CULLEN VALLEY MINE
ANNUAL REVIEW

1 January – 31 December 2019

FINAL

March 2020

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FINAL

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	G Goodwin	19 March 2020	G Goodwin	19 March 2020
V2	G Goodwin	25 March 2020	G Goodwin	25 March 2020

Annual Review Title Block

Name of operation:	Cullen Valley Mine
Name of operator:	Shoalhaven Coal Pty Ltd (trading as Castlereagh Coal)
Development consent:	DA-200-5-2003 (as modified)
Name of holder of development consent:	Shoalhaven Coal Pty Ltd
Mining leases:	EL 5712, EL 6007, EL 8618, EL 8619, ML 1455, ML 1488, ML 1556, ML 1557
Name of holder of mining leases:	Shoalhaven Coal Pty Ltd
Water licence:	80WA706148
Name of holder of water licence:	Shoalhaven Coal Pty Ltd
MOP start date:	31 December 2015
MOP end date:	30 June 2020
Annual Review start date:	1 January 2019
Annual Review end date:	31 December 2019

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 2019 to 31 December 2019, 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:	25 March 2020

Table of Contents

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 2019 to 31 December 2019 (referred to hereafter as the 2019 report period).

It is noted that an Independent Environmental Audit (IEA) was undertaken during the 2016 reporting period.

The IEA identified non-compliances with the EPL, Development Approval and the 2003 Environmental Impact Statement mitigation measure commitments. Further details regarding the status of the non-compliances identified by the IEA are located at **Appendix 1**. Actions which were completed prior to the 2019 reporting period and are no longer active have been removed from the table as they are no longer relevant. A copy of the 2016 IEA is located on the CVM website.

The compliance status for the report period is summarised in Table 1.1. A total of four non-compliances occurred during the report period relating to three events. The non-compliances recorded during the report 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**
Environmental Protection Licence EPL 10341	No – Refer to **Table 1.3**
Exploration Licence (EL) 5712	Yes
EL 6007	Yes
EL 8618	Yes
EL 8619	Yes
Mining Lease (ML) 1455	Yes
ML 1488	Yes
ML 1556	Yes
ML 1557	Yes
Water Access Licence 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 during the 2019 Report Period

Relevant Approval	Condition No.	Description (Summary)	Compliance Status	Comment and proposed action	Where addressed in Annual Review
Development Approval DA-200-5-2003 EPL 10341	Condition 27 Schedule 4 L6.1	Two odour complaints associated with sub-surface heating areas at CVM.	**Non-compliant**	Non-compliant due to 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 2019 to manage and treat sub-surface heating, refer to **Section 6.9**.	**Section 6.9**
Development Approval DA-200-5-2003	Schedule 4 Condition 25	Failure to monitor dust deposition in accordance with the required sampling period.	**Non-compliant**	Depositional dust monitoring for December 2019 was not conducted in accordance with the required sampling method identified in the development consent. The dust gauge was not collected within the required sample period (30 days +/- 2 days) as detailed in the relevant Australian Standard (AM-19). Due to bushfires at Shoalhaven nearby Invincible Colliery and in the surrounding areas, the dust gauges were inaccessible, and the environmental conditions on the scheduled retrieval date posed unacceptable health and safety risks.	**Section 6.3**
Development Approval DA-200-5-2003	Schedule 6 Condition 8	Failure to conduct Community Consultative Committee meeting at required frequency.	**Administrative Non-compliance**	The Community Consultative Committee (CCC) did not meet at the required frequency specified in the Development Consent. Schedule 6 Condition 8(c) of the Development Consent specifies that the CCC must meet at least twice a year, however the CCC met during the reporting period in November 2019 only. It was determined during this meeting that the CCC in the future would once per year while the mine is in care and maintenance. A CCC meeting could be called, should the status of the operations change.	**Section 9.0**

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 CVM formerly Tyldesley Colliery around 1904 and continued up until the 1960s 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 (DPI) 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 management and compliance. The Mining Engineering Manager's contact details are included in Table 2.1 below.

Table 2.1 Key Personnel Responsible for Environmental Management of CVM during 2019 Report Period

Name	Contact details
Graham Goodwin Mining Engineering Manager	Based at 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 Development Approval-200-5-2003 (as modified) requires an Annual Review (AR) to be prepared and submitted to the Director General of the Department of Planning, Infrastructure and Environment (DPIE) 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 report 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 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 LA_{max}, LA_1, LA_{90} and LA_{eq} 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 Report on waste monitoring and minimisation in the AEMR, to the satisfaction of the Director-General.	Waste is discussed in Section **6.11**.
Schedule 4 – Specific Environmental Conditions: Greenhouse Gas		
60.	(e) report on greenhouse gas monitoring and minimisation in the AEMR	Greenhouse gas is discussed in **Section 6.14**.
Schedule 6 – Environmental Management, Monitoring, Auditing and Reporting: Annual Report		
5.	The Proponent shall submit an AEMR to the Director- General and relevant agencies. This report must:	This document

Conditions		Addressed in Section
	a) identify the standards and performance measures that apply to the project;	Relevant sections throughout **Section 6.0**
	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 6.0, Section 11.0**

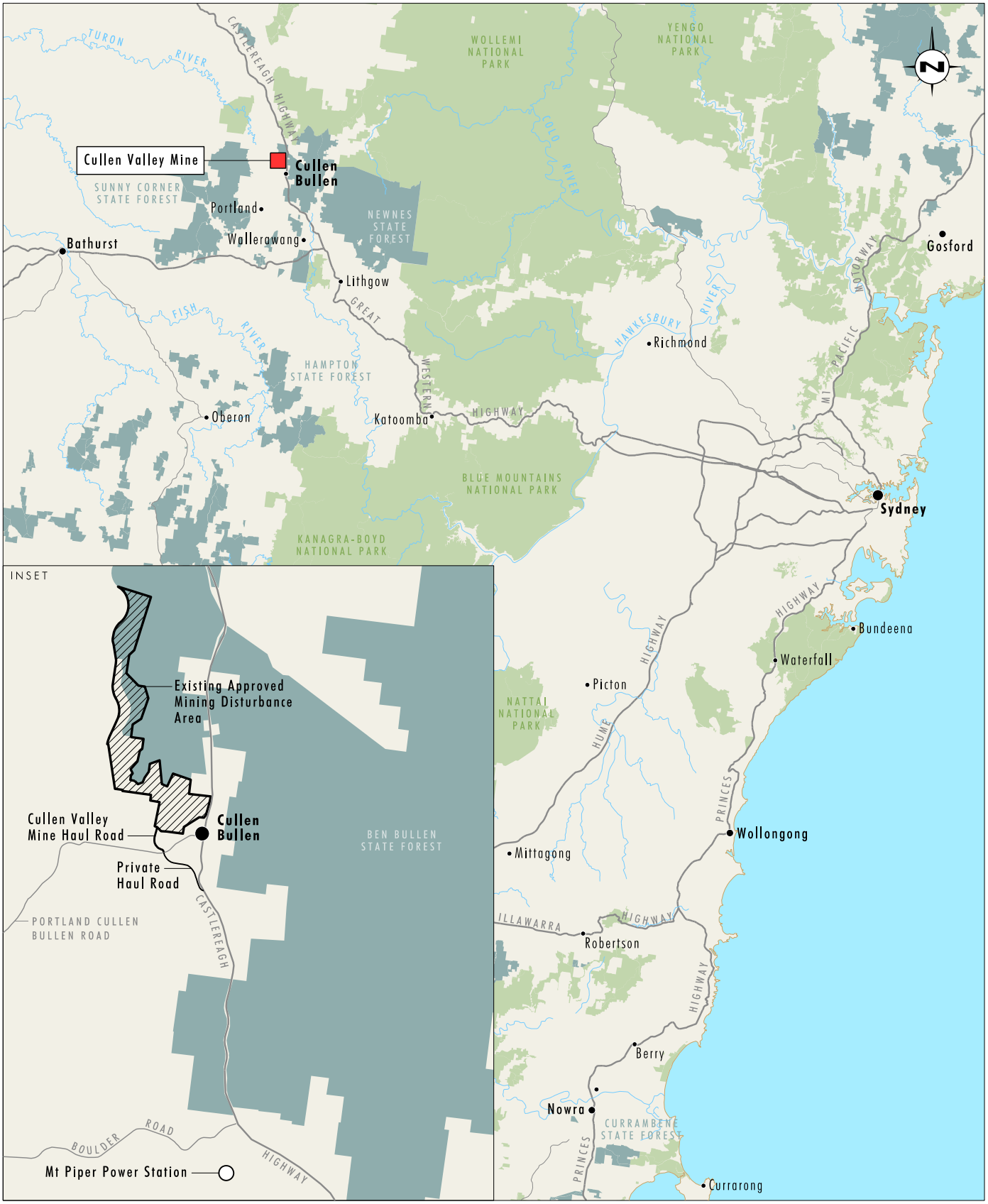


FIGURE 2.1

Locality Plan
Cullen Valley Mine

3.0 Approvals

The operations of CVM during 2019 were regulated by a range of leases, licences and approvals from various State government authorities as 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
Exploration Licence (EL) 5712	10 April 2000	10 April 2019	Renewal application submitted – determination pending.
EL 6007	8 October 2002	7 October 2018	Renewal application submitted – determination pending.
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	Renewal application submitted – determination pending
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 80WA 706148	16 January 2012	5 July 2025	Current

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 plans and the approval status of each plan at the end of the report period.

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) during December 2019. 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
Care and Maintenance MOP (Sedgman, 2015)	Yes	26 October 2018	Yes	NSW Resources Regulator
Environmental Management Plan (Coalpac, 2012c)	Yes	N/A	N/A	DPE
Flora and Fauna Management Plan (Coalpac 2012a)	Yes	N/A	N/A	DPE
Flora and Fauna Management Plan (Umwelt, 2017b)	N/A	29 June 2017	Pending	DPE
Species Management Plan (Clandulla Geebung) (Coalpac, 2012f)	N/A	31 August 2017	Pending	DPE
Environmental Monitoring Program (Coalpac, 2009)	Yes	N/A	N/A	DPE
Blast Management Plan (Coalpac, 2012d)	Yes	N/A	N/A	DPE
Fire Management Plan (Coalpac, 2012e)	Yes	N/A	N/A	DPE
CVM and Invincible Colliery Pollution Incident Response Management Plan (PIRMP), (Umwelt, 2019)	N/A	N/A	N/A	EPA

Care and maintenance activities at CVM are undertaken in accordance with an approved Care and Maintenance (C&M) MOP (Sedgman, 2015). An extension to the MOP term to the 30 June 2020 was approved during the report period.

4.0 Operations Summary

4.1 Mining operations

CVM remains in care and maintenance and as such no production occurred during the report period. A summary of the production figures and mining activity for 2019 and the forecast production for 2020 is provided 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 since this time.

Table 4.1 Production Summary

Material	Approved Limit (specify source)	2018 Previous reporting period (Actual)	2019 This reporting period (Actual)	2020 Next reporting 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	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 report 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 report 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 report 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 report 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 report period. Therefore, no tailings were produced.

4.2 Other operations

During the report period, the works undertaken included 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 report period.

4.3 Next report period

Shoalhaven Coal will continue to investigate opportunities to recommence mining at CVM. Currently there are no coal mining operations proposed during 2020 and it is envisaged that the operation will remain in care and maintenance.

5.0 Actions required from previous annual review

Following submission of the 2018 Annual Review to DPE on 28 March 2019, DPE provided comment on the Annual Review in correspondence to Shoalhaven on 17 June 2019. DPE advised that the Annual Review was considered to generally satisfy the requirement of the Approval in relation to Annual Reviews and requested that the Annual Review be made publicly available on the company website. A copy of the 2018 Annual Review is available on the Castlereagh Coal website.

DPE did not request any further action in relation to the 2018 Annual Review or future annual reviews.

6.0 Environmental Performance

In accordance with the Annual Review Guidelines (DPE, 2015), this section describes the environmental monitoring and management measures undertaken at CVM during the report period. **Section 3.1** details the environmental management plans which have been prepared for the operation.

A range of environmental monitoring is required to be undertaken by the Development Consent, 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 report 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 report 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 30 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 at the closest residential area as a result of mine operations.

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 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 2019 groundwater monitoring have been compared to the groundwater trigger levels contained in the CVM Water Management Plan (Umwelt, 2017b).

6.1.5 Biodiversity predictions

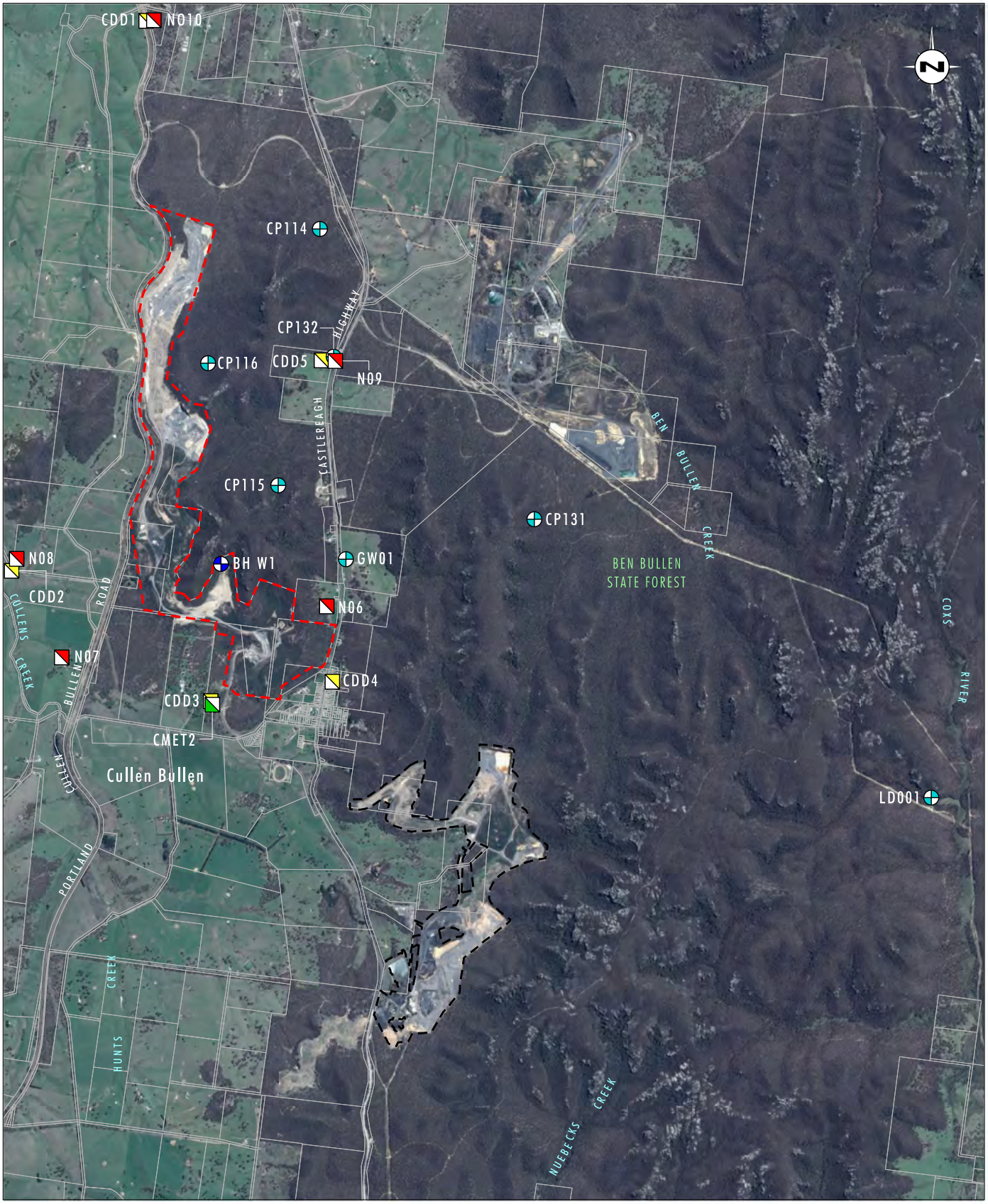
Only one threatened plant species, Capertee Stringybark, was found to occur in the study area during the Feldmast EIS (1997). The EIS predicted that no local population of Capertee Stringybark would be placed at risk of extinction as a result of the proposed mining operations. The 2003 EIS made similar 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 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 2019

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 2019. Historic trends are shown in **Section 6.5**.	No further action required.
Air Quality	Refer to **Section 6.1.2**	Air Quality monitoring conforms to EIS predictions. Non-compliance relates to failure of air quality monitoring equipment. 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 to EIS predictions. Refer to **Section 6.4.2**. 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 was undertaken and is discussed in **Section 6.4.2** and **Appendix 4**.	No further action required.
Biodiversity	Refer to **Section 6.1.5**	Rehabilitation areas are progressing towards satisfactory completion.	The revised Biodiversity Monitoring Program commenced in 2019 and will be continued in 2020.	No further action required.



Legend

- Existing Approved Mining Disturbance Area - Cullen Valley
- Existing Approved Mining Disturbance Area - Invincible
- Depositional Dust Monitoring Point
- Meteorological Station
- Noise Monitoring Point
- Surface Water Monitoring Point
- Groundwater Monitoring Point

FIGURE 6.1

Environmental Monitoring Locations
Cullen Valley Mine

6.2 Meteorological monitoring

Meteorological monitoring is undertaken at CVM. The CVM weather station (CMET2) is located at the training centre adjacent to 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 407.0 mm of rainfall over 115 rain days during the report period. The highest rainfall occurred during January (161.8 mm), while April had the lowest rainfall (0.8 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. The maximum temperature recorded during the report period was in December (39.69°C @ 2m, 38.94°C @10m) and the lowest temperature occurred in August (-10.28°C @ 2m, -8.3°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 (100.0%) and the lowest was during November (5.97%) as shown in Table 6.3.

6.3 Air quality

6.3.1 Environmental management measures

CVM's Environmental Management Plan (Coalpac, 2012c), includes an Air Quality Management Plan (AQMP), which defines 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 <10 µm (PM_{10}) (see Figure 6.1).

6.3.2 Performance criteria

The air quality performance criteria specified in DA 200-5-2003 are reproduced in Table 6.2 .

Table 6.2 Air quality performance 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		Air temp @ 10m		Humidity (%)	
				Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January 2019	161.8	161.8	17	12.55	39.04	13.03	38.17	13.90	99.00
February 2019	24.2	186.0	8	4.81	33.85	5.77	32.64	11.79	99.40
March 2019	77.4	263.4	13	3.64	32.9	4.27	31.66	15.97	100.0
April 2019	0.8	264.2	4	-1.48	27.56	0.14	26.61	14.56	98.80
May 2019	30.6	294.8	19	-3.05	20.78	-2.08	20.61	21.95	98.70
June 2019	14.2	309.0	16	-7.75	19.19	-6.38	18.72	25.34	99.00
July 2019	8.6	317.6	8	-8.19	18.34	-17.9	18.17	13.41	98.30
August 2019	11.2	328.8	6	-10.28	20.66	-8.30	19.95	8.70	97.90
September 2019	38.6	367.4	9	-6.17	25.46	-5.01	24.50	6.38	97.30
October 2019	8.2	375.6	5	-3.56	30.76	-2.37	29.63	9.36	95.30
November 2019	27.4	403.0	8	-0.01	35.56	1.12	34.34	5.97	96.50
December 2019	4.0	407.00	2	3.18	39.69	5.03	38.94	6.78	93.70
Total	407.0	-	115	-	-	-	-	-	-

6.3.3 Environmental outcomes

6.3.3.1 Dust deposition

Deposited dust is monitored on a 30 ±2 day cycle at five representative locations around the mine site (dust deposition gauges CDD1 to CDD5). The annual average criterion for deposited dust (4 g/m^2/month) was not exceeded at any of the dust deposition gauges during the report period. The annual average dust levels for all locations was less than 2 g/m^2/month and therefore complied with air quality performance criteria. It is noted that the December results were considered to be significantly influenced by regional bushfire events. The exclusion of the December result from the annual average calculation however represents a maximum change of 0.4 g/m2/month. and as such are not considered non-compliances as discussed in **Section 6.3.3.1**.

The monthly deposited dust monitoring results for 2019 are shown in Table 6.4 and is compared with historical results in **Appendix 2**.

During December 2019, the dust gauge was not collected within the prescribed sample period (30 days ± 2 days) as required in the relevant Australian Standard (AM-19). The collection of the dust gauges was postponed due to bushfires in the immediate vicinity of CVM and the health and safety risks that collection of, the dust gauges posed.

Table 6.4 Deposited dust monitoring results

Date	Total Insoluble Solids (g/m^2/month)				
	CDD1	CDD2	CDD3	CDD4	CDD5
January 2019	3.2	2.1	1.2	2	2.8
February 2019	2.5	0.7	1.4	1.8	0.8
March 2019	0.8	0.6	1.7	2.8	1
April 2019	0.5	0.3	0.4	0.8	0.4
May 2019	0.4	0.8	0.6	1.0	1.2
June 2019	0.4	0.5	0.2	0.4	0.5
July 2019	0.2	0.3	0.2	0.5	0.3
August 2019	0.4	0.7	0.6	1.4	0.8
September 2019	0.8	1.2	1.0	1.1	0.9
October 2019	0.05	1.3	1.3	2.2	1.9
November 2019	0.8	0.2	1.2	1.6	7.1^
December 2019	5.2*	4.1*	5.2*	5.1*	5.7*
Annual Average 2019	**1.3**	**1.1**	**1.3**	**1.7**	**1.9**
Annual Average 2019 (Excluding December 2019 result)	**0.9**	**0.8**	**0.9**	**1.4**	**1.6**

** Result non-compliant with exposure period due to inaccessibility of gauges during December*

^ Result contained insects and tree bark

6.3.3.2 Particulate matter

Monitoring of particulate matter was conducted during 2019. 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 report 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

Annual Average	PM_{10} (µg/m³)	TSP (µg/m³)*
Criterion	30	90
All data	23.4	58.5
Excluding results influenced by extraordinary events	10.5	24.1

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

6.3.3.3 Exceedances influenced by extraordinary events

Results in excess of the 24-hour maximum allowable limit for PM_{10} (50µg/m³) were recorded on five occasions during the report period being:

- 22 November 2019 (145µg/m³)
- 10 December 2019 (115µg/m³)
- 16 December 2019 (280µg/m³)
- 22 December 2019 (105µg/m³)
- 28 December 2019 (180µg/m³)

These elevated concentrations appear to have been significantly influenced by an extraordinary event, being large-scale bushfires within in the Lithgow Local Government Area (LGA) and Blue Mountains region and Australian east coast generally. For example, the Gospers Mountain Fire which was a widespread, multi-fronted fire which burned over 500,000 hectares.

However, these exceedances were not considered non-compliances with the respective criterion as the results were attributed to localised bushfire events and were considered to be "exceptional events" according to the National Environment Protection (Ambient Air Quality) Measure (NEPM). The NEPM defines an exceptional event as:

> *"… a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of 1 day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust. "*

The dust results during the above dates have been presented in the report with relevant calculations including and excluding these results provided for completeness.

Elevated air quality monitoring results in excess of the 24-hour PM_{10} criteria were also recorded at OEH's air quality monitoring stations over the corresponding time period. There were no operations undertaken at CVM on these days that would have led to the generation of dust.

6.3.4 Trends in data

Table 6.6 presents the 2019 annual average dust deposition along with the previous five years. Graphs of the long-term dust deposition levels are included in **Appendix 2**. The annual averages for particulate matter recorded at CVM during 2019 are above the range of results recorded in the previous five years (with the

exception of CDD2 and CDD5). All the 2019 results are however well below the performance criteria. The annual averages are considered to have been influenced by the effects of localised and widespread bushfire events, as discussed in **Section 6.3.3.1**.

Table 6.6 Annual averages for dust deposition 2014-2019

Reporting period	Total Insoluble Solids (g/m^2/month)				
	CDD1	CDD2	CDD3	CDD4	CDD5
Criteria	4	4	4	4	4
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
2018	0.8	0.9	1.0	1.2	1.5
2019	1.3	1.1	1.3	1.7	1.9
Annual Average 2019 (Excluding December 2019 result)	0.9	0.8	0.9	1.4	1.6

A graph of the PM_{10} and TSP monitoring data for 2019, as well as historical data trends, is shown in **Appendix 2**.

The 2019 raw annual average deposited dust level at CDD1, CDD3 and CDD4 are the highest in recent years, however, still well below the performance criteria. The raw annual averages for all other monitoring locations are within the range recorded in recent years. Excluding the results influenced by bushfire events during 2019 (December results), the 2019 annual averages at all monitoring locations would be consistent with the historical range of results in the previous five years, except for CDD1 and CDD4.

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

During 2017 a standalone Water Management Plan (WMP) (Umwelt, 2017b) for the CVM was submitted to DPE for approval (refer to **Section 3.1**). The WMP sets out water quality criteria, mitigation measures and monitoring procedures for the management of surface water and groundwater. In 2020, Shoalhaven Coal will seek clarification of the status of the 2017 CVM WMP.

6.4.1 Surface water quality

6.4.1.1 Environmental management measures

The surface water management system at CVM utilises a series of settlement dams. The system is primarily operated as a closed loop system. 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, dirty and mine waters and to capture dirty water for re-use and provide controls to treat captured dirty water to a standard suitable for discharge off-site.

The Tyldesley Mine underground workings are also used to store excess water from the WMS. 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.

CVM operates under EPL 10341. The EPL provides water quality criteria and water quality monitoring requirements for water discharges 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 EPL discharge criteria for these discharge points.

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

Pollutant	Concentration Limit
Oil & Grease	10 mg/L
pH	6.5 – 8.5
Total suspended solids	30 mg/L

6.4.1.3 Environmental outcomes

Water quality monitoring is conducted monthly at settlement dams associated with LDP 001 and LDP 004 regardless of the discharge status. This is undertaken for due diligence purposes to monitor the water quality within the respective dams. There were no discharge events from LDP 001 and LDP 004 during the 2019 report period. The results of the monthly due diligence monitoring at Dam 1 and Dam 4 are included in **Appendix 3**.

6.4.1.4 Trends in data

As noted above, during the 2019 report period there was no discharge from EPL Points LDP001 and LDP004. The monthly water quality results in Dam 1 and Dam 4 during 2019 are therefore for due diligence purposes only, refer to **Appendix 3.**

Due Diligence Monitoring

The pH results for Dams 1 and 4 during the report period range between 6.6 and 8.4, as shown in **Appendix 3**. This range is generally consistent with those recorded during the previous 2018 report period (i.e. 6.4 and 8.1). These levels are within the EPL discharge criteria however, there were no discharges during the report period.

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

TSS results were elevated in Dam 1 during February but were below the EPL discharge criteria for remaining months. The February results may have been impacted by the rain event at the time of sample collection.

TSS results at Dam 4 remained below the EPL discharge criteria 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 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 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 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).

6.4.2.2 Performance criteria

There are no pollutant concentration limits for groundwater specified in the Development Approval or EPL for CVM. The CVM WMP (Umwelt, 2017b) includes trigger values against which groundwater monitoring results are compared. For the purposes of this Annual Review, the groundwater results obtained during the report 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 trigger level/range for key groundwater monitoring parameters that are specific to bores CP115, CP116 and GW01. Results outside of these ranges are 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**).

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 for the trigger levels. The groundwater triggers will be reviewed considering the additional data now available, with any update included in the MOP and Water Management Plan during 2020.

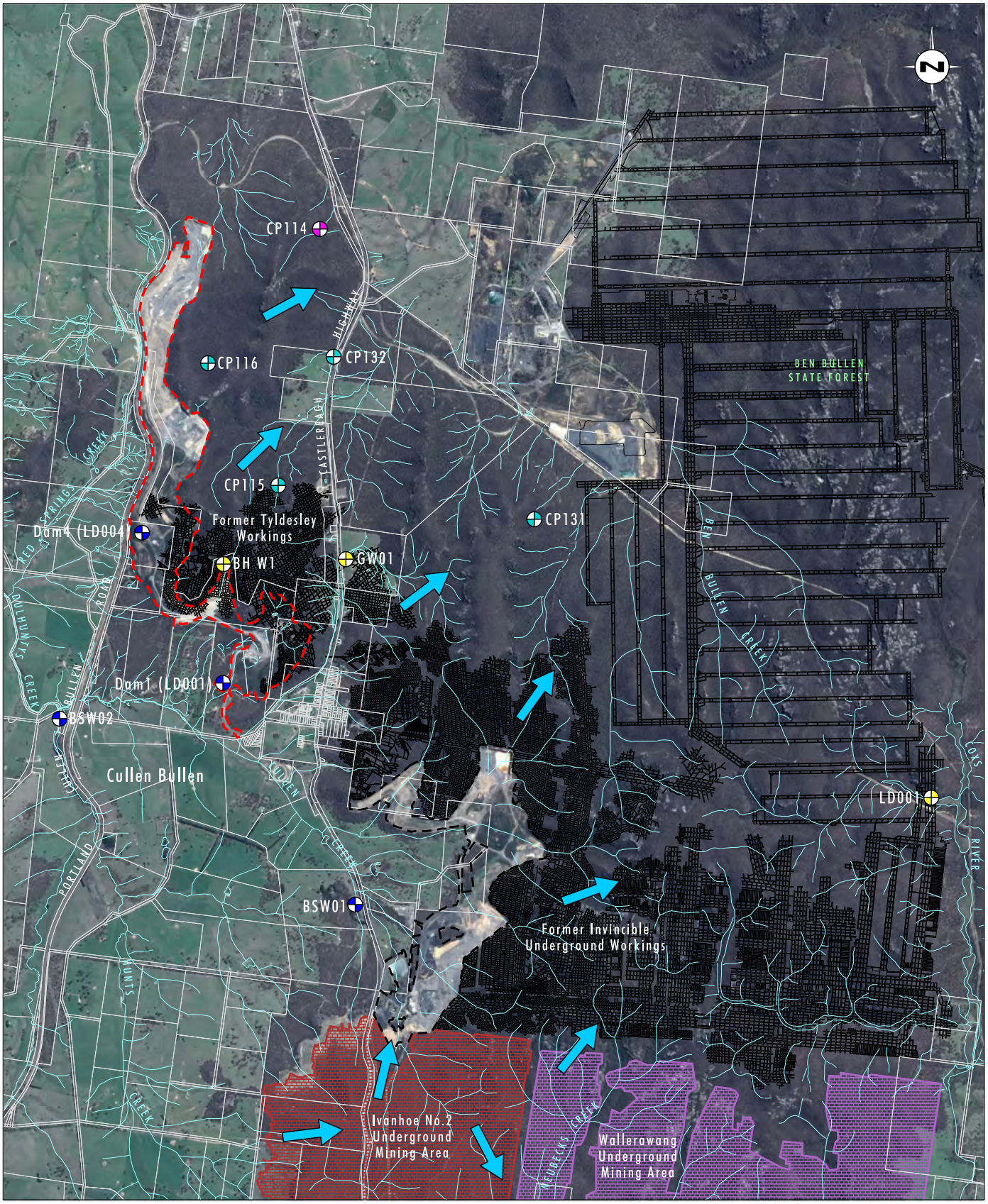
[2] GW01 has not been monitored for Hardness as part of groundwater quality baseline monitoring. Total Alkalinity has been used as a proxy for Hardness, and will be utilised as a trigger for this bore until sufficient baseline data for hardness has been obtained for this bore to develop a trigger value.

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 groundwater data set which is a limited data set of between nine and eleven annual groundwater samples at each location between the period 2011 – 2017. It was therefore intended that the groundwater trigger levels for the CVM groundwater bores were to be refined during 2020 to incorporate the additional monitoring data. The trigger action response plan, as detailed in the CVM WMP (Umwelt, 2017b) defines a process for reviewing results 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).'*

6.4.2.3 Environmental outcomes

During the report period, groundwater monitoring was conducted on two occasions (refer to Table 6.9). A discussion of the 2019 groundwater monitoring results is included in **Section 6.4.2.4**.



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 6.9 2019 groundwater monitoring

Sampling Date	Overview of sampling
May 2019	Monitoring undertaken during May 2019 was applicable only to selected bores and parameters, based on results from November 2018. Bore CP115 is monitored every six months (Umwelt, 2017b) due to proximity to operations.
November 2019	Monitoring undertaken during November 2019 was applicable only to selected bores and parameters, based on results from May 2019.

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, CP 132 and LD001. These bores provide a baseline for comparison with the impact bores.

Standing Water Level

The standing water level in the impact bores during the report period are within the trigger level range, as shown in Table 6.10.

Table 6.10 Impact bores standing water levels and triggers

Bore	Groundwater Level (mAHD) Trigger Range	May 2019 Groundwater Level (mAHD)	November 2019 Groundwater Level (mAHD)	Complied with Trigger Level?
CP116	890 - 894	893.05	892.75	Yes
CP115	892 - 896	894.27	894.01	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 115) has shown little variation 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 and increasing slightly in May 2019, as shown graphically in **Appendix 3**. The reference bores of LD001, CP132 and CP131 however show greater variability in the long-term standing water level trends, as shown graphically in **Appendix 3.**

pH

The pH results for CP116 and CP115 during the report period were within the trigger level range, as shown in Table 6.11. At both CP116 and CP115, the pH level has decreased from that recorded in November 2018. A slight increase in pH occurred between samples in May and November 2019, however this increase appears to be consistent with the trends observed across both impact and reference bores, as shown graphically in **Appendix 3**. As such, these results are considered to be reflective of a wider regional trend and not the result of CVM activities.

The pH trend across both impact and reference bores is generally consistent over time, with isolated spikes and drops observed for individual sampling dates. Since December 2017 the bores have demonstrated a general increase in pH, as shown graphically in **Appendix 3**.

The pH level at GW01 was above the trigger range and historical maximum, based on a sample size of two. However, the pH results at GW01 are within the ANZECC guidelines' default trigger values (6.5 – 8.0 for freshwater reservoir and lowland river ecosystems, 6.5-7.5 for upland river ecosystems) and as such, the potential for environmental harm associated with these results is expected to be low. With regard to domestic stock, the ANZECC guidelines also recommend that a pH of > 6 should be maintained to limit corrosion and fouling of watering systems, and that soil and animal health will not generally be affected by water with pH in the range of 4-9. In accordance with the CVM WMP (Umwelt, 2017b) Shoalhaven Coal will continue to monitor pH results and no specific investigation is recommended at this time. .

Table 6.11 Impact bores pH levels and triggers

Bore	pH Trigger Range	May 2019 pH Level	November 2019 pH Level	Complied with Trigger Level?
CP116	5.82 – 7.2	6.83	7.07	Yes
CP115	6.26 – 7.3	6.85	6.95	Yes
GW01	6.14 – 6.82	No sample required*	7.09	No

* GW01 is sampled annually.

Electrical Conductivity

The Electrical Conductivity (EC) in the impact bores during the report period are below the trigger level, as shown in Table 6.12.

Table 6.12 Impact bores electrical conductivity levels and triggers

Bore	Electrical Conductivity (µS/cm) Trigger Level	May 2019 EC Level (µS/cm)	November 2019 EC Level (µS/cm)	Complied with Trigger Level?
CP116	Upper limit 840	372	428	Yes
CP115	Upper limit 970	723	817	Yes
GW01	Upper limit 939	No sample required*	778	Yes

*GW01 is sampled annually.

The long-term trend in EC values across the reference bores is mixed, as shown graphically in **Appendix 3**:

- LD001 has shown some variability (±20 µS/cm) around 130 µS/cm, increasing to 166µS/cm in November 2018 and 175µS/cm in November 2019, which was above previous maximum levels.
- CP114 exhibits a slight increase in 2019 monitoring from 285 µS/cm to 294 µS/cm, with historical results showing occasional small spikes, stable periods and steady declines.
- CP131 was dry during an attempted sampling in November 2019, consistent with previous monitoring events during 2017 and 2018.
- CP132 monitoring results have increased initially, dropping in 2017 and peaking in November 2018 before decreasing in November 2019.

The long term trend in EC values in the impact bores shows greater variability than reference bores, as shown graphically in **Appendix 3**.

- CP116 monitoring results in 2019 have continued to increase from November 2016 following an isolated spike in November 2015. The November 2019 result of 428µS/cm is the highest recorded since 2015, but well below the historical maximums of 840µS/cm as shown in **Appendix 3**.
- CP115 monitoring results exhibit greater variability. The results since April 2014 have ranged from 398µS/cm (April 2018) to 770µS/cm (May 2017). The November 2019 result is the second highest recorded as shown in **Appendix 3**.
- GW01 EC levels in November 2019 are similar to the November 2018 result of 779µS/cm.

Sulphate

The sulphate levels in the impact bores during the report period are below the trigger level, with the exception being the November 2019 results for CP115, as shown in Table 6.13.

Table 6.13 Impact bores sulphate levels and triggers

Bore	Sulphate (mg/L) Trigger Level	May 2019 Sulphate Level (mg/L)	November 2019 Sulphate Level (mg/L)	Complied with Trigger Level?
CP116	Upper limit 140	58	50	Yes
CP115	Upper limit 380	348	396	No
GW01	Upper limit 338	No sample required*	315	Yes

*GW01 is sampled annually

The long-term sulphate values for the reference bores ranges from 11-25 mg/L at LD001 and 12-28 mg/L at CP114. CP132 shows greater variability with results ranging between 17mg/L - 145 mg/L. There is a variability of up to 70 mg/L between consecutive samples, as shown graphically in **Appendix 3**. The 2019 result at CP132 of 73 mg/L fall within historical range.

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. The long-term range for impact bore CP115 is above historical trends (396 mg/L). In accordance with the CVM WMP (Umwelt, 2017b) Shoalhaven Coal will continue to monitor sulphate levels. The result at CP115 is most likely associated with non-acid forming material (overburden and/or in-situ rock) and low surface water recharge and no specific investigation is recommended at this time.

The long-term sulphate values for impact bores range from 20 mg/L to 140 mg/L at CP116 and 276 (November 2018) to 315 in November 2019 at GW01. While the results at GW01 for November 2019 were above the historical maximum (based on a sample size of two), it was below the sulphate trigger level.

Hardness

The hardness levels in the impact bores during the report period are below the trigger level, with the exception being the November 2019 result for CP115, as shown in Table 6.14. 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 6.14 Impact bores hardness levels and triggers

Bore	Hardness (mg/L) Trigger Level	May 2019 Hardness Level (mg/L)	November 2019 Hardness Level (mg/L)	Complied with Trigger Level?
CP116	Upper limit 210	135	176	Yes
CP115	Upper limit 376	349	399	No
GW01	Total Alkalinity Upper limit 100 mg of $CaCO_3$	No sample required*	356	No

*GW01 is sampled annually

The long-term trend in hardness values for the reference bores is mixed, as shown graphically in **Appendix 3**:

- LD001 shows little change throughout, with a slight increase in November 2019 to 56mg/L, which was above previous maximum by 3 mg/L.
- CP114 shows small variability around 100mg/L before a result of 350mg/L in December 2017. Monitoring results in 2019 have returned to levels that are typical of the pre the December 2017 spike.
- CP131 was dry during November 2019, which is consistent with previous monitoring events during 2017 and 2018.
- CP132 initially was consistent around a level of 150 mg/L (April 14 to Nov 15), before spiking at 200 mg/L on November 2016 and declining to 50 mg/L in December 2017. Results increased to 210 mg/L in November 2018. The result in November 2019 of 213mg/L is slightly above the historical maximum of 210 mg/L. Monitoring will continue to be undertaken at this bore.

The impact bores also show different long-term trends in hardness as shown in **Appendix 4**:

- CP 116 has declined from an initial level of 210 before stabilising in April 2014 around a level of 100-125mg/L and has increased during 2018 (135mg/L) and 2019 monitoring (176mg/L). Monitoring will continue to be undertaken at this bore to monitor hardness.
- CP115 shows an overall increasing trend, from 210 mg/L in February 2011, increasing to a range of 350-387 mg/L and peaking in December 2017. During 2018, CP115 decreased in hardness to 338 mg/L in November, before spiking again to 399mg/L in November 2019 which is slightly above the historical maximum. Monitoring will continue to be undertaken at this bore to monitor hardness.
- GW01 increased from 329 mg/L in November 2018 to 356 mg/L in November 2019, which was above the trigger levels and above the historical maximum (based on a sample size of two).

Given the restricted baseline dataset, the values for pH and hardness at GW01, sulphate and hardness at CP115 were possibly within the range of likely expected values for the bore and are not necessarily indicative of groundwater impact. An analysis of water licences in the region 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.

Re-Sampling of CP115 and GW01 will be undertaken in 2020 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.

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

Nitrate

Results for 2019 monitoring together with the long-term trends show that both impact and reference bores have very low levels of nitrate. The levels of nitrate are typically less than the laboratory detection limit (shown graphically at **Appendix 3**).

Metals

Results of monitoring undertaken during 2019 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 metal results obtained during 2019 and trends in data is therefore limited. It is noted that in recent years bores CP115, CP116 and CP 132 have been monitored every 6 months, with the remaining bores monitored annually during November. Results are discussed below:

- Monitored every 6 months:
    - Impact bore CP115 –The November 2019 manganese concentration was above the historical maximum. Monitoring of Iron levels recorded a spike in May 2019 before dropping to a new minimum November 2019. The remaining metal analytes (Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Molybdenum, Nickel, Selenium, Zinc and Mercury) levels recorded in May and November 2019 were within the range of previous results. Insufficient data is available to set meaningful trigger levels metals at this stage, based on ANZECC guidelines.
    - Impact bore CP116 – Monitoring undertaken during 2019 recorded metals concentrations for manganese and zinc above the historical maximum levels. The iron level recorded in November 2019 was below the previous historical minimum. These trends will continue to be monitored during 2020. 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. The remaining metal analytes (Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Molybdenum, Nickel, Selenium, Zinc and Mercury) levels recorded in May and November 2019 were within the range of previous results.

Reference bore CP132 – No sample was required during May 2019, as sampling was required for selected bores and parameters only. In November 2019, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Molybdenum Selenium and Mercury all returned results that were below the limit of detection. Nickel, zinc and manganese showed an increase in November 2019 which was above the previous historical maximum, while Iron levels recorded in November 2019 were significantly below the previous range. These trends will continue to be monitored during 2020.

- Monitored Annually:

  Impact bore GW01 – No sample was required during May 2019 as sampling was required for selected bores and parameters only. In November 2019, Aluminium, Arsenic, Chromium, Copper, Lead, Molybdenum, Selenium and Mercury all returned results that were below the limit of detection. With

the exception of Iron and Zinc, the remaining metal analytes (Cadmium, Manganese and Nickel) had levels recorded in 2019 which were within the range of previous results (Note values for manganese and nickel were in excess of the 95% ANZG freshwater protection criteria. Both Iron and Zinc levels showed an increase in December 2017, decreasing in November 2018 before increasing to levels in 2019 which were above the historical maximum levels. These trends will continue to be monitored during 2020. As monitoring of GW01 only commenced in December 2017, it is difficult to determine whether these results are within historical range of expected results as the dataset is limited.

- Reference bore LD001 – During November 2019, Aluminium, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Molybdenum, Selenium and Mercury all returned results which were below the limit of detection. Manganese and zinc had levels recorded which were within the historical maximum, while results for Copper and Nickel were below the previous historical minimums. These trends will continue to be monitored during 2020.
- Reference bore CP114 – Results of monitoring completed during November 2019 for Arsenic, Cadmium, Chromium, Molybdenum, Selenium and Mercury were below the limit of detection. Results for Aluminium and Manganese were above the previous historical maximum. These trends will continue to be monitored during 2020. The remaining analytes (Iron, Copper Nickel, Lead and Zinc) were 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. 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, however the CVM groundwater triggers will be reviewed considering the additional data now available, with any update included in the MOP and revised Water Management Plan during 2020. The

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 details mitigation measures and monitoring procedures for noise management. There were no mining operations during the report 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 6.15 and Table 6.16 summarises the criteria across the Development Approval and EPL 10341.

Table 6.15 Noise criteria in DA 200-5-2003

Location	Day – L_{Aeq} (15 minute) (dB)	Evening – L_{Aeq} (15 minute) (dB)	Night – L_{Aeq} (15 minute) (dB)	Night - L_{A1} (1 minute) (dB)
Red Springs (east of rail line)	37	35	35	45
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

Table 6.16 Noise criteria in EPL 10341

Location	Day – L_{Aeq} (15 minute) (dB)	Evening – L_{Aeq} (15 minute) (dB)	Night – L_{Aeq} (15 minute) (dB)	Night - L_{A1} (1 minute) (dB)
Red Springs (east of rail line)	35	35	35	45
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	40	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 criteria during the report period as shown in Table 6.17. On all monitoring occasions, the noise from CVM was inaudible. There were no complaints received regarding noise during the reporting period.

Table 6.17 2019 Quarterly noise monitoring results

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

IA – noise from CVM was inaudible

6.5.4 Trends in data

The quarterly noise monitoring results for the period 2011 – 2019 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

The 2019 Biodiversity Monitoring was undertaken in accordance with the approved CVM Environmental Monitoring Program (Coalpac, 2009), and the CVM Flora and Fauna Management Plan (Coalpac, 2012a). Biodiversity monitoring commenced at CVM in 2012 (Kleinfelder, 2011-2015) and has been undertaken by Umwelt since 2016 (refer to **Figure 6.2**).

Existing vegetation communities and fauna habitat have been previously characterised during the Ecological Impact Assessment (Cumberland Ecology, 2014). Ongoing monitoring aims to document the condition of vegetation and habitats throughout the CVM Compensatory Habitat Areas and Rehabilitation Zones.

As noted in **Section 3.1**, CVM submitted a revised Flora and Fauna Management Plan (Umwelt, 2017) to DPE during 2017 however consultation is required to be undertaken with OEH prior to DPE review of the plan. This is expected to occur in 2020.

The CVM CHA contains eight monitoring plots located across following three vegetation types:

- Tablelands Dry Woodland – CH1, CH2, CH3, CH5, CH6 and CH8
- Sandstone Dry Ridgetop Woodland – CH7
- Tablelands Sheltered Valley Forest – CH4

The Cullen Valley Rehabilitation Zones contains 15 monitoring plots located across nine rehabilitation areas defined by year:

- 2002 – plot FP5
- 2003 – plots R7, R8, FP9, FP22 and FP10
- 2004 – plot FP10 and FP11
- 2005 – plot FP6
- 2006 – plot 2006NE
- 2009 – plot R5
- 2010 – plot R4
- 2012 – plots R1 and R3
- 2014 – plot 2014NE

6.6.2 Monitoring Methodology

The 2019 biodiversity monitoring was undertaken at the CVM CHA and Rehabilitation Zone monitoring sites 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 Zones in 2019 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).

An assessment of compliance against the relevant biodiversity and rehabilitation performance and completion criteria for CVM is summarised in **Table 8.2**.

6.6.3 Environmental outcomes/trends in data

6.6.3.1 Environmental conditions

Prior to monitoring in 2019 a period of low rainfall was experienced (i.e. between April and December the monthly rainfall totals ranged from 0.8mm to 38.6mm). Drought conditions, varying from intense drought to drought affected (weakening) have generally been recorded at Cullen Bullen by DPI since July 2017 (DPI 2020) (Plate 6.1). The total annual rainfall recorded at Lidsdale (approximately 10km south east of CVM) in 2019 was 455 mm, which is approximately 60% of the average annual rainfall recorded over the last 60 years (738 mm) (BOM 2020b).

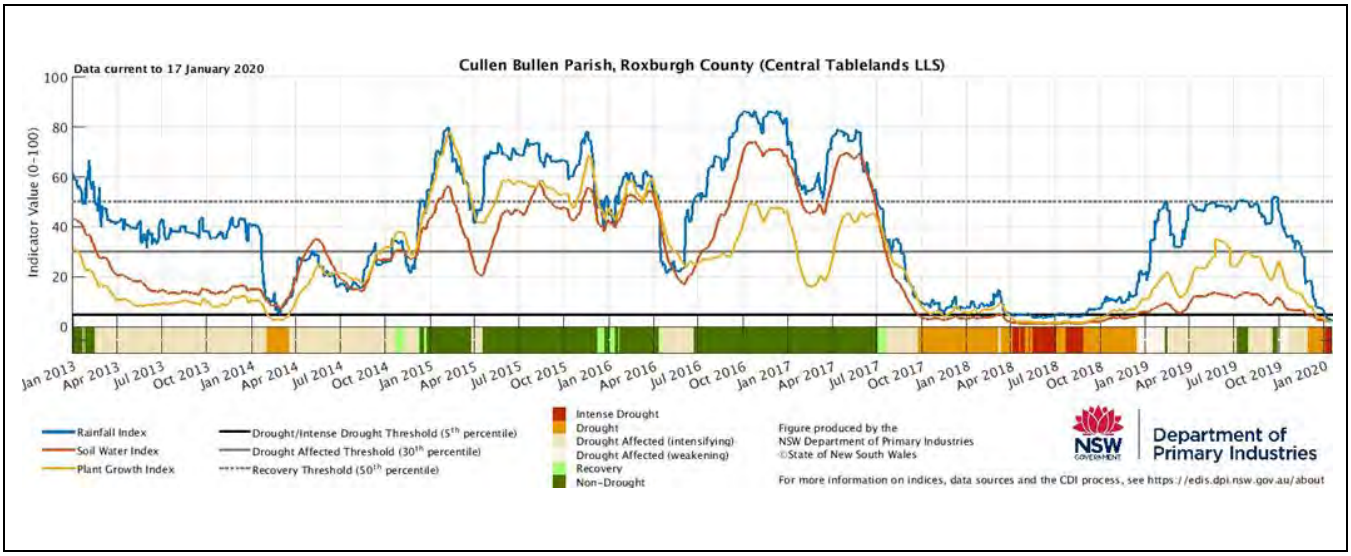


Plate 6.1 Seasonal environmental conditions recorded at Cullen Bullen

6.6.3.2 CVM compensatory habitat areas

The CVM CHA consists of three vegetation communities, being Tablelands Dry Woodland, Tablelands Sheltered Valley Forest and the Sandstone Ridgetop Woodland. Native vegetation within the CHA was considered to be in moderate condition across all woodland and forest habitats however it was found to be affected by extended drought conditions. Monitoring in 2019 recorded a decrease in the overall floristic composition and vegetation condition for most CHA monitoring locations compared to monitoring in 2018. Woodland and forest habitats demonstrated a moderate decrease in the vegetative cover throughout all stratums (refer Plate 6.2). Moderate die back was observed throughout the canopy while the midstory was generally sparse and demonstrated severe dieback for those species persisting. In 2019 bare earth was more commonly observed across all CHA monitoring locations. Where ground layer vegetation was present a decrease in native species diversity was observed, compared to 2018. Herbivory was frequently observed for native forbs and grasses persisting in woodland and forest habitats. The vegetation of the CHA demonstrates minimal degradation due to human influences with the exception of vehicle tracks, minor logging and rubbish dumping by others. Given the above no flora management activities are recommended.

Plate 6.2 Condition of CHA monitoring location CH6 (Left – 2018; Right - 2019)

The CHA provides habitat for a range of fauna groups including amphibians, birds, reptiles, as well as arboreal and ground dwelling mammals and marsupials. While the vegetation condition has declined from that recorded in 2018, the CHA continues to provide a number of stable habitats for fauna including woody debris, hollow bearing trees, fallen timber, escarpment and large rocky outcrops. Other habitats previously recorded, such as permanent water sources and patches of dense leaf litter appeared to be in decline since monitoring was last undertaken in 2018. Dams which contained water in 2018 were found dry or reduced to shallow puddles in 2019. These water sources are important for a range of fauna including frogs, microbats, mammals and birds especially in periods of drought. Dams provide water for drinking, as well as a range of micro habitats for amphibians and foraging habitat for insectivores such as microbats and birds.

Monitoring in 2019 recorded a decline in overall species diversity throughout the CHA with a total of 55 fauna species recorded compared to 69 species recorded during monitoring in 2018. Approximately 65% of the fauna diversity is represented by birds with 35 species recorded across all CHA monitoring sites. The remaining 20 fauna species recorded during 2019 monitoring consist 18 mammal species, one reptile species and one frog species. While most fauna groups experienced a decline in the species diversity, the number of mammal species detected during monitoring increased from 11 species in 2018. Microbat monitoring in 2019 consisted of site stratification to decrease the number of sample sites and increase the detection period of the Anabat ultrasonic recording device from one hour to an entire night of recording. A total of 10 microbat species were confidently identified in 2019 based on call analysis compared to two species recorded during monitoring in 2018. The availability of diverse habitats structures, the proximity of the CHA to Ben Bullen State Forest and rural areas, is the likely reason that the CHA retains reasonably high degree of fauna species diversity and the occurrence of threatened species during severe environmental conditions.

A total of five threatened species were recorded in the CHA at Cullen Valley Mine during 2019, including:

- powerful owl (*Ninox strenua*) listed as vulnerable under the Biodiversity Conservation Act 2016 (BC Act)
- squirrel glider (*Petaurus norfolcensis*) listed as vulnerable under the BC Act
- eastern freetail-bat (*Mormopterus ridei*) listed as vulnerable under the BC Act
- greater glider (*Petauroides volans*) listed as vulnerable under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (refer to Plate x)
- large-eared pied bat (*Chalinolobus dwyeri*) listed as vulnerable under the BC Act and EPBC Act.

All species have been recorded in previous surveys.

Plate 6.3 A greater glider foraging near CHA monitoring site CH7

6.6.3.3 Rehabilitation zones

The Cullen Valley Rehabilitation Zones are identified by the year each zone was established: being 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2012 and 2014.

Monitoring in 2019 recorded a severe decline of vegetative cover throughout the middle and upper stratums across all rehabilitation ages (refer to Plate 6.4). Shrubs and young trees establishing in these stratums frequently displayed foliage loss as a result of die back. Ground layer vegetation demonstrated similar declines, where native forbs were generally absent from many monitoring locations and native grasses exhibited severe die off. In contrast to this, six monitoring sites (located in rehabilitation years 2002, 2003, 2005, 2006, and 2014) were found to maintain moderate to good grass cover. Extended drought conditions were considered to be a leading contributor to this deterioration and further evidence will be drawn from future monitoring events.

Plate 6.4 Condition of CVM Rehabilitation Monitoring Location FP6 (Left – 2018; Right – 2019)

In 2019 evidence of improved ecosystem functionality and developing habitat features of was found in most rehabilitation areas. This has assisted with maintaining the midstory and canopy species as they establish and assisted to develop landscape function. Salvaged woody debris was commonly recorded in younger areas of rehabilitation, however the production of leaf litter and woody debris as a natural process was limited.

Characteristics of ecosystem function, such as the natural accumulation of leaf litter and woody debris were evident in older rehabilitations areas as they continue to progress towards a self-sustaining ecosystem. The production of woody debris through acacia senescence, deterioration of existing woody debris, and the presence of detritivores (such as wood roaches and weevils) were also recorded during 2019. Ants were observed opportunistically throughout most rehabilitation zones and are important for topsoil development, as well as facilitating the transfer of water, oxygen and nutrients within the soil profile. The presence of trees and shrubs bearing seed, and successional acacia saplings in proximity to those individuals recently senesced, indicates how these areas are progressing toward a self-sustaining condition.

Monitoring in 2019 recorded a total of 54 fauna species, comprising 34 bird species, 17 mammal species, and three reptile species. This represents a decline in total fauna species diversity compared to monitoring in 2018 (60 species) and 2017 (70 species). The same methods for monitoring microbats was undertaken in both the CHA and rehabilitation areas in 2019 where the number of sites were stratified based on the rehabilitation establishment year. A total of nine microbat species were confidently identified in 2019 based on call analysis compared to two species recorded during monitoring in 2018.

Fauna species diversity of rehabilitation areas was considered to be influenced by age and structure of rehabilitation areas, as well as the declining condition of surrounding remnant habitats including the CHA and Ben Bullen State Forest as a result of drought conditions. This was evident during 2019 monitoring where the CVM rehabilitation areas were found to support a similar fauna species diversity as the CHA with a total of 55 fauna species detected (refer to **Section 6.6.3.2**). This is particularly the case for highly mobile fauna such as birds, microbats and arboreal mammals that move between habitat patches while foraging. Tall acacias were observed flowering sporadically throughout southern rehabilitation zones beyond the confines of monitoring plots. In a landscape context these rehabilitation areas provide important food resources for nectarivorous fauna (birds and arboreal mammals in particular) during drought conditions, while adjacent remnant vegetation was largely devoid of flowering material at the time of monitoring. This was particularly evident where a total of 17 sugar gliders (*Petaurus breviceps*), four common brushtail possum (*Trichosurus vulpecula*), and three common ring tail possums (*Pseudocheirus peregrinus*) were recorded within a 200 m radius of monitoring location 2014NE.

Compensatory habitat features such as nest boxes provide an artificial substitute for species including a variety of gliders, birds and microbats, which have consistently use the boxes based on monitoring undertaken 2016 – 2018. Monitoring in 2019 recorded one sugar glider (*Petaurus breviceps*) in a nest box located south rehabilitation monitoring location FP11 (see Plate 6.5).

Plate 6.5 Sugar glider recorded in a nest box during monitoring

A total of two threatened species were recorded in the rehabilitation zones at CVM during monitoring in 2019. These were the large-eared pied bat (*Chalinolobus dwyeri*) listed as vulnerable under the BC Act and the EPBC Act, and greater broad-nosed bat (*Scoteanax rueppellii*) listed as vulnerable under the BC Act. 2019 represents the first time that greater broad-nosed bat was recorded by the biodiversity monitoring program, all other species have been recorded previously.

6.6.3.4 Clandulla geebung monitoring

In 2019 a total of 88 Clandulla geebung (*Persoonia marginate*) plants were recorded within the monitoring site. This demonstrates a slight population decrease since monitoring was undertaken in 2018 (94 plants) and 2017 (100 plants). Of the 88 plants identified in 2019, 24 individuals were recorded bearing fruit, while no individuals were identified with bud or flower. These observations indicate that this population is healthy and reproducing despite the prevailing drought conditions. Overall, there was 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

Monitoring of rehabilitation and compensatory habitat areas will continue in 2020.

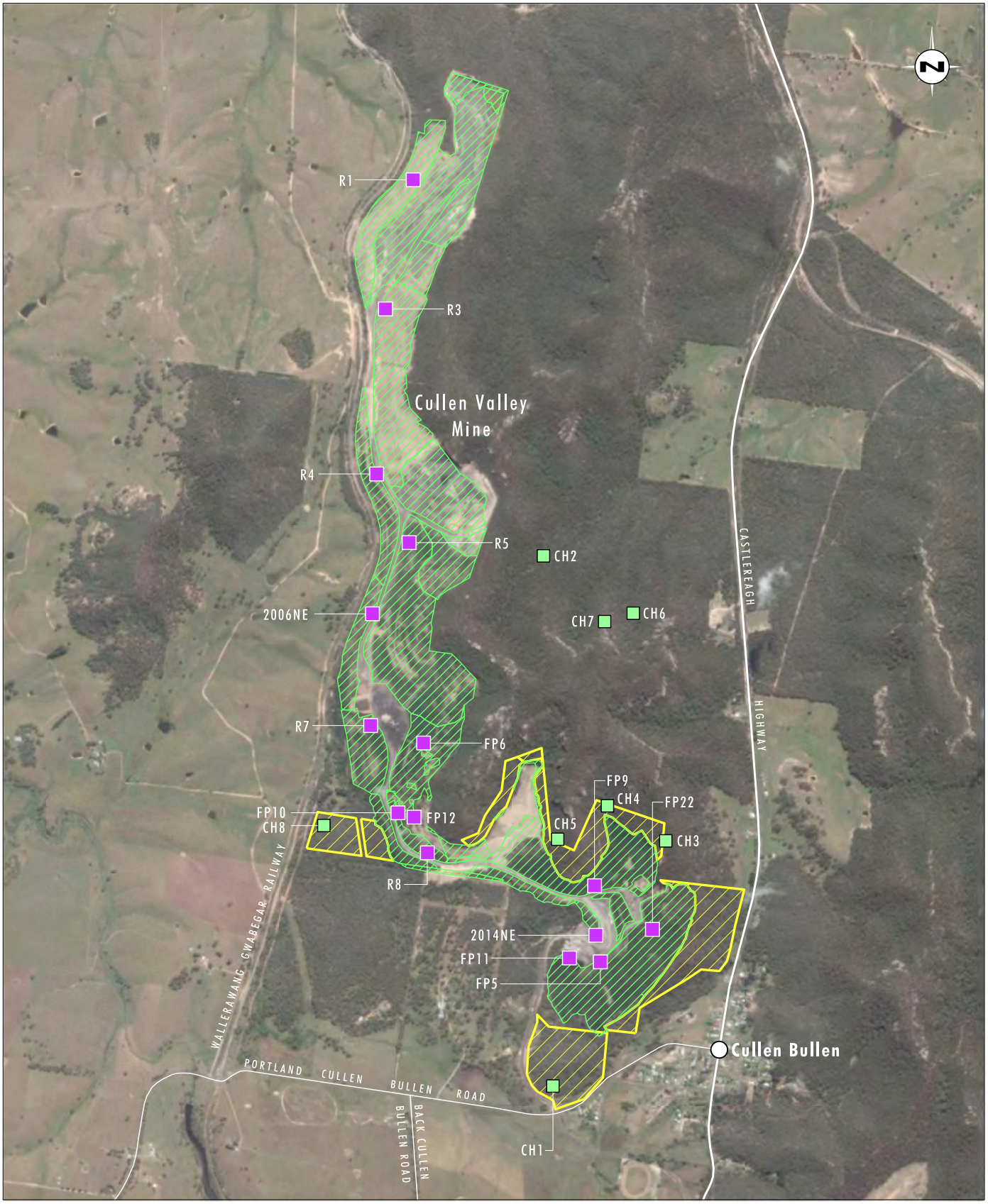


Image Source: Google Earth (MAR 2015)
Data Source: Kleinfelder (2017)

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Legend

- Compensatory Habitat Area
- Rehabilitation Zones
- Rehabilitation Monitoring Sites
- Compensatory Habitat Monitoring Sites

FIGURE 6.3

Cullen Valley
Environmental Monitoring Sites

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6.7 Weeds and feral animals

6.7.1 Weeds

In 2019 both the CVM Rehabilitation Areas and CHA demonstrated a minor decrease in the presence of weeds. This is consistent with observations of general habitat and vegetation health decline where the total vegetation cover found to decrease compared to monitoring undertaken in 2018. Monitoring results indicated that the weeds within the CVM Rehabilitation Areas and CHA generally occur in very low abundance. Those weeds present were typically cosmopolitan weed species such as catsear (*Hypochaeris radicata*), St John's wort (*Hypericum perforatum*), and fireweed (*Senecio madagascarensis*).

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 CVM Rehabilitation Zones have been established for up to 18 years (2002). Small fluctuations are common when monitoring the presence and management of weeds and generally vary in response to a range of natural variables such as rainfall and drought. The likelihood of exotic species further colonising throughout Rehabilitation Areas is low, given the soil structure, absence of topsoil, and the density of tree and shrub species established in the rehabilitation zone. Given the cover and abundance of weeds no management intervention is required at this time.

6.7.2 Feral animals

6.7.2.1 Compensatory habitat area

Two introduced species were observed within the CHA during 2019, being one fox (*Vulpes vulpes*) near CH1 and one feral cat (*Felis catus*) near CH6. No management intervention is required at this time.

6.7.2.2 Rehabilitation area

One introduced species, the brown hare (*Lepus capensis*), was recorded near FP11 monitoring site during 2019. This species was recorded during previous monitoring along with Red fox (*Vulpes Vulpes*) and rabbit (*Oryctolagus cuniculus*). Feral animal management intervention is not recommended at this time.

6.8 Erosion and sediment control

6.8.1 Environmental management measures

The objective of the CVM water management system is to separate clean water and dirty/mine water. Erosion and sediment control focus on the management of 'dirty' water which is runoff from disturbed areas. The erosion and sediment controls (ESC's) established during mining remains in place whilst the operation is under care and maintenance. These ESC's include dirty water sediment dams, open drainage channels with established vegetation and/or rock armouring and drop structures where required.

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

Visual inspections of the water management system and erosion and sediment controls are monitored by the mine manager with repairs undertaken on an as needs basis.

6.8.4 Trends in data and proposed improvements

Visual inspections of the water management system and erosion and sediments controls indicate that both are operating as intended.

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 30 January 2013) and the 2011 to 2015 CVM Care and Maintenance (C&M) MOP. During the report period, CVM sought an extension to the CVM C&M MOP (Sedgman, 2015) to extend the duration of the MOP. DRG approved the extension on 29 November 2018 with the MOP now approved until 30 June 2020.

Subsurface heating at CVM has been observed in five main areas being area R1, F1, F2, F3 and F4 (refer to Figure 6.4). The active extent of the subsurface heating has been mapped for applicable years (see Figure 6.4).

Mapping of the extent of subsurface heating has occurred since 2016. Previously only hot spots were mapped. In regard to the physical extent of heating areas as shown on Figure 6.4 it is important to note the following:

- 2015 – showed only hot spots at Area R1
- 2016 – showed the area impacted by sub-surface heating, noting that the area was not necessarily showing active signs of heating at that point in time (i.e. the presence of active subsurface heating smell, smoke and /or surface cracking)
- 2017 (revised mapping methodology commenced) – areas shown are those which showed signs of active heating (i.e. temperature, sulphurous smell, smoke, discoloration of the ground, vegetation die back or stress and /or surface cracking). These areas were observed in F1, F2, F3, R1 and a new area F4)
- 2018 – Areas shown are those showing signs of active heating. During the 2018 report period, area F4 was also cleared of vegetation, excavated and compacted as a treatment measure.
- 2019 – Areas shown are those showing signs of active heating. During the report period, area F3 was cleared of vegetation, excavated and compacted as a treatment measure.

Table 6.18 shows the area subject to active heating at the time of monitoring.

Table 6.18 Summary of subsurface heating impact extent (2016 - 2019)

Subsurface Heating Area Name	Area of active subsurface heating(ha)			2019 Comment
	2017	2018	2019	
F1	0.26	0.03	0.78*	Active heating observed, with an increase to the area impacted extending to the south east in 2019; Site F1 merged with Site F4.
F2	0.28	0	0.76	Active heating observed, with an increase to the area impacted extending upslope and along the contour.
F3	0.07	0.19	0.13	Active heating observed with the area impacted consistent with previous mapped extent. The 2019 area mapped was cleared of vegetation during report period as part of management activities
F4	0.1	0	0.78*	Active heating observed with an increase to the area impacted extending along the contour; Site F4 merged with Site F1.
R1	0.05	0.46	0.46	Active heating observed, with a small increase to the area impacted extending to the south and north-east in 2019 which is outside the previous mapped extent.

**Subsurface heating areas F1 and F4 combined – total area of patch displayed in brackets*
*Note: **Section 6.9** explains how these mapping areas have been calculated.*

Active subsurface heating was recorded across all existing management areas. The 2019 extent of active subsurface heating in:

- Area F1 extends outside of the previously mapped footprints and has joined with Area F4 and was typically not observed in the previously mapped footprints of F1 and to a lesser extent F4.
- Area F2 includes and extends outside of the 2017 mapped footprint.
- Area F3 is generally consistent with the previous mapped footprint.
- Area R1 has had a small increase to the southeast outside the previous mapped footprints and largely remains in the previously mapped footprint.

Regenerating vegetation was recorded at two areas impacted by sub-surface heating in 2019, being Site F4 and Site R1. New growth and saplings of eucalyptus and acacia species were observed encroaching the cleared area of R4 treated in 2018. Coppice growth (i.e. regrowth shoot on the tree trunk) was evident on taller established eucalyptus trees in the southern portion of R4. Continued growth of existing established vegetation and natural regeneration was evident throughout areas fringing the north-west and east of Site R1. These areas of Site R1 previously experienced severe die back such that the ground surface is covered by moderately-dense wood debris from fallen Acacia and Eucalypts. Subsequent monitoring surveys will provide further information regarding how rehabilitation responds subsurface heating impacts.

CVM continues to observe variation in the level of vegetation regeneration and erosion issues where different subsurface treatment techniques have been implemented. Where aggressive subsurface management measure are applied erosion issues are more prevalent and natural regeneration of

vegetation is slower when compared to areas where targeted remediation works have been undertaken. This is difference is believed to be due to the presence of woody debris and seed back in the soil in areas where targeted remediation works have been undertaken. Recording of this information will inform what treatment techniques will be implemented in the future. The ongoing management of these areas will be undertaken with the management measures as detailed in the CVM C&M MOP (Sedgman, 2015).

6.9.1 Environmental management measures

The management measures to monitor and treat sub surface heating are detailed in the CVM Care and Maintenance MOP (Sedgman, 2015) and include:

- weekly monitoring of heating areas (temperature / heat gun, sulphurous smell, smoke, discoloration of the ground, vegetation dieback or stress and /or surface cracking)
- capping of surface cracking using cement
- excavation and compaction of material as required.

6.9.2 Environmental outcomes and further improvements

During 2019, minor repair works (i.e. localised earthworks – excavation of cracks and backfilling with inert material and compacting and filling cracks with concrete) was undertaken in subsurface heating areas with the exception of Area F3.

During 2020 CVM will continue to monitor for subsurface heating and will engage a subsurface heating expert to advise on the treatment measures to be applied at all active subsurface heating areas.

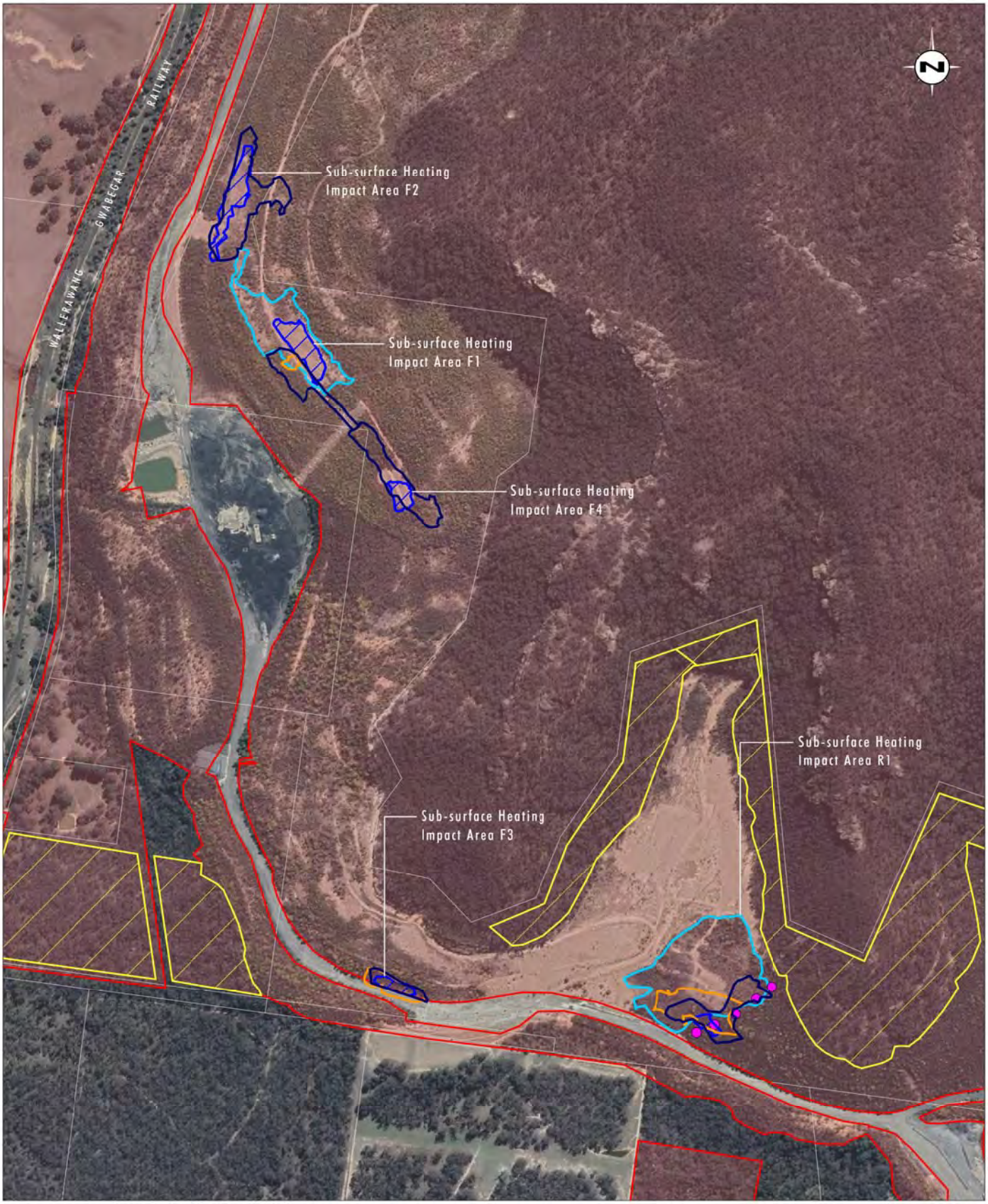

Image Source: Google Earth (Sep 2018)
Data Source: Kleinfelder (2017)

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Legend

- Study Area
- Compensatory Habitat Area
- Active Subsurface Heating Areas 2019
- Active Subsurface Heating Areas 2018
- Active Subsurface Heating Areas 2017
- Sub-surface Heating Impact Areas 2016
- Sub-surface Heating Impact Area - SE Boundary (Kleinfelder 2015)

FIGURE 6.4

Sub-surface Heating Impact Areas
Cullen Valley Mine Area

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6.10 Blasting

There was no blasting conducted at CVM during the report 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 are directed to a septic system which is pumped out by a licensed waste collection and disposal contractor on an as-needs basis.

During the report 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 report period.

6.14 Greenhouse gas emissions

As the site was in care and maintenance during the report period, greenhouse gas emissions were minimal. Emissions are limited to a small fleet of vehicles/equipment which are utilised for care and maintenance works as well as minor works undertaken to handle VENM / ENM received on site. 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. NGERs reporting was undertaken during the 2019 report period.

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
- 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 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.

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

Licence and water take information is summarised in Table 7.1. During the report period, there was 2.5 ML extracted from Tyllies Bore.

Table 7.1 Water take during 2019 reporting period

Water Licence No.	Water sharing plan, source and management zone (as applicable)	Entitlement	Passive take / inflows	Active Pumping	Total (ML)
80WA706148	Sydney Basin MDB Groundwater Source Water Sharing Plan – NSW Murray Darling Basin porous rock groundwater sources	80 units	2.5 ML from Tyllies Bore (GW01)	0	2.5

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. As noted in **Section 6.8.3** and **Section 6.9**, rehabilitation works undertaken during the report period largely included works to treat subsurface heating.

There was no tree planting or tree seeding undertaken during the report period. An assessment of the status of the existing CVM rehabilitation against the performance indicators and completion criteria as detailed within the CVM CM MOP (Sedgman, 2015) is detailed in **Section 8.3**.

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

Table 8.1 CVM rehabilitation status

Mine Area Type	Previous reporting period (actual) 2018 (ha)	This reporting period (actual) 2019 (ha)	Next reporting period (forecast) 2020 (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 have 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. 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 2019 biodiversity monitoring program have been compared against the objectives as defined in the CVM C&M MOP (Sedgman, 2015). Monitoring undertaken during 2019 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.

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 removal of buildings or other infrastructure and no new rehabilitation areas were established during the 2019 report period as the mine is currently in care and maintenance. Subsurface heating treatment is discussed in **Section 6.9**.

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

Domain Objectives	Performance indicators	Completion criteria	2019 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
	Plant health	More than 75% of trees are healthy and growing as indicated by monitoring.	Progressing towards satisfactory completion All Invincible Rehabilitation Areas demonstrated a decline in tree health (die back) due to extended drought conditions. While less than 75% of persisting trees were considered to be healthy, it is considered that their condition will likely return when drought conditions ease.
	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. No weed management works are 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 2019 monitoring report.

Domain Objectives	Performance indicators	Completion criteria	2019 Status Against Completion Criteria
	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 naturally forming habitats provided by the surrounding un-mined forests and woodlands. Rehabilitation Areas rely on habitat features established during the establishment phase of rehabilitation (such as woody debris, log piles etc.). The Rehabilitated Areas are progressing towards the pre-existing or surrounding landforms. 2019 monitoring demonstrated that rehabilitation areas provided an important supplementary food source compared to remnant habitats affected by drought.
	Presence of fauna species	Vertebrate surveys demonstrate that bird, mammal, reptile and frog communities are becoming established in rehabilitated sites.	Progressing towards satisfactory completion. A decrease in fauna species diversity was recorded in 2019 compared to previous monitoring. This likely has occurred as a result of declining habitat condition during extended drought. Fauna survey results suggest that rehabilitation habitats are not yet able to permanently support animal populations (nesting and refuge habitat), however flowering acacia species provide important food resources for nectivorous fauna during drought. Further evidence will be drawn from future monitoring events as drought conditions ease, habitat corridors continue to establish, and permanent habitat features become more frequent.
	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.

Domain Objectives	Performance indicators	Completion criteria	2019 Status Against Completion Criteria
Final rehabilitation areas to achieve rehabilitation completion criteria	Vegetation cover	No bare areas that have obviously failed and are greater than 0.5 ha in total area.	Progressing towards satisfactory completion. All Rehabilitation Areas inspected were considered to meet this criteria milestone in 2019, with exception of areas affected by subsurface heating.
	Tree cover	No treeless areas greater than 0.5 ha are present.	Progressing towards satisfactory completion. No treeless area greater than 0.5 hectares were observed during the 2019 monitoring, with exception of areas affected by subsurface heating.
	Shrub/grass cover	Monitoring and visual estimation show grass or shrub cover to be >50%.	Progressing towards satisfactory completion. 2019 monitoring and visual estimation show grass or shrub cover to be >50% on the Rehabilitation Zones. It is noted that these are mainly exotic cover crop species.
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.	The separation and management of clean and dirty water continued during the report period in accordance with the water management system.
Disturbed landform is graded and shaped to reflect natural landforms and is free-draining.	Sediment and erosion control	Monitoring by the Mining Engineering Manager 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.
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.	The separation and management of clean and dirty water continued during the report period in accordance with the water management system.

Domain Objectives	Performance indicators	Completion criteria	2019 Status Against Completion Criteria
		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.	The separation and management of clean and dirty water continued during the report period in accordance with the water management system.
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	There were no discharge events from LDP 001 and LDP 004 during the 2019 report period.

8.5 Actions for the next reporting period

During 2020, CVM will undertake the following works:

- Submit an updated Mining Operations Plan (MOP) which includes:

Subsurface Heating

A program outlining the tasks and dates to update the Plan of Works for the containment and extinguishing of subsurface heating prepared by a suitably qualified person. This updated Plan of Works is to include:

- A figure showing the extent of all areas affected by subsurface heating.
- Details of the rehabilitation works to be undertaken on all areas affected by subsurface heating. Reporting against the program of works will be via the Annual Review.
- A monitoring program that identifies the locations of subsurface burning coal material and addresses the risk of changes in subsurface temperature on an ongoing basis.
- A subsurface heating Trigger Action Response Plan (TARP), as well as any other potential risks to rehabilitation success.

Surface Water Management

A Surface Water / Erosion Plan of Works which has been prepared by a suitably qualified person. This Plan of Works is to include:

- A figure showing the location of all areas affected surface water erosion.
- Details of the rehabilitation works to be undertaken on all areas affected by surface water erosion.
- Identifies any refinement to the current water management systems, as required.
- Outlines the performance monitoring program for the water management systems.
- Identifies how surface water will be controlled and managed on steep batters and slopes, to prevent and manage gully erosion.
- A surface water management Trigger Action Response Plan (TARP), as well as any other potential risks to rehabilitation success.

Water Management Plan

Confirm the status of the 2017 CVM WMP (Umwelt, 2017), and submit an updated WMP for review by DPIE if needed.

9.0 Community

9.1 CCC meetings

One community consultation meeting was held in the reporting period on 27 November 2019, and therefore did not meet at the required frequency of two meetings per year as specified in the Development Consent.

During the November 2019 meeting, information was presented on environmental monitoring and performance, complaints received, statutory reporting, rehabilitation and land management works undertaken on site.

It was agreed during this meeting that the CCC would meet during 2020 in December only, due to the care and maintenance status of the operations. A CCC meeting could be called, should the status of the operations change.

The outcomes of the CCC meeting is detailed in the meeting minutes available on the Castlereagh Coal website.

9.2 Complaints

In accordance with Condition M5 of the EPL, 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 report period. These were received on 21 June 2019 and 14 August 2019. The complaints were in relation to odour from a subsurface heating area on site. Following the receipt of the complaints, Shoalhaven Coal undertook prompt repair works to manage the subsurface heating odour. A comparison of complaints received between 2011 and 2018 is outlined in Table 9.1 below.

Table 9.1 Comparison of complaints

Complaint Type	2011	2012*	2013	2014	2015	2016	2017	2018	2019
Noise	9	9	1	0	1	0	0	0	0
Air quality	5	5	2	0	1	0	0	0	0
Blasting	3	5	0	0	0	0	0	0	0
Traffic	4	13	0	0	0	0	0	0	0
Water	0	0	0	2	0	0	0	0	0
Subsurface Heating	2	0	0	0	0	4	2	3	2
Other	2	4	2	1	0	0	0	0	0
Total	**25**	**36**	**5**	**3**	**2**	**4**	**2**	**3**	**2**

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

10.0 Audit information

An Independent Environmental Audit (IEA) was conducted during 2016 in accordance with Schedule 6, Condition 6 of the Development 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.

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 Castlereagh 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 is 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, 2019) was not activated during the report period. Non-compliances noted during the report period are detailed in **Section 1.0**.

12.0 Activities to be undertaken in the next reporting period

There are no mining activities proposed at CVM in the next report period (1 Jan 2020 – 31 Dec 2020) as the site is currently managed under a care and maintenance arrangement. During the 2020 report period, Shoalhaven Coal will continue to implement the various approved environmental management plans. During quarter 3 of 2020 the Water Management Plan will be updated to consider the additional groundwater monitoring data obtained in 2019 as part of the groundwater monitoring triggers and outcome of the water management review. During the next reporting period, Shoalhaven Coal will seek an extension of time to the due date of the next IEA, as the mine has remained on care and maintenance since 2016 when the previous audit was undertaken.

During 2020, rehabilitation works will continue to monitor for subsurface heating. In accordance with correspondence received from the NSW Resources Regulator Shoalhaven Coal will have the surface heating Plan or Works and surface water management practices reviewed and updated by a suitably qualified expert. involve further subsurface heating capping works as described in **Section 6.9**. Rehabilitation activities proposed in the 2020 report period are detailed in **Section 8.5**.

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, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017b). Cullen Valley Mine Environmental Noise Monitoring Quarter 2, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017c). Cullen Valley Mine Environmental Noise Monitoring Quarter 3, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017d). Cullen Valley Mine Environmental Noise Monitoring Quarter 4, 2018. 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.

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

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

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

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

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

Umwelt (2019). Cullen Valley Mine & Invincible Colliery Pollution Incident Response Management Plan.

APPENDIX 1

Status of 2016 audit actions

Appendix 1 2019 Annual Review IEA Action Plan Update

Consent Condition	Audit Finding	Compliance identified during audit	Audit Recommendation	Proposed Action and Timing	Status
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. **2018 Annual Review Update** During 2018, Shoalhaven Coal has continued to implement the PoW as detailed in the approved MOP. Subsurface heating management is detailed in Section 6.9 of the Annual Review. **2019 Annual Review Update** During 2019, Shoalhaven Coal has continued to implement the PoW as detailed in the approved MOP. Subsurface heating management is detailed in Section 6.9 of the Annual Review. A further review of subsurface heating management techniques and measures utilised at CVM will be undertaken during the 2020 report period.	Ongoing
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. This monitoring program includes eight survey sites across the compensatory habitat area. A brief	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 the Annual Review. Currently there is little detail in the Annual Review regarding the performance and management of	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. **2018 Annual Review Update** The CVM Flora and Fauna management plan was updated and submitted to DPE for review on 29 June 2017. During 2019, Shoalhaven Coal will liaise with DPE regarding the status of the management plan. **2019 Annual Review Update** During 2019, Shoalhaven Coal undertook biodiversity monitoring which included monitoring within compensatory habitat areas on site. This monitoring will continue in 2020 and Shoalhaven Coal will liaise with DPIE regarding the update of the CVM Flora and Fauna Management Plan.	Ongoing

Consent Condition	Audit Finding	Compliance identified during audit	Audit Recommendation	Proposed Action and Timing	Status
	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 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.		

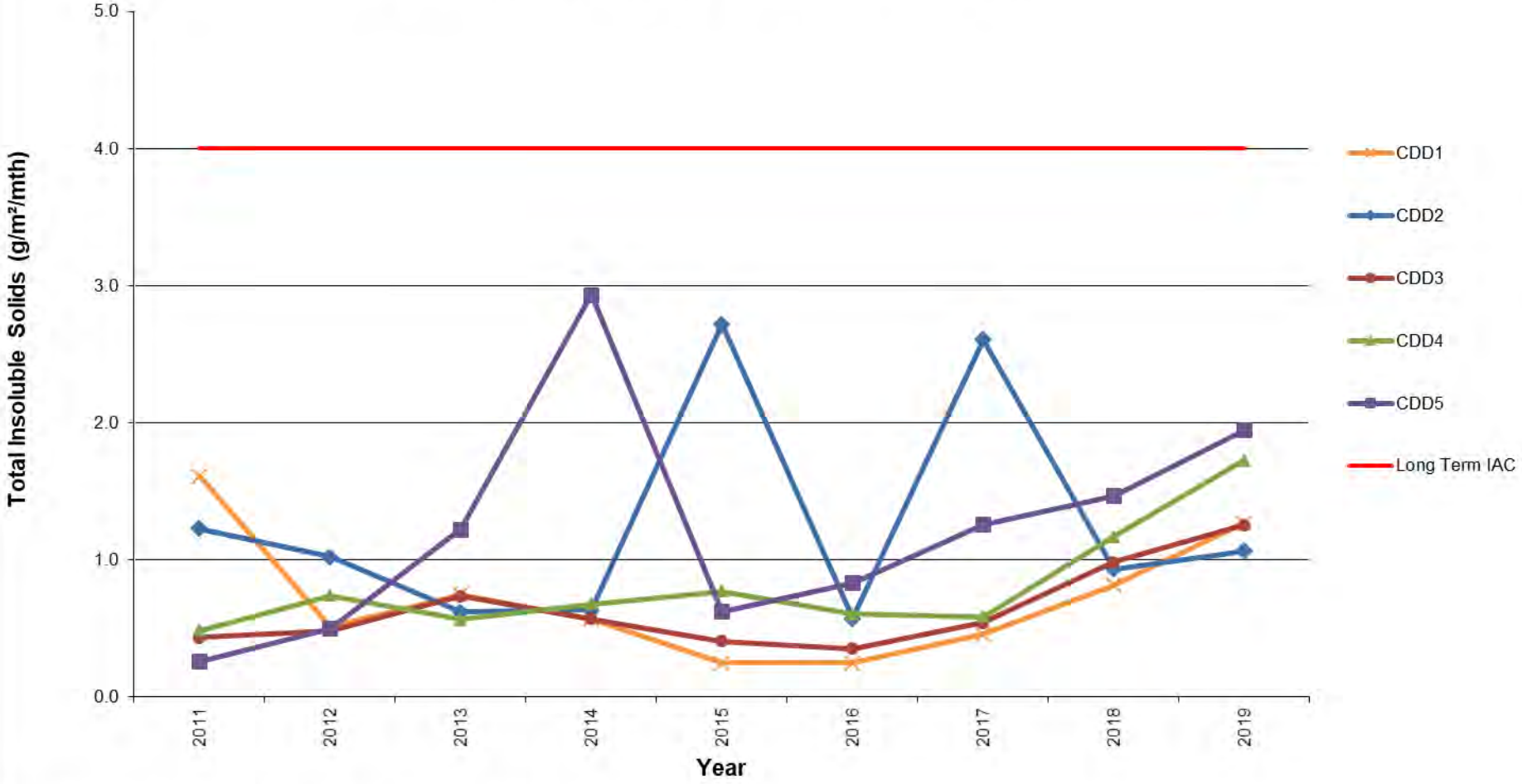
Licence Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing	Status
EPL L6.1	There have been odour complaints in every year of the audit period with relating to the area of sub surface heating. These have been outlined in the AEMR/Annual Reviews. There has been some works 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 **2018 Annual Review Update** Odour complaints have been recorded during the 2018 report period and these complaints are detailed in Section 9 of the Annual Review. Subsurface heating management measures implemented during the report period are consistent with actions identified in the 2017 Annual Review update and are also detailed in Section 6.9 of the Annual Review. **2019 Annual Review Update** Odour complaints have been recorded during the 2019 report period and these complaints are detailed in Section 9 of the Annual Review. Subsurface heating management measures implemented during the report period are consistent with actions identified in the 2017 and 2018 Annual Review update and are also detailed in Section 6.9 of the 2019 Annual Review. A further review of subsurface heating management techniques and measures utilised at CVM will be undertaken during the 2020 report period as detailed in the Annual Review.	Ongoing

EIS Commitments	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing	Status
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). **2018 Annual Review Update** Results of 2018 Biodiversity Monitoring are included in the 2018 Annual Review. **2019 Annual Review Update** Results of 2019 Biodiversity Monitoring are included in the 2019 Annual Review.	Ongoing

APPENDIX 2

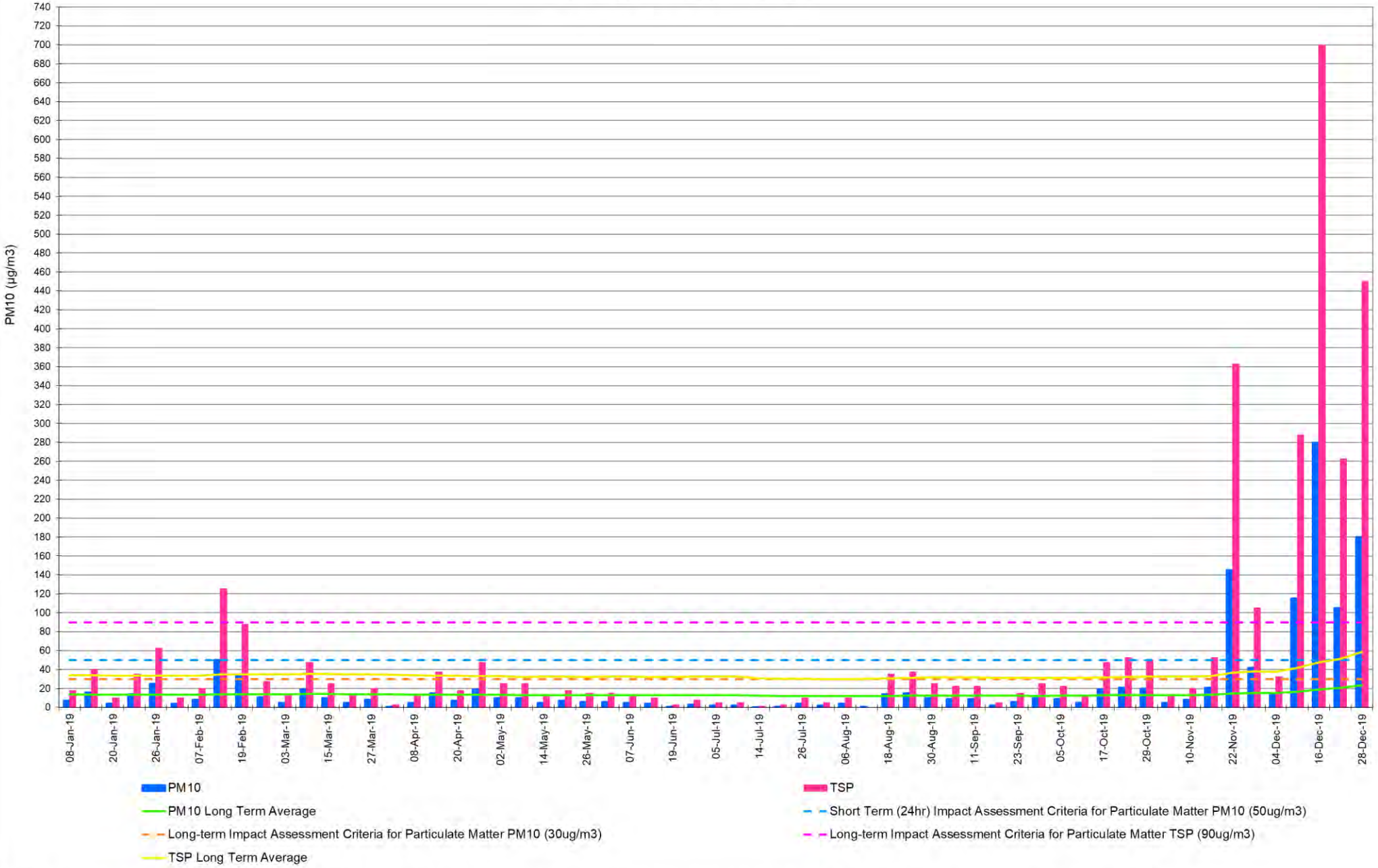
Air quality monitoring graphs

Air Quality - Deposited Matter 2011 to 2019



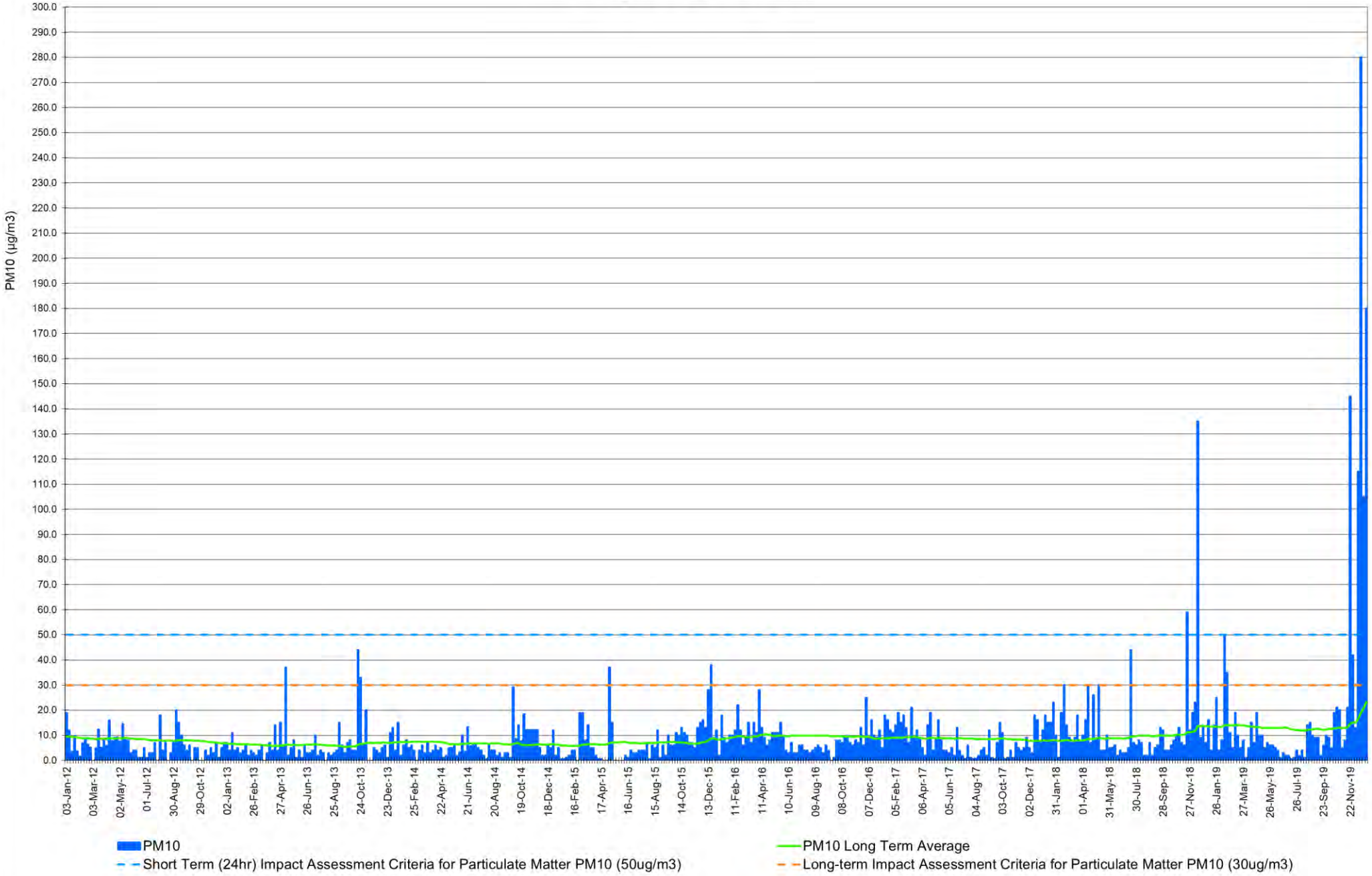
Note: Graph displays annual average total insoluble solids.
Note: Graph includes December 2019 results which were non-compliant with exposure period due to inaccessibility of dust gauges due to bushfire events. For comparative purposes, Annual Averages excluding these results can be found in Table 6.4 of the 2019 Cullen Valley Annual Review.

Cullen Valley Mine
PM10 HVAS Comparative Results
January 2019 to December 2019



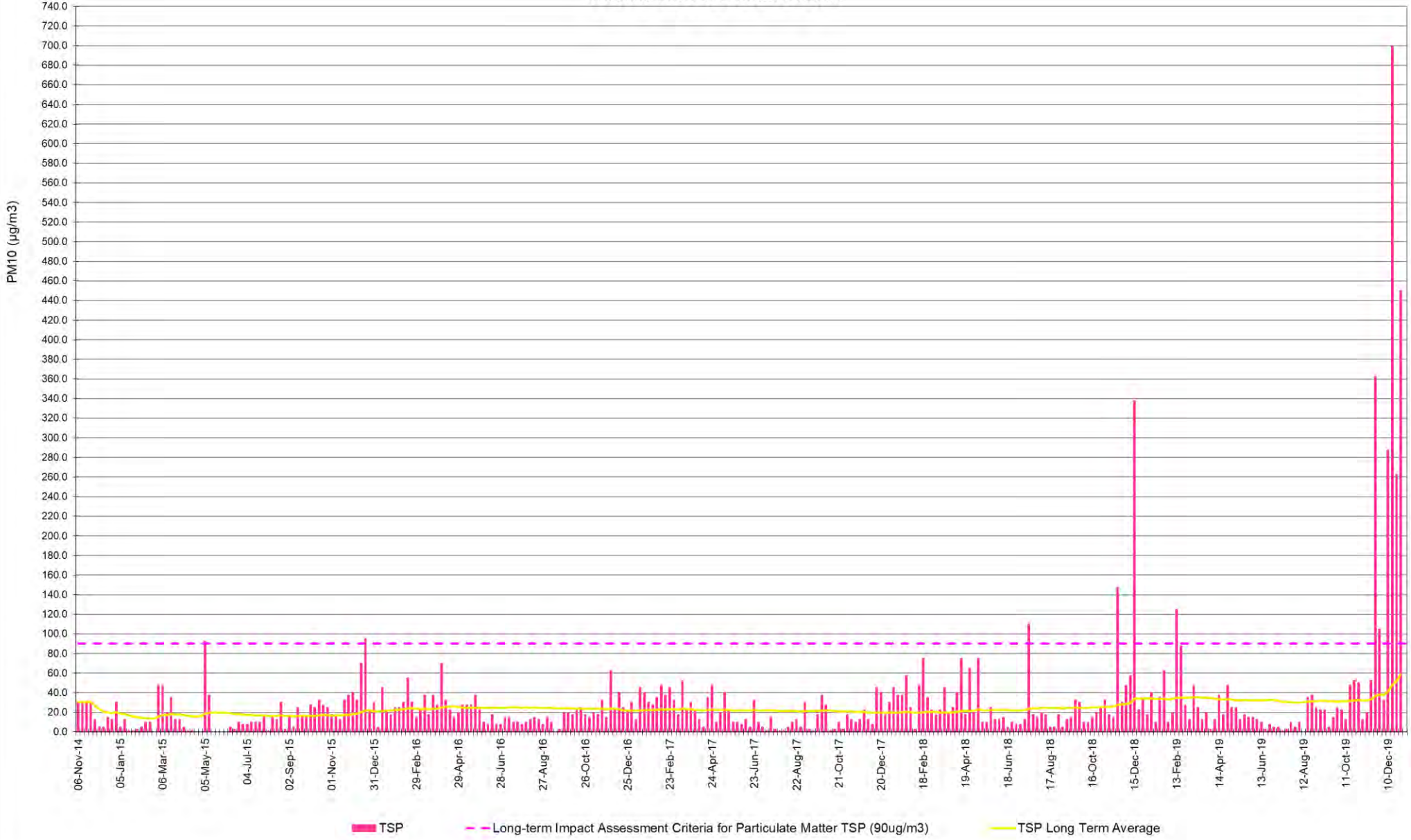
Note: Graph includes December 2019 results which were influenced by extraordinary events. For comparative purposes, Annual Averages excluding these results can be found in Table 6.5 of the 2019 Cullen Valley Annual Review.

Cullen Valley Mine
PM10 Results
January 2012 to December 2019



Note: Graph includes December 2019 results which were influenced by extraordinary events. For comparative purposes, Annual Averages excluding these results can be found in Table 6.5 of the 2019 Cullen Valley Annual Review.

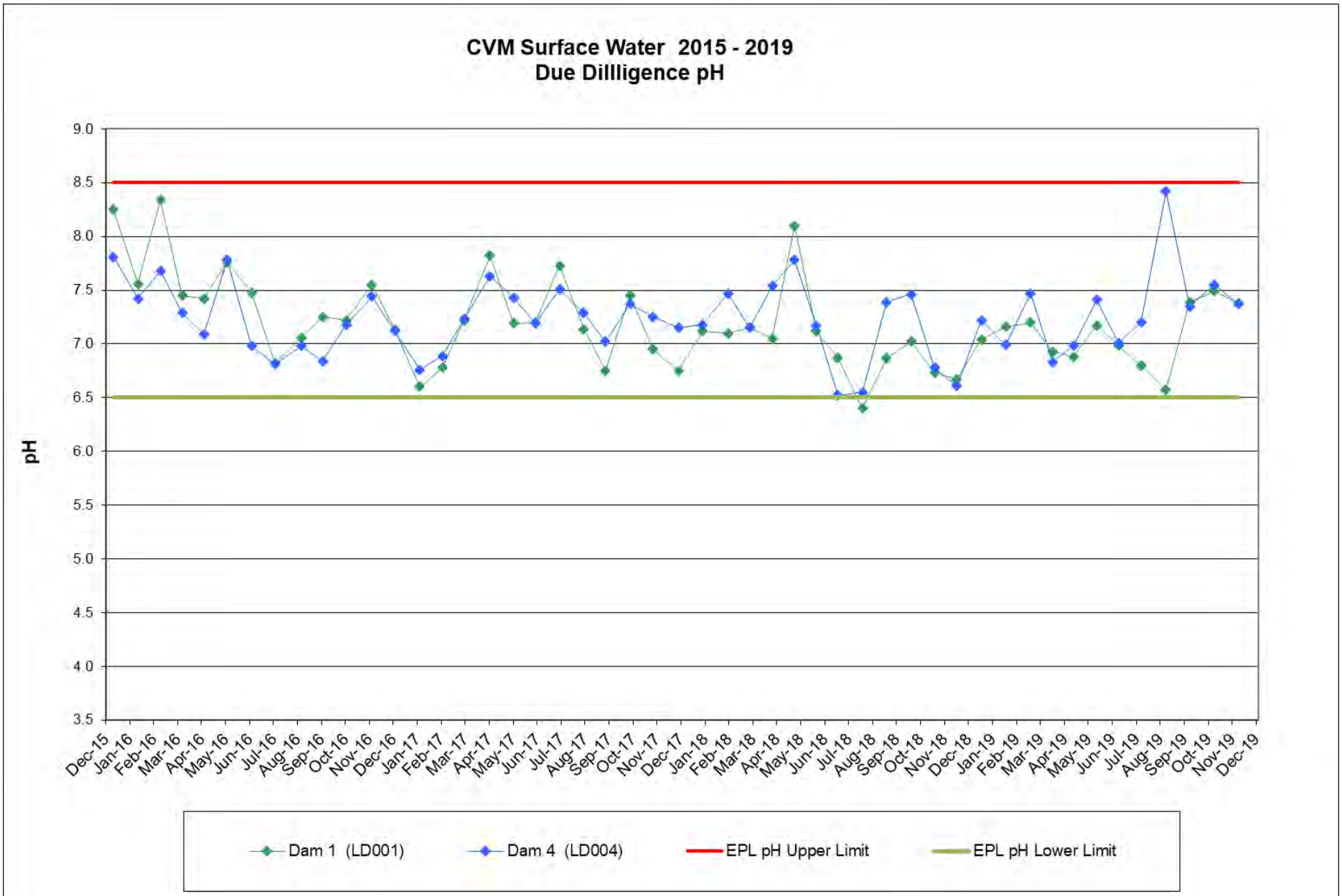
Cullen Valley Mine
TSP Results
October 2014 to December 2019



Note: Graph includes December 2019 results which were influenced by extraordinary events. For comparative purposes, Annual Averages excluding these results can be found in Table 6.5 of the 2019 Cullen Valley Annual Review.

APPENDIX 3

Surface water monitoring graphs and tables


CVM Surface Water 2015 - 2019
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
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
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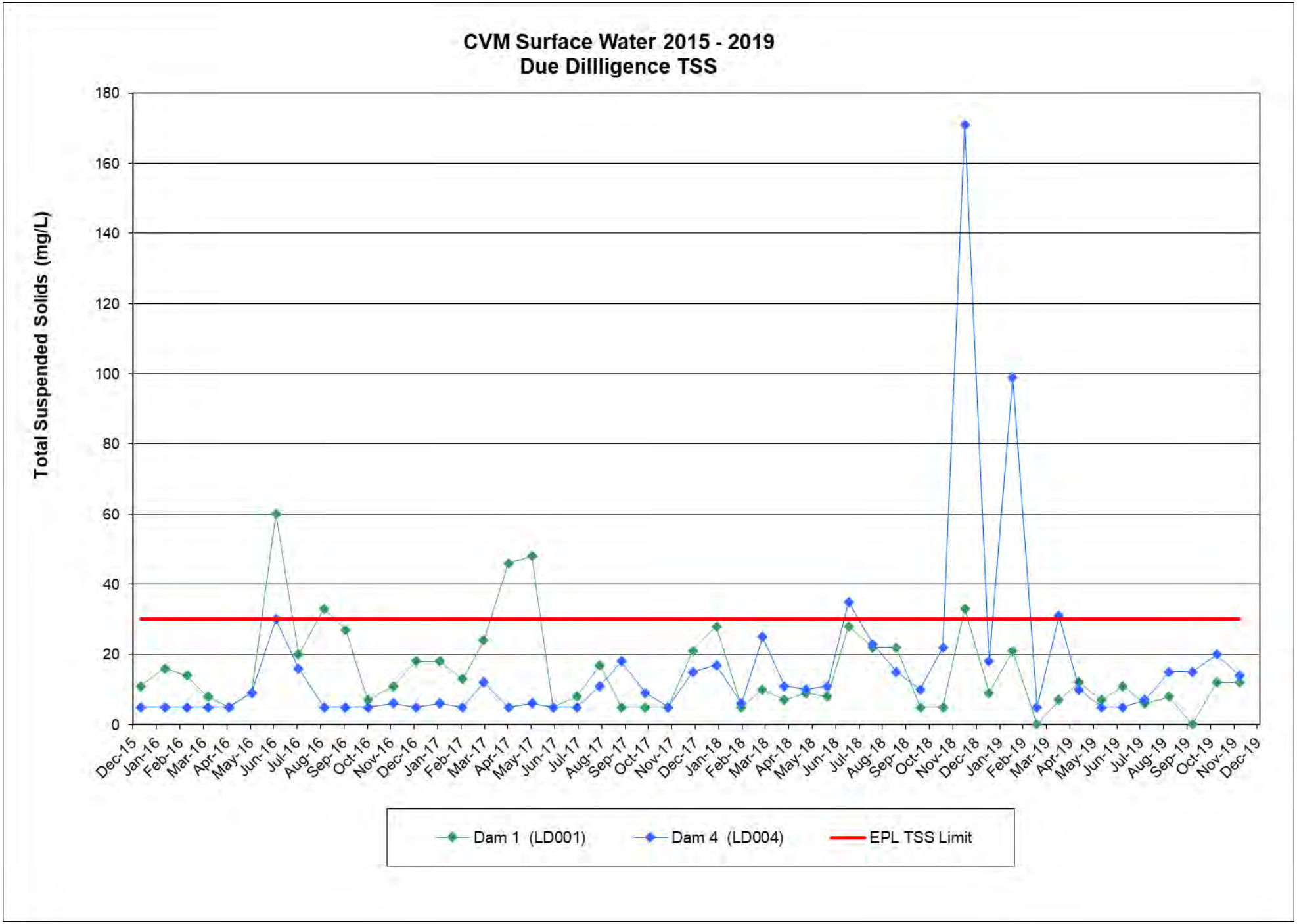
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Dam 1 (LD001)
Dam 4 (LD004)
EPL pH Upper Limit
EPL pH Lower Limit


CVM Surface Water 2015 - 2019
Due Dillligence TSS
Total Suspended Solids (mg/L)
180
160
140
120
100
80
60
40
20
0
Dec-15
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
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Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Dam 1 (LD001)
Dam 4 (LD004)
EPL TSS Limit

The water quality monitoring results for CVM are shown in the table below. It is noted that there were no discharges during the 2019 report period and the below sampling is undertaken monthly for due diligence sampling only.

Sampling Date	pH	Oil & Grease (mg/L)	TSS (mg/L)
Dam 1 (LD001)			
7/01/2019	7.04	<5	9
7/02/2019	7.16	<5	21
11/03/2019	7.20	<5	<5
9/04/2019	6.93	<5	7
6/05/2019	6.88	<5	12
5/06/2019	7.17	<5	7
3/07/2019	6.98	<5	11
1/08/2019	6.8	<5	6
2/09/2019	6.57	<5	8
3/10/2019	7.39	<5	<5
4/11/2019	7.49	<5	12
5/12/2019	7.38	<5	12
Dam 4 (LD004)			
7/01/2019	7.22	<5	18
7/02/2019	6.99	<5	99*
11/03/2019	7.47	<5	5
9/04/2019	6.83	<5	31
6/05/2019	6.98	<5	10
5/06/2019	7.41	<5	5
3/07/2019	7.01	<5	5
1/08/2019	7.2	<5	7
2/09/2019	8.42	<5	15
3/10/2019	7.35	<5	15
4/11/2019	7.55	<5	20
5/12/2019	7.37	<5	14
BSW03			
7/01/2019	7.67	<5	14
7/02/2019	7.05	<5	13
11/03/2019	7.56	<5	5
9/04/2019	7.64	<5	81^
6/05/2019	7.57	<5	62

5/06/2019	7.87	<5	56
3/07/2019	7.00	<5	41
1/08/2019	7.59	<5	15
2/09/2019	8.15	<5	19
3/10/2019	8.04	<5	<5
4/11/2019	8.81	<5	51
5/12/2019	8.42	<5	45

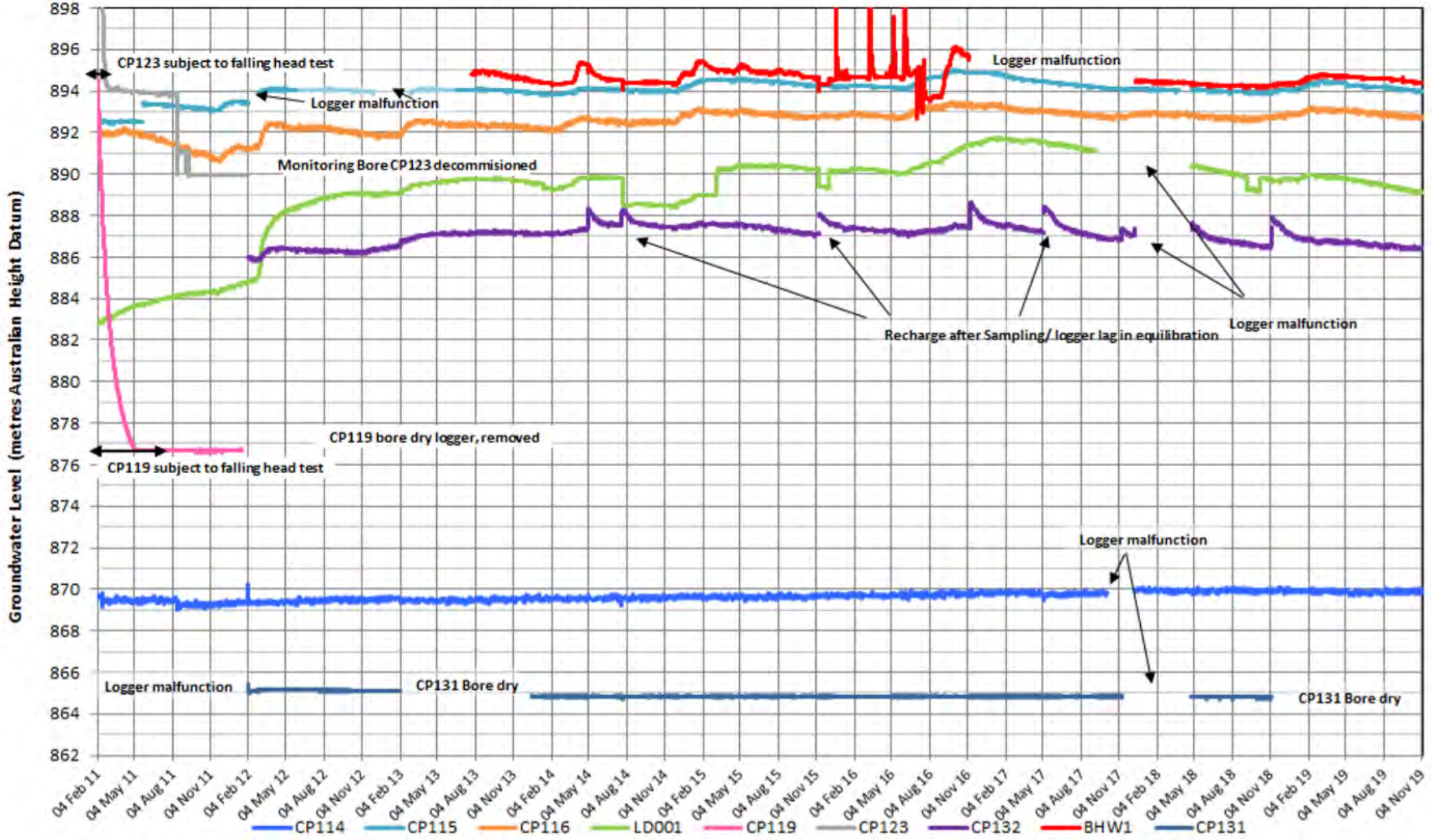
** Note: The TSS result at Dam 4 during February may have been impacted by rainfall runoff carrying suspended particles into the dams on the day of sampling.*

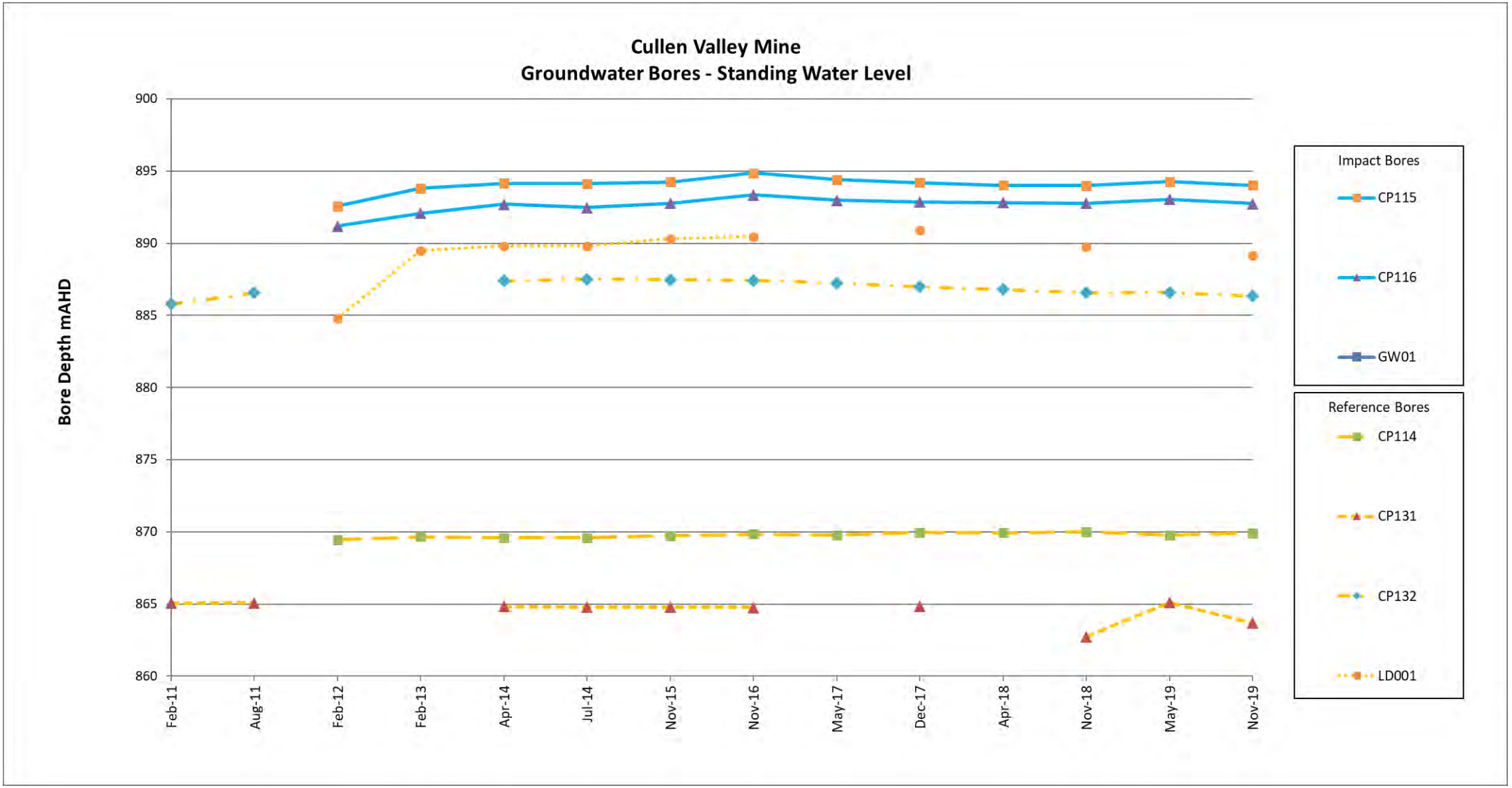
^ Note: The TSS result at BSW03 during April was greater than previous historical maximum's. Monitoring of this trend was continued during 2019 and the level decreased to within the range of historical results.

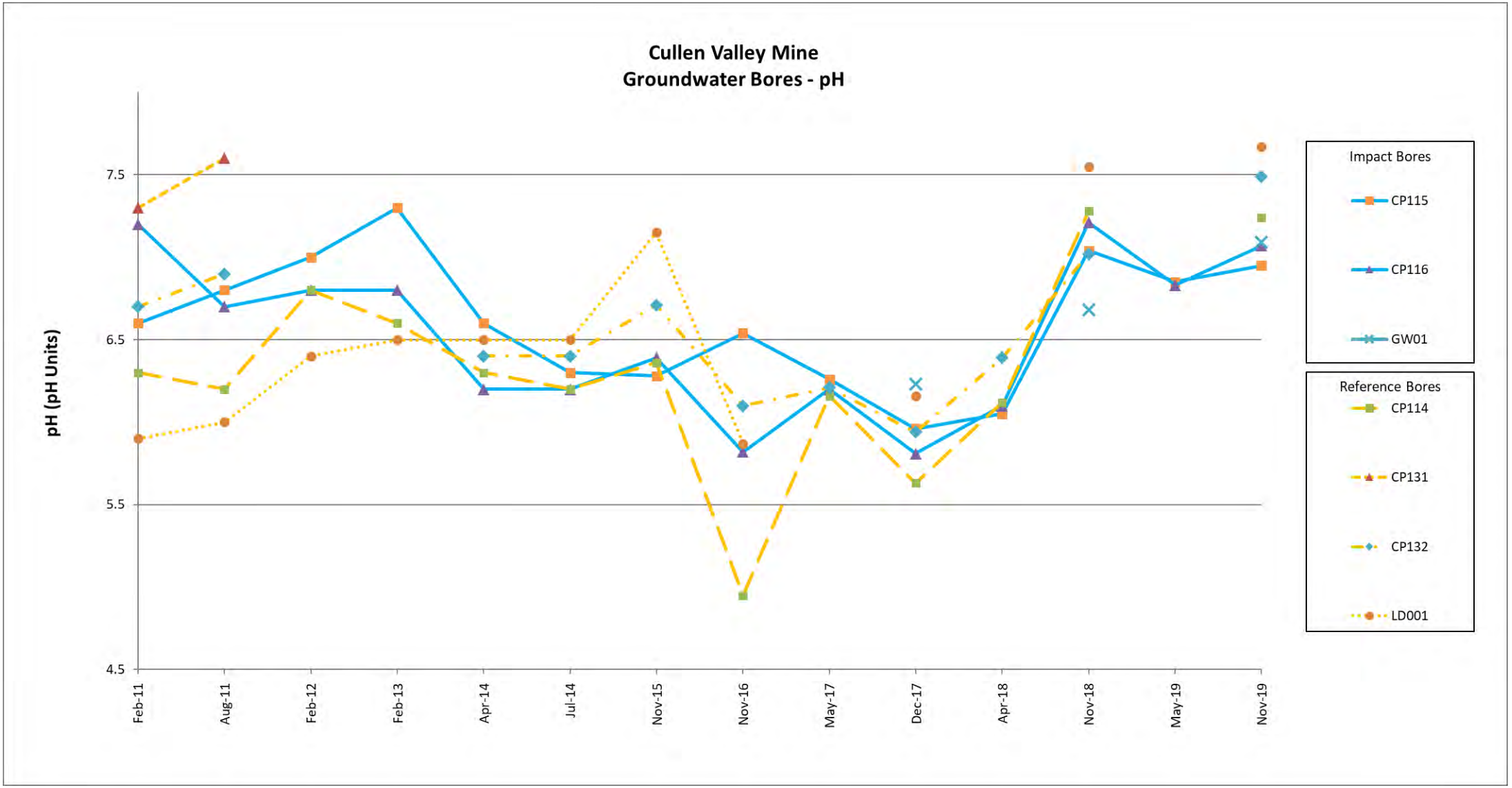
APPENDIX 4

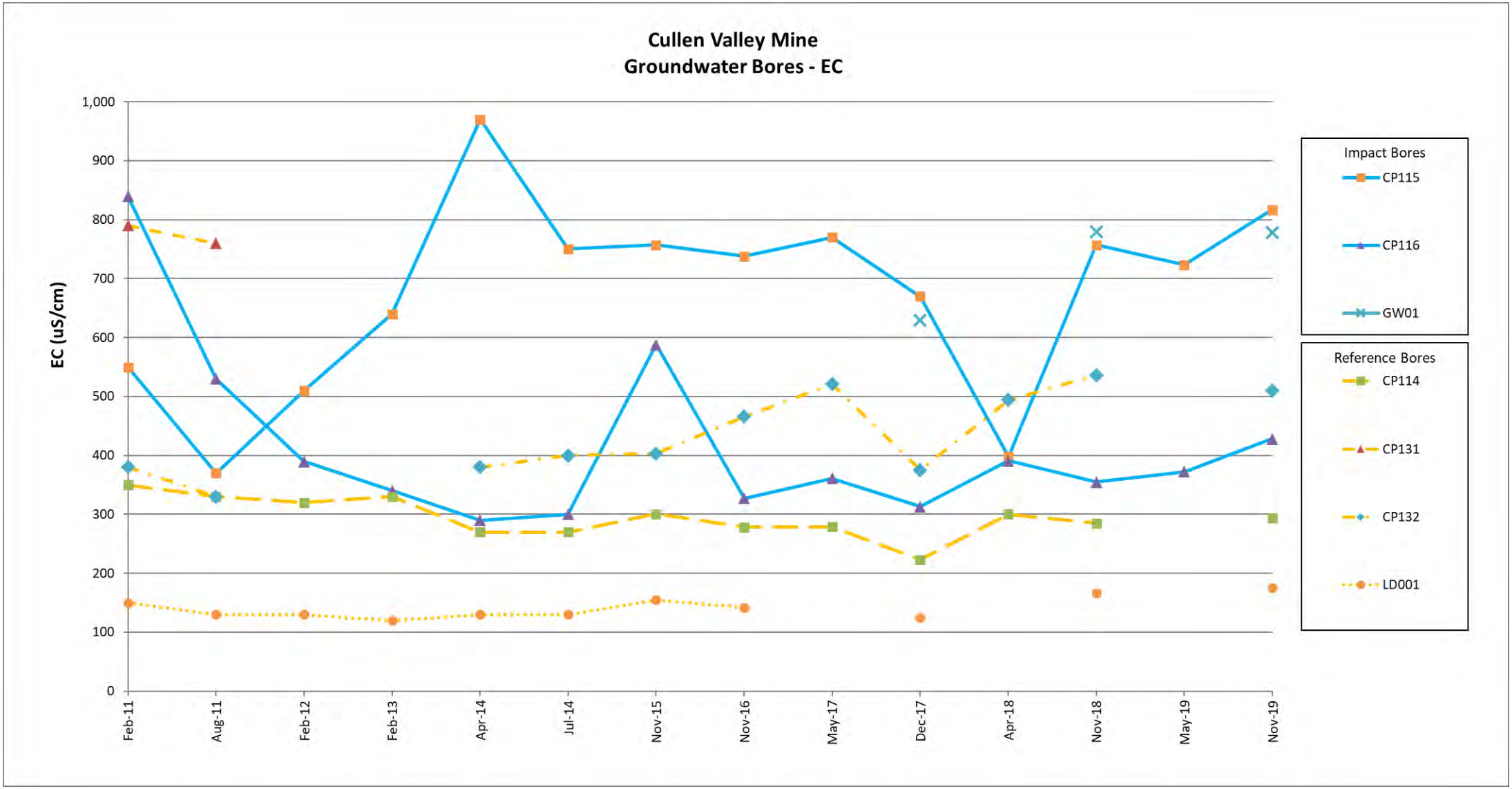
Groundwater monitoring graphs and tables

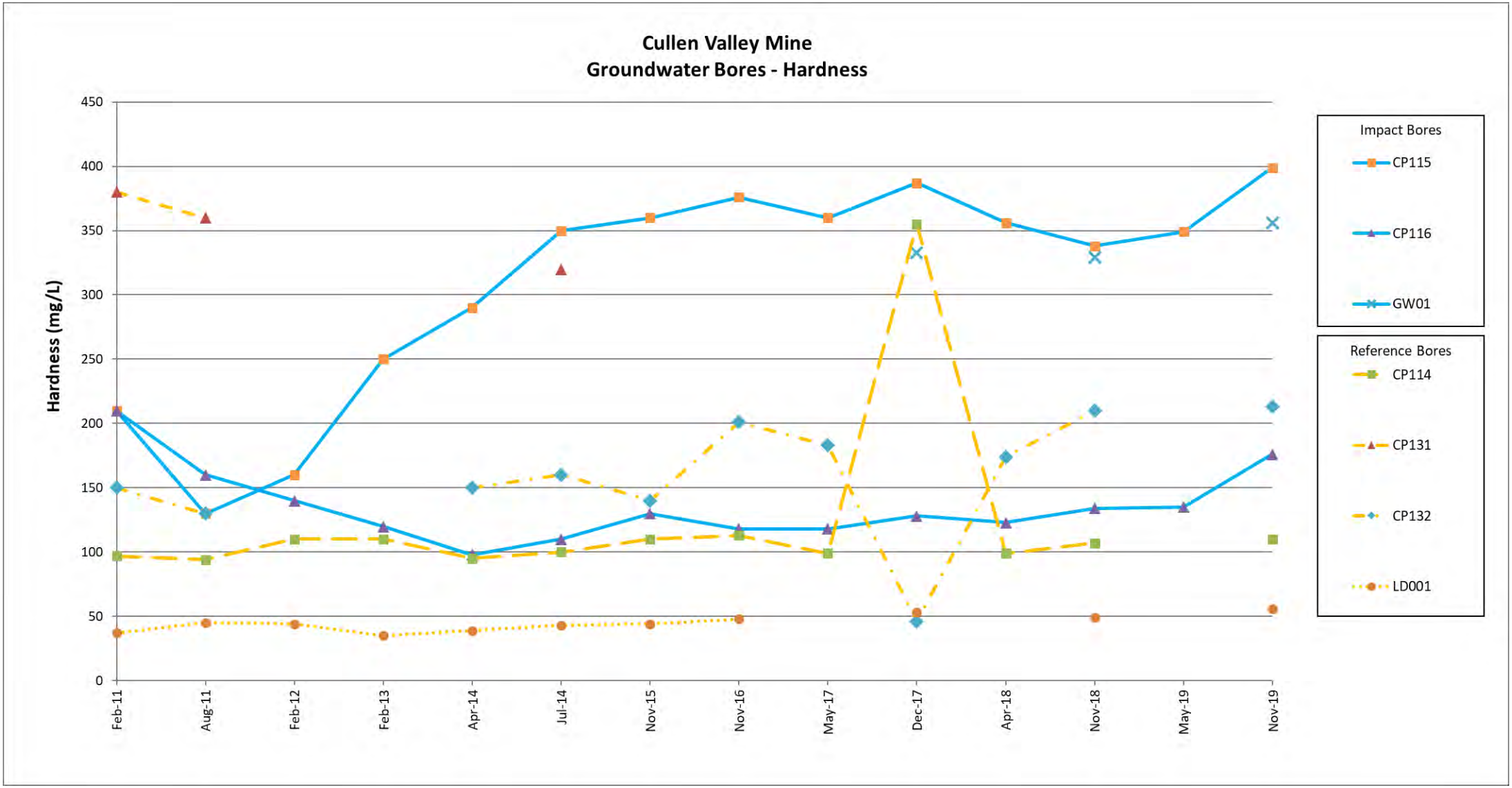
Groundwater Hydrographs - Cullen Valley (2011-2019)

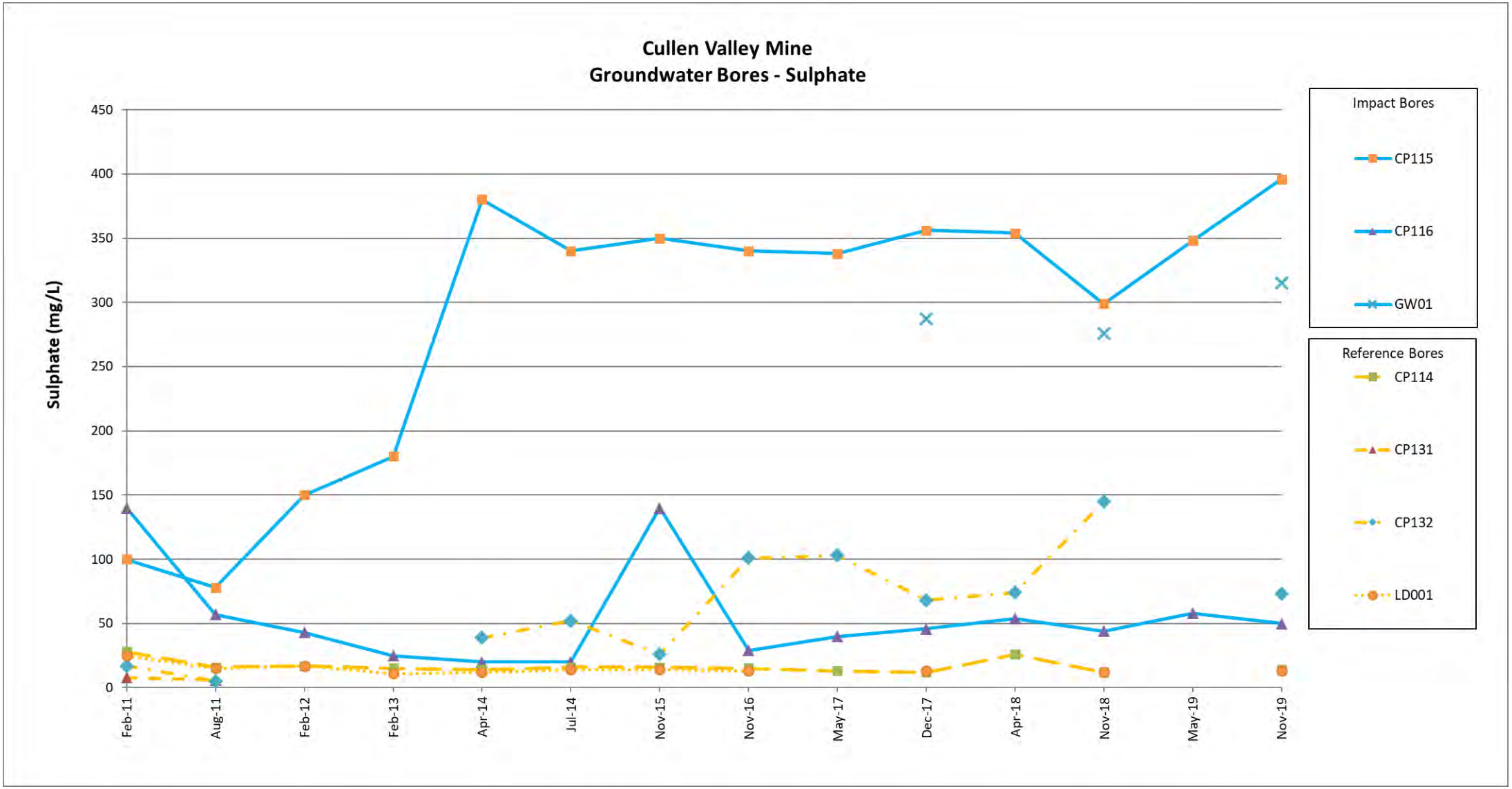


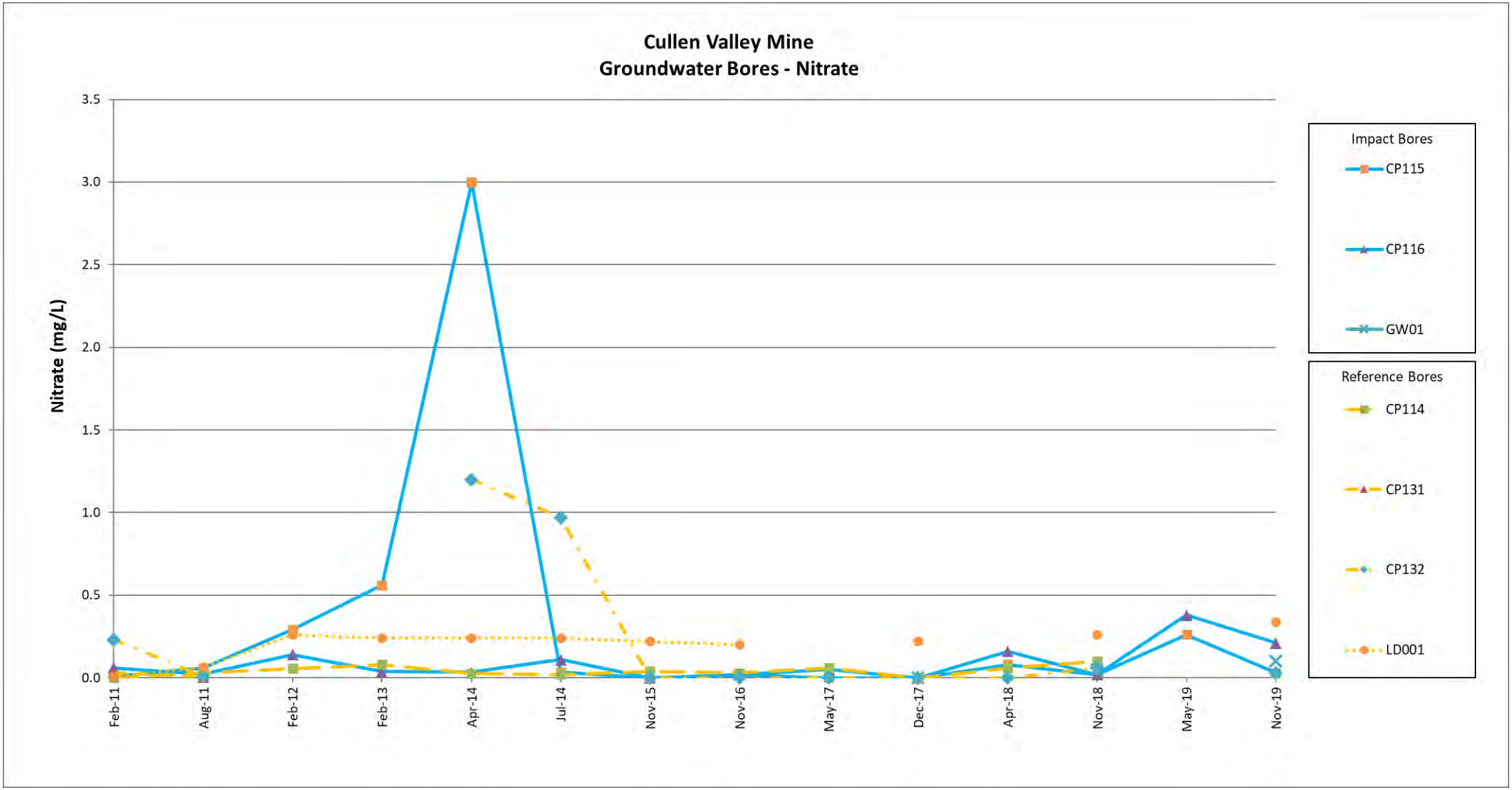

Cullen Valley Mine
Groundwater Bores - Standing Water Level
Bore Depth mAHD
900
895
890
885
880
875
870
865
860
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
May-19
Nov-19
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


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
Apr-18
Nov-18
May-19
Nov-19
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
Apr-18
Nov-18
May-19
Nov-19
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
Apr-18
Nov-18
May-19
Nov-19
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - Sulphate
Sulphate (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
Apr-18
Nov-18
May-19
Nov-19
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
Apr-18
Nov-18
May-19
Nov-19
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001

The results of groundwater monitoring conducted during the 2017-2019 reporting periods are provided below.

Sample Site:	CP114						CP115					
Sample date	5/5/2017	13/12/2017	26/4/2018	6/11/2018	6/05/2019	6/11/2019	5/05/2017	13/12/2017	27/4/2018	6/11/2018	6/05/2019	6/11/2019
AHD (RL) (m)	869.78	869.96	869.94	869.99	869.78	869.90	894.41	894.19	894.02	893.98	894.27	894.01
Depth to aquifer (m)	36.18	36.00	36.02	35.97	36.19	36.07	56.87	57.09	57.21	57.30	56.96	52.27
pH	6.16	5.63	6.12	7.28		7.24	6.26	5.96	6.05	7.04	6.85	6.95
Electrical Conductivity (µS/cm	279	223	300	285		294	770	670	398	757	723	817
Nitrite (mg/L)	<0.05	<0.05	0.06	<0.01		<0.01	<0.05	<0.05	0.05	<0.01	<0.01	<0.01
Total Oxidised Nitrogen (mg/L)	0.060	<0.05	0.12	0.1		0.03	<0.05	<0.05	0.13	0.02	0.26	0.03
Chloride (mg/L)	5	22	8	15		13	5	4	4	3	11	3
Nitrate (mg/L)	0.060	<0.05	0.06	0.1		0.03	<0.05	<0.05	0.08	0.02	0.26	0.03
Sulphate (mg/L)	13	12	26	12		14	338	356	354	299	348	396
Alkalinity (mg/L)	110	100	100	104		121	62	62	64	46	62	53
Calcium (mg/L)	23	86	23	23		26	85	94	85	81	82	97
Magnesium (mg/L)	10	34	10	12		11	36	37	35	33	35	38
Sodium (mg/L)	8	12	13	12		9	11	13	13	16	13	14
Potassium (mg/L)	5	10	6	6		5	10	11	10	10	10	12
Total Hardness (mg CaCO3/L)	99	355	99	107		110	360	387	356	338	349	399
Aluminium (µg/L)	<10	280	20	60		330	<10	490	10	<10	<10	<10

Arsenic (µg/L)	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1
Cadmium (µg/L)	<0.1	<0.1	<0.1	<0.1		<0.1	0.2	0.1	<0.1	<0.1	<0.1	<0.1
Chromium (µg/L)	<1	1	<1	<1		<1	2	2	<1	<1	<1	<1
Copper (µg/L)	1	9	3	2		3	<1	10	<1	<1	<1	<1
Iron (µg/L)	2240	12800	<50	1350		2000	9450	12300	7880	7840	9090	5750
Lead (µg/L)	<1	15	<1	<1		2	<1	17	<1	<1	<1	<1
Manganese (µg/L)	964	414	535	635		1170	424	461	448	388	463	543
Molybdenum (µg/L)	8	<1	1	1		<1	2	<1	<1	5	1	<1
Nickel (µg/L)	6	3	4	27		11	16	3	3	49	12	3
Selenium (µg/L)	<10	<10	<10	<10		<10	<10	<10	<10	<10	<10	<10
Zinc (µg/L)	48	86	21	16		57	317	86	115	78	87	62
Mercury (mg/L)	<0.0001	<0.0001	<0.0001	Removed from monitoring program		<0.0001	<0.0001	<0.0001	<0.0001	Removed from monitoring program	Removed from monitoring program	<0.0001
Sample Site:	**CP116**						**CP131**					
Sample date	5/05/2017	13/12/2017	27/4/2018	6/11/2018	6/05/2019	6/11/2019	5/5/2017	13/12/2017	27/4/2018	6/11/2018	6/05/2019	5/11/2019
AHD (RL) (m)	892.98	892.86	892.82	892.76	893.05	892.75		864.85		862.75	865.1	863.69
Depth to aquifer (m)	49.62	49.74	49.75	49.81	49.52	49.82		74.37		76.35	74.09	75.5
pH	6.20	5.81	6.10	7.21	6.83	7.07	NS	*	NS	*	WL	NS
Electrical Conductivity (µS/cm	361	313	391	355	372	428						
Nitrite (mg/L)	<0.05	<0.05	<0.05	<0.01	<0.01	0.01						

Total Oxidised Nitrogen (mg/L)	0.05	<0.05	0.16	0.02	0.38	0.21						
Chloride (mg/L)	16	20	16	16	20	21						
Nitrate (mg/L)	0.05	<0.05	0.16	0.02	0.38	0.21						
Sulphate (mg/L)	40	46	54	44	58	50						
Alkalinity (mg/L)	110	104	124	104	98	120						
Calcium (mg/L)	26	28	28	29	31	44						
Magnesium (mg/L)	13	14	13	15	14	16						
Sodium (mg/L)	12	14	14	15	15	15						
Potassium (mg/L)	6	7	6	6	7	8						
Total Hardness (mg CaCO3/L)	118	128	123	134	135	176						
Aluminium (µg/L)	10	<10	<0.01	80	<10	40						
Arsenic (µg/L)	<1	<1	<1	<1	<1	<1						
Cadmium (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1						
Chromium (µg/L)	1	<1	<1	1	<1	<1						
Copper (µg/L)	<1	<1	<1	<1	<1	<1						
Iron (µg/L)	11800	12000	10200	14500	9530	550						
Lead (µg/L)	<1	<1	<1	<1	<1	<1						
Manganese (µg/L)	561	562	551	553	645	703						
Molybdenum (µg/L)	2	<1	<1	<1	<1	<1						
Nickel (µg/L)	2	1	1	2	3	3						
Selenium (µg/L)	<10	<10	<10	<10	<10	<10						
Zinc (µg/L)	105	19	56	5	143	37						

Mercury (mg/L)	<0.0001	<0.0001	<0.0001	Removed from monitoring program	Removed from monitoring program	<0.0001						
Sample Site:	**CP 132**						**LD001**					
Sample date	5/05/2017	12/12/2017	26/4/2018	6/11/2018	6/05/2019	6/11/2019	5/5/2017	12/12/2017	26/4/2018	7/11/2018	6/05/2019	5/11/2019
AHD (RL) (m)	887.23	886.981	886.79	886.56	886.58	886.33	NS	890.88	NS	889.73	NS	889.14
Depth to aquifer (m)	18.53	18.78	18.97	19.20	19.8	19.43		49.25		50.40		50.99
pH	6.21	5.94	6.39	7.02	NS	7.49		6.16		7.55		7.67
Electrical Conductivity (µS/cm	521	375	494	536		510		125		166		175
Nitrite (mg/L)	<0.05	<0.05	-	<0.1		<0.01		<0.05		<0.01		<0.01
Total Oxidised Nitrogen (mg/L)	<0.05	<0.05	-	0.06		0.03		0.22		0.26		0.34
Chloride (mg/L)	32	36	32	26		33		6		5		9
Nitrate (mg/L)	<0.05	<0.05	-	0.06		0.03		0.22		0.26		0.34
Sulphate (mg/L)	103	68	74	145		73		13		12		13
Alkalinity (mg/L)	104	108	140	86		134		56		63		67
Calcium (mg/L)	42	12	401	48		54		13		13		14
Magnesium (mg/L)	19	4	18	22		19		5		4		5
Sodium (mg/L)	13	6	14	19		15		6		8		7
Potassium (mg/L)	9	7	9	10		11		8		8		8
Total Hardness (mg CaCO3/L)	183	46	174	210		213		53		49		56
Aluminium (µg/L)	<10	<10	-	<10		<10		<10		<10		<10

Arsenic (µg/L)	<1	<1	-	<1		<1		<1		<1		<1
Cadmium (µg/L)	<0.1	<0.1	-	<0.1		<0.1		<0.1		<0.1		<0.1
Chromium (µg/L)	<1	<1	-	<1		<1		<1		<1		<1
Copper (µg/L)	<1	<1	-	<1		<1		10		6		<1
Iron (µg/L)	8430	7250	-	9820		50		<50		<50		<50
Lead (µg/L)	<1	<1	-	<1		<1		<1		<1		<1
Manganese (µg/L)	267	222	-	303		340		4		<1		2
Molybdenum (µg/L)	1	<1	-	<1		<1		<1		<1		<1
Nickel (µg/L)	<1	<1	-	1		2		8		8		7
Selenium (µg/L)	<10	<10	-	<10		<10		<10		<10		<10
Zinc (µg/L)	14	<5	-	5		15		138		150		142
Mercury (mg/L)	<0.0001	<0.0001	-	Removed from monitoring program		<0.0001		<0.0001		Removed from monitoring program		<0.0001
Sample site:	**GW01**						**BHW1**					
Sample date	04/05/2017	13/12/2017	27/4/2018	6/11/2018	6/05/2019	4/11/2019	4/05/2017	13/12/2017	27/4/2018	8/11/2018	6/05/2019	4/11/2019
AHD (RL) (m)	NS	N/A (Tap)	NS	N/A (Tap)	NS	-	895.00	894.52	NS	894.29	894.72	894.44
Depth to aquifer (m)		N/A (Tap)		N/A (Tap)		-	43.8	44.28		44.51	44.08	44.36
pH		6.23		6.68		7.09	6.42	WL		WL	WL	WL
Electrical Conductivity (µS/cm		629		779		778	485					
Nitrite (mg/L)		<0.05		<0.01		<0.01	<0.05					

Total Oxidised Nitrogen (mg/L)		<0.05		0.5		0.1	<0.05					
Chloride (mg/L)		22		18		22	22					
Nitrate (mg/L)		<0.05		0.05		0.1	<0.05					
Sulphate (mg/L)		287		276		315	67					
Alkalinity (mg/L)		84		68		80	190					
Calcium (mg/L)		64		64		70	46					
Magnesium (mg/L)		42		41		44	19					
Sodium (mg/L)		19		22		21	10					
Potassium (mg/L)		13		13		13	8					
Total Hardness (mg CaCO3/L)		333		329		356	193					
Aluminium (µg/L)		<10		<10		<10	<10					
Arsenic (µg/L)		<1		<1		<1	3.00					
Cadmium (µg/L)		<0.1		0.1		0.1	0.1					
Chromium (µg/L)		<1		<1		<1	<1					
Copper (µg/L)		<1		<1		<1	<1					
Iron (µg/L)		7780		310		8600	3580					
Lead (µg/L)		<1		<1		<1	<1					
Manganese (µg/L)		1960		2060		2020	366					
Molybdenum (µg/L)		<1		<1		<1	<1					
Nickel (µg/L)		24		16		20	22					
Selenium (µg/L)		<10		<10		<10	<10					
Zinc (µg/L)		38		29		42	17100					

Mercury (mg/L)		<0.0001		-		<0.0001	<0.0001					

NS – No sample required (Annual Monitoring only)

** – Insufficient water available to sample or bore dry*

WL – Water Level only

APPENDIX 5

Noise monitoring results

Historical Noise monitoring results for years 2011, 2012, 2015 - 2019 are shown in **Tables A to G**. Contribution from CVM was inaudible for all monitoring undertaken for 2013, and 2014.

Table A 2019 Quarterly 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	39 (IA)	44 (IA)	41 (IA)	43 (IA)
Hillcroft (N08)	35	40 (IA)	44 (IA)	39 (IA)	38 (IA)
Forest Lodge (N10)	40	36 (IA)	43 (IA)	43 (IA)	32 (IA)
Doble Gate (N09)	43	62 (IA)	54 (IA)	63 (IA)	59 (IA)
Tilley (N06)	43	72 (IA)	67 (IA)	64 (IA)	68 (IA)

Table B 2018 Quarterly 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	34 (IA)	38 (IA)	33 (IA)	40 (IA)
Hillcroft (N08)	35	35 (<20)	39 (IA)	40 (IA)	33 (IA)
Forest Lodge (N10)	40	50 (IA)	27 (IA)	43 (IA)	33 (IA)
Doble Gate (N09)	43	47 (IA)	49 (IA)	50 (IA)	49 (IA)
Tilley (N06)	43	66 (IA)	62 (IA)	68 (IA)	67 (IA)

Table C 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 D 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 E 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 F 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 G 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