appendix 4**. Monitoring will continue in accordance with the requirements of the CVM WMP (Umwelt, 2017b).

Metals

Results of monitoring undertaken during December 2017 for dissolved metals within the Impact bores are highly variable. Metals are usually analysed for trends as a group (or groups of metals) rather than on an individual metal basis. This is usually completed where sufficient baseline information is available to analyse potential trends. Given the restricted available dataset, the ability to meaningfully analyse metals results obtained during 2017 and trends in data is therefore limited. Results are discussed below:

- Impact bore CP115 – Monitoring undertaken during May 2017 did not identify any metals above the baseline range. The results of monitoring completed in December 2017 indicate that Aluminium, Iron and Lead were at above the previous maximum levels. The remaining metal analytes (Arsenic, Cadmium, Chromium, Copper, Manganese, Molybdenum, Nickel, Selenium, Zinc and Mercury) levels recorded in May 2017 and December 2017 were within the range of previous results. Given the low pH value for December 2017 for this bore, metals in solution could be expected to also increase, however this has only occurred for certain metals, as discussed above. In summary, insufficient data is available to set meaningful trigger levels for metals at this stage, based on ANZECC guidelines.

- Impact bore CP116 – the iron levels recorded during May 2017 and December 2017 consecutively exceed the previous maximum level recorded. The remaining metal analytes levels recorded in May 2017 and December 2017 were within the range of previous results. A trend of increasing dissolved Iron can be seen within bore CP116. This trend will continue to be monitored. However, with the limited available dataset, it is difficult to determine whether these results are within the historical range of expected results from this bore. There is no ANZECC level for Iron and there are no registered bore users in the area down-dip of CVM, there are no users which would be impacted by this result.

- Impact bore GW01 – annual groundwater monitoring of GW01 only commenced in December 2017. Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Molybdenum, Selenium, and Mercury all return results which were below the limit of detection. Iron, Manganese, Nickel and Zinc returned levels above the limit of detection. The level of iron recorded was however below the previous minimum. Manganese, Nickel and Zinc levels were however with the range of previous results.

- Reference bore CP132 - results of monitoring completed during May and December 2017 have identified that CP132 had levels of dissolved iron and manganese within the range of previous results; all remaining metals were lower than the laboratory detection limit.

- Reference bore LD001 - Aluminium, Arsenic, Cadmium, Chromium, Iron, Lead, Molybdenum and Selenium, all return results which were below the limit of detection. The levels for Copper, Manganese and Nickel were however with the range of previous results. The level of Zinc recorded was however above the previous maximum.

- Reference bore CP114 - results of monitoring completed during December 2017 recorded levels above the previous maximum for Aluminium, Chromium, Copper, Iron and Lead. However, the levels for Chromium and Copper were only 1 µg/L above the previous maximum. All other metal levels were either below the laboratory detection limit or within the previous range of results.

The CVM WMP (Umwelt, 2017b) does not include trigger values for metals, due to the limited data set and variable nature of the dissolved metals in groundwater samples taken to date. Given the significant variability not only between impact bores and reference bores and within the individual bores, the data does not warrant further investigation. In order to develop trigger levels for the metals results obtained from the CVM bores, 24 contiguous monthly samples would be required, as per ANZECC guidelines (ANZECC, 2000). Given the phase of operations at the site (i.e. care and maintenance), there are no proposed changes to the groundwater monitoring regime.

6.4.2.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM WMP (Umwelt, 2017b).

6.5 Noise

6.5.1 Environmental management measures

CVM's Environmental Management Plan (Coalpac, 2012c) includes a Noise Management Plan (NMP), which sets out noise criteria, mitigation measures and monitoring procedures for noise management.

There were no mining operations during the reporting period, however, quarterly attended monitoring was conducted at five locations around CVM in accordance with the CVM Environmental Management Plan (Coalpac, 2012c). Noise controls and mitigation measures are implemented to ensure compliance with noise impact assessment criteria.

6.5.2 Performance criteria

Noise criteria is specified in the Development Approval and EPL 10341. **Table 6.16** summarises the criteria across the Development Approval and EPL 10341.

Table 6.16 Noise criteria in CVM development approval

Location	Day – L_{Aeq} (15 minute)	Evening – L_{Aeq} (15 minute)	Night – L_{Aeq} (15 minute)	Night - L_{A1} (1 minute)
Red Springs (east of rail line)	35 dB(A)	35 dB(A)	35 dB(A)	45 dB(A)
Red Springs (west of rail line)	43	38	35	45
Hillcroft (east of rail line)	35	35	35	45
Hillcroft (west of rail line)	43	38	35	45
Forest Lodge	40	40	38	45
Doble Gate	43	38	35	45
Tilley	43	38	35	45

6.5.3 Environmental outcomes

There were no exceedances of the Development Approval or EPL impact assessment criteria during the reporting period as shown in **Table 6.17**. On all monitoring occasions, the noise from CVM was inaudible. There were no complaints received in regards to noise during the reporting period.

Table 6.17 2017 Quarterly noise monitoring results

Location	Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$)	Quarter 2 ($L_{Aeq\ 15min}$)	Quarter 3 ($L_{Aeq\ 15min}$)	Quarter 4 ($L_{Aeq\ 15min}$)
Red Springs (N07)	44 (IA)	33 (IA)	34 (IA)	34 (IA)	44 (IA)
Hillcroft (N08)	42 (IA)	37 (IA)	29 (IA)	29 (IA)	42 (IA)
Forest Lodge (N10)	33 (IA)	34 (IA)	31 (IA)	31 (IA)	33 (IA)
Doble Gate (N09)	47 (IA)	50 (IA)	45 (IA)	45 (IA)	47 (IA)
Tilley (N06)	65 (IA)	68 (IA)	67 (IA)	67 (IA)	65 (IA)

IA – noise from CVM was inaudible

6.5.4 Trends in data

The Quarterly noise monitoring results for the period 2011 – 2015 are summarised in **Appendix 5**. The results show CVM has largely been inaudible at each noise monitoring location since CVM entered care and maintenance.

6.5.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM EMP (Coalpac, 2012c), in relation to noise management.

6.6 Biodiversity

6.6.1 Environmental management measures

CVM's Environmental Monitoring Program (Coalpac, 2009) and Flora and Fauna Management Plan (Coalpac, 2012a) have been prepared in accordance with the Development Approval outlining the required monitoring of rehabilitation and compensatory habitat sites.

Biodiversity monitoring has been undertaken at CVM since the base line survey in 2012 (Kleinfelder, 2012-2015) and was has been undertaken by Umwelt since 2016 (refer to **Figures 6.3 and 6.4**). Existing vegetation communities and fauna habitat have been previously characterised during the Ecological Impact Assessment (Cumberland Ecology, 2014). As noted in **Section 3.1**, CVM submitted a revised Flora and Fauna Management Plan (Umwelt, 2017) to DPE during 2017.

6.6.2 Performance criteria

During 2017, biodiversity monitoring was undertaken for the Cullen Valley Mine Compensatory Habitat Area (CHA) and within Rehabilitation Areas as shown on **Figure 6.3**. The biodiversity monitoring program for CVM was based on the monitoring requirements documented in the following plans:

- Cullen Valley Mine Flora and Fauna Management Plan (Coalpac, 2012a); and
- Cullen Valley Mine Environmental Monitoring Program (Hansen Bailey, 2009).

In addition to the monitoring requirements stated in the above documents, monitoring undertaken of the CHA and rehabilitation areas in 2017 included the following:

- floristic monitoring within fixed plots (20m x 10m) every 10 ha;
- fauna surveys to identify the fauna species and habitats quality;
- Clandulla geebung and Capertee stringybark monitoring (biodiversity conservation area);
- vegetation dieback surveys in areas of subsurface heating (further discussed in **Section 6.9**) and
- an assessment against the performance/completion criteria with the CVM C&M MOP (Sedgman, 2015).

6.6.3 Environmental outcomes/trends in Data

6.6.3.1 CVM compensatory habitat areas

Native vegetation within the CHA is considered to be in good condition, with a low abundance of weeds. The three vegetation communities monitored in 2017 (i.e. the Tablelands Dry Woodland type, Tablelands Sheltered Valley Forest type and the Sandstone Ridgetop Woodland type) were floristically and structurally similar to that observed in previous monitoring events. This is expected as the CHA consists of intact woodland situated adjacent to Ben Bullen State Forest forming a corridor facilitating native species recruitment.

The vegetation of the CHA demonstrates minimal degradation due to human influences with the exception of vehicle tracks and rubbish dumping by others. Vegetation within these sites remains in healthy condition with minimal signs of stress or degradation (such as disease or herbivory). This is reassuring considering the dry weather that has been experienced since the 2016 monitoring event. Given the above no flora management activities are recommended at the present time.

The CHA exhibits good fauna habitat characteristics, with well-established woodland and forest communities providing a stable range of habitat features. An abundance of fauna habitat features were recorded during the survey (e.g. woody debris, hollow bearing trees, fallen timber, permanent dams, escarpment and large rocky outcrops). The occurrence and abundance of such features highlight the importance of retaining a diversity of complex habitat structures, as evidenced by the similarity of fauna species diversity between monitoring events. As such, the CHA supports substantial species diversity with 58 fauna species recorded during fauna survey. A large proportion of this is birds with 41 species recorded across all CHA sites. The proximity of the CHA to Ben Bullen State Forest is also likely to influence the diversity of fauna species and the occurrence of threatened species.

A total of three threatened species were recorded in the CHA's at Cullen Valley Mine. These were the greater glider (*Petauroides volans*), squirrel glider (*Petaurus norfolcensis*), and Clandulla geebung (*Persoonia marginata*). All three species are listed as vulnerable under the EPBC Act and have been recorded in previous surveys events.

6.6.3.2 Rehabilitation areas

The Cullen Valley rehabilitation areas are identified by the year each area was established. There are currently 12 rehabilitation areas across both mine sites over 11 different years (2002, 2003, 2004, 2005, 2006, 2008, 2009, 2010, 2011, 2012 and 2014 rehabilitation areas). The CVM Rehabilitation Area contains nine rehabilitation areas being 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2012 and 2014.

Rehabilitation at CVM is considered successful across all years, as the vegetation condition is considered to be generally in good condition with a low abundance of weed species. Floristic composition and habitat function of rehabilitation areas have overall remained consistent with previous monitoring events, excluding the new areas of subsurface heating (see **Section 6.9**).

The formation of habitat features and ecosystem function was found to improve within the younger rehabilitation areas. A gradual improvement in the seeding mixes and seeding rates along with the introduction of organic material has assisted vegetation establishment. Woody debris and large timber logs were more frequently recorded in younger areas of rehabilitation. These features aid habitat stability by forming sediment traps and increase ground cover to reduce effects of erosion. Ecosystem functionality of lower condition areas can be enhanced by implementing some additional management actions including increasing the amount of woody debris to develop and improve soil structure and facilitate organic matter deposition, enhancing the available compensatory habitat through installing nest boxes and hollow logs, and targeted plantings of native ground cover and tubestock where required.

The results of the 2017 fauna survey consider fauna diversity to be high at 70 species. This is higher than the 58 species recorded in the CHA. This is an excellent result given they are from the rehabilitated areas. This high diversity is likely due to the proximity of the rehabilitation sites to the established remnant habitat of the CHA and Ben Bullen State Forest. This is particularly the case for highly mobile fauna such as birds that move between habitat patches while foraging. Additionally, the range of ages of vegetation within the rehabilitation areas provides an increased level of habitat complexity, providing a variety of habitat for different species. Compensatory habitat features such as nest boxes provide an artificial substitute for species including a variety of gliders, birds and microbats, which have been shown to consistently use the boxes based on the 2017 and 2016 monitoring.

6.6.3.3 Clandulla geebung monitoring

In the 2017 biodiversity monitoring surveys, 100 Clandulla geebung plants were recorded within the established Clandulla geebung monitoring site. This is an increase from the results of the previous year, which recorded 83 plants, and the 92 plants recorded during baseline surveys in 2012. While no flowering specimens were recorded, plants were commonly found fruiting (57 %) indicating that this population is healthy. Overall, there has been no discernible change in this population which suggests that the population is stable and currently not affected by the previous mining activities.

6.6.4 Proposed improvements

Annual biodiversity monitoring will be continued in 2018. The methods of floristic monitoring should however be reviewed prior to undertaking any future monitoring. A well designed and adaptive method of monitoring as detailed in the revised CVM Flora and Fauna Management Plan (Umwelt, 2017) is recommended such that the effectiveness of management intervention can be assessed qualitatively against target completion values (TARPS). This process will track the progression of rehabilitated and compensatory habitat areas and required actions. Both of which will be reported in future Annual Reviews.

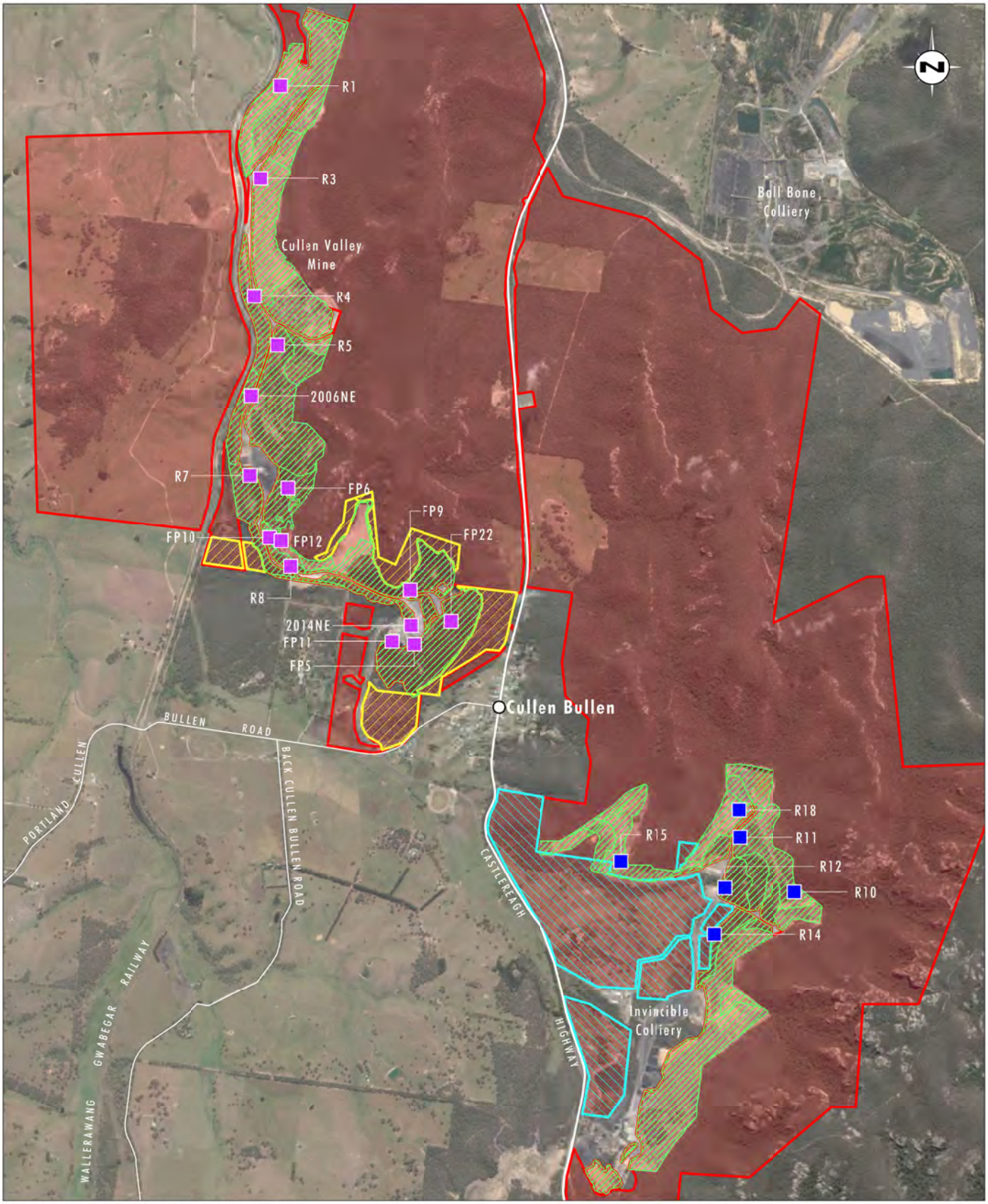


Image Source: Google Earth (MAR 2015)
Data Source: Kleinfelder (2017)

0 0.5 1.0 2.0km
1:35 000

Legend

- Study Area
- Compensatory Habitat Area
- Biodiversity Offset Area
- Rehabilitation Zones
- Rehabilitation Monitoring Sites - Incincible
- Rehabilitation Monitoring Sites - Cullen Valley

FIGURE 6.3

Rehabilitation Monitoring Sites Cullen Valley Mine and Invincible Colliery

File Name (A4): R35/3968_045.dgn
20180302 12.25

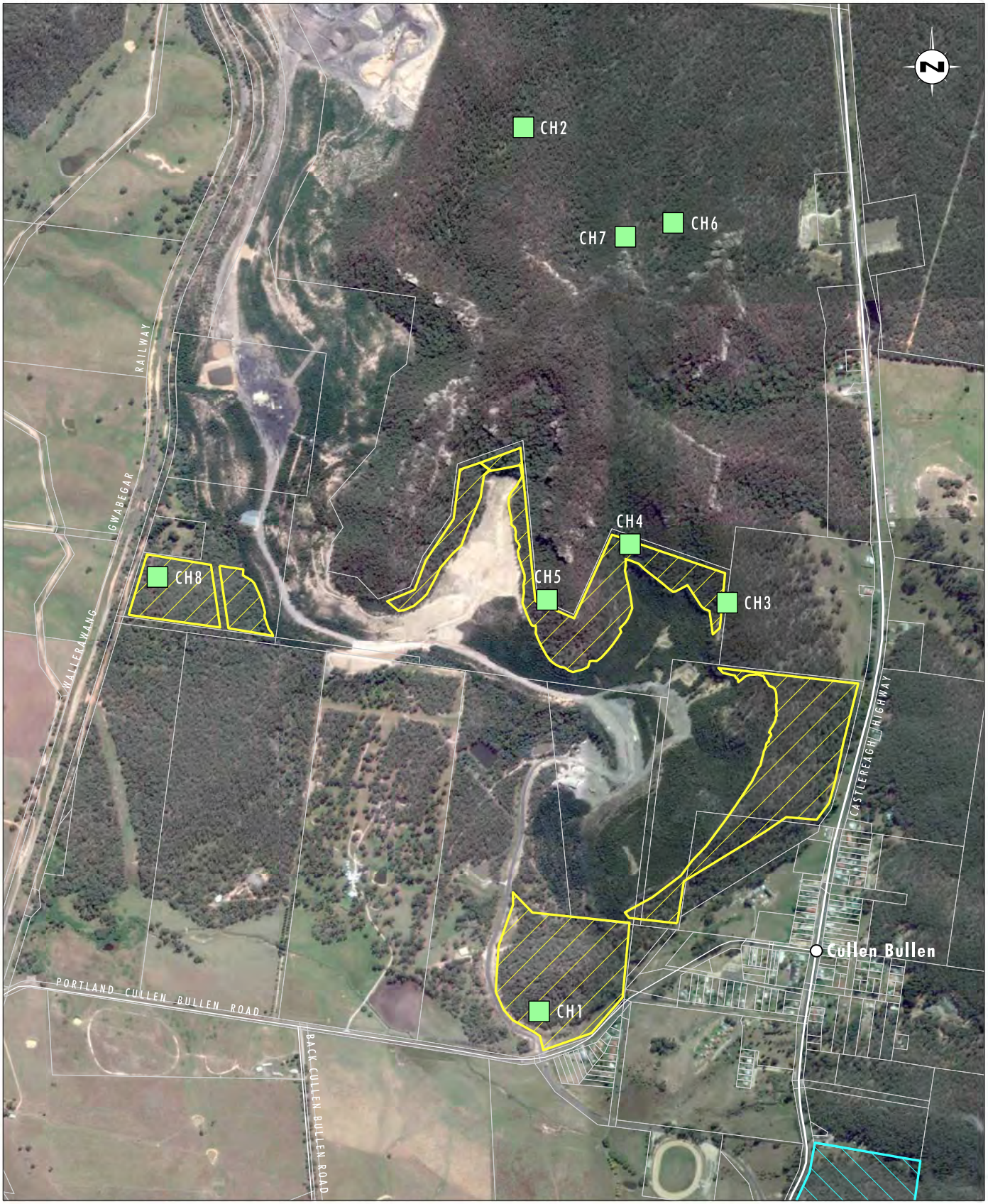


Image Source: Google Earth (MAR 2015)
Data Source: Kleinfelder (2017)

0 250 500 750m
1:15 000

Legend

- Compensatory Habitat Area
- Biodiversity Offset Area
- Compensatory Habitat Monitoring Sites

FIGURE 6.4

Compensatory Habitat Monitoring Sites
Cullen Valley Mine

File Name (A4): R35/3968_044.dgn
20180312 10.54

6.7 Weeds and feral animals

6.7.1 Weeds

Weeds within these areas were generally found to be cosmopolitan weed species such as catsear (*Hypochaeris radicata*) or St John's wort (*Hypericum perforatum*) and are not likely to cause a significant impact to vegetation condition at this stage. While studies have shown that bare ground favours the establishment of some weed species via colonisation from surrounding areas, this does not appear to be the case considering rehabilitation areas have been established for up to 16 years (2002). The likelihood of exotic species further colonising rehabilitation areas is low, given the soil structure and the density of tree and shrub species currently in established in the rehabilitation areas.

Weed management is conducted in accordance with the Cullen Valley Mine Flora and Fauna Management Plan (Coalpac, 2012a) and spraying is targeted towards known weed species occurrences within the site. Weed spraying was undertaken during January 2017 at locations where required.

6.7.2 Feral animals

6.7.2.1 Compensatory habitat area

No pest fauna species were recorded within the CHA during 2017 monitoring surveys.

6.7.2.2 Rehabilitation area

Two introduced species were recorded within Cullen Valley Rehabilitation Areas, being the brown hare (*Lepus capensis*) and rabbit (*Oryctolagus cuniculus*). The Biodiversity Monitoring Report (Umwelt, 2017d) recommended the 2018 feral animal management program management program target the red fox and rabbit.

6.8 Erosion and sediment control

6.8.1 Environmental management measures

During the report period, a standalone WMP (Umwelt, 2017b) was prepared in response to findings of the 2016 IEA (SLR, 2016). The 2017 WMP sets out the erosion and sediment control strategy, management measures, together with the monitoring and maintenance procedures.

The intent of the CVM water management system is to separate clean water and dirty/mine water at CVM. This ESCP is focused on the management of 'dirty' water which is runoff from disturbed areas. The erosion and sediment control techniques and management principles in the WMP are generally in accordance with the Blue Book (Landcom, 2004). The ESCs previously implemented for CVM during mining are currently, and will remain, in place for water management whilst the operation is under care and maintenance. These ESCs include dirty water sediment dams, open drainage channels with established vegetation and/or rock armouring where required and drop structures.

Permanent Erosion and Sediment Control (ESC) measures within the CVM include containment and diversion of "clean" water around disturbed areas and containment of runoff from these disturbed areas within on-site sediment dams.

6.8.2 Performance criteria

There are no performance criteria for erosion and sediment control specified in either the Development Approval or the EPL.

6.8.3 Environmental outcomes

In May 2017, works were undertaken to repair a number of existing drains and drop structures, refer to **Plates 1 to 4**.

6.8.4 Trends in data and proposed improvements

As detailed in **Section 6.8.3**, during the reporting period works were undertaken to repair drainage structures and existing erosion on site. Visual inspections of the erosion control repairs has indicated that the repaired structures are operating as intended, with the performance of these erosion control structures to be reviewed during 2018.

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the WMP, in relation to ESC management.

6.9 Subsurface heating

In 2011, the former Department of Resources and Energy (DRE) issued the previous mine owner/ operator (Coalpac) with a Section 240 direction requiring a concentrated effort to manage and extinguish subsurface heating in a noise bund and in other areas within ML 1488. The direction also required rehabilitation of heating affected areas. Subsequently, a plan of work was developed and included within the Plan of Works MOP Variation (dated 30th January 2013) and the 2011 to 2015 CVM Care and Maintenance (C&M) MOP. During the reporting period, CVM sought an extension to the CVM C&M MOP (Sedgman, 2015) to extend the duration of the MOP term until 31 December 2018. DRG approved the extension on 29 November 2017.

Subsurface heating at CVM has been observed to occur in three main areas on site being area R1, F1 and F2 (refer to **Figure 6.5**).

Table 6.18 shows the size of the subsurface heating areas in 2016 based on the extent of previous disturbance as identified in the field. During 2017, the extent of active sub surface heating as evidenced by current vegetation die back/stress and surface expression of subsurface heating characteristics (e.g. smell, smoke and /or surface cracking) was mapped during ecological monitoring completed in December 2017. Sites F1, F2 and R1, where they no longer show signs of active sub surface heating have shown positive signs of recovery since the last monitoring event in 2016. Initial observations indicate that the diversity and speed of recovery may be linked to the approach used to manage the subsurface heating (i.e. the more active/aggressive the approach the slower the vegetation will regenerate at that location). Active remediation works were undertaken at F1 between the 2016 and 2017 monitoring events. This appears to have slowed the vegetation regeneration compared to other locations and has resulted in a hard crusted ground layer compared to surrounding floristic monitoring sites. Evidence of regeneration was recorded at F1 and R1 with canopy and shrub species of adjacent rehabilitated area colonising the bare ground. Supplementary management actions will be investigated during 2018 to assist the recovery of native vegetation and to restore ecosystem function to a level that is similar to surrounding areas. Rapid floristic assessments of the recovering subsurface heating impacted areas will be undertaken as part of future monitoring programs.

PLATE 1
Drop Structure 2 Repairs
Before

PLATE 2
Drop Structure 2 Repairs
After

PLATE 3
Drain Repairs
Before

PLATE 4
Drain Repairs
After

Two additional heating areas (i.e. F3 and F4) were identified at CVM during 2017. These areas have been monitored as part of the 2017 ecological monitoring program. Both areas presented early signs of subsurface heating (e.g. foliage dieback and subtle burn marks at the base of trees and shrubs). Subsequent monitoring surveys will provide an indication of how subsurface heating impacts the area over time and when management intervention should occur. The ongoing management of these areas will be undertaken with the management measures as detailed in the CVM C&M MOP (Sedgman, 2015).

Table 6.18 Summary of subsurface heating impact extent (2016 – 2017)

Subsurface Heating Area#	Approximate Size in 2016 (Extent of previously mapped disturbance) (ha)	Approximate Size 2017 of active Heating Area (ha)
F1	1.05	0.26
F2	0.28	Not recorded due to vegetation regeneration
F3	-	0.07
F4	-	0.1
R1	1.97	0.05

*Note: **Section 6.9** explains how these mapping areas have been calculated.*

6.9.1 Environmental management measures

Management measures utilised at CVM to treat sub surface heating are detailed in the CVM C&M MOP (Sedgman, 2015) with the management measures developed in consultation with DRG. Environmental management controls implemented by CVM to monitor and treat subsurface heating include:

- Weekly monitoring of heating areas;
- Capping of surface cracking using cement; and
- Excavation and compaction of material as required.

During the reporting period CVM has observed a variation in the level of vegetation regeneration between the different treatment techniques used and has started to map the size of the active heating areas. Recording of this information will in part be used to guide what treatment techniques will be implemented in the future. Aggressive/active treatment techniques (e.g. large scale excavation of heating areas) will only be undertaken should the amenity of off-site receivers be impacted.

6.9.2 Environmental outcomes and further improvements

During 2017, further inspection of vegetation dieback areas was undertaken as well as ongoing monitoring of subsurface heating areas, refer to **Figure 6.5**. Minor works (i.e. localised earthworks – excavation of cracks and backfilling with inert material and compacting and filling cracks with concrete) was undertaken in Areas R1. Monitoring and treatment of heating areas will continue during 2018.

6.10 Blasting

There was no blasting conducted at CVM during the reporting period.

6.11 Waste management

As no mining activities were undertaken during the report period and as there is only one staff member on site, minimal quantities of waste, typically office waste, was generated.

Sewage from the workshop areas is directed to a septic system which is pumped out by a licensed waste collection and disposal contractor on an as-needs basis.

During the reporting period only minimal oil and greases were stored on site. Any maintenance works required on machinery and equipment is undertaken within existing bunded areas. Waste oils and grease are collected by a licensed waste recycling contractor on an as needs basis.

All paper and general wastes from workshop areas is disposed of in garbage bins located adjacent to the workshop areas, which are collected by a licensed contractor on an as needs basis.

6.12 Hazardous material management

Hazardous material storage tanks containing oils, grease and degreasers have been emptied, isolated and secured. Any excess storage tanks have been removed from the site. Storage tanks remaining onsite have been kept empty during the care and maintenance period.

The above ground self bunded diesel tank (Transtank) is not currently operational during the care and maintenance period. Up to 35,000L of diesel may be stored in the facility if diesel is required for environmental works on site. Two EPA registered radionuclide fixed radiation gauges (No.s RR20215 and RR21832) have been decommissioned and are stored onsite.

6.13 Heritage

6.13.1 Indigenous heritage

Previous archaeological surveys did not locate any Aboriginal artefacts or sites within the approved open cut mining area. However, two sites of significance were recorded in close proximity to the approved mining area. A campsite-stone artefact scatter (C-OS-1) and a rock shelter site (C-S-1). A further two sites where identified in surveys undertaken during 2011 and include 45-1-2542 and RSC-OS-1. These sites are located outside of the existing mining area.

6.13.2 Non-indigenous heritage

No mining activities or exploration works were undertaken in proximity of locations of European heritage significance during the reporting period.

6.14 Greenhouse gas emissions

As the site is in care and maintenance during the reporting period, greenhouse gas emissions were minimal. Emissions are limited to a small fleet of vehicles/equipment which are utilised for care and maintenance works. CVM is below the trigger thresholds for National Greenhouse and Energy Report System (NGERS) report as a single facility, however a consolidated greenhouse gas emissions report is completed by the ownership group which takes into account other business interests, in accordance with NGERS requirements.

6.15 Bushfire

A CVM Fire Management Plan (Coalpac, 2012e) has been developed and includes a number of measures to minimise bushfire risk. These measures include:

- fitting fire extinguishers to all earthmoving and mining equipment;
- fitting and maintaining efficient exhaust systems and spark arresters to mobile equipment;
- advising NSW Rural Fire Service, regulatory authorities and neighbours of any burning-off operations;
- facilitating that vehicles with low level exhaust systems do not leave defined tracks in locations and conditions likely to lead to ignition of combustible plant material; and
- maintaining, at the request of Forestry Corporation NSW, existing fire trails or access roads at the extremities of the lease area, which serve as access for firefighting services as well as establishing a fire break to the limits of operations at the open cut.

6.16 Mine subsidence

Mining operations at CVM ceased in 2012. There have been no reportable incidents and no subsidence management measures required to be implemented by CVM during the report period.

6.17 Public safety

Access to working areas of the CVM open cut are controlled by locked gates. Access to CVM by members of the public is via contact at the mine office where visitors or contractors can only be escorted by site personnel around the site.

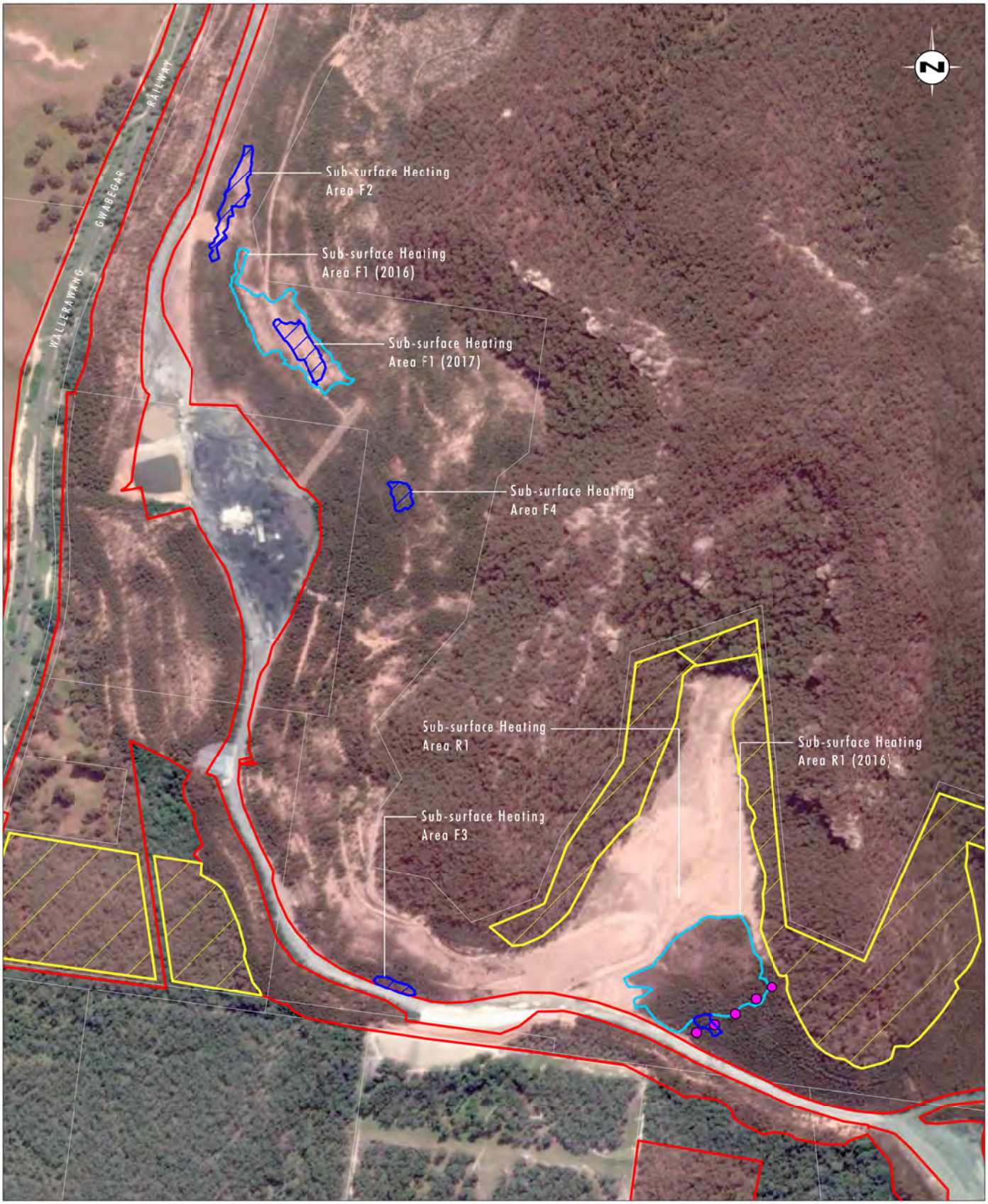


Image Source: Google Earth (MAR 2015)
Data Source: Umwelt (2017)

0 100 200 400m
1:7 500

Legend

- Study Area
- Compensatory Habitat Area
- Active Sub-surface Heating Areas (2017)
- Sub-surface Heating Areas (2016)
- Sub-surface Heating Impact Area - SE Boundary (Kleinfelder, 2015)

FIGURE 6.5

Active Sub-surface Heating Areas Cullen Valley Mine

7.0 Water usage

7.1 Water management system

The water management system at CVM is described within the CVM WMP (Umwelt, 2017b) and also within **Section 6.4** of this document.

7.2 Water take

There has been no water drawn from external sources under water licences detailed in **Table 7.1** during the reporting period. Licence and water take information is summarised in **Table 7.1**.

Table 7.1 Water take during reporting period

Water Licence #	Water sharing plan, source and management zone (as applicable)	Entitlement	Passive take/ inflows	Active pumping	Total
80WA706148	Sydney Basin MDB Groundwater Source Water Sharing Plan – NSW Murray Darling Basin porous rock groundwater sources	80 units	0	0	0

8.0 Rehabilitation

8.1 Status of mining and rehabilitation

CVM has operated on a care and maintenance basis since coal mining ceased in December 2012. Previously established rehabilitation areas include 132.8 ha of land mined since the commencement of open cut mining operations at the CVM. As noted in **Section 6.8.3** and **Section 6.9**, rehabilitation works undertaken during the report period included works to treat subsurface heating as well as repair works undertaken to erosion control structures. There was no tree planting or tree seeding undertaken during the reporting period. An assessment of the status of the existing CVM rehabilitation against the performance indicators and completion criteria as detailed within the CVM C&M MOP (Sedgman, 2015) is detailed in **Section 8.3**.

During the 2018 reporting period, CVM propose to receive VENM/ENM material from various infrastructure construction projects in Sydney. Shoalhaven Coal will use this material to meet the rehabilitation obligations (i.e. the filling of the voids and the progression of the final landform). The material will be transported to CVM by road from Sydney and received during the hours of operation approved under DA-200-5-2003. The volumes and location of emplaced VENM / ENM during 2018 and the rehabilitation progression will be reported in the 2018 CVM Annual Review.

During 2018 Castlereagh Coal will update the mines material balance to determine the locations where the VENM/ENM will be placed. The volumes and location of emplaced VENM/ENM and the rehabilitation progression will be reported in the 2018 CVM Annual Review.

The status of rehabilitation at CVM is detailed in **Table 8.1.**

Table 8.1 CVM rehabilitation status

Mine Area Type	Previous Report Period (actual) 2016 (ha)	This Report Period (actual) 2017 (ha)	Next Report Period (forecast) 2018 (ha)
A. Total mine footprint (all areas including active disturbance areas and rehabilitation areas)	193.9	193.9	193.9
B. Total active disturbance (areas within the footprint still requiring rehabilitation)	56.7	56.7	56.7
C. Land being prepared for rehabilitation	4.4	4.4	4.4
D. Land under active rehabilitation	132.8	132.8	132.8
E. Completed rehabilitation (areas that have achieved completion criteria and been signed-off by DRE)	0	0	0

8.2 Post rehabilitation land uses

The proposed final land use aims to emulate the pre-mining environment and will enhance local and regional ecological linkages across the site and adjacent areas. The primary objective of site revegetation and regeneration is to create a stable final landform with acceptable post-mining land use and suitability.

Rehabilitation will be established progressively with the receipt of VENM / ENM and will be managed in accordance with the CVM Flora and Fauna Management Plan (Umwelt, 2017a). In the long term, rehabilitation areas will become integrated with adjacent native vegetation communities. Rehabilitation areas will continue to be monitored on an annual basis and will be managed until self-sustaining. Final rehabilitation areas will achieve the rehabilitation completion criteria specified in the approved CVM C&M MOP (Sedgman, 2015) prior to relinquishment.

8.3 Completion criteria assessment

The results of the 2017 biodiversity monitoring program have been compared against the objectives of as defined in the CVM C&M MOP (Sedgman, 2015). Monitoring undertaken during 2017 has indicated that the CHA's within CVM are providing consistent native flora and fauna habitat compared to baseline information and previous annual monitoring results.

An assessment of the rehabilitation of CVM against the performance indicators and completion criteria as detailed in the CVM C&M MOP (Sedgman, 2015) is provided in **Table 8.2**. It is noted that not all criteria from the MOP were assessed during the 2017 biodiversity monitoring surveys as some criteria had not yet been triggered e.g. criteria related to the decommissioning of infrastructure. Criteria relevant to rehabilitation works undertaken to date on site are shown in **Table 8.2**. Actions recommended from the Biodiversity monitoring are discussed in **Section 6.6**.

8.4 Rehabilitation activities

Although the mine is in care and maintenance, management and monitoring of rehabilitation areas is undertaken in accordance with the approved CVM Flora and Fauna Management Plan (Coalpac, 2012a).

There has been no renovation or removals of buildings or other infrastructure and no new rehabilitation areas were established during the 2017 reporting period as the mine is currently in care and maintenance. Subsurface heating treatment and erosion control repairs are discussed in **Section 6.8** and **Section 6.9**.

In the long term, CVM rehabilitation areas are to become integrated with adjacent native vegetation communities.

Table 8.2 Assessment of CVM rehabilitation against MOP Performance Indicators and completion criteria

Domain Objectives	Performance indicators	Completion criteria	2017 Status Against Completion Criteria
Revegetation works are undertaken in accordance with the Flora and Fauna Management Plan.	Plant establishment	Planting/seeding is assessed during annual monitoring as becoming successfully established.	Progressing towards satisfactory completion No further works required
Established rehabilitation areas to be monitored on an annual basis and managed until self-sustaining.	Species composition	A range of native shrubs, grasses and other understorey species have established through topsoil, seeding or recolonization.	Progressing towards satisfactory completion No further works required at this stage.
	Plant health	More than 75% of trees are healthy and growing as indicated by monitoring.	Progressing towards satisfactory completion Only the 2010 areas, were found not to have 75% or more healthy trees. Given the current care and maintenance status of the site, it is expected that the 2010 Rehabilitation Areas will passively regenerate over time. All other Rehabilitation Areas inspected were considered to meet this criteria milestone.
	Weed establishment	A spraying program for the control of declared plants and other weeds has been implemented on the site.	Satisfied A spraying program for the control of declared plants and other weeds has been implemented on the site where required.
	Soil conditions	Soil salinity is sufficiently low to allow survival and growth of plant species, soil pH levels are within the range to allow plant growth.	Not monitored as part of the 2017 monitoring report.
	Fauna habitat structure	Fauna habitat includes a range of vegetation structural habitats, e.g. eucalypts, shrubs, ground cover and a developing litter layer.	Progressing towards satisfactory completion Rehabilitated areas are not old enough to support the range of habitats and rely on habitat features established during the planting phase of rehabilitation (such as woody debris, log piles etc.). The rehabilitated areas are progressing towards the pre-existing or surrounding landforms.

Domain Objectives	Performance indicators	Completion criteria	2017 Status Against Completion Criteria
	Presence of fauna species	Vertebrate surveys demonstrate that bird, mammal, reptile and frog communities are becoming established in rehabilitated sites.	Progressing towards satisfactory completion Results suggest that habitats of rehabilitated areas are improving the connectivity to surrounding remnant habitats. Evidence suggests that the progress of established vegetation has encouraged fauna activity and utilisation of these areas for foraging and temporary refuge. Further evidence will be drawn from future monitoring events.
	Biodiversity monitoring	Annual biodiversity monitoring indicates that rehabilitation areas are becoming integrated with adjacent vegetation communities	Progressing towards satisfactory completion Rehabilitated Areas are not old enough to support the range of habitats provided by the surrounding un-mined forests and woodlands. The rehabilitated areas are progressing towards the pre-existing or surrounding landforms.
Final rehabilitation areas to achieve rehabilitation completion criteria	Vegetation cover	No bare areas that have obviously failed and are greater than 0.5ha in total area.	Progressing towards satisfactory completion All rehabilitation areas inspected were considered to meet this criteria milestone, with exception to areas affected by subsurface heating. Previous monitoring noted bare areas within the 2014 rehabilitation area, however this is likely due to the age of vegetation.
	Tree cover	No treeless areas greater than 0.5ha are present.	Progressing towards satisfactory completion No treeless area greater than 0.5 hectares were observed during the 2017 monitoring.
	Shrub/grass cover	Monitoring and visual estimation show grass or shrub cover to be >50%.	Progressing towards satisfactory completion Monitoring and visual estimation show grass or shrub cover to be >50% on the Rehabilitation areas in 2017. It is noted that these are mainly exotic cover crop species.

Domain Objectives	Performance indicators	Completion criteria	2017 Status Against Completion Criteria
Water management system to be maintained and monitored in accordance with the Water Management Plan	Mine affected water	Clean water is diverted around unsealed areas and directed through the water management system.	Progressing towards satisfactory completion Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works proposed during 2018 report period.
Disturbed landform is graded and shaped to reflect natural landforms and is free-draining.	Sediment and erosion control	Weekly monitoring by the MEM and annual monitoring of rehabilitation areas does not detect any major erosion/washouts that will compromise vegetation establishment or safety of final surfaces.	Progressing towards satisfactory completion Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works proposed during 2018 report period.
Water management system to be maintained and monitored in accordance with the Water Management Plan.	Water management system	Clean water to be diverted around operational mining areas and directed through the water management system.	Progressing towards satisfactory completion Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works proposed during 2018 report period.
		Mine affected water and sediment laden water from bare ground surfaces is captured and diverted to sediment ponds and dams for treatment prior to discharge from the site.	Progressing towards satisfactory completion Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works proposed during 2018 report period.
Water management structures to be retained in place until rehabilitation is complete and post-mining landforms achieve stability and land use suitability.	Discharge water quality	Water quality at the licenced discharge point is assessed as being within EPL licence release limits prior to discharge	Progressing towards satisfactory completion There were no discharges from EPL Points during the 2017 report period, refer to **Section 6.4.1**.

8.5 Actions for the next report period

During 2018, rehabilitation works will involve:

- further subsurface heating capping works as described in **Section 6.10**;
- the receipt of the VENM/ENM to fill voids, establish the final landform and progressive rehabilitation at CVM; and
- update the mines material balance to determine the locations where the VENM/ENM will be placed. The volumes and location of emplaced VENM/ENM and the rehabilitation progression will be reported in the 2018 CVM Annual Review.

9.0 Community

9.1 CCC meetings

Two meetings were held in 2017 with CCC meetings on 27 April 2017 and 13 December 2017. During these meetings, information was presented on environmental monitoring, statutory reporting, works undertaken on site as well as updates regarding the Invincible Southern Extension Project. The outcomes of the CCC meetings are detailed in the meeting minutes available on the Castlereagh Coal website.

9.2 Complaints

Shoalhaven Coal maintains a complaints register to record and respond to complaints received from the community. The register is included in the Castlereagh Coal website. Two complaints were received from the local community during the reporting period (i.e. 26 April 2017 and 11 September 2017). The complaints were in relation to odour from a subsurface heating area on site. Following the receipt of the complaints, Castlereagh Coal undertook prompt repair works to manage the subsurface heating odour. A comparison of complaints received between 2011 and 2017 is outlined in **Table 9.1** below.

Table 9.1 Comparison of complaints

Complaint type	2011	2012	2013*	2014	2015	2016	2017
Noise	9	9	1	0	1	0	0
Air quality	5	5	2	0	1	0	0
Blasting	3	5	0	0	0	0	0
Traffic	4	13	0	0	0	0	0
Water	0	0	0	2	0	0	0
Subsurface Heating	2	0	0	0	0	4	2
Other	2	4	2	1	0	0	0
Total	**25**	**36**	**5**	**3**	**2**	**4**	**2**

** CVM was placed in care and maintenance in December 2012*

10.0 Audit information

10.1 DPE independent environmental audit

An Independent Environmental Audit (IEA) was conducted during 2016 in accordance with Schedule 6, Condition 6 of the project approval DA-200-5-2003. The audit timeframe covered the period from November 2010 to September 2016. The mine was operated by the previous mine owner Coalpac up until May 2015. The current owner, Shoalhaven Coal, was only responsible for operations from May 2015 onwards and therefore many of the non-compliances detected by the audit were outside the control of Shoalhaven Coal. In addition, a large number of the non-compliances that have occurred during Shoalhaven Coal's ownership are as a direct result of historical practices conducted by Coalpac.

Shoalhaven Coal is currently addressing all issues identified during the audit. An action plan was developed as an outcome of the audit findings and follow up actions have been implemented as required in consultation with DPE. The updated audit action plan is included on the Shoalhaven Coal website. In accordance with the Development Approval the next IEA to be undertaken at CVM is required to be conducted by June 2021.

Key actions required to be implemented by Shoalhaven Coal following the 2016 IEA and where these items are discussed in the Annual Review are presented below. Further detail on the status of each action can be found in **Appendix 1**).

- Continued treatment of subsurface heating and repair of erosion control structures (refer to **Section 6.8** and **6.9**);
- completion of annual biodiversity monitoring (refer to **Sections 6.6** and **8.3**);
- revision and submission of updated Flora and Fauna and Water Management Plans to DPE (refer to **Section 3.1**);
- continued progression of rehabilitation of CVM (refer to **Section 8.0**).

11.0 Incidents and non-compliances during the report period

The CVM PIRMP (Umwelt, 2017c) was not activated during the reporting period.

Non-compliances noted during the report period are detailed in **Section 1.0**.

Shoalhaven Coal received a Show Cause notice in regards to groundwater quality on 21 April 2017 in regards to groundwater sampling undertaken during 2017. Shoalhaven Coal completed a groundwater report to address the requirements of the show cause notice with the report submitted to DPE on 29 May 2017. Shoalhaven Coal subsequently received a Warning Letter and Voluntary Undertaking on 13 June 2017. The warning letter was in relation to the groundwater monitoring results reporting accuracy and that the results were not investigated prior to the submission of the Annual Review. Groundwater monitoring data for the 2017 report period is included in **Section 6.4.2.**

12.0 Activities to be undertaken in the next report period

There are no mining activities proposed at CVM in the next report period (1 Jan 2018 – 31 Dec 2018) as the site is currently managed under a care and maintenance arrangement.

The primary activity to be undertaken during the 2018 reporting period is expected to be the importation of VENM/ENM to fill voids, the progression of the final landform and progressive rehabilitation of the final landform. Shoalhaven coal will continue to implement the various approved environmental management plans during the next reporting period. The CVM Water Management Plan will be updated to include the revised baseline data conditions.

During 2018, rehabilitation works will involve:

- further subsurface heating capping works as described in **Section 6.10**;
- the receipt of the VENM/ENM to fill voids, establish the final landform and progressive rehabilitation at CVM; and
- update the mines material balance to determine the locations where the VENM/ENM will be placed. The volumes and location of emplaced VENM/ENM and the rehabilitation progression will be reported in the 2018 CVM Annual Review.

13.0 References

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000. (ANZECC, 2000) An Introduction to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Commonwealth Government.

Castlereagh Coal (2018). Care and Maintenance Mining Operations Plan Cullen Valley Mine.

Coalpac (2009). Environmental Monitoring Program.

Coalpac (2012a). Cullen Valley Mine Flora and Fauna Management Plan.

Coalpac (2012b). Cullen Valley Mine Species Management Plan (Clandulla Geebung).

Coalpac (2012c). Environmental Management Plan.

Coalpac (2012d). Blast Management Plan.

Coalpac (2012e) Fire Management Plan.

Castlereagh Coal (2018). Cullen Valley Mine Care and Maintenance Mining Operations Plan

Global Acoustics Pty Ltd (2017a). Cullen Valley Mine Environmental Noise Monitoring Quarter 1, 2017. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017b). Cullen Valley Mine Environmental Noise Monitoring Quarter 2, 2017. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017c). Cullen Valley Mine Environmental Noise Monitoring Quarter 3, 2017. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017d). Cullen Valley Mine Environmental Noise Monitoring Quarter 4, 2017. Prepared for Shoalhaven Coal.

International Environmental Consultants, 1997. Feldmast Coal Project Environmental Impact Statement.

International Environmental Consultants, 2004. Cullen Valley Mine Open Cut Extension Environmental Impact Statement

NSW Government (2015). Annual Review Guideline.

Sedgman (2015) Cullen Valley Mine Care and Maintenance MOP.

Umwelt (2017a). Flora and Fauna Management Plan.

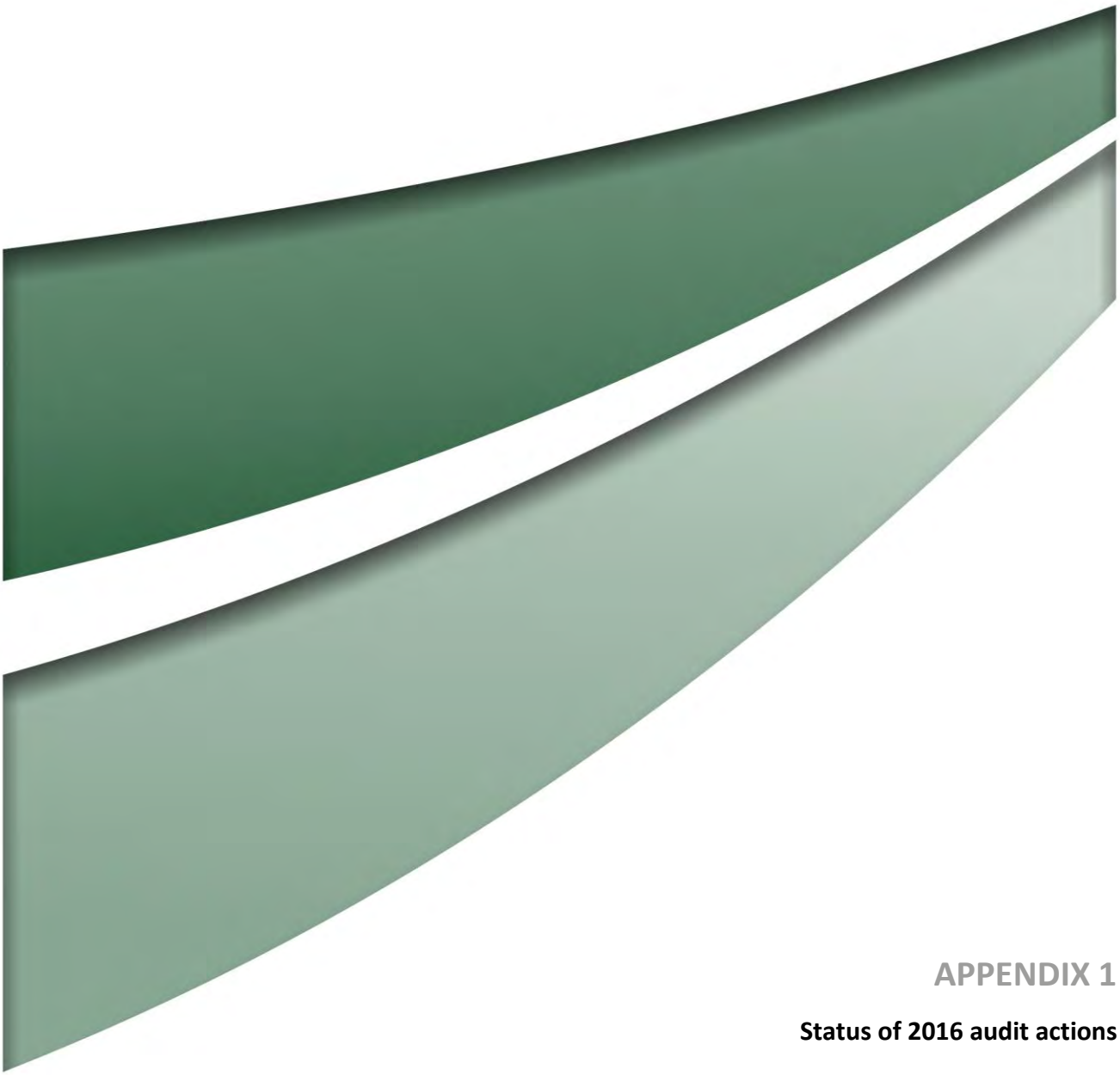
Umwelt (2017b). Water Management Plan Cullen Valley Mine.

Umwelt (2017c). Cullen Valley Mine & Invincible Colliery Pollution Incident Response Management Plan. Prepared for Shoalhaven Coal.

Umwelt (2017d). 2017 Biodiversity Monitoring Report. Cullen Valley Mine and Invincible Colliery, Castlereagh Highway Draft.

Umwelt (2017e). Cullen Valley Mine Groundwater Quality Investigation.

SLR Consulting (2016). Cullen Valley Mine Independent Environmental Audit. Prepared for Shoalhaven Coal Pty Limited



APPENDIX 1

Status of 2016 audit actions

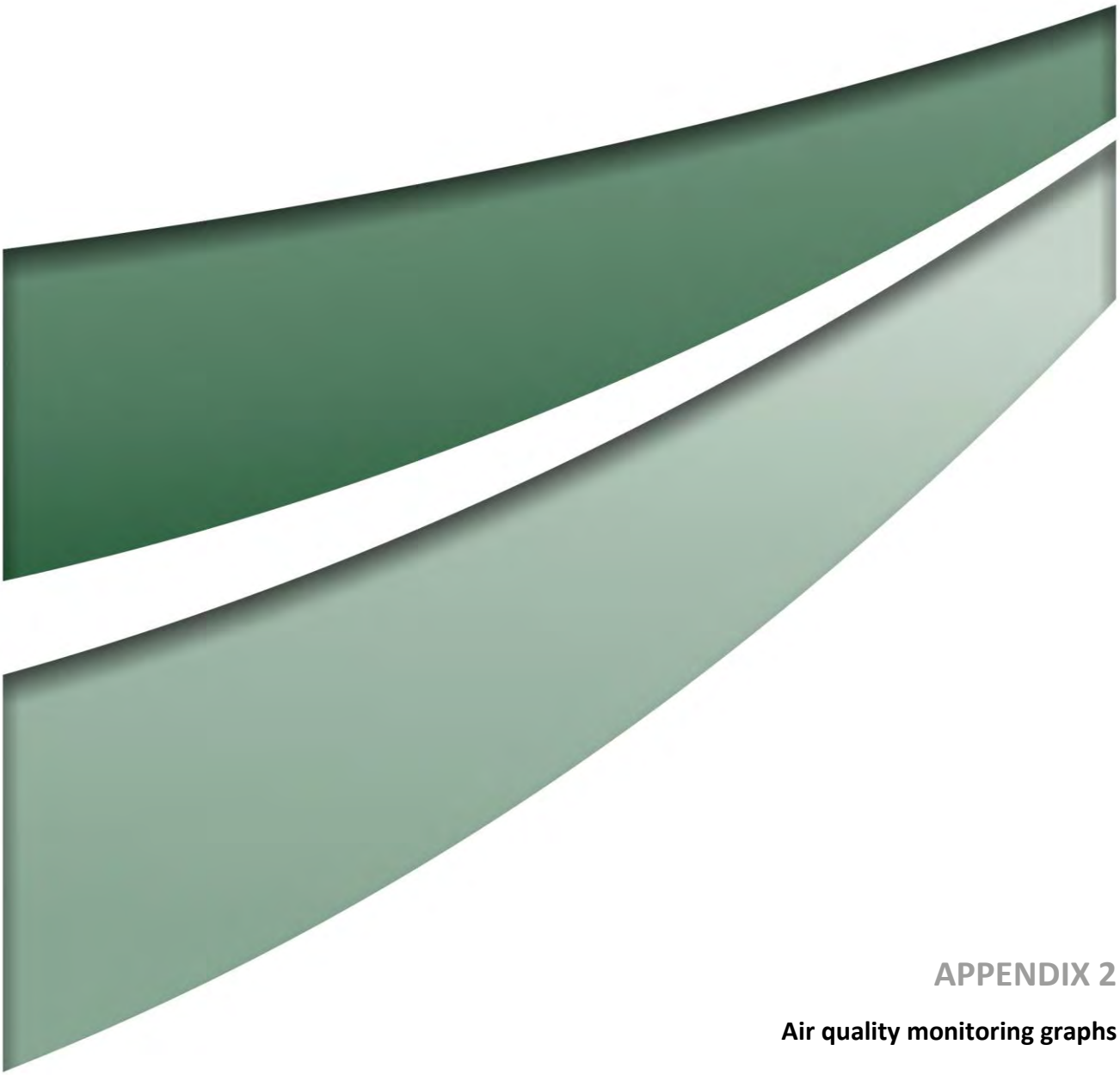
Appendix 1 2017 Annual Review IEA Action Plan Update

Consent Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
DA Sch 4, Condition 2	2010 AEMR - During the report period, CVM complied with the criteria LAeq(15 minute) noise limits at all locations with the exception of Hillcroft in Q1 and Q3. The noise levels at Hillcroft exceeded the criteria by 5 and 2 dB(A) respectively. This was outside the audit period. 2011 AEMR - CVM complied with the daytime LAeq (15 minute) noise criteria at all locations during the report period, with the exception of the Hillcroft property (N08) during Q2. 2012 AEMR - CVM complied with the daytime LAeq (15 minute) noise criteria at all locations during the report period, with the exception of the Hillcroft property (N08) which exceeded the noise criteria on one occasion during Q2. 2013, 14 and 15 AEMR's - Nil exceedances These noise non - compliances related to when the site was operating and under previous ownership. Noise is a minor issue during care and maintenance, however if mining activities were to recommence there would be a requirement for additional noise controls.	Non-compliant	Noise is a minor issue during care and maintenance, however if mining activities were to recommence there should be a full review of noise mitigation measures to reduce the chance of non - compliances relating to noise. The Noise Management Plan would require to be updated.	Noise exceedances occurred during Coalpac ownership of the mine. The noise management plan would only be updated if and when mining operations recommence at CVM. Noise mitigation measures for mining operations would be reviewed at that time. **2017 Annual Review Update** No further action required. As noted above, if mining operations recommence the Noise Management Plan will be updated.
DA Sch 4, Condition 27	There have been odour complaints in every year of the audit period with this relating to the area of sub surface heating. These have been outlined in the AEMR/Annual Reviews. There has been some works at site (movement of material) to control the fire/odour issue with investigations still continuing. Based on discussions with site this is an ongoing issue that is being managed by Shoalhaven Coal in consultation with experts and the Departments. Shoalhaven Coal are also resolving drainage issues that are directly linked to 2017 heating issues particularly venting, smoke and odour prior to capping.	Non-compliant	Continue to investigate issue and develop a strategy to remediate. Continue to monitor and report on the odour issue. Implement actions where possible.	Sub-surface heating is being managed by Shoalhaven Coal in consultation with specialist consultants and the Departments. Shoalhaven are also undertaking reconstruction of contour and flume drains to direct water away from areas to reduce the incidence of venting, smoke and odour. Stage 1 works will be monitored during Q2 and Q3 2017. **2016 Annual Review Update** In accordance with Section 12.0 of the Annual Review and DRE requirements, during 2017 Shoalhaven Coal will review and manage subsurface heating across the site, and an updated Plan of Works (PoW) for management of subsurface heatings will be developed as part of the updated C&M MOP. **2017 Annual Review Update** During 2017, Shoalhaven Coal undertook repairs to a number of erosion control structures and these are discussed in the 2017 CVM Annual Review. Shoalhaven Coal has continued to implement the PoW as detailed in the approved MOP and liaise with the Division of Resources and Geoscience, during the reporting period.
DA Sch 4, Condition 31	a) Partially covered under Section 2.2 of the Compensatory Habitat Plan. No differentiation between short term and long term management. There should be goals developed for short term e.g. Year 1, medium term Year 5 and long-term Year 10. b) Covered under Section 2.2.3.1 of the Compensatory Habitat Plan. This section outlines fencing and prohibiting access. Minimal signage was identified at the site illustrating the compensatory habitat area. There has been no evidence of disturbance (from the site inspection) associated with the Cullen Valley project within the compensatory habitat area. A detailed plan within the Flora and Fauna Management Plan outlines the boundaries of these areas. c) Covered under Section 2.2.3.1 including fencing and signage. d) Baseline vegetation communities are shown in Figure 2 of the audit report. Description of existing vegetation within Section 2.2.2. e) Implementation within Section 2.2.3 of the Compensatory Habitat Plan. Details of monitoring are outlined in the Annual Flora, Fauna and Rehabilitation Monitoring Program which is undertaken by Kleinfelder.	Administrative non-compliance	There is no differentiation between short term and long term management of compensatory habitat area. To be included in future updates. Completion criteria for the compensatory habitat area should be included in this Management Plan. All management plans would be required to be updated prior to recommencement of operations as agreed with DP&E. The ecological monitoring has been prepared to a high standard, however there are no definitive goals for the compensatory habitat area or other rehabilitation areas. These criteria and goals should be developed as well as being included within the management plan and monitoring reports. Where possible this criteria should be linked with MOP criteria. There should be a more detailed analysis of monitoring results relating to the compensatory habitat area within	Annual Biodiversity Monitoring was undertaken in December 2016 and was broadened from the scope of previous biodiversity monitoring. This monitoring included assessment of the compensatory habitat areas. As requested by DPE, the Flora and Fauna Management Plan will be updated by 30 June 2017. **2017 Annual Review Update** The CVM Flora and Fauna management plan was updated and submitted to DPE for review on 29 June 2017. DPE have not provided any comments on the draft management plan to date.

Consent Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
	This monitoring program includes eight survey sites across the compensatory habitat area. A brief methodology relating to the monitoring within the compensatory habitat area is outlined within Section 3.2 of the 2015 Annual Flora, Fauna and Rehabilitation Monitoring Program. f) There is no criteria for the compensatory habitat area within the Compensatory Habitat Plan. SLR recognises that this management plan was completed prior to the site being managed by Shoalhaven Coal.		the Annual Review. Currently there is little detail in the Annual Review regarding the performance and management of the compensatory habitat area, with reference to the very detailed ecological monitoring report. Although the Kleinfelder report is very detailed, a summary section or table within the report would be useful in determining key changes within monitoring locations and proposed actions within specific sections of the compensatory habitat area. The recommendations from the Annual Flora, Fauna and Rehabilitation Monitoring Program should be implemented by Shoalhaven Coal. This includes: • Development of a feral animal control strategy. It should be noted the feral animals identified within the compensatory habitat area are consistent with the surrounding landscape. • Dumping has occurred to a minor extent within the compensatory habitat area. During the inspection SLR did not view these areas, but the Ecological Report recommends rubbish is removed.	
DA Sch 4, Condition 47	(a) minimal infrastructure visible from offsite (b) noise bunds act as visual screens c) revegetating underway on noise bunds, was rehabilitated previously but had to be re-turned and shaped due to sub - surface heating (d) lots of areas still required for rehabilitation. Pre 2012 rehabilitation appears to be of a good quality with low degree slopes, topsoil used and a mix of grasses, acacias and eucalypts. Poor results in large sections of the post 2012 rehabilitation was observed with erosion in some areas. This is possibly due to steep slopes and lack of topsoil. No rehabilitation has been completed (apart from rehabilitation maintenance) since Shoalhaven Coal commenced managing the site. In 2016 the focus has been to improve existing rehabilitation. Biodiversity monitoring is conducted annually in rehabilitation areas and will be conducted again in December 2016. Based on discussions with Shoalhaven Coal the scope of works for this monitoring has been broadened from the monitoring conducted between 2011-2015	Non-compliant	SLR recommends engaging a specialist to review the reasons for poor rehabilitation (post 2012 rehabilitation) to improve existing rehabilitation as well as future rehabilitation. Some possible options to improve future rehabilitation include: * soil and material testing. * reducing slope angle and landform design; * application of ameliorates such as gypsum, biosolids; and * review of seed mix (including grass within seed mix). It is acknowledged there is little topsoil available for future rehabilitation. Further rehabilitation/biodiversity monitoring should be compared against completion criteria from the MOP. Local seed should be collected for rehabilitation in accordance with the Flora and Fauna Management Plan.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the monitoring conducted between 2011-2015. Annual Biodiversity Monitoring was completed during December 2016. **2016 Annual Review Update** Results of 2016 Biodiversity Monitoring are included in the 2016 Annual Review **2017 Annual Review Update** Biodiversity monitoring was undertaken in 2017 with the results included in the CVM 2017 Annual Review.
DA Sch 6, Condition 5	AEMRs/Annual Reviews sighted for 2011 to 2015. A comparison against the EIS predictions was not been completed in the recent C&M AEMRs/Annual Reviews. SLR understands that most EIS commitments are not relevant to the site as it is under care and maintenance; however some predictions for water should be reviewed and reported against. Monitoring results are compared against monitoring limits/criteria. There was a comparison of dust data across five years with this outlining the long-term trend. Details of complaints are included however there is no comparison over five years which means this is an administrative non-compliance. Details of complainants (names) should not be included in the AEMR/Annual Reviews.	Administrative non-compliance	Ensure key EIS predictions are reviewed in future Annual Reviews. Provide details of complaints across five years.	This Annual Review provides a comparison of EIS predictions in **Section 6.1**. A review of complaints is provided in **Section 9.0**. **2017 Annual Review Update** The CVM reporting period monitoring results and environmental performance have been included in the 2016 and 2017 CVM Annual Reviews.

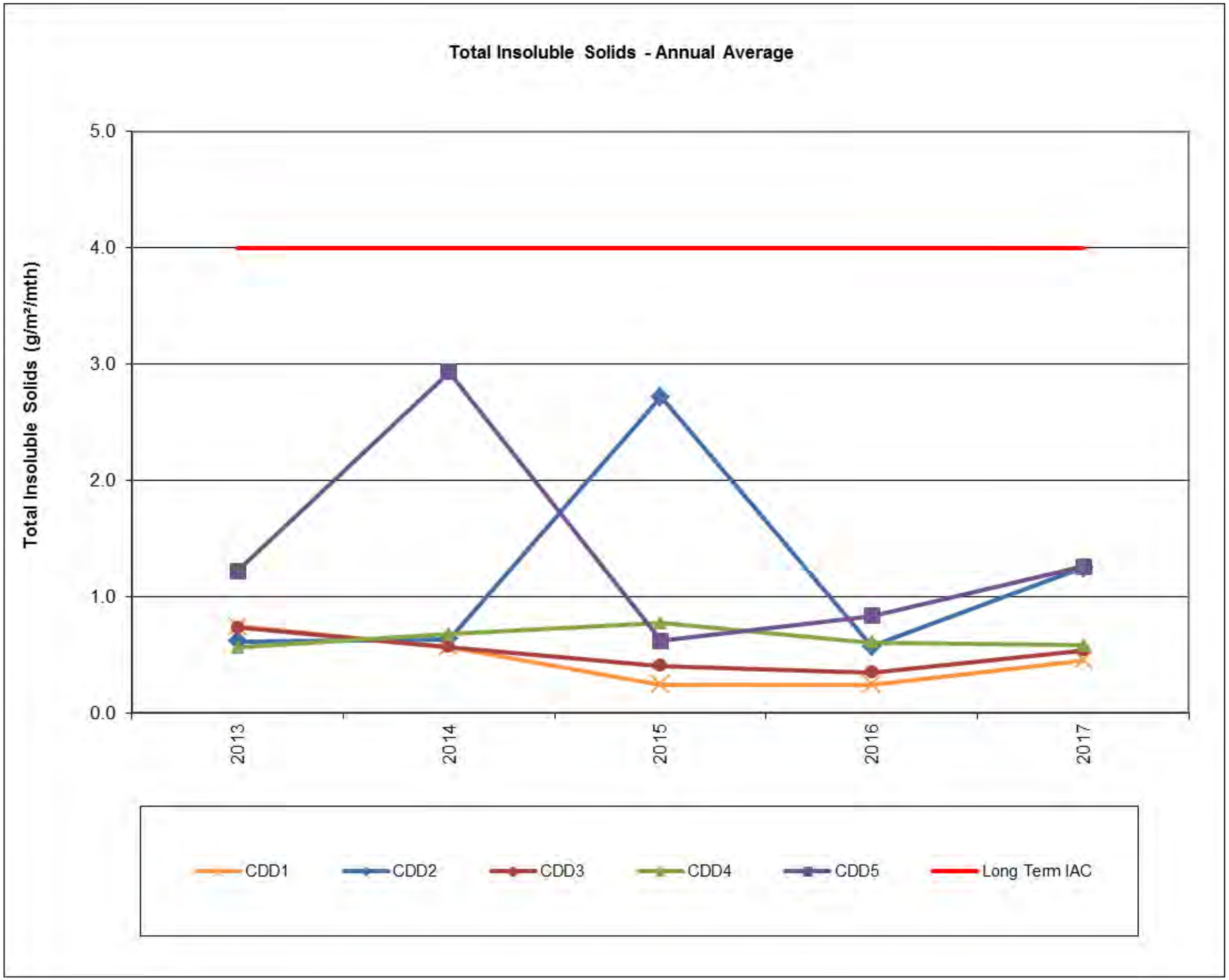
Licence Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
EPL L4.5	Quarterly noise monitoring reports state the source of the meteorological data utilised for determining meteorological conditions. The data is generally sourced from the Cullen Valley weather station however, it is noted that the noise monitoring reports prepared for 2015 state that meteorological data has been sourced from the Bureau of Meteorology Met station in Bathurst. This is located approximately 45 km from the site and is unlikely to be representative of onsite weather conditions. Temperature inversion conditions are reported in the quarterly noise monitoring reports and are calculated from sigma theta data. Where met data is obtained from Bathurst, standard stability class is assumed. Shoalhaven Coal informed SLR that the weather station at CVM had been shut down and was inoperable prior to Shoalhaven Coal ownership. Shoalhaven Coal has reinstated and serviced the weather station to allow recording and download of meteorological data during care and maintenance. Prior to recommencement of operations, the weather station will be calibrated according to the Australian Standard to allow data to be used for noise monitoring purposes.	Administrative non-compliance	Ensure that meteorological data is sourced from the onsite meteorological station. If this is not possible due to equipment failure etc., justification for the use of alternative meteorological data and its relevance should be provided.	The noise monitoring requires weather data from an accredited source. The weather station at CVM had been shut down and was inoperable prior to Shoalhaven Coal ownership. Shoalhaven Coal has now reinstated and serviced the weather station to allow recording and download of meteorological data during care and maintenance. Prior to recommencement of operations, the weather station will be calibrated according to the Australian Standard to allow data to be used for noise monitoring purposes. This action will only be required if and when mining operations recommence at CVM. **2017 Annual Review Update** As noted above, prior to the commencement of any mining operations the weather station will be calibrated to enable its use for noise monitoring purposes.
EPL L6.1	There have been odour complaints in every year of the audit period with relating to the area of sub surface heating. These have been outlined in the AEMR/Annual Reviews. There has been some works at site (movement of material) to control the fire/odour issue with investigations still continuing. Based on discussions with site this is an ongoing issue that is being managed by Shoalhaven Coal in consultation with experts and the Departments. Shoalhaven Coal are also resolving drainage issues that are directly linked to sub surface heating issues particularly venting, smoke and odour prior to capping.	Non-compliant	Continue to investigate issue and develop a strategy to remediate. Continue to monitor and report on the odour issue.	Sub-surface heating is being managed by Shoalhaven Coal in consultation with specialist consultants and the Departments. Shoalhaven Coal are also undertaking reconstruction of contour and flume drains to direct water away from areas to reduce the incidence of venting, smoke and odour. Stage 1 works will be monitored during Q2 and Q3 2017. **2016 Annual Review Update** In accordance with Section 12.0 of the Annual Review and DRE requirements, during 2017 Shoalhaven Coal will review and manage subsurface heating across the site, and an updated PoW for management of subsurface heatings will be developed as part of the updated C&M MOP. **2017 Annual Review Update** During 2017, Shoalhaven Coal undertook repairs to a number of erosion control structures and these are discussed in the 2017 CVM Annual Review. Management measures utilised at CVM to treat sub surface heating are detailed in the CVM C&M MOP (Sedgman, 2015) with the management measures developed in consultation with DRG. Environmental management controls implemented by CVM to monitor and treat subsurface heating include: • Weekly hearing monitoring of heating areas; • Capping of surface cracking using cement; • Excavation and compaction of material as required

EIS Commitments	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
2003 EIS Section: Flora	Rehabilitation works have attempted to replicate a woodland/forest community. Results have been variable with good results prior to 2012, and average since. No Capertee Stringybark seed has been collected for rehabilitation.	Non-compliant	Recommend engaging a specialist to review reasons for poor rehabilitation (post 2012 rehabilitation) to improve existing rehabilitation as well as future rehabilitation. Some possible options to improve future rehabilitation include: * soil and material testing. * reducing slope angle and landform design; * application of ameliorates such as gypsum, biosolids; * review of seed mix (including grass within seed mix); It is acknowledged there is little topsoil available for future rehabilitation. Further rehabilitation/biodiversity monitoring should be compared against completion criteria from the MOP. Local seed should be collected for rehabilitation in accordance with the Flora and Fauna Management Plan.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2016 Annual Review Update** Results of 2016 Biodiversity Monitoring are included in the 2016 Annual Review **2017 Annual Review Update** Results of 2017 Biodiversity Monitoring are included in the 2017 Annual Review. The biodiversity monitoring includes a comparison of CVM rehabilitation to the performance indicators / completion criteria included in the CVM C&M MOP (Sedgman, 2015).
2003 EIS Section: Rehabilitation	There are still large sections of disturbed areas that have not been rehabilitated.	Non-compliant	Same as 'Flora' recommendation to improve rehabilitation.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2017 Annual Review Update** As detailed within the 2017 CVM Annual Review, during the 2018 Report Period CVM propose to utilise VENM / ENM to fill site voids and progress with the rehabilitation of the mine.
2003 EIS Section: Soil Resources	Topsoil was used in most of the rehabilitation prior to 2012, however does not appear to be used in post 2012 rehabilitation.	Non-compliant	Same as 'Flora' recommendation to improve rehabilitation.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2017 Annual Review Update** Results of 2017 Biodiversity Monitoring are included in the 2017 Annual Review. The biodiversity monitoring includes a comparison of CVM rehabilitation to the performance indicators / completion criteria included in the CVM C&M MOP (Sedgman, 2015).

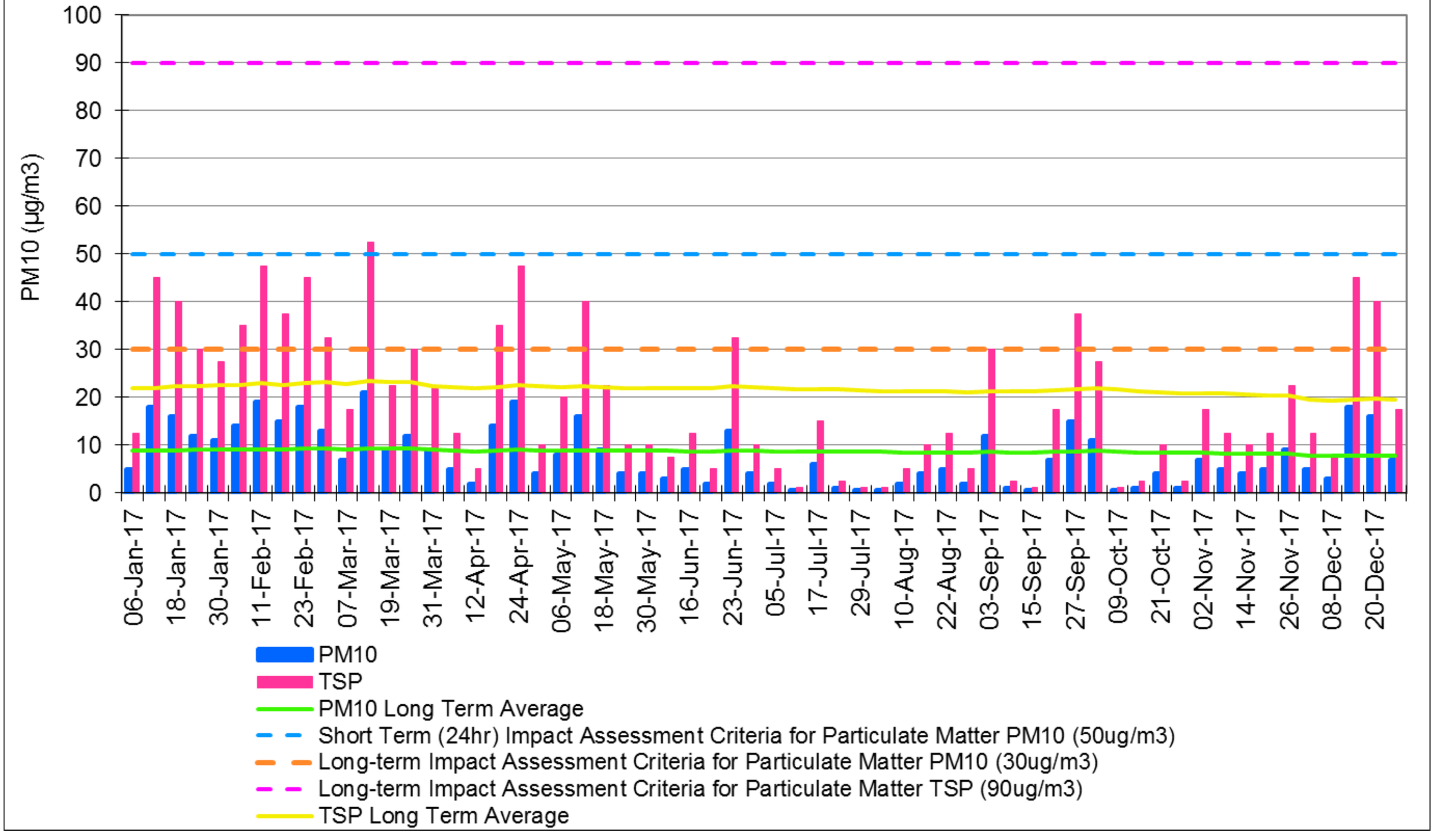


APPENDIX 2

Air quality monitoring graphs

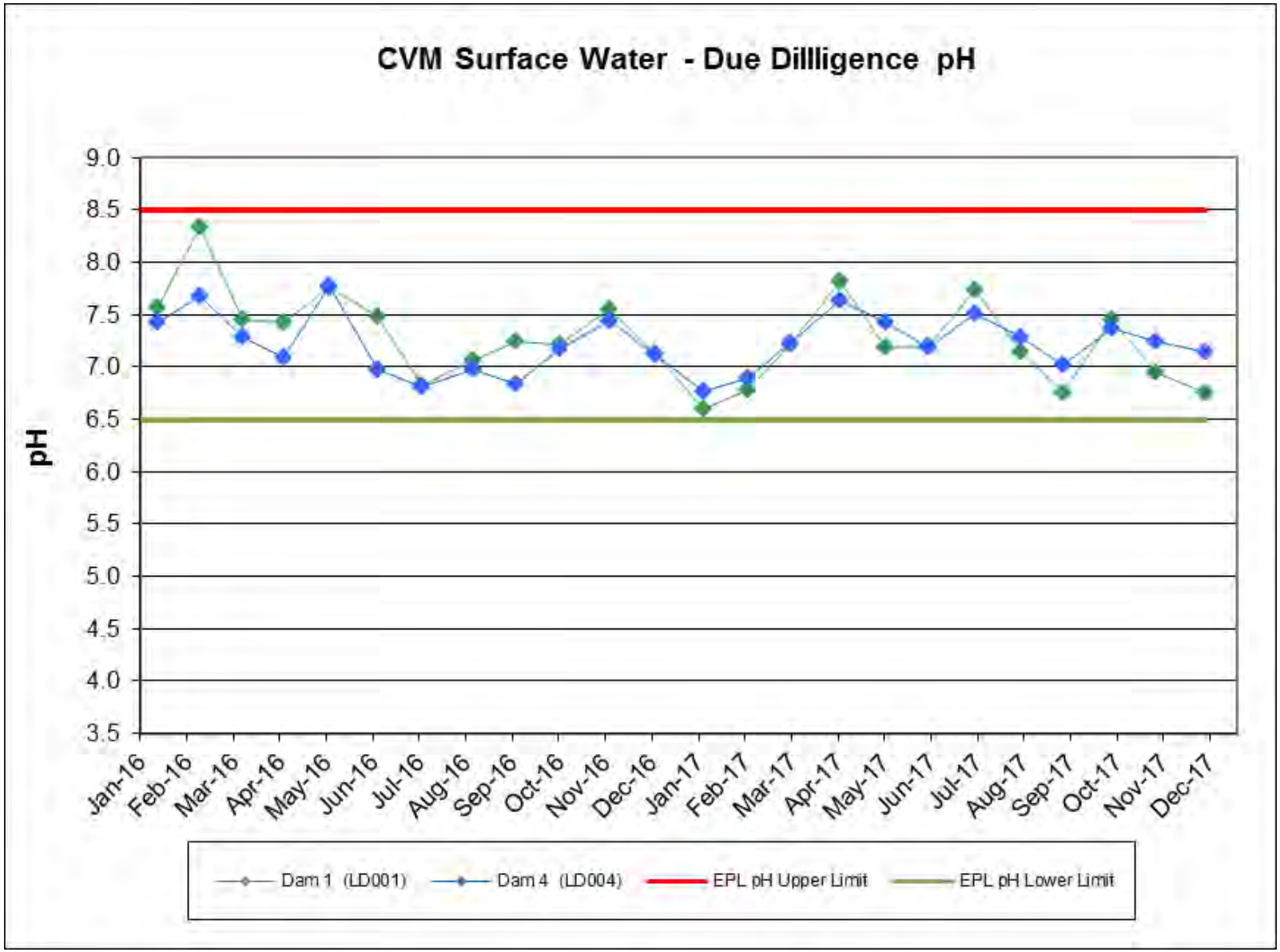

Total Insoluble Solids - Annual Average
Total Insoluble Solids (g/m²/mth)
5.0
4.0
3.0
2.0
1.0
0.0
2013
2014
2015
2016
2017
CDD1
CDD2
CDD3
CDD4
CDD5
Long Term IAC

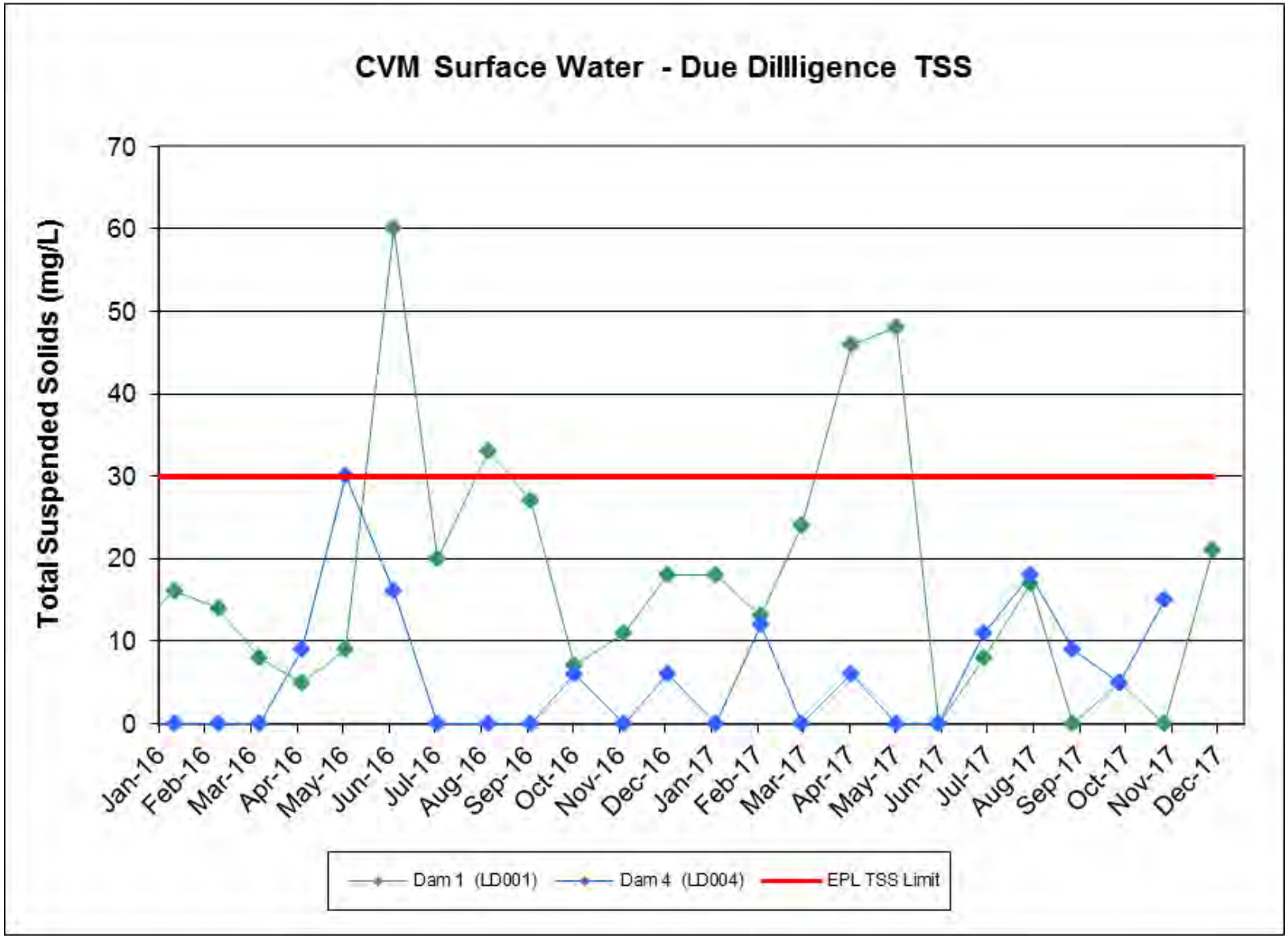
Cullen Valley Mine
PM10 HVAS Comparative Results
January 2017 to December 2017



APPENDIX 3

Surface water monitoring graphs and tables


CVM Surface Water - Due Dillligence pH
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Dam 1 (LD001)
Dam 4 (LD004)
EPL pH Upper Limit
EPL pH Lower Limit


CVM Surface Water - Due Dillligence TSS
Total Suspended Solids (mg/L)
70
60
50
40
30
20
10
0
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Dam 1 (LD001)
Dam 4 (LD004)
EPL TSS Limit

The water quality monitoring results for CVM are shown in **Table A**.

Table A Water quality monitoring results in site dams and receiving environments

Sampling date	pH	Oil and grease	TSS
Dam 1			
10/1/2017	6.60	<5	18
9/2/2017	6.78	<5	13
9/3/2017	7.22	<5	24
11/4/2017	7.82	<5	46
12/5/2017	7.19	<5	48
9/6/2017	7.20	<5	<5
10/7/2017	7.73	<5	8
10/8/2017	7.14	<5	17
7/9/2017	6.75	<5	<5
9/10/2017	7.45	<5	5
8/11/2017	6.95	<5	<5
11/12/2017	6.75	<5	21
Dam 4			
10/1/2017	6.76	<5	6
9/2/2017	6.89	<5	<5
9/3/2017	7.23	<5	12
11/4/2017	7.63	<5	<5
12/5/2017	7.43	<5	6
9/6/2017	7.19	<5	<5
10/7/2017	7.51	<5	<5
10/8/2017	7.29	<5	11
7/9/2017	7.02	<5	18
9/10/2017	7.37	<5	9
8/11/2017	7.25	<5	5
11/12/2017	7.15	<5	15
BSW03			
10/1/2017	6.45	<5	28
9/2/2017	6.89	<5	25
9/3/2017	7.26	<5	59
11/4/2017	7.08	<5	17
12/5/2017	7.05	<5	15
9/6/2017	6.75	<5	12
10/7/2017	7.18	<5	8
10/8/2017	6.60	<5	14
7/9/2017	6.63	<5	9
9/10/2017	6.94	<5	8
8/11/2017	6.92	<5	17
11/12/2017	7.43	<5	40

The results of groundwater monitoring conducted during the 2017 reporting period are provided in **Table B & C.**

Table B May 2017 Groundwater monitoring results

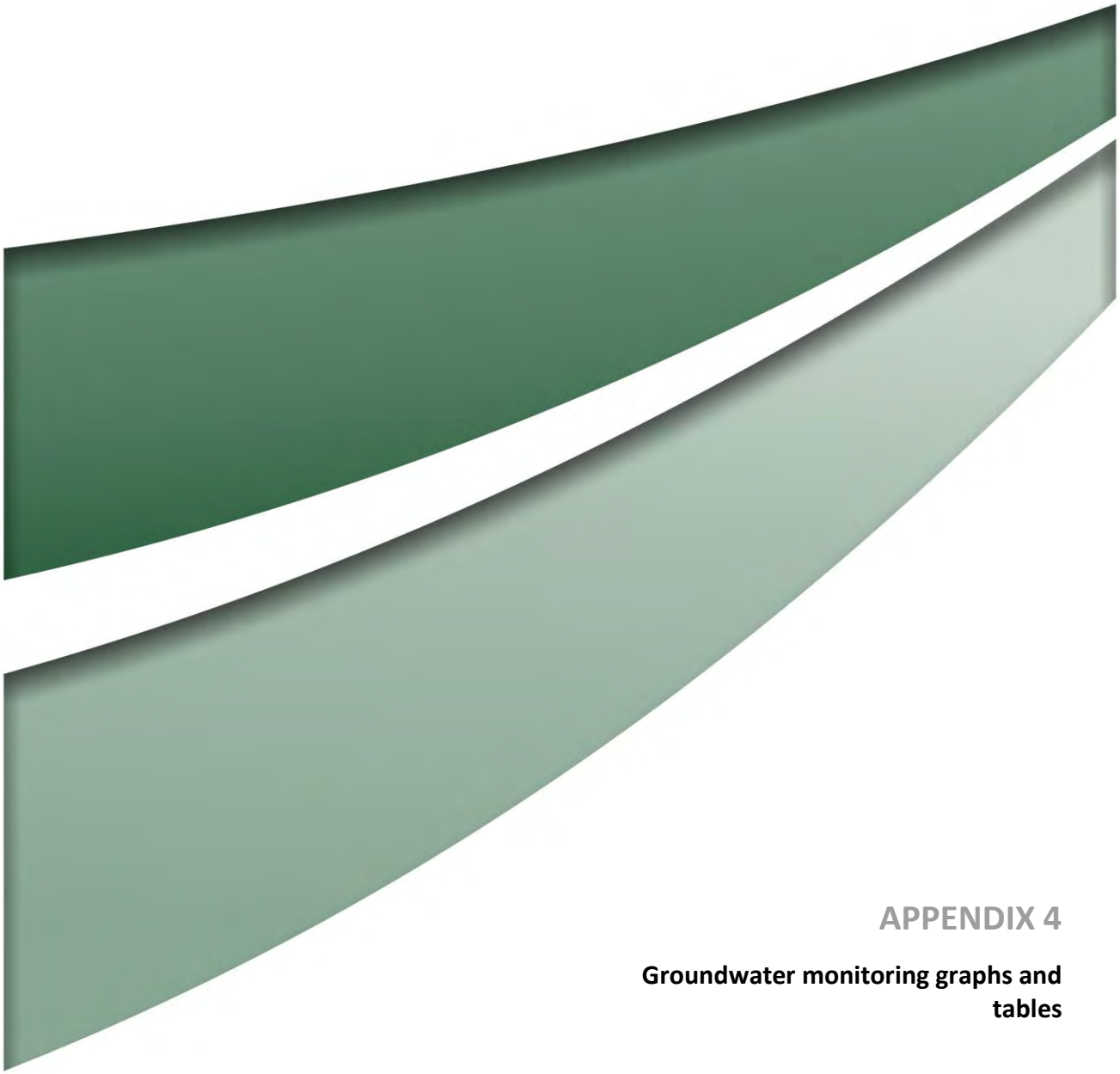
Sample site	CP114	CP115	CP116	CP131	CP132	LD001	BHW1
Sample date	5/5/2017	5/5/2017	5/5/2017	5/5/2017	5/5/2017	5/5/2017	5/5/2017
AHD (RL) (m)	869.77	894.32	882.95	-	887.26	-	895.00
Depth to aquifer (m)	35.32	56.06	58.87	-	17.50	-	43.80
pH	6.16	6.26	6.20		6.21	-	6.42
Electrical Conductivity (µS/cm	279	770	361		521	-	485
Nitrite (mg/L)	<0.05	<0.05	<0.05		<0.05	-	<0.05
Total Oxidised Nitrogen (mg/L)	0.060	<0.05	0.05		<0.05	-	<0.05
Chloride (mg/L)	5	5	16		32	-	22
Nitrate (mg/L)	0.060	<0.05	0.05		<0.05	-	<0.5
Sulphate (mg/L)	13	338	40		103	-	67
Alkalinity (mg/L)	110	62	110		104	-	190
Calcium (mg/L)	23	85	26		42	-	46
Magnesium (mg/L)	10	36	13		19	-	19
Sodium (mg/L)	8	11	12		13	-	10
Potassium (mg/L)	5	10	6		9	-	8
Total Hardness (mg $CaCO_3$/L)	99	360	118		183	-	193
Aluminium (µg/L)	<10	<10	10		<10	-	<10
Arsenic (µg/L)	<1	<1	<1		<1	-	3.00
Cadmium (µg/L)	<0.1	0.2	<0.1		<0.1	-	0.1
Chromium (µg/L)	<1	2	1		<1	-	<1
Copper (µg/L)	1	<1	<1		<1	-	<1
Iron (µg/L)	2240	9450	11800		8430	-	3580
Lead (ug/L)	<1	<1	<1		<1	-	<1
Manganese (ug/L)	964	424	561		267	-	366
Molybdenum (ug/L)	8	2	2		1	-	<1
Nickel (ug/L)	6	16	2		<1	-	22
Selenium (ug/L)	<10	<10	<10		<10	-	<10
Zinc (ug/L)	48	317	105		14	-	17100
Mercury (mg/L)	<0.0001	<0.0001	<0.0001		<0.0001	-	<0.0001

Table C December 2017 Groundwater monitoring results

Sample site	CP114	CP115	CP116	*	CP132	LD001	BHW1
Sample date	13/12/18	13/12/18	13/12/18	*	13/12/18	13/12/18	13/12/18
AHD (RL) (m)	869.96	894.19	892.86	*	886.981	890.88	894.52
Depth to aquifer (m)	35.13	56.19	48.96	*	17.78	49.25	44.28
pH	5.63	5.96	5.81	*	5.94	6016	WL
Electrical Conductivity (µS/cm	223	670	313	*	375	125	WL
Nitrite (mg/L)	<0.05	<0.05	<0.05	*	<0.05	<0.05	WL
Total Oxidised Nitrogen (mg/L)	<0.05	<0.05	<0.05	*	<0.05	0.22	WL
Chloride (mg/L)	22	4	20	*	36	6	WL
Nitrate (mg/L)	<0.05	<0.05	<0.05	*	<0.05	0.22	WL
Sulphate (mg/L)	12	356	46	*	68	13	WL
Alkalinity (mg/L)	100	62	104	*	108	56	WL
Calcium (mg/L)	86	94	28	*	12	13	WL
Magnesium (mg/L)	34	37	14	*	4	5	WL
Sodium (mg/L)	12	13	14	*	6	6	WL
Potassium (mg/L)	10	11	7	*	7	8	WL
Total Hardness (mg $CaCO_3$/L)	355	387	128	*	46	53	WL
Aluminium (µg/L)	280	490	<10	*	<10	<10	WL
Arsenic (µg/L)	<1	<1	<1	*	<1	<1	WL
Cadmium (µg/L)	<0.1	0.1	<0.1	*	<0.1	<0.1	WL
Chromium (µg/L)	1	2	<1	*	<1	<1	WL
Copper (µg/L)	9	10	<1	*	<1	10	WL
Iron (µg/L)	12800	12300	12000	*	7250	<50	WL
Lead (ug/L)	15	17	<1	*	<1	<1	WL
Manganese (ug/L)	414	461	562	*	222	4	WL
Molybdenum (ug/L)	<1	<1	<1	*	<1	<1	WL
Nickel (ug/L)	3	3	1	*	<1	8	WL
Selenium (ug/L)	<10	<10	<10	*	<10	<10	WL
Zinc (ug/L)	86	86	19	*	<5	138	WL
Mercury (mg/L)	<0.0001	<0.0001	<0.0001	*	<0.0001	<0.0001	WL

** Bore dry.*

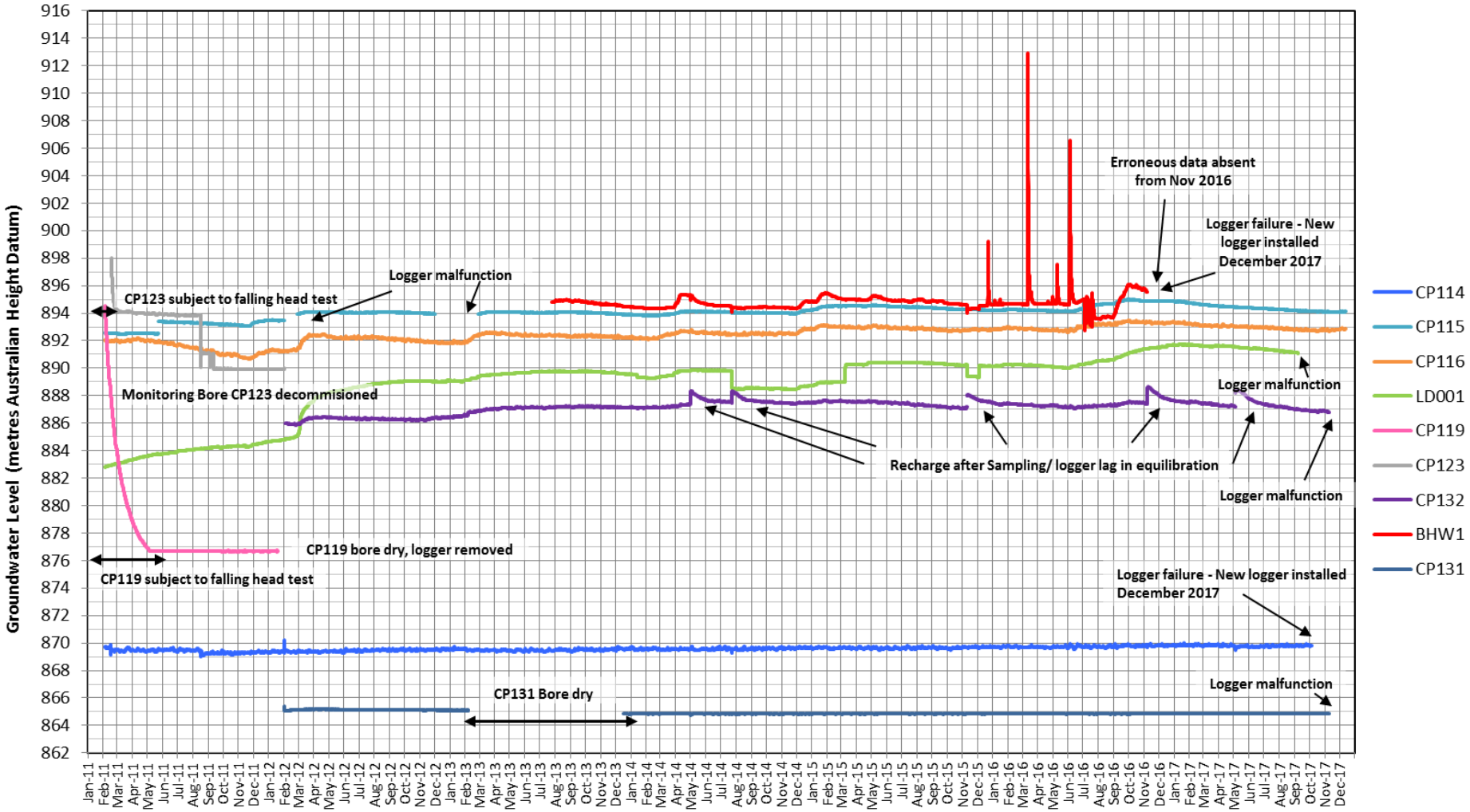
WL Water Level only

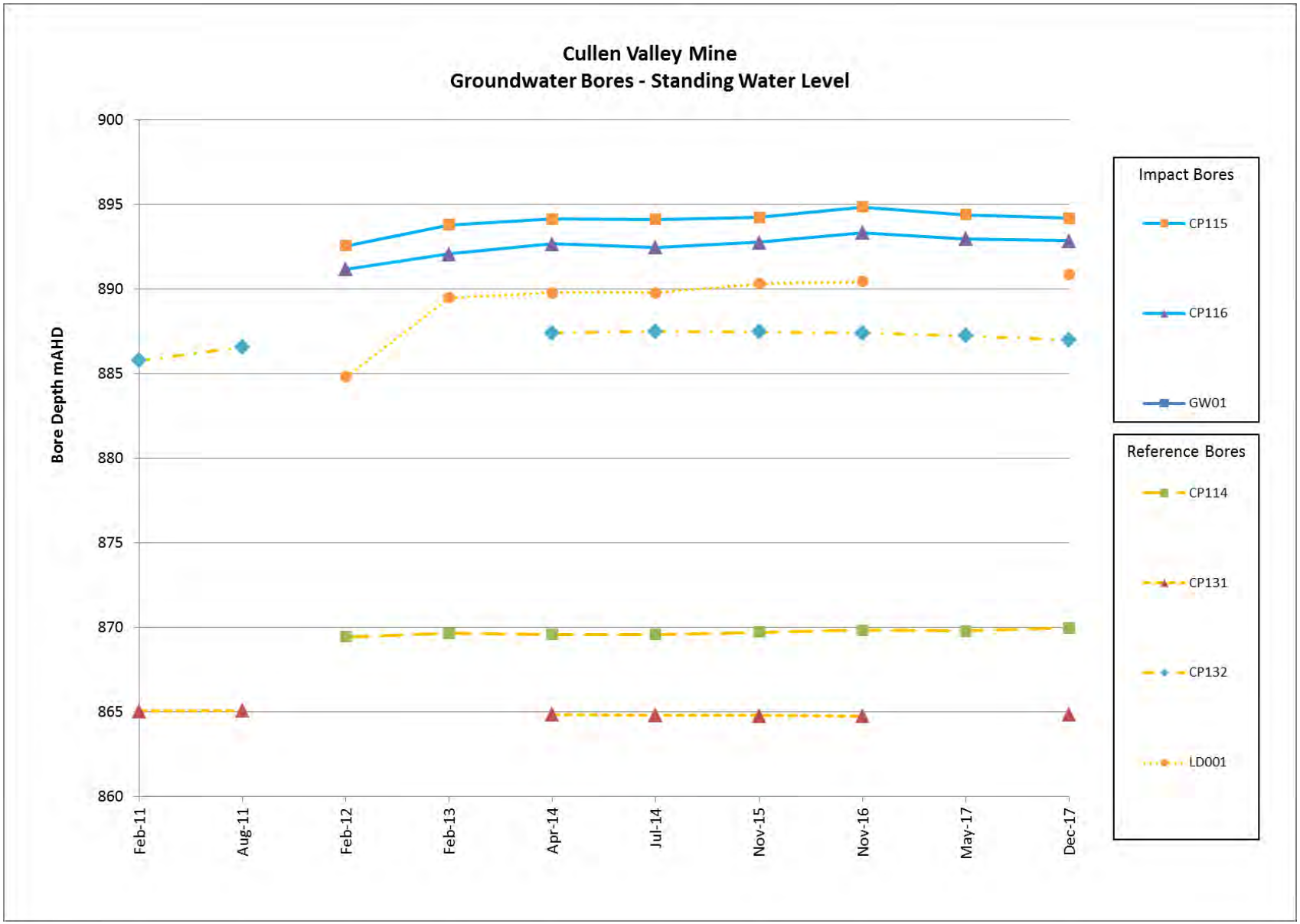


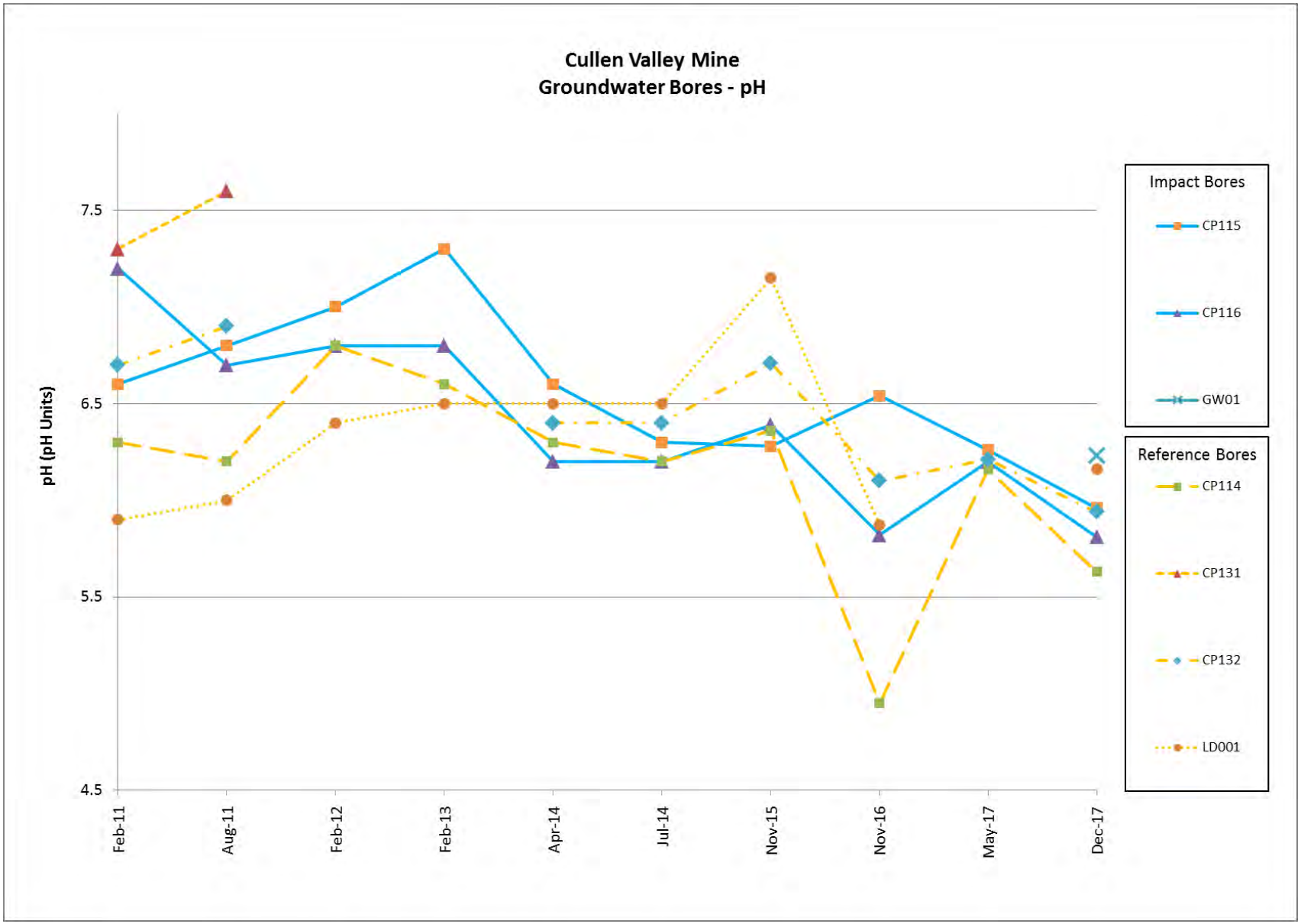
APPENDIX 4

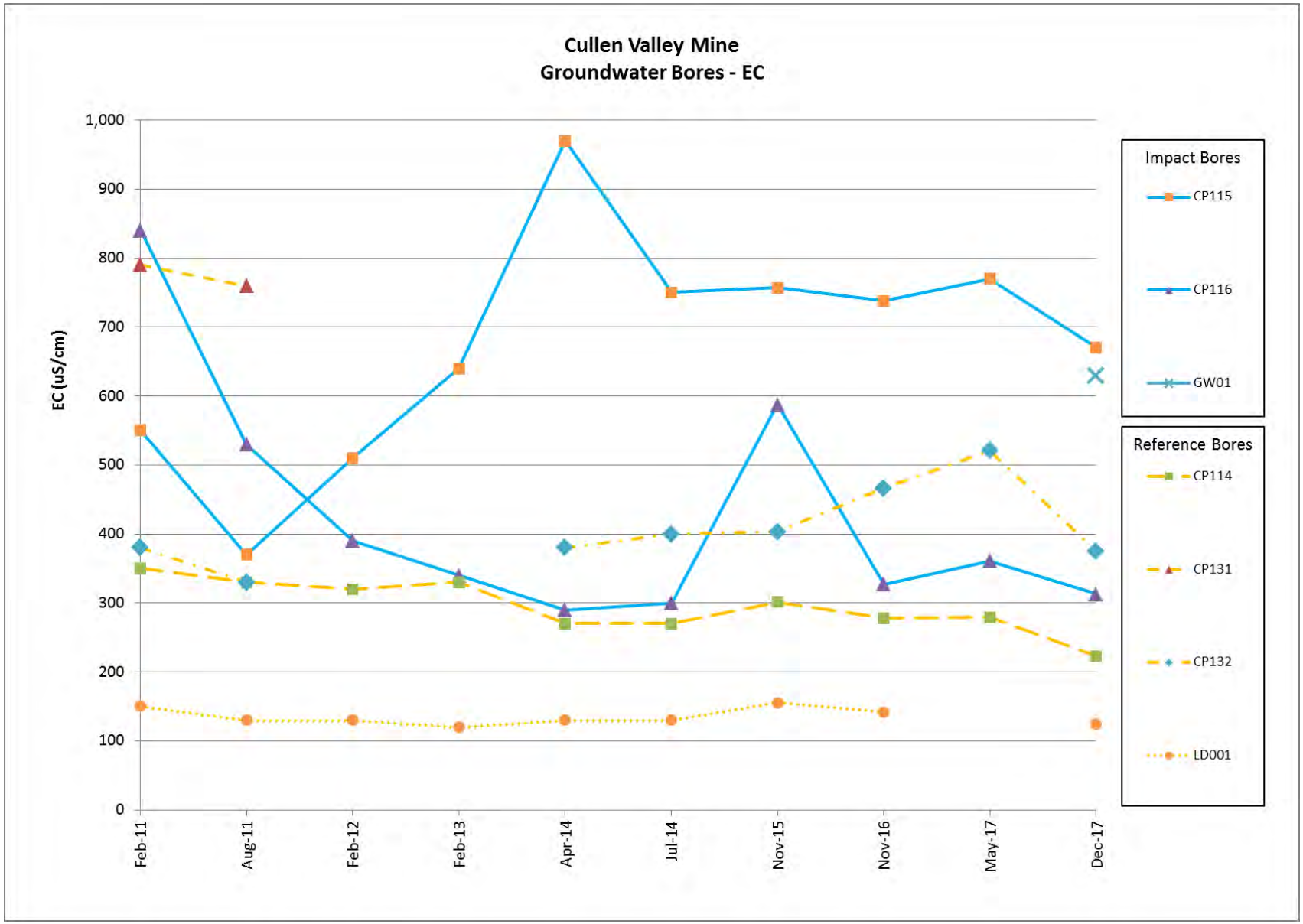
Groundwater monitoring graphs and tables

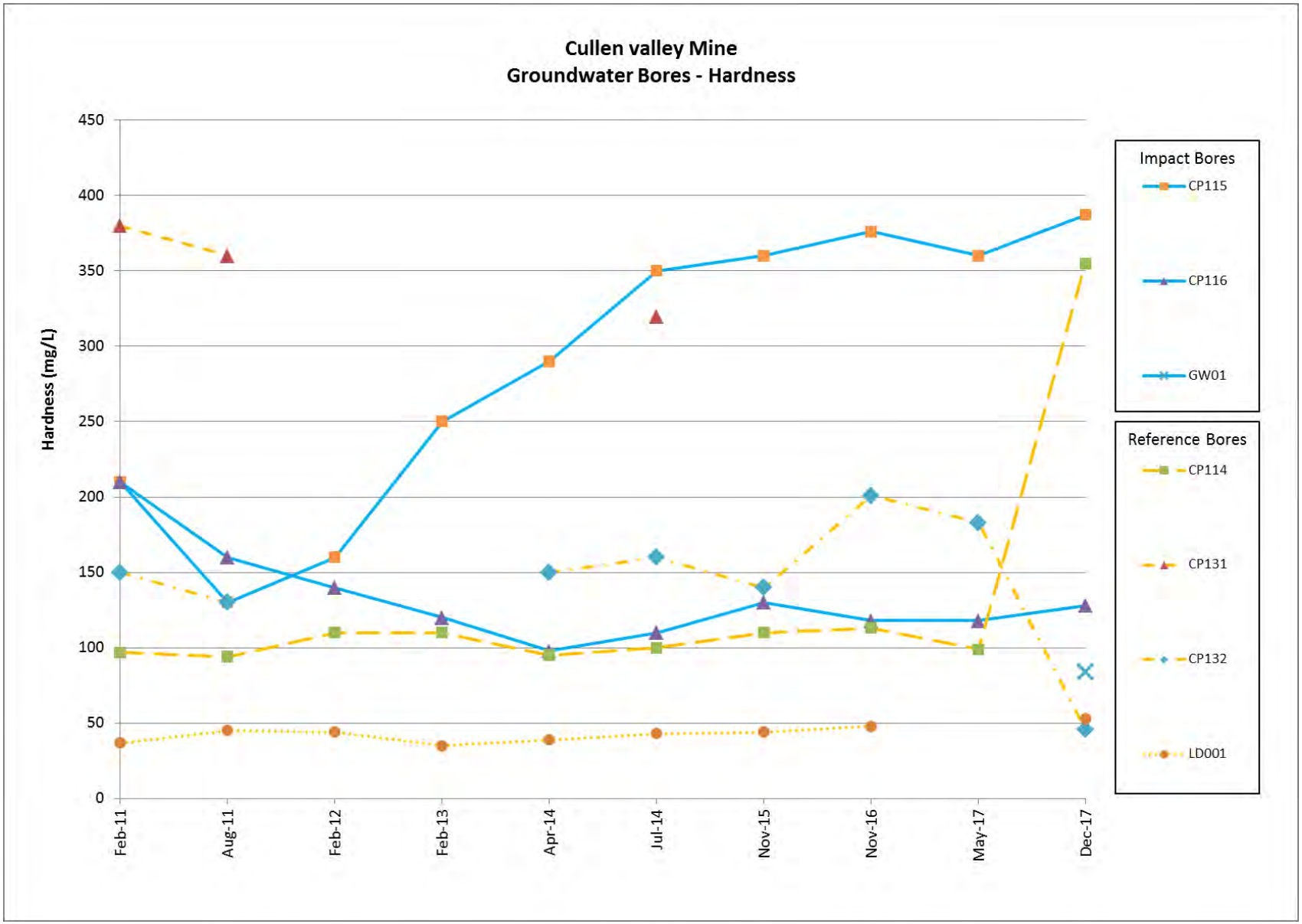
Groundwater Hydrographs - Cullen Valley Mine (2011-2018)

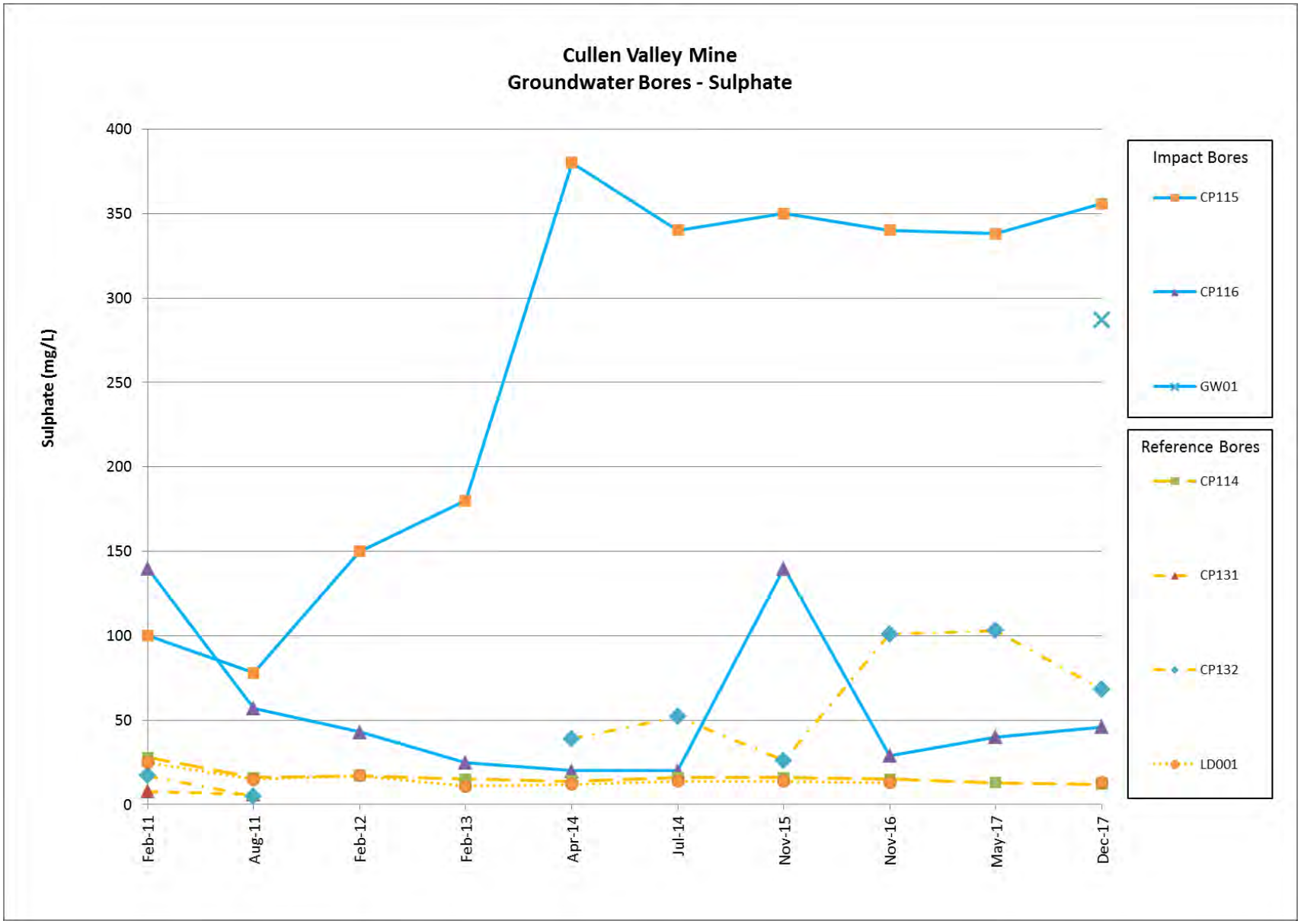


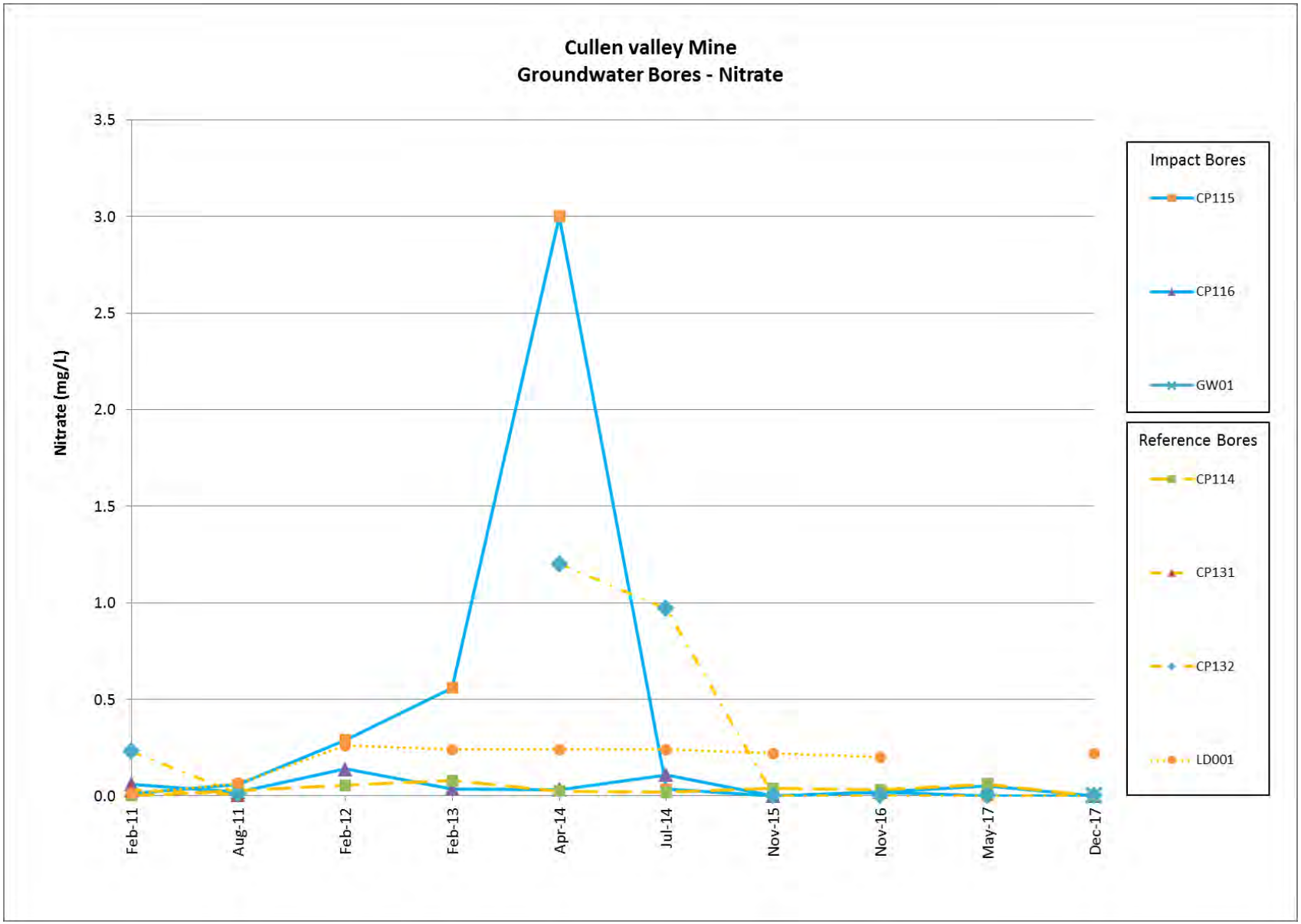

Cullen Valley Mine
Groundwater Bores - Standing Water Level
Bore Depth mAHD
900
895
890
885
880
875
870
865
860
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001

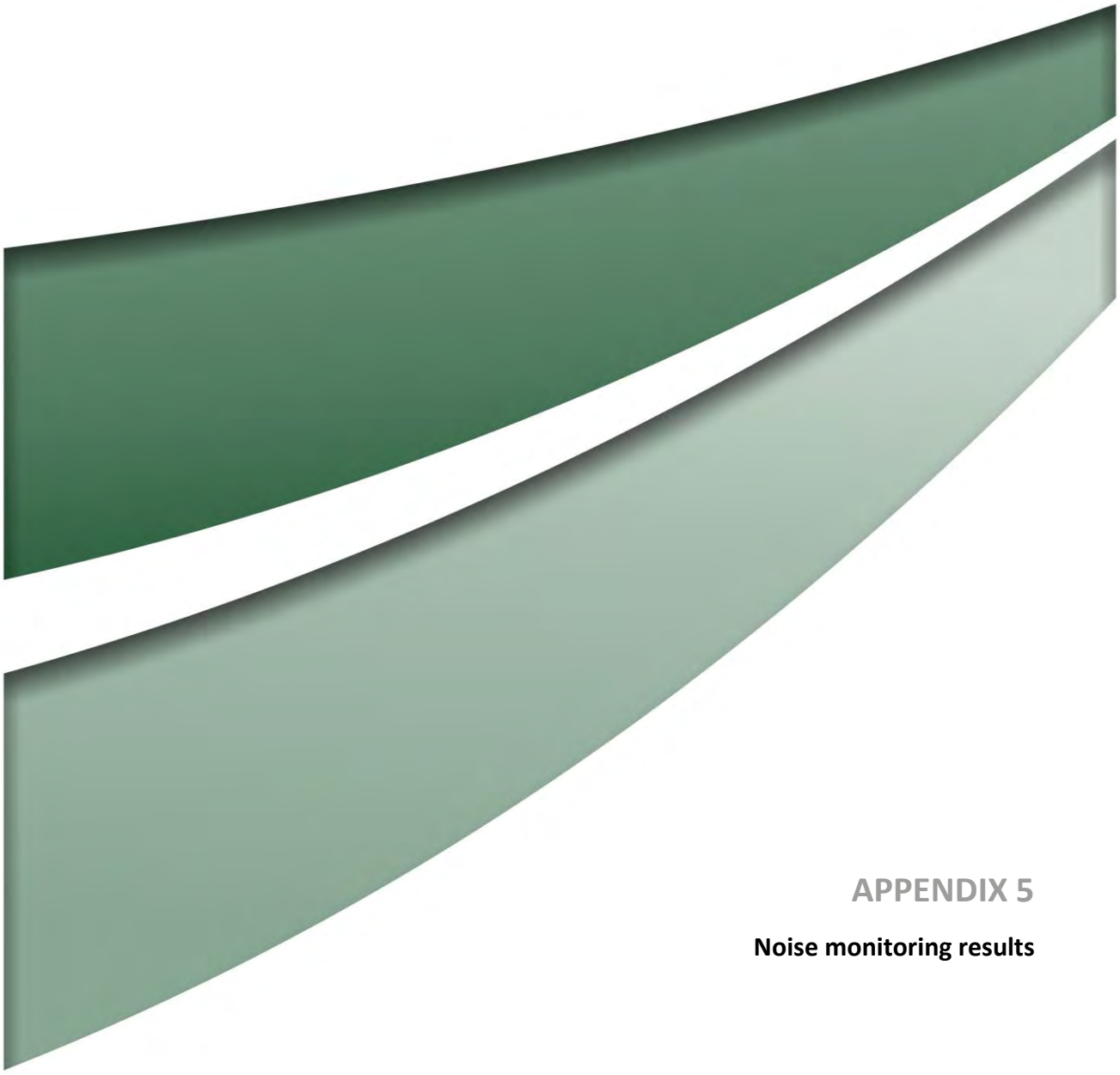

Cullen Valley Mine
Groundwater Bores - pH
pH (pH Units)
7.5
6.5
5.5
4.5
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - EC
EC (uS/cm)
1,000
900
800
700
600
500
400
300
200
100
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen valley Mine
Groundwater Bores - Hardness
Hardness (mg/L)
450
400
350
300
250
200
150
100
50
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - Sulphate
Sulphate (mg/L)
400
350
300
250
200
150
100
50
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen valley Mine
Groundwater Bores - Nitrate
Nitrate (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001



APPENDIX 5

Noise monitoring results

Historical Noise monitoring results for years 2017, 2016, 2015, 2012 and 2011 are shown in **Tables A, B, C, D** and **E**. Contribution from CVM was inaudible for all monitoring undertaken for 2013, and 2014.

Table A 2017 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	44 (IA)	33 (IA)	34 (IA)	34 (IA)
Hillcroft (N08)	35	42 (IA)	37 (IA)	29 (IA)	29 (IA)
Forest Lodge (N10)	40	33 (IA)	34 (IA)	31 (IA)	31 (IA)
Doble Gate (N09)	43	47 (IA)	50 (IA)	45 (IA)	45 (IA)
Tilley (N06)	43	65 (IA)	68 (IA)	67 (IA)	67 (IA)

Table B 2016 Quarterly Noise Monitoring Results*

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	32 (IA)	37 (IA)	36 (IA)	36 (IA)
Hillcroft (N08)	35	40 (IA)	37 (IA)	35 (IA)	35 (IA)
Forest Lodge (N10)	40	32 (IA)	33 (IA)	30 (IA)	36 (IA)
Doble Gate (N09)	43	46 (IA)	52 (IA)	49 (IA)	48 (IA)
Tilley (N06)	43	67 (IA)	66 (IA)	67 (IA)	66 (IA)

Table C 2015 Quarterly Noise Monitoring Results*

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	42 (IA)	32	43 (IA)	41 (IA)
Hillcroft (N08)	35	34	39 (IA) #	35	38 (IA)
Forest Lodge (N10)	40	40	28	40	42 (IA)
Doble Gate (N09)	43	64 (IA)	49 (IA) #	51 (IA) #	49 (IA)
Tilley (N06)	43	66 (IA)	69 (IA) #	66 (IA) #	69 (IA)

IA – noise from the mine was inaudible therefore criteria do not apply

 # – these measurements were affected by wind speeds > 3m/s2 therefore criteria do not apply

Table D 2012 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$)	Quarter 2 ($L_{Aeq\ 15min}$)	Quarter 3 ($L_{Aeq\ 15min}$)	Quarter 4 ($L_{Aeq\ 15min}$)
Red Springs (N07)	37	33	35	30	32
Hillcroft (N08)	35	35	39	32	33
Forest Lodge (N10)	40	<25	30	<25	NM
Doble Gate (N09)	43	IA	IA	IA	IA
Tilley (N06)	43	IA	IA	IA	IA

IA – noise from the mine was inaudible therefore criteria do not apply

NM – noise was not measurable

Table E 2011 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$)	Quarter 2 ($L_{Aeq\ 15min}$)	Quarter 3 ($L_{Aeq\ 15min}$)	Quarter 4 ($L_{Aeq\ 15min}$)
Red Springs (N07)	37	IA	33	<20	IA
Hillcroft (N08)	35	31	37	30	<20
Forest Lodge (N10)	40	26	<30	<25	<25
Doble Gate (N09)	43	IA	IA	IA	IA
Tilley (N06)	43	IA	IA	IA	IA

IA – noise from the mine was inaudible therefore criteria do not apply

umwelt

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

Perth

PO Box 783
West Perth WA 6872
First Floor
7 Havelock Street
West Perth WA 6005

Ph. 1300 793 267

Canberra

PO Box 6135
56 Bluebell Street
O'Connor ACT 2602

Ph. 02 6262 9484

Sydney

50 York Street
Sydney NSW 2000

Ph. 1300 793 267

Brisbane

Level 11
500 Queen Street
Brisbane QLD 4000

Ph. 1300 793 267

www.umwelt.com.au