METROPOLITAN COAL

2019 ANNUAL REVIEW




Peabody

METROPOLITAN COAL

2019 ANNUAL REVIEW

Project No. MET-20-22
Document No. 01021305

Name of Operation	Metropolitan Coal
Name of Operator	Peabody Energy Australia Pty Ltd
Project Approval	Project Approval 08_0149
Name of Holder of Project Approval	Metropolitan Collieries Pty Ltd
Mining Leases	Consolidated Coal Lease 703 Mining Lease 1610 Mining Lease 1702 Mining Purpose Lease 320 Coal Lease 379
Name of Holder of Mining Leases	Metropolitan Collieries Pty Ltd
Water Licence	Water Access Licence – WAL25410 Bore Licence Certificate – 10BL603595
Name of Holder of Water Licence	Metropolitan Collieries Pty Ltd
MOP Start Date	October 2012
MOP End Date	September 2020
Annual Review Start Date	1 January 2019
Annual Review End Date	31 December 2019

I, Jon Degotardi, certify that this audit report is a true and accurate record of the compliance status of Metropolitan Coal for the period 1 January to 31 December 2019 and that I am authorised to make this statement on behalf of Peabody Energy Australia Pty Ltd.

Note.

a) The Annual Review is an 'environmental audit' for the purposes of section 9.39(2) of the Environmental Planning and Assessment Act 1979. Section 9.42 provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.

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

Name of Authorised Reporting Officer	Jon Degotardi
Title of Authorised Reporting Officer	Manager – Technical Services
Signature of Authorised Reporting Officer	
Date	31/03/2020

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1 STATEMENT OF COMPLIANCE

The compliance status of the Metropolitan Coal Mine with its relevant approval conditions at the end of the review period (31 December 2019) is provided in Table 1.

Table 1
Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Project Approval 08_0149	No
Development Consent D90/832	Yes
Consolidated Coal Lease 703	Yes
Mining Lease 1610	Yes
Mining Lease 1702	Yes
Coal Lease 379	Yes
Mining Purpose Lease 320	Yes
Environment Protection Licence No. 767	Yes

Table 2 summarises the non-compliances with the approval conditions.

Table 2
Summary of Non-Compliances

Relevant Approval	Condition Number	Condition Description	Compliance Status	Comment	Report Section
Project Approval 08_0149	Condition 1, Schedule 3	Subsidence Impact Performance Measures (Table 1 of Project Approval)	Non-compliant	Exceedance of the Eastern Tributary watercourse subsidence impact performance measure in relation to iron staining and pool flow/drainage behaviour downstream of the Longwall 26 maingate.	6.2 and 13.1
Project Approval 08_0149	Condition 1, Schedule 4	Noise Impact Assessment Criteria (Table 2 of Project Approval)	Non-compliant	Noise monitoring has identified sustained non-compliances during the review period.	7.1 and 13.2

Compliance Status Key for Table 2 – Non-Compliances

Risk Level	Colour Code	Comment
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).

2 INTRODUCTION

Metropolitan Coal is wholly owned by Peabody Energy Australia Pty Ltd (Peabody), and is located adjacent to the township of Helensburgh and approximately 30 kilometres (km) north of Wollongong in New South Wales (NSW) (Figure 1). Metropolitan Coal is located within Consolidated Coal Lease (CCL) 703, Mining Lease (ML) 1610 and ML 1702. Metropolitan Coal is one of the earliest established and longest continually running coal mining operations in Australia, with a history dating back to the 1880s.

Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) by the Minister for Planning under section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of Project Approval (08_0149) is available on the Peabody website (http://www.peabodyenergy.com). The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. The extent of the mine's surface facilities area is shown on Figure 2.

The surface facilities include administration buildings, workshops, bath houses, ablution facilities, haul roads, access roads, fuel and consumables storages, hardstand areas, a coal handling and preparation plant (CHPP), stockpiles (including run-of-mine [ROM] coal, product coal and coal reject stockpiles), underground coal reject emplacement plant and associated coal handling infrastructure (e.g. conveyors, transfer points and buffer bins).

Coal extracted from the underground mining operations is transferred by conveyor to the surface facilities area. ROM coal is crushed, screened and washed at the CHPP. The majority of product coal is transported by train to the Port Kembla Coal Terminal (in Wollongong) for domestic and overseas customers. CHPP coal reject material is transported by truck to the Glenlee Washery, is emplaced in unused workings, used on site for construction purposes or beneficially reused for engineered fill purposes at urban developments in the Illawarra region.

The Environmental Management Structure of the Project is shown on Figure 3. It includes the Metropolitan Coal Environmental Management Strategy, developed to provide the strategic context for environmental management at Metropolitan Coal, and management plans and monitoring programs applicable to the underground mining area or mine's surface facilities area.

Metropolitan Coal submitted the Longwall 304 Extraction Plan to the Department of Planning & Environment (DP&E) in April 2019. The Longwall 304 Extraction Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences, subject to the previously approved Metropolitan Coal Extraction Plans for Longwalls 20-27 and Longwalls 301-303. DP&E approved the Longwall 304 Extraction Plan in July 2019 and mining of Longwall 304 commenced on 28 July 2019. Under this annual review, environmental performance for the period 1 January 2019 to 30 June 2019 is reported against the Longwalls 301-303 Extraction Plan and the environmental performance for the period 1 July 2019 to 31 December 2019 is reported against the Longwall 304 Extraction Plan.

In accordance with the mining lease conditions, Metropolitan Coal has also prepared the *Metropolitan Coal Mining Operations Plan, 2012 – 2020* (herein referred to as the Metropolitan Coal MOP).

2.1 PURPOSE AND SCOPE

Metropolitan Coal's environmental reporting requirements include an Annual Review, which is to be prepared in accordance with Condition 3, Schedule 7 of the Project Approval, an Annual Environmental Management Report, to be prepared in accordance with CCL 703, and an Annual Rehabilitation Report, to be prepared in accordance with ML 1610, ML 1702, MPL 320 and CL 379.

The Metropolitan Coal 2019 Annual Review has been prepared to meet the above reporting requirements and to review the environmental performance of the Project during the review period (i.e. 1 January to 31 December 2019), consistent with the NSW Government (2015) *Annual Review Guideline for State Significant Mining Developments*.

2.2 MINE CONTACTS

Contact details for key Metropolitan Coal employees are provided below:

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3 APPROVALS

Metropolitan Coal operates under a number of statutory approvals, leases and licences granted by the NSW Government as outlined in Table 3.

Table 3
Consent, Lease and Licence Details

Consent/Lease/Licence	Authority	Grant/Renewal	Expiry Date
Project Approval 08_0149	DPIE	22/6/2009	22/6/2032
Project Approval 08_0149 – Mod 1	DPIE	8/9/2010	22/6/2032
Project Approval 08_0149 – Mod 2	DPIE	2/7/2011	22/6/2032
Project Approval 08_0149 – Mod 3	DPIE	3/10/2013	22/6/2032
Development Consent D90/832	WCC	5/1/1995	-
Consolidated Coal Lease 703	DRG	1/4/2004	26/1/2024
Mining Lease 1610	DRG	7/5/2014	26/9/2031
Coal Lease 379	DRG	14/11/2013*	4/10/2033
Mining Purpose Lease 320	DRG	16/6/2014	9/12/2035
Mining Lease 1702	DRG	13/10/2014	13/10/2035
Bore Licence Certificate 10BL603595	DPIE-Water	25/1/2013	24/1/2028
Camp Creek Weir Surface Water Certificate of Title	DPIE-Water	28/11/2012	-
Environment Protection Licence (EPL) No. 767	EPA	9/9/2002	-
Radiation Licence – Radiation Management Licence 5063985	EPA	27/9/2019	27/9/2020
Licence to store explosives and/or security sensitive dangerous substances – Licence XSTR200082	SafeWork NSW	15/06/2017	15/06/2022

Note: DPIE = NSW Department of Planning, Industry and Environment; DRG = NSW Division of Resources and Geoscience; EPA = NSW Environment Protection Authority; WCC = Wollongong City Council.

* Date lease offer was signed.

4 OPERATIONS SUMMARY

4.1 MINING OPERATIONS

Metropolitan Coal submitted the Longwall 304 Extraction Plan to the DP&E in April 2019. On 16 July 2019, the DPIE granted approval for Longwall 304 Extraction Plan with conditions.

During the review period, the extraction of Longwall 303 was completed on 2 June 2019 (Figure 4). The extraction of Longwall 304 commenced on 28 July 2019 and continued for the remainder of the review period.

Metropolitan Coal submitted the Longwalls 305-307 Extraction Plan to the DPIE in October 2019 and is expected to be approved in the next review period.

The amount of waste rock/overburden, ROM coal, coal reject and product coal produced in the previous reporting period, current reporting period and forecast for the next reporting period is provided in Table 4.

Table 4
Production Summary

Material	Approval Limit	2018 Reporting Period (Actual)	2019 Reporting Period (Actual)	2020 Reporting Period (Forecast)
Waste Rock/Overburden	N/A	N/A	N/A	N/A
ROM Coal	3.2 Mt per calendar year[1]	2,024,404 t	1,851,831 t	1,752,190 t
Coal Reject[2]	N/A	439,506 t[3]	368,873 t[4]	N/A
Saleable Product[2,5]	2.8 Mt per calendar year[1]	1,584,898 t	1,456,847 t	1,317,464 t

N/A = not applicable; Mt = million tonnes; t = tonnes.

1 Condition 6, Schedule 2 of the Project Approval states:

The Proponent shall not:

(a) extract more than 3.2 million tonnes of ROM coal from the mining area in a calendar year, or

(b) transport more than 2.8 million tonnes of product coal from the site in a calendar year.

2 Coal rejects and saleable product out of the CHPP.

3 Of the 439,506 t of coal reject produced, 295,781 t was transported to the Glenlee Washery for disposal, 74,281 t was beneficially re-used as engineered fill material at the Sanctuary Ponds residential development, and approximately 61,894 t was emplaced underground.

4 Of the 368,873 t of coal reject produced, 63,669 t was transported to the Glenlee Washery for disposal, 259,411 t was beneficially re-used as engineered fill material at the Albion Park Bypass project, and 45,793 t was blended with 12,026 t of product coal to meet end use specifications, and was delivered to Port Kembla Coal Terminal via rail.

5 Note, there is no Approval limit for saleable product itself. The only Approval limit relating to saleable product is the amount of product coal transported from the site in a calendar year. Note that the quantities presented in Table 4 reflect the saleable product produced by Metropolitan Coal and are therefore not consistent with the quantities dispatched from site that are reported on the Peabody website in the Truck and Rail Register.

4.2 OTHER OPERATIONS – METROPOLITAN COAL SURFACE FACILITIES AREA

In addition to the Project Approval limits detailed in Table 4, other relevant operational conditions are described in Table 5 and primarily relate to the Metropolitan Coal surface facilities area.

During the review period, Metropolitan Coal continued the coal reject backfill emplacement project. Metropolitan Coal also continued its consultation with the Wollongong City Council regarding the potential for coal rejects to be beneficially re-used at the Helensburgh Landfill and completed construction of a gas drainage plant at the No. 3 Vent Shaft site.

Table 5
Other Relevant Operational Conditions

Operational Condition		Operational Condition Met?	Comment
Limits on Approval (Project Approval Conditions 5, 7 and 8, Schedule 2)	5. *The Proponent may undertake mining operations in the mining area for up to 23 years from the date of this approval.* *Note: Under this approval, the Proponent is required to rehabilitate the site and perform additional undertakings to the satisfaction of the Director-General. Consequently, this approval will continue to apply in all other respects other than the right to conduct mining operations until the site has been properly rehabilitated.*	Yes	Metropolitan Coal was granted approval for the Project in June 2009.
	7. *The Proponent shall not export any coal reject from the site after 2021 without the written approval of the Director-General.*	Yes	-
	8. *The Proponent shall not emplace coal reject on the surface of the site without the written approval of the Director-General.* *Note: This condition applies to the Camp Gully Emplacement Area, as well as to the rest of the surface of the site. It does not apply to the proposed additional coal reject stockpile shown in Appendix 4.*	Yes	Metropolitan Coal has DPIE approval to emplace coal reject on the site when used for construction purposes (e.g. as engineered fill material). No construction activities requiring fill were undertaken and no coal reject was emplaced on the surface of the site during the review period.
Structural Adequacy (Project Approval Condition 9, Schedule 2)	• *The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structure, are constructed in accordance with:* *(a) the relevant requirements of the BCA; and* *(b) any additional requirements of the MSB in areas where subsidence effects are likely to occur.* *Notes:* • *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for the proposed building works.* • *Part 8 of the EP&A Regulation sets out the requirements for the certification of the project.*	Yes	Building construction activities during the reporting period included the completion of construction of a new gas drainage plant at Metropolitan's Vent Shaft No. 3. Building Code of Australia requirements were stipulated for all buildings.
Demolition (Project Approval Condition 10, Schedule 2)	• *The Proponent shall ensure that all demolition work is carried out in accordance with Australian Standard AS 2601-2001: The Demolition of Structures, or its latest version.*	Yes	Metropolitan Coal did not undertake any demolition activities during the review period.
Operation of Plant and Equipment (Project Approval Condition 11, Schedule 2)	• *The Proponent shall ensure that all plant and equipment used at the site is:* *(a) maintained in a proper and efficient condition; and* *(b) operated in a proper and efficient manner.*	Yes	All plant and equipment in use at Metropolitan Coal is regularly serviced in accordance with the relevant Industry & Investment NSW *Mining Design Guidelines* to ensure plant and equipment is maintained in proper and efficient condition. All plant and equipment are operated in a proper and efficient manner.

Table 5
Other Relevant Operational Conditions (continued)

Operational Condition		Operational Condition Met?	Comment
Rail Noise (Project Approval Condition 4, Schedule 4)	4. *The Proponent shall only use locomotives that are approved to operate on the NSW rail network in accordance with noise limits L6.1 to L6.4 in RailCorp's EPL (No. 12208) and ARTC's EPL (No. 3142) or a Pollution Control Approval issued under the former Pollution Control Act 1970.*	Yes	All locomotives used by Metropolitan Coal are approved to operate on the NSW rail network in accordance with the relevant noise limits.
Blasting (Project Approval Condition 7, Schedule 4)	• *The Proponent shall not undertake blasting operations at the surface facilities area without the written approval of the Director-General.*	Yes	No blasting activities were carried out at the surface facilities area during the review period. Minor blasting underground is necessary at times when geological structures are encountered that cannot be excavated by the continuous miner or the longwall mining machine and when a section of the longwall roof falls ahead of the hydraulic supports of the longwall mining machine.

4.3 OPERATIONAL ACTIVITIES IN THE NEXT REPORTING PERIOD

Longwall 304 commenced extraction on 28 July 2019 and was completed on 28 January 2020. The figures presented in this Annual Review show the proposed Longwalls 305 to 307 layouts. In the next reporting period, Longwall 305 is anticipated to commence extraction in April 2020 (Figure 5).

The amount of waste rock/overburden, ROM coal, coal reject and product coal forecast for the next reporting period is provided in Table 4.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

As part of DP&E's approval of the Metropolitan Coal 2018 Annual Review, it requested a status update on any outstanding recommendations identified in the 2017 Metropolitan Coal Independent Environmental Audit Report. The Metropolitan Coal 2018 Annual Review was subsequently updated to state that all recommendations made in the 2017 Independent Environmental Audit have been closed out.

6 ENVIRONMENTAL PERFORMANCE – UNDERGROUND MINING AREA AND SURROUNDS

This section provides a summary of the key environmental monitoring results for subsidence, surface water, groundwater, biodiversity, land, heritage, built features and public safety in the underground mining area, an assessment of environmental performance and a description of the management measures implemented during the review period.

Each section indicates the relevant management plan or monitoring program where details of the underground mining management and monitoring are available. The Metropolitan Coal management plans/monitoring programs are available on the Peabody website (http://www.peabodyenergy.com).

The Longwall 304 Extraction Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences, subject to the previously approved Metropolitan Coal Extraction Plans for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303.

6.1 SUBSIDENCE MONITORING

The Metropolitan Coal Longwall 304 Subsidence Monitoring Program was prepared to validate subsidence predictions and analyse the relationship between the subsidence effects and subsidence impacts of the Metropolitan Coal Longwall 304 Extraction Plan in accordance with Condition 6(e), Schedule 3 of the Project Approval.

Subsidence movements are surveyed in three dimensions using a total station survey instrument and real time Global Navigation Satellite System units. The subsidence parameter monitoring locations are shown on Figure 6.

A review of the subsidence survey results and comparison between the predicted and observed subsidence movements for the review period has been conducted by Mine Subsidence Engineering Consultants (MSEC). The report prepared by MSEC is provided in Appendix A. A summary of the key findings is provided below.

6.1.1 Predicted and Observed Subsidence Movements

The review period included the completion of Longwall 303 and partial extraction of Longwall 304. Details of the observed and predicted subsidence movements at the subsidence monitoring locations (300 XL Line, Princes Highway Line, Optic Water Line, M1 North Bound Line, Transmission Line, Transmission Towers, Telecommunication Towers, Bridge 2 [Old Princes Highway Underpass], Cawley Road Overbridge, Eastern Tributary Cross Line and Ridge Top Survey Stations) are provided in Appendix A. The monitoring locations are shown on Figure 6.

The observed subsidence profile shapes and subsidence parameters were generally similar to those predicted or within limits of accuracy of the predicted subsidence parameters. The maximum observed total conventional subsidence along the 300 XL Line and Optic Water Line was greater than predicted. The greater than predicted subsidence at the northern end of the longwalls is believed to have been influenced by variation in extracted seam thickness due to operational and geotechnical reasons at the northern end of Longwall 301 (Appendix A).

During the reporting period, Metropolitan Coal also continued its trial of the effectiveness of LiDAR as a subsidence survey technique compared to traditional subsidence survey techniques following the extraction of Longwall 303. The ground movements measured using the LiDAR surveys are generally consistent with the predictions and observed survey data along the monitoring lines (Appendix A).

Metropolitan Coal used a Trigger Action Response Plan (TARP) designed to monitor valley closure movements on the Eastern Tributary. The Eastern Tributary Valley Closure TARP has been successfully implemented by Metropolitan Coal for Longwall 303.

A maximum total closure of 14 millimetres (mm) was observed across rockbar ETAU at 27 December 2019. Minor upsidence of less than 8 mm was also observed in the relative subsidence monitoring data. The results were reviewed by a Technical Committee, comprising industry and technical representatives, in accordance with the TARP. Metropolitan Coal made a decision to cease mining of Longwall 304 on 31 December 2019 based on the increasing rate of closure observed at ETAU. Longwall 304 was completed 28 January 2020 at chainage 130 metres (m) with no observed impact to the pool upstream of rockbar ETAU.

Condition 3, Schedule 3 of the Project Approval states:

3. *If the subsidence effects and subsidence impacts of the project exceed the relevant predictions by more than 15% at any time after mining has progressed beyond the halfway mark of Longwall 21, or if the profile of vertical displacement does not reflect predictions, then the Proponent shall use appropriate numerical modelling to supplement the subsequent predictions of subsidence effects and subsidence impacts for the project to the satisfaction of the Director-General.*

A comparison of the maximum observed and maximum predicted total conventional subsidence for the Project after each longwall for Longwalls 3 to 27 and Longwalls 301 to 303 and partial extraction of Longwall 304 is shown in Chart 1. The comparison of conventional subsidence effects excludes the valley cross lines which represent non-conventional subsidence movements.

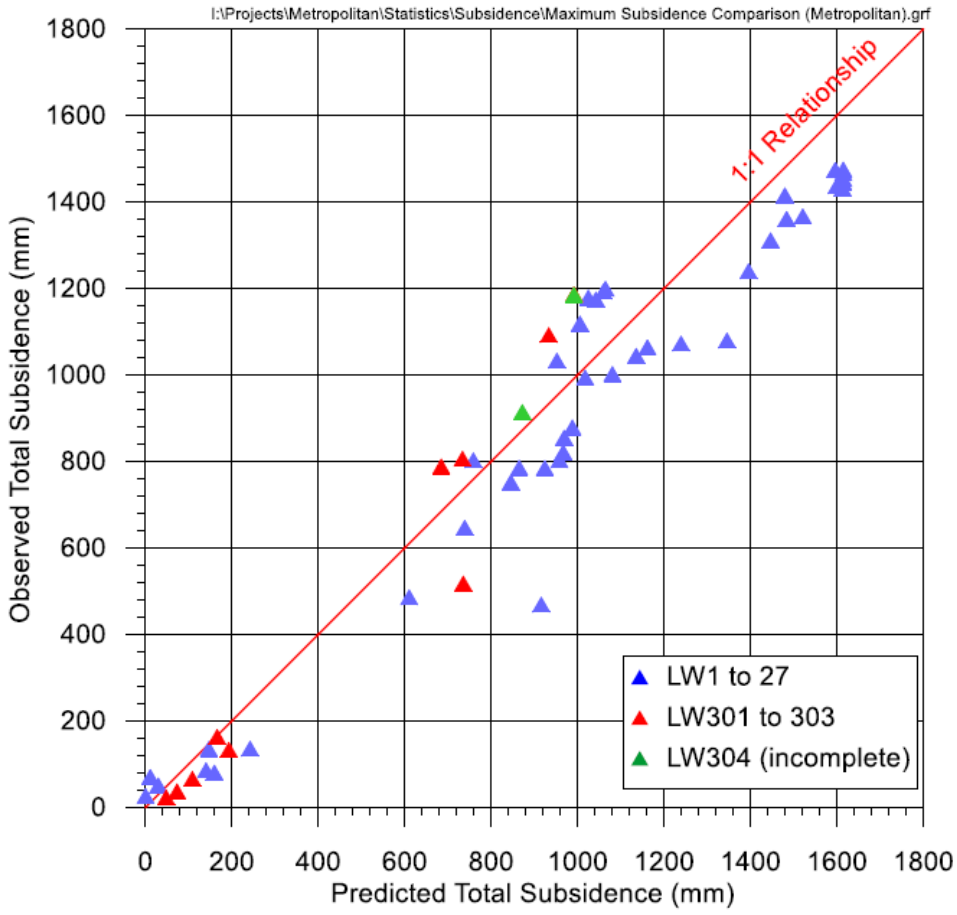


Chart 1 Comparison Between the Maximum Observed and Maximum Predicted Total Conventional Subsidence for Longwalls 3 to 27, Longwalls 301 to 303 and Partial Extraction of Longwall 304 at Metropolitan Colliery

An analysis of the maximum observed versus maximum predicted vertical subsidence was undertaken by MSEC (Appendix A). Based on the results of survey data to date and comparison with predicted conventional subsidence parameters, the profiles of vertical displacement adequately reflect the predictions. The overall subsidence effects of the project do not exceed predictions by more than 15% (Appendix A).

6.2 WATER MANAGEMENT

The Metropolitan Coal Longwall 304 Water Management Plan was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwall 304 Extraction Plan on watercourses (including the Woronora Reservoir), aquifers and catchment yield in accordance with Condition 6, Schedule 3 of the Project Approval.

The Longwall 304 Water Management Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303.

Hydro Engineering & Consulting (Appendices B1 and B2) and HydroSimulations (Appendices C1 and C2) have reviewed the environmental performance of the Project in relation to surface water and groundwater in the underground mining area and surrounds for the reporting period.

The surface water, groundwater and meteorological monitoring locations are shown on Figures 7 to 12.

Sections 6.2.1 to 6.2.11 provide a summary of the surface water and groundwater assessments for the reporting period. Section 6.2.12 provides a summary of the Woronora Reservoir Impact Strategy, conducted in accordance with Condition 2 of the Longwalls 301 and 302 approval.

Section 6.8 provides a summary of the assessments against the water resource and watercourse subsidence impact performance indicators and measures for the reporting period.

6.2.1 Stream Features

Visual inspections and photographic surveys of Waratah Rivulet (from Pool P [downstream of Longwall 23] to the full supply level of the Woronora Reservoir) and the Eastern Tributary (from the full supply level of the Woronora Reservoir to the maingate of Longwall 26) were conducted within three months of the completion of Longwall 303.

The visual and photographic surveys conducted at the completion of each longwall provide a detailed photographic record of stream features. The visual and photographic surveys have recorded observations of mining impacts including surface cracking, iron staining, gas releases and water discoloration/opacity. A summary of the observations for the reporting period is provided for the Waratah Rivulet (Table 6) and Eastern Tributary (Table 7). The location of mapped pools on the Waratah Rivulet and Eastern Tributary are provided in Appendix D.

During the reporting period, weekly inspections have also been undertaken where gas releases occur, and monthly inspections have been undertaken of the Eastern Tributary between the full supply level of the Woronora Reservoir and the Longwall 26 maingate to document surface cracking and iron staining. The results of these inspections are included in Table 7.

Visual inspections and photographic surveys of the Waratah Rivulet (from Pool P to the full supply level of the Woronora Reservoir) and Eastern Tributary (from the Woronora Reservoir full supply level to the Longwall 26 maingate) will be conducted within three months of the completion of Longwall 304 (i.e. within the next reporting period). Visual inspection and photographic surveys of the Eastern Tributary from the full supply level of the Woronora Reservoir to the maingate of Longwall 26 will also be conducted monthly when mining of longwalls 304 and 305 is within 400 m of the stream.

Table 6
Monitoring of Stream Features – Waratah Rivulet, Downstream of Longwall 23 Maingate

Stream Feature	Summary of Observations
Surface Cracking	No surface cracking was observed downstream of the Longwall 23 maingate on the Waratah Rivulet during the Longwall 303 inspections. The performance indicator, *No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W*, was not exceeded during the reporting period.
Surface Flow/ Pool Water Levels	During the Longwall 303 visual inspections in June 2019, the surface flow/pool water levels were noted to be lower than, or consistent with, the October 2018 inspection (following the completion of Longwall 302) as a result of the prevailing climatic conditions. The performance indicator, *No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W*, was exceeded at Pool U in August and September 2019. The recorded water level in Pool U fell below its previous minimum in August and September 2019, and did not appear to be due to an error type, nor was the same behaviour observed at the control pools on the Woronora River. An assessment against the performance measure was undertaken for Pool U (Appendix E) and confirmed the performance measure had not been exceeded. Water levels in pools on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir (i.e. in Pools P, Q, R, S, T, U, V and W) have been monitored using a continuous water level sensor and logger (Figure 7 and Appendix D). The monitoring results for the reporting period are discussed in Section 6.2.3 and Appendices B1 and B2.
Iron Staining/ Flocculent	No change in iron staining was observed between Pools P to W on the Waratah Rivulet as a result of mining during the reporting period. Natural seeps and associated iron staining (as recorded by baseline mapping) continue to be recorded within this reach. The performance indicator, *Visual inspection of the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir does not show significant changes in the extent or nature of iron staining that isn't also occurring in the Woronora River (control site)*, was not exceeded during the reporting period.
Gas Releases	Gas releases continued to be observed and monitored on the Waratah Rivulet at: • Pool A, from January to November 2019; • Pool L, from January to October 2019; • Pool P, from January to June and August to November 2019; • Pool S, from January to March 2019; and • Pool U, from January to July and September to November 2019. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed. The performance indicator, *Gas releases in Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir have not increased beyond those observed up to the commencement of Longwall 301 extraction*, was exceeded at Pool P in August and September 2019 and at Pool U in July, September and October 2019. Assessments against the performance measure were undertaken (Appendices F1 and F2) and confirmed the performance measure had not been exceeded.
Water Discoloration/ Opacity	Pools along the Waratah Rivulet continue to be observed with a green opacity.

Table 7
Monitoring of Stream Features – Eastern Tributary, between the Full Supply Level of the Woronora Reservoir and the Longwall 26 Maingate

Stream Feature	Summary of Observations
Surface Cracking	As at 8 December 2019, cracking had been recorded at Rock bar ETAF(2), Pool ETAG, Pool ETAH, Rock bar ETAH, Pool ETAI, Rock bar ETAI, Pool ETAJ, Pool ETAK, Rock bar ETAK, Pool ETAL, Boulderfield ETAL, Rock bar ETAL, Pool ETAM, Boulderfield ETAM, Pool ETAN, Rock bar ETAN, Pool ETAO, Rock bar ETAO, Pool ETAP, Boulderfield ETAP, Rock bar ETAP, Pool ETAQ, Rock bar ETAQ, Pool ETAR, Rock bar ETAR and Rock bar ETAU. Monthly inspections undertaken from January to December 2019 identified new cracking at Pool ETAH, Pool ETAL and Pool ETAO. Existing cracking was observed to have widened at Boulderfield ETAM. No cracking has been recorded at Pool ETAS or Pool ETAT to date. No changes to the existing cracking at Pool ETAU were observed during the reporting period. The performance indicator, *No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU*, was not exceeded during the reporting period.
Surface Flow/ Pool Water Levels	In January 2017, impacts to Eastern Tributary pools resulted in the exceedance of the negligible environmental consequences performance measure for the Eastern Tributary in relation to diversion of flows and drainage behaviour (emphasis added): *Negligible environmental consequences over at least 70% of the stream length (that is **no diversion of flows, no change in the natural drainage behaviour of pools,** minimal iron staining and minimal gas releases).* The exceedance of this component of the Eastern Tributary performance measure was reported to the DP&E and other relevant agencies in February 2017. A summary of the Eastern Tributary Incident was provided in the Metropolitan Coal 2016 Annual Review and an update was provided in the Metropolitan Coal 2017 Annual Review. In summary, between the full supply level of the Woronora Reservoir and the Longwall 26 maingate, mine subsidence has resulted in the diversion of flows or change to the natural drainage behaviour of Pools ETAG to ETAR (Figure 7 and Appendix D). As at December 2019, mining had not resulted in the diversion of flows or change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU (Figure 7 and Appendix D). The performance indicator for visual observations, *No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU*, was not exceeded during the reporting period. Water levels in Pool ETAU and in Pools ETAS/ETAT (since May 2018) have been monitored using a continuous water level sensor and logger (Figure 7 and Appendix D). The monitoring results are discussed in Section 6.2.3 and in Appendices B1 and B2 and indicate the natural drainage behaviour of Pools ETAS/ETAT and ETAU have not been impacted by mine subsidence.
Iron Staining/ Flocculent	On 14 October 2016, Metropolitan Coal reported the exceedance of the Eastern Tributary performance measure in relation to iron staining to the DP&E and other relevant agencies (emphasis added): *Negligible environmental consequences over at least 70% of the stream length (that is no diversion of flows, no change in the natural drainage behaviour of pools, **minimal iron staining** and minimal gas releases).* A summary of the Eastern Tributary Incident was provided in the Metropolitan Coal 2016 Annual Review and an update was provided in the Metropolitan Coal 2017 Annual Review. Since October 2016, inspections have been conducted monthly to record the extent of iron staining. From January to December 2019, iron staining was not visible from Boulderfield ETAF to Rock bar ETAP as a result of the limited amount or absence of water in the pools, however iron staining was typically evident in the reach from Pool ETAQ to Boulderfield ETAU.
Gas Releases	No gas releases were observed on the Eastern Tributary during the reporting period. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed. The performance indicator, *Gas releases in Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26 have not increased beyond those observed up to the commencement of Longwall 301 extraction*, was not exceeded during the reporting period.
Water Discoloration/ Opacity	Orange in colour where iron staining occurred. Pools along the Eastern Tributary observed with a green opacity.

The results of the stream inspections are consistent with the potential subsidence impacts described in the Metropolitan Coal Project Environmental Assessment (Project EA) (Helensburgh Coal Pty Ltd [HCPL], 2008), the Preferred Project Report (HCPL, 2009) and the Longwall 304 Water Management Plan, including cracking and dilation of bedrock which has resulted in the localised diversion of a portion of the surface flow through either:

- **diversion into subterranean flows**, where water travels via new mining induced fractures and opened natural joints in the bedrock into near-surface dilated strata beneath the bedrock, ultimately re-emerging at the surface downstream; or
- **leakage through rock bars**, where the rate of leakage from pools through rock bars to the downstream reaches of the stream is increased by new mining induced fractures.

The Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans indicated that the effects of underflow would be localised to the subsidence affected reaches of streams. Underflow has been observed to result in lower water levels in pools as they become hydraulically connected with the fracture network. During prolonged dry periods when flows recede to low levels, the number of instances where loss of flow continuity between pools occurs increases with a greater proportion of the flow being conveyed entirely in the subsurface fracture network.

The Preferred Project Report and Longwall 304 Water Management Plan indicated that valley closure values of greater than 200 mm were predicted at pools/rock bars on the Waratah Rivulet upstream of the maingate of Longwall 23, downstream to rock bar ETAL on the Eastern Tributary, and on Tributary B. The NSW Planning Assessment Commission's Report for the Metropolitan Coal Project (NSW Planning Assessment Commission, 2009) indicates the Panel considered 'negligible consequence' for a watercourse to mean, *'no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases'*, and was assumed to be achieved in circumstances where predicted valley closure was less than 200 mm.

Up until December 2016, the monitoring of water levels/drainage behaviour of pools on the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir was consistent with predictions. In the Longwalls 20-22 Extraction Plan Subsidence Assessment it was recognised that fracturing resulting in surface flow diversion could be observed at a site where the predicted total closure is less than 200 mm, although none had been observed to date. The report also noted that reference to the 200 mm predicted total closure value should be viewed as an indication of low probability (10%) of impact rather than certainty. In the Longwalls 23-27 Extraction Plan Subsidence Assessment, additional case studies were added to the pool impact model, including cases where loss of pool water levels had occurred at less than 200 mm predicted total closure. Similar to the previous database for Longwalls 20-22, the updated database showed that based on a maximum predicted total closure of 200 mm, the proportion of pools that experienced loss of pool water levels was around 10%.

In December 2016 and January 2017, a number of pools with predicted closure values of less than 200 mm experienced loss of pool water levels. This resulted in the exceedance of the negligible environmental consequences performance measure for the Eastern Tributary in relation to diversion of flows and drainage behaviour. The impacts are considered to be anomalous in that more than 15% of pools on the Eastern Tributary have experienced loss of pool water levels at predicted closure values of less than 200 mm. However, the combined data that is available to MSEC for the Southern Coalfield (including the Waratah Rivulet and Eastern Tributary results) indicates that less than 10% of all pools have experienced the diversion of flow at predicted closure values of less than 200 mm, consistent with previous assessments of potential pool impacts. On their own, the impacts for the Eastern Tributary are outside of the predictions of the empirical based model.

Metropolitan Coal's actions in relation to the Eastern Tributary Incident are described in Section 13.1. No additional pools downstream of the Longwall 26 maingate to those identified previously as being impacted (in terms of drainage behaviour) have been impacted during the review period.

The key potential subsidence impacts and environmental consequences in relation to bed gradients, scouring and stream alignment described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans included:

- Potential changes in bed gradients could occur, however, were anticipated to be small relative to the existing grades.
- An increased potential for scouring of the stream bed and banks (at locations where the predicted tilts considerably increase the natural pre-mining stream gradients). The potential for scouring is greatest in stream sections with alluvial deposits. Since the streambed of the Waratah Rivulet and the Eastern Tributary is predominantly erosion-resistant Hawkesbury Sandstone, scouring was expected to be very low.
- Subsidence fracturing of bedrock has the potential to cause dislodgement of rock fragments during high flow events.
- The potential for changes to stream alignment as a result of mine subsidence effects was considered to be low.
- Minor stream bank erosion, where changes in channel gradients result in increases in flow energy. It would be expected that bank erosion would be relatively minor and comprise a slow retreat of the bank until a new dynamic equilibrium is reached.

The results of the stream inspections have generally been consistent with these predictions. On the Waratah Rivulet (in a section of the stream over Longwall 21) and Eastern Tributary (in a section of the stream over Longwalls 20 and 21) increased ponding from changes in bed gradients has previously resulted in the prolonged inundation of the adjacent riparian vegetation which has resulted in some vegetation dieback on a local scale as described in Section 6.3.3.

As described in the Southern Coalfield Panel Report (Department of Planning [DoP], 2008) and the NSW Planning Assessment Commission's Report for the Metropolitan Coal Project (NSW Planning Assessment Commission, 2009), under certain conditions the cracking of stream beds and underlying strata has the potential to result in changes in water quality, particularly ferruginous springs and/or development of iron bacterial mats. Experience at Metropolitan Coal prior to Project Approval indicated that areas of the substratum can be covered by iron flocculent material for several hundred metres downstream of mine subsidence fractures.

Metropolitan Coal has monitored the extent of iron staining through visual and photographic surveys and assessed the extent of iron staining against the subsidence impact performance measures as follows:

- *Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).*
- *Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.*

From January to December 2019, iron staining was not visible within the Eastern Tributary from Boulderfield ETAF to Rock bar ETAP as a result of the limited amount or absence of water in the pools, however iron staining was typically evident in the reach from Pool ETAQ to rockbar ETAU.

Prior to approval of the Project in 2009, no gas releases had been observed along the Waratah Rivulet, Eastern Tributary or other tributaries over the Metropolitan Coal lease, either before or during mining. Notwithstanding, the Project EA, Preferred Project Report, and Longwall 304 Water Management Plan recognised there was the potential for gas releases to occur.

Monitoring of gas releases undertaken during the reporting period in accordance with the Metropolitan Coal Longwall 304 Water Management Plan identified an exceedance of the performance indicator (with regard to free carbon dioxide as CO_2 concentrations) at Pools P and U on the Waratah Rivulet (Pool P – 32 mg/L on 6 August 2019 and 20 mg/L on 3 September 2019, and Pool U – 34 mg/L on 31 July 2019, 38 mg/L on 3 September 2019 and 20 mg/L on 15 October 2019). No other gas releases observed on the Eastern Tributary or Waratah Rivulet exceeded the performance indicator. Assessment of the gas releases in Pools P and U on the Waratah Rivulet for the period July to September 2019 (provided in Appendix F1) and for October 2019 (provided in Appendix F2) indicate the Waratah Rivulet subsidence impact performance measure had been met.

6.2.2 Surface Water Flow

Waratah Rivulet stream flow data (GS 2132102, Figure 7) is analysed to assess whether a statistically significant reduction in the quantity of water entering Woronora Reservoir in the post-mine period relative to the pre-mine period has occurred, that has not also occurred in the control catchment(s).

The quantity of water entering the Woronora Reservoir is not considered to be significantly different post-mining compared to pre-mining if the median of the ratios (of 14 day sums of monitored flow) for the 'sliding' 12 month period does not fall below the 20th percentile of the baseline data.

The streamflow records for GS 2132102 provided by WaterNSW were incomplete for the review period and, as such, assessment of the results for the review period, 1 July to 31 December 2019, against the Longwall 304 Water Management Plan significance levels/triggers was unable to be conducted at the time of reporting. Assessment against the performance indicator for the review period, 1 July to 31 December 2019, will be undertaken in the next review period (Appendix B2). The 12 month sliding median is shown on Chart 2.

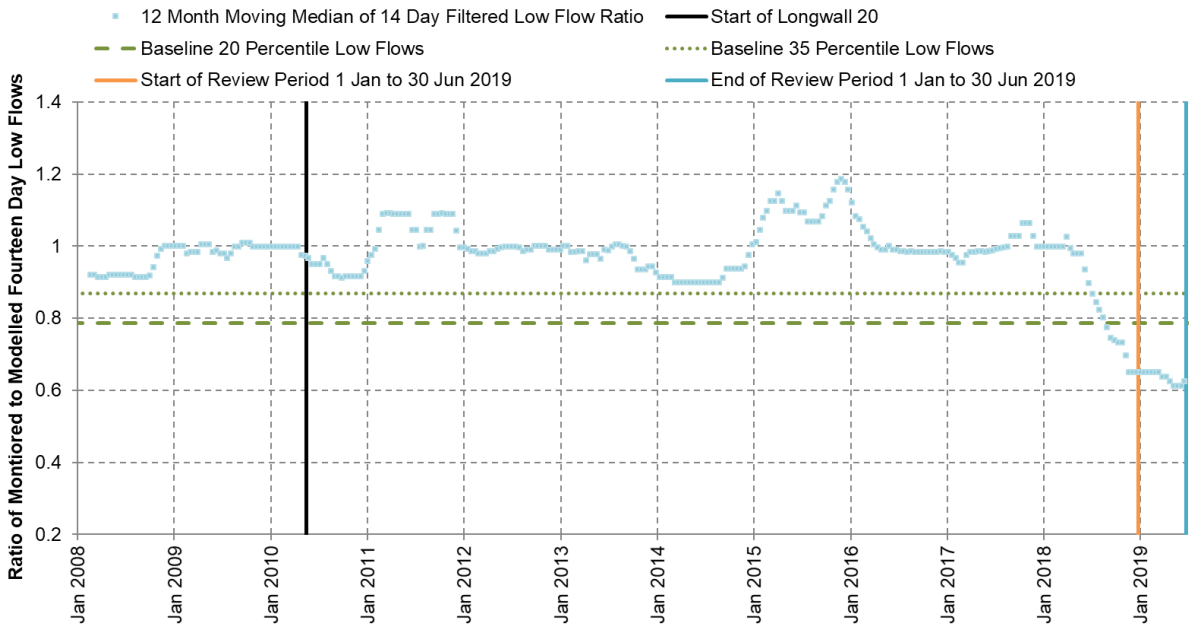


Chart 2 One Year Sliding Median for the Ratios of the 14 Day Sums of Monitored and Modelled Flow Rates at Waratah Rivulet (GS 2132102)

For the Project EA a comprehensive analysis of stream flow data and data on the yield behaviour of Woronora Reservoir indicated that past mining at Metropolitan Coal had no discernible effect on the inflow to, or yield from, the reservoir. Surface water flow monitoring indicates there has been a negligible reduction in the quantity of water resources reaching the Woronora Reservoir during the review period.

The results show that the 12 month sliding median of the 14 day filtered low flow fell below the 20th percentile of the baseline data during 2018 and remained below the 20th percentile of the baseline data during the January to June 2019 review period. Results of the assessment for the review period indicate that the performance indicator for the quantity of flow reaching the Woronora Reservoir from Waratah Rivulet was not exceeded between January and June 2019 (Appendix B2).

Chart 3 shows the flow monitoring data that is available since gauging station construction on the Eastern Tributary (GS 300078; Figure 7) in September 2012 compared to model predictions. The results for the reporting period indicate that flow has been continuous at the gauging station and that it has been generally consistent with, or above, model predictions (Chart 3). This indicates that flows reaching the Woronora Reservoir have not been reduced by mining (Appendices B1 and B2).

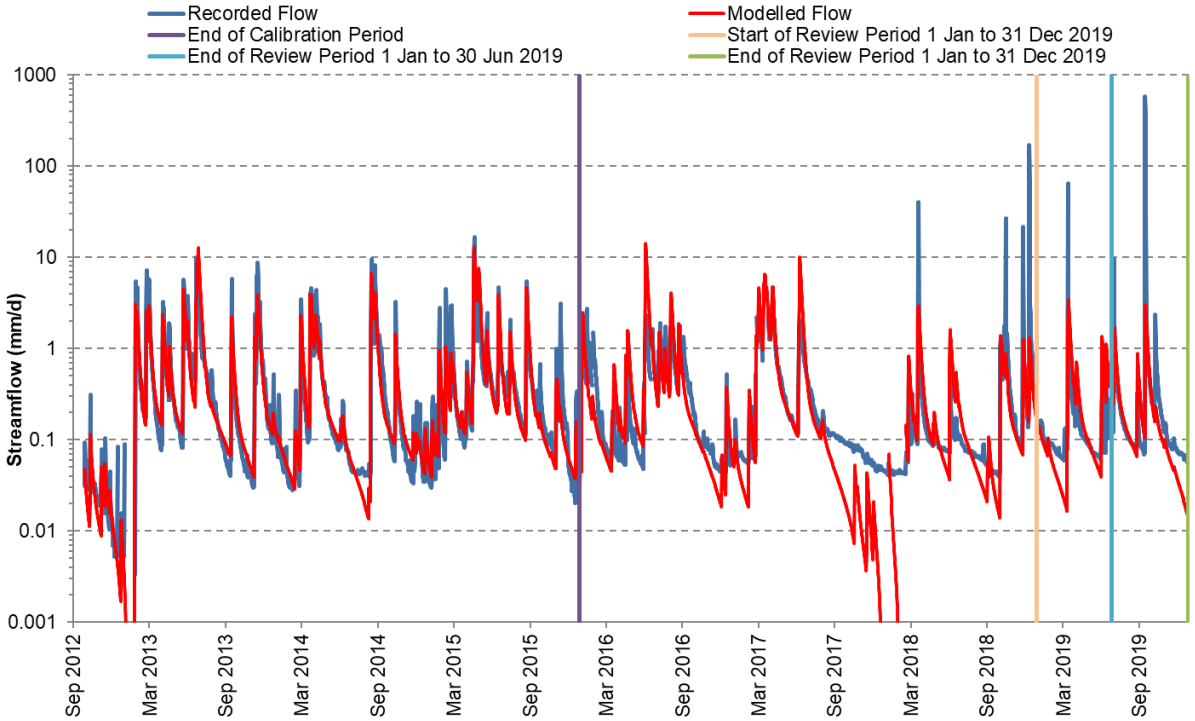


Chart 3 Monitored and Model Predicted Flows – Eastern Tributary Upstream of Woronora Reservoir

6.2.3 Pool Water Levels

The water level in a number of pools on the Waratah Rivulet, Eastern Tributary, Tributary B and Woronora River (Figure 7) has been either manually monitored on a daily basis[2] or monitored using a continuous water level sensor and logger.

During the reporting period, Waratah Rivulet Pools C, D, E, F, G, G1, H, I, J, K, M, O, P, Q, R, S, T, V and W remained above their cease to flow levels or historical minimums. Pools A, B, L, N and U on the Waratah Rivulet (Charts 4 to 8) fell below their cease to flow levels or historically low water levels during the reporting period. Pool A fell below the cease to flow level from February until mid-March 2019 and in late December 2019, Pool B fell below the cease to flow level from mid-December 2019 and Pool N fell below the cease to flow level for a short period in March 2019 and from mid-December 2019. Records for Pool L indicate that the water level fell below the cease to flow level for two one-hour periods in November and one one-hour period in December 2019, though did not fall below the previously recorded minimum. The Pool U water level fell below the previously recorded minimum water level in August, September, November and December 2019. The reduction in water levels at these pools is consistent with a reduction in water levels in the control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River (Charts 9 to 12) during the same periods (Appendices B1 and B2). Water level records for control pools WRP1, WRP2, WRP3 and WRP4 indicate that the pool water levels declined during these periods, with a substantial decline recorded between November and December 2019. The WRP1 water level declined below the historically recorded minimum for parts of October, November and December 2019, while the water level of WRP 2, WRP 3 and WRP 4 declined below the historically recorded minimum in December 2019 (Appendix B2).

There was an exceedance of the performance indicator *Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum* for Pool U in August and September 2019. The water level for Pool U fell below its previous minimum and did not appear due to an error type, nor was the same behaviour observed at the control pools on Woronora River (e.g. the water level in the control pools did not fall below their historical minimum). In accordance with the Longwall 304 Water Management Plan, this triggered an assessment against the performance measure by HEC (Appendix E).

The assessment found that the performance measure *Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)* was not exceeded (Appendix E).

Mining has not resulted in the diversion of flows or change to the natural drainage behaviour of pools on the Waratah Rivulet downstream of the maingate of Longwall 23 (i.e. Pools P to W).

[2] Specifically, Pools B, C, E, G, G1, H and I on Waratah Rivulet.

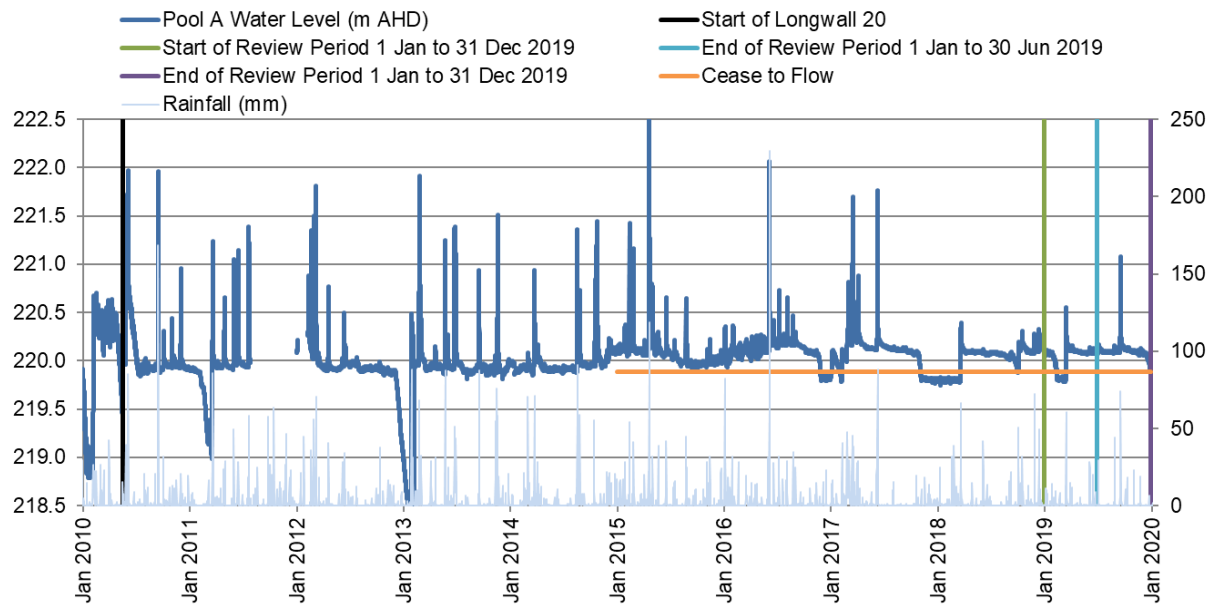


Chart 4 Pool A Waratah Rivulet

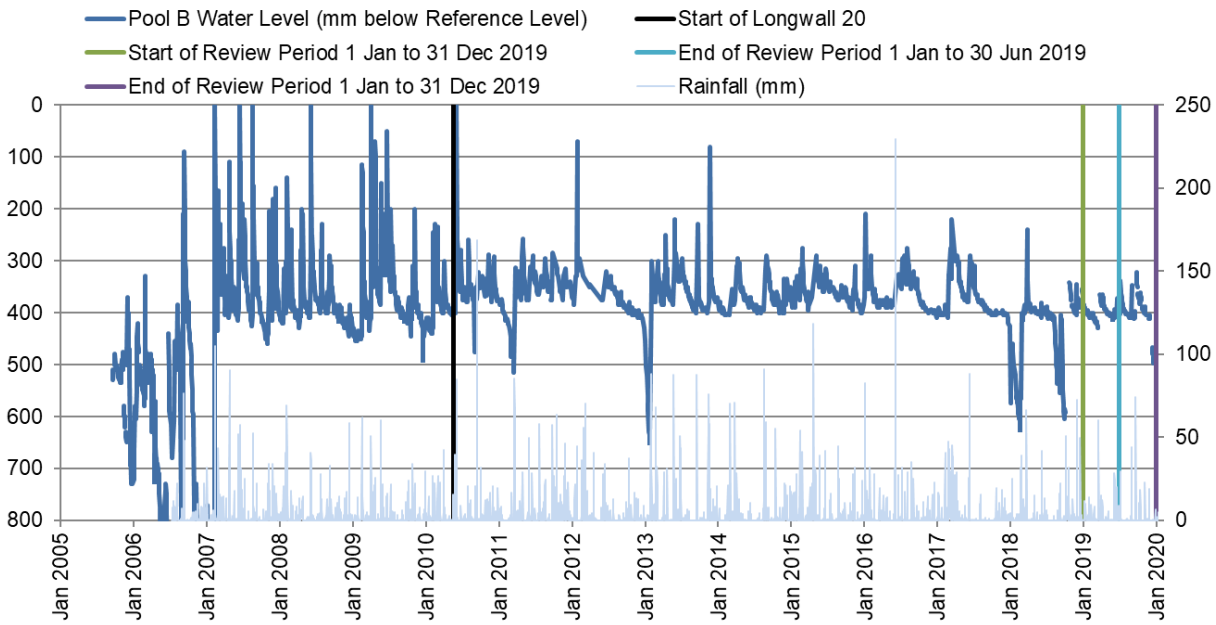


Chart 5 Pool B Waratah Rivulet (Manual Observations)[3]

[3] Data gaps in the manual measurements for Pool B during the review period are due to periods in which high rainfall or fire restrictions prevented access to the monitoring site.

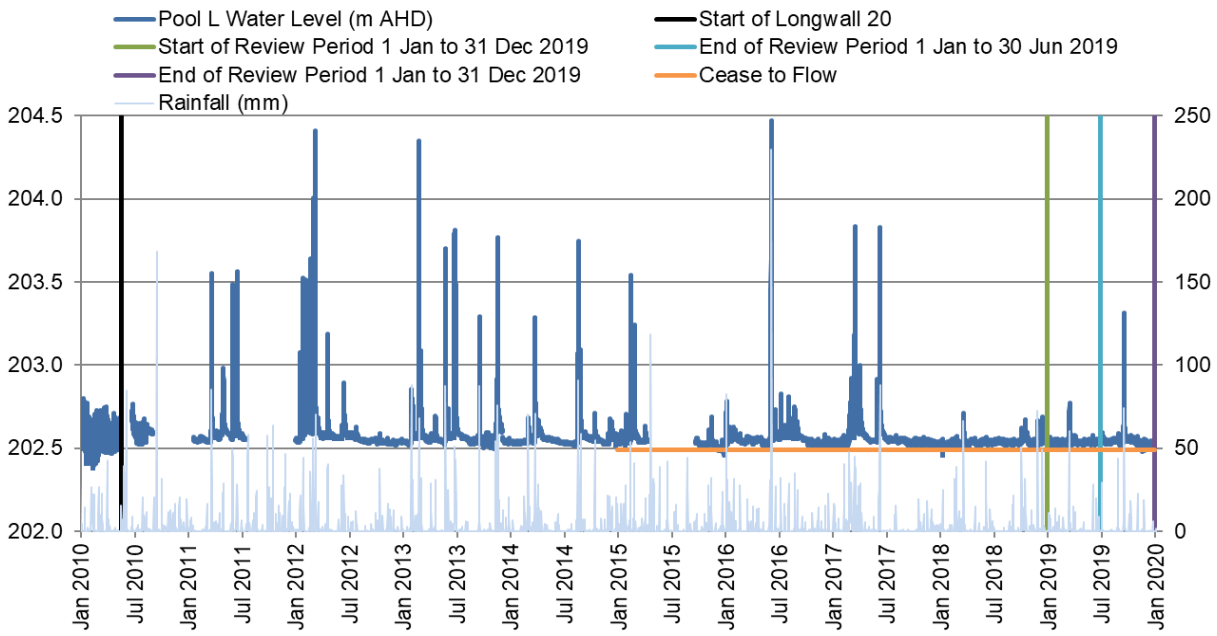


Chart 6 Pool L Waratah Rivulet

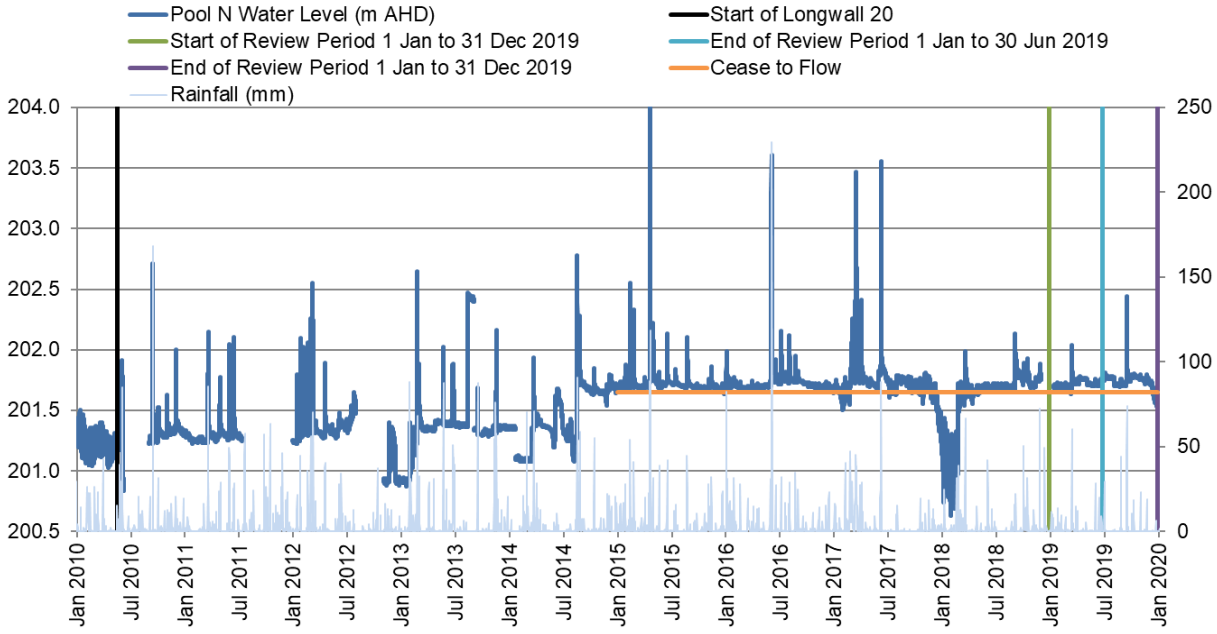


Chart 7 Pool N Waratah Rivulet[4]

[4] Pool N water level sensor did not record any data during December 2018. Subsequently, the sensor was replaced in January 2019.

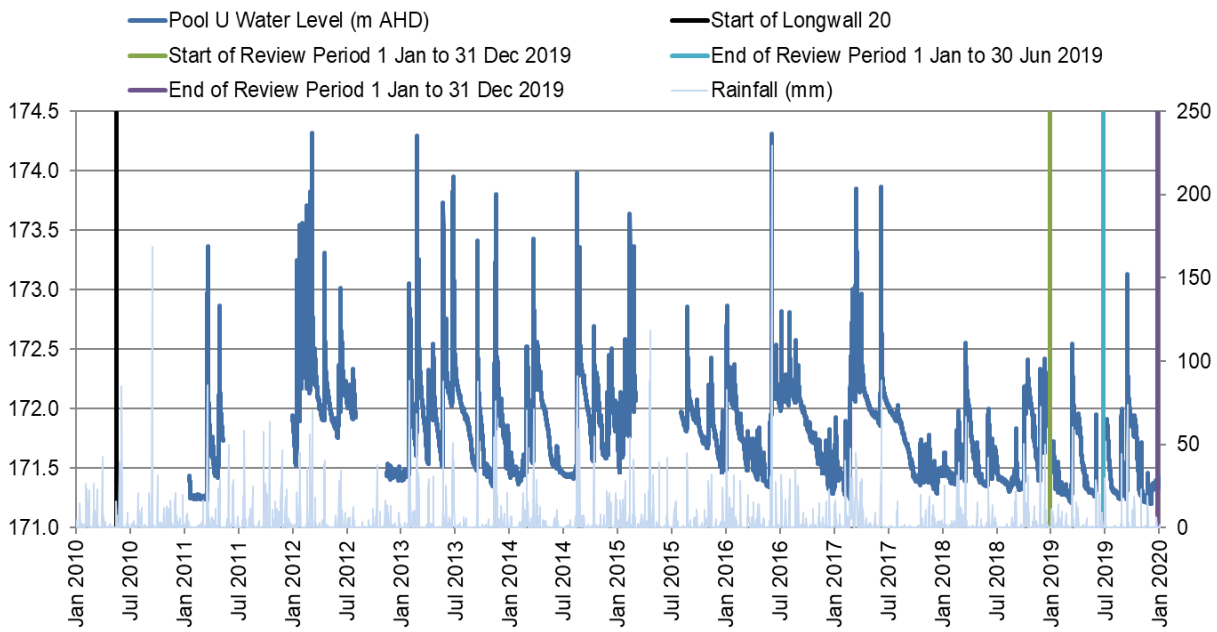


Chart 8 Pool U Waratah Rivulet[5]

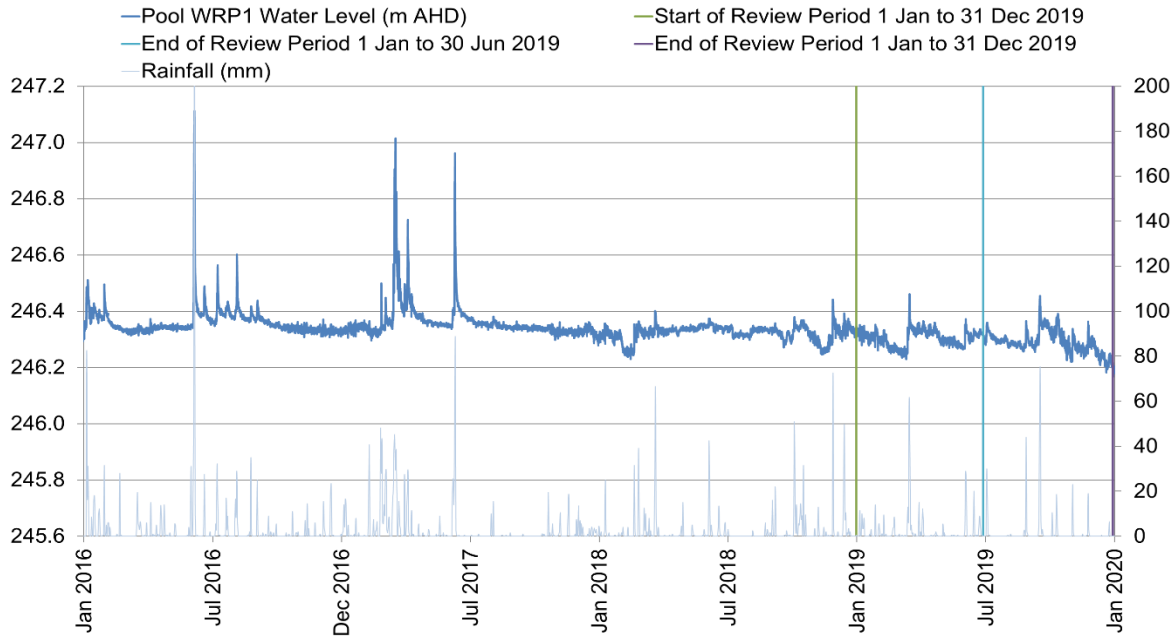


Chart 9 Pool WRP1

[5] The sensor malfunctioned on 6 June 2019 and was replaced in July 2019. The sensor malfunctioned on 8 December 2019 and was replaced in February 2020. As such, no data was recorded during these periods.

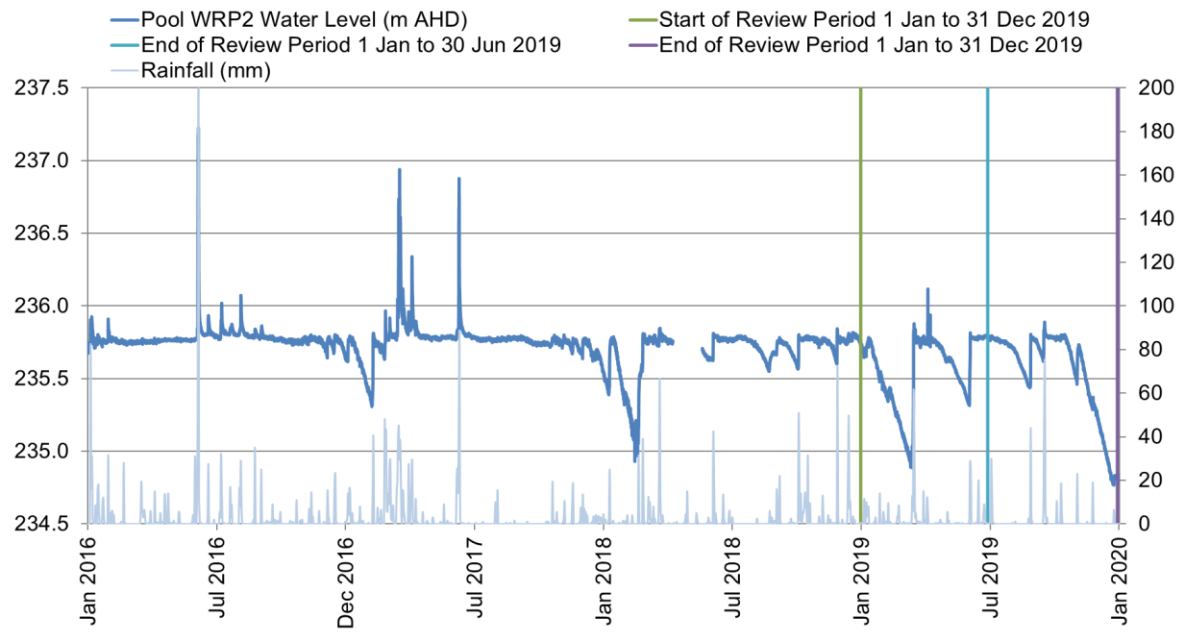


Chart 10 Pool WRP2

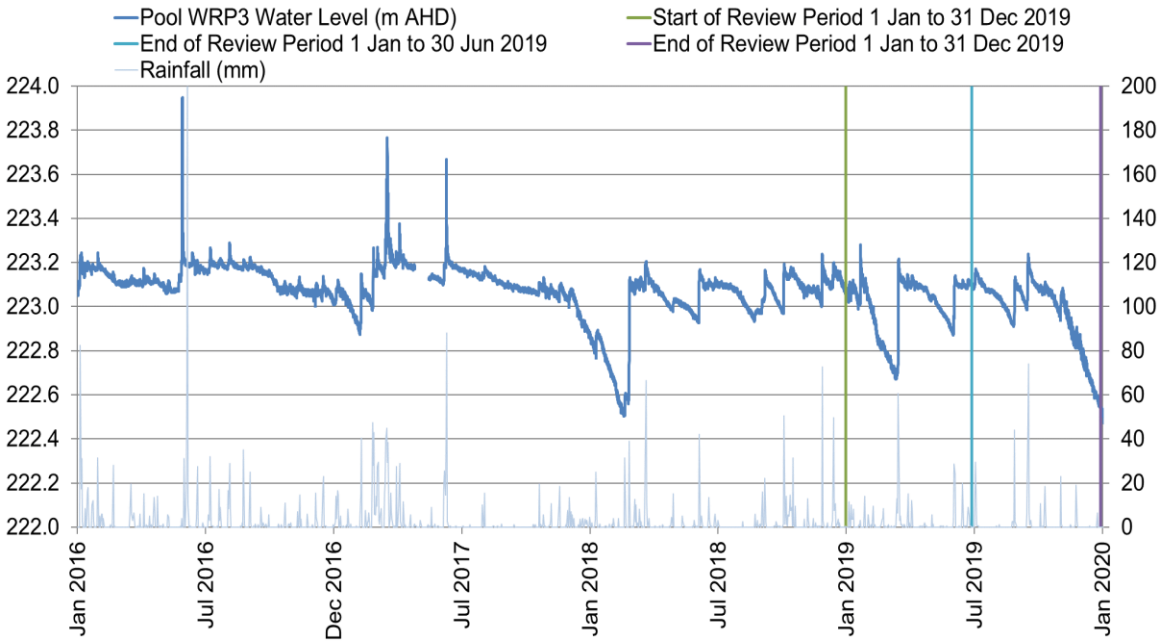


Chart 11 Pool WRP3

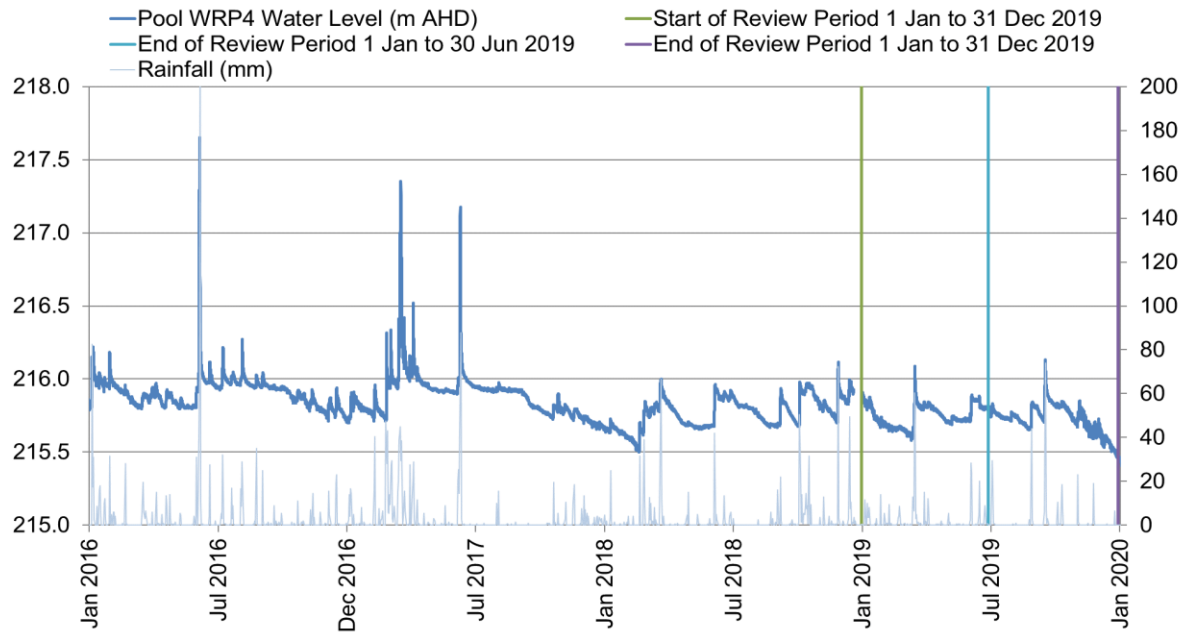


Chart 12 Pool WRP4[6]

On the Eastern Tributary, water levels in Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK[7], ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT[8] and ETAU are monitored using a continuous water level sensor and logger (Figure 7).

Water levels in Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP and ETAQ on the Eastern Tributary were regularly below their cease to flow levels or historically low water levels during the reporting period (Charts 13 to 27). These pools water levels responded to rainfall events during the reporting period before returning to below their cease to flow levels or sensor levels. The water level of Pool ETAR was above the sensor level for the majority of the reporting period, except in late December 2019, where the water level fell below the sensor level (Chart 28). The water level of Pool ETAS/ETAT and Pool ETAU did not fall below their cease to flow level during the reporting period (Appendices B1 and B2).

Consistent with historical behaviour, Pool RTP1 on Tributary B was not flowing for the majority of the reporting period, except for a short duration following a rainfall event in September 2019. Pool RTP2 on Tributary B was typically below its cease to flow level, however water levels rose for short durations following rainfall events (Appendices B1 and B2).

[6] Pool water level data for WRP4 was erroneous from 20/12/2018 to 01/01/2019 and removed from the dataset. The erroneous data was a result of a logger positioning error.

[7] Only small rock bars separate Pools ETAI, ETAJ and ETAK, with the pools joining to become the one large pool as water levels rise. Pool ETAK is controlled by a more substantial rock bar. Readings from the water level sensor situated in Pool ETAI is considered to also be representative of the water level in Pools ETAJ and ETAK.

[8] Due to the nature of rock bar ETAS, Pool ETAS and Pool ETAT typically record the same level. A continuous water level sensor and logger was installed at Pool ETAT during the reporting period. Water level data for Pools ETAS/ETAT is available from 24 May 2018.

As described in Section 6.2.1, the Eastern Tributary pool water level monitoring results for the review period were consistent with the potential subsidence impacts and environmental consequences described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans in that data that is available to MSEC for the Southern Coalfield (including the Waratah Rivulet and Eastern Tributary results) indicates that less than 10% of all pools have experienced the diversion of flow at predicted closure values of less than 200 mm, consistent with previous assessments of potential pool impacts. On their own, the impacts for the Eastern Tributary are outside of the predictions of the empirical based model.

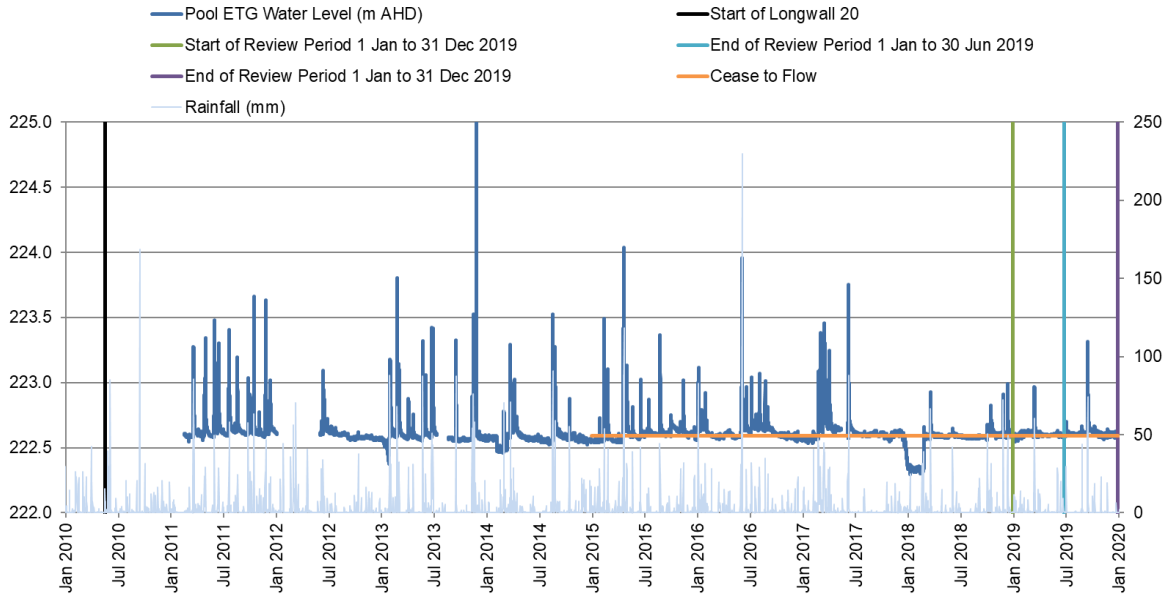


Chart 13 Pool ETG

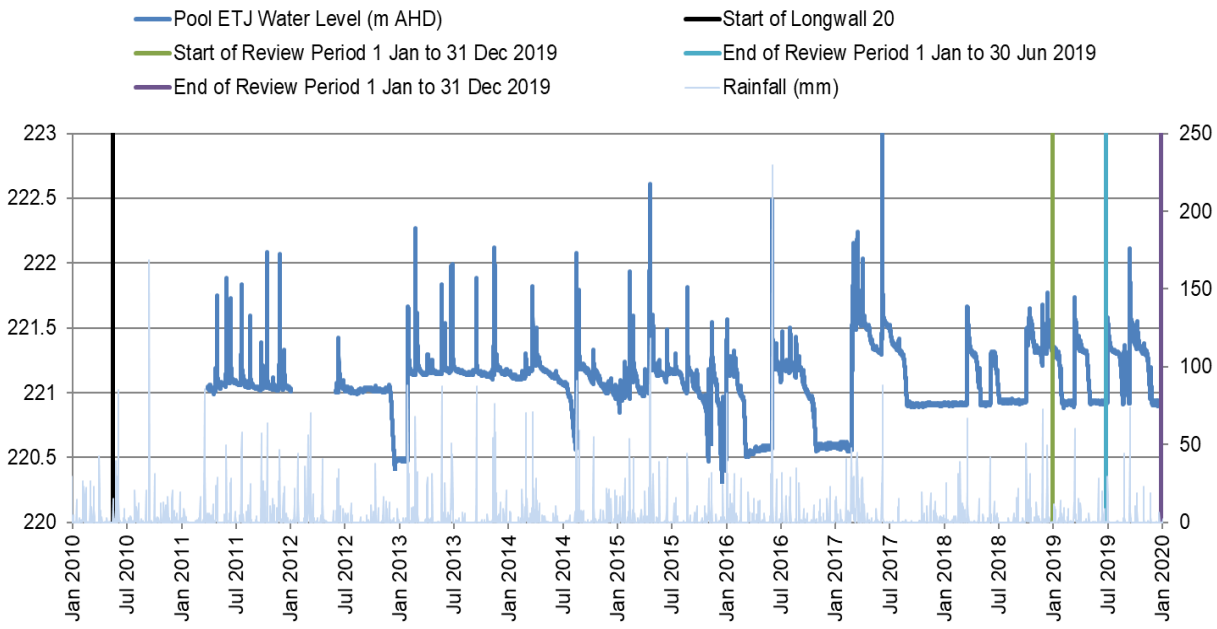


Chart 14 Pool ETJ

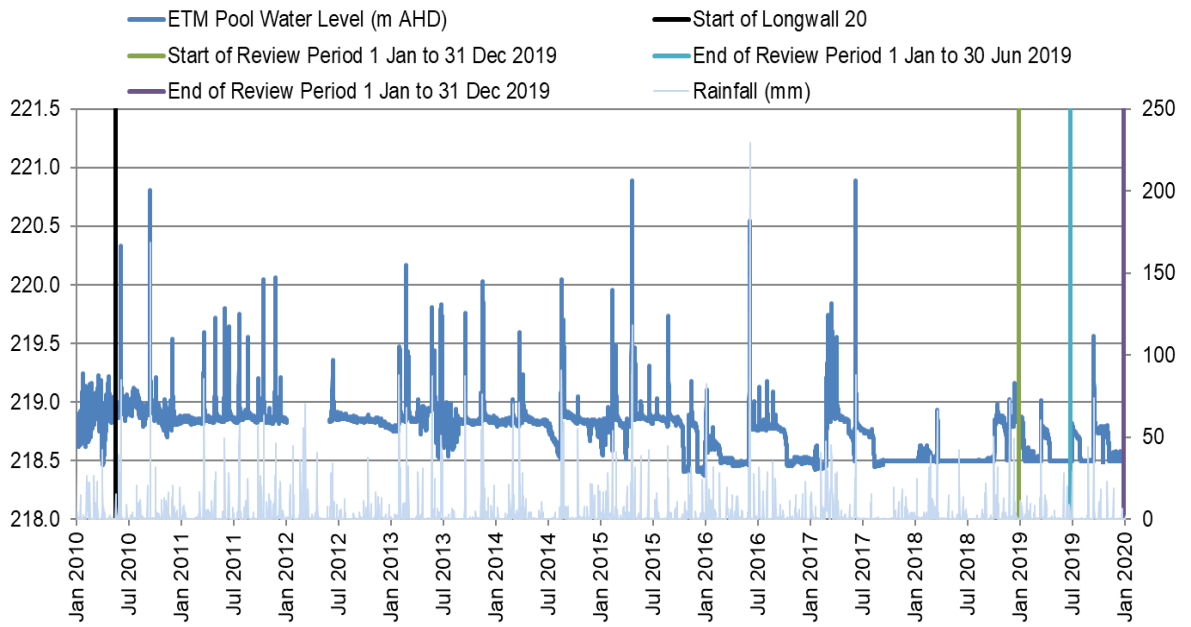


Chart 15 Pool ETM

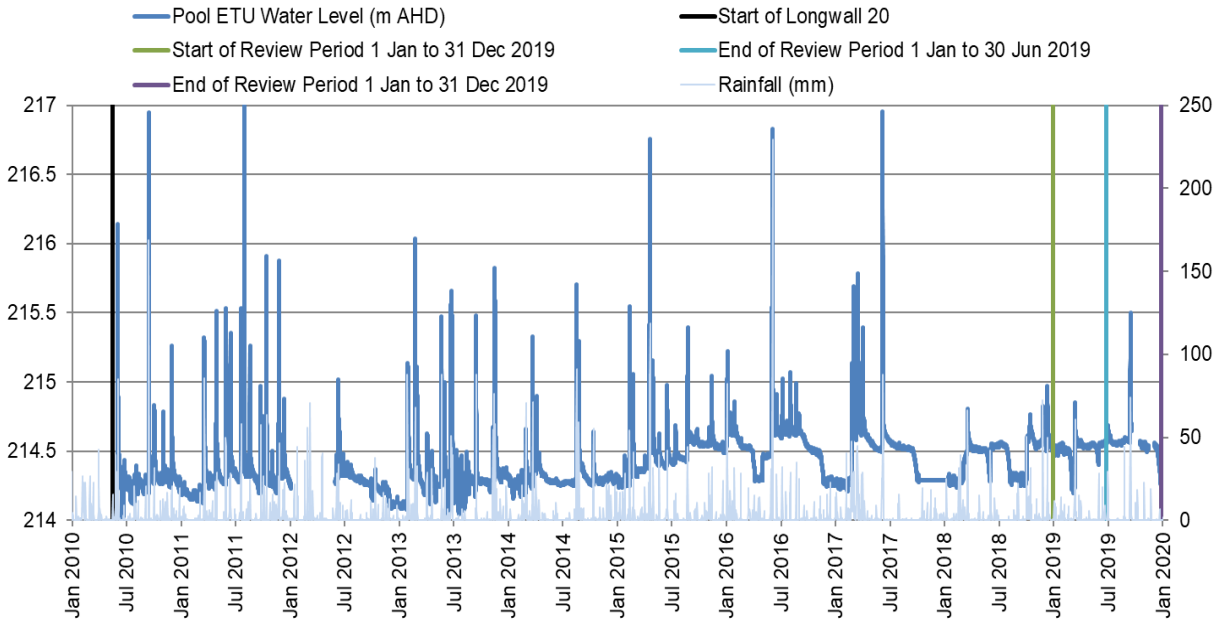


Chart 16 Pool ETU[9]

[9] The water level sensor was not restarted and hence data was not recorded between 23 September 2019 and 21 October 2019. A communication error with the sensor occurred resulting in lost data between 18 November 2019 and 8 December 2019.

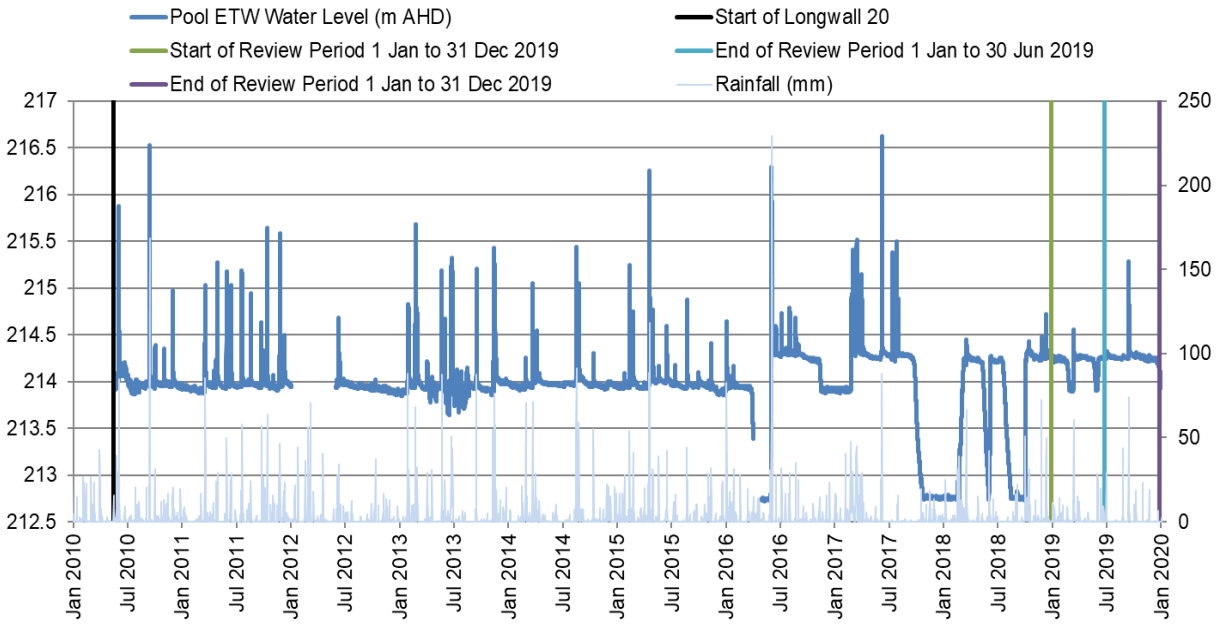


Chart 17 Pool ETW[10,11]

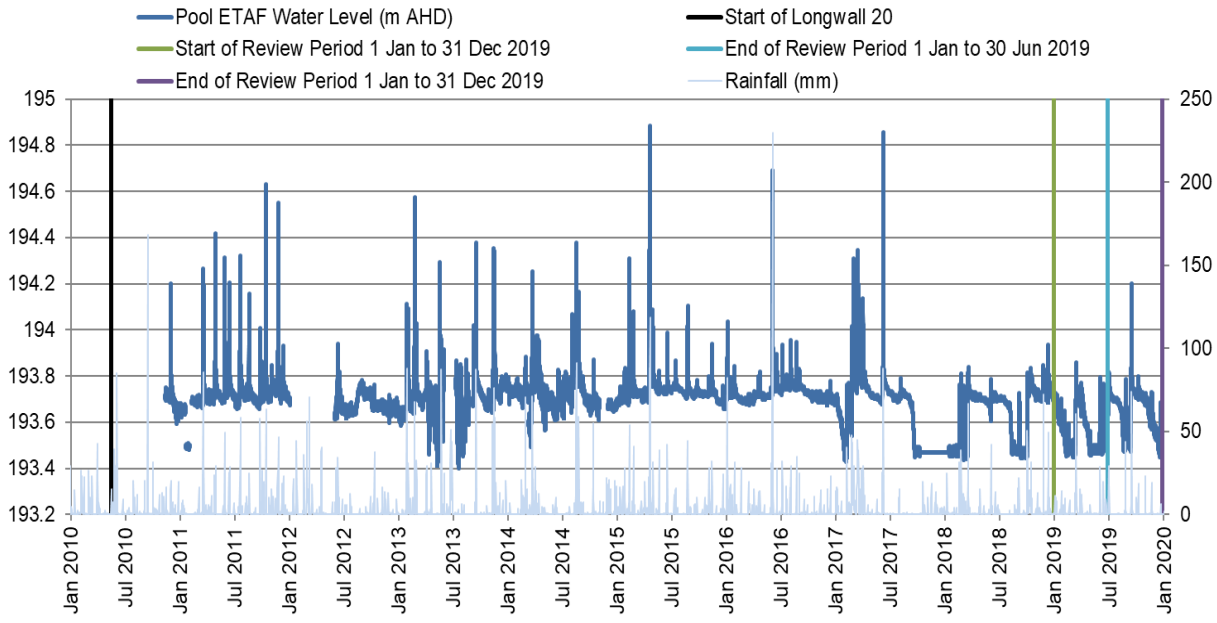


Chart 18 Pool ETAF

[10] Note discrepancies in water levels caused by pool being dry and water level sensor being exposed at time of download.

[11] After heavy rainfalls in early June 2016, the diver stand at Pool ETW became clogged with sediment and the diver was unable to reach the bottom. On 14 July 2016, a new diver was installed at Pool ETW to replace the previous diver. In September 2017, the old diver was cleared of sediment and was able to be used again. The original diver extends deeper into the pool, allowing additional information to be obtained during periods when the pool water level is below the cease to flow level. Data shown after September 2017 is from the original diver.

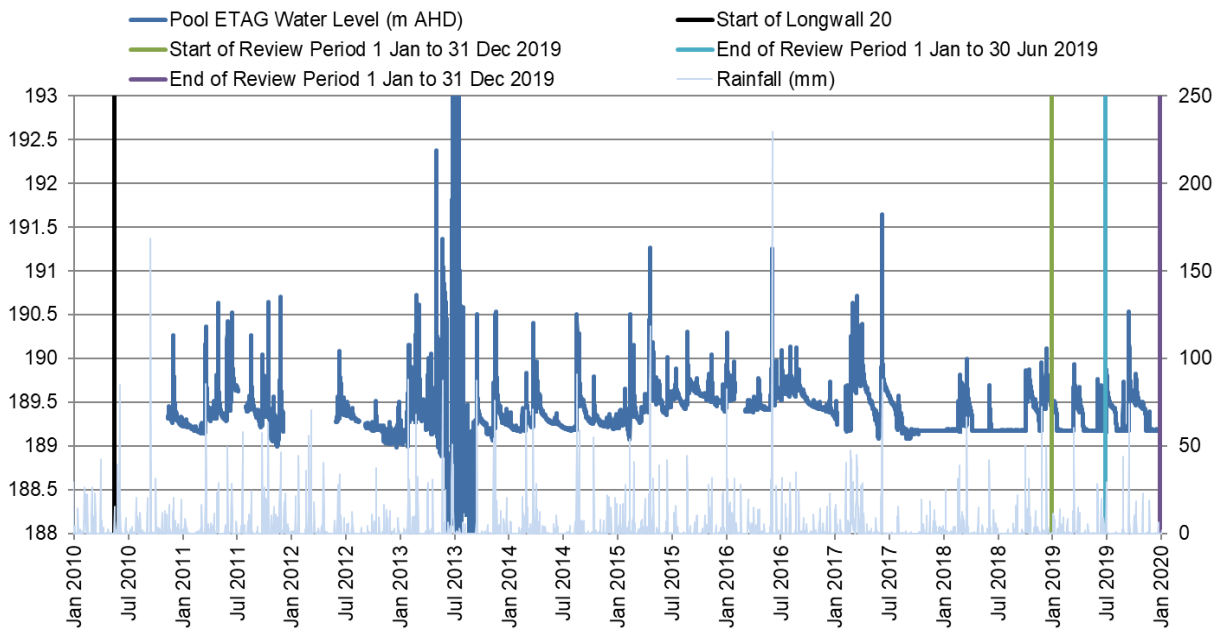


Chart 19 Pool ETAG

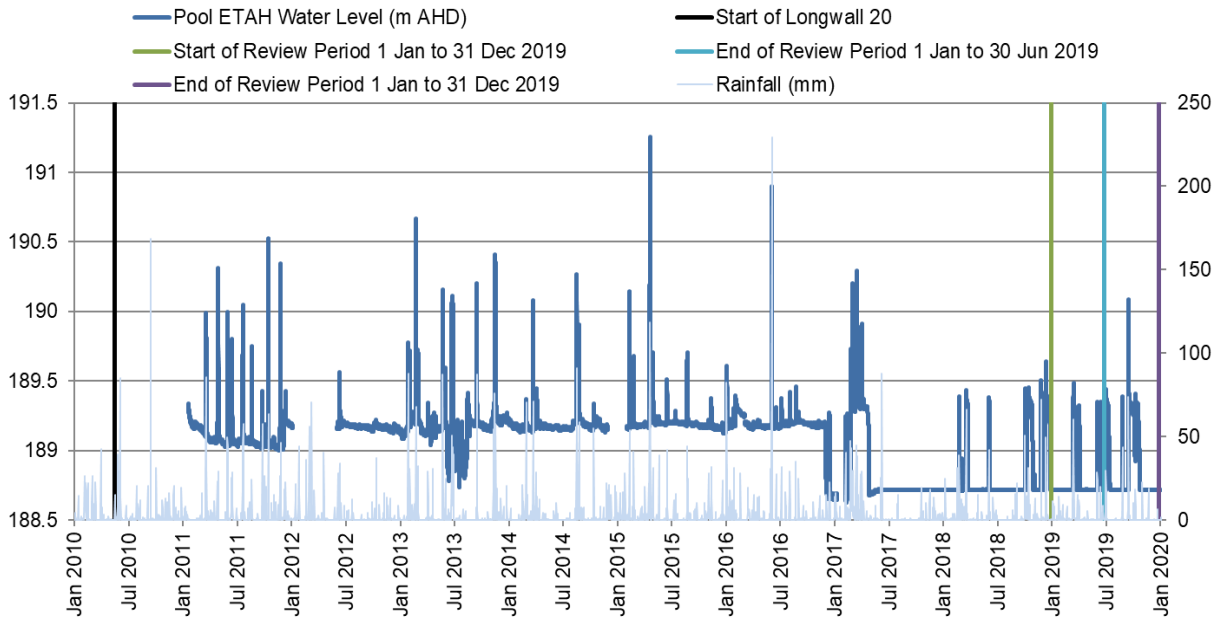


Chart 20 Pool ETAH[12]

[12] Water level was below measurable levels for ETAH from the 10/12/18 to the 31/12/18.

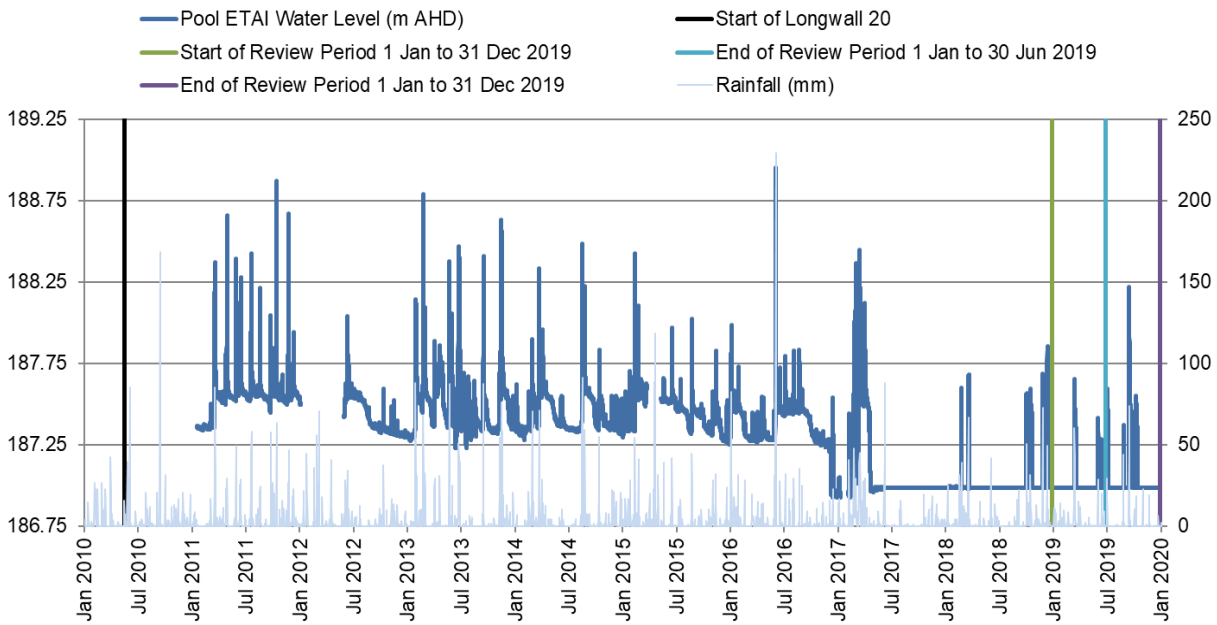


Chart 21 Pool ETAI[13]

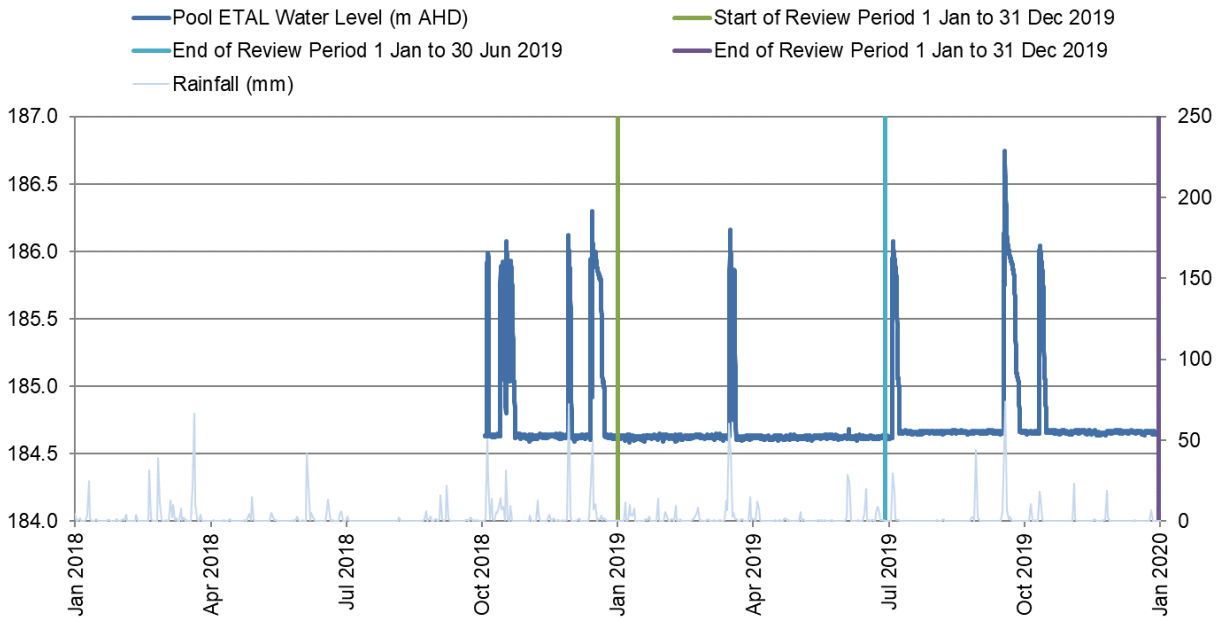


Chart 22 Pool ETAL

[13] Water level was below measurable levels for ETAI from the 10/12/18 to the 31/12/18.

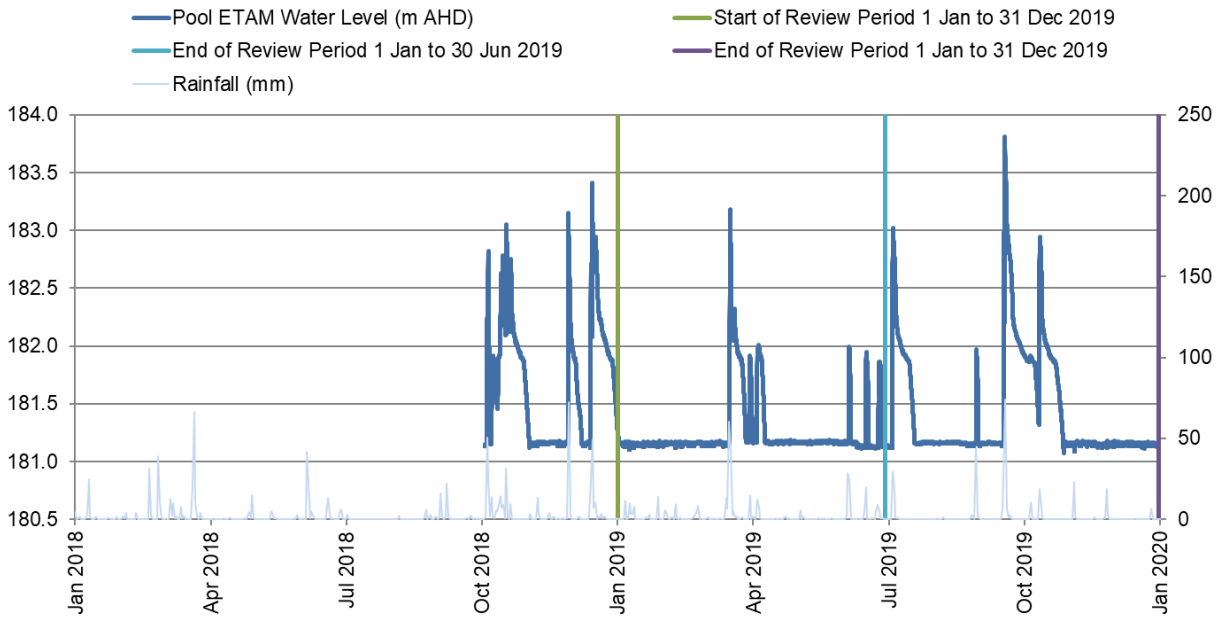


Chart 23 Pool ETAM

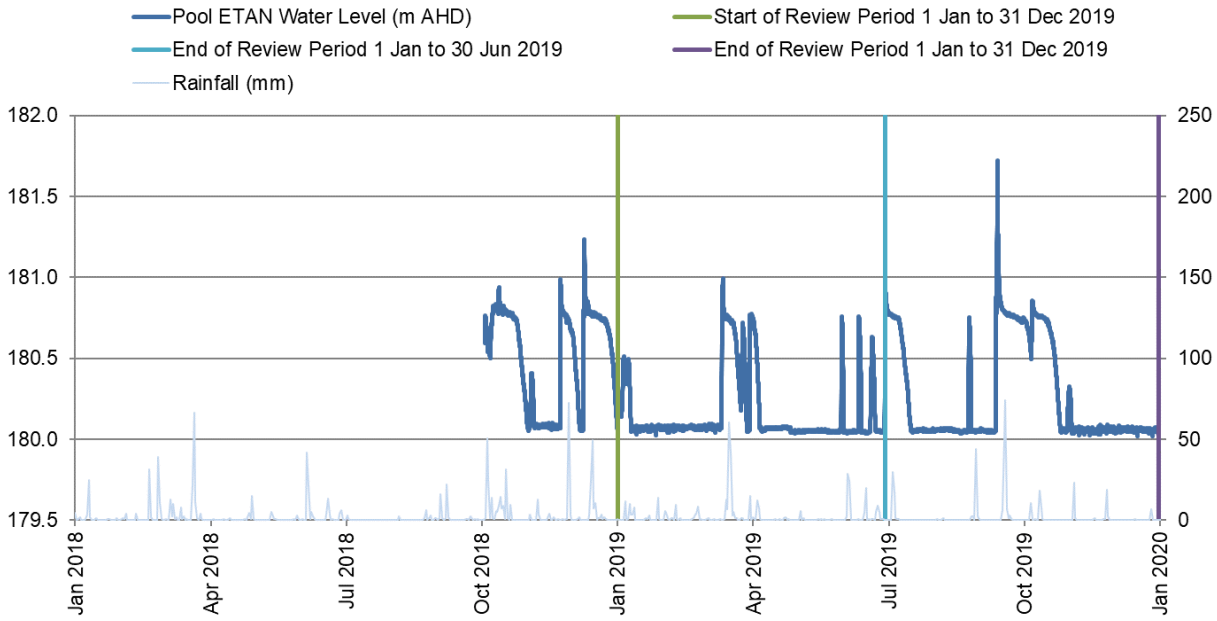


Chart 24 Pool ETAN

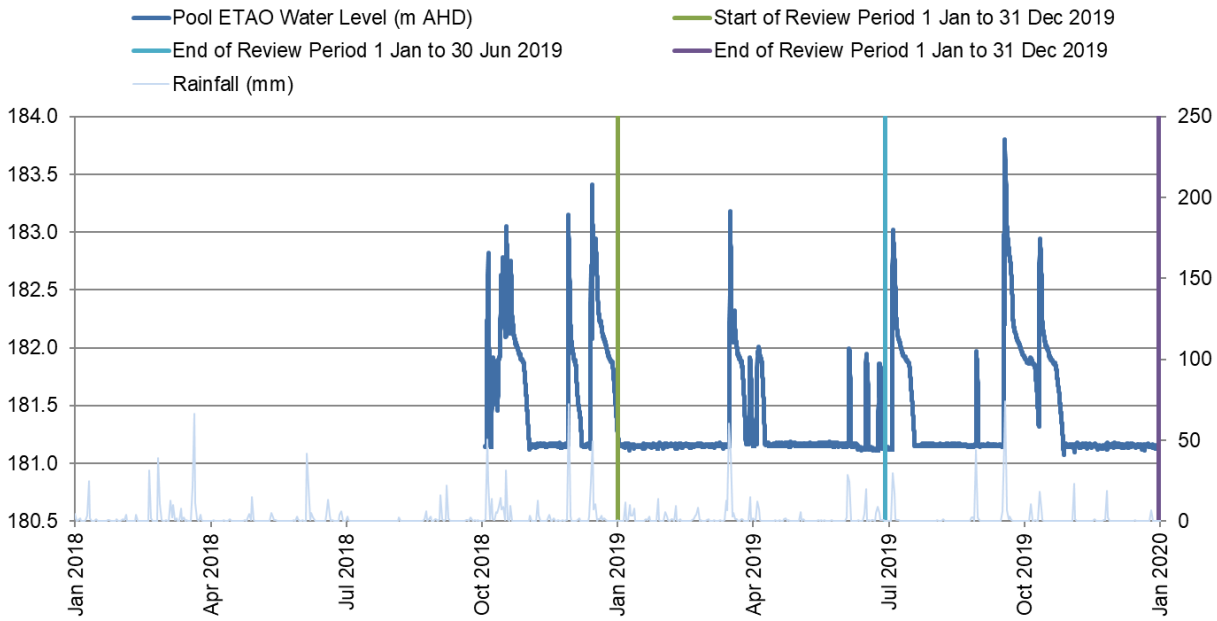


Chart 25 Pool ETAO

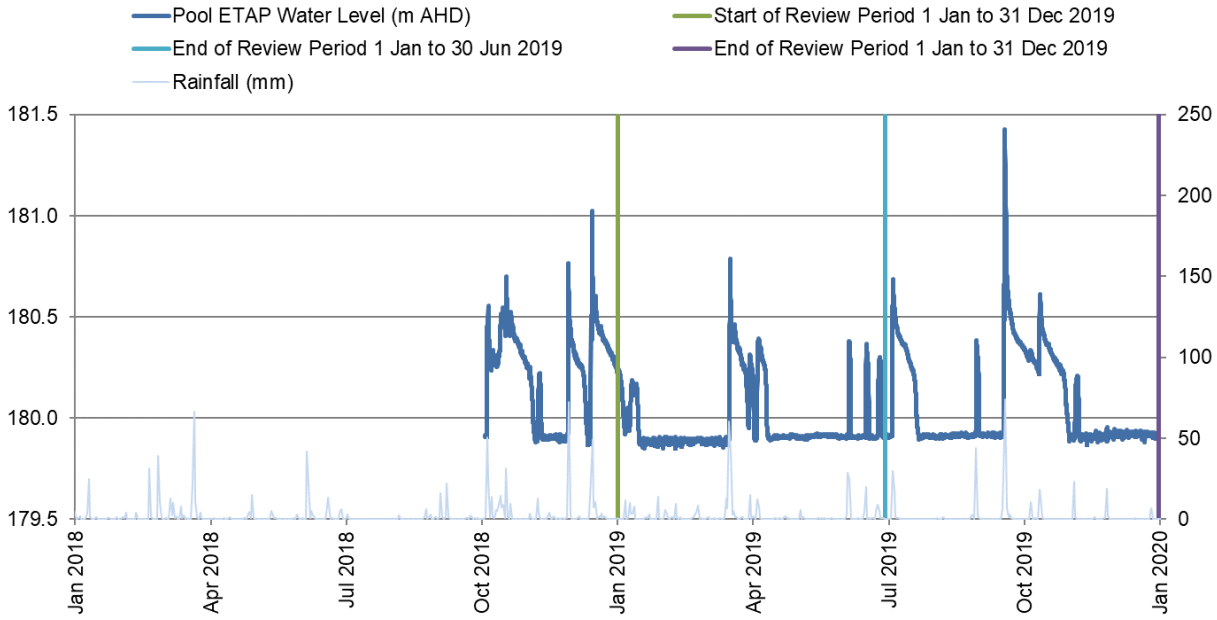


Chart 26 Pool ETAP

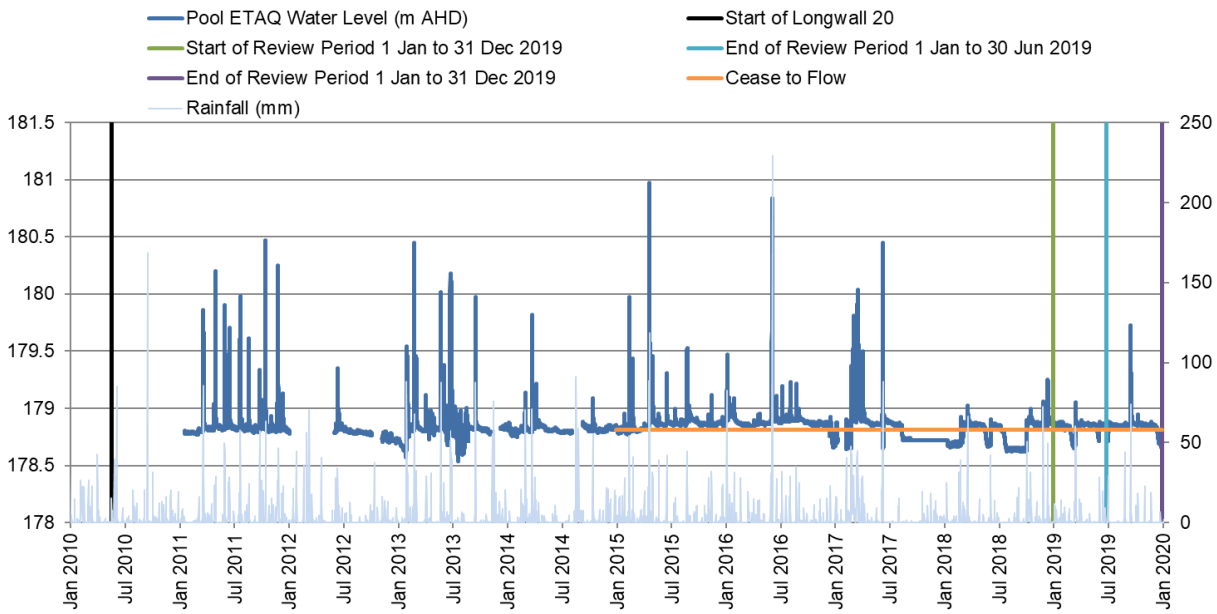


Chart 27 Pool ETAQ

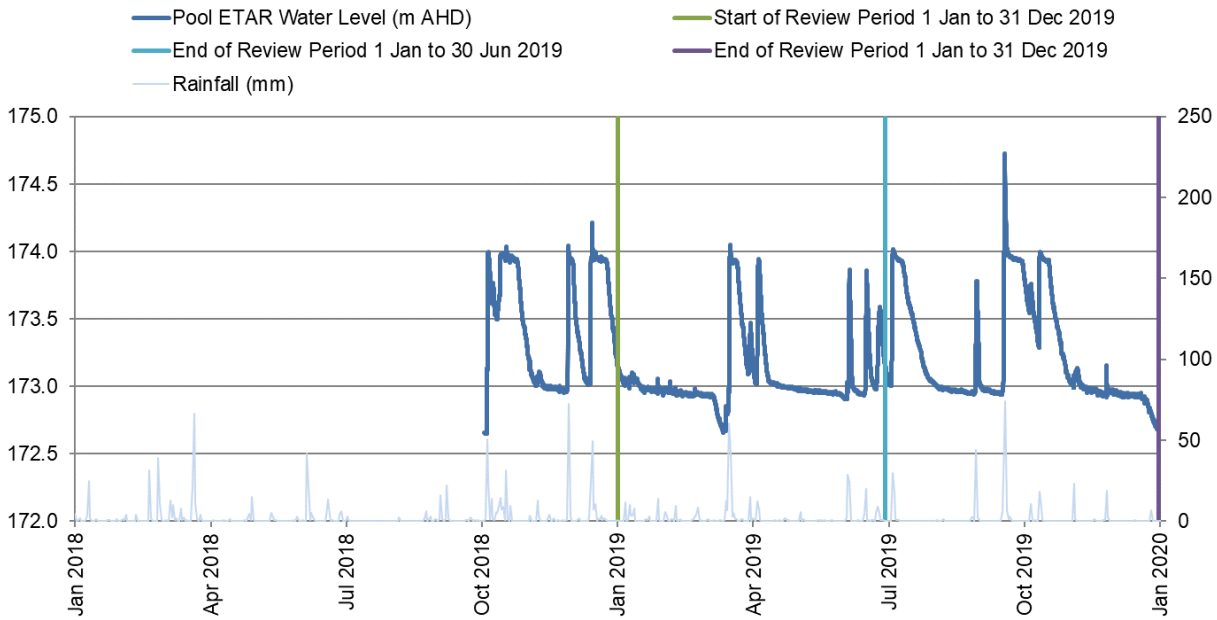


Chart 28 Pool ETAR

6.2.4 Stream Water Quality

Surface water quality sampling has been conducted monthly in the Waratah Rivulet (sites WRWQ2, WRWQ6, WRWQ8, WRWQ9, WRWQM, WRWQN, WRWQP, WRWQR, WRWQT, WRWQW), Eastern Tributary (sites ETWQF, ETWQJ, ETWQN, ETWQU, ETWQW, ETWQAF, ETWQAH, ETWQAQ, ETWQAU), Tributary B (site RTWQ1), Tributary D (site UTWQ1), Far Eastern Tributary (site FEWQ1), Honeysuckle Creek (site HCWQ1), Bee Creek (site BCWQ1) and Woronora River (WOWQ1 and WOWQ2) (Figure 8) in accordance with the Metropolitan Coal Longwall 304 Water Management Plan.

In October 2016, Metropolitan Coal increased the frequency of water quality sampling at select sites on the Eastern Tributary (sites ETWQF, ETWQN, ETWQAF, ETWQAG, ETWQAH, ETWQAI, ETWQAK, ETWQAQ and ETWQAU) and at site WOWQ2 on the Woronora Reservoir from monthly to weekly in response to the Eastern Tributary Incident. The weekly sampling continued throughout the reporting period.

Trends in the monitoring data to date for key parameters (pH, electrical conductivity [EC], dissolved iron, dissolved manganese and dissolved aluminium) are summarised in Table 8 and shown on Charts 29 to 53 (Appendices B1 and B2).

Water quality data has been analysed for key water quality parameters of relevance to water supply and the effects of subsidence, namely iron, manganese and aluminium at site WRWQ9 on Waratah Rivulet, site ETWQ AU on Eastern Tributary and at control site WOWQ2 on the Woronora River.

The performance indicator, *Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2,* is considered to have been exceeded if data analysis indicates a significant change in the quality of water post-mining of Longwall 20. Specifically, if[14]:

- any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for two consecutive months; or
- over a three month period the water quality parameter exceeds the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month; or
- the six month mean of the water quality parameter exceeds the adjusted baseline mean plus one standard deviation for two consecutive assessment periods (i.e. over two six monthly reports); and
- there was not a similar exceedance of the trigger at the control site.

Assessment of Water Quality at Site WRWQ9

There was no exceedance of the performance indicator as a result of the assessment methods for dissolved iron, dissolved aluminium or dissolved manganese at site WRWQ9 on the Waratah Rivulet during the reporting period. There were no exceedances of the same triggers at control site WOWQ2 on Woronora River (Appendices B1 and B2).

Assessment of Water Quality at Site ETWQ AU

There were no exceedances of the performance indicator as a result of the assessment methods for dissolved aluminium during the reporting period. There were exceedances of the performance indicator as a result of the assessment methods for dissolved iron and dissolved manganese during the reporting period (Appendices B1 and B2).

[14] Note each 'mean' is calculated as a geometric mean.

Table 8
Summary of Results for Key Water Quality Parameters During the Reporting Period

Stream(s)	pH	EC	Dissolved Iron	Dissolved Manganese	Dissolved Aluminium
Waratah Rivulet (sites WRWQ2, WRWQ6, WRWQ8, WRWQ9, WRWQM, WRWQN, WRWQP, WRWQR, WRWQT and WRWQW) (Charts 29 to 38)	• Upstream sites (e.g. sites WRWQ2 and WRWQ6) were slightly acidic to near neutral. • Middle and lower reach sites (e.g. sites WRWQ8, WRWQT and WRWQW) were higher (slightly alkaline). • WRWQ8 and WRWQT have shown a generally increasing trend in pH since mid-2016. • Historically high pH values (field) were recorded at WRWQ8 (8.26), WRWQT (8.91) and WRWQW (8.40) in December 2019.	• Generally higher in comparison with pre-2018 values, though consistent with 2018 values. • No historically high values were recorded during the reporting period.	• Concentrations were typically below 0.5 milligrams per litre (mg/L), with the exception of WRWQM. • WRWQM recorded concentrations above 0.5 mg/L but at or below 1 mg/L in June (0.57 mg/L), August (0.64 mg/L) and November (0.64 mg/L) 2019.	• Concentrations were generally low and consistent with historical trends. • A slight increasing trend in dissolved manganese concentrations has been observed for WRWQ2, WRWQ6, WRWQ8, WRWQM and WRWQN since 2016. • No historically high concentrations were recorded during the reporting period.	• Concentrations were either low (0.02 mg of less) or below the detection limit (less than 0.01 mg/L).
Woronora River (sites WOWQ1 and WOWQ2, control stream) (Charts 38 to 43)	• Slightly acidic pH levels. • Consistent with historical trends.	• Values recorded at WOWQ2 have increased in variability since 2016 and tend to be more elevated.	• Generally low and similar to values recorded in Waratah Rivulet, except for WOWQ2. • WOWQ2 recorded a concentration of 1.37 mg/L in March 2019 (less than the historical high concentration [1.5 mg/L] recorded in March 2011).	• Typically low concentrations at WOWQ2. • A historically high concentration of 0.26 mg/L was recorded at WOWQ1 in January 2019. Field notes reported that there was no flowing water at the time of sampling which may have contributed to the result.	• Typically low concentrations (less than 0.05 mg/L) at WOWQ2, except in September 2019. • A concentration of 0.11 mg/L was recorded at WOWQ2 in September 2019 (less than the historical high concentration [0.18 mg/L]). • Slightly elevated concentrations recorded at WOWQ1, though consistent with historical values.

Table 8 (Continued)
Summary of Results for Key Water Quality Parameters During the Reporting Period

Stream(s)	pH	EC	Dissolved Iron	Dissolved Manganese	Dissolved Aluminium
Eastern Tributary (sites ETWQF, ETWQJ, ETWQN, ETWQU, ETWQW, ETWQAF, ETWQAH, ETWQAQ and ETWQAU)[1] (Charts 44 to 47)	• Slightly acidic to slightly alkaline conditions. • Consistent with historical values except for ETWQAH. • Variable pH levels were recorded at ETWQAH, though the lowest historically recorded value was not exceeded during the reporting period.	• Results are generally more elevated and variable relative to pre-2016 values. • The highest historically recorded values were not exceeded.	• Elevated concentrations have been recorded in the Eastern Tributary since mid-2016, with similar concentrations reported for the reporting period. • Elevated concentrations ranging from 0.72 to 8.2 mg/L were recorded at ETWQAQ, though the highest historically recorded values were not exceeded. • A historically high dissolved iron concentration was recorded at EWQN in December 2019 (3.98 mg/L), for all other sites, the highest historically recorded values were not exceeded.	• Elevated concentrations of dissolved manganese have been recorded in the Eastern Tributary since mid-2016. • The highest concentration recorded during the reporting period was at ETWQAQ (1.3 mg/L), with concentrations of less than 1 mg/L recorded at all other sites.	• Variable concentrations were recorded at all sites during the reporting period. • A historically high concentration of 0.15 mg/L was recorded at ETWQU in March 2019. • Historically high concentrations of 0.34 mg/L, 0.26 mg/L and 0.27 mg/L were recorded at ETWQF, ETWQN and ETWQAU, respectively, in September 2019.
Bee Creek (site BCWQ1, control stream), Honeysuckle Creek (site HCWQ1, control stream), Far Eastern Tributary (site FEWQ1), Tributary B (site RTWQ1) and Tributary D (site UTWQ1) (Charts 48 to 53)	• Bee Creek and Honeysuckle Creek had slightly acidic pH levels. • Far Eastern Tributary, Tributary B and Tributary D had near neutral pH levels. • Overall, the pH levels were consistent with historical values, except for RTWQ1. • A historically high pH level was recorded at RTWQ1 in December 2019 (8.6).	• The electrical conductivity values at all sites tended to be more elevated and variable relative to pre-2013 values, with this trend continuing throughout the reporting period.	• Low and consistent with historical values. • An elevated dissolved iron concentration of 2.22 mg/L was recorded at BCWQ1 in November 2019.	• Low and consistent with historical values, except for BCWQ1. • A historically high dissolved manganese concentration was recorded at BCWQ1 in November 2019 (0.36 mg/L).	• Less than 0.1 mg/L at FEWQ1, RTWQ1 and UTWQ1. • Spikes of dissolved aluminium levels persisted at BCWQ1 and HCWQ1 over the reporting period.

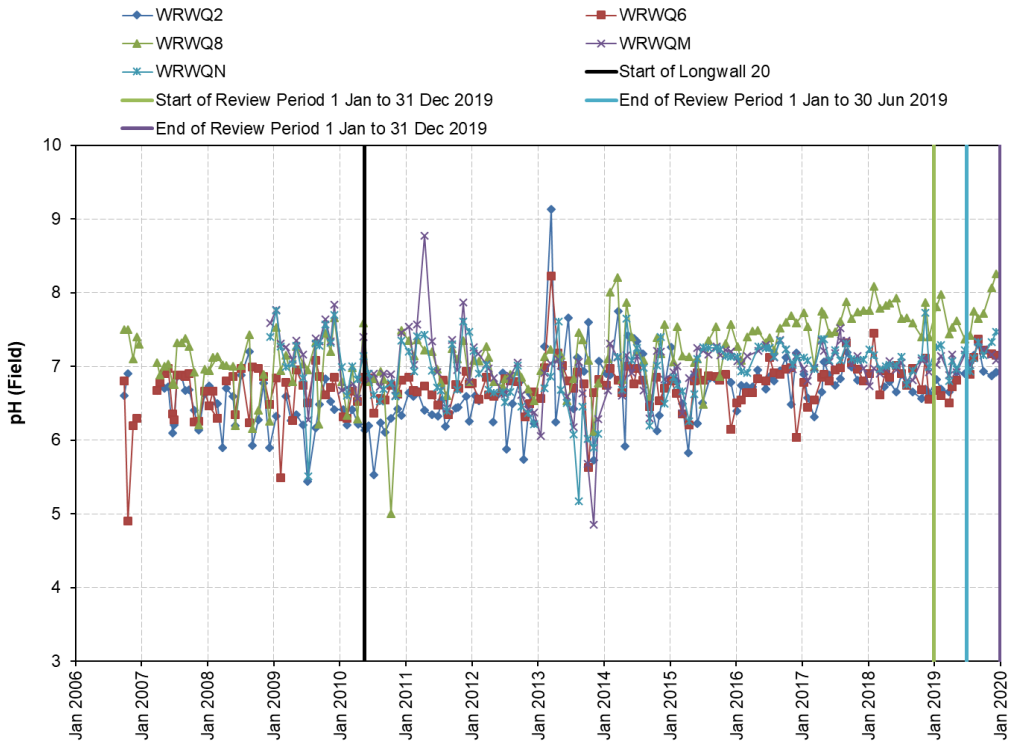


Chart 29 pH Levels Waratah Rivulet – Upper to Middle Reach Sites

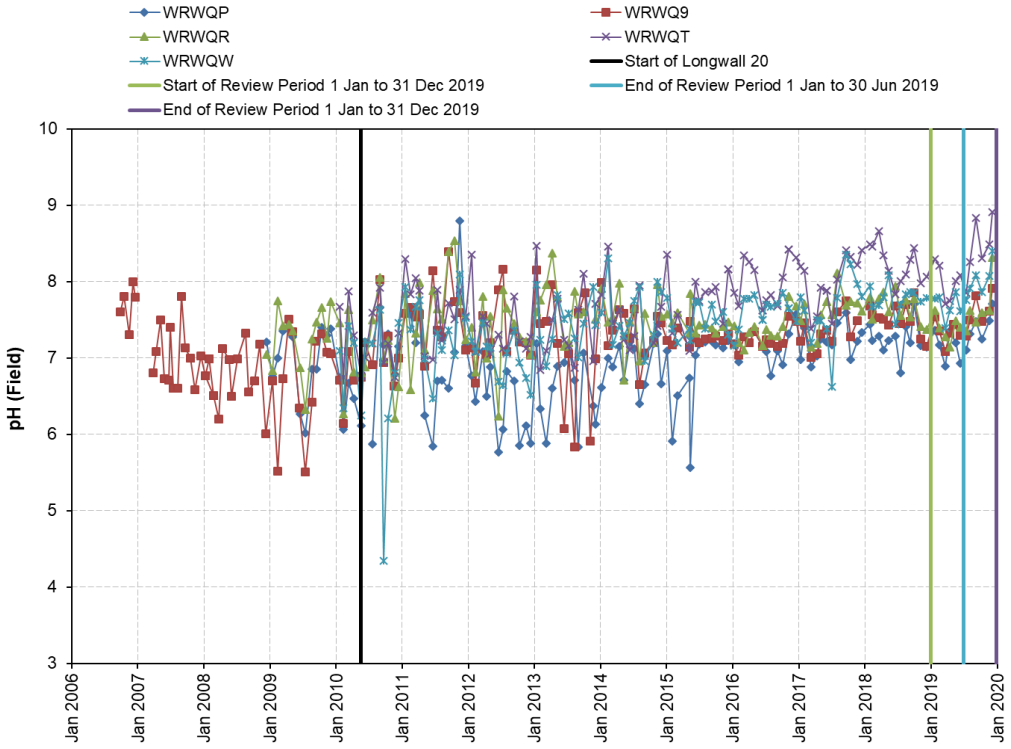


Chart 30 pH Levels Waratah Rivulet – Lower Reach Sites

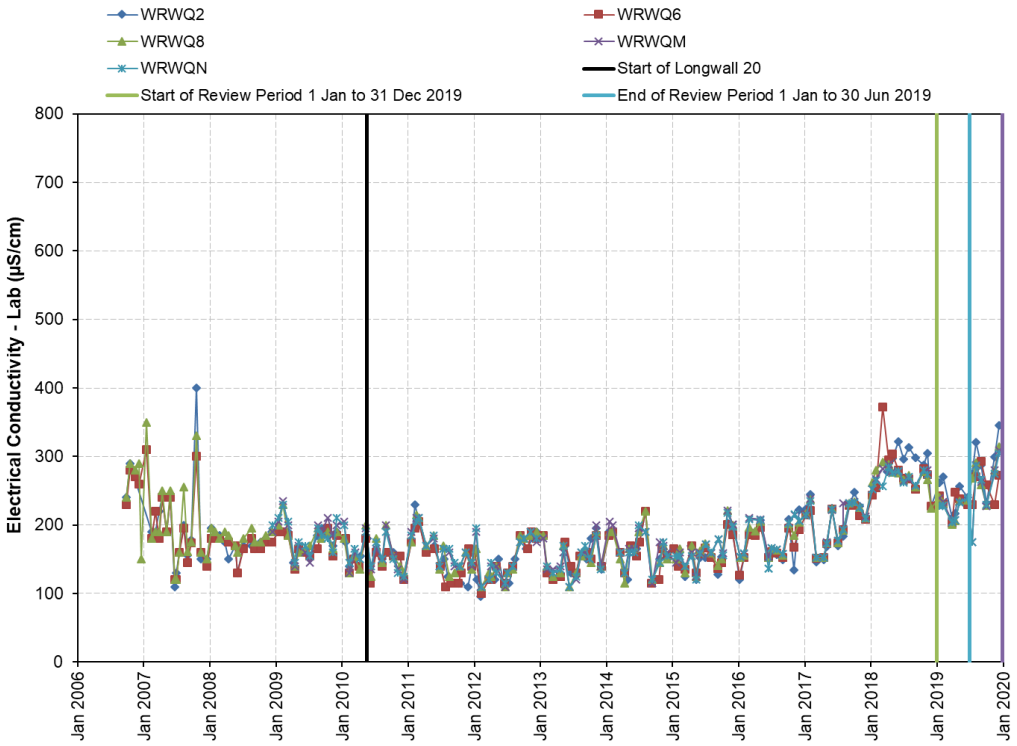


Chart 31 EC Waratah Rivulet – Upper to Middle Reach Sites

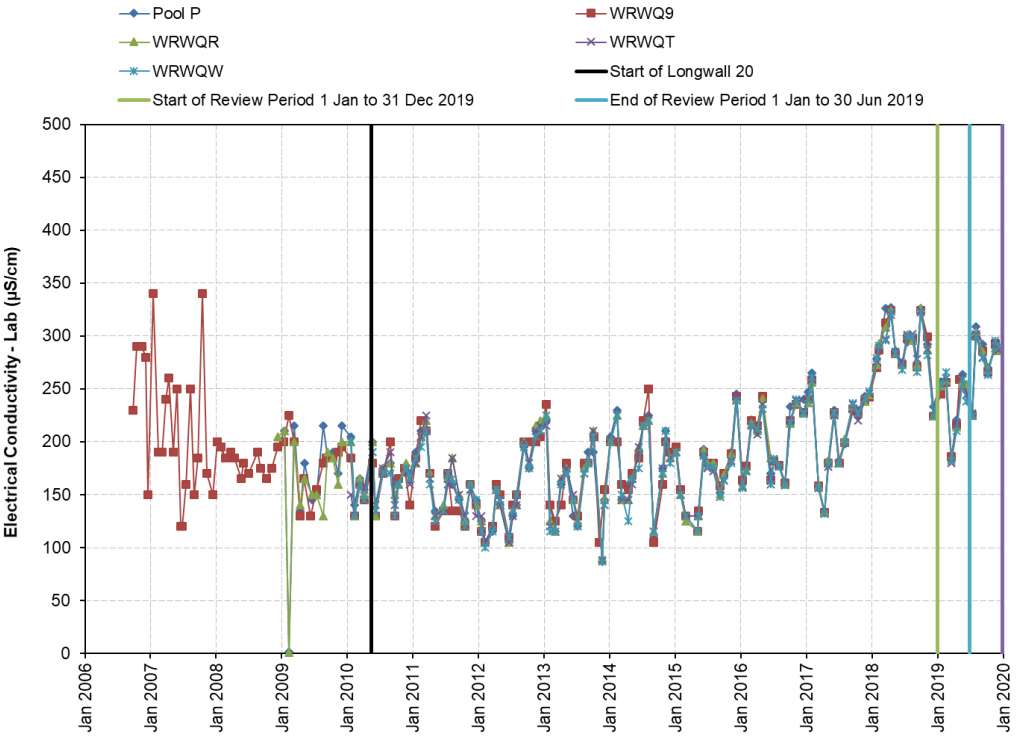


Chart 32 EC Waratah Rivulet – Lower Reach Sites

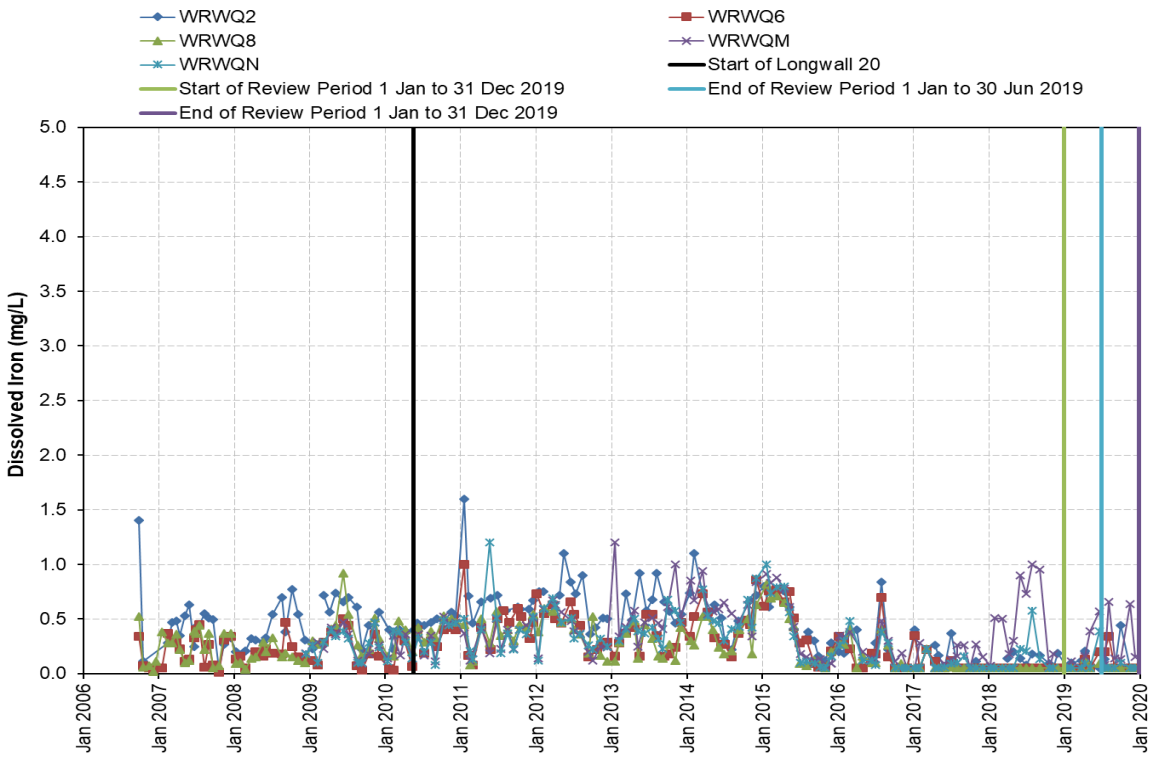


Chart 33 Dissolved Iron Waratah Rivulet – Upper and Middle Reach Sites

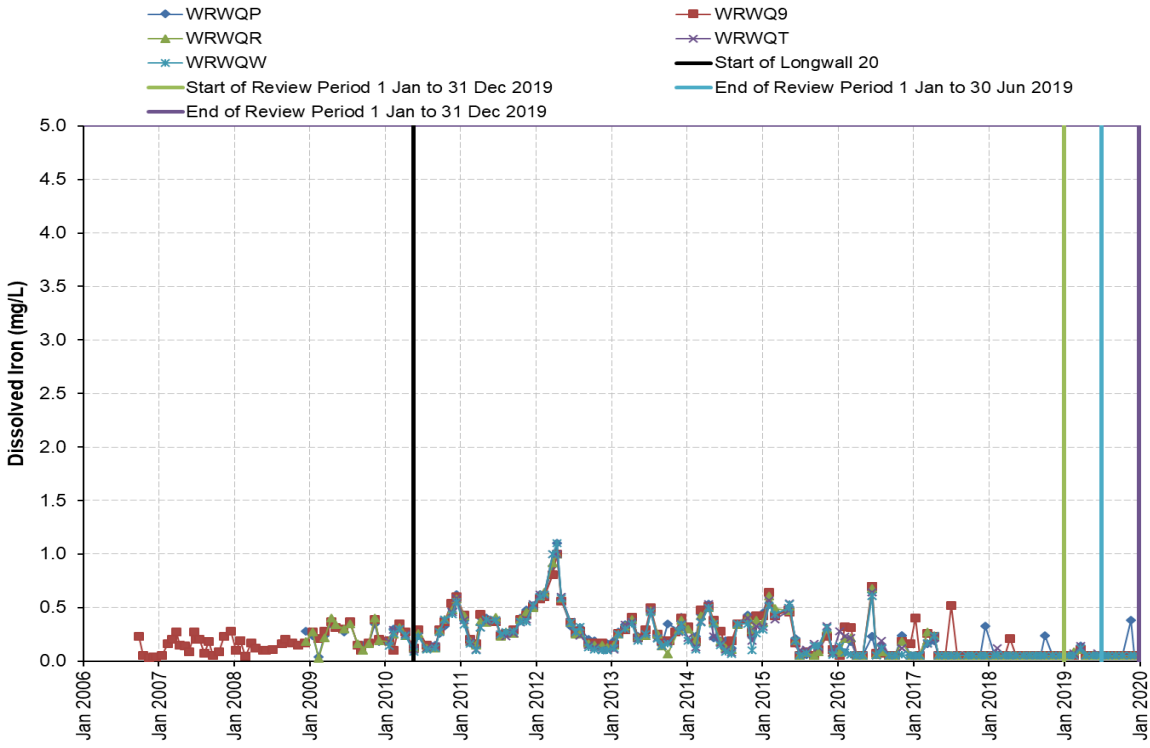


Chart 34 Dissolved Iron Waratah Rivulet – Lower Reach Sites

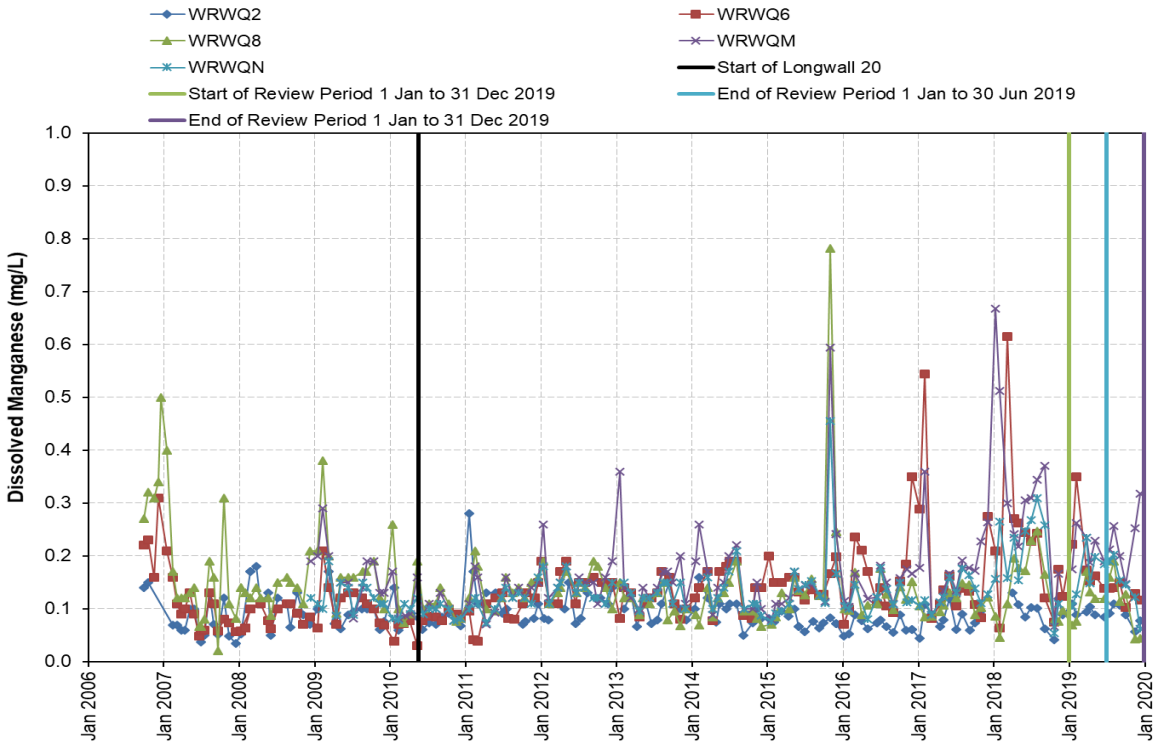


Chart 35 Dissolved Manganese Waratah Rivulet – Upper to Middle Reach Sites

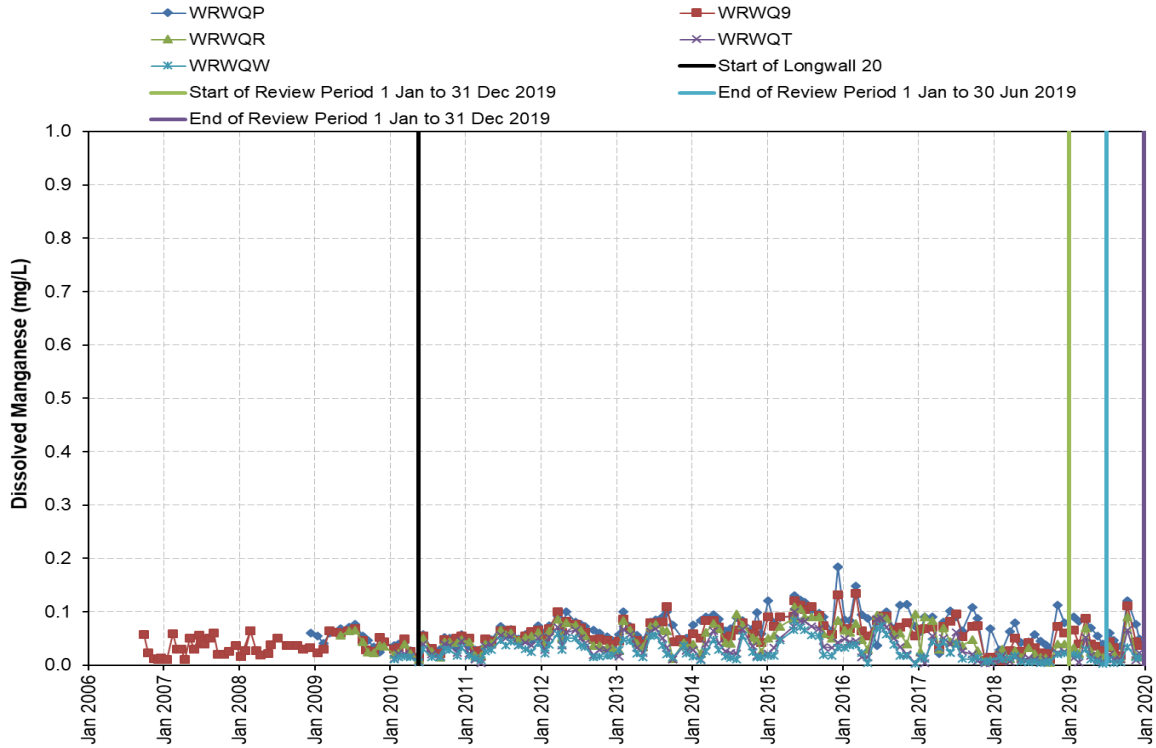


Chart 36 Dissolved Manganese Waratah Rivulet – Lower Reach Sites

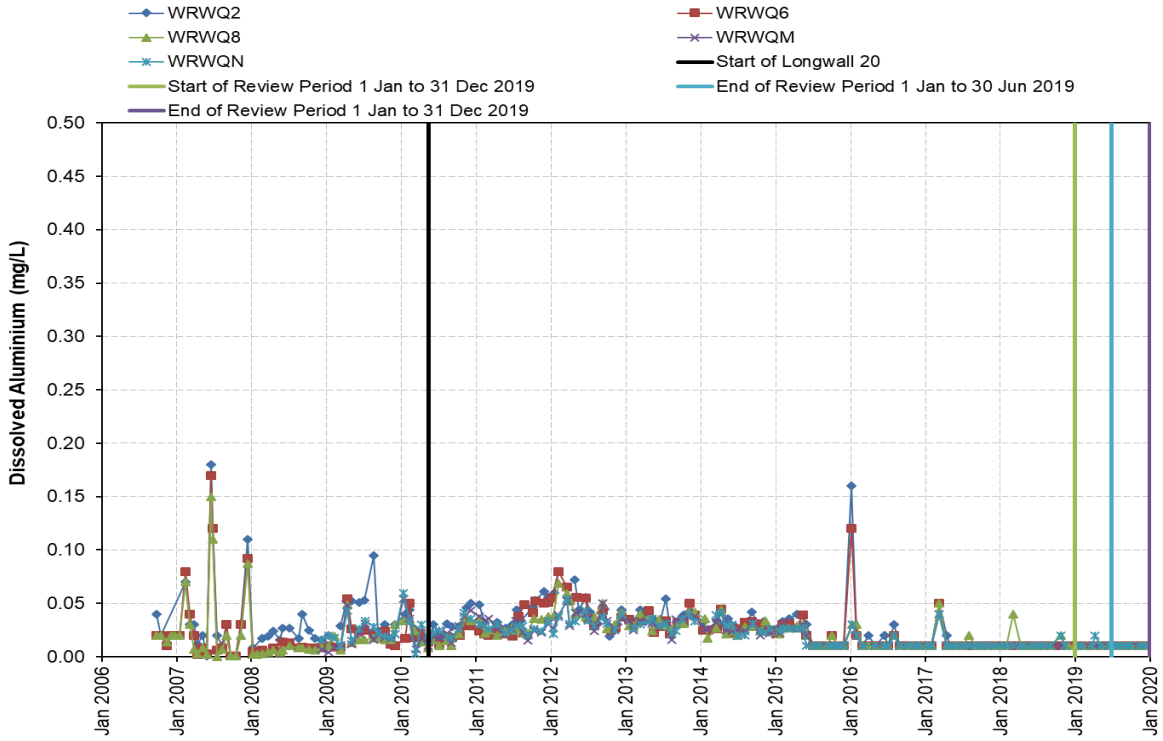


Chart 37 Dissolved Aluminium Waratah Rivulet – Upper to Middle Reach Sites

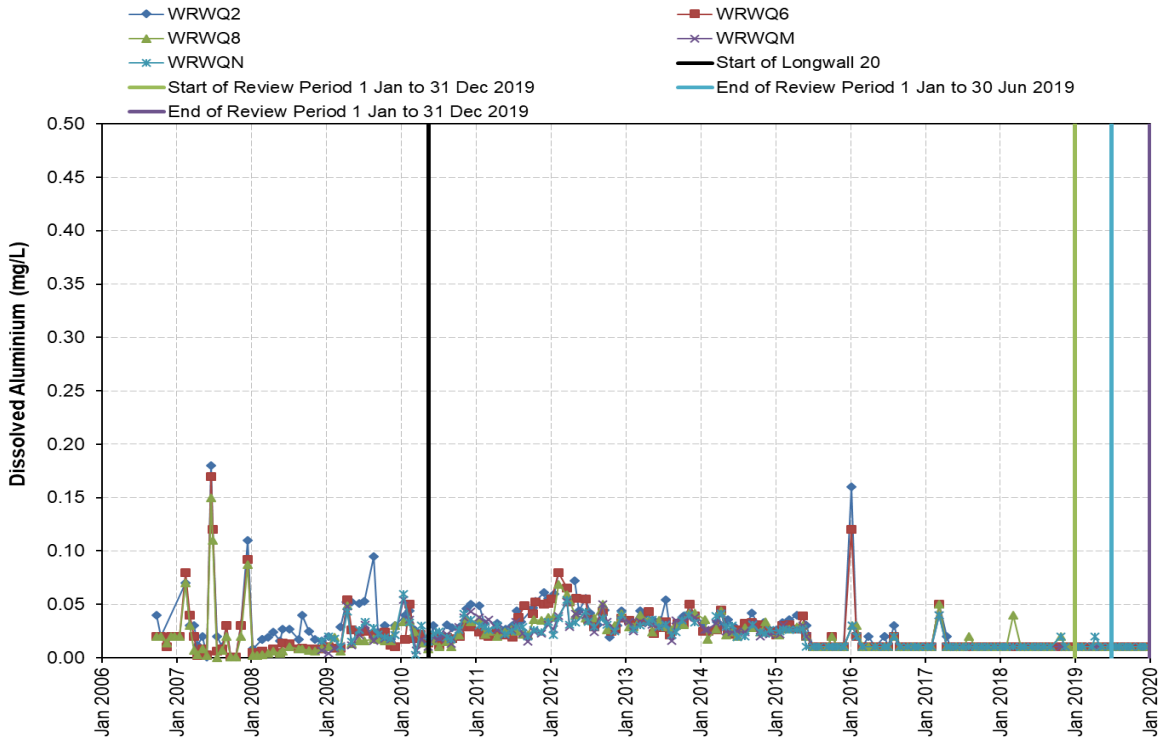


Chart 38 Dissolved Aluminium Waratah Rivulet – Lower Reach Sites

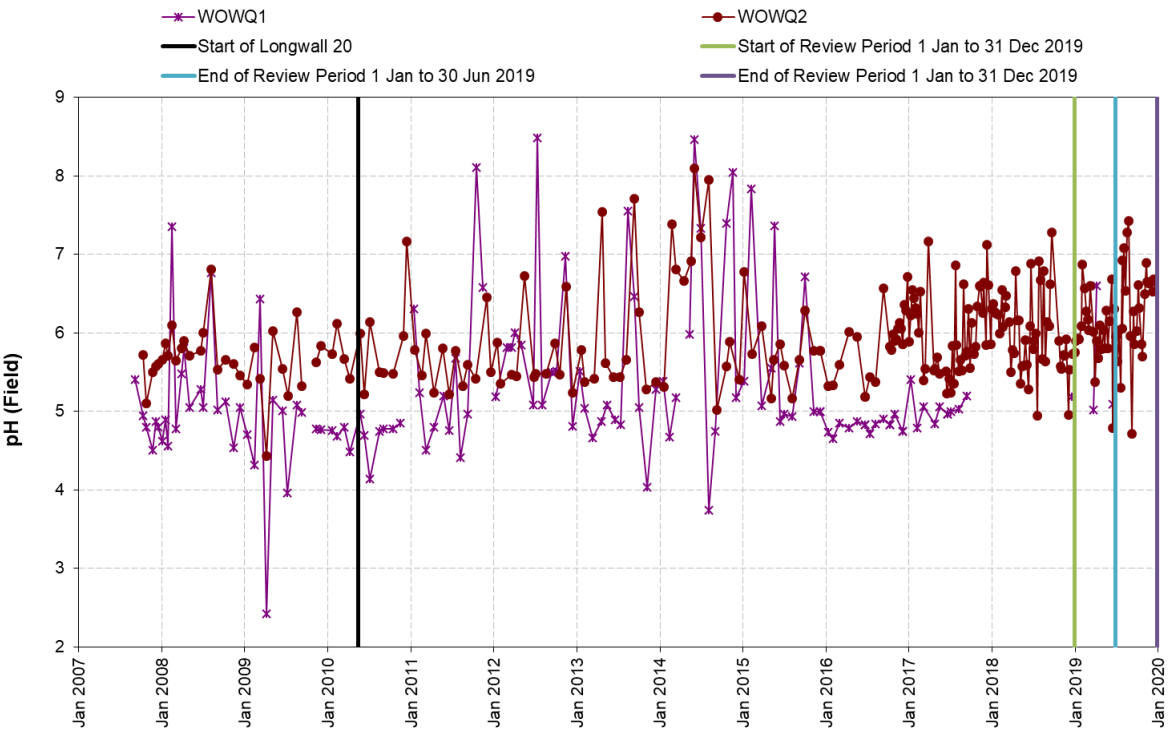


Chart 39 pH Levels Woronora River[15]

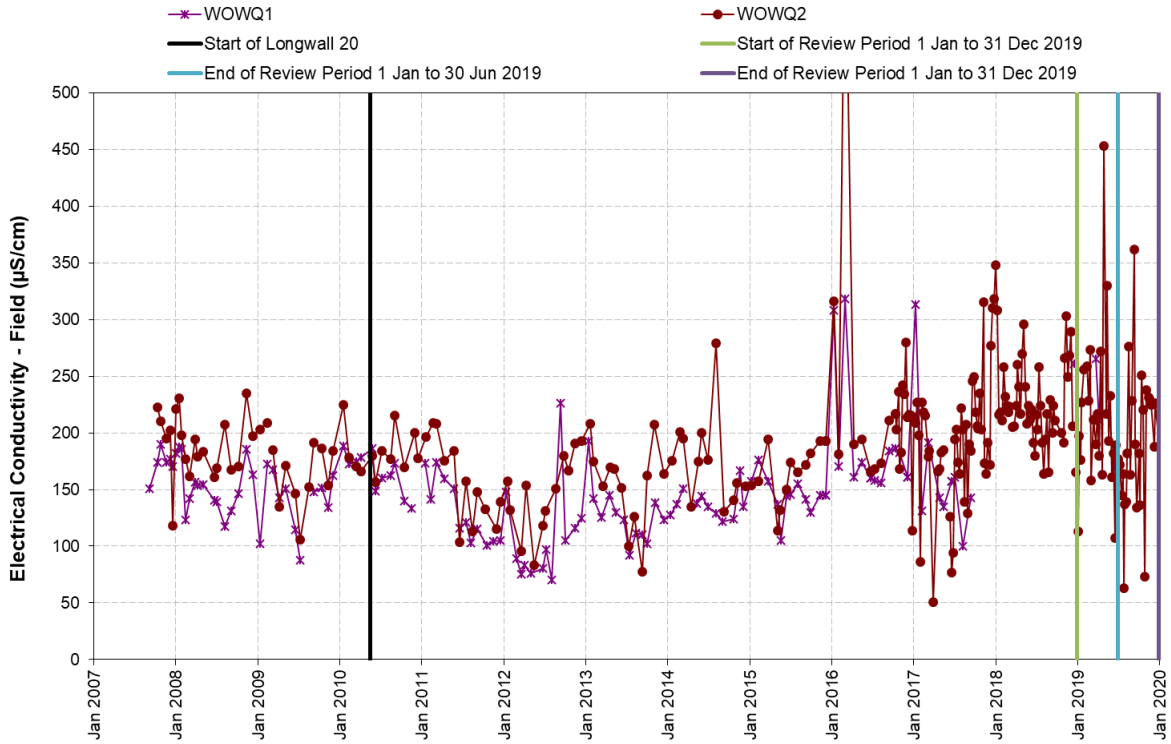


Chart 40 EC Woronora River

[15] WOWQ1 was dry between 23 October 2017 and 20 December 2018, in May 2019 and between 3 July 2019 and 12 December 2019 and hence no water quality samples were collected.

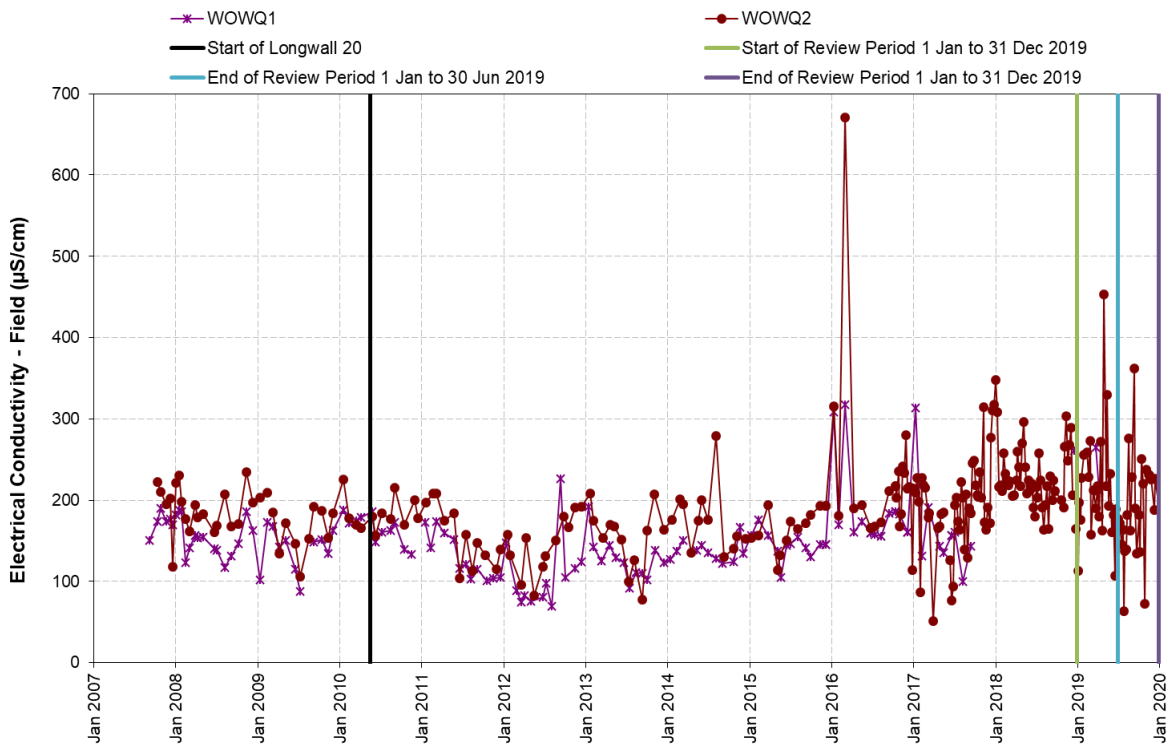


Chart 40a EC Woronora River

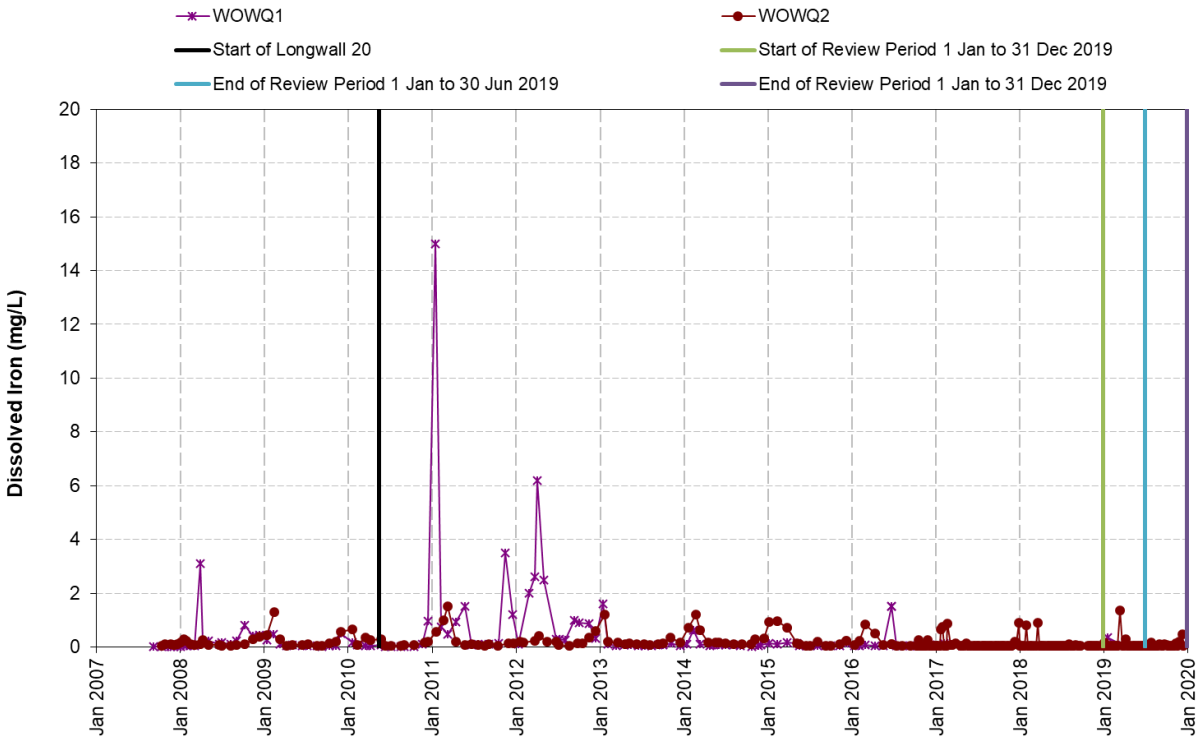


Chart 41 Dissolved Iron Woronora River

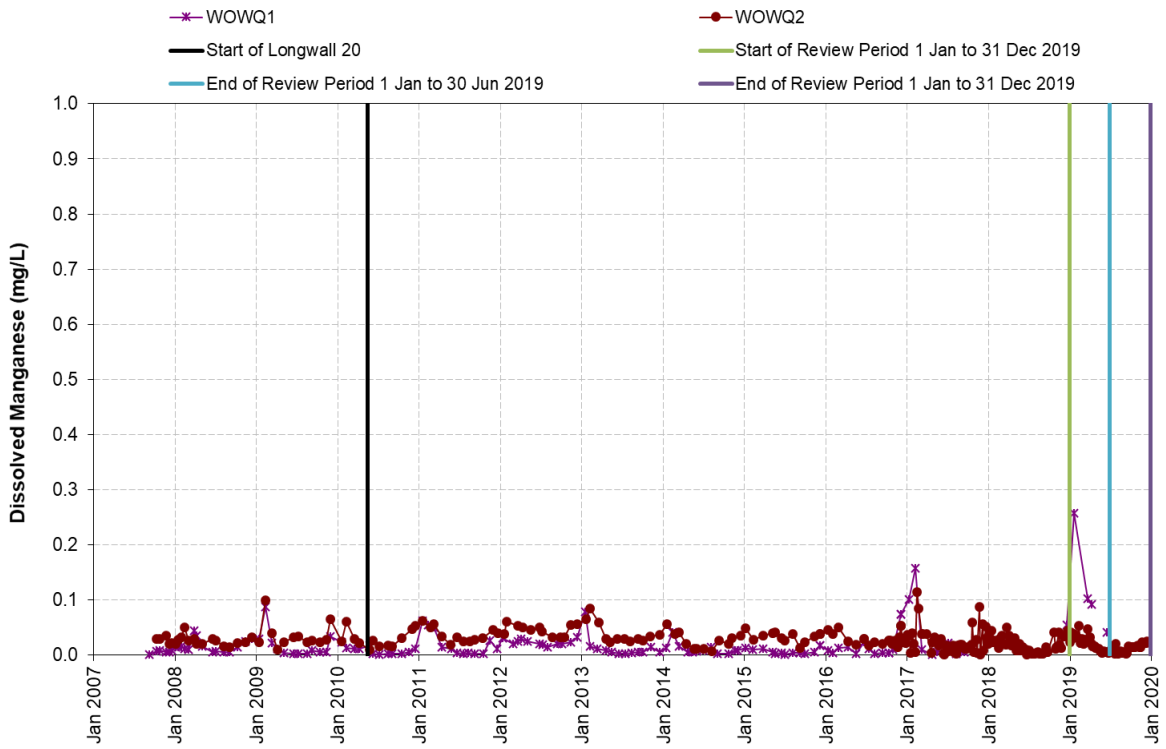


Chart 42 Dissolved Manganese Woronora River

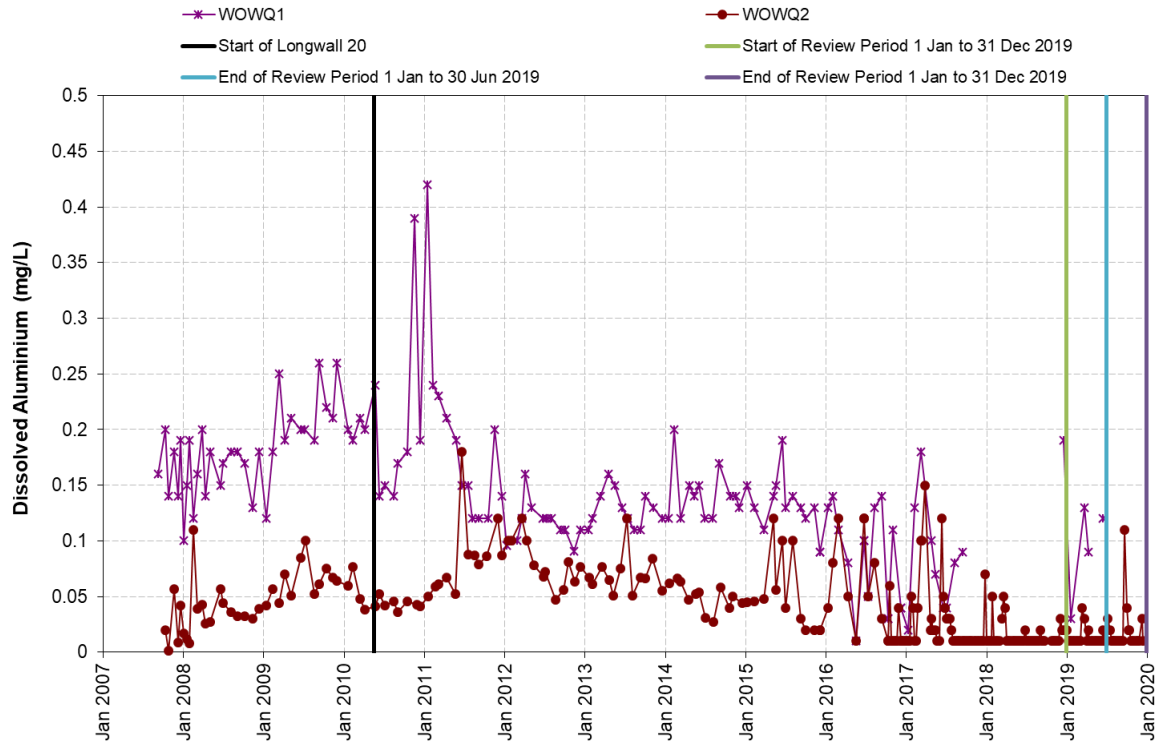


Chart 43 Dissolved Aluminium Woronora River

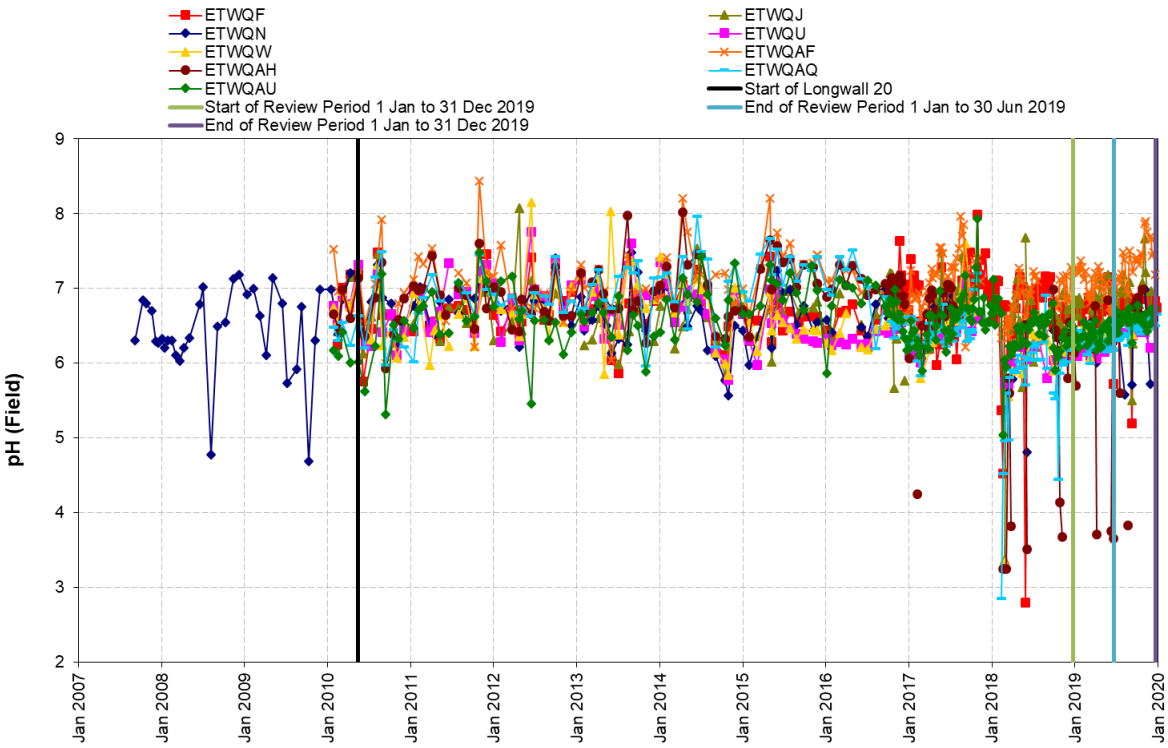


Chart 44 pH Levels Eastern Tributary

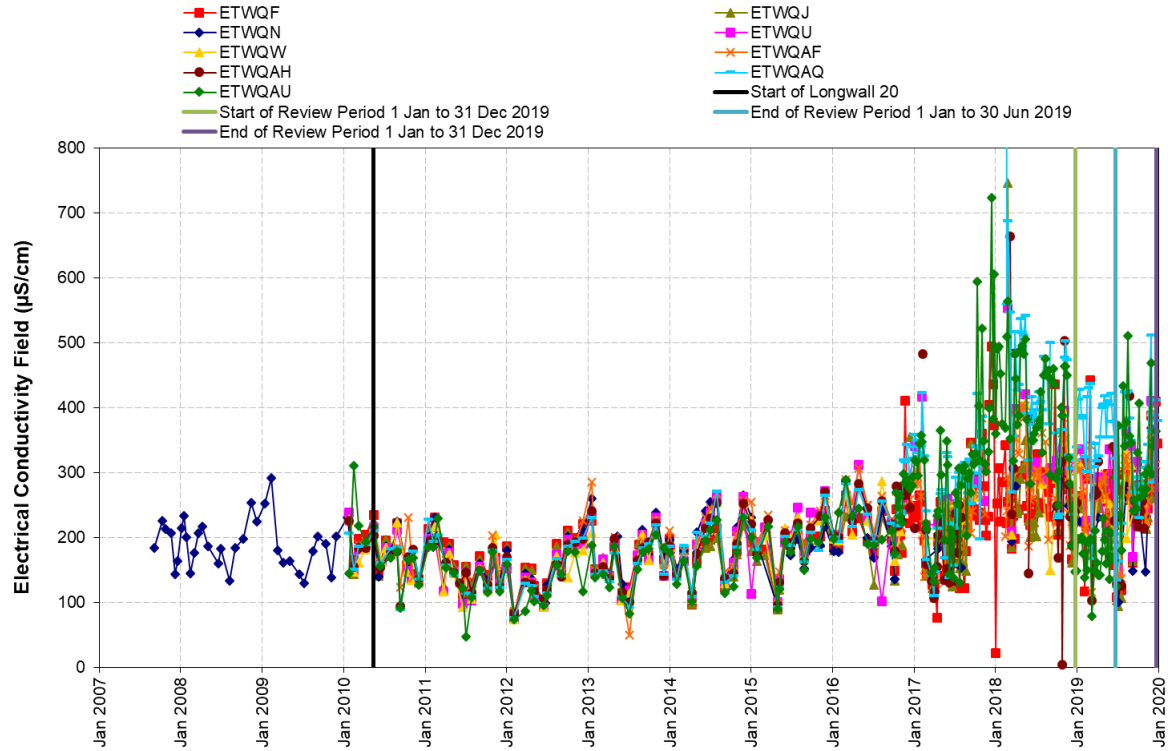


Chart 45 EC Eastern Tributary

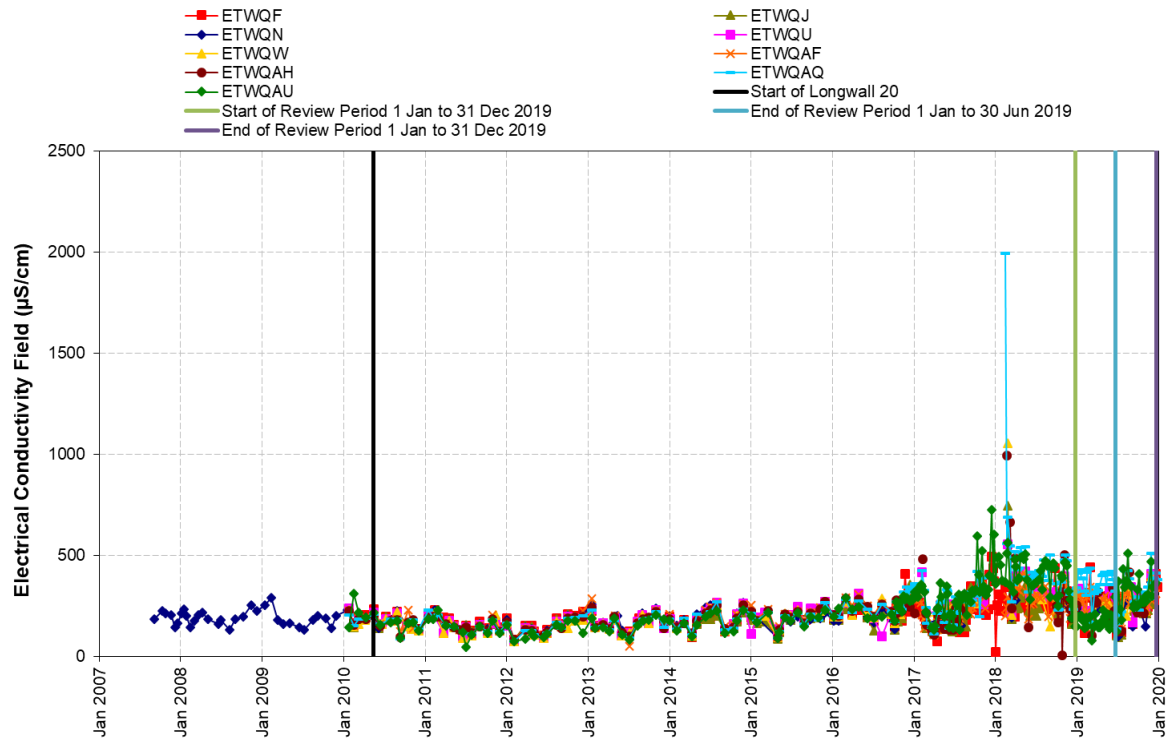


Chart 45a EC Eastern Tributary

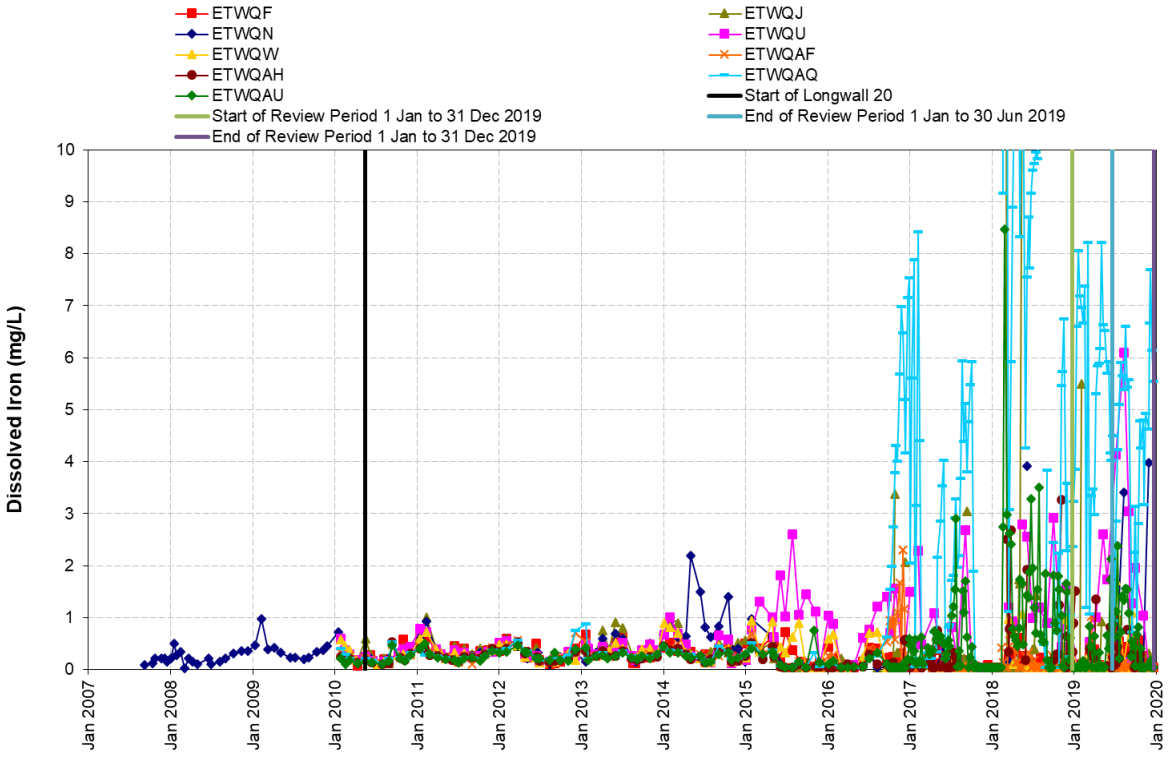


Chart 46 Dissolved Iron Eastern Tributary

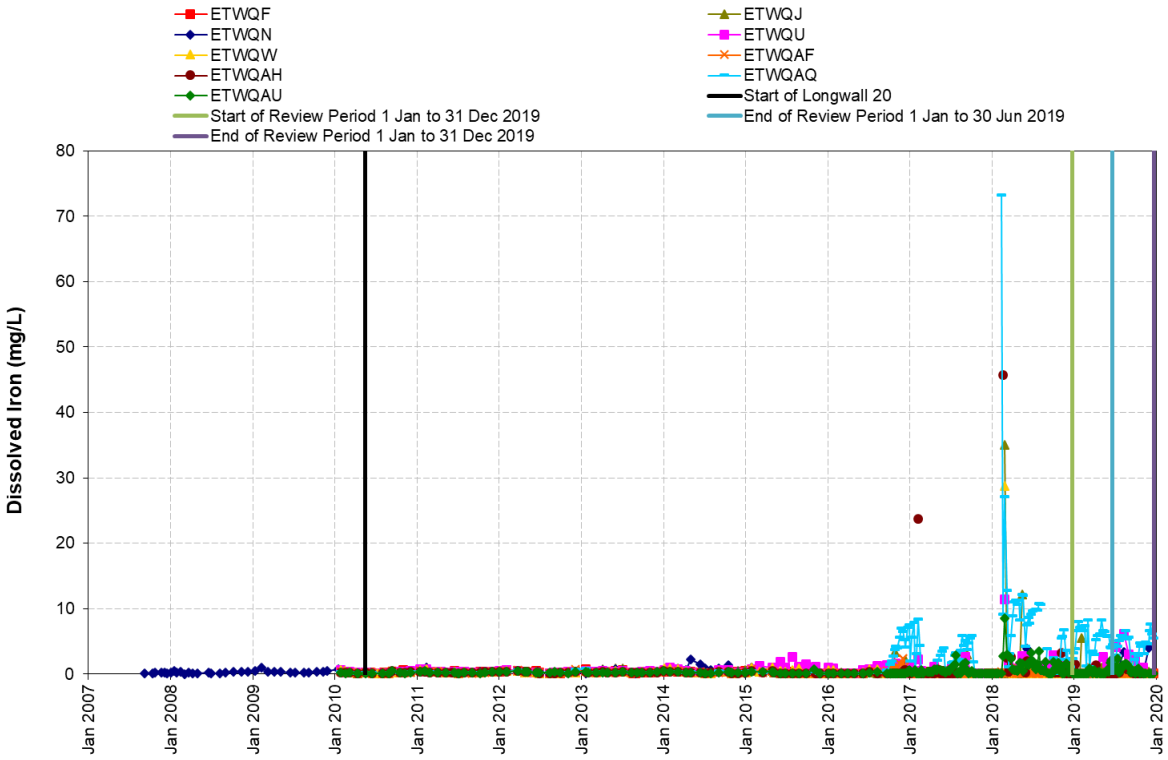


Chart 46a Dissolved Iron Eastern Tributary

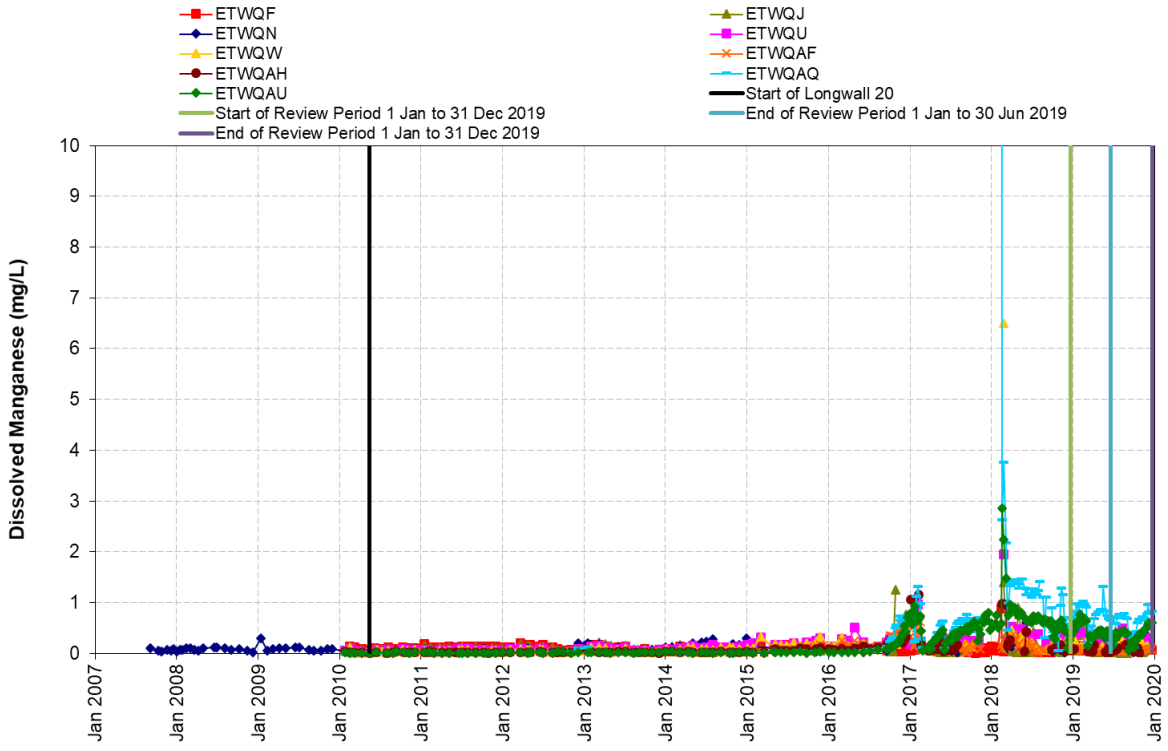


Chart 47 Dissolved Manganese Eastern Tributary

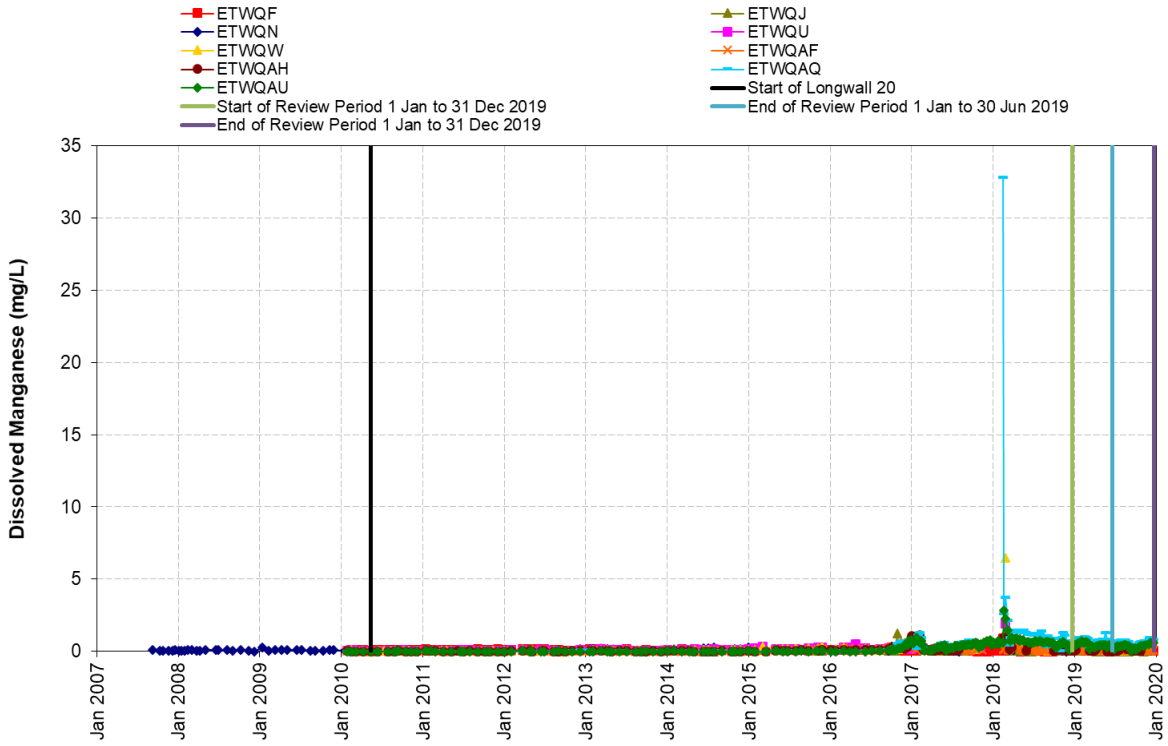


Chart 47a Dissolved Manganese Eastern Tributary

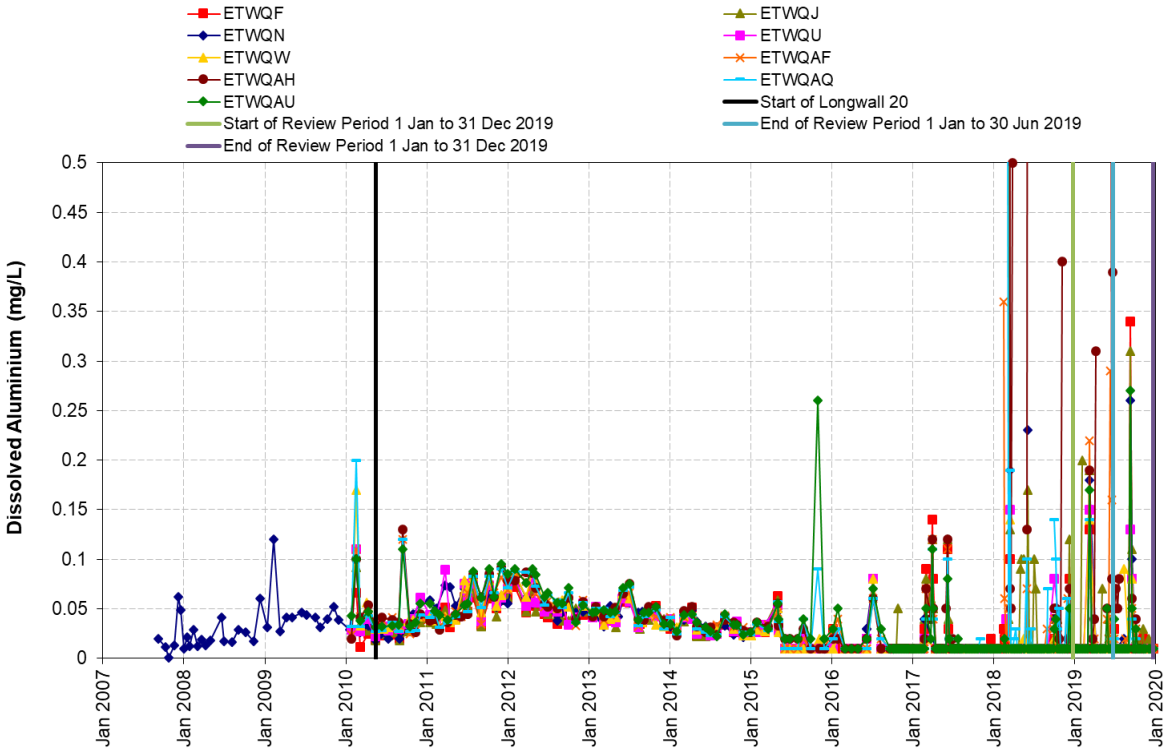


Chart 48 Dissolved Aluminium Eastern Tributary

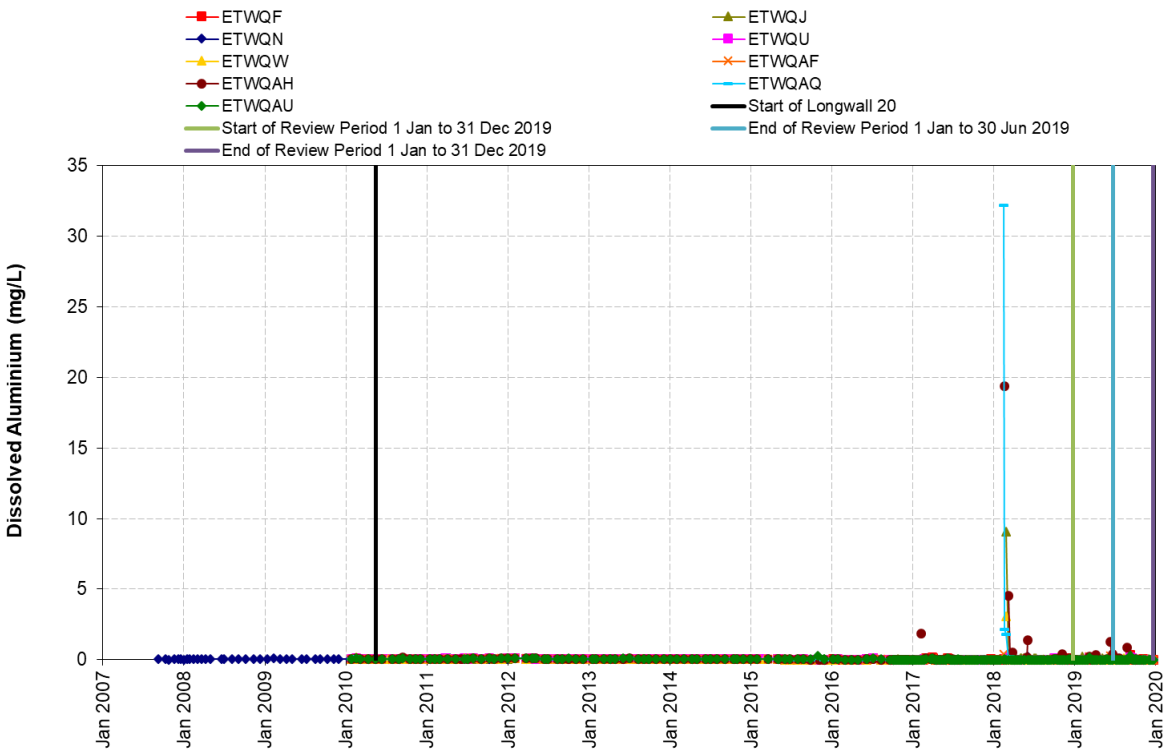


Chart 48a Dissolved Aluminium Eastern Tributary

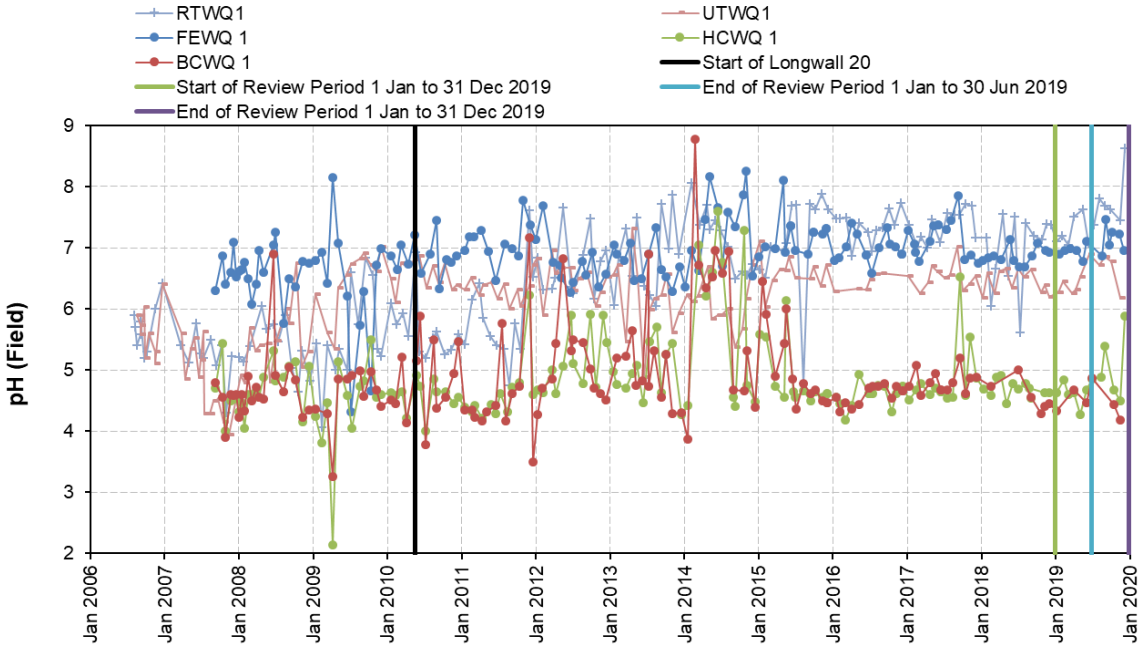


Chart 49 pH Levels Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

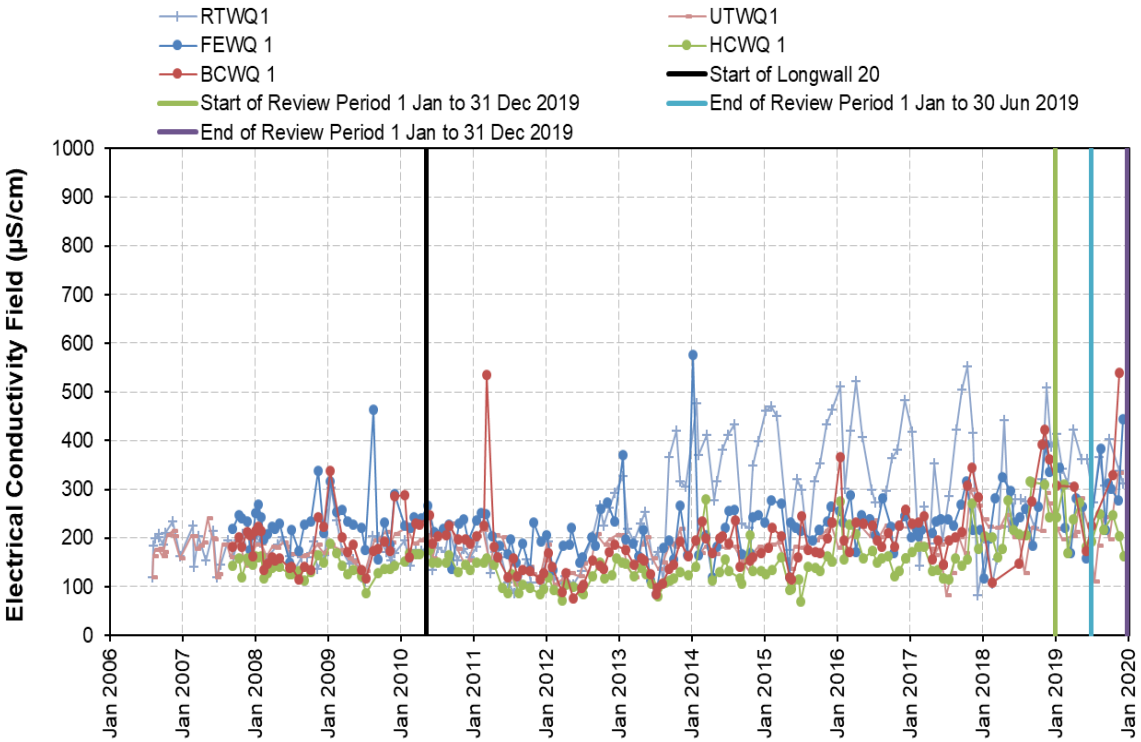


Chart 50 EC Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

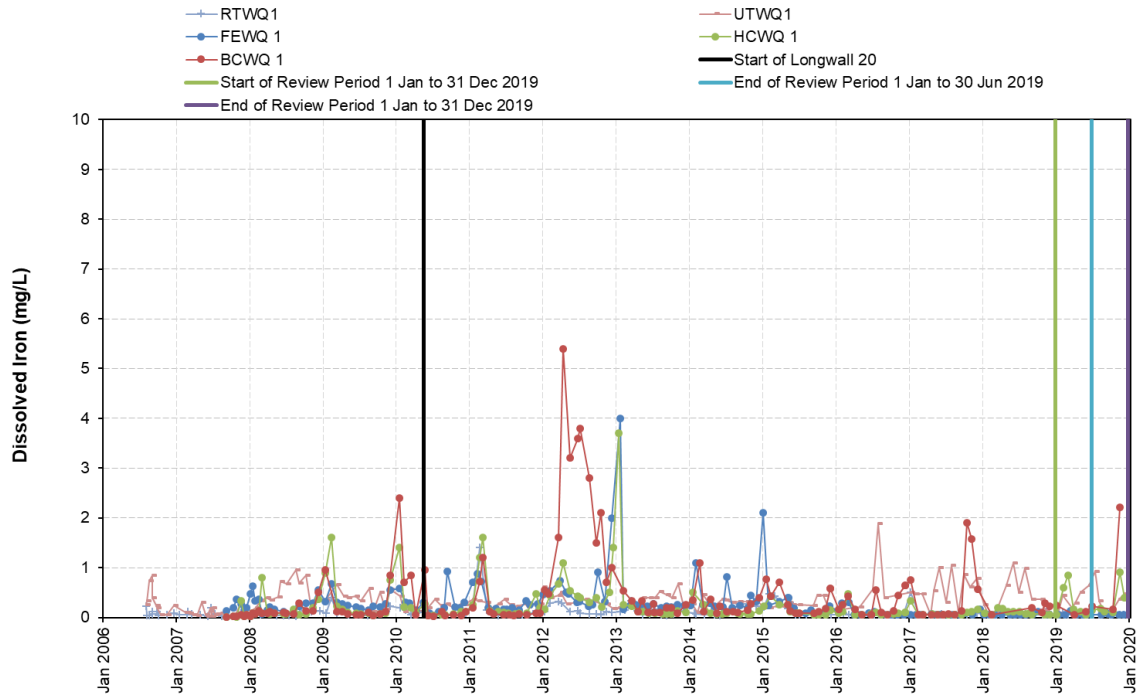


Chart 51 Dissolved Iron Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

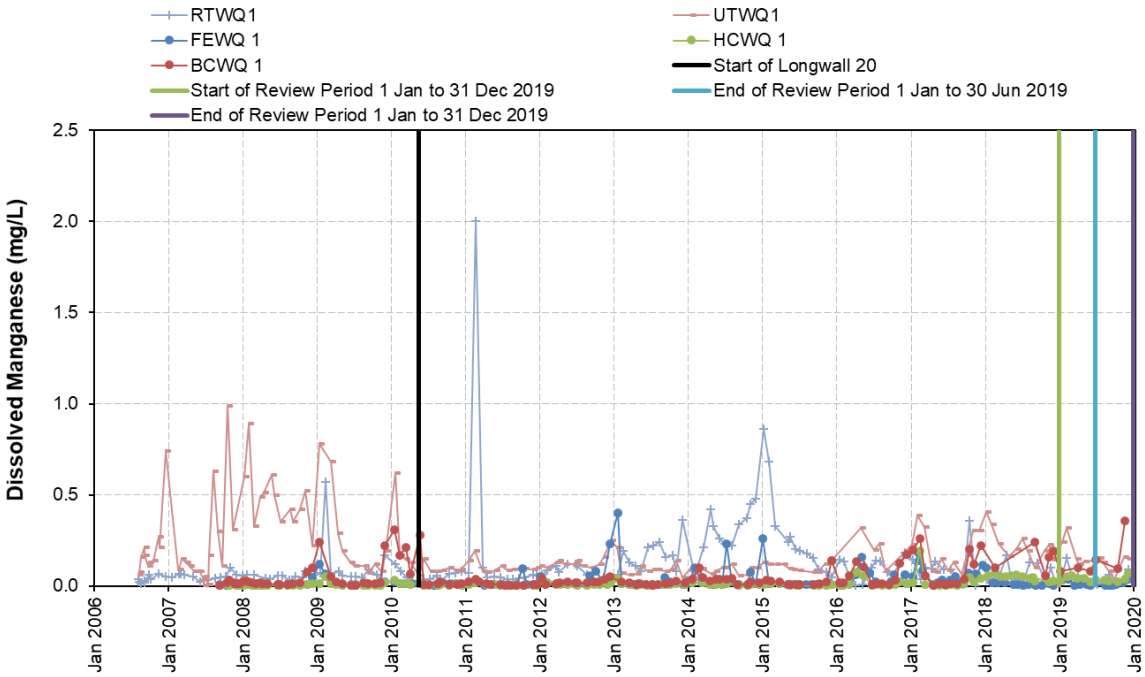


Chart 52 Dissolved Manganese Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

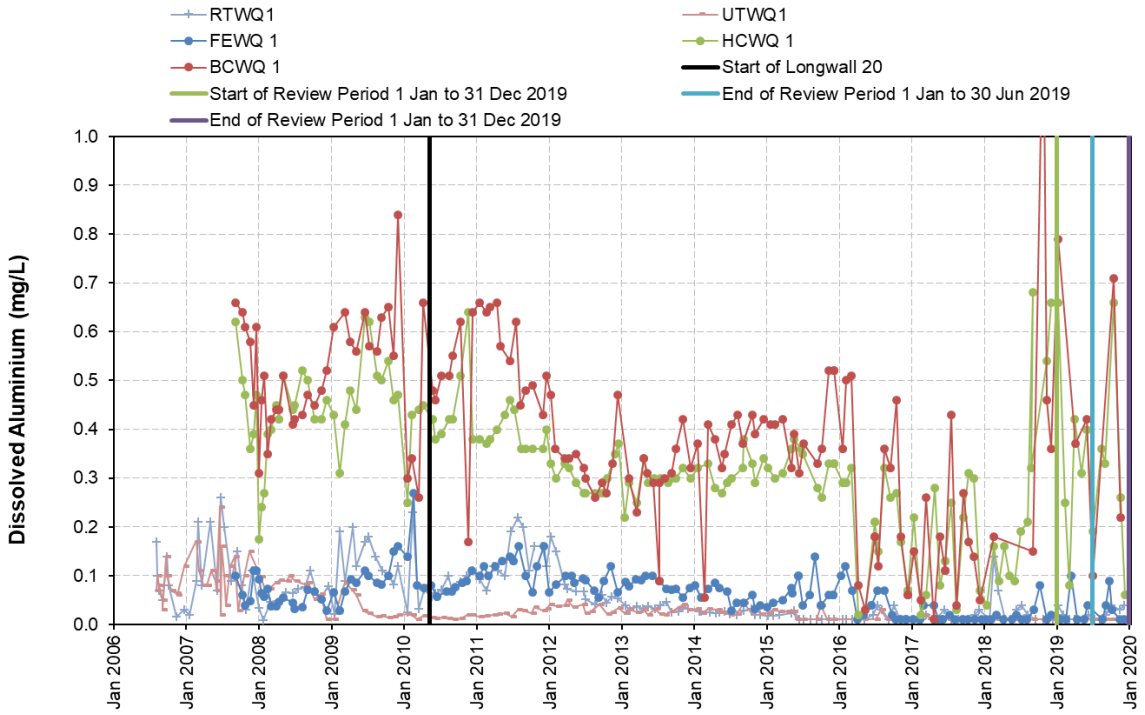


Chart 53 Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

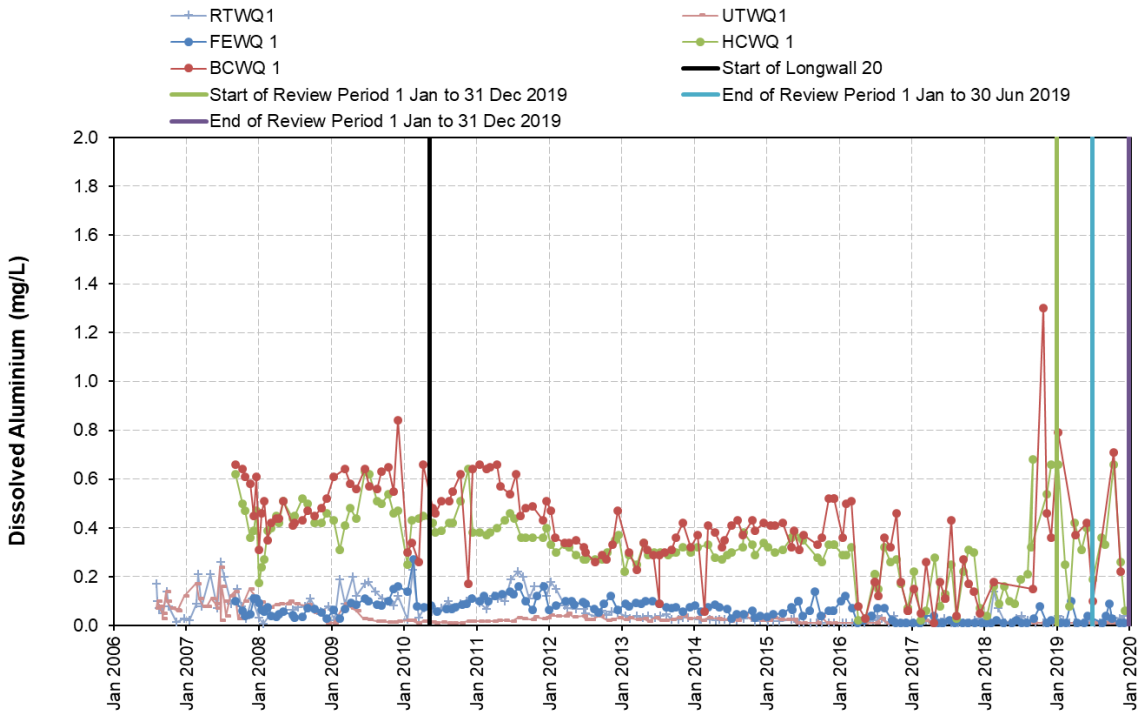


Chart 53a Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

The dissolved iron concentrations exceeded the adjusted baseline mean plus two standard deviations at sampling site ETWQ AU in June, July, August and September 2019. This resulted in exceedances of the adjusted baseline mean plus two standard deviations for two consecutive months in July (June and July 2019), August (July and August 2019) and September (August and September 2019) (Chart 54).

Dissolved iron concentrations also exceeded the adjusted mean plus two standard deviations in one month, the adjusted mean plus one standard deviation in the second month and the adjusted mean plus two standard deviations in the third month in August (June, July and August 2019) and September (July, August and September 2019) (Chart 54).

There were no exceedances of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved iron (Chart 55).

The dissolved manganese concentrations continued to exceed the adjusted baseline mean plus two standard deviations at sampling site ETWQ AU from January to December 2019 (Chart 56).

Dissolved manganese concentrations also exceeded the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month from January to December 2019 (Chart 56).

There was also an exceedance of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved manganese at sampling site ETWQ AU (Chart 57).

There were no exceedances of these triggers at control site WOWQ2 on the Woronora River (Appendices B1 and B2).

The cracking and dilation of bedrock and associated diversion of surface flow and leakage of water through rock bars at pools which has occurred on the Eastern Tributary, including at the location of the stream which was the subject of the exceedance of the Eastern Tributary watercourse performance measure (the Eastern Tributary Incident), has resulted in increases in dissolved manganese and iron.

As a result of the performance indicator exceedances for dissolved manganese and dissolved iron at site ETWQ AU on the Eastern Tributary, assessments were made against the subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir.* The assessments were undertaken by Associate Professor Barry Noller and are provided in Appendix F3.

The manganese and iron concentrations reaching the Woronora Reservoir have been considered. Water quality monitoring results to date indicate there has been a negligible reduction in the quality of water resources reaching the Woronora Reservoir. The watercourse performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir,* is not considered to have been exceeded (Appendix F3).

The environmental consequences of subsidence impacts on water quality were predicted by the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans to be similar to that previously observed at Metropolitan Coal, specifically, transient pulses of iron, manganese and aluminium, which would likely occur following fresh cracking of the stream bed.

Monitoring and analysis of water quality data will continue in accordance with the Longwall 304 Water Management Plan. Metropolitan Coal is committed to the remediation of pools on the Eastern Tributary. It is anticipated that the stream remediation activities (described in Section 10.3.2) will reduce the transfer of iron and manganese from the groundwater to the Eastern Tributary. Metropolitan Coal will commence stream remediation in Q2 2020 in accordance with the approved Stream Remediation Plan.

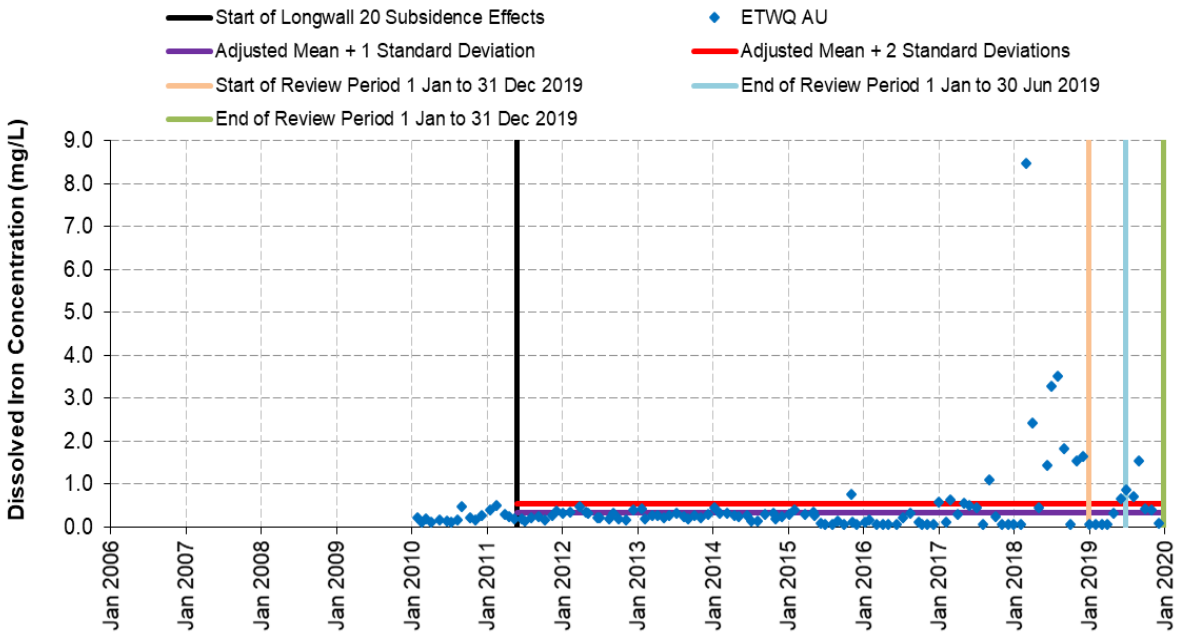


Chart 54 Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

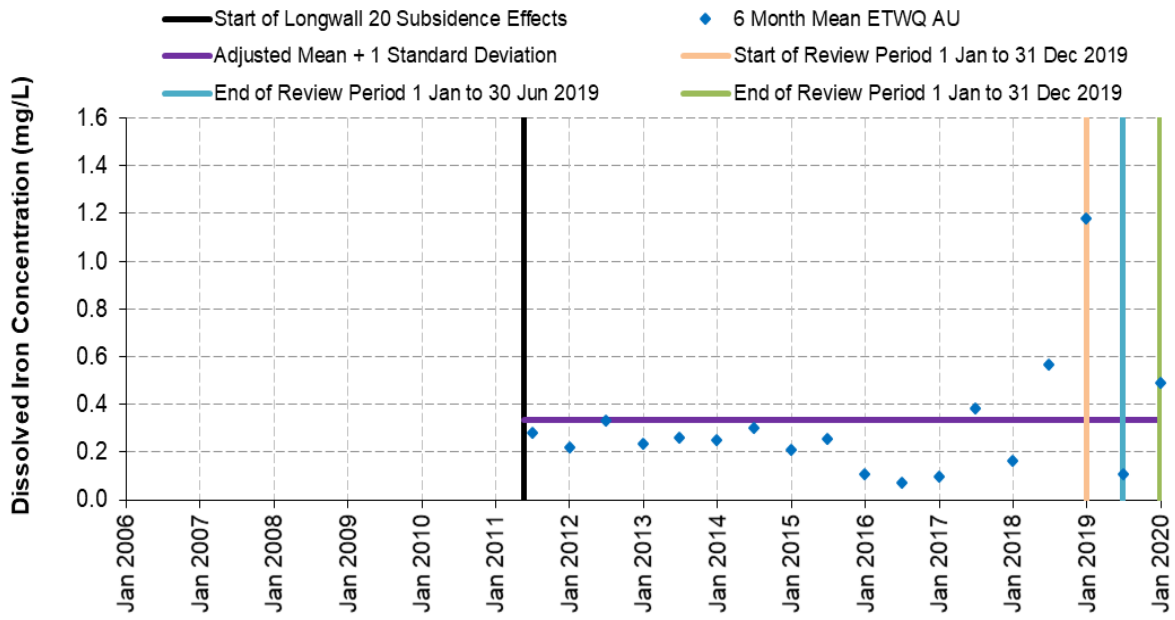


Chart 55 Six Month Means of Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

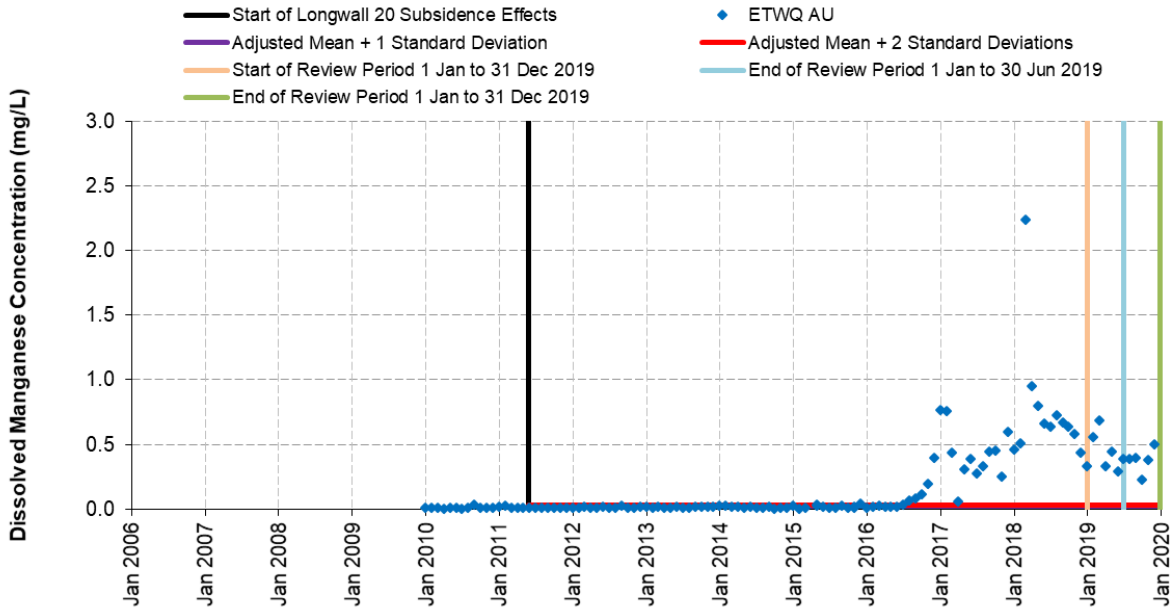


Chart 56 Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

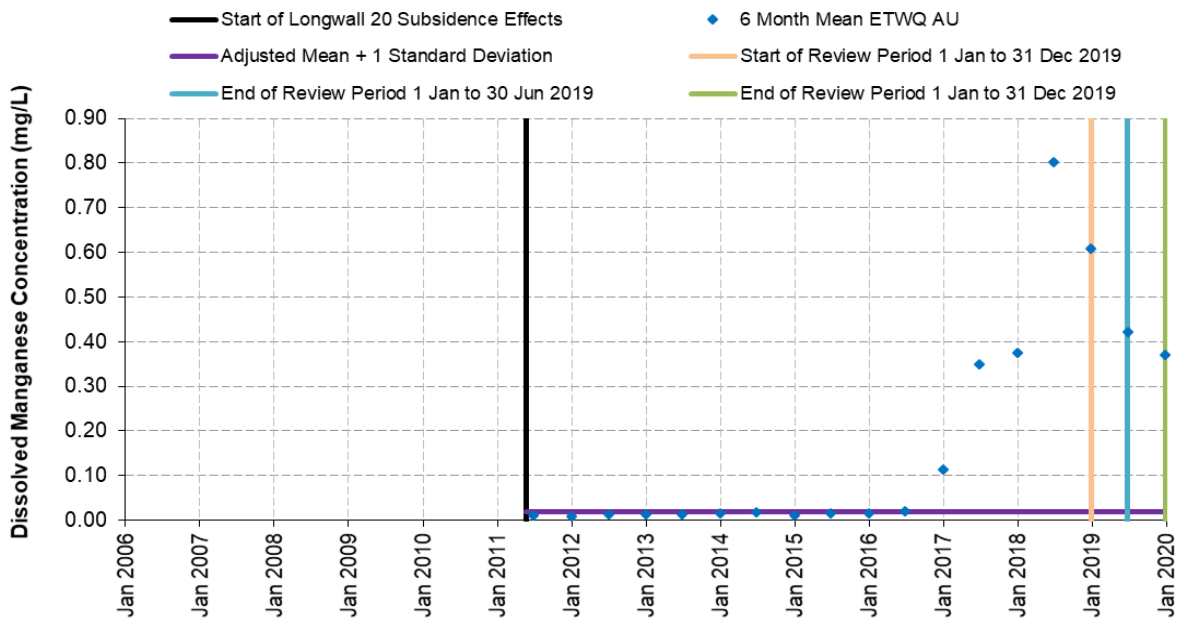


Chart 57 Six Month Means of Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

6.2.5 Woronora Reservoir Water Quality

Metropolitan Coal has sourced water quality data for the Woronora Reservoir from WaterNSW in accordance with a data exchange agreement. Results in relation to total iron, aluminium and manganese at levels from 0 m to 9 m below the reservoir surface for Woronora Reservoir throughout the period of record are presented in Charts 58 to 60.

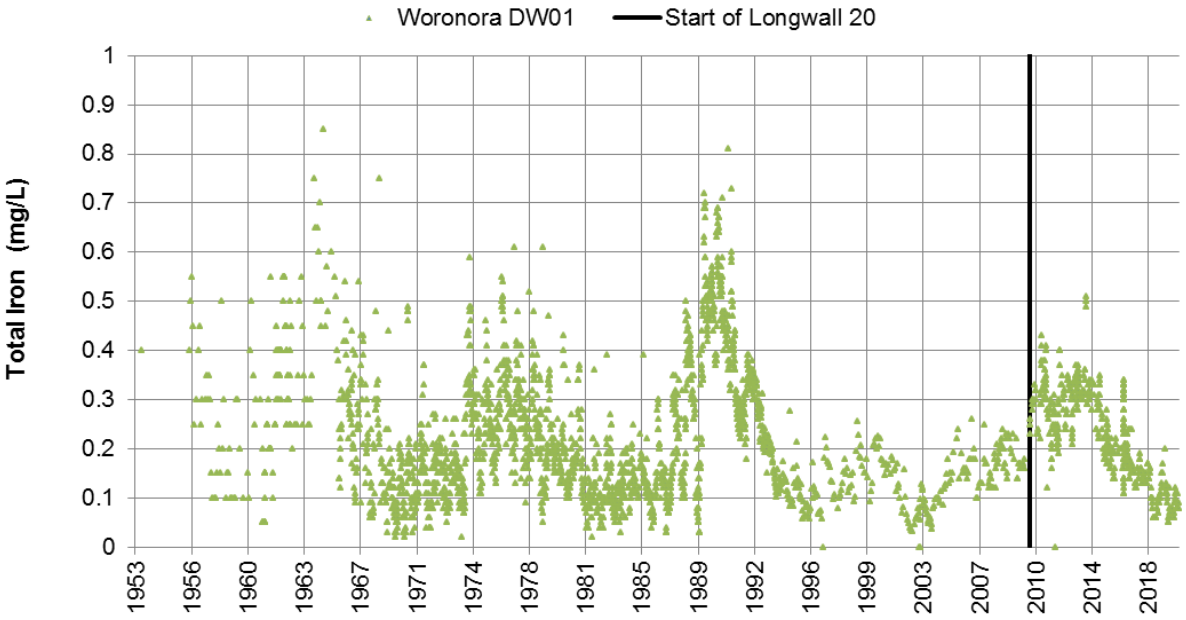


Chart 58 Total Iron Concentration Woronora Reservoir

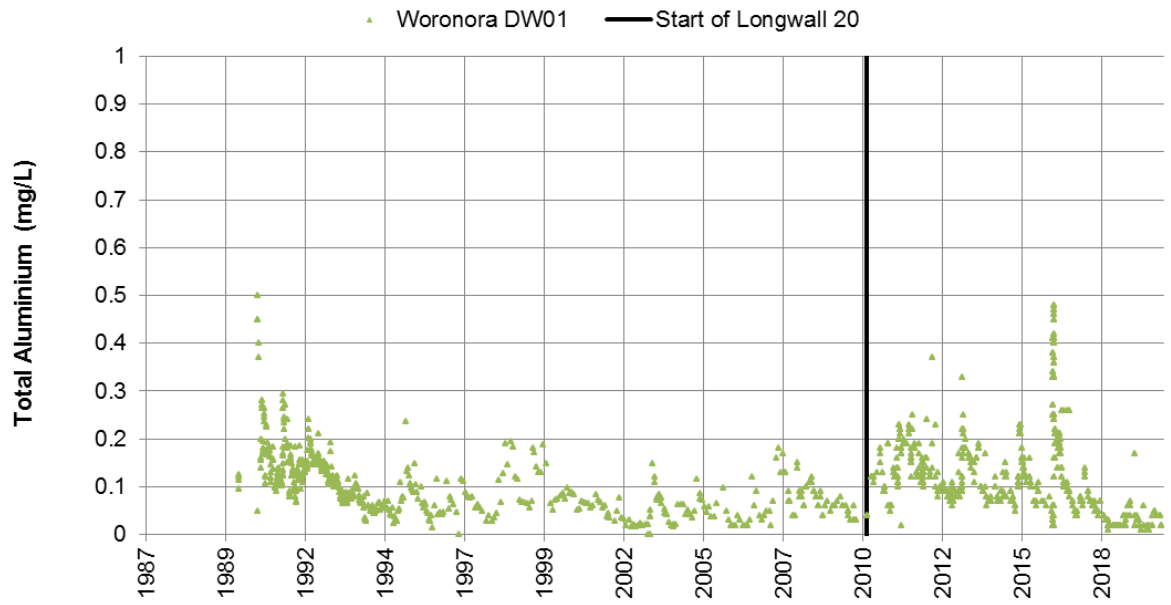


Chart 59 Total Aluminium Concentration Woronora Reservoir

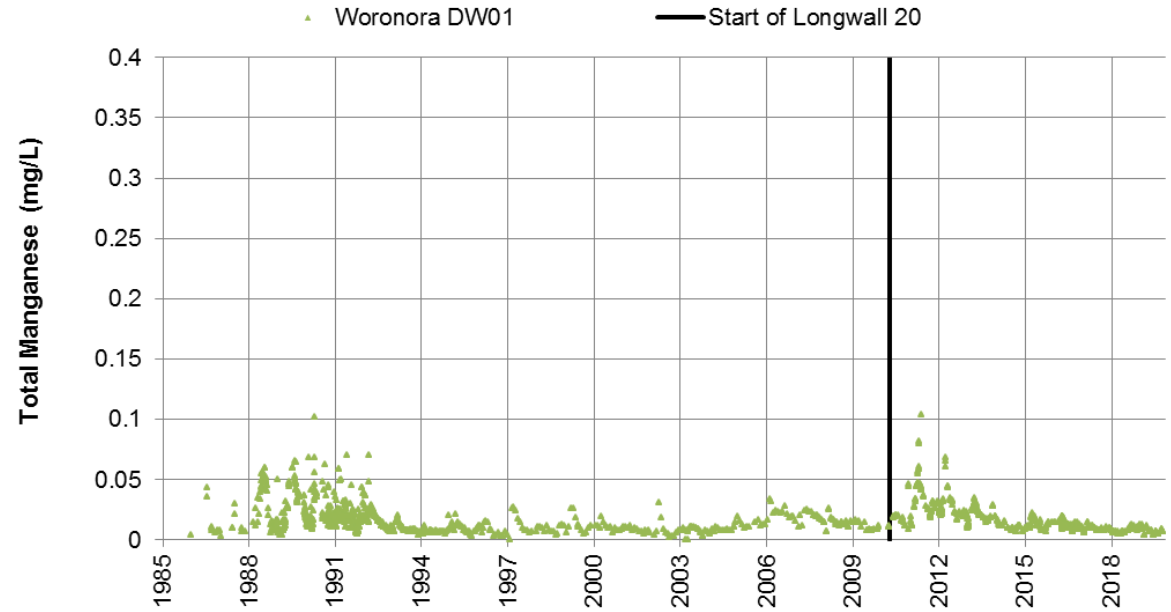


Chart 60 Total Manganese Concentration Woronora Reservoir

Water quality data in the Woronora Reservoir is analysed annually and assessed against the following performance indicator:

> *Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations.*

The performance indicator is considered to have been exceeded if data analysis indicates a significant change in the quality of water post-mining, specifically if the current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is above the baseline 20 year average recurrence interval (ARI) exceedance curve for any range of the duration percentages from 0% to 75%. The results of this assessment are shown on Chart 61, Chart 62 and Chart 63, respectively.

There were no exceedances of the Woronora Reservoir water quality performance indicator (the 20 year ARI exceedance curve) for total iron, total aluminium or total manganese during the review period (Charts 61, 62 and 63, respectively) (Appendix B2). There were also no exceedances of the 10 year ARI exceedance curve for total iron, total aluminium or total manganese (Charts 61, 62 and 63, respectively). The results for total iron, total aluminium and total manganese equate to a Level 1 significance level (Appendix B2).

The Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans predicted the Project would not impact on the performance of the Woronora Reservoir and would have a neutral effect on water quality. The water quality monitoring results are consistent with the predictions.

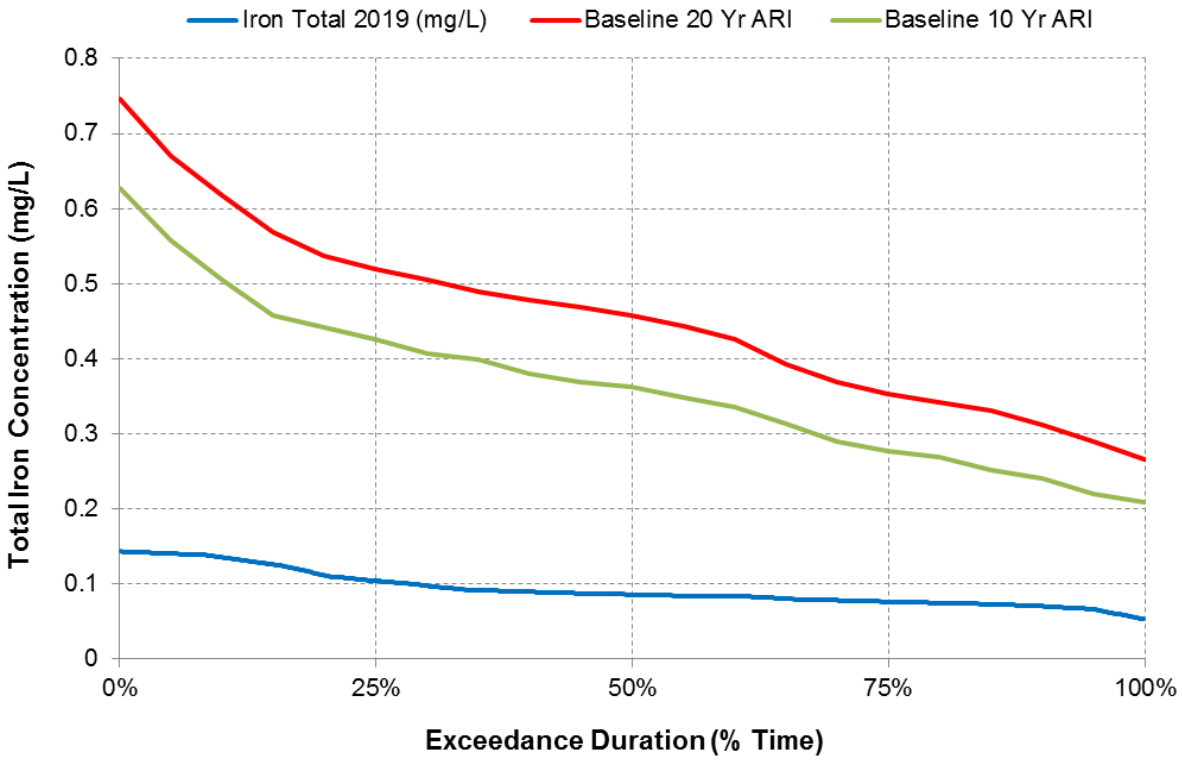


Chart 61 Total Iron Performance Indicator Woronora Reservoir 2019

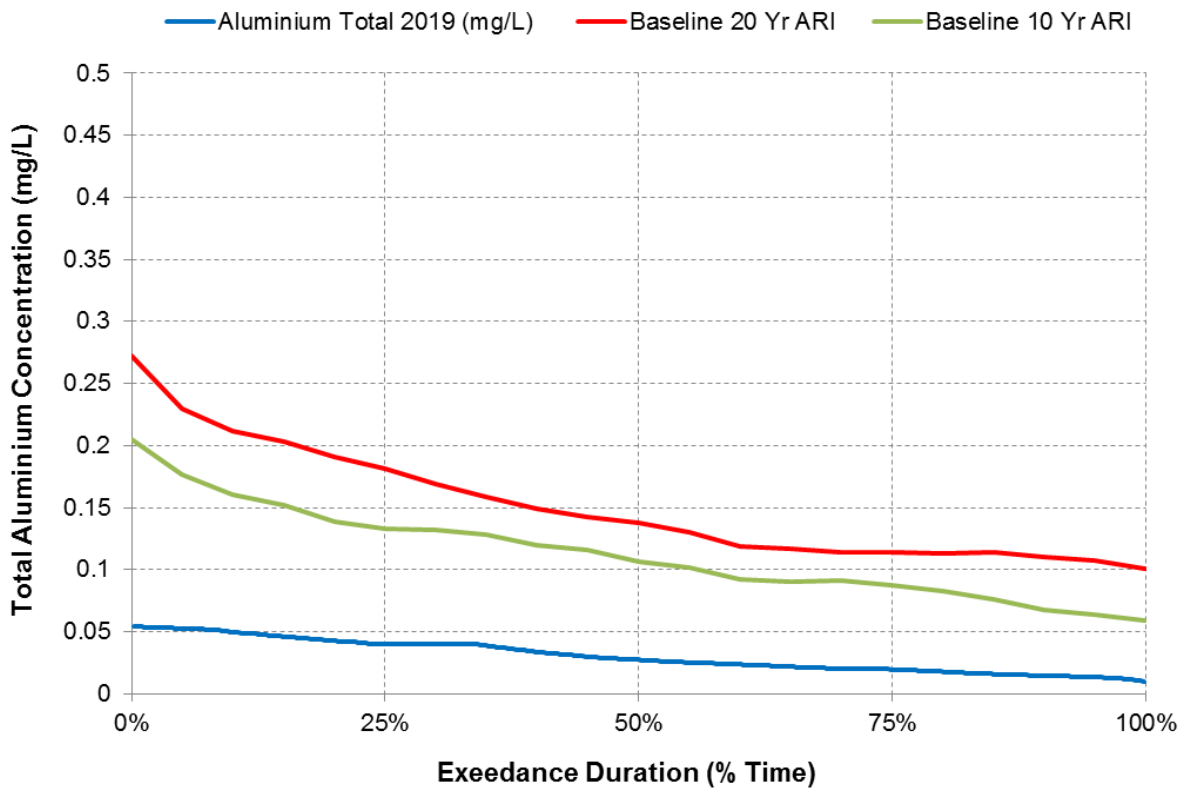


Chart 62 Total Aluminium Performance Indicator Woronora Reservoir 2019

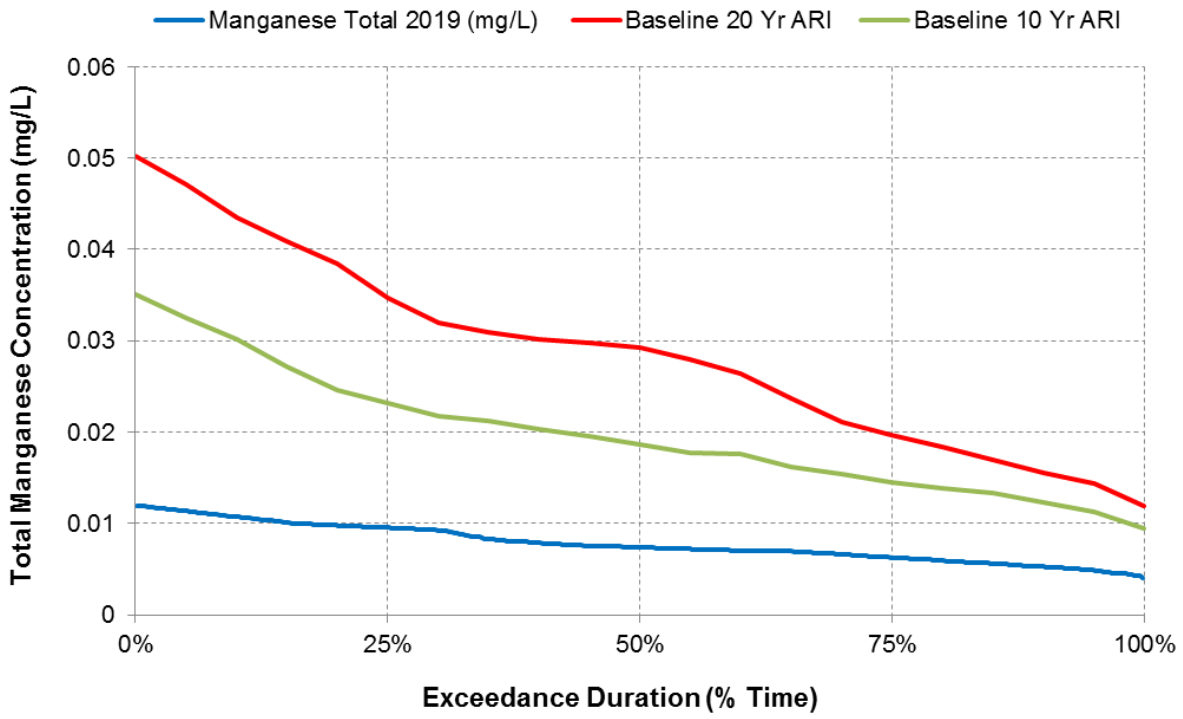


Chart 63 Total Manganese Performance Indicator Woronora Reservoir 2019

6.2.6 Swamp Groundwater Levels

Groundwater monitoring of upland swamps has involved the use, where practicable, of paired piezometers, one in the swamp substrate (at approximately 1 m depth) and one in the underlying sandstone (at a depth of approximately 10 m) (Figure 9). Data shows that water levels within the swamps over longwalls are typically perched above those of the local Hawkesbury Sandstone groundwater levels and indicates a separate control on swamp water levels. That is, the swamps are primarily surface water fed systems and generally water infiltrates downwards from the swamps to the groundwater.

Swamp substrate water levels are assessed against the following upland swamp groundwater performance indicator:

> *Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to control swamps or seasonal variations in water levels experienced by upland swamps prior to mining*.

Swamp Monitoring for Longwalls 20-27

Paired piezometers have been monitored in Swamp 25 overlying Longwalls 20-22, Swamps 28, 30, 33 and 35 overlying Longwalls 23-27, and in control swamps 101, 137a, 137b and Bee Creek Swamp (Figure 9). At Swamp 20 (overlying Longwall 21) and at control swamp Woronora River Swamp 1, multiple piezometers have been monitored (i.e. one swamp substrate piezometer to a depth of approximately 1 m and two sandstone piezometers to depths of approximately 4 and 10 m) (Figure 9).

The upland swamp groundwater performance indicator has been exceeded at Swamp 20 since 2012. Swamp 20 substrate water levels changed from being permanently saturated to being periodically saturated as a result of the passing of Longwall 21 (Chart 64 and Appendices C1 and C2). There is a very strong correlation with rainfall trend at Swamp 20 and control swamp Woronora River Swamp 1 over the period of record. As the rate of decline in the two piezometers is similar from 2013, but different in 2012, it is considered that Longwall 21 caused a mining effect at Swamp 20, but the effects have not been exacerbated by Longwalls 22-27 or Longwalls 301-304 (Appendices C1 and C2). The water levels in both Swamp 20 and control swamp Woronora River Swamp 1 were at the base of the dataloggers for the entirety of the reporting period, except for a response to rainfall in Swamp 20 in September 2019, however water levels did not reach the two standard deviation limit (Chart 64 and Appendices C1 and C2).

A mining effect to the substrate water levels of Swamp 28 (overlying Longwall 24) was identified in 2016 based on the incomplete recovery of substrate water levels following rainfall events (Chart 65 and Appendices C1 and C2). Swamp 28 is considered to have an impact from mining of Longwall 25, although no effect on swamp substrate water levels occurred when Longwall 24 passed directly beneath the monitoring site (Appendices C1 and C2). The substrate piezometer at Swamp 28 returned to dry conditions from September 2017, remaining so until the end of this reporting period, as did the two control swamp piezometers (Swamps 137a and 137b; Chart 65).

The substrate water piezometer in Swamps 25, 30, 33 and 35 remained dry through the reporting period except for a response to the rainfall event in September 2019. The control Swamps 137a and 137b remained dry through the entire reporting period, while Swamp Bee Creek showed a small response to rainfall in the second half of 2019. Semiquantitative comparisons of the swamp substrate water levels of Swamps 25, 30, 33 and 35 with control swamps and rainfall records do not show a definitive mining effect and the dry conditions are regarded as a natural response to reduced rainfall (Appendices C1 and C2).

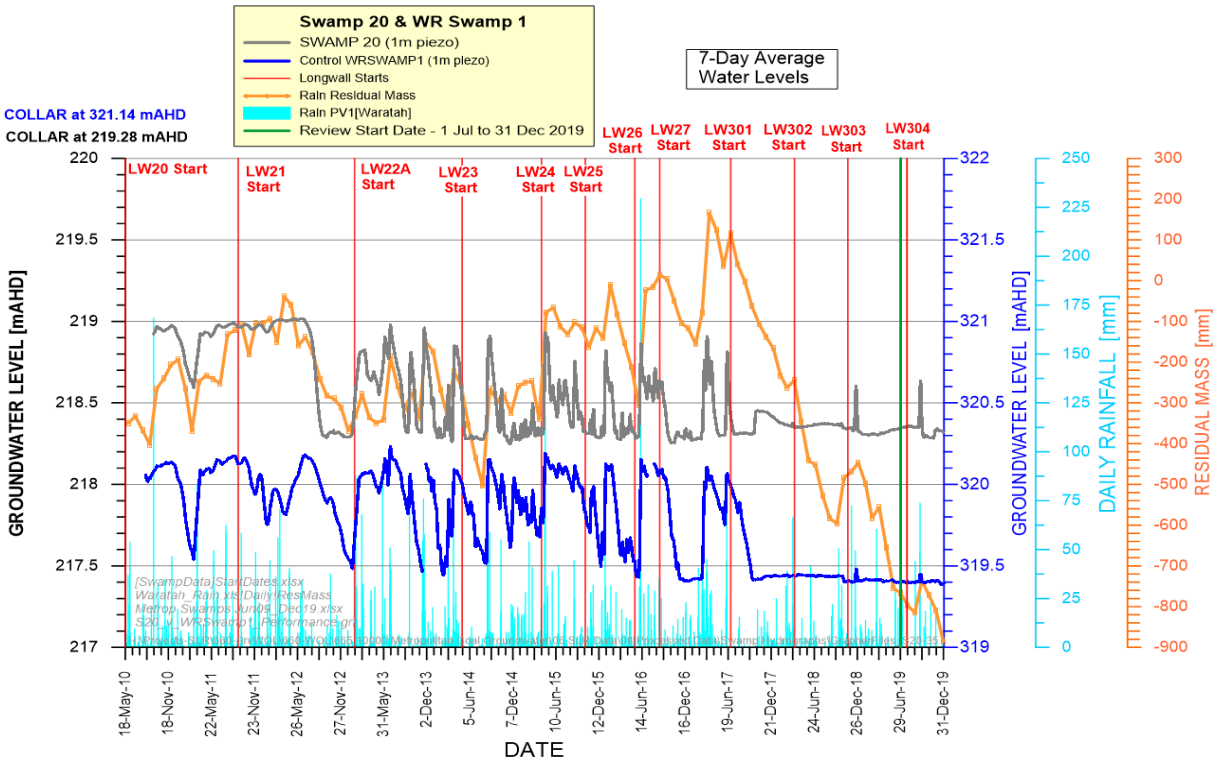


Chart 64 Comparison of Piezometer Responses at Swamp 20 and Woronora River 1 Control Swamp

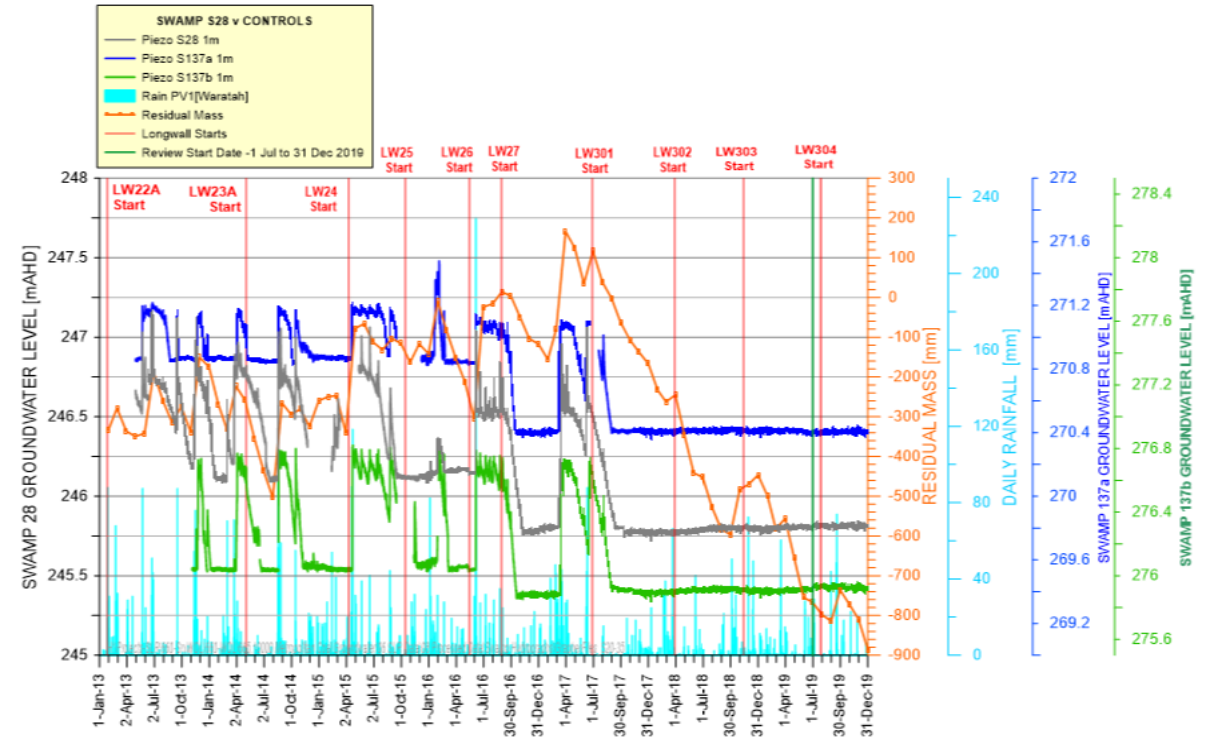


Chart 65 Groundwater Hydrographs at Swamp 28 and Two Control Swamps (137a and 137b)

Swamps Monitoring for Longwalls 301-304

Paired piezometers (i.e. one swamp substrate piezometer and one sandstone piezometer) have also been monitored in Swamps 40, 41, 46, 50, 51, 52 and 53 overlying Longwalls 301-304 (Figure 9). As indicated in Section 4.1, Longwall 303 was completed on 2 June 2019 and the extraction of Longwall 304 commenced on 28 July 2019 and continued for the remainder of the review period.

The swamp substrate hydrographs for Swamps 40, 41, 46, 50, 51, 52 and 53 indicate that the correlation of swamp substrate with the rainfall trend is strong (Appendices C1 and C2). Data analysis for the reporting period indicates the seven day moving averages for Swamps 41 and 53 were at or above the swamp's minimum recorded in the baseline period (Appendices C1 and C2).

Data analysis for the reporting period indicates the seven day moving averages for Swamp 40, 46, 51 and 52 were below the swamp's minimum recorded in the baseline period. Semiquantitative comparisons of the swamp substrate water levels of Swamps 40, 46, 51 and 52 with control swamps and rainfall records do not show a definitive mining effect and the dry conditions are regarded as a natural response to reduced rainfall (Appendices C1 and C2).

The key potential subsidence impacts and environmental consequences on perched groundwater systems described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans and Biodiversity Management Plans, included:

- Any cracking of the bedrock within upland swamps is expected to be isolated and of a minor nature, due to the relatively low magnitudes of the predicted strains and the relatively high depths of cover.
- Surface cracking resulting from mine subsidence within the upland swamps is not expected to result in an increase in the vertical movement of water from the perched water table into the regional aquifer as the sandstone bedrock is massive in structure and permeability decreases with depth.
- It is expected that any surface cracking that may occur would be superficial in nature (i.e. would be relatively shallow) and would terminate within the unsaturated part of the low permeability sandstone. Any changes in swamp water levels as a result of cracking are expected to be immeasurable when compared to the scale of seasonal and even individual rainfall event based changes in swamp groundwater levels.
- Whilst swamp grades vary naturally, the predicted maximum mining-induced tilts are generally orders of magnitude lower than the existing natural grades within the swamps. The predicted tilts would not have any significant effect on the localised or overall gradient of the swamps or the flow of water. Any minor mining-induced tilting of the scale and nature predicted is not expected to significantly increase lateral surface water movements which are small in relation to the other components in the swamp water balance.

No change to the fundamental surface hydrological processes and upland swamp vegetation were expected within upland swamps.

In relation to impacts of the Project on upland swamps, the NSW Planning Assessment Commission (2009) concluded that the mining parameters were such that:

- for most swamps in the Project Area, there was low risk of negative environmental consequences; and
- that there was a very low risk that a significant number of swamps would suffer such consequences.

While the water lost from Swamp 20 and Swamp 28 was retained in the unsaturated sandstone above the regional water table, the changes in swamp water levels as a result of cracking are measurable when compared to seasonal individual rainfall event based changes in swamp groundwater levels. There is currently no sign that the vegetation in Swamp 20 is being impacted by the changed hydrological conditions, however, the vegetation monitoring results suggest that the changes in vegetation occurring in Swamp 28 have been significantly different to changes in the control swamps since autumn 2017 (refer Section 6.3.1).

6.2.7 Shallow Groundwater Levels

Shallow Groundwater Level Sites near Streams

Continuous water level monitoring of shallow groundwater levels has been conducted at sites WRGW1, WRGW2 and WRGW7 along Waratah Rivulet and sites ETGW1[16] and ETGW2 on the Eastern Tributary (Figure 10).

At the time of passage of the Longwall 21 mining face past the piezometer sites WRGW1 and WRGW2 on the Waratah Rivulet (March 2012), the groundwater levels dropped by approximately 1 m (Chart 66). Since March 2012, groundwater levels recorded at WRGW1 and WRGW2 have fluctuated in response to seasonal rainfall variations with a seasonal (dry) minimum that is approximately 0.75 m below previous levels (Chart 66 and Appendices C1 and C2). From January to June 2018 the rainfall residual mass continued to decline and water levels at WRGW1 and WRGW2 spiked following rainfall in March 2018. From July 2018, the water level trend followed the rainfall residual mass trend, declining from July to September 2018 and increasing from October to December 2018. During January to June 2019, the water level correlated with the daily rainfall including a large spike following the March rainfall event, and generally correlated with the residual mass curve except for January and February, when following rainfall in December 2018 the water level increased while the monthly rainfall was below average. The water levels in the second half of 2019 displayed usual correlation with the daily rainfall with a large spike at a September 2019 rainfall event. The water levels followed the similar trend similar with the residual mass curve until September 2019 and then showed opposite manner till the end of reporting period. This was due to the monthly total rainfalls were less than the long-term average, meaning the residual trend continued dropping but the water level followed daily rainfall trends. The water levels have not returned to pre-March 2012 levels.

Shallow groundwater levels at site WRGW7 remained correlated with rainfall trends and unaffected by mining during the reporting period[17] (Chart 67; Appendices C1 and C2).

At the Eastern Tributary sites ETGW1 and ETGW2, shallow groundwater levels have previously followed the rainfall trends closely (Chart 68) and have continued to show a close correlation during the reporting period. The variations at these sites are unrelated to mining (Appendices C1 and C2). Although Woronora Reservoir water levels also respond to rainfall with a similar pattern, a groundwater hydraulic gradient is maintained towards the reservoir because the groundwater levels are 10-14 m higher than the dynamic reservoir levels (Appendices C1 and C2).

[16] Site ETGW1 was unable to be sampled since August 2017.

[17] WRGW7 readings up to 15/11/2018.

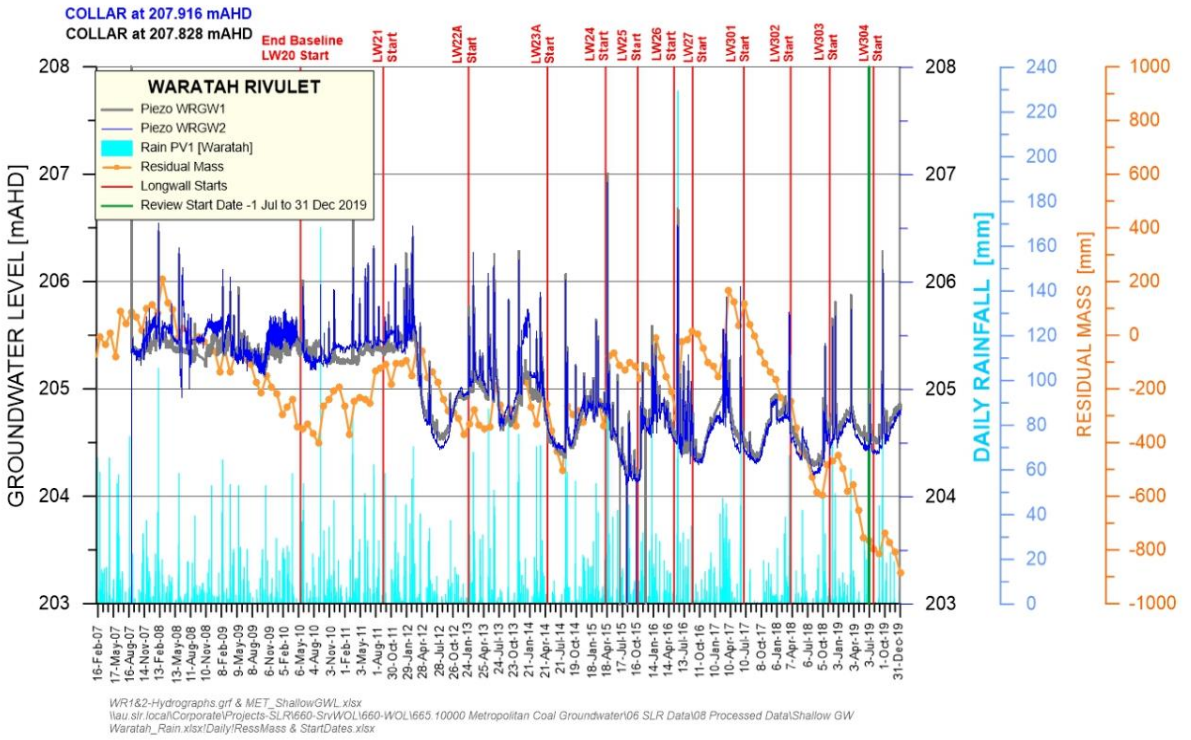


Chart 66 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW1 and WRGW2

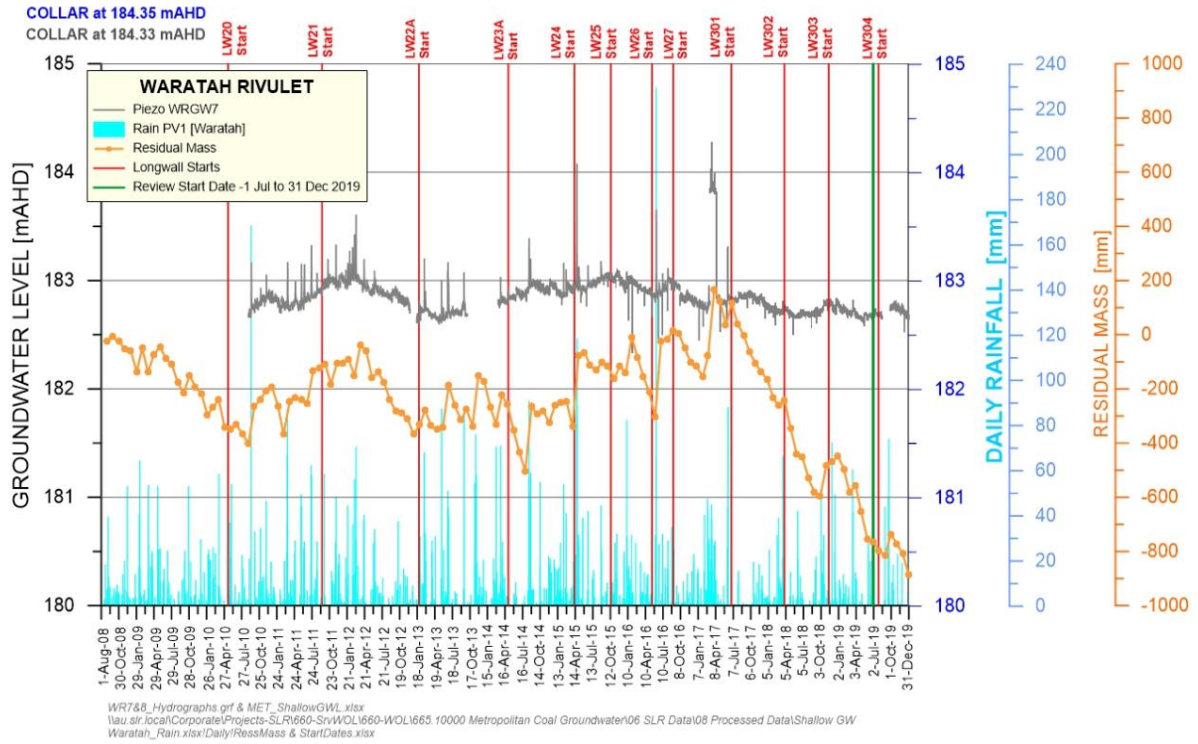


Chart 67 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW7

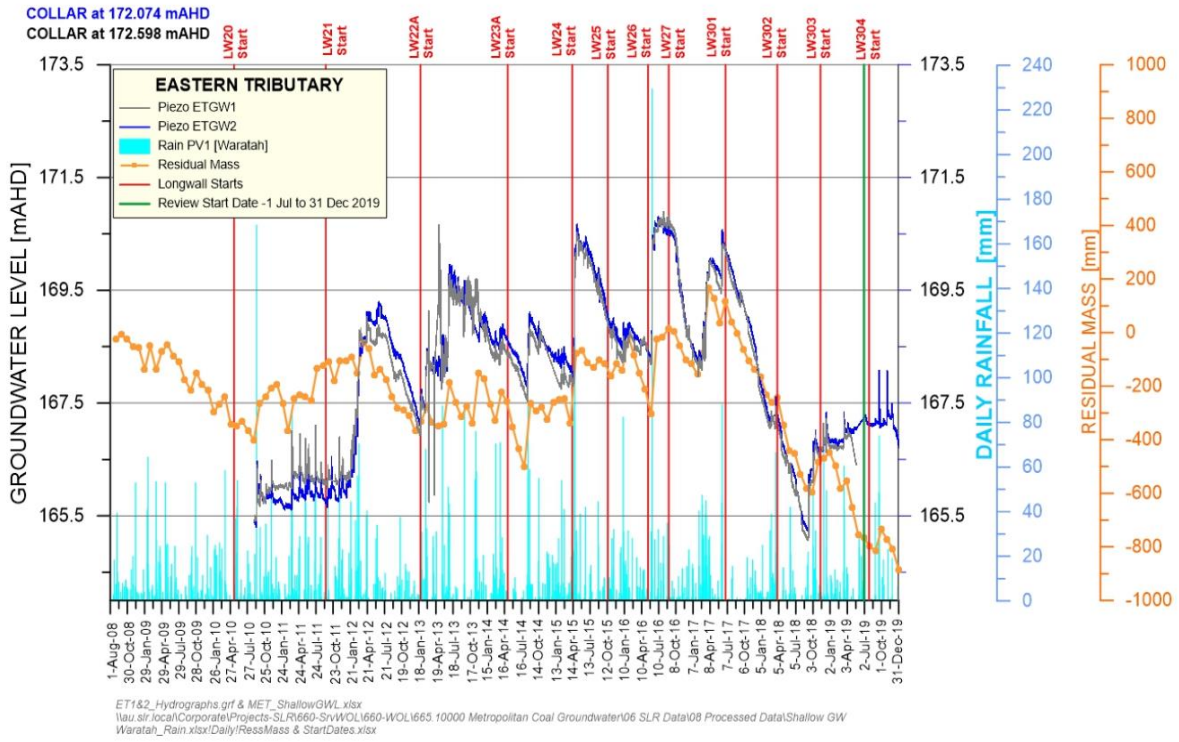


Chart 68 Shallow Groundwater Hydrographs on Eastern Tributary at ETGW1 and ETGW2

Shallow Groundwater Transect

Continuous groundwater level monitoring has also been conducted at an approximately east-west transect of bores (sites T1, T2, T3, T4 and T5) located to the west of Longwalls 301-303 (Figure 10) in accordance with the Longwalls 301-303 Water Management Plan, and the Longwall 304 Water Management Plan.

The measured water level transect for shallow bores T1-T5 are shown in Chart 69. The water levels measured on 17 December 2019 at T1, T2, T3 and T5 were slightly lower than previously recorded except at T5 (Appendices C1 and C2). The water level at bore T4 remains anomalous and unreliable as its head has always been higher than the head at upgradient site T5. This is considered unlikely to be a groundwater divide as it is not related to the topographic ridge well upgradient (Appendices C1 and C2).

Groundwater levels at bores T2, T3 and T5 are assessed against the following performance indicators for Longwalls 301-304:

The water level at bore T2 is greater than 170.0 m AHD[18]*.*

The water level at bore T3 is greater than 171.8 m AHD[18]*.*

The hydraulic gradient from transect bore T5 to bore T3 is reduced by no more than 10% from that measured on 30 June 2017.

[18] The performance indicators for the water levels of bores T2 and T3 were removed in the Longwall 304 Water Management Plan which commenced in July 2019.

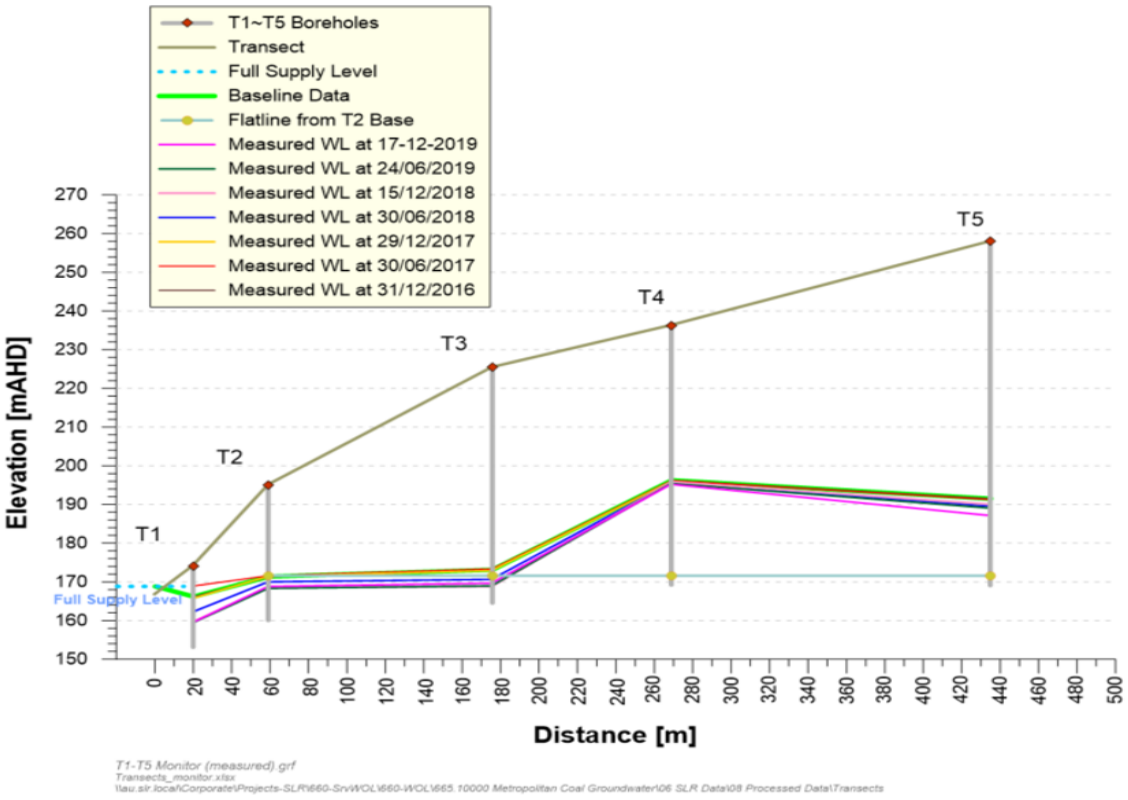


Chart 69 Measured T1-T5 Boreholes Transect

The performance indicators are designed to provide an early warning for assessment of negligible leakage from the Woronora Reservoir. Leakage from the Woronora Reservoir to the surrounding groundwater environment would occur if there is a reversal of hydraulic gradient (i.e. when the water table in surrounding piezometers is below the water level in the Woronora Reservoir).

The hydraulic gradient from bore T5 to bore T3 was at the Level 1 trigger level and then dropped to Level 2 in November 2019 during the reporting period (Chart 70 and Appendices C1 and C2).

The performance indicator for bore T3 was exceeded in April 2018 (Chart 71) and the performance indicator for bore T2 was exceeded in July 2018 (Chart 72). The Woronora Reservoir water level has been displayed on Charts 71 and 72 to aid interpretation. An assessment against the subsidence impact performance measure, *Negligible leakage from the Woronora Reservoir,* was undertaken when the exceedance of the Level 3 Trigger and performance indicator was first identified for bore T3 in April 2018 (Appendix G1).

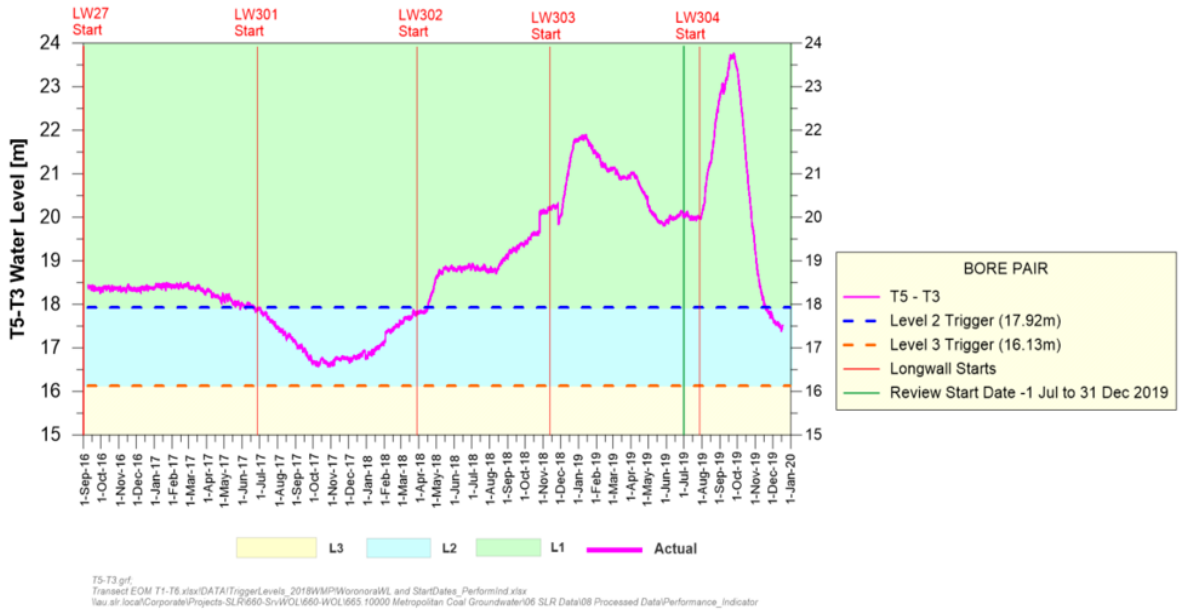


Chart 70 Hydraulic Gradient Measured from Bore T5 to Bore T3

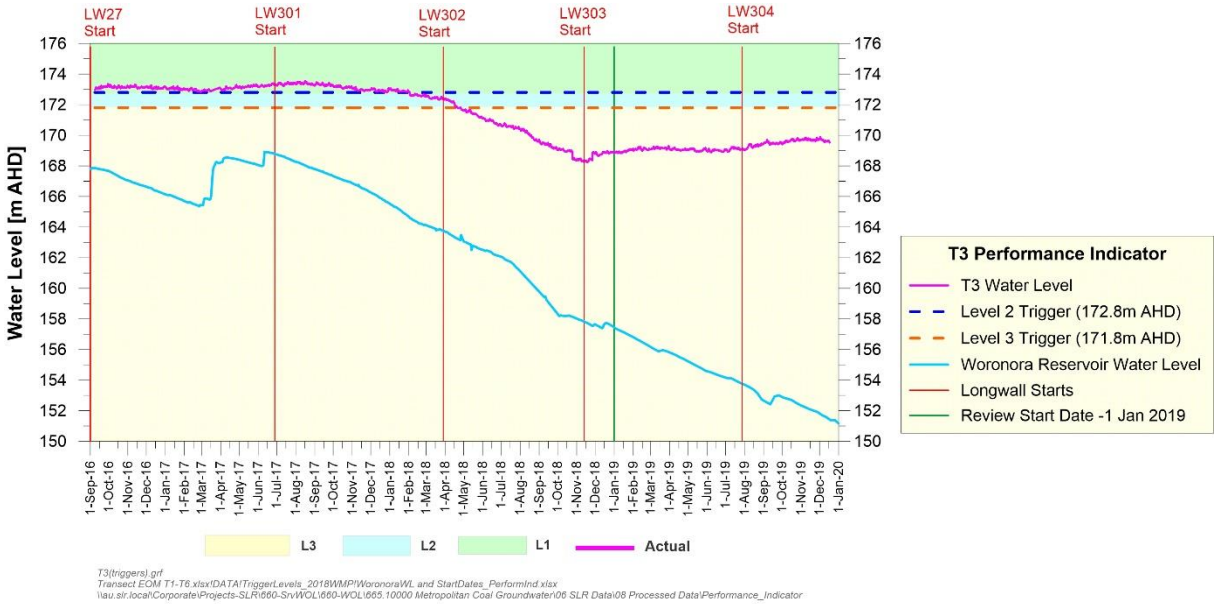


Chart 71 Groundwater Level at Bore T3[19]

[19] Bore T3 was removed from the Longwall 304 Water Management Plan and, therefore, the TARP trigger levels are only applicable to the 1 January 2019 to 30 June 2019 period.

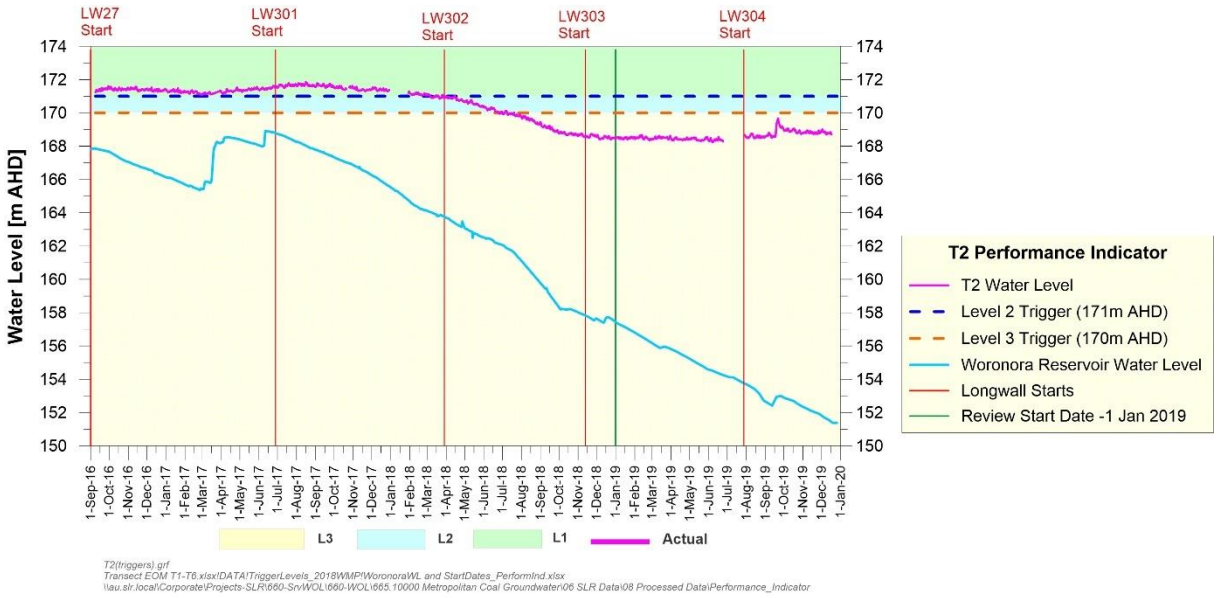


Chart 72 Groundwater Level at Bore T2[20]

Charts 71 and 72 indicate that the declining water levels in bores T2 and T3 are driven by a decline in the Woronora Reservoir water level due to climatic conditions and dam operations. HydroSimulations (Appendix G1) concluded that there has not been an exceedance of the performance measure for negligible leakage from the Woronora Reservoir.

Given the strong dependence of bore T2 and bore T3 water levels on the Woronora Reservoir water level, HydroSimulations considered there to be no merit in setting any absolute trigger levels at these sites (Appendix G1). HydroSimulations recommended the bore T2 and bore T3 trigger levels be either modified to take into consideration changes in the water level of the Woronora Reservoir or be removed in the next revision of the Metropolitan Coal Longwalls 301-303 Water Management Plan.

It was also considered likely by HydroSimulations that the water levels in bores T2 and T3 would continue to fall if the dry prevailing climatic conditions continued (Appendix G1). If monthly analyses of water levels in bores T2 and T3 indicate the water levels reflect a similar trend to the Woronora Reservoir water levels (i.e. they fall when water levels in the Woronora Reservoir fall) and the water levels in bores T2 and T3 remain above the Woronora Reservoir water level, there was considered to be no need to conduct further assessments against the performance measure, *Negligible leakage from the Woronora Reservoir* (Appendix G1).

The bore T2 and T3 trigger levels were not included in the Longwall 304 Water Management Plan, which commenced in July 2019.

The key potential subsidence impacts and environmental consequences on shallow groundwater systems and inflows to the Woronora Reservoir described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans included:

- Permanent mining-induced changes in the groundwater levels of shallow aquifers in connection with streams and ecosystems at Metropolitan Coal would not occur to any significant degree (i.e. the direction of shallow groundwater system flow [i.e. in the Hawkesbury Sandstone] has not been altered by mining).

[20] Bore T2 was removed from the Longwall 304 Water Management Plan and, therefore, the TARP trigger levels are only applicable to the 1 January 2019 to 30 June 2019 period.

- As there is an alternation of thick sandstone/claystone lithologies, there is a constrained zone in the overburden that remains rigid and acts as a bridge which isolates shallow and deep aquifers. At the substantial depths of cover of the Project, there would not be connective cracking from the mined seam to the surface.
- The depressurisation effects described below for the deep groundwater system would not propagate to the Hawkesbury Sandstone where the shallow groundwater system is located. As a result, no measurable impacts on registered bores in the wider Project area and surrounds would be expected.

Based on the analysis of the conceptual groundwater system, there would be negligible loss of groundwater yield to the Woronora Reservoir. This is reinforced by the groundwater modelling which indicates negligible reduction in cumulative average inflows to the Woronora Reservoir. In relation to the potential loss of catchment yield, the NSW Planning Assessment Commission (2009) was of the view that the risk of any significant loss is very low unless a major geological discontinuity is encountered during mining that provides a direct hydraulic connection between the surface and the mine workings.

The groundwater monitoring results are considered to be consistent with the potential subsidence impacts and environmental consequences described in the Project EA, Preferred Project Report and the Metropolitan Coal Water Management Plans.

6.2.8 Deep Groundwater Levels

Immediately above a mined coal seam, rocks collapse into the void created by the removal of coal to form a caved zone and a fractured zone develops above the caved zone. This causes aquifer properties to change (e.g. permeability and porosity) and results in a higher vertical permeability as a result of mining.

A three-dimensional numerical model of groundwater flow was developed in 2008 for the Project EA. The groundwater model was recalibrated in December 2012 for the Preferred Project Layout by revising the hydraulic conductivities in the Hawkesbury Sandstone and the Bald Hill Claystone. At this time, two extra layers were added to the Hawkesbury Sandstone section to improve resolution of the vertical hydraulic gradient in the shallow groundwater system. The model simulations are based on initial conditions at the end of Longwall 14, consistent with the Project EA assessment (Heritage Computing, 2008). Model outputs have been examined every six months for review of environmental performance.

Time Series Head Variations and Vertical Head Differences

Continuous groundwater level/pressure monitoring has been conducted at bores 9HGW0 (Longwall 10 Goaf Hole), 9EGW1B, 9FGW1A, 9GGW1-80, 9GGW2B, 9HGW1B, PM02, PM01 (9DGW1B), 9EGW2A, PM03, PHGW1B, PHGW2A, F6GW3A, F6GW4A, TBS02-250R, TBS03-230 and 9EGW2-4 (Figure 10) in accordance with the Longwall 304 Water Management Plan. The time-series head variations and vertical head differences for these bores have been examined (Appendices C1 and C2).

The monitoring sites closest to Longwalls 301-304 are bore F6GW4A (between Longwall 303 and Longwall 304), bore F6GW3A (to the south of Longwall 301) and bore 9GGW2B (above 300-series mains and to the south-west of Longwall 304) (Figure 10 and Appendices C1 and C2).

New groundwater monitoring bores were installed in the third quarter of 2017 as a component of the Woronora Reservoir Impact Strategy including a goaf hole over Longwall 302 (302GW01). Metropolitan Coal installed five copper wire and four optical fibre piezometers in hole 302GW01 to monitor groundwater as longwall extraction progressed. Unfortunately, most of the sensor cables were severed by ground movement as Longwall 302 passed under the site (Appendices C1 and C2).

Metropolitan Coal also installed additional bores over Longwall 302 (TBS02-80, TBS02-250 and TBS02-15) and Longwall 303 (TBS03–230 and TBS03-15). The two deep holes each have vibrating wire piezometers (VWPs) installed 15 m above and below the Bald Hill Claystone (192 m and 243 m at TBS02-250; 162 m and 213 m at TBS03-230). Two standpipes at 90 m and 190 m were installed in February 2019 over Longwall 302; currently both are recording data.

The TBS02 piezometer at 192 m failed in November 2018 (following passing of Longwall 302) and the piezometer at 243 m failed in January 2019 (following passing of Longwall 303). The TBS02 Replacement Bore (piezometers at 90 m, 150 m, 180 m and 245 m) was installed and commenced monitoring on 24 January 2019; three of the four piezometers are recording data. The piezometer at 245 m failed in February 2019.

The TBS03 piezometer at 213 m failed in June 2018 (following passing of Longwall 302) and the piezometer at 162 m depth failed in December 2018 (following passing of Longwall 303). The TBS03 Replacement bore (VWPs at 162 m, 213 m, 245 m and 265 m) was installed and commenced monitoring on 12 April 2019. Currently all VWPs have lost communications. The VWP at 162 m and 213 m failed in November 2019. The VWP at 245 m and 265 m failed in September 2019 and October 2019 respectively. There is no plan to replace the failed VWPs.

The time-series record for bore F6GW4A is shown on Chart 73. This bore is two panel widths from Longwall 301 and one panel width from Longwall 302. The respective mining faces came closest to the bore in late-September 2017 and late-May 2018, at which times distinct features are evident on all hydrographs. The passage of Longwall 301 caused mild responses, generally short-term increases in head, while the passage of Longwall 302 caused sharp cusp-like features on the Hawkesbury Sandstone hydrographs, sustained rises in the upper and mid Bulgo Sandstone, and strong declines in the three deepest piezometers (Appendices C1 and C2). From July to December 2018, the Bulli Seam piezometer (512 m) continued to depressurise, following the passage of Longwall 302, becoming depressurised and stabilising in October 2018. The approach and passage of Longwall 303 occurred in November and December 2018 respectively. The Scarborough Sandstone and Bulgo Sandstone sensors (201 m, 278 m, 362 m, 440 m) all displayed depressurisation beginning at this time. The two upper Hawkesbury Sandstone hydrographs displayed rises during November to December 2018. The rises in head are attributable to lateral and vertical compression. During the current reporting period F6GW4A was undermined by Longwall 303 causing the depressurisation and disabling of the six lower sensors (139 m, 201 m, 278 m, 362 m, 440 m and 512 m). The upper and mid Hawkesbury Sandstone piezometers (50 m and 90 m) also displayed a lowering of groundwater head following the passage of Longwall 303 and Longwall 304 (Appendices C1 and C2).

The time-series record for bore F6GW3A is shown on Chart 74. Bore F6GW3A is located adjacent to Longwall 301, approximately 150 m beyond its southern end, and approximately 800 m from Longwall 27. Significant depressurisation has occurred from historical workings to the east at approximately 500 m distance. The 450 m deep piezometer at the base of the Coal Cliff Sandstone displays significant depressurisation continuing from the mining of the first heading in the 300 mains in November 2013. The rise in pressure in the 380 m piezometer, noted in the previous reporting periods as potentially related to compression from the adjacent Longwall 302 beginning in March 2018, continued at a slight rate during the current reporting period. However, communications lost due to the vandalised aerial cable for four VWPs at 220 m, 308 m, 380 m and 450 m on 22 September 2019. A new aerial cable has been installed and is recording data. The Hawkesbury Sandstone piezometers 50 m, 70 m, 100 m and 135 m remained stable during the reporting period (Appendices C1 and C2).

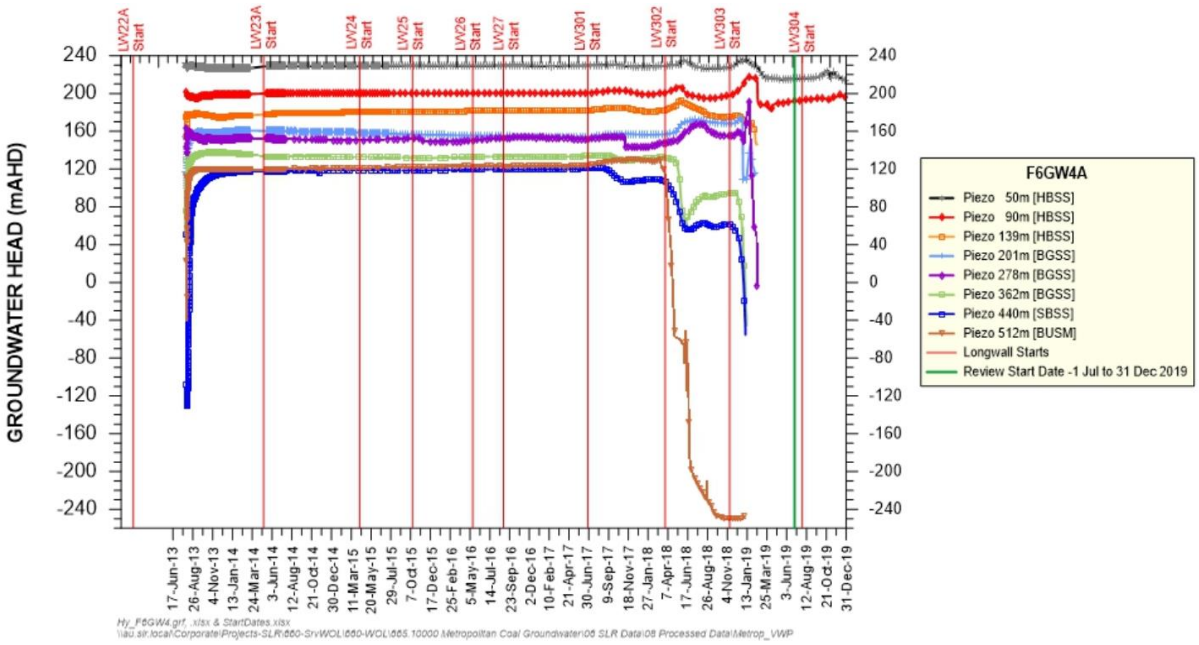


Chart 73 Time Variations in Potentiometric Heads at F6GW4A

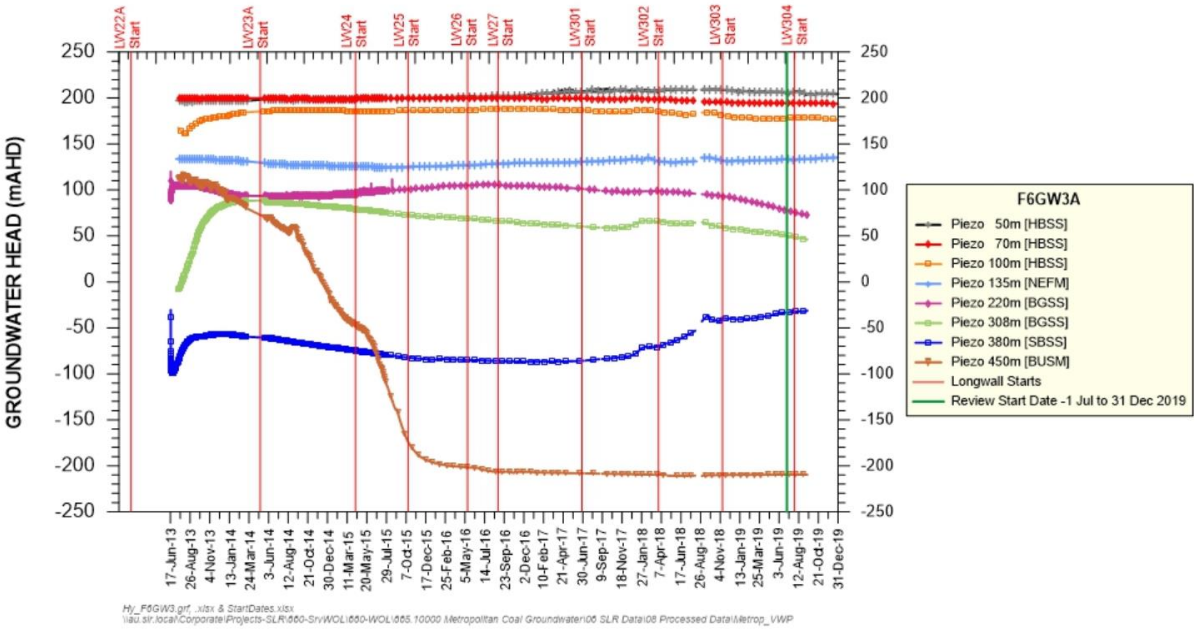


Chart 74 Time Variations in Potentiometric Heads at F6GW3A

The time-series record for bore 9GGW2B is shown on Chart 75. As the hydrographs show inconsistent head variations with depth, some of the piezometers are unreliable. During the passage of Longwall 24 (>600 m away), minor drawdowns were observed in the Bulli Coal Seam and the Scarborough Sandstone, but other sensors exhibited no effect or a rise in head (Appendices C1 and C2). The passage of Longwall 25 (>400 m away) caused distinct drawdowns in the Scarborough Sandstone, Wombarra Claystone, Stanwell Park Claystone and upper Bulgo Sandstone. Characteristic arcuate segments between cusps associated with subsequent longwall crossings are evident in the Scarborough Sandstone, Wombarra Claystone and Stanwell Park Claystone, but not in the Bulli Coal Seam. The lower Bulgo Sandstone shows rising head arcuate segments for Longwall 26 and Longwall 27 crossings, due to compression at that level. Sympathetic drawdowns are also exhibited in the three Hawkesbury Sandstone piezometers at the times of the Longwall 26 and Longwall 27 crossings. The 138 m, 163 m, 304 m and 474 m deep vibrating wire piezometers have not recorded data since the end of 2016. The 340 m deep VWP has not recorded data since June 2017. The upper, mid and lower Hawkesbury Sandstone piezometers (55 m, 80 m and 106 m) remained stable during the reporting period (Appendices C1 and C2).

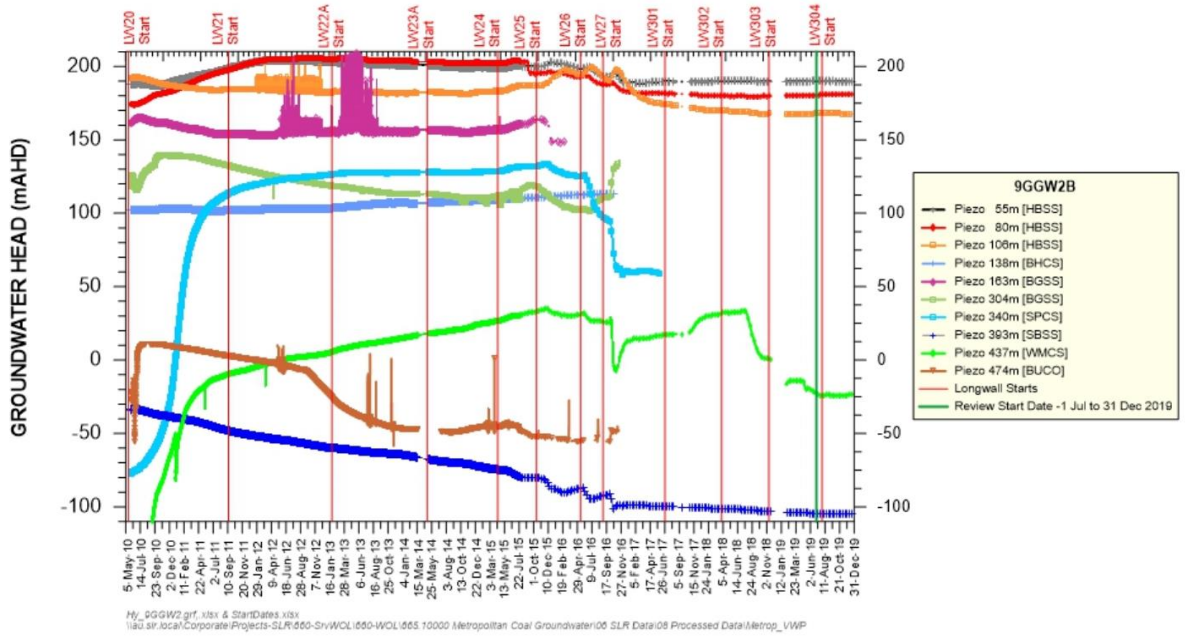


Chart 75 Time Variations in Potentiometric Heads at 9GGW2B

The time-series record for bores 9EGW2A and 9EGW2-4 are shown on Chart 76. Bore 9EGW2A experienced failure of some lower level instrumentation in late 2017. An additional hole was drilled adjacent to 9EGW2A (bore 9EGW2-4) to a depth of 557 m to install new piezometers at the same RLs as the failed piezometers in December 2017. The observed rise in pressure at bore 9EGW2A in November 2017 is a result of drilling for the adjacent 9EGW2-4 replacement hole. Since December 2017 9EGW2A has displayed a declining trend, which continued during the reporting period.

Assessment of Vertical Potentiometric Head Profiles

Vertical potentiometric head profiles at Bores 9GGW2B and F6GW3A are used to assess connective cracking between the surface and the mine in accordance with the Longwall 304 Water Management Plan.

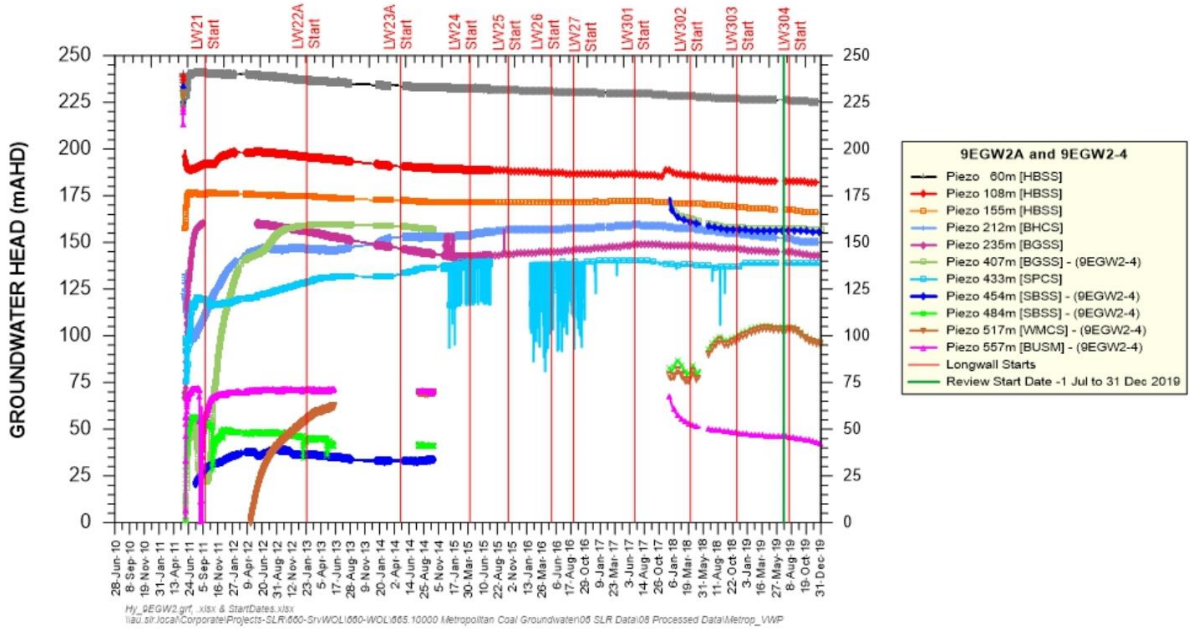


Chart 76 Time Variations in Potentiometric Heads at 9EGW2A and 9EGW2-4

The vertical potentiometric head profiles have been assessed against the following performance indicators:

> *Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore 9GGW2B does not occur.*
>
> *Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore F6GW3A does not occur.*

The performance indicators were not exceeded during the reporting period because the measured potentiometric head profiles are consistent in shape and do not lie significantly to the left of the predicted model curves (Appendices C1 and C2).

Assessment of Hydraulic Gradient to the Woronora Reservoir

The groundwater head of Bores F6GW4A, PHGW2A, 9GGW2B, 9EGW2A and PM02 are compared to the full supply level of the Woronora Reservoir to assess reductions in hydraulic gradient from the bores to the Woronora Reservoir.

The results have been assessed against the following performance indicators:

> *The hydraulic gradient to the Woronora Reservoir at full supply level from Bore F6GW4A is reduced by no more than 20% from that measured to 30 June 2017*[21]*.*
>
> *The hydraulic gradient to the Woronora Reservoir at full supply level from Bore PHGW2A is reduced by no more than 40% from that measured to 30 June 2017*[22]*.*
>
> *The hydraulic gradient to the Woronora Reservoir at full supply level from Bore 9GGW2B is reduced by no more than 40% from that measured to 30 June 2017.*

[21] The performance indicator for bore F6GW4A was removed from the Longwall 304 Water Management Plan.

[22] The performance indicators for Bores PHGW2A, 9EGW2A and PM02 were modified in the Longwall 304 Water Management Plan to refer to a hydraulic gradient change of no more than 40% (previously 20%).

The hydraulic gradient to the Woronora Reservoir at full supply level from Bore 9EGW2A is reduced by no more than 40% from that measured to 30 June 2017[18].

The hydraulic gradient to the Woronora Reservoir at full supply level from Bore PM02 is reduced by no more than 40% from that measured to 30 June 2017[18].

The performance indicators for bores 9GGW2B, PHGW2A and PM02 were not exceeded during the reporting period (Appendices C1 and C2).

An exceedance of the Longwalls 301-303 Water Management Plan Level 3 trigger and performance indicator was identified for bore 9EGW2A in March 2019 and an assessment against the subsidence impact performance measure *Negligible leakage from the Woronora Reservoir* was undertaken (Chart 77). The assessment concluded that the performance measure had not been exceeded and recommended the trigger levels be revised in the Longwall 304 Water Management Plan to allow for climatic conditions (Appendix G2). Accordingly, the performance indicator was revised, and the revised performance indicator was not exceeded during the reporting period, while the Woronora Reservoir water level continued to decline; maintaining the hydraulic gradient towards the reservoir (Appendices C1 and C2).

The rising level observed at bore F6GW4A in October 2017 correlates with Longwall 301 passing to the east. F6GW4A also responded to the passing of Longwall 302 in May 2018 and rose with the approach of Longwall 303 in November and December 2018. During the reporting period, bore F6GW4A has gone from Level 1 to Level 3, displaying an impact associated with the mining of Longwall 303 (Chart 78). The exceedance of the Longwalls 301-303 Water Management Plan Level 3 trigger and performance indicator was first identified for bore F6GW4A in February 2019 and an assessment against the subsidence impact performance measures, *Negligible leakage from the Woronora Reservoir*, and, *No connective cracking between the surface and the mine*, was undertaken (Appendix G3). The assessment concluded that the performance measures had not been exceeded and, as localised subsidence effects had compromised the vibrating wire piezometer monitoring results, it was recommended that bore F6GW4A be removed from the Longwall 304 Water Management Plan (Appendices C1 and C2).

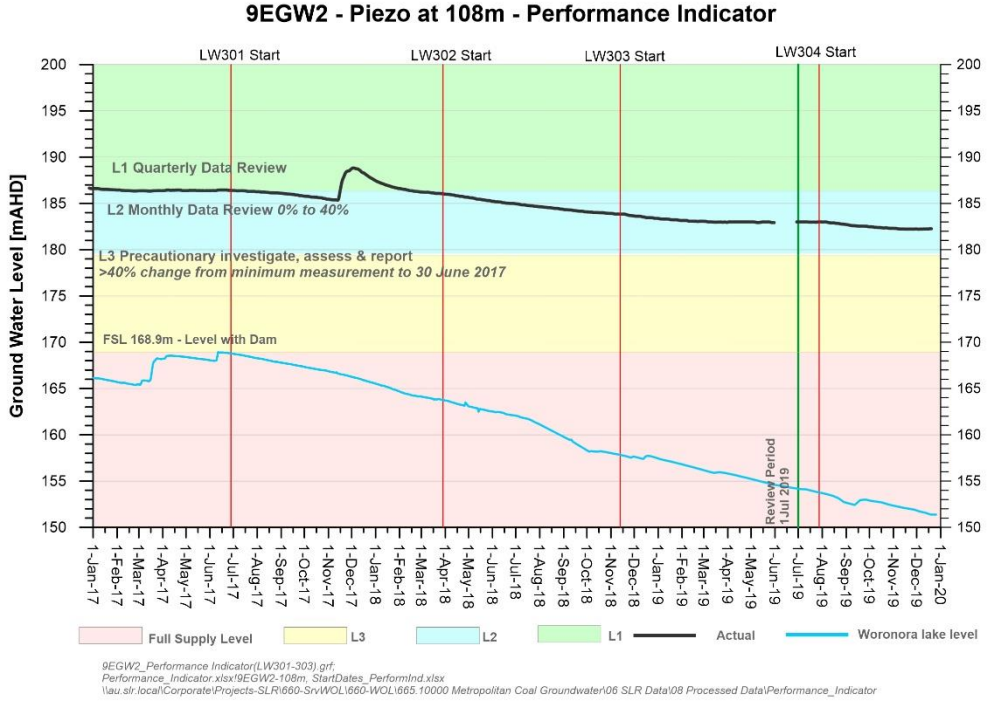


Chart 77 7-day Average mid Hawkesbury Sandstone Groundwater Levels at 9EGW2A since 1 January 2017

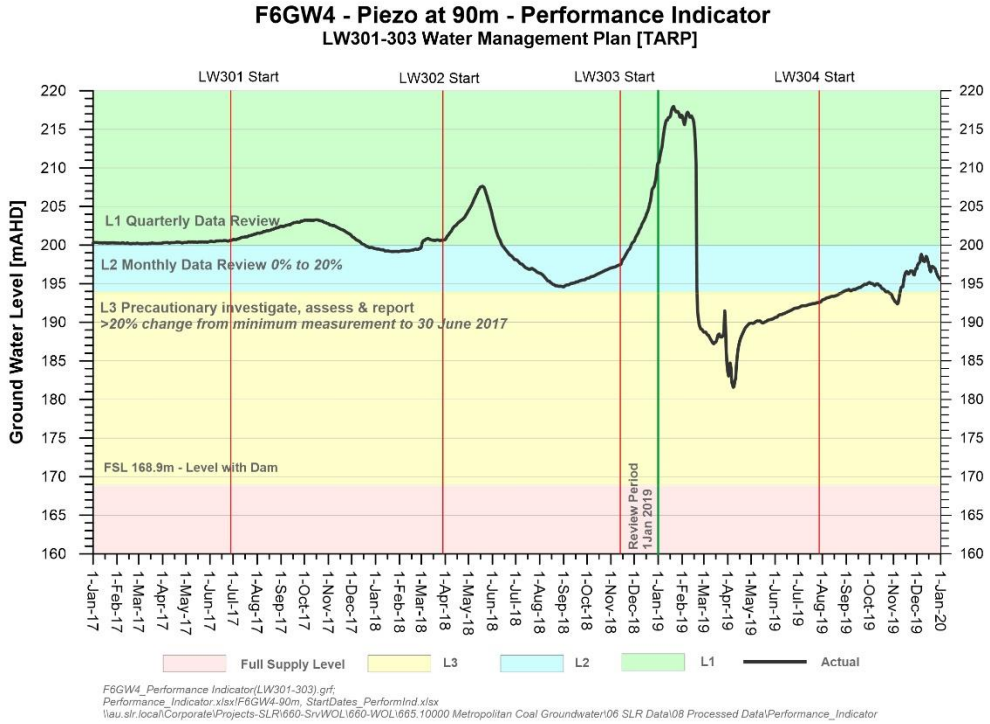


Chart 78 7-day Average mid Hawkesbury Sandstone Groundwater Levels at F6GW4A since 1 January 2017

The key potential subsidence impacts and environmental consequences on the deep groundwater system described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans, included:

- Based on experience at Metropolitan Coal, substantial depressurisation of the deep aquifers in the fractured zone above the goaf is restricted to a height of less than 130 m from the top of the goaf, while transient pressure effects have been observed to propagate to a height of about 300 m above the goaf. That is, there is a pronounced increase in vertical hydraulic gradient in the deep groundwater system over the Metropolitan Coal longwalls.
- Above goaf zones there would be substantial changes in fracture porosity and permeability, due to opening up of existing joints, new fractures and bed separation. Permeability increases would have accompanying reductions in lateral hydraulic gradients, with associated changes in groundwater levels and pressures. Pronounced changes in groundwater levels can occur without any significant drainage into a mine, particularly from the Narrabeen Group sandstones.
- Groundwater discharge to the mined seam would occur from above and below the seam in proportion to local permeabilities. The water make (i.e. groundwater inflow) is expected to be in the order of 0.1 megalitres per day (ML/day) for Longwalls 20-27 and from 0.045 to 0.6 ML/day for Longwalls 301-303. Modelling indicated that the inflow could be up to 0.5 ML/day from the deep groundwater system during the mining of Longwall 24 and up 0.14 ML/day during the mining of Longwalls 301 to 304.
- Due to the substantial depths of cover at the Project, there would not be connective cracking from the mined seam to the surface. Groundwater modelling for the Project indicates that there is expected to be eventual recovery of deep groundwater system pressures over many decades following the cessation of mining.

The NSW Planning Assessment Commission (2009) concluded that given the considerable depth of mining and the restricted panel width in the Project area, that, in the absence of geological structures such as faults and igneous intrusions (sills, dykes and diatremes), there is a very high probability that a constrained zone will be associated with the mine layout proposed over the Project area, thereby preventing direct hydraulic connections between mine workings and surface water bodies.

The groundwater monitoring results are considered to be consistent with the potential subsidence impacts and environmental consequences described in the Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans.

6.2.9 Groundwater Quality

Groundwater quality at sites WRGW1 to WRGW7[23] on Waratah Rivulet (Figure 11) is shown on Charts 79 to 81 for iron, manganese and pH, respectively.

Groundwater quality monitoring at sites WRGW1 to WRGW7 indicates dissolved iron concentrations are usually in the 1-10 mg/L range, with the exception of sites WRGW1 and WRGW2 which peaked at 14 mg/L in earlier years (2010-2011) (Chart 79). Dissolved iron concentrations have remained below 11 mg/L during reporting period (Chart 79, Appendices C1 and C2).

Dissolved manganese concentrations at the Waratah Rivulet sites have typically been less than 1 mg/L. Higher concentrations of manganese were reported for WRGW3 in June 2015 (3.36 mg/L), September 2015 (1.47 mg/L), March 2017 (1.31 mg/L) and April 2017 (1.65 mg/L) and for WRGW6 in April 2017 (1.77 mg/L) (Chart 80). During the reporting period, all sites remained below 1.1 mg/L (Chart 80, Appendices C1 and C2).

[23] WRGW4 has been sheared and no longer sampled since 2011.

Dissolved aluminium concentrations have been low, and largely below the detection limit (Appendices C1 and C2).

The pH level at the Waratah Rivulet sites has been generally acidic and usually between pH 5.5 and 7. Occasional excursions in excess of pH 9 and less than pH 5 in prior reporting periods are unsustained outliers. The pH level at all sites remained within the historical range during the reporting period (Chart 81, Appendices C1 and C2).

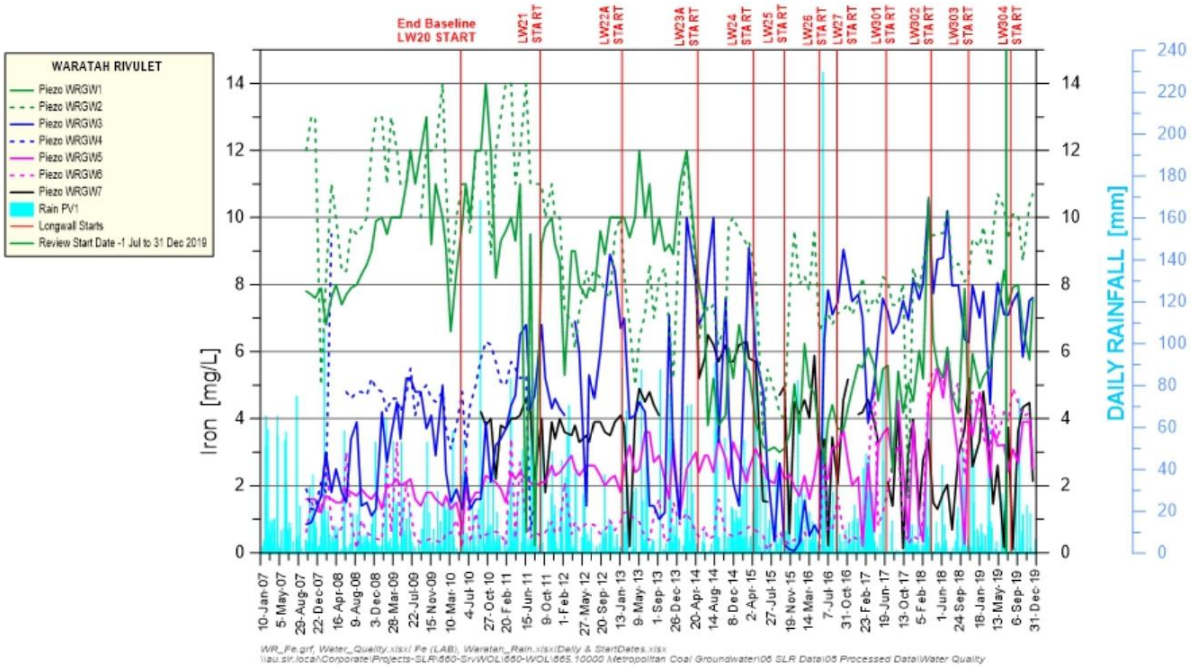


Chart 79 Iron Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

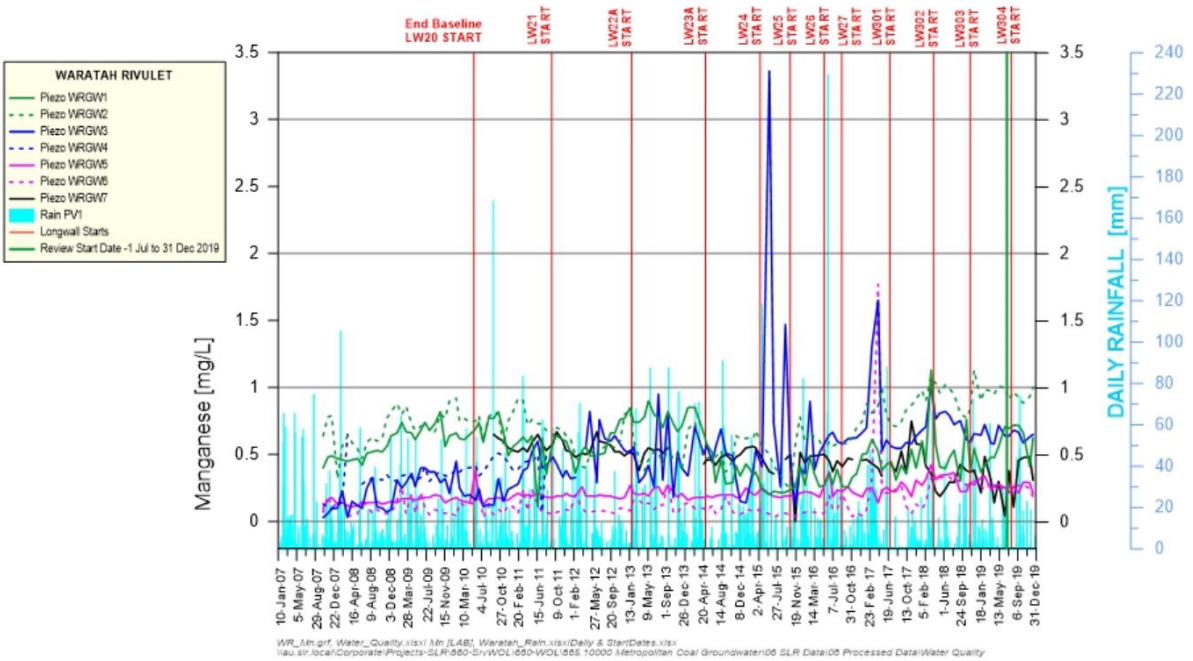


Chart 80 Manganese Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

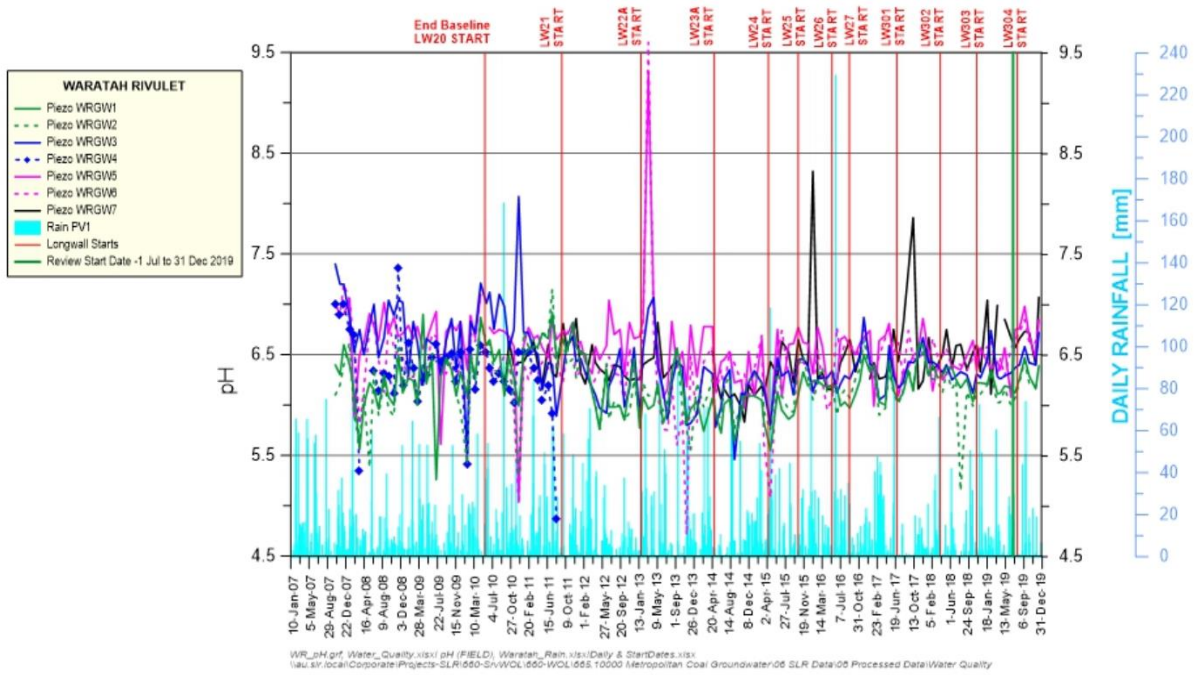


Chart 81 pH Levels at WRGW1 to WRGW7 on Waratah Rivulet

Groundwater quality at Eastern Tributary sites ETGW1 and ETGW2 (Figures 10 and 11) is shown on Charts 82 to 84 for iron, manganese and pH, respectively. Bore ETGW1 was unable to be sampled for groundwater quality from January to March 2017 and since August 2017. Bore ETGW2 was also unable to be sampled from August to October 2018.

Groundwater quality monitoring on the Eastern Tributary (Figure 11) indicates high iron concentrations with an increasing trend, and larger variability than recorded in the period 2010–2015, persisted until July 2017 when the concentration decreased. Dissolved iron concentrations fluctuated throughout 2017, with the previous maximum concentration for the period of record (21.5 mg/L) recorded in June 2017 and the minimum concentration for the period of record (0.4 mg/L) recorded in September 2017 (Chart 82). Dissolved iron concentrations at site ETGW2 continued to display a variable trend during the reporting period, with a new maximum concentration recorded (21.8 mg/L), and a new minimum recorded (< 0.05 mg/L) (Chart 82).

During the reporting period, manganese concentrations increased with a peak of 1 mg/L at ETGW2 (Chart 83). The values continue to be consistently higher than the historically recorded manganese concentrations at these sites. Previously ETGW2 recorded its maximum concentration 0.97 mg/L in February 2017. During the current reporting period manganese concentrations were recorded between 0.66 and 1 mg/L. The increasing trend in Fe and Mn concentrations in the Eastern Tributary sites has been occurring since December 2015 and appears to be continuing.

Aluminium was below 0.01 mg/L in all samples during the reporting period (Appendices C1 and C2).

The groundwater at the Eastern Tributary sites is generally acidic, ranging between pH 5.5 and pH 6.5 for most of the monitoring record (since 2010). At ETGW2, pH remained between pH 5.7 and pH 6.6 during the reporting period (Chart 84) (Appendices C1 and C2).

The Project EA, Preferred Project Report and Metropolitan Coal Water Management Plans predicted local surface water quality impacts as a result of enhanced groundwater-surface water interactions (as described for surface water quality above). The groundwater quality monitoring results are considered to be consistent with the predictions.

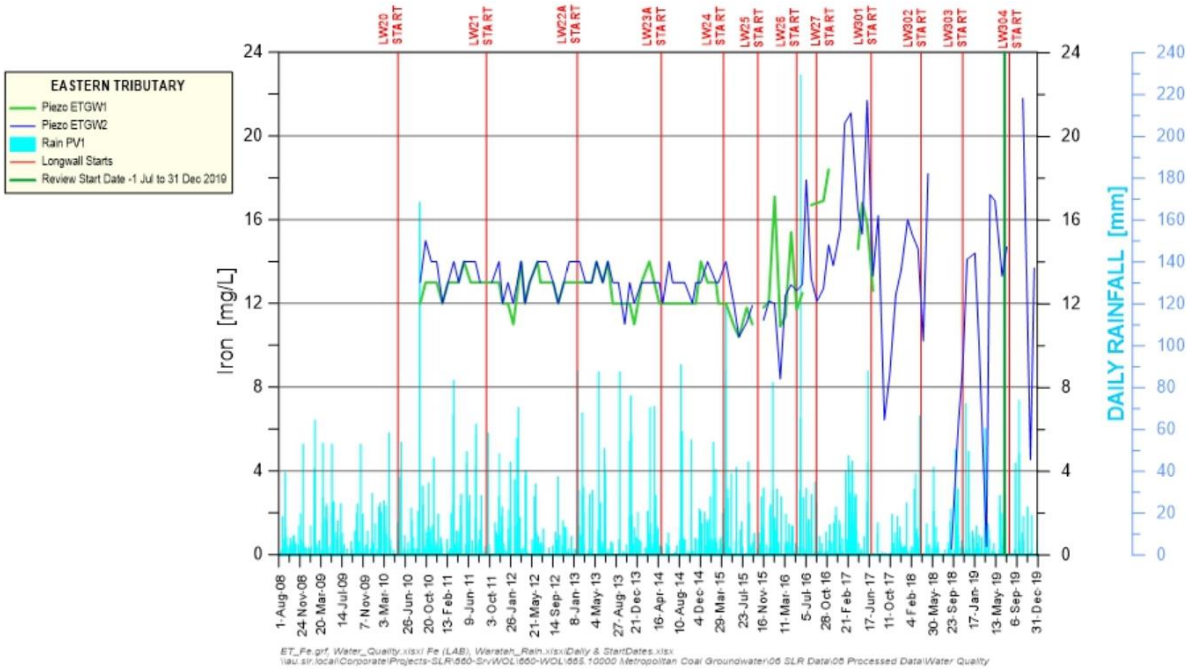


Chart 82 Iron Concentrations at ETGW1[24] and ETGW2

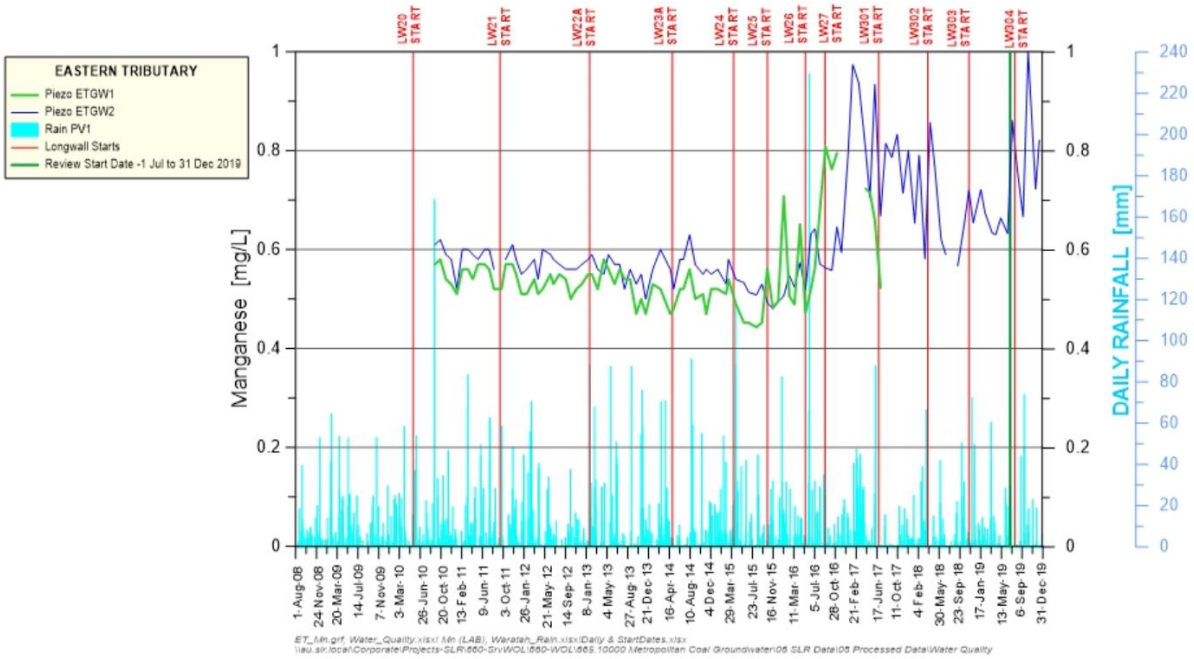


Chart 83 Manganese Concentrations at ETGW1 and ETGW2

[24] Site ETGW1 was unable to be sampled from January to March 2017, and since August 2017.

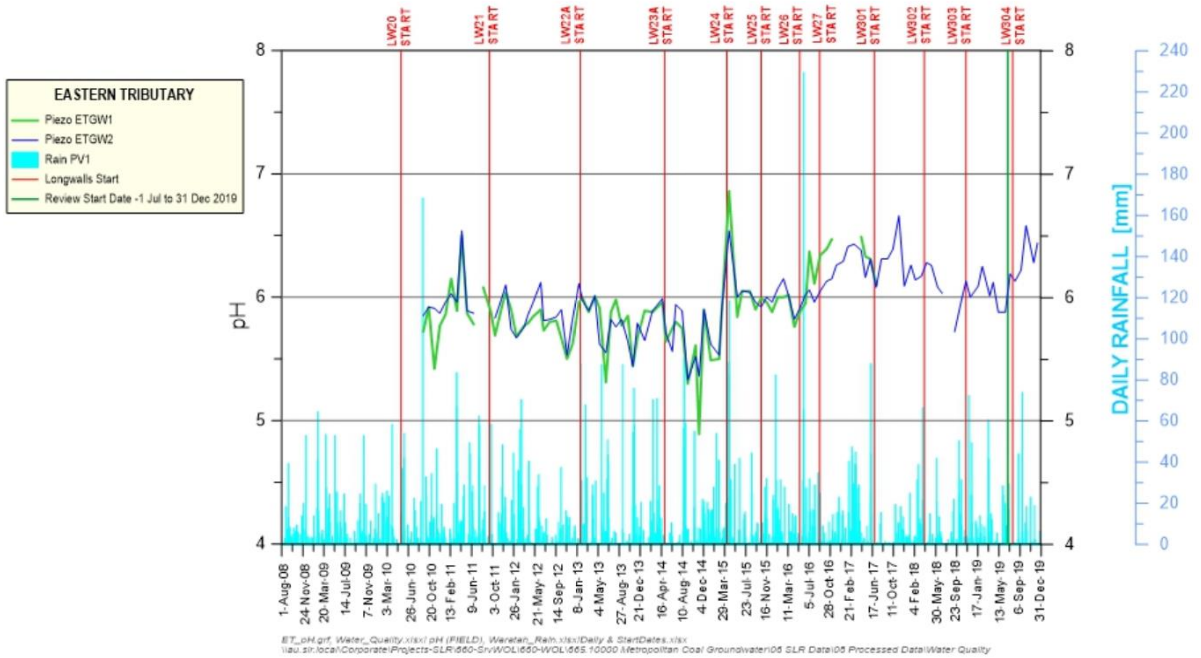


Chart 84 pH Levels at ETGW1 and ETGW2

6.2.10 Inspections of Mine Workings

Mine inspections did not identify any abnormal water flows from the goaf, geological structure, or strata generally during the reporting period.

6.2.11 Mine Water Intake

Monitoring of the mine water balance comprises:

- Metered water reticulated into the mine (recorded continuously and downloaded monthly).
- Backfill water used to assist pumping into the mine (recorded continuously and downloaded monthly).
- Metered water reticulated out of the mine (recorded continuously and downloaded monthly).
- Manual measurement of moisture content into and out of the mine through the mine ventilation system using a digital psychrometer. The frequency of readings is as follows:
  - every hour over a 9 hour period on two occasions during a 12 month period;
  - daily (week day) except public holidays or other circumstances (access, fan maintenance, etc.) that prevent readings to be taken; and
  - once per week as a minimum.
- Measurement of the *in-situ* moisture content of the coal during channel sampling for coal quality.
- Measurement of the moisture content of ROM coal conveyed out of the mine at the drift portal using an automated moisture scanner. A fully automated data acquisition system records and stores the data.

The inferred water make (i.e. groundwater that has seeped into the mine from the strata) is calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal). Given the large fluctuations in daily water usage and the cycle period for water entering the mine, a 20 day average is used to provide a more reliable estimate of water make.

The 20 day average daily mine water make was approximately -0.09 ML/day during the reporting period (i.e. well below the 0.5 ML/day TARP trigger) (Chart 85).

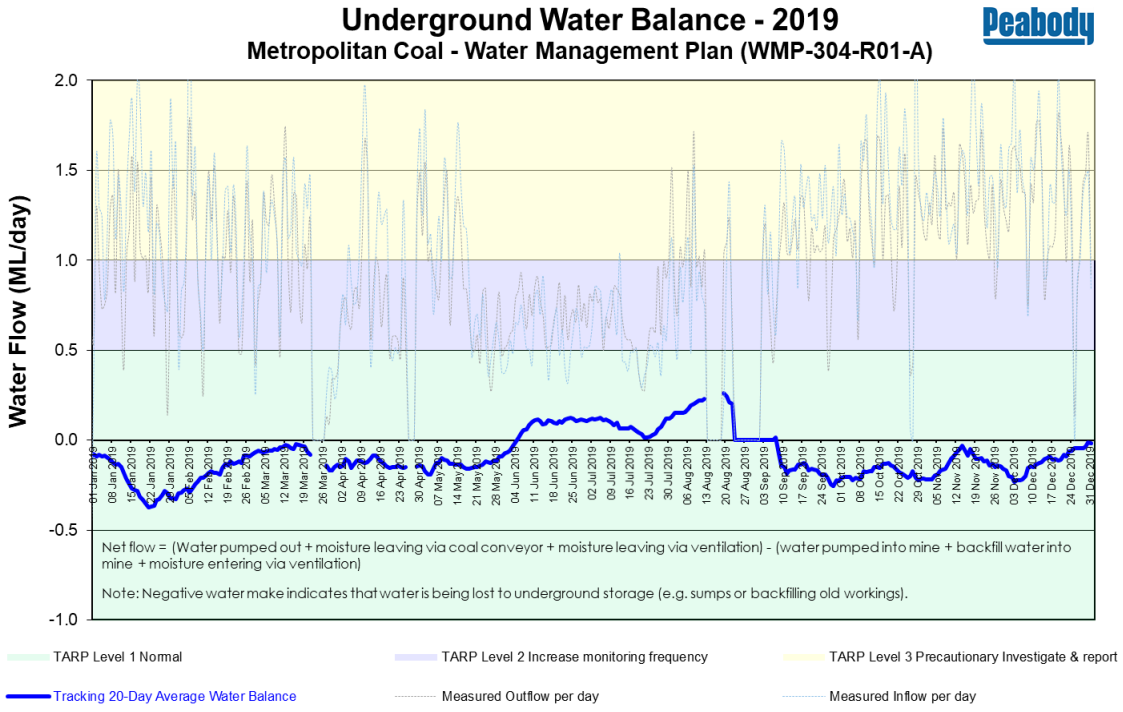


Chart 85 Estimated Daily Mine Water Make

6.2.12 Woronora Reservoir Impact Strategy

Condition 2 of the Longwalls 301 and 302 approval requires Metropolitan Coal to conduct further investigation into potential impacts on the Woronora Reservoir. Metropolitan Coal engaged independent experts to prepare a Woronora Reservoir Impact Strategy to provide a staged plan of action for further investigations and a report into the impacts of mining near the reservoir. Professor Bruce Hebblewhite (B. K. Hebblewhite Consulting), Dr Frans Kalf (Kalf and Associates Pty Ltd) and Emeritus Professor Thomas McMahon (University of Melbourne) were endorsed by the DP&E for the Woronora Reservoir Impact Strategy in May 2017.

The *Woronora Reservoir Strategy Report - Stage 1* was provided by the independent experts to the DP&E in September 2017. The Stage 1 report included recommendations for further groundwater and surface water investigations and monitoring and was approved by the Secretary for Planning in December 2017.

The *Woronora Reservoir Strategy Report - Stage 2* (Hebblewhite *et. al.,* 2019) was provided by the independent experts to the DPIE in June 2019. The Stage 2 report includes additional recommendations in regard to groundwater and surface water investigations and monitoring, based on further data and analysis arising from the ongoing monitoring programs, including those recommended in the original Stage 1 report.

The Stage 2 report represents the second stage of the Woronora Reservoir Impact Strategy, based on further data and analysis arising from the ongoing monitoring programs, including those recommended in the Stage 1 report.

The findings of the Stage 2 report are summarised in the Longwalls 305-307 Water Management Plan.

6.3 BIODIVERSITY MANAGEMENT

The Metropolitan Coal Longwalls 301-303 Biodiversity Management Plan was prepared to manage the potential environmental consequences of the Longwalls 301-303 Extraction Plan on aquatic and terrestrial flora and fauna, with a specific focus on swamps, in accordance with Condition 6, Schedule 3 of the Project Approval.

The Longwall 304 Water Management Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303.

Sections 6.3.1 to 6.3.5 provide a summary of the biodiversity assessments for the reporting period. Section 6.8 provides a summary of the assessments against the biodiversity subsidence impact performance indicators and measures for the reporting period.

6.3.1 Upland Swamp Vegetation Monitoring

6.3.1.1 Longwalls 20-22 and Longwalls 23-27

Upland swamp vegetation monitoring is conducted biannually (in autumn and spring) at a number of swamps overlying or adjacent to Longwalls 20-22 and Longwalls 23-27 and at a number of control swamps (Figure 9).

In autumn 2019, visual inspections were conducted in Swamps 16, 17, 18, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 35, 36 and 94 overlying or adjacent to Longwalls 20-27 and in control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp.

Transect/quadrat monitoring was conducted in Swamps 16, 17, 18, 20, 24 and 25 overlying or adjacent to Longwalls 20-22, in Swamps 28, 30, 33, 35 and 94 overlying or adjacent to Longwalls 23-27 and in control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp.

Indicator species monitoring for Longwalls 20-22 includes 20 tagged individuals of *Epacris obtusifolia* (in Swamps 18, 24, 25, 101, 111a and 125), *Sprengelia incarnata* (in Swamps 24, 101 and 125) and *Pultenaea aristata* (in Swamps 18, 24, 25, 101 and 111a). Three indicator species characteristic of the Tea Tree Thicket vegetation community, namely *Banksia robur, Callistemon citrinus* and *Leptospermum juniperinum* are monitored in Swamp 20 and at control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp.

Indicator species monitoring for Longwalls 23-27 includes 20 tagged individuals of *Epacris obtusifolia* (in Swamps 19, 30, 33, 35, 94, 101, 111a, 125, 135, 136, 137a, 137b and 138), *Pultenaea aristata* (in Swamps 19, 30, 33, 35, 94, 101, 111a, 135, 136, 137a and 138), *Sprengelia incarnata* (in Swamps 19, 33, 35, 94, 101, 125, 135, 136, 137a and 138) and *Banksia robur* and *Callistemon citrinus* in Swamp 28 and control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp.

The vegetation survey results for autumn 2019 have been assessed in accordance with the Longwalls 301-303 Biodiversity Management Plan. The results of the autumn 2019 survey in relation to the Biodiversity Management Plan Trigger Action Response Plan are summarised in Section 6.8. The results of the Longwalls 20-22 and Longwalls 23-27 upland swamp vegetation monitoring programs (up to and including the autumn 2019 survey) can be summarised as follows (Appendices H1, H2, H4 and H5):

- Visual inspections did not identify any cracking of exposed bedrock areas or swamp sediments in longwall swamps as a result of mine subsidence.
- Areas in which active erosion was observed were all minor and limited to fire trails, access tracks, drainage lines (Swamp 125) or as surface wash in control swamps 101 and 137a.
- Iron-stained groundwater seepage has been observed since spring 2012 on the terminal rocky step and/or the small rocky step of Swamp 20. Standing water was not observed in the single Tea Tree Thicket longwall site, Swamp 20, where it has been observed in previous seasons. In autumn 2019, iron staining continued to be reduced in area compared to previous seasons.
- The autumn 2019 survey was conducted following an extremely dry period from July 2017. Prior to the survey period rainfall was well below average for all months but increased slightly above average during October and November 2018. Above average rainfall was also recorded in March 2019 during the autumn 2019 survey. These dry conditions is reflected in the occurrence of only minor seepage observed within the longwall swamps and the water stress frequently observed in the vegetation throughout the survey in all swamps. No seepage was recorded at any of the control swamps in autumn 2019.
- Visual inspections of Restioid Heath/Banksia Thicket swamps identified that vegetation at both longwall and control sites was found to be in a range of conditions, with yellowing and senescence considered to be common and widespread, particularly in longwall swamps. The occurrence of stressed vegetation within both longwall and control swamps, and areas well beyond the current survey area, indicates the yellowing and dieback is likely attributable to environmental conditions, including the stress associated with drying out of shallow soils during below-average rainfall prior to and during the autumn 2019 survey period, and not related to mining of Longwalls 20-27. Notwithstanding, minor recovery in the form of new growth on many of the impacted species was apparent in autumn 2019 in Swamps 16, 17, 18, 24, 25, 31, 32, 33, 34, 35 and 36.
- For the Tea Tree Thicket swamps, vegetation of both longwall and control swamps was found to be generally in good condition in autumn 2019. Some isolated dieback was recorded throughout most longwall and control swamps. Consistent with previous observations including the baseline monitoring period, dieback of *Empodisma minus* and *Gleichenia microphylla* in Swamp 28 appeared to be more common compared to control swamps, attributed to the dense mid-storey vegetation shading the understorey. Consistent with all prior surveys, no standing water was observed within Swamp 28.
- No notable changes in vegetation structure, dominant species or estimated cover which could be attributed to impacts associated with the mining of Longwalls 20-27 were recorded within longwall or control swamps in autumn 2019.
- Fluctuations in species cover/abundance and condition have been recorded across all sites. No patterns of increasing or decreasing cover/abundance, or declines in vegetation condition, were identified in relation to individual species across sites or groups of species (i.e. swamp indicator species, generalist species, shrubs, ground covers) within sites.

- Species richness within individual Restioid Heath/Banksia Thicket swamps in autumn 2019 was within the range of previous seasons for all Longwall 20-27 swamps, with the exception of Swamps 30 and 101 (Charts 86 and 87). Analysis of species richness within Restioid Heath/Banksia Thicket sites using analysis of variance (ANOVA) did not detect significant differences between longwall and control sites in any season including autumn 2019.
- Species richness within individual Tea Tree Thicket sites in autumn 2019 was within the range of previous seasons at all longwall and control sites for Longwalls 20-27, with the exception of Swamp 28 (Chart 88).
- Monitoring of indicator species indicates the observed mortality at Restioid Heath/Banksia Thicket and Tea Tree Thicket swamps appears to be driven by natural factors including predation, competition with other vegetation and abiotic factors and not related to longwall mining.
- The upland swamp vegetation performance indicator, *vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps*, has not been exceeded for any of the monitored Restioid Heath/Banksia Thicket Swamps or Swamp 20 (Tea Tree Thicket vegetation).
- The vegetation performance indicator has been exceeded at longwall Tea Tree Thicket Swamp 28 since autumn 2017 based on the continual decline in condition of both the understorey and species richness, and the high mortality rate of *Banksia robur* in comparison to the control sites. Assessments against the biodiversity subsidence impact performance measure, *negligible impact on the species, populations or ecological communities* have been completed and the performance measure has been met (Appendices I1 and I3).

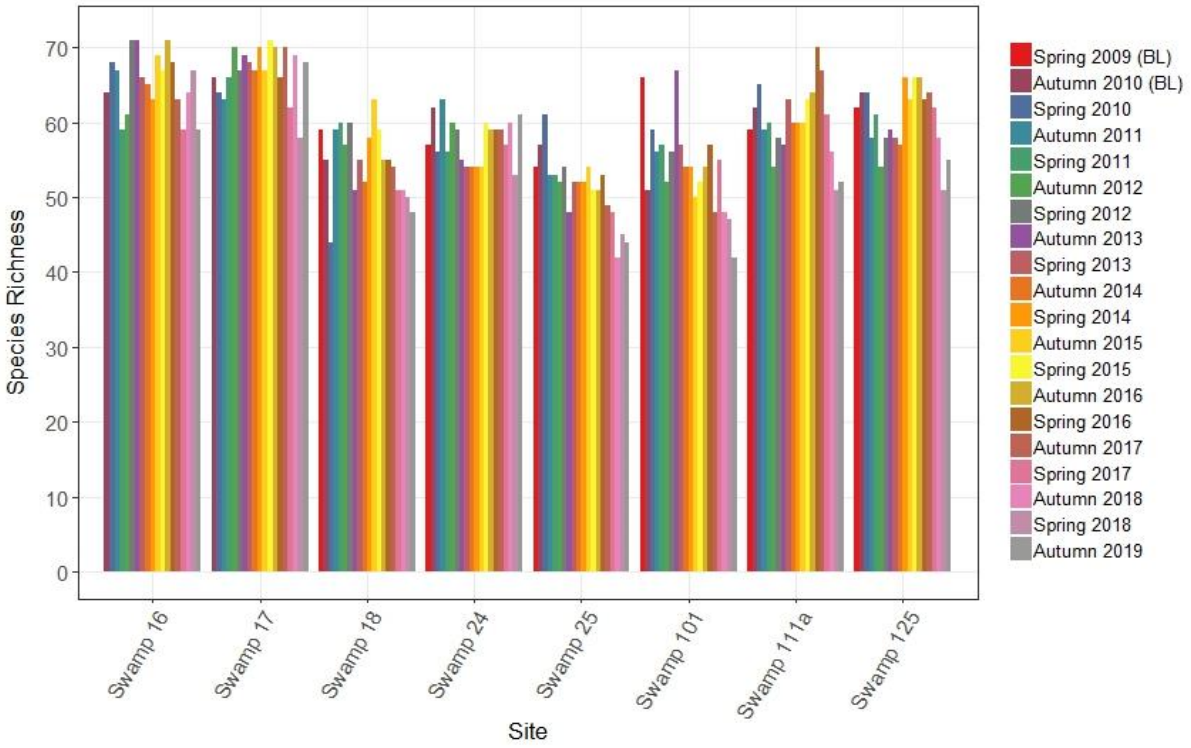


Chart 86 Native Species Richness in Longwalls 20-22 Upland Swamp Sites Supporting Restioid Heath and Banksia Thicket, Spring 2009 – Autumn 2018

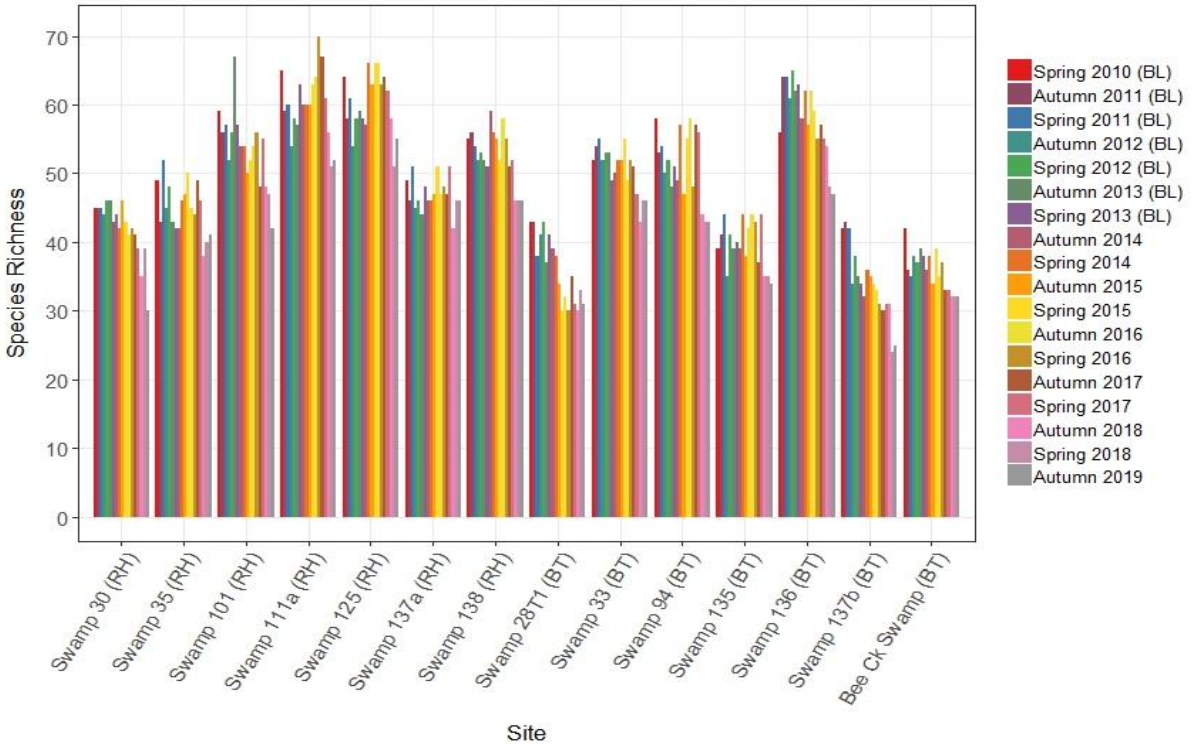


Chart 87 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Restioid Heath and Banksia Thicket, Spring 2010 – Autumn 2019

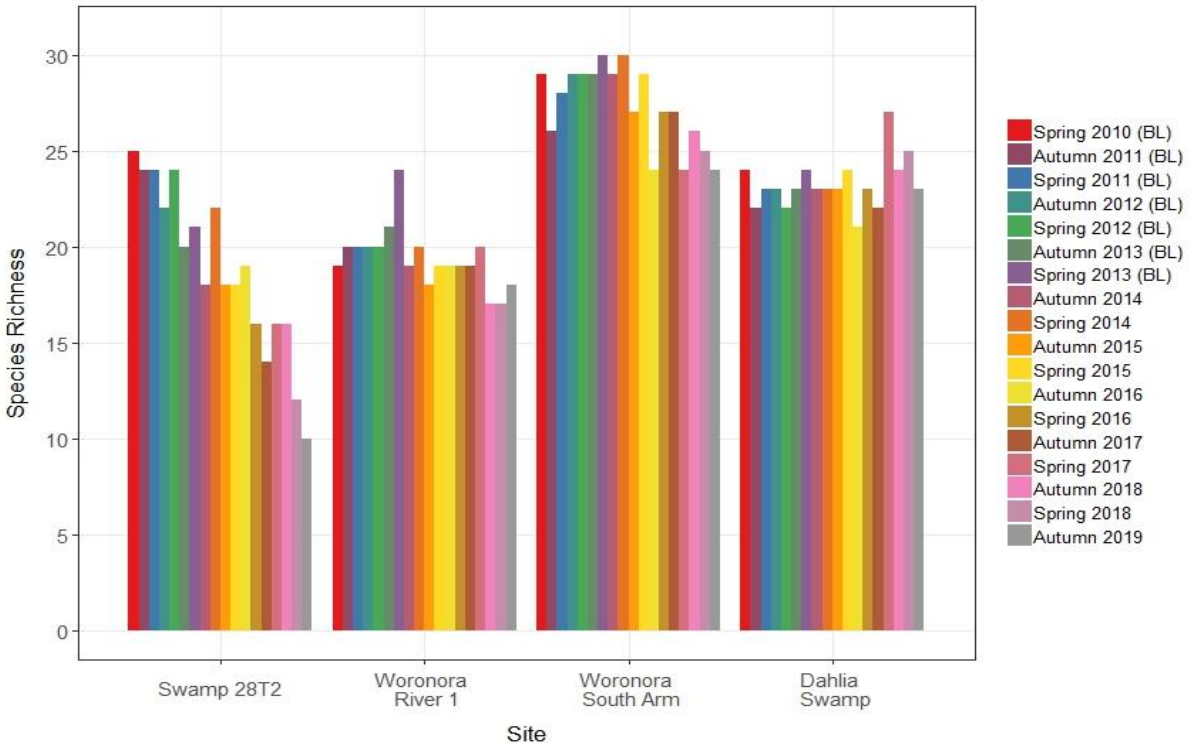


Chart 88 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Tea Tree Thicket, Spring 2010 – Autumn 2019

The spring 2018 and autumn 2019 Longwalls 20-22 and Longwalls 23-27 Vegetation Monitoring Reports prepared by Eco Logical Australia (Ecological) are provided in Appendices H1, H2, H4 and H5, respectively.

6.3.1.2 Longwalls 301-303

The upland swamp vegetation monitoring program used for Longwalls 301-303 (visual, transect/quadrat and indicator species monitoring) is consistent with those used for the Longwalls 20-22 and Longwalls 23-27 upland swamp vegetation monitoring programs. Upland swamp vegetation monitoring is conducted biannually (in autumn and spring) at a number of swamps overlying or adjacent to Longwalls 301-303 and at a number of control swamps (Figure 9).

In autumn 2019, visual inspections were conducted in Swamps 38, 40, 41, 46, 47, 48, 49, 50, 51/52, 53 and 58 and transect/quadrat monitoring was conducted in Swamps 40, 41, 46, 51/52 and 53 overlying or adjacent to Longwalls 301-303. Control Swamps 101, 111a, 125, 135, 136, 137a, 137b and 138, were selected for comparison with the swamps over Longwalls 301-303 and the same transect/quadrat monitoring methodology was used to survey each of these swamps in autumn 2019. Swamps 46 and 51/52 were subject to WaterNSW hazard reduction burns following the autumn 2017 baseline survey and prior to the spring 2017 survey.

Indicator species monitoring for Longwalls 301-303 previously included 20 tagged individuals of *Epacris obtusifolia* (in Swamps 40, 51/52, 53, 101, 136 and 137a) and *Sprengelia incarnata* (in Swamps 40, 51/52, 53, 101, 136 and 137b). However, subsequent to the autumn 2017 baseline survey and prior to the spring 2017 survey, Swamp 51/52 was subject to WaterNSW hazard reduction burns, resulting in the death of indicator species in Swamp 51/52. As a result, indicator species monitoring in Swamp 51/52 was removed from the monitoring program.

The vegetation survey results for autumn 2019 have been assessed in accordance with the Longwalls 301-303 Biodiversity Management Plan. The results of the autumn 2019 survey in relation to the Biodiversity Management Plan Trigger Action Response Plan are summarised in Section 6.8. The results of the Longwalls 301-303 upland swamp vegetation monitoring program (up to and including the autumn 2019 survey) can be summarised as follows:

- Visual inspections did not identify any cracking of exposed bedrock areas or swamp sediments in longwall swamps as a result of mine subsidence.
- Areas in which active erosion was observed were minor and limited to sheet/surface wash in Swamps 48, 51/52, 101 and 137a, and along the drainage line of Swamp 125.
- The autumn 2019 survey was conducted following an extremely dry period from July 2017. Prior to the survey period rainfall was well below average for all months but increased slightly above average during October and November 2018. Above average rainfall was also recorded in March 2019 during the autumn 2019 survey. These dry conditions have contributed to the absence of observed seepage within all longwall and control swamps, except for longwall Swamps 40, 49 and 51/52 where minor seepage was observed.
- Vegetation at both longwall and control sites was found to be generally in good condition with no unusual areas of vegetation senescence observed. Some isolated dieback and senescence of individuals occurred throughout most longwall and control swamps.
- Species richness within individual valley side swamps in autumn 2019 was similar to the range recorded in previous seasons for most longwall and control swamps, and was consistent with the fluctuations observed within the baseline monitoring period. All observed changes in species richness are considered to be within the range of natural fluctuations in response to weather, population dynamics, seasonality of survey and natural disturbances including grazing by fauna species.

- Fluctuations in species cover/abundance and condition were recorded across all sites throughout the baseline monitoring period. No patterns of increasing or decreasing cover/abundance, or declines in vegetation condition, were identified during the autumn 2019 monitoring in relation to individual species across sites or groups of species (i.e. swamp indicator species, generalist species, shrubs, ground covers) within sites.
- In autumn 2019 the proportion of upland swamp indicator species which were dead was greater at longwall sites than control sites for both indicator species, *Epacris obtusifolia* and *Sprengelia incarnata.* This trend has been observed within the baseline monitoring period. Since the large increase in the proportion of dead indicator species observed for control sites in autumn 2018, the seasonal increases have been consistent in control sites. Mortality of tagged indicator species may be attributed to environmental conditions including the stress associated with drying out of shallow soils during periods of below-average rainfall.
- In autumn 2019, the mean vegetation condition of tagged *Sprengelia incarnata* and *Epacris obtusifolia* individuals was been lower than the range observed across the baseline monitoring seasons for both longwall and control sites. As these declines have occurred at both longwall and control swamps it is considered to reflect the natural fluctuations in plant health associated with herbivory, resource competition, ageing plants and, in particular, the ongoing drought conditions.
- The flowering status of tagged indicator species, as recorded in the mean reproductive status, shows that across all seasons flowering has been highly variable, particularly within control sites. The mean reproductive status of tagged indicator species has also been variable between longwall and control swamps in individual seasons.
- The upland swamp performance indicator '*The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamp*s' has not been exceeded for any of the Longwalls 301-303 upland swamps to date.

The spring 2018 and autumn 2019 Longwalls 301-303 Vegetation Monitoring Reports prepared by Eco Logical are provided as Appendices H3 and H6, respectively.

6.3.2 Upland Swamp Groundwater Monitoring

Swamp substrate water levels are assessed against the following upland swamp groundwater performance indicator:

> *Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to control swamps or seasonal variations in water levels experienced by upland swamps prior to mining*.

As described in Section 6.2.6, semi-quantitative comparisons of the swamp substrate water levels of Swamps 25, 30, 33 and 35 with control swamps and rainfall records do not show a definitive mining effect and the dry conditions are regarded as a natural response to reduced rainfall (Appendices C1 and C2).

The swamp substrate hydrographs for Swamps 40, 41, 46, 51, 52 and 53 indicate that the correlation of swamp substrate with the rainfall trend is strong (Appendices C1 and C2). Data analysis for the reporting period indicates the seven day moving averages for Swamps 40, 46, 51 and 53 were at or above the swamp's minimum recorded in the baseline period (Appendices C1 and C2).

The upland swamp groundwater performance indicator has been exceeded at Swamp 20 since 2012. Swamp 20 substrate water levels changed from being permanently saturated to being periodically saturated as a result of the passing of Longwall 21 (Chart 64 and Appendices C1 and C2). The water levels in both Swamp 20 and control swamp Woronora River Swamp 1 were at the base of the dataloggers for the entirety of the reporting period from July 2017 to November 2018.

A mining effect to the substrate water levels of Swamp 28 (overlying Longwall 24) was identified in 2016 based on the incomplete recovery of substrate water levels following rainfall events (Chart 65 and Appendices C1 and C2). Swamp 28 is considered to have an impact from mining of Longwall 25, although no effect on swamp substrate water levels occurred when Longwall 24 passed directly beneath the monitoring site (Appendices C1 and C2). The substrate piezometer at Swamp 28 returned to dry conditions from September 2017, remaining so until the end of this reporting period, as did the two control swamp piezometers (Swamps 137a and 137b; Chart 65).

The subsidence impacts on the substrate water levels of Swamp 20 and Swamp 28 have triggered assessments against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities*. The Swamp 20 and Swamp 28 threatened flora and fauna assessments by Ecoplanning and Cenwest Environmental Services are provided in Appendices I1 and I2, respectively. The assessments conclude that the subsidence impact performance measure has been met.

6.3.3 Riparian Vegetation Monitoring

Riparian vegetation monitoring is conducted at a number of sites on the Waratah Rivulet and Eastern Tributary, overlying Longwalls 20-27 and downstream of Longwalls 20-27 (Figure 13).

The vegetation survey results for autumn 2019 have been assessed in accordance with the Longwalls 301-303 Biodiversity Management Plan. The results of the autumn 2019 survey in relation to the Biodiversity Management Plan Trigger Action Response Plan are summarised in Table 9 in Section 6.8. The results of the Longwalls 20-22 and Longwalls 23-27 riparian vegetation monitoring programs (up to and including the autumn 2019 survey) can be summarised as follows:

- Water levels across all riparian sites along both Waratah Rivulet and Eastern Tributary were observed to be lower than those observed during the previous spring 2018 survey, following the below-average rainfall that preceded the autumn 2019 surveys. Along the Eastern Tributary there was no water at MRIP06 and very low water levels at MRIP05 and only minor flow at MRIP09.
- Scouring of the stream bank and erosion of sediments was observed across all riparian monitoring sites in autumn 2019, attributed to high water flows following heavy rain events (e.g. March 2017). The extent of bank scouring ranged from minor to severe and was often associated with sandy areas where vegetation was lost during high water flows. However, many previously impacted sites are showing significant recovery, including the development of a good covering of shrubs and sedges.
- Vegetation was generally observed in good condition across and adjacent to all riparian monitoring sites in autumn 2019. Exceptions to the generally good condition of vegetation within these riparian sites was limited to isolated and scattered individuals observed with dieback and flood impacts including prone vegetation and burial by flood debris.
- Within longwall site MRIP02 along the Waratah Rivulet, riparian vegetation overall was in an improved condition in autumn 2019 compared to that observed in autumn 2018, with no significant increase in the extent of dieback from spring 2018 recorded. At longwall sites MRIP05 and MRIP06 along the Eastern Tributary, dieback of groundcover and shrub layer vegetation had been previously recorded along a discontinuous band, immediately adjacent to the water's edge (i.e. along the top of bank). In autumn 2019, the condition of the vegetation appeared improved, similar to that observed in the previous spring 2018 survey.

- In autumn 2019, the percent cover and height of the structural layers was generally similar to that recorded for spring 2018. Across all seasons (since the surveys commenced in spring 2008), the vegetation structure, dominant species and estimated cover for each stratum has varied between sites and between seasons within sites. These trends and the fluctuations observed in other sites, are considered to reflect the natural variations in the height and cover/abundance of vegetation structural layers through time (including in response to flooding impacts).
- Species richness in autumn 2019 was generally similar to previous seasons with all values within the range of previous seasons for individual sites (Charts 89 and 90). The exception was one control site, MRIP03, where species richness was lower than the previously recorded for this site.
- In autumn 2019 the mean vegetation condition for tagged riparian indicator species was greater in longwall sites than controls site for *Prostanthera linearis*, whilst mean vegetation condition was greater within control sites than longwall sites for *Lomatia myricoides*, and mean vegetation condition of *Schoenus melanostachys* was the same for longwall and control sites. At longwall sites the mean vegetation condition remained similar in autumn 2019 to the previous spring 2018, while at control sites the mean vegetation condition increased slightly.
- In autumn 2019 the mean reproductive status for tagged riparian indicator species was similar between longwall and control sites for *Lomatia myricoides*. For *Prostanthera linearis* and *Schoenus melanostachys* mean reproductive status was greater at longwall sites than at control sites, although the difference was small.
- Two species of conservation significance were recorded at riparian vegetation monitoring sites in autumn 2019, namely *Hibbertia nitida* and *Lomandra fluviatilis*. *Hibbertia nitida* was commonly recorded with a healthy condition, similar to spring 2018 which represents an improvement in the overall condition of this species relative to previous monitoring periods. *Lomandra fluviatilis* was predominantly observed in good condition. This represents an increase in vegetation condition on previous years.
- Eleven introduced species were observed within riparian monitoring sites in autumn 2019, namely *Ageratina adenophora* (Crofton Weed) (MRIP02), *Andropogon virginicus* (Whiskey Grass) (MRIP02 and MRIP12), *Cirsium vulgare* (Spear Thistle) (MRIP01), *Conyza sp.* (MRIP01, MRIP02 and MRIP10), *Cyperus eragrostis* (Umbrella Sedge) (MRIP02), *Cyperus brevifolius* (Mullumbimby Couch) (MRIP04), *Digitaria sp.* (MRIP01), *Gamochaeta sp.* (MRIP01, MRIP02 and MRIP10), *Hypochaeris radicata* (Catsear) (MRIP01 and MRIP12) *Senecio madagascariensis* (Fireweed) (MRIP04 and MRIP10) and *Sonchus oleraceus* (Common Sowthistle) (MRIP02).

The spring 2018 and autumn 2019 Longwalls 20-22 and Longwalls 23-27 Vegetation Monitoring Reports prepared by Eco Logical Australia (Ecological) are provided in Appendices H1, H2, H4 and H5, respectively.

6.3.4 Aquatic Biota and Their Habitats

The aquatic ecology monitoring programs for Longwalls 20-22 and Longwalls 23-27 were designed to monitor subsidence-induced impacts on aquatic ecology (referred to as stream monitoring) and the response of aquatic ecosystems to the implementation of potential future stream remediation works (referred to as pool monitoring). The locations of the monitoring sites are shown on Figure 14.

The Longwall 304 Biodiversity Management Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27. No additional aquatic ecology monitoring sites have been established for Longwalls 301-304.

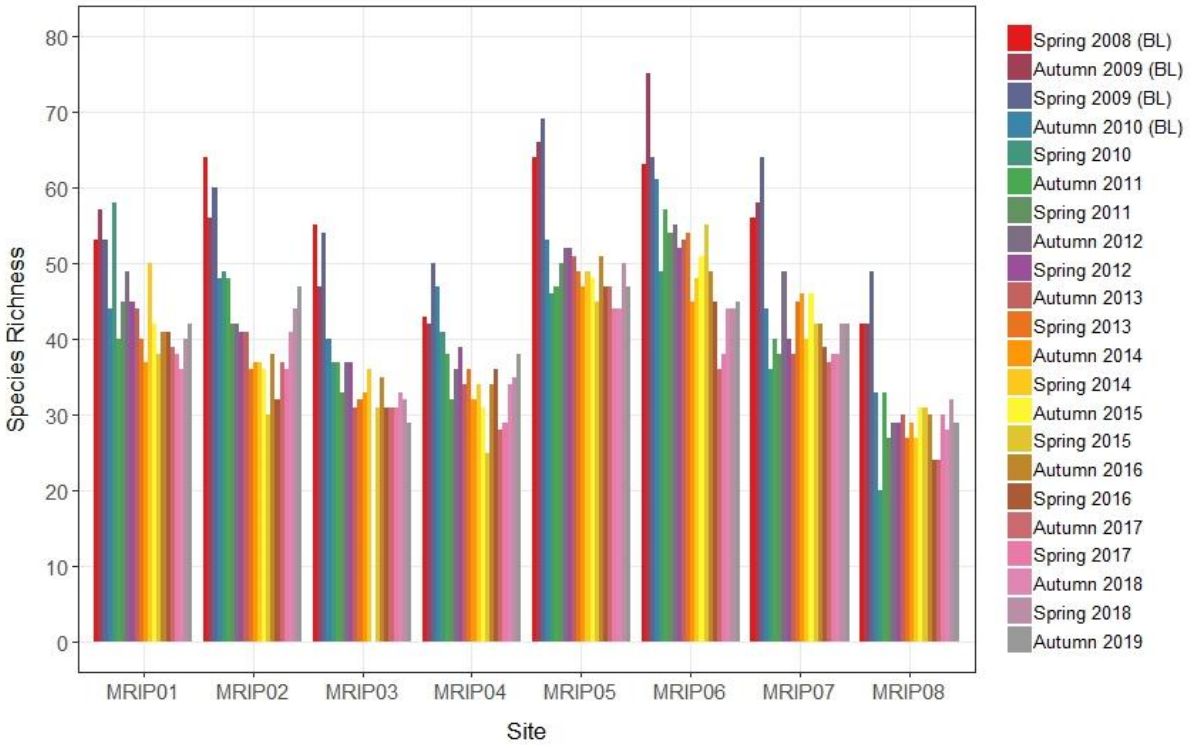


Chart 89 Native Species Richness within Riparian Monitoring Sites across All Seasons – Longwalls 20-22 Monitoring Program

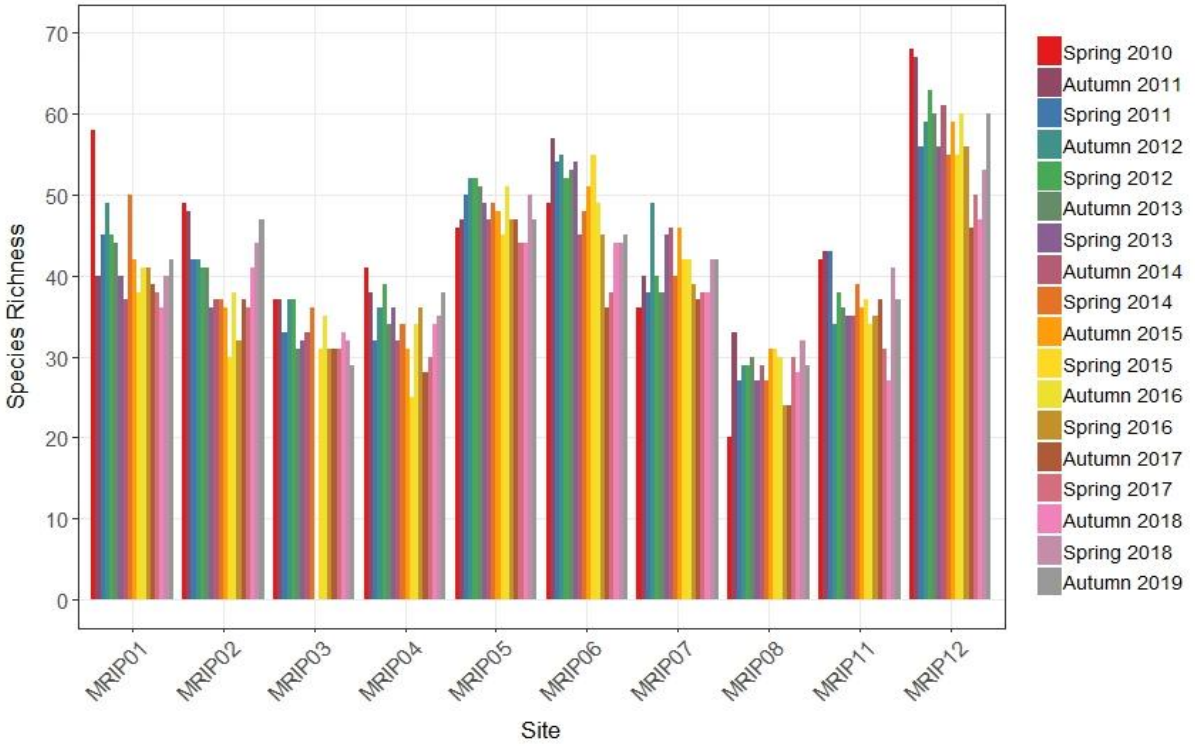


Chart 90 Native Species Richness within Riparian Monitoring Sites across All Seasons – Longwalls 23-27 Monitoring Program

Multivariate and univariate statistical procedures (Permutational Multivariate Analyses of Variance [PERMANOVA] and Plymouth Routines in Multivariate Ecological research [PRIMER] software packages) are used to examine temporal and spatial patterns in macroinvertebrates and macrophytes sampled within the study area. Specifically, PERMANOVA's are used to test hypotheses related to differential changes (e.g. before-vs-after commencement of mining) in multivariate and univariate (e.g. total number of taxa, total abundance and abundances of the most important taxonomic groups identified from the samples) estimates occurring in streams or pools subject to mining (i.e. potential 'impact' streams) in comparison to independent streams or pools that are not subject to mine subsidence (i.e. control places).

The spring 2018 Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Reports prepared by Bio-Analysis Pty Ltd are provided in Appendix I (J1 and J2, respectively). The autumn 2019 Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Reports prepared by Bio-Analysis Pty Ltd are provided in Appendix I (J3 and J4, respectively).

The results of the Longwalls 20-22 and Longwalls 23-27 aquatic ecology programs (up to and including the autumn 2019 survey) are summarised below.

6.3.4.1 Stream Monitoring Program

Eastern Tributary

In autumn 2019, pool water levels at Locations C1, C2, C3 and C4 on the Eastern Tributary[25] were generally observed to be similar to or below pre-mining levels and some sites were dry or had no surface flow as a result of mining impacts. Iron staining/flocculent continued to be observed in submerged areas of the stream channel along the Eastern Tributary.

Multivariate and univariate analyses of the monitoring data were used to test whether there was evidence of significant change in aquatic macroinvertebrate and macrophyte indicators at Eastern Tributary locations before to after mining of Longwall 20 (mining commenced in May 2010) and Longwall 23 (mining commenced in May 2014), in relation to Control locations.

Analyses for Longwalls 20-22 detected a significant before-to-after mining change in the structure of the assemblage of aquatic macrophytes at Location C1 in spring 2014 in relation to the control locations, but not subsequently. At Location C1, analyses for Longwalls 23-27 detected a significant before-versus-after mining change in the structure of the aquatic macroinvertebrate assemblage in relation to the control locations in spring 2016 (T17) and autumn 2019 (T22). Mean numbers of the mayfly family, Leptophlebiidae, have been significantly more variable within the after-period at Location C1 since autumn 2015. Analyses for Longwalls 23-27 detected a significant change in the structure of assemblages of macrophytes at Location C1 in spring 2017, in relation to the control locations.

For the first time since sampling commenced, multivariate analysis of the aquatic macroinvertebrate data detected a significant interaction of the factors Period x Impact that would indicate an impact from mining on the structure of the assemblage at Location C2. Analyses for Location C2 have detected a significant decrease in mean numbers of the freshwater shrimp family, Atyidae, within the after-period since autumn 2016. Notably, reduced mean numbers of Atyidae have now persisted at Location C2 for three consecutive years.

[25] The Eastern Tributary is also known as Tributary C. Locations ET1 to ET4 shown on Figure 14 are the same as Locations C1 to C4 discussed in this section of the Annual Review, and in Appendices J1 and J2.

In spring 2018 and autumn 2019, a significant change in mean abundance of aquatic macroinvertebrates was detected at Location C2 between the before- and after-periods, in relation to the control locations. The structure of the macrophyte assemblage at Location C2 also appears to have changed significantly within the after-period for Longwalls 23-27 although changes prior to the spring 2017 survey did not appear to be related to mining activities.

In autumn 2013, dieback of riparian vegetation was noted at one of the sites sampled at Location C3 (i.e. Site C3-2), thought to be associated with tilting of the stream bank by mine subsidence. Occasional falls in pool water levels below pre-mining levels have been recorded at Site C3-2 since spring 2015, including within autumn 2019. To date, analyses have not detected significant changes in aquatic macroinvertebrate or aquatic macrophyte indicators sampled at Location C3 that would indicate an impact from mining.

Temporal patterns in diversity of macroinvertebrates at Location C4 have differed significantly between periods since spring 2018, in relation to the control locations. A significant decrease in Atyidae was detected at Location C4 within the after-period in autumn 2016, spring 2018 and autumn 2019. Atyidae were not collected at Location C4 in autumn 2017, spring 2018 or autumn 2019. Analyses detected a significant before-to-after mining change in the structure of assemblages of aquatic macrophytes at Location C4 in relation to the controls in spring 2018 and autumn 2019.

The subsidence impacts at Location C1 have triggered an assessment against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities,* which have been undertaken by Ecoplanning and Cenwest Environmental Services (Appendices I2 and I3). The assessments conclude that the subsidence impact performance measure has been met.

Waratah Rivulet

To date, analyses comparing temporal changes in components of assemblages of macroinvertebrates and macrophytes at Locations WT3, WT4 and WT5 on the Waratah Rivulet with control locations have not detected significant changes from before- to after-mining of the Longwalls 20-22 underground mining area.

Univariate analyses however, have detected a significant change in mean diversity of macroinvertebrates at Location WT3 within the after-period in spring 2016, autumn 2018, spring 2018 and autumn 2019. Differences appear to be related to diversity decreasing at Location WT3 within the after-mining period whilst there was an increase at the control locations.

There were no conspicuous differences in mean diversity at Locations WT4 or WT5 in relation to the control locations.

Mean abundance of macroinvertebrates and mean numbers of Leptophlebiidae and Atyidae did not differ at locations WT3, WT4 or WT5 in relation to the control locations between the before- and after-mining periods.

Tributary B – Locations B1 and B2

A considerable drop in water level was noted in a large pool at Location B1 in spring 2012. Since autumn 2013, pools along the study reach have been mostly dry and there has been no surface flow as a result of mine subsidence. Quantitative sampling of aquatic macroinvertebrates has not been carried out at Location B1 on Tributary B in spring 2013 or since spring 2014 due to insufficient habitat available for sampling.

Past analyses examining patterns of change in the assemblage of aquatic macroinvertebrates and key components at Location B1 on Tributary B in relation to control locations found evidence of impacts related to mining activities within the Longwalls 20-22 underground mining area. Analyses indicate that the assemblage of macrophytes at Location B1 have experienced a degree of environmental stress since spring 2012 as a result of mining activities within the Longwalls 20-22 underground mining area.

Since spring 2016, subsidence associated with extraction of Longwalls 23-27 appears to have impacted aquatic indicators at Location B2. These impacts include evidence of a reduction in availability and quality of aquatic habitat and significant changes in numbers of Leptophlebiidae and Atyidae. To date, no changes to aquatic macrophyte indicators have been evident.

As described in the Metropolitan Coal 2017 Annual Review, the aquatic ecology subsidence impact performance indicator, *The aquatic macroinvertebrate and macrophyte assemblages in streams are not expected to experience long-term impacts as a result of mine subsidence*, has been exceeded at Location B1 and Location B2 on Tributary B for aquatic macroinvertebrates since the spring 2016 survey and assessments have been made against the performance measure. Given the distance from Longwalls 301-303, Tributary B is not expected to experience any measurable subsidence or valley related movements resulting from the extraction of Longwalls 301-303.

6.3.4.2 Pool Monitoring Program

Large Pool ETAH and small Pools ETAG, ETAI and ETAK on Tributary C/Eastern Tributary were dry at the time of the spring 2017 and autumn 2018 surveys and there was no surface flow for a considerable distance upstream or downstream of the pools. In spring 2018, water was present in Pool ETAH (up to approximately 10 cm deep in places), but the water level was well below pre-mining levels. Flow was apparent in and out of Pool ETAG in spring 2018 and water level was similar to pre-mining levels. Pools ETAI and ETAK were dry at the time of the spring 2018 survey. Large Pool ETAH and small Pools ETAG, ETAI and ETAK were dry at the time of the autumn 2019 survey.

Metropolitan Coal will conduct stream remediation of pools on the Eastern Tributary in accordance with the Metropolitan Coal Stream Remediation Plan. In accordance with the Longwalls 301-303 Biodiversity Management Plan, assessment against the performance indicator *The aquatic macroinvertebrate and macrophyte assemblages in pools are not expected to experience long-term impacts as a result of mine subsidence* at Pools ETAG, ETAH, ETAI and ETAK will be undertaken after one year of the completion of stream remediation on the Eastern Tributary.

Pools on Waratah Rivulet

Multivariate analyses comparing temporal and spatial patterns of change in assemblages of aquatic macroinvertebrates in large pools (J, M1 and N) and small pools (K, L and M) sampled on the Waratah Rivulet with the control pools have not detected significant differences in the structure of assemblages of macroinvertebrates.

Univariate analyses detected a significant increase in mean diversity of macroinvertebrates in Pools J (from autumn 2015 to autumn 2017) and M1 (from autumn 2015 to spring 2018) in relation to the control pools. Differences in diversity are likely to be related to mining impacts and have now persisted at Pool M1 for more than 3 consecutive years. Notably, analyses did not detect a significant difference in diversity of macroinvertebrates in Pool M1 in autumn 2019.

Mean cover of macrophytes at Pool M1 has decreased significantly within the after-period since autumn 2016 but not at the control pools.

Diversity of macrophytes has become significantly more variable at Pool N within the after period (since autumn 2016).

To date, analyses examining temporal and spatial patterns of change in aquatic macroinvertebrates and macrophytes have identified no significant changes to aquatic macrophyte indicators in Pools K, L and M.

Univariate analyses however, have detected a significant change in mean diversity of macroinvertebrates in the Pools K, L and M within the after-period since autumn 2015, in relation to the control pools. Overall, there appears to have been an increase in diversity in the rivulet pools within the after-period, but little change within the control pools. Notably, differences in diversity in the small rivulet pools are likely to be related to mining impacts and have now persisted for more than 3 consecutive years.

The subsidence impacts at Pools K, L, M, M1 and N have triggered assessments against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities,* which have been undertaken by Ecoplanning and Cenwest Environmental Services (Appendices I2 and I3). The assessments conclude that the subsidence impact performance measure has been met.

6.3.4.3 Assessment of Subsidence Impacts and Environmental Consequences on Aquatic Habitats and Biodiversity

The key potential subsidence impacts and environmental consequences for streams described in the Project EA, Preferred Project Report and Metropolitan Coal Biodiversity Management Plans include impacts on aquatic habitats (e.g. alteration of hydrology, pool habitat, in-stream connectivity and water quality), and on biodiversity (e.g. aquatic macrophytes, macroinvertebrates, fish and riparian vegetation). In summary, the key potential environmental consequences described in the Project EA, Preferred Project Report, and Metropolitan Coal Biodiversity Management Plans include:

- Changes in stream flows as a result of fracturing of bedrock and the consequent diversion of a portion of the total stream flow as underflow. The effects of underflow would be most noticeable during periods of low flow and on the frequency of no flow, while the effects on the frequency and magnitude of high flows would be negligible.
- Changes in pool water levels and in-stream connectivity - underflow has been observed to result in lower water levels in pools as they become hydraulically connected with the fracture network. During prolonged dry periods when flows recede to low levels, the number of instances where loss of flow continuity between pools occurs increases with a greater proportion of these lower flows being conveyed entirely in the subsurface fracture network.
- Impacts on water quality following cracking of the stream bed that can reduce the quality of habitat for aquatic biota (e.g. generation of iron flocculent material).
- Minor stream bank erosion, where changes in channel gradients result in increases in flow energy.
- Impacts on aquatic macrophytes plants (e.g. as a result of changes in hydrology described above) resulting in exposure and desiccation or smothering of plants by iron flocculent material. Aquatic macrophytes have evolved reproductive strategies to cope with the variable nature of flow in streams and wetlands within Australia. Obligate water plants generally require permanent water, however they can recolonise once water becomes available again.
- Localised impacts on aquatic macroinvertebrates as a result of changes in aquatic habitat/hydrology described above. The Project is unlikely to have any significant long-term impacts on assemblages of macroinvertebrates.
- The conveyance of surface water flows to sub-surface fractures in the area affected by subsidence has the potential to reduce available habitat for fish and connectivity among sections of the stream channel, impeding fish passage.

The results of aquatic ecology monitoring are considered to be consistent with the potential subsidence impacts and environmental consequences described in the Project EA, Preferred Project Report and the Metropolitan Coal Water Management Plans and Biodiversity Management Plans.

However, the subsidence impacts on Location C1 on the Eastern Tributary, and Pools K, L M, M1 and N on the Waratah Rivulet, have triggered assessments against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities*. The threatened flora and fauna assessments prepared by EcoPlanning and Cenwest Environmental Services are provided in Appendices I1 and I2, respectively. The assessments conclude that the subsidence impact performance measure has been met.

Subsidence impacts on Tributary B have resulted in no surface flow along the stream in the vicinity of Location B1 for an extended period of time. This change in aquatic habitat/hydrology has resulted in long term impacts to the aquatic macroinvertebrate assemblage at this location (location B1) and downstream at location B2. This has not resulted in an exceedance of the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations or ecological communities*.

Metropolitan Coal will conduct stream remediation of pools on the Eastern Tributary in accordance with the Metropolitan Coal Stream Remediation Plan. During 2020, Metropolitan Coal plans to conduct stream remediation at Pools ETAH and ETAK.

6.3.5 Amphibian Surveys

Monitoring programs have been developed for Longwalls 20-22, Longwalls 23-27, Longwalls 301-303 and Longwalls 305-307 to monitor amphibian species, with a focus on the habitats of the Giant Burrowing Frog (*Heleiporus australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*) associated with tributaries. The locations of the monitoring sites are shown on Figure 15.

Sites are surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions. The spring/summer 2018 survey was carried out over six days and six nights in March 2019. The survey period was delayed due to the exceptionally dry weather leading up to and after December 2018. No second survey period was possible due to a lack of suitable survey conditions being unavailable as a result of the ongoing dry conditions.

6.3.5.1 Longwalls 20-22 Amphibian Monitoring

The spring/summer 2018 Longwalls 20-22 Amphibian Monitoring Report prepared by Cenwest Environmental Services is provided in Appendix K1.

The spring/summer 2018 survey is the tenth amphibian survey for Longwalls 20-22. At the time of the spring/summer 2018 survey six test sites above Longwalls 20-22 had been undermined for periods ranging from five to seven years. Habitats of five test sites (1, 2, 4, 5 and 6) have been adversely impacted by longwall mining.

Five amphibian species were recorded by the spring/summer 2018 survey, including three in test sites and four in control sites, being representatives from the two families Myobatrachidae and Hylidae. The most species diverse site in the spring/summer 2018 survey with four species was test site 10, while sites 2, 3, 4, 6 and 8 recorded two species each (Figure 15). The Red-crowned Toadlet was located at three test sites (sites 2, 3 and 4), and one control site (site 10). The Giant Burrowing Frog was not recorded during the spring/summer 2018 survey. Individuals of the Giant Burrowing Frog have only been recorded during the 2009 (1 control site), 2011 (1 test site, 1 control site) and 2016 (1 control site) surveys. Littlejohn's Tree Frog (*Litoria littlejohni)* was recorded for the first time for Longwalls 20-22, during the spring/summer 2018 survey at control site 10, and was again recorded at control site 10 during the spring/summer 2018 survey.

Five breeding events (three species) were recorded by the spring/summer 2017 survey in both test and control sites. No breeding events were recorded for the Red-crowned Toadlet, Giant Burrowing Frog or Littlejohn's Tree Frog.

Since the commencement of the Longwalls 20-22 amphibian monitoring program, species diversity across all sites has varied between five (2013 and 2018) and 11 (2009). At test sites, species diversity has varied between three and nine species and at control sites, between two and nine species.

6.3.5.2 Longwalls 23-27 Amphibian Monitoring

The spring/summer 2018 Longwalls 23-27 Amphibian Monitoring Report prepared by Cenwest Environmental Services is provided in Appendix K2.

The spring/summer 2018 survey is the ninth amphibian survey for Longwalls 23-27. All test sites above Longwalls 23-27 had been undermined prior to the commencement of the spring/summer 2016 survey. Habitats of two sites (13 and 14) have been adversely impacted by longwall mining. However, both sites 13 and 14 have usually demonstrated the highest amphibian species diversity of the ten survey sites over eight survey years, with the exception of the 2016 to 2018 surveys, with 2017 and 2018 being exceptionally dry years.

Six amphibian species were recorded by the spring/summer 2018 survey, including five in test sites (13, 14 and 16) and three in control sites (19, 20 and 22), also being representatives from the two families Myobatrachidae and Hylidae. The most widespread frog was the Common Eastern Froglet (*Crinia signifera*), recorded at test sites 13, 14 and 16, and control sites 19, 21 and 22. The Red-crowned Toadlet was located a test site 16 and control site 22. The Giant Burrowing Frog was not located during the survey. Littlejohn's Tree Frog was recorded for the first time for Longwalls 23-27 during the spring/summer 2017 survey at control site 18, and was again recorded at control site 21 during the spring/summer 2018 survey.

Four species (Common Eastern Froglet, Southern Rocket Frog [*Litoria freycineti*], Peron's Tree Frog and the Green Stream Frog), were found breeding in the spring/summer 2018 survey, all at test site 14, however these were only minor breeding events. No breeding events were recorded for the Red-crowned Toadlet, Giant Burrowing Frog or Littlejohn's Tree Frog.

Since the commencement of the Longwalls 23-27 amphibian monitoring program, species diversity across all sites has varied between three (2017) and eight (2010). At test sites, species diversity has varied between two and seven species and at control sites, between two and six species.

6.3.5.3 Longwalls 301-303 Amphibian Monitoring

Baseline amphibian surveys have been conducted in spring/summer 2015 and spring/summer 2016 at six test sites (23, 24, 25, 26, 27 and 28) overlying Longwalls 301-303 (Figure 15). The control sites for Longwalls 301-303 consist of the eleven existing control sites associated with Longwalls 20-22 and Longwalls 23-27. The spring/summer 2018 survey was the second survey conducted since the commencement of Longwalls 301-303.

The results of the spring/summer 2018 Longwalls 301-303 amphibian monitoring survey are included in the Longwalls 301-307 Amphibian Survey Report prepared by Cenwest Environmental Services, and is provided as Appendix K3.

At the time of the spring/summer 2018 survey, all test sites had been undermined by Longwalls 301-303. No longwall test sites were adversely impacted by mining at the time of the spring/summer 2018 survey.

In the spring/summer 2018 survey, two amphibian species were recorded, namely the Common Eastern Froglet (sites 23, 26, 27 and 28) and Red-crowned Toadlet (site 23). No evidence of breeding was observed for any species in the spring/summer 2018 survey.

6.3.5.4 Longwalls 305-307 Amphibian Monitoring

As described in the Longwall 304 Biodiversity Management Plan, test sites 29 and 30 have been established proximal to Longwalls 305-307, while no additional control sites were required to ensure a continually robust experimental design. That is, the control sites for Longwalls 305-307 consist of the eleven existing control sites associated with Longwalls 20-22 and Longwalls 23-27. The spring/summer 2018 survey represents the first baseline data survey of Longwalls 305-307 sites 29 and 30.

The results of the spring/summer 2018 Longwalls 305-307 amphibian monitoring survey are included in the Longwalls 301-307 Amphibian Survey Report prepared by Cenwest Environmental Services, and is provided as Appendix K3.

Three amphibian species were recorded by the spring/summer 2018 survey, namely the Common Eastern Froglet (sites 29 and 30), Red-crowned Toadlet (site 30) and Blue Mountains Tree Frog (site 29).

One breeding event was recorded during the spring/summer 2018 survey, namely for the Common Eastern Froglet (site 29).

The spring/summer 2019 amphibian survey will constitute the second and final baseline survey of sites 29 and 30 established for Longwalls 305-307, the result for which will be reported in the Metropolitan Coal 2020 Annual Review.

6.3.5.5 Statistical Analysis of Amphibian Monitoring Results

A feature of the amphibian surveys to date is the high numbers of zero records that dominate the data, indicating a non-normal distribution (i.e. a skewed distribution of data). This means that the results of the amphibian surveys cannot be analysed by simple parametric statistics such as Chi^2 or an analysis of variance (ANOVA). A Poisson regression[26] analysis has been carried out by Dr Bernard Ellem for Cenwest Environmental Services to analyse the amphibian survey results obtained to date (i.e. to spring/summer 2018). The three data sets (Longwalls 20-22, 23-27 and 301-303) have been analysed together to increase the resolution of the analyses.

[26] Poisson regression is a generalized linear model form of regression analysis used to model count data and contingency tables.

To date, no adverse impact from mining has been detected for the amphibian assemblage at the 95% confidence level for Longwalls 20-22 and Longwalls 301-303.

As reported in the 2018 Annual Review, analyses undertaken following the Longwalls 23-27 spring/summer 2017 survey detected a significant difference between the test and control sites at the 95% confidence level at sites 15, 16 and 17 for the spring/summer 2014 survey. The impact was not detected by the Poisson Regression analyses conducted following the 2014, 2015 and 2016 surveys and may be a result of the improved capacity of the model over time as the data set builds. Notwithstanding, an ongoing impact could not be detected following the Longwalls 23-27 spring/summer 2018 survey.

The monitoring results are consistent with the predictions described in the Project EA, Preferred Project Report, and Metropolitan Coal Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 Biodiversity Management Plans, specifically, that it is unlikely that any vertebrate population would be put at risk by the Project. Thus, the performance indicator, *the amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites*, has not been exceeded for the spring/summer 2018 survey for Longwalls 20-22, 23-27 or 301-303.

6.3.5.6 Littlejohn's Tree Frog Targeted Surveys

As previously described in the Metropolitan Coal 2018 Annual Review, following the results of the spring/summer 2016 amphibian monitoring survey which recorded Littlejohn's Tree Frog for the first time, Metropolitan Coal commissioned a targeted survey for the Littlejohn's Tree Frog, which was subsequently carried out in October and November 2018. A recommendation of the October/November 2018 targeted survey was to undertake one more targeted survey for Littlejohn's Tree Frog in 2019 only under optimal survey conditions in June - July following heavy rainfall (> 50 mm over a week) with access to sites preferably whilst it still raining. The results of the October/November 2018 targeted survey were reported in the 2018 Annual Review.

Widespread rainfall fell across the Woronora Plateau in early July 2019, which provided suitable conditions for the conduct of an additional targeted survey. Accordingly, a targeted survey for the Littlejohn's Tree Frog was carried out in July 2019, the results for which are provided as Appendix I4.

These surveys have established that Littlejohn's Tree Frog is found in very low numbers within the Project underground mining area, and is likely to be more widespread across the Woronora catchment than previously thought and has a patchy distribution. No breeding events have been recorded for Littlejohn's Tree Frog to date.

Given the above, Cenwest Environmental Services considers that no further targeted surveys are required to be undertaken for Littlejohn's Tree Frog (Appendix I4).

6.4 LAND MANAGEMENT

The Metropolitan Coal Longwall 304 Land Management Plan was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwall 304 Extraction Plan on cliffs, overhangs, steep slopes and land in general, in accordance with Condition 6, Schedule 3 of the Project Approval.

The Longwall 304 Land Management Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303.

Sections 6.4.1 and 6.4.2 provide a summary of the land assessments for the review period. Section 6.8 provides a summary of the assessments against the cliffs and overhangs, steep slopes and land in general subsidence impact performance indicators and measures for the reporting period.

6.4.1 Cliffs and Overhangs

Visual inspections of cliffs and overhangs were conducted monthly when mining of Longwalls 20-22 and/or Longwalls 23-27 was within 400 m of sites COH1, COH2, COH3, COH4, COH5, COH6, COH6A, COH7, COH8, COH9, COH10, COH14, COH15 and COH16 (Figure 16) and following the completion of each longwall to record evidence of subsidence impacts. A vertical tension crack (approximately 50 mm wide and 15 m long) on the cliff face and a small rock fall (approximately 1.5 m long, 0.5 m wide and 0.5 m^3) were recorded at site COH2 (Figure 16) in December 2013 during the mining of Longwall 22. No additional subsidence impacts at the cliff or overhang sites were recorded following the completion of Longwall 27.

A new cliff and overhang site (COH17) was identified below the full supply level on the Eastern Tributary arm of the Woronora Reservoir in August 2018. Detailed baseline recording for this site was conducted prior to commencement of Longwall 303 extraction. The location of the site COH17 is shown on Figure 16.

In accordance with the Longwall 304 Land Management Plan, visual inspections of site COH17 were conducted monthly when mining of Longwall 303 and Longwall 304 was within 400 m of the site and at the completion of Longwall 303. No subsidence impacts on site COH17 were identified during the reporting period. A visual inspection of site COH17 will be undertaken within 3 months following the completion of Longwall 304 in the next reporting period.

The Project EA, Preferred Project Report and Metropolitan Coal Longwall 304 Land Management Plan predicted that the length of potential cliff instabilities would be expected to be less than 3% of the lengths of the cliffs. The total length of cliffs and associated overhangs within the Project underground mining area is approximately 924 m. Less than 3% of the total length of cliffs (and associated overhangs) within the mining area have experienced mining-induced rock fall.

6.4.2 Steep Slopes and Land in General

Visual inspections for subsidence impacts on steep slopes and land in general are conducted by Metropolitan Coal and its contractors as part of routine works conducted in the catchment.

No subsidence impacts on steep slopes or land in general were identified by Metropolitan Coal or its contractors during the reporting period. No management measures were required to be implemented.

The recorded subsidence impacts are consistent with the potential subsidence impacts described in the Project EA, Preferred Project Report Longwall 304 Land Management Plan, specifically that the size and extent of surface cracking at the steep slopes and land in general would be similar to that observed previously at Metropolitan Coal, and that the maximum predicted systematic strains would be of sufficient magnitude to result in the fracturing of sandstone and, hence, there is potential for rock falls, particularly where rock ledges are marginally stable.

6.5 HERITAGE MANAGEMENT

The Metropolitan Coal Longwall 304 Heritage Management Plan was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwall 304 Extraction Plan on Aboriginal heritage sites or values in accordance with Condition 6, Schedule 3 of the Project Approval.

The Longwall 304 Heritage Management Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303.

Sections 6.5.1 and 6.5.2 provides a summary of the heritage assessments for the review period. Section 6.8 provides a summary of the assessments against the Aboriginal heritage sites subsidence impact performance indicators and measures.

6.5.1 Longwalls 20-22, 23-27 and 301-303

Aboriginal heritage monitoring programs have been implemented at Metropolitan Coal for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 to monitor the impacts and environmental consequences of Project related subsidence on Aboriginal heritage sites. The monitoring programs have been undertaken by a suitably qualified archaeologist (with experience in rock art recording and management) and representatives of the Aboriginal stakeholders.

Of the 72 Aboriginal heritage sites that have been subject to monitoring for Longwalls 20-22, Longwalls 23-27 and/or Longwalls 301-303, 13 have been determined to have changes due to mining induced subsidence.

Five Aboriginal heritage sites (FRC 15, FRC 281, FRC 283, FRC 284 and MET 1) have been determined to have changes due to mining induced subsidence from Longwalls 20-22 (Figure 17). The observed impacts at each site were as follows:

- Site FRC 15 – vertical cracking, not coincident with any art.
- Site FRC 281 – multiple cracks running either through or adjacent to the motifs (although the majority of art showed no damage or changes).
- Site FRC 283 – cracking of the rear wall of the shelter, not coincident with any art.
- Site FRC 284 – fracturing of the rear wall of the shelter and exfoliation, not coincident with any art.
- Site MET 1 – two vertical cracks along the rear wall and ceiling of the shelter, not coincident with any art.

Seven Aboriginal heritage sites (FRC 28, FRC 29, FRC 34, FRC 60, FRC 176, FRC 275 and FRC 301) have been determined to have changes due to mining induced subsidence from Longwalls 23-27 (Figure 17). The observed impacts at each site were as follows:

- Site FRC 28 – vertical cracking of the rear shelter wall, opening of horizontal planes/joints and movement of the rock shelf that is part of the shelter floor, not coincident with any art.
- Site FRC 29 – horizontal crack along the back wall and a joining vertical crack, not coincident with any art.
- Site FRC 34 – horizontal cracking along the roof of the shelter and cracking over the most southern hand stencil on the back panel.
- Site FRC 60 – three vertical cracks along the back wall of the shelter, no art recorded at this shelter, the artefacts could not be relocated.

- Site FRC 176 – where vertical cracking along the northern and southern ends of the shelter was observed, not coincident with art.
- Site FRC 275 – opening of horizontal bedding plane at rear of the shelter, five vertical hairline cracks along the back wall of the shelter, not coincident with any art.
- Site FRC 301 – surface cracking on the rock platform, not coincident with the grinding grooves.

One Aboriginal heritage site, FRC 76, was determined to have changes due to mining induced subsidence from Longwalls 301-303. The observed impacts were as follows:

- Site FRC 76 - opening of the horizontal bedding plane along the back wall, not coincident with any art.

Aboriginal heritage site monitoring results for Longwalls 20-27 and Longwalls 301-303 have been assessed against the Aboriginal heritage subsidence impact performance measure:

> *Less than 10% of Aboriginal heritage sites within the mining area are affected by subsidence impacts.*

For the purpose of measuring performance against the Aboriginal heritage subsidence impact performance measure, sites are considered to be "affected by subsidence impacts" if they exhibit one or more of the following consequences that cannot be attributed to natural weathering or deterioration:

- overhang collapse;
- cracking of sandstone that coincides with Aboriginal art or grinding grooves; and
- rock fall that damages Aboriginal art.

The mining area is defined by the Project Approval and is shown on Figure 1 of this report (labelled as Project Underground Mining Area Longwalls 20-27 and 301-317). There are 143 Aboriginal heritage sites within the mining area.

Of the sites at which changes due to mining induced subsidence have occurred, sites FRC 34 and FRC 281 have been affected by subsidence impacts as a result of cracking of sandstone that coincides with Aboriginal art. This means that less than 2% of sites within the mining area have been affected by subsidence impacts. In addition to the changes recorded as a result of mining induced subsidence, natural weathering processes can also result in changes/deterioration of Aboriginal heritage sites.

Metropolitan Coal acknowledges that all Aboriginal heritage sites are considered to be culturally significant to the Aboriginal people who have a traditional connection to Country.

The Aboriginal heritage monitoring results are consistent with the potential subsidence impacts and environmental consequences described in the Project EA, Preferred Project Report and Metropolitan Coal Heritage Management Plans, including the potential for open sites and overhang sites to be impacted by the cracking of sandstone resulting from mine subsidence. The observed rate of subsidence effects at the time of the Project EA and Preferred Project Report was that up to 10% of sites experience an effect such as cracking, accelerated weathering or blockfall. It was expected that the majority of identified Aboriginal heritage sites would experience no significant change, particularly when compared to natural deteriorating processes unrelated to mining.

6.5.2 Longwall 304

In accordance with the Metropolitan Coal Longwall 304 Heritage Management Plan, the next round of Aboriginal heritage surveys is to be undertaken within three months of the completion of Longwall 304.

Monitoring of the Longwalls 20-27 and 301-303 Aboriginal heritage sites, at which previous monitoring indicates continued change due to mining induced subsidence, will be monitored as a component of the Longwall 304 Heritage Management Plan.

As the Longwalls 301-303 Aboriginal heritage monitoring report found that no Aboriginal heritage sites associated with Longwalls 20-27 showed continued change due to mining induced subsidence, no further monitoring of Aboriginal heritage sites associated with Longwalls 20-27 will be undertaken.

The Aboriginal heritage site that showed a change for the first time by the Longwalls 301-303 monitoring survey, namely site FRC 76 (Section 6.5.1) will be monitored within three months of the completion of Longwall 304.

Monitoring will also be conducted of Aboriginal heritage sites FRC 77, FRC 78, FRC 86, FRC 90 and FRC 309 for Longwall 304 within three months of the completion of Longwall 304 (Figure 17).

6.6 BUILT FEATURES MANAGEMENT

The Metropolitan Coal Longwall Built Features Management Plans were prepared to manage the potential environmental consequences of the Metropolitan Coal Longwall 304 Extraction Plan on built features in accordance with Condition 6, Schedule 3 of the Project Approval.

Metropolitan Coal continued with public safety fencing, as per agreement with South Eastern Sydney Local Health District (SESLHD), around derelict cottages B04a-B09a, water tank B14t02, Kiln F01b and communication towers adjacent to SESLHD Garrawarra Centre property to exclude public access to these areas during nearby mining.

During the review period the following non-survey monitoring occurred:

- M1 Motorway – inspection and audit of pavement condition, cutting risk ranking, bridge audits and culvert condition inspection.
- Waterfall General (Garrawarra) Cemetery – post mining condition audit of grave sites completed with no noted change other than natural items.
- Optic Fibre Cables – Telstra and Vocus Optical Time Doman Reflectometer routine cable analysis completed.
- Water pipeline – visual inspections of pipeline route for moisture when LW face in proximity to pipe and acoustic leak monitoring system.
- Princes Highway – weekly visual inspections of pavement, culverts and road furniture nearby longwall operations.
- Railway – railway culverts post mining structural and condition inspection.
- Garrawarra – Post Longwall extraction condition inspection of Garrawarra Facilities to confirm negligible damage criteria.
- End of Panel Longwall 303 LiDAR analysis examining broader landscape subsidence changes.

Monitoring of infrastructure owned by Axicom, Endeavour Energy, Vocus, TransGrid, Optus, Telstra, Roads and Maritime Services, SESLHD, Sydney Trains, Sydney Water and Wollongong City Council was conducted during the review period for subsidence impacts. No subsidence impact to any built feature was evident over the review period.

The Project Approval requires Metropolitan Coal not to exceed the following built features subsidence impact performance measure:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The built features subsidence impact performance measure was not exceeded during the review period.

The Project Approval also requires Metropolitan Coal not to exceed the subsidence impact performance measure for items of heritage or historical significance at the Garrawarra Centre:

> *Negligible damage (fine or hairline cracks that do not require repair), unless the owner of the item and the appropriate heritage authority agree otherwise in writing.*

The heritage subsidence impact performance measure for the Garrawarra Centre was not exceeded during the review period.

6.7 PUBLIC SAFETY MANAGEMENT

The Metropolitan Coal Longwall 304 Public Safety Management Plan was prepared to manage the potential consequences of the Metropolitan Coal Longwall 304 Extraction Plan on public safety within the underground mining areas in accordance with Condition 6, Schedule 3 of the Project Approval.

Monitoring of cliffs and overhangs, steep slopes and land in general has been conducted for subsidence impacts in accordance with the Metropolitan Coal Longwall 304 Land Management Plan. Monitoring of infrastructure items has been conducted in accordance with the Metropolitan Coal Built Features Management Plans. No subsidence impacts were identified during the reporting period that were considered to pose a risk to public safety.

Further, no subsidence safety incidents were reported by visitors, personnel or contractors to Metropolitan Coal in the underground mining area during the reporting period.

6.8 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The subsidence impact performance indicators and performance measures in Table 9 were developed to address the predictions of subsidence impacts and environmental consequences on water resources, watercourses, biodiversity, land, heritage, built features and public safety included in the Project Environmental Assessment, Preferred Project Report, Metropolitan Coal Longwalls 301-303 and Longwall 304 Extraction Plans.

Assessments against the subsidence impact performance indicators and performance measures have been conducted for the reporting period in Table 9.

Table 9
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT								
Negligible Reduction to the Quantity of Water Resources Reaching the Woronora Reservoir								
Negligible reduction to the quantity of water resources reaching the Woronora Reservoir	*Changes in the quantity of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining, that are not also occurring in the control catchment(s)*	WaterNSW gauging station on Waratah Rivulet (GS 2132102)	Surface water flow	Level 3	The median of the ratios falls below the 20th percentile of the baseline data.	Surface water flow was at Level 3 for the 1 January to 30 June 2019 review period, though the same was also occurring in the control catchment.	No[1]	No
Negligible Reduction to the Quality of Water Resources Reaching the Woronora Reservoir								
Negligible reduction to the quality of water resources reaching the Woronora Reservoir	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2*	Site WRWQ9 on the Waratah Rivulet	Iron (Fe) Manganese (Mn) Aluminium (Al) [Field filtered]	Level 1	Data analysis indicates no water quality parameter exceeds the adjusted baseline mean plus two standard deviations.	Dissolved iron, aluminium and manganese were at Level 1 throughout the reporting period.	No	No
		Site ETWQ AU on the Eastern Tributary	Iron (Fe) Manganese (Mn) Aluminium (Al) [Field filtered]	Level 1	Data analysis indicates no water quality parameter exceeds the adjusted baseline mean plus two standard deviations.	Dissolved aluminium was at Level 1 throughout the reporting period. Dissolved iron was at Level 1 from January to May and October to December 2019.	No	No
				Level 2	Data analysis indicates any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for one month.	Dissolved iron was at Level 2 in June 2019.	No	No
				Level 3	Data analysis indicates: • any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for two consecutive months; or • over a three month period the water quality parameter exceeds the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month; or • the six month mean exceeds the adjusted baseline mean plus one standard deviation for two consecutive assessment periods (i.e. over two six monthly reports); and • there was not a similar exceedance of the trigger at the control site.	Dissolved iron was at Level 3 in July, August and September 2019. Dissolved manganese was at Level 3 throughout the reporting period.	Yes	No Assessments conducted by Associate Professor Barry Noller (Appendix F3)
No Connective Cracking Between the Surface and the Mine and Negligible Leakage from Woronora Reservoir								
No connective cracking between the surface and the mine	*Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally*	Underground	Inspections of development workings for water accumulation	Level 1	Normal water flow identified from the goaf, geological structure, or the strata generally.	-	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)								
No Connective Cracking Between the Surface and the Mine and Negligible Leakage from Woronora Reservoir (Continued)								
No connective cracking between the surface and the mine	*The 20-day average mine water make does not exceed 1 ML/day*	Underground	• Metered water reticulated into the mine (mine inflow) • Metered water reticulated out of the mine (mine outflow) • Moisture content into and out of the mine through the mine ventilation system (mine inflow and outflow) • *In-situ* moisture content of the coal (mine inflow) • Moisture content of ROM coal conveyed out of the mine at the drift portal (mine outflow)	Level 1	20-day average mine water make is less than or equal to 0.5 ML/day.	-	No	No
	Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore 9GGW2B does not occur.	Bore 9GGW2B	Groundwater pressures/levels	Level 2	9GGW2B Head Profile is consistent with the shape of, and does not lie significantly to the left of the predicted High Inflow Model Curve.	-	No	No
	Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore F6GW3A does not occur	Bore F6GW3A	Groundwater pressures/levels	Level 2	F6GW3A Head Profile is consistent with the shape of, and does not lie significantly to the left of the predicted High Inflow Model Curve.	-	No	No
No connective cracking between the surface and the mine **Negligible leakage from the Woronora Reservoir**	*The hydraulic gradient to the Woronora Reservoir at full supply level from Bore F6GW4A is reduced by no more than 20% from that measured to 30 June 2017*[XXX]*.*	Bore F6GW4A (90.0 m)	Groundwater pressures/levels	Level 3	F6GW4A < 193.71 m AHD.	The hydraulic gradient first dropped below 193.71 m AHD in February 2019.	Yes	No Assessment conducted by SLR in May 2019 (Appendix G3). Bore F6GW4A was removed from TARP in the Metropolitan Coal Longwall 304 Water Management Plan.
	The hydraulic gradient to the Woronora Reservoir at full supply level from Bore PHGW2A is reduced by no more than 20% from that measured to 30 June 2017.	Bore PHGW2A (97.5 m)	Groundwater pressures/levels	Level 1	PHGW2A >= 186.92 m AHD.	-	No	No
Negligible leakage from the Woronora Reservoir	*The hydraulic gradient to the Woronora Reservoir at full supply level from Bore 9GGW2B is reduced by no more than 40% from that measured to 30 June 2017.*	Bore 9GGW2B (80.3 m)	Groundwater pressures/levels	Level 2	9GGW2B < 181.38 m AHD and > 176.38 m AHD.	-	No	No
	The hydraulic gradient to the Woronora Reservoir at full supply level from Bore 9EGW2A is reduced by no more than 20% from that measured to 30 June 2017.	Bore 9EGW2A (107.5 m)	Groundwater pressures/levels	Level 3	9EGW2A < 182.83 m AHD.	The hydraulic gradient first dropped below 182.83 m AHD in March 2019.	Yes	No Assessment conducted by SLR in May 2019 (Appendix G2). Tarp for Bore 9EGW2A modified in the Metropolitan Coal Longwall 304 Water Management Plan.

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)								
No Connective Cracking Between the Surface and the Mine and Negligible Leakage from Woronora Reservoir (Continued)								
Negligible leakage from the Woronora Reservoir	*The hydraulic gradient to the Woronora Reservoir at full supply level from Bore 9EGW2A is reduced by no more than 40% from that measured to 30 June 2017.*	Bore 9EGW2A (107.5 m)	Groundwater pressures/levels	Level 2	9EGW2A < 186.32 m AHD and > 179.35 m AHD.	-	No	No
	The hydraulic gradient to the Woronora Reservoir at full supply level from Bore PM02 is reduced by no more than 40% from that measured to 30 June 2017.	Bore PM02 (100 m)	Groundwater pressures/levels	Level 1	PM02 ≥ 183.86 m AHD.	-	No	No
	The water level at bore T2 is greater than 170.0 m	Bore T2	Groundwater levels	Level 3	T2 ≤ 170.0 m AHD.	The water level at Bore T2 first dropped below 170.0 m AHD in July 2018.	Yes	No Assessment undertaken by HydroSimulations (Appendix G1). Trigger levels for bores T2 and T3 were removed in the Metropolitan Coal Longwall 304 Water Management Plan.
	The water level at bore T3 is greater than 171.8 m	Bore T3	Groundwater levels	Level 3	T3 ≤ 171.8 m AHD.	The water level at Bore T3 first dropped below 171.8 m AHD in April 2018.	Yes	
	The hydraulic gradient from transect bore T5 to bore T3 is reduced by no more than 10% from that measured on 30 June 2017	Bores T3 and T5	Groundwater levels	Level 2	T5-T3 < 17.92 m and > 16.13 m.	The hydraulic gradient from transect bore T5 to bore T3 dropped below 17.92 m in November 2020.	No	No
Negligible Reduction to the Quality of Water Resources in the Woronora Reservoir								
Negligible reduction in the water quality of Woronora Reservoir	*Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations*	Woronora Reservoir (site DW01) (subject to data availability from WaterNSW)	Total Iron (Fe) Total Manganese (Mn) Total Aluminium (Al)	Level 1	The current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is below the baseline 10 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.	Total iron, total manganese and total aluminium were at Level 1 for the period that WaterNSW data was available.	No	No
Negligible Environmental Consequences on Waratah Rivulet								
Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)	***No Diversion of Flows, No Change in the Natural Drainage Behaviour***							
	No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W	Pools P to W on Waratah Rivulet	Streambed cracking and drainage behaviour (visual observations)	Level 1	No mine-induced surface cracking or impacts to natural drainage behaviour observed.	Pools P to W were at Level 1 throughout the reporting period.	No	No
	Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum	Pools P, T, U, V and W on Waratah Rivulet	Pool water level	Level 1	The water level in Pools P, T, U, V or W has not been below the pool's previous minimum.	Pools P, V and W were at Level 1 throughout the reporting period. Pool U was at Level 1 from January to July and in October 2019.	No	No
				Level 2	The water level in Pools P, T, U, V or W has been below the pool's previous minimum, however, is considered to be due to an error type.	Pool U was at Level 2 in November and December 2019, as the same was occurring in control pool WRP1 in November and December 2019 and control pools WRP 2, WRP 3 and WRP 4 in December 2019.	No	No
				Level 3	The water level in Pools P, T, U, V or W has been below the pool's previous minimum and does not appear to be due to an error type; and the same is not occurring in control pool(s).	Pool U was at Level 3 in August and September 2019.	Yes	No Assessment undertaken by HEC (Appendix E).
	Analysis of water level data for Pools Q, R and S indicates the water levels are above that required to maintain water over the downstream rock bar	Pools Q, R and S on the Waratah Rivulet	Pool water level	Level 1	The water level in Pools Q, R or S has been above that required to maintain water over the downstream rock bar.	Pools Q, R and S were at Level 1 throughout the reporting period.	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)								
Negligible Environmental Consequences on Waratah Rivulet								
Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)	***Minimal Iron Staining***							
	Visual inspection of the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir does not show significant changes in the extent or nature of iron staining that isn't also occurring in the Woronora River (control site)	Waratah Rivulet, from Pool P to the full supply level of the Woronora Reservoir	Nature and extent of iron staining	Level 1	The extent or nature of iron staining in the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir has not changed.	-	No	No
	Minimal Gas Releases							
	Gas releases in Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir have not increased beyond those observed up to the commencement of Longwall 301 extraction	Waratah Rivulet, from Pool P to the full supply level of the Woronora Reservoir	Free Carbon Dioxide as CO_2 (mg/L) Methane (mg/L)	Level 1	Free carbon dioxide concentrations are equal to or less than 4 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir. Methane concentrations are equal to or less than 0.159 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir.	Pool P was at Level 1 in April, May, June, July, October, November and December 2019. Pool S was at Level 1 in January, February and April to December 2019. Pool U was at Level 1 in January, February, March, April, May, August, November and December 2019. Pool W was at Level 1 throughout the reporting period.	No	No
				Level 2	Free carbon dioxide concentrations are above 4 mg/L and equal to or less than 13 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir. Methane concentrations are above 0.159 mg/L and equal to or less than 0.478 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir.	Pool P was at Level 2 in January and March 2019 (free carbon dioxide concentrations) and in February 2019 (free carbon dioxide and methane concentrations). Pool S was at Level 2 in March 2019 (free carbon dioxide concentrations). Pool U was at Level 2 in June 2019 (free carbon dioxide concentrations).	No	No
				Level 3	Free carbon dioxide concentrations are above 13 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir. Methane concentrations are above 0.478 mg/L in Waratah Rivulet pools from Pool P to the full supply level of the Woronora Reservoir.	Pool P was at Level 3 in August and September 2019 (free carbon dioxide concentrations). Pool U was at Level 3 in July, September and October 2019 (free carbon dioxide concentrations).	Yes	No Assessments conducted by Professor Barry Noller (Appendices F1 and F2)

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)								
Negligible Environmental Consequences on Eastern Tributary								
Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26[2, 3]	***No Diversion of Flows, No Change in the Natural Drainage Behaviour***							
	No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU	Pools/rock bars ETAS, ETAT and ETAU on the Eastern Tributary.	Stream cracking and drainage behaviour (visual observations)	Level 1	No mine-induced surface cracking at Pool ETAS or Pool ETAT; no increase in previous cracking at Pool ETAU. No impacts to natural drainage behaviour observed.	-	No	No
	Analysis of water level data for Pool ETAS/ETAT and Pool ETAU indicates the water levels are above that required to maintain water over the downstream rock bar	Pool ETAS/ETAT and ETAU on the Eastern Tributary.	Pool water level	Level 1	The water levels in Pool ETAS/ETAT and Pool ETAU have been above that required to maintain water over the downstream rock bar	-	No	No
	Minimal Iron Staining							
	N/A	Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	Nature and extent of iron staining	On 14 October 2016, Metropolitan Coal reported the exceedance of the Eastern Tributary performance measure in relation to iron staining to the DP&E and other relevant agencies. Iron staining/flocculent is present at a number of stream features between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir. Metropolitan Coal to monitor the nature and extent of iron staining on the Eastern Tributary during the mining of Longwalls 301-303. Metropolitan Coal to implement contingency measures (stream remediation measures) in accordance with the Project Approval.		-	N/A	Yes
	Minimal Gas Releases							
	Gas releases in Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26 have not increased beyond those observed up to the commencement of Longwall 301 extraction	Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	Free Carbon Dioxide as CO_2 (mg/L) Methane (mg/L)	Level 1	Free carbon dioxide concentrations are equal to or less than 4 mg/L in Eastern Tributary pools between the full supply level of the Woronora Reservoir and the maingate of Longwall 26. Methane concentrations are equal to or less than 0.159 mg/L in Eastern Tributary pools between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.	Pools ETAG, ETAH, ETAI, ETAL and ETAM were at Level 1 throughout the reporting period.	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT								
Upland Swamp Vegetation Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The vegetation in upland swamps is not expected to experience changes significantly different to vegetation in control swamps*	Swamps 16, 17, 18, 20, 24 and 25 overlying or adjacent to Longwalls 20-22 Swamps 19, 28, 30, 31, 32, 33, 34, 35, 36 and 94 overlying or adjacent to Longwalls 23-27 Swamps 38, 40, 41, 46[4], 47, 48, 49, 50, 51/52[4], 53 and 58 overlying or adjacent to Longwalls 301-303 and Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp	Visual inspections Transect/ quadrat data Population monitoring of indicator species	Level 1	Data analysis indicates: • there is not a declining trend in the condition of longwall swamp vegetation; and • there are no significant changes in vegetation between the mined and control swamps.	Swamps 16, 17, 18, 24, 25, 31, 32, 33, 34, 35, 36, 38, 46, 47, 48, 49, 50, 51/52 and 58.	No	No
				Level 2	Data analysis indicates: • there is a declining trend in the condition of longwall swamp vegetation over time, however a similar trend is occurring in control swamp vegetation; or • there are significant differences in vegetation between the mined and control swamps, however, the data indicates longwall swamp vegetation is consistent with the baseline monitoring results.	**Swamp 20** Continued observation of Gleichenia spp. dieback across Swamp 20, however a similar trend has been observed in control swamp Woronora River 1 and Woronora River south arm, although signs of recovery (regrowth) were observed. Continue close monitoring of trends in vegetation to assess the contribution of dry climatic conditions versus mine subsidence impacts. **Swamps 19, 30 and 94** Vegetation monitoring indicates a declining trend in the condition of longwall Swamps 19, 30 and 94 in autumn 2019, particularly with regards to senescing shrubs and declining species richness (Swamps 30 and 94 only) and condition ratings (Swamps 19, 30 and 94) . A similar trend, however, is occurring in control swamp vegetation. Continue close monitoring of trends in vegetation to assess the contribution of dry climatic condition versus mine subsidence impacts. **Swamps, 40, 41 and 53** Vegetation monitoring indicates a declining trend in the condition of longwall swamp vegetation in autumn 2019 in Swamp 40, however a similar trend is occurring in control swamp vegetation. Vegetation monitoring indicates a significant difference in vegetation condition and cover/abundance data, between longwall (Swamps 40, 41 and 53) and control swamps in spring 2018, however swamp vegetation is consistent with the baseline monitoring results. Continue close monitoring of trends in vegetation to assess the contribution of dry climatic conditions versus mine subsidence impacts.	No	No
				Level 3	Data analysis indicates: • there is a declining trend in the condition of longwall swamp vegetation over time that is not occurring in control swamp vegetation; or • there are significant differences in vegetation between the mined and control swamps, and the data indicates longwall swamp vegetation is not consistent with the baseline monitoring results.	**Swamp 28** Vegetation monitoring indicates a continuing decline in the vegetation condition of Swamp 28 in autumn 2019, particularly with regards to condition of understorey species, loss of species richness and mortality of indicator species. Continue close monitoring of trends in vegetation to assess the contribution of dry climatic conditions versus mine subsidence impacts.	Yes	No Assessment undertaken by Ecoplanning and Cenwest Environmental Services (Appendices I1 and I3)

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT (Continued)								
Upland Swamp Groundwater Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to control swamps or seasonal variations in water levels experienced by upland swamps prior to mining*[5]	Swamp 25 overlying Longwalls 20-22 Swamps 30, 33 and 35 overlying Longwalls 23-27 Swamps 40, 41, 46, 51, 52 and 53 overlying Longwalls 301-303 Control Swamps 101, 137a, 137b and Bee Creek Swamp.	Swamp substrate groundwater levels	Level 1	Data analysis for Longwalls 20-27 swamps indicates: • the seven day moving average for Swamps 25, 30 and 33 is within the 5th percentile established for the swamp's full length of record; and • the seven day moving average for Swamp 35 is within two standard deviations below the mean established for the swamp's full length of record. Data analysis for Longwalls 301-303 swamps indicates: • the seven day moving average for Swamps 40, 41, 46, 51, 52 and 53 is at or above the minimum established for the swamp's full length of record.	Swamps 41 and 53.	No	No
				Level 2	Data analysis for Longwalls 20-27 swamps indicates: • the seven day moving average for Swamps 25, 30 and 33 is below the 5th percentile established for the swamp's full length of record; • the seven day moving average for Swamp 35 lie outside two standard deviations below the mean established for the swamp's full length of record; and • semi-quantitative comparisons with control swamps and rainfall record indicates that dry swamp conditions are natural. Data analysis for Longwalls 301-303 swamps indicates: • the seven day moving average for Swamps 40, 41, 46, 51, 52 and 53 is below the minimum established for the swamp's full length of record; and • semi-quantitative comparisons with control swamps and rainfall record indicates that dry swamp conditions are natural.	Swamps 25, 30, 33, 35,40, 46, 51 and 52.	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT (Continued)								
Riparian Vegetation Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at Metropolitan Coal*	Locations adjacent to riparian vegetation monitoring sites (MRIP01 to MRIP12) and areas traversed whilst accessing the monitoring sites: • sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 overlying Longwalls 20-22; • sites MRIP11 and MRIP12 overlying Longwalls 23-27; • sites MRIP03, MRIP04 and MRIP10 downstream of Longwall 23A; and sites MRIP07 and MRIP08 downstream of Longwalls 23-27 and within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwalls 301-303	The extent of vegetation subject to vegetation dieback	Level 1	No dieback of riparian vegetation greater than 50 cm from the stream as a result of mine subsidence.	Sites MRIP01, MRIP03, MRIP04, MRIP06, MRIP07, MRIP08, MRIP10 and MRIP11.	No	No
				Level 2	Vegetation monitoring: • does not identify an increase in the extent of vegetation dieback compared to that observed at site MRIP02 on the Waratah Rivulet and between sites MRIP05 and MRIP09 on the Eastern Tributary; and • does not identify vegetation dieback greater than 50 cm from the stream at sites MRIP01, MRIP03, MRIP04, MRIP06, MRIP07, MRIP08, MRIP10, MRIP11 or MRIP12, as a result of mine subsidence.	Sites MRIP02, MRIP05, MRIP09 and MRIP12.	No	No
Monitoring of Aquatic Biota, Stream Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The aquatic macroinvertebrate and macrophyte assemblages in streams are not expected to experience long-term impacts as a result of mine subsidence*[6]	Two sampling sites (approximately 100 m in length) at the following locations: • Location WT3 on Waratah Rivulet, Locations ET1, ET3 and ET4 on the Eastern Tributary overlying Longwalls 20-27. • Locations WT4 and WT5 on the Waratah Rivulet, downstream of Longwalls 20-27. • Location ET2 on the Eastern Tributary, downstream of Longwalls 20-27 and within the Longwalls 301-303 35° angle of draw and/or predicted 20 mm subsidence contour. • Control Locations: WR1 on Woronora River; and OC on O'Hares Creek.	Aquatic macroinvertebrates Aquatic macrophytes	Level 1	Data analysis indicates no significant changes in relation to control places pre-mining compared to post-extraction: - occur in the aquatic macroinvertebrate and macrophyte assemblages in Waratah Rivulet or the Eastern Tributary at Locations WT3, ET1, ET3 or ET4, located within the LW20-22 and LW23-27 mining areas during the mining of LW301-303; or - occur in the aquatic macroinvertebrate and macrophyte assemblages in the Eastern Tributary at Location ET2 during the mining of LW301-303.	Longwalls 20-22 monitoring program autumn 2019 results: - Locations WT3 (all parameters excluding those noted in Level 2 below), WT4 and WT5. - Locations ET1, ET2 (all parameters excluding those noted in Level 2 below) and ET3. Longwalls 23-27 monitoring program autumn 2019 results: - Locations ET1 (all parameters excluding those noted in Level 2 below), ET2 and ET4 (all parameters excluding those noted in Level 2 below).	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT (Continued)								
Monitoring of Aquatic Biota, Stream Monitoring (Continued)								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The aquatic macroinvertebrate and macrophyte assemblages in streams are not expected to experience long-term impacts as a result of mine subsidence*[6]	Two sampling sites (approximately 100 m in length) at the following locations: • Location WT3 on Waratah Rivulet, Locations ET1, ET3 and ET4 on the Eastern Tributary overlying Longwalls 20-27. • Locations WT4 and WT5 on the Waratah Rivulet, downstream of Longwalls 20-27. • Location ET2 on the Eastern Tributary, downstream of Longwalls 20-27 and within the Longwalls 301-303 35° angle of draw and/or predicted 20 mm subsidence contour. • Control Locations: WR1 on Woronora River; and OC on O'Hares Creek.	Aquatic macroinvertebrates Aquatic macrophytes	Level 2	Data analysis indicates significant (not long-term), changes in relation to control places pre-mining compared to post-extraction: - occur in the aquatic macroinvertebrate and macrophyte assemblages in Waratah Rivulet or the Eastern Tributary at Locations WT3, ET1, ET3 or ET4, located within the LW20-22 and LW23-27 mining areas during the mining of LW301-303; or - occur in the aquatic macroinvertebrate and macrophyte assemblages in the Eastern Tributary at Location ET2 within the LW301-303 mining area after the completion of Longwall 306.	Longwalls 20-22 monitoring program autumn 2019 results: - Location WT3 (change in diversity of macroinvertebrates in spring 2016, autumn 2018, spring 2018 and autumn 2019). - Location ET2 (change in Atyidae in spring 2015 but not subsequently; altered macrophyte assemblage[7] in spring 2014 but not subsequently). Longwalls 23-27 monitoring program autumn 2019 results: - Location ET1 (significant change in assemblage of macroinvertebrates recorded in spring 2016 and autumn 2019; altered macrophyte assemblage within the after-period however, changes prior to spring 2017 do not appear to be related to mining). - Location ET2 (significant change in assemblage of macroinvertebrates in autumn 2019 and abundance of macroinvertebrates in spring 2018 and autumn 2019; altered macrophyte assemblage within the after-period however, changes prior to spring 2017 do not appear to be related to mining). - Location ET4 (altered patterns of diversity of macroinvertebrates since spring 2018; decreased numbers of Atyidae in autumn 2016, spring 2018 and autumn 2019; altered macrophyte assemblage within the after-period in spring 2018 and autumn 2019).	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT (Continued)								
Monitoring of Aquatic Biota, Stream Monitoring (Continued)								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The aquatic macroinvertebrate and macrophyte assemblages in streams are not expected to experience long-term impacts as a result of mine subsidence*[6]	Two sampling sites (approximately 100 m in length) at the following locations: • Location WT3 on Waratah Rivulet, Locations ET1, ET3 and ET4 on the Eastern Tributary overlying Longwalls 20-27. • Locations WT4 and WT5 on the Waratah Rivulet, downstream of Longwalls 20-27. • Location ET2 on the Eastern Tributary, downstream of Longwalls 20-27 and within the Longwalls 301-303 35° angle of draw and/or predicted 20 mm subsidence contour. Control Locations: WR1 on Woronora River; and OC on O'Hares Creek.	Aquatic macroinvertebrates Aquatic macrophytes	Level 3	Data analysis indicates significant long-term changes[6] in relation to control places pre-mining compared to post-extraction: - occur in the aquatic macroinvertebrate and macrophyte assemblages in Waratah Rivulet or the Eastern Tributary at Locations WT3, ET1, ET3 or ET4, located within the LW20-22 and LW23-27 mining areas during the mining of LW301-303; or - occur in the aquatic macroinvertebrate and macrophyte assemblages in the Eastern Tributary at Location ET2 within the LW301-303 mining area after the completion of Longwall 306.	Longwalls 23-27 monitoring program autumn 2019 results: - Location ET1 (increased variability in numbers of Leptophlebiidae since autumn 2015).	Yes	No Assessment undertaken by Ecoplanning and Cenwest Environmental Services (Appendices I2 and I3)
Monitoring of Aquatic Biota, Pool Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The aquatic macroinvertebrate and macrophyte assemblages in pools are not expected to experience long-term impacts as a result of mine subsidence*	Larger pools J, M1 and N on Waratah Rivulet and ETAH on the Eastern Tributary, overlying Longwalls 20-27. Smaller pools K, L and M on Waratah Rivulet and ETAG, ETAK and ETAI on the Eastern Tributary, overlying Longwalls 20-27. One larger control pool on Woronora River (Pool WP) and one larger control pool on O'Hares Creek (Pool OC). Three smaller control pools on Woronora River (Pools WP-A, WP-B and WP-C) and three smaller control pools on O'Hares Creek (Pools OC-A, OC-B and OC-C).	Aquatic macroinvertebrates Aquatic macrophytes	Level 1	Data analysis indicates no significant changes or significant (not long term) changes in relation to control places pre-mining compared to post-extraction: - occur in the aquatic macroinvertebrate and macrophyte assemblages at pools J, K, L, M1, M or N; or - occur in the aquatic macroinvertebrate and macrophyte assemblages at pools ETAG, ETAH, ETAI or ETAK.	Larger pools autumn 2019 results: - Pool J (change in diversity of macroinvertebrates from autumn 2015 to autumn 2017). Smaller pools autumn 2018 results: - Pools K, L and M on Waratah Rivulet (all parameters). - Pools ETAG, ETAK and ETAI on the Eastern Tributary (all parameters excluding those noted in Level 2 below).	No	No
				Level 3	Data analysis indicates significant long-term changes in relation to control places pre-mining compared to post-extraction: - occur in the aquatic macroinvertebrate and macrophyte assemblages in pools J, K, L, M1, M or N after one year of the completion of stream remediation on Waratah Rivulet; or - occur in the aquatic macroinvertebrate and macrophyte assemblages in pools ETAG, ETAH, ETAI or ETAK after one year of the completion of stream remediation on the Eastern Tributary.	Larger pools: - Pool M1 (change in diversity of macroinvertebrates from autumn 2015 to spring 2018 but not autumn 2019; decrease in cover of macrophytes since autumn 2016); - Pool N (change in diversity of macrophytes since autumn 2016); and - Pool ETAH on Eastern Tributary. Smaller pools: - Pools K, L and M (change in diversity of macroinvertebrates since autumn 2015) on Waratah Rivulet; and - Pools ETAG, ETAK and ETAI on the Eastern Tributary.	Yes[7]	No Assessment undertaken by Ecoplanning and Cenwest Environmental Services (Appendices I2 and I3)

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Comments	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
Amphibian Monitoring								
Negligible impact on Threatened Species, Populations, or Ecological Communities	*The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites*	Test sites 1 to 6 overlying Longwalls 20-22 Test sites 13 to 17 overlying Longwalls 23-27 Test sites 23 to 28 overlying Longwalls 301-303 Control sites 7 to 12 and 18 to 22.	Amphibian species diversity and relative abundance	Level 1	Data analysis does not identify a significant change in the amphibian population.	Spring/summer 2018 survey results: – Sites 1 to 6, sites 13 to 17, and sites 23 to 28.	No	No
LAND MANAGEMENT								
Cliffs and Overhangs, Steep Slopes and Land in General								
Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining-induced rock fall	-	Cliff sites COH1, COH2, COH3, COH4, COH5, COH6, COH6A, COH7, COH8, COH9, COH10, COH14, COH15, COH16 and COH17	Cliff instabilities	- Visual inspections of the cliffs and overhangs were conducted monthly when mining of Longwalls 20-22 and/or Longwalls 23-27 were within 400 m of sites and following the completion of each longwall to record evidence of subsidence impacts. - Visual inspections of the cliffs and overhangs following the completion of Longwall 27 did not identify any additional subsidence impacts to those recorded during the mining of Longwalls 20-27.		-	-	No
	Steep slopes and land in general experience sandstone fracturing/cracking and rock falls that do not require management measures to be implemented	Steep slopes and land in general within 600 m of Longwalls 20-27 and Longwalls 301-303	Sandstone fracturing/cracking and rock falls	Level 1	No subsidence impacts (i.e. sandstone fracturing/ cracking and rock falls) recorded on steep slopes or land in general: • not previously recorded within 600 m of Longwalls 20-27; or • recorded within 600 m of Longwalls 301-303.	-	No	-
HERITAGE MANAGEMENT								
Aboriginal Heritage Sites Monitoring								
Less than 10% of Aboriginal heritage sites within the mining area are affected by subsidence impacts	*Less than 7% of Aboriginal heritage sites within the mining area are affected by subsidence impacts*	Monitoring of the Longwalls 20-22 and Longwalls 23-27 Aboriginal heritage sites at which Longwalls 23-27 Round 5 monitoring indicates continued change due to mining induced subsidence, namely sites MET 1, FRC 28, FRC 29, FRC 34, FRC 60 and FRC 176 Monitoring of Aboriginal heritage sites FRC 76 (sandstone overhang with art only) and FRC 117 (sandstone overhang with art and PAD)	Cracking of sandstone at open sites Cracking and/or exfoliation of sandstone, blockfall, displacement, breakage and/or collapse of sandstone overhang sites Damage or deterioration of art motifs	Level 1	Monitoring results indicate sites FRC 281 and FRC 34 have been affected by subsidence impacts.	Currently at Level 1 significance level. Survey of Aboriginal heritage sites will be conducted within three months of the completion of Longwall 304.	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BUILT FEATURES MANAGEMENT – GARRAWARRA CENTRE COMPLEX							
Negligible damage (that is fine or hairline cracks that do not require repair), unless the owner of the item and the appropriate heritage authority agree otherwise in writing **Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing**	• *No greater tilt impact to buildings than Category A or B (i.e. mining induced ground tilt of less than 7 mm/m) for items of historical or heritage significance (i.e. either 'high' or 'exceptional' in the Conservation Plan for the Garrawarra Centre for Aged Care [Howard Tanner & Associates, 1993])* • *No greater strain impact to buildings than Category 0 or 1 (i.e. crack width of less than 1 mm) for items of historical or heritage significance (i.e. either 'high' or 'exceptional' in the Conservation Plan for the Garrawarra Centre for Aged Care [Howard Tanner & Associates, 1993])* • *No more than repairable (minor) defects (cracks, etc.) in the structural integrity for all other buildings, houses, structures and other services (including telecommunications towers and compounds, powerlines, pipelines and associated connections) due to mining* • *The electrical clearance from vegetation is maintained* • *Serviceability of the private roads and access roads/tracks has been maintained* • *The land in general is expected to experience minor cracking consistent with that observed during the extraction of previous longwalls at Metropolitan Coal (i.e. no more than minor cracking)*	Garrawarra Centre Complex Buildings/Structures (Excluding Services)	Subsidence effects parameters, fine or hair line cracks, cracking at pre-existing rock joints, columns, opening and closing of joints, or tilting of piers, water tank leaks and structural integrity	Level 1	Expected subsidence conditions	No	No
		Garrawarra Centre Complex Services	Subsidence effects parameters, ground tension cracks and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – ENDEAVOUR ENERGY							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *The structural integrity of the 132 kV transmission lines and towers is maintained* • *The structural integrity of the timber poles and high voltage powerlines is maintained* • *The electrical clearance from vegetation is maintained* • *The serviceability of the access roads/tracks is maintained*	132 kV Towers	Subsidence effects parameters, differential movements, ground deformations, observable surface cracking, and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – TRANSGRID							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *The structural integrity of the transmission line and towers is maintained* • *The electrical clearance from vegetation is maintained* • *The serviceability of the access roads/tracks is maintained*	330 kV Towers	Subsidence effects parameters, differential movements, ground deformations, observable surface cracking, and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – VOCUS							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *Negligible transmission loss in fibre optic cables from mine subsidence impacts* • *The structural integrity of the cable line and associated joint housing pit is maintained* • *The serviceability of the access roads/tracks is maintained*	Optical Fibre Cable – Major Interstate Trunk Cable: SM1 *Waterfall to Corrimal Section*	Subsidence effects parameters, OTDR (OTDR) signal loss, and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – OPTUS							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *Negligible transmission loss from mine subsidence impacts* • *The structural integrity of the cable lines and associated facilities is maintained* • *The serviceability of the access roads/tracks is maintained*	Optical Fibre Cable – Trunk: IOF SYD-MEL 2 *(Coastal Inter Office Fibre two sections known as WAT-WOL 2 and WAT-WOL 3)*	Subsidence effects parameters, OTDR signal loss, and faults	Level 1	Expected subsidence conditions	No	No
		Optical Fibre Cable – Cable: 36S SMOF *(In leased Telstra Conduit and Manholes/pits. Cable manufacturer: MM Olex. Heavy polyethylene sheath, manufactured prior to 1993 and installation completed 1993)*	Subsidence effects parameters, OTDR signal loss, and faults	Level 3	Subsidence 15% greater than predicted. No signal degradation in the Optus optical fibre cable has been reported.	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BUILT FEATURES MANAGEMENT – TELSTRA							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *Negligible transmission loss in fibre optic cables from mine subsidence impacts* • *The structural integrity of the cable line and associated facilities is maintained* • *The structural integrity of the telecommunications tower and compound is maintained* • *The serviceability of the access roads/tracks is maintained*	Trunk Cable F KNST 2005 ENGA-HBGH 80f Sydney-Melbourne No.3 Optical Fibre Cable (*Labelled as Cable 1)*	Subsidence effects parameters, OTDR signal loss, and faults	Level 1	Expected subsidence conditions	No	No
		Customer Access Network (CAN) Cables: F ENGA 3001 6f Engadine-Garrawarra-Mobile Phone Tower optical fibre cable / F ENGA 3005 12f Engadine-Garrawarra-RIM and Garrawarra Hospital customer cable *(Labelled as Cable 2)*	Subsidence effects parameters, OTDR signal loss, and faults	Level 2	Subsidence along the 300 XL Line	No	No
		Customer Access Network (CAN) Copper Cables	Subsidence effects parameters, anomalous service condition, complaints and faults	Level 2	Subsidence along the 300 XL Line	No	No
		Telecommunications Tower (and Compound)	Subsidence effects parameters and faults	Level 2	Subsidence along the 300 XL Line	No	No
BUILT FEATURES MANAGEMENT – RMS							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	*<u>Bridge Distortion and Cracking</u>* • *absolute 3D horizontal movement of survey lines (M1 Northbound Line and Transmission Line) of 50 mm or more at key points on the ground near the bridge;* • *relative movement of 5 mm or more between any two points monitored by the conventional survey system;* • *relative movement of 2 mm or more between any two points monitored by the FBG sensor system; and* • *crack in concrete elements exceeding 0.2 mm width* *<u>M1 Princes Motorway Pavement Deformation</u>* • *a measured compressive ground strain of greater than 0.5 mm/m;* • *pavement cracking;* • *deterioration in ride quality; and* • *defects in minor structures such as kerbs and gutters, pits, etc.* *<u>Cuttings and Faults</u>* • *a measured ground strain of greater than 0.5 mm/m;* • *rock falls;* • *cracking or visual deterioration at the rock face; and* • *visual displacement at joints* *<u>Culverts</u>* • *visual displacement at joints;* • *cracks in culverts; and* • *ponding*	Bridge 2 (Old Princes Highway Underpass)	Subsidence effects parameters, absolute horizontal movements, incremental relative movement, structural cracks, observable subsidence ground deformations, and faults	Level 1	Expected subsidence conditions	No	No
		Cawley Road Overpass	Subsidence effects parameters, absolute horizontal movements, incremental relative movement, structural cracks, observable subsidence ground deformations, and faults	Level 1	Expected subsidence conditions	No	No
		Pavements	Subsidence effects parameters, absolute horizontal movements, observable subsidence ground deformations, pavement cracking, deterioration in ride quality, defects in structure, and faults	Level 1	Expected subsidence conditions	No	No
		Cuttings	Subsidence effects parameters, absolute horizontal movements, observable subsidence ground deformation, rock fall, cracking or visual deterioration at the rock face, visual displacement at joints, and faults	Level 1	Expected subsidence conditions	No	No
		Culverts	Subsidence effects parameters, absolute horizontal movements, observable subsidence ground deformations, cracking in culverts, visual displacement at joints, ponding, and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – WOLLONGONG CITY COUNCIL OLD PRINCES HIGHWAY							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *No pavement cracking exceeding 5 mm, or other defects of the road pavement resulting in deterioration of ride quality* • *No ponding of water on the road surface as a result of changes in grade from subsidence associated with Longwalls 301-303* • *No joint displacement or cracking or other defects of the drainage structure (e.g. pipes/culverts) in excess of 5 mm* • *Serviceability of guard rails, marker posts and signage is maintained*	Pavements, Drainage Structures and Furniture	Subsidence effects parameters, observable subsidence ground deformations including ponding, pavement cracking, joint displacement or cracking/defects of drainage structures, defects in minor structures, and faults	Level 2	Tilt greater than 3.5 mm Expected subsidence conditions	No	No

Table 9 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Highest Significance Level/Trigger Recorded		Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
BUILT FEATURES MANAGEMENT – WOLLONGONG CITY COUNCIL GENERAL [GARRAWARRA] CEMETERY							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *No defects to the structural integrity of headstones or fencing (beyond the baseline [pre-mining] conditions)* • *The land in general is expected to experience minor cracking consistent with that observed during the extraction of previous longwalls at Metropolitan Coal (i.e. no more than minor cracking)*	Waterfall General [Garrawarra] Cemetery	Subsidence effects parameters, observable impacts to fencing, surface cracking and buckling, and damage to grave sites and/or monuments	Level 2	Elevated subsidence recorded	No	No
BUILT FEATURES MANAGEMENT – SYDNEY WATER							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *No more than repairable (minor) leakages of the water pipelines occur due to mining* • *No more than repairable (minor) defects (cracks, etc.) in the structural integrity of the pipes and associated connections occur due to mining*	Pipelines	Subsidence effects parameters, observable subsidence ground deformations or surface cracks, cracks or leaks, loss of flow/pressure, and faults	Level 2	Elevated subsidence recorded	No	No
BUILT FEATURES MANAGEMENT – SYDNEY TRAINS							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *No defects or deformation of the Illawarra Railway Line due to mining* • *The structural integrity of the telecommunications tower (and compound) is maintained*	Illawarra Railway Line	Subsidence effects parameters, absolute horizontal movements, observable subsidence ground deformations, defects or deformation, and faults	Level 1	Expected subsidence conditions	No	No
		Telecommunications Tower (and Compound)	Subsidence effects parameters, anomalous service condition, and faults	Level 1	Expected subsidence conditions	No	No
BUILT FEATURES MANAGEMENT – AXICOM							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	• *Structural integrity of the telecommunications towers and compounds has been maintained* • *Serviceability of the access roads/tracks has been maintained*	Telecommunications Towers (and Compounds)	Subsidence effects parameters, differential horizontal movement, and faults	Level 1	Expected subsidence conditions	No	No
PUBLIC SAFETY MANAGEMENT							
Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing	*Public safety will be ensured in the event that any hazard to the general public arising from subsidence effects becomes evident.*	Cliffs and overhangs, steep slopes and land in general Built features	Public safety	Level 1	Expected subsidence conditions	No	No

1 The streamflow records for GS 2132102 provided by WaterNSW were incomplete for the reporting period and, as such, assessment of the results for the review period, 1 July to 31 December 2019, against the Longwall 304 Water Management Plan significance levels/triggers was unable to be conducted at the time of reporting. Assessment against the performance indicator for the review period, 1 July to 31 December 2019, will be undertaken in the next review period.

2 The no diversion of flows, no change in natural drainage behaviour component of this performance measure was exceeded during the mining of Longwalls 23-27, triggering contingency measures for the impacted pools. This TARP monitors pools not impacted during the mining of Longwalls 23-27.

3 The minimal iron staining component of this performance measure was exceeded during the mining of Longwalls 23-27, triggering contingency measures for the impacted pools. The nature and extent of iron staining on the Eastern Tributary will continue to be monitored during the mining of Longwalls 301-304.

4 Subsequent to the autumn 2017 baseline survey and prior to the spring 2017 survey, Swamp 46 and Swamp 51/52 were subject to WaterNSW hazard reduction burns.

5 This performance indicator has been exceeded at Swamp 20 since 2012 and at Swamp 28 since 2016. Swamp water levels at Swamp 20 and Swamp 28 will continue to be analysed on a six monthly basis and assessments against the performance measure will be conducted annually.

6 This performance indicator has been exceeded at Location B1 since the autumn 2016 survey and at Location B2 since the spring 2016 survey and assessments have been made against the performance measure. Aquatic macroinvertebrate (if sufficient aquatic habitat is available for sampling) and macrophyte sampling at these locations will be conducted every three years after spring 2018, in autumn and spring (i.e. next surveys to be conducted in autumn 2021 and spring 2021) consistent with the revised monitoring schedule for Location B1 for previous Longwalls 18-19A. Given the distance from Longwalls 301-304, Tributary B will not experience any measurable subsidence or valley related movements resulting from the extraction of Longwalls 301-304.

7 The performance indicator *The aquatic macroinvertebrate and macrophyte assemblages in pools are not expected to experience long-term impacts as a result of mine subsidence* has not been exceeded at Pools ETAG, ETAH, ETAI and ETAK. In accordance with the Longwalls 301-303 Biodiversity Management Plan, assessment against the performance indicator at these pools will be undertaken after one year of the completion of stream remediation on the Eastern Tributary.

7 ENVIRONMENTAL PEFORMANCE – SURFACE FACILITIES AREA

This section provides a summary of the key environmental monitoring results for noise, air quality, traffic and waste at the surface facilities area, an assessment of environmental performance and a description of the management measures implemented during the review period.

The environmental performance of surface facilities water management is described in Section 8.

Each section indicates which management plan contains details of the surface facilities management and monitoring. The Metropolitan Coal management plans are available on the Peabody website (http://www.peabodyenergy.com).

7.1 NOISE MANAGEMENT

The Metropolitan Coal Noise Management Plan has been prepared for the surface facilities area in accordance with Condition 8, Schedule 4 of the Project Approval.

Real-time Noise Monitoring

Real-time noise monitoring for the Project is undertaken using an unattended statistical noise logger located at the northern boundary of 16 Oxley Place (Figure 18). Real-time noise monitoring is used as an internal noise management tool and not for compliance purposes.

The real-time noise monitor records noise levels 24 hours a day, 7 days a week, and a graphical summary of the previous 24 hours of noise is sent to mine staff via email on a daily basis.

A real-time noise performance indicator, *The $L_{Aeq(5\ minute)}$ night-time noise level does not exceed 50 dB(A) for six consecutive 5 minute samples*, has been developed in consideration of façade reflection and as an alert to the potential exceedance of the noise acquisition criteria.

Real-time noise monitoring includes an audio function which allows the monitor to record audio of the noise signal and an 'alarm' function whereby noise data is processed and compared against the real-time noise performance indicator. The audio of these events can then be reviewed to see if the cause is Project related, allowing Metropolitan Coal to investigate the causes and potential controls for high Project related noise events.

The real-time noise performance indicator is considered to be exceeded if the $L_{Aeq(5\ minute)}$ night-time noise level exceeds 50 A-weighted decibels (dB[A]) for six consecutive 5 minute samples.

The real-time noise performance indicator was triggered 53 times during the review period, compared to 125 times in 2018 and 178 times in 2017. Reviews conducted following these triggers typically indicated that the source was overflying aircraft, birds, bats, insects, vehicles on Parkes Street, dogs barking, thunder, wind and/or rain.

Attended Noise Monitoring

Consistent with the Metropolitan Coal Noise Management Plan, attended noise monitoring for the Project has consisted of quarterly monitoring at 16 Oxley Place, 53 Parkes Street, 50 Parkes Street and 36 Old Station Road (sites representative of the nearest residences to the Project [Figure 18]) to quantify the intrusive noise emissions from the mine, including coal processing and transportation operations that contribute to the overall level of ambient noise.

Noise monitoring is conducted for 15 minute periods during the daytime, evening and night-time over two consecutive days and nights and compared to applicable Noise Impact Assessment Criteria, Noise Mitigation Criteria and Noise Acquisition Criteria (refer Section 7.5 and Appendix L).

The attended quarterly noise monitoring and compliance results for the review period are available in the quarterly monitoring reports prepared by SLR Consulting Pty Ltd (Appendix L). A comparison of the quarterly attended monitoring results at each location for the period September 2010 to December 2019 is provided in Figures 19a to 19d.

In summary, during 2019, attended monitoring indicated exceedances of the noise criteria detailed in Conditions 1, 2 and 3, Schedule 4 of Project Approval (08_0149) as follows:

- Daytime (L_{Aeq}):
  - Monitoring at 16 Oxley Place (in Quarters 1 and 2) measured noise levels of 55 dBA and 54 dBA, respectively, which were non-compliant with the daytime Noise Impact Assessment Criterion (50 dBA) and exceeded the daytime Noise Mitigation Assessment Criterion (53 dBA).
- Evening (L_{Aeq}):
  - No exceedances of the evening Noise Impact Assessment Criterion (45 dBA), Noise Mitigation Criterion (48 dBA) or Noise Acquisition Criterion (50 dBA) were recorded.
- Night-time (L_{Aeq}):
  - No exceedances of the night-time Noise Impact Assessment Criterion (45 dBA), Noise Mitigation Criterion (48 dBA) or Noise Acquisition Criterion (50 dBA) were recorded.
- Night-time (L_{A1}):
  - Monitoring at 16 Oxley Place in Quarters 1, 2, 3 and 4 measured noise levels of 56 dBA, 53 dBA, 55 dBA and 54 dBA, respectively, which were non-compliant (Quarters 1 and 2) and conditionally[27] non-compliant (Quarters 3 and 4) with the night-time L_{A1} Noise Impact Assessment Criterion (50 dBA).
  - Monitoring at 50 Parkes Street in Quarter 3 measured a noise level of 57 dBA, which was non-compliant with the night-time L_{A1} Noise Impact Assessment Criterion (50 dBA).
  - Monitoring at 36 Old Station Road in Quarters 1 and 3 measured noise levels of 60 dBA and 58 dBA, respectively, which were conditionally[27] non-compliant and non-compliant, respectively, with the night-time L_{A1} Noise Impact Assessment Criterion (50 dBA).

Identification of Sustained Non-compliances – Attended Noise Monitoring

A sustained non-compliance has been defined as two consecutive quarters of non-compliant noise monitoring results at the same representative attended noise monitoring location, coinciding with normal mine operations.

Sustained non-compliances with respect to the daytime intrusive (L_{Aeq}) Noise Impact Assessment Criteria (Table 2, Condition 1, Schedule 4 of the Project Approval) have been identified during 2019 at 16 Oxley Place. The sustained non-compliances at 16 Oxley Place occurred in Quarters 1 and 2 (Appendix L).

[27] A conditional non-compliance with Condition 1 or Condition 3, Schedule 4 of the Project Approval. Stability Class F or absence of Stability Class corresponds to an estimated Environmental Lapse Rate (ELR) ranging from 1.5°C/100m to 4.0°C/100m. PA 08_0149 limits temperature inversions up to 3.0°C/100m. In the absence of direct measurement of the ELR, it cannot be certain if the actual temperature inversion was less than 3.0°C/100m for this period. Accordingly, where the Mine Noise Level is measured to be above the Impact Criteria, a conditional non-compliance has been nominated since the relevance of the recorded noise level for the survey period for compliance purposes is not certain.

A sustained non-compliance with respect to the night-time maximum (L_{A1}) Noise Impact Assessment Criteria (Table 2, Condition 1, Schedule 4 of the Project Approval) was also identified during 2019 at 16 Oxley Place (in Quarters 1, 2, 3 and 4) (Appendix L).

Further details are provided in Section 7.5.

Identification of Non-compliances – Noise Modelling

Metropolitan Coal, in consultation with its noise specialist (SLR Consulting), has continued to review and evaluate appropriate contingency measures and conduct further technical evaluation of the implementation of these measures during 2019.

This has included ongoing noise modelling of predicted noise levels at nearby residences in order to determine the remaining reasonable and feasible noise mitigation measures that could be implemented in consultation with the DPIE.

The noise modelling predicted non-compliances with the Noise Impact Assessment Criteria at seven residences in Oxley Place during the day-time, evening and night-time. Exceedances of the Noise Mitigation Criteria were also predicted at the seven residences in Oxley Place during the day-time, evening and night-time. The modelling also predicted compliance with the Noise Acquisition Criteria at all residences (Appendix M).

Further details are provided in Section 7.5.

It should be noted that all of the residences modelled to be experiencing exceedances of the Noise Mitigation Criteria have previously been offered noise mitigation measures on a voluntary basis by Metropolitan Coal (in the form of double glazing). Of the nine residences predicted to exceed the Noise Mitigation Criteria, only two did not accept the previous offer by Metropolitan Coal (Appendix M). In 2018, one of the two remaining residences accepted an offer of noise mitigation.

Reporting and Notification of Noise Exceedances

In August 2019 and March 2020 (i.e. following conclusive identification of sustained non-compliances and review of associated noise modelling), Metropolitan Coal notified a number of nearby residents that the most recent noise modelling continues to predict are experiencing noise levels exceeding the Noise Impact Assessment Criteria contained in the Project Approval. Residences predicted to experience non-compliances or conditional compliances based on the most recent noise modelling were notified. The notifications also advised the residents of the current process underway to re-assess noise impacts (Section 14).

Noise Management

Operational noise levels from the Metropolitan Coal Mine were materially higher prior to the approval of the Metropolitan Coal Project in June 2009.

A range of operational noise control measures have been implemented since that time, in association with extensive upgrades of existing infrastructure at the surface facilities area, including the upgrade of the CHPP. Extensive noise reduction works have been implemented progressively and noise monitoring and modelling has been used to identify areas where additional reasonable and feasible noise attenuation measures could be implemented. The Metropolitan Coal 2010 to 2018 Annual Reviews describe the noise mitigation measures implemented prior to 2019.

The extensive and long running noise control program has reduced noise emissions at nearby residences. However, Metropolitan Coal has found the number of remaining, reasonable and feasible noise controls is diminishing.

During 2017, in consultation with the DP&E, Metropolitan Coal prepared a technical review of remaining available feasible noise mitigation measures and an associated evaluation of the reasonableness of these options (the Noise Mitigation Assessment) (SLR Consulting, 2017). This assessment was independently peer reviewed by Hatch. The reasonable and feasible contingency mitigation measures identified by Metropolitan Coal included:

- Ensuring all crusher and washer doors are closed at all times (except when being accessed).
- Progressively replacing the idlers on all surface conveyors with low noise idlers.

Following DP&E's review of the Noise Mitigation Assessment, Metropolitan Coal signed a Voluntary Undertaking which formalised the implementation of the mitigation measures identified by the 2017 Noise Mitigation Assessment. This included a timeframe for implementation of the identified mitigation measures (i.e. all existing conveyor idlers were replaced with low noise idlers by 31 December 2018), subsequent remodelling of noise levels and consultation with residents with predicted residual noise exceedances above the noise mitigation criteria who had not previously accepted noise mitigation was undertaken in 2019.

In accordance with the Voluntary Undertaking, Metropolitan Coal completed an assessment in 2018 of Metropolitan's noise levels under the Noise Policy for Industry (released in 2017) and provided to DP&E in April 2018.

Metropolitan Coal will continue to implement noise monitoring, management and modelling in accordance with the Metropolitan Coal Noise Management Plan.

It is noted that Metropolitan Coal did not receive any requests for at-receiver noise mitigation in accordance with Condition 3, Schedule 4 of Project Approval (08_0149) in 2019. Metropolitan Coal has previously offered double glazing noise mitigation voluntarily to a number of the nearest private residences.

Operational Noise Complaints

During the review period, three complaints pertained to temporary nuisance noises onsite. In each case an investigation was carried out and actions implemented to eliminate or reduce the noise source, with these actions communicated to the resident. A complaint was also received regarding loading of trains in the early morning. The resident was advised of the site's ongoing efforts to minimise train loading during this period, with a relatively small number of trains loaded at this time compared to daytime loading.

7.2 AIR QUALITY AND GREENHOUSE GASES MANAGEMENT

The Metropolitan Coal Air Quality and Greenhouse Gas Management Plan has been prepared for the surface facilities area in accordance with Condition 13, Schedule 4 of the Project Approval.

Environmental Resource Management (ERM) has reviewed the environmental performance of the Project in relation to air quality for the review period. The report prepared in support of this Metropolitan Coal 2019 Annual Review is provided in Appendix N.

Dust Deposition

Metropolitan Coal monitors monthly dust deposition rates at ten dust gauges (DG1 to DG10, Figure 20), consistent with EPL No. 767 and the Metropolitan Coal Air Quality and Greenhouse Gas Management Plan.

Sampling during the review period was conducted at all monitoring points at the frequencies described in Conditions M2.1 and M2.2 of EPL No. 767. During 2019, all of the potential 120 samples (10 sites over 12 months) were deployed during the period and therefore represents 100% data availability.

The results of the dust deposition monitoring are assessed against air quality performance indicators and air quality impact assessment criteria. The results of the assessment are provided in Section 7.5 and key aspects are summarised below.

The performance indicator for annual average deposited dust of 3 grams per square metre per month (g/m^2/month) was met at DG1 to DG2 and DG4 to DG10 during the reporting period. However, DG3 is exceeding the performance indicator (Chart 91). The laboratory analysis documentation was reviewed for DG3 to determine any further reasons for the high dust deposition rates. The visual analysis of dusts for July show that 60% of the dust comprised of vegetation, 20% each of polysaccharide slime and dirt and the remainder classified as coal and insects. For August, 35% of the total deposited dust contained dirt, 30% vegetation, 20% polysaccharide, 15% coal and the remainder insects. The annual average dust deposition rate at all dust gauges did not exceed 4 g/m^2/month. Compliance was thus achieved with the annual average performance criterion for dust deposition during the reporting period (Chart 91).

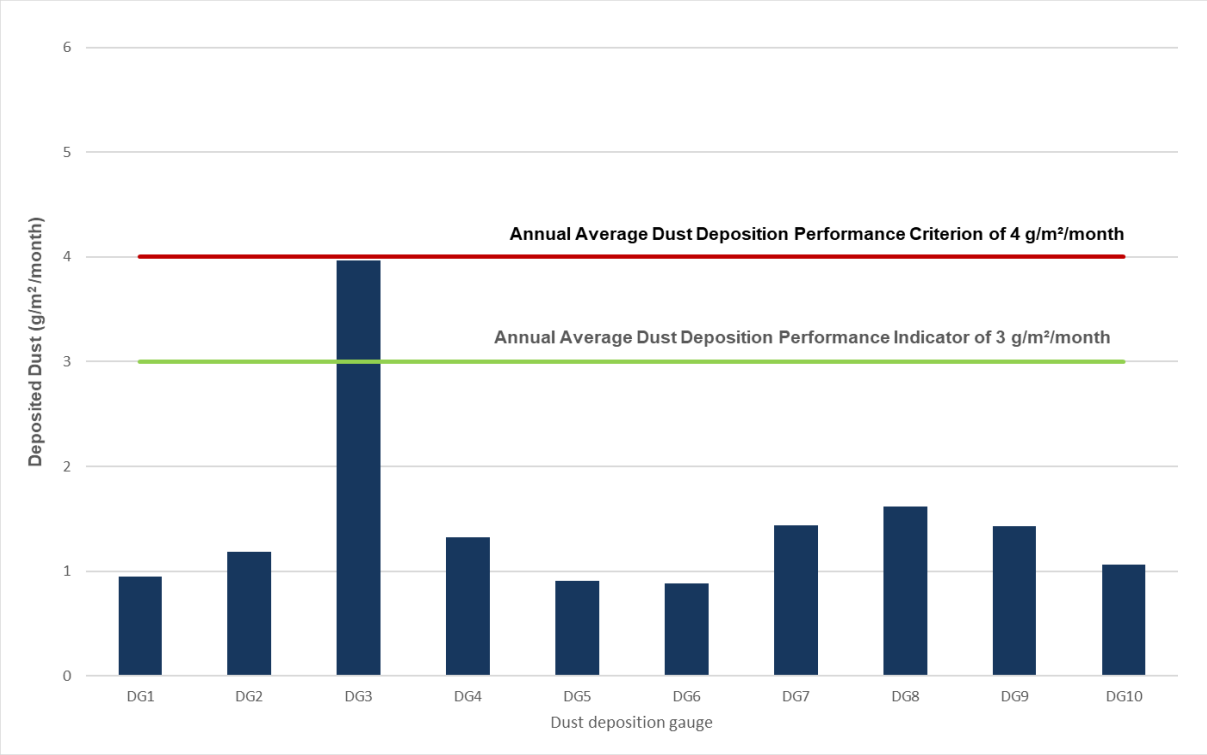


Chart 91 Annual Average Dust Deposition Rates Measured at Dust Gauges (DG1 to DG10)

Annual average dust deposition rates at each gauge from 2003 to 2019 are shown in Chart 92 and Chart 92a. From 2003 to 2019, there were no clear trends in dust deposition rates; however, relatively higher dust deposition rates were recorded at some sites in 2009 and 2015. The annual average dust deposition rate at each gauge in 2019 was within or below the range previously recorded for the dust gauges.

The Project EA (modelling for Years 3 and 15) predicted that the annual average dust deposition due to the Project plus background would not be above the applicable 4 g/m^2/month amenity criterion at any receiver (modelling for Years 3 and 15). The air quality monitoring results are consistent with the Project EA predictions in relation to dust deposition.

Chart 92 Annual Average Dust Deposition Rates at DG1 to DG10 from 2003 to 2010

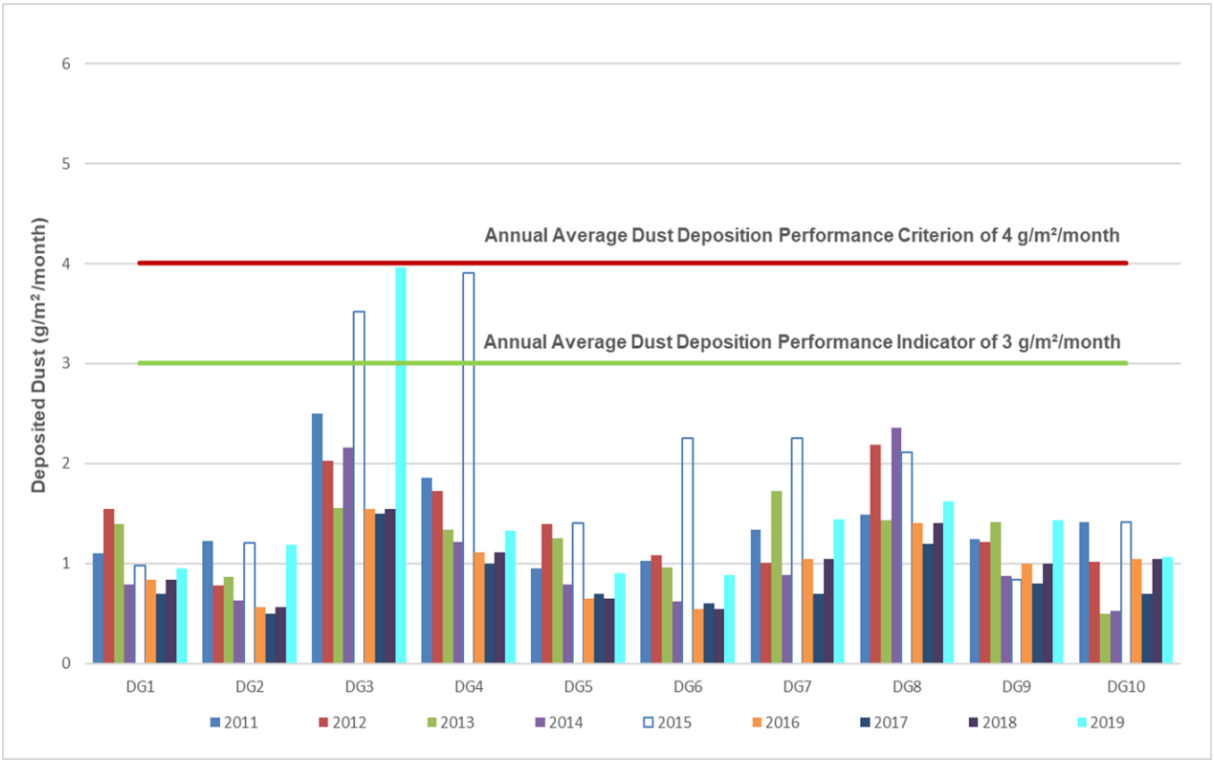


Chart 92a Annual Average Dust Deposition Rates at DG1 to DG10 from 2011 to 2019

Particulate Matter

One Tapered Element Oscillating Microbalance (TEOM) and one High Volume Air Sampler (HVAS) are located near the surface facilities area (Figure 20). The TEOM allows for continuous measurement of particulate matter less than 10 micrometres in diameter (PM_{10}) concentrations at ten-minute intervals, while the HVAS provides an average PM_{10} concentration for a specific 24-hour period, on a one-day-in-six cycle.
Sampling of PM_{10} during the review period was conducted at all monitoring points at the frequencies described in Conditions M2.1 and M2.2 of EPL No. 767. The results of the PM_{10} monitoring are assessed against air quality performance indicators and air quality impact assessment criteria. The results of the assessment are provided in Section 7.5 and key aspects are summarised below.

The annual average PM_{10} concentrations (measured by the HVAS) from 2007 to 2019 are shown on Chart 93. The annual average PM_{10} concentration measured at the HVAS for the review period was 16.4 micrograms per cubic metre (µg/m³), which is lower than the annual average PM_{10} performance indicator of 25 µg/m³ and well below the annual average PM_{10} air quality impact assessment criterion of 30 µg/m³ (Chart 93).

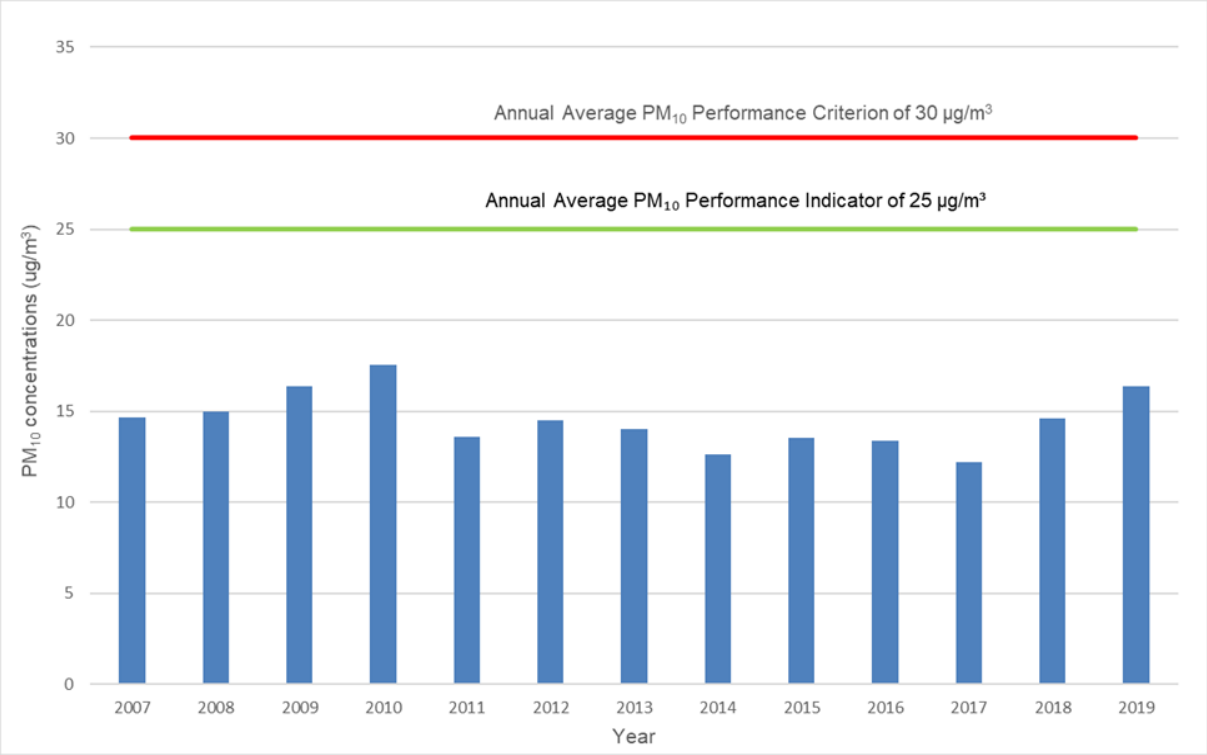


Chart 93 Annual Average PM_{10} Concentrations from 2007 to 2019 (measured by the HVAS)

There were sixteen exceedances of the PM_{10} 24-hour average performance indicator concentration (37.5 µg/m³) recorded by the TEOM during 2019 (Chart 94). Exceedances on 12 February 2019 and 7 August 2019 are documented as being related to dust storms in Eastern Australia and a hazard reduction burn at South Waterfall, respectively. Many bushfires started early in September 2019 and continued worsening until the end of the year, covering hundreds of thousands of hectares in NSW.

Exceedances of the 24-hour average performance indicator concentration on 26 October 2019, 30 October to 1 November 2019, 12 November 2019, 21 November 2019, 22 November 2019, 26 November 2019, 29 November 2019, 6 December 2019, 10 December 2019, 19 December 2019, 21 December 2019 and 31 December 2019 coincided with bushfires in NSW (Appendix N).

Chart 95 indicates that there were four exceedances of the PM_{10} 24-hour average performance indicator concentration recorded by the HVAS. An exceedance on 2 May 2019 coincided with hazard reduction burning in the region while on 22 November 2019, 28 November 2019 and 10 December 2019 were recorded during bushfire season in NSW.

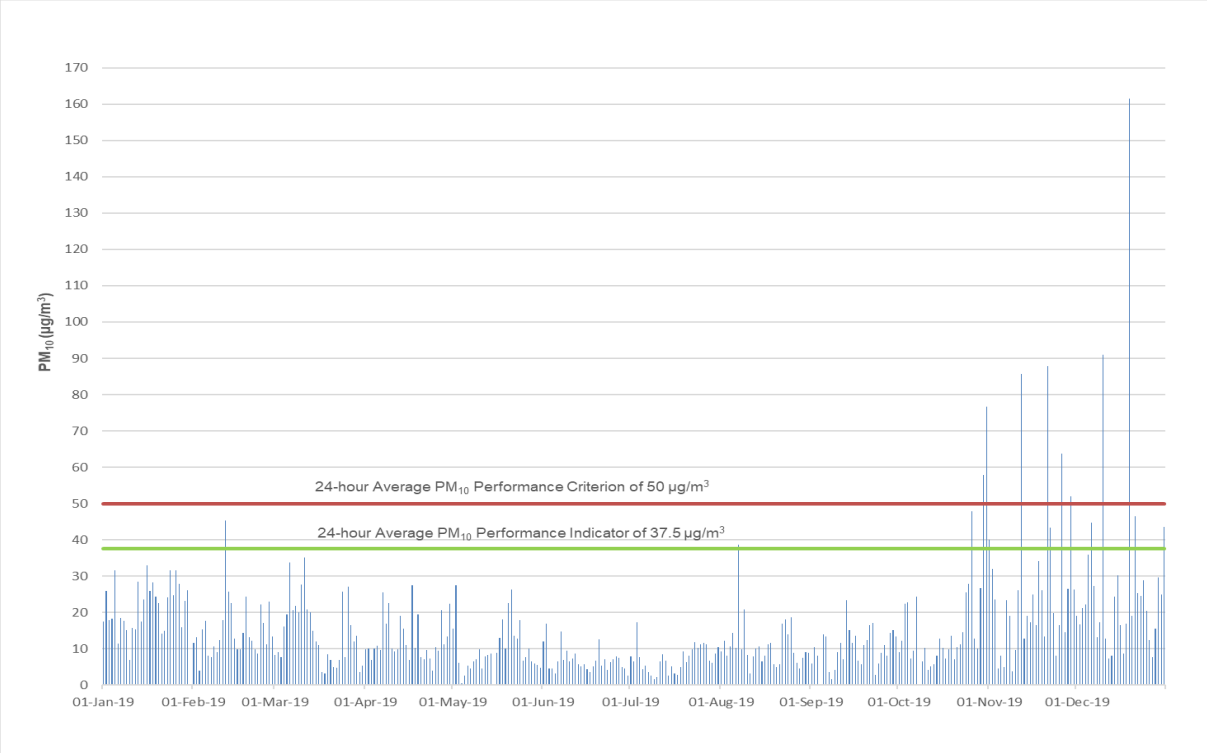


Chart 94 24-hour Average PM_{10} Concentrations (measured by the TEOM)

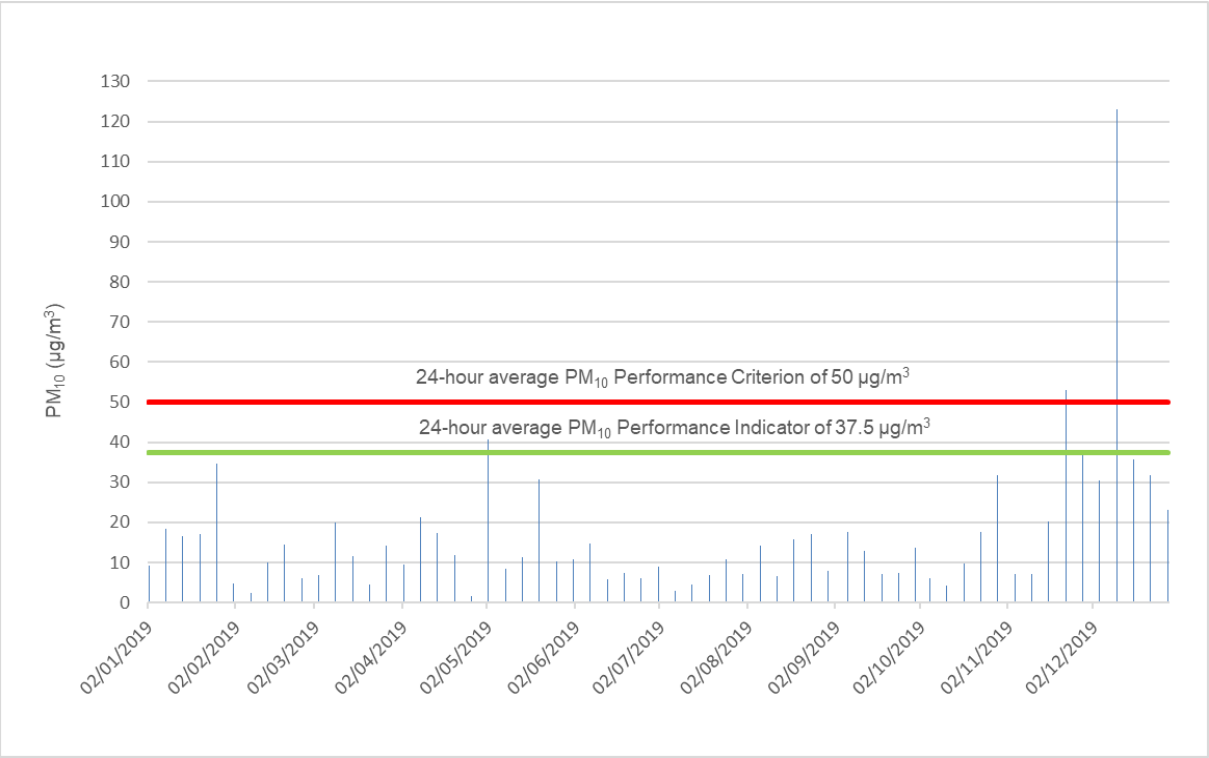


Chart 95 24-hour Average PM_{10} Concentrations (measured by the HVAS)

The highest 10-minute average PM_{10} concentration measured at the TEOM for the review period was 857.8 µg/m^3 on 19 December 2019. These values exceeded the air quality performance indicator for the 10-minute average PM_{10} concentration of 150 µg/m^3. However, these observations were noted to coincide with bushfire activity within NSW and, as a result, the exceedance of the performance indicator is not considered to be a result of the Project.

There were several exceedances throughout the year of 10-minute average PM_{10} concentration. Exceedances on 27 to 31 January 2019 and 10 March 2019 were due to TEOM maintenance outage. Exceedances on 17 April 2019, 2 May 2019 and 7 August 2019 coincide with the hazard reduction burns in the region while higher readings on 12 February 2019 were noted to be related to a dust storm affecting Eastern Australia. Similarly, exceedances on 15 November 2019, 21 November 2019, 26 November 2019, 1 to 2 December, 5 to 6 December 2019, 10 December 2019, 19 December 2019 and 21 December 2019 are anticipated to be associated with bushfire activities within the NSW. There were a number of days (15 to 18 January 2019, 22 January 2019 and 25 January 2019) when exceedances were from undocumented sources, however prevailing wind direction at the time of the exceedances, as well as coinciding elevated PM_{10} levels at the regional (Wollongong) air quality station maintained by the NSW Office of Environment & Heritage suggests a larger scale source of PM_{10}, likely as a result of drought conditions in western NSW.

The predicted annual average PM_{10} (Project plus background) concentrations modelled for Years 3 and 15 in the Project EA were not predicted to be above the 30 µg/m^3 assessment criterion at any receiver. The maximum 24-hour average PM_{10} concentrations modelled for Years 3 and 15 by the Project EA were not predicted to exceed the assessment criterion (Project only) of 50 µg/m^3 at any receiver. Residences located in close proximity to the major surface facilities area on Parkes Street were predicted to experience maximum 24-hour average PM_{10} concentrations close to the criteria (i.e. 49 µg/m^3) in Year 15 due to their close proximity to the coal stockpiles and train loading activities.

The monitoring results in 2019 are thus considered to be lower than the Project EA predictions in relation to particulate matter.

Management Measures

A number of ongoing air quality management measures are implemented at Metropolitan Coal to manage and mitigate air quality impacts, as reported in previous Annual Reviews. During the review period, Metropolitan Coal installed a train wagon profiler to evenly spread and wash loose coal off the wagon gunnels after it is loaded by front end loader. The consistent profile minimises turbulence during transport, reducing coal dust emissions from the wagons

7.3 TRAFFIC MANAGEMENT

The Metropolitan Coal Traffic Management Plan has been prepared to minimise the traffic impacts of the Project on the residential areas and schools within Helensburgh in accordance with Condition 22, Schedule 4 of the Project Approval.

Metropolitan Coal monitors the amount of product coal transported from site by road and by rail. A total of 1,310,600 t of product coal was transported from site by rail during the review period. No product coal was transported from the site by road.

Metropolitan Coal also monitors the amount of coal reject that is transported from the site each year. A total of 368,873 t of coal reject was transported from the site by road in 2019. Of this total 63,669 t was transported to the Glenlee Washery for disposal and 259,411 t was beneficially re-used as engineered fill material at the Albion Park Bypass project. An additional 45,793 t was blended with product coal which was delivered to Port Kembla Coal Terminal via rail.

In September 2010, a Road Safety Audit of the Mine Access Road and Parkes Street intersection was conducted in accordance with Condition 17(a), Schedule 4 of the Project Approval. The Road Safety Audit recommended an upgrade of the Parkes Street and Colliery Road intersection. However, Metropolitan Coal was unable to address all of the recommended intersection upgrades due to the inability to obtain a mutually acceptable outcome with the Wollongong City Council (as reported in the 2016 Annual Review). In May 2016, the DP&E (Compliance Southern Region) noted that Metropolitan Coal had made considerable effort to address the findings in the road safety report, however recommended a road safety expert be engaged to review whether the works undertaken are sufficient to address the original risk identified, or whether alternative/additional actions can be undertaken to address the risk.

In 2019 Metropolitan Coal continued to meet with the Wollongong City Council to discuss if a mutually acceptable outcome regarding the intersection upgrade could be reached, and will continue to consult with Council in 2020.

7.4 WASTE MANAGEMENT

The Metropolitan Coal Waste Management Plan has been prepared for the surface facilities area in accordance with Condition 25, Schedule 4 of the Project Approval to identify waste streams and monitor the quantities generated, identify waste management measures to minimise waste generation, and ensure that waste generated by Metropolitan Coal is appropriately stored, handled and disposed.

Waste generated by Metropolitan Coal can include tyres, oil, sewage effluent, paint, lead acid batteries, coal rejects, drift waste rock, office waste (e.g. paper, plastics, and cardboard), scrap metal, general inert waste (e.g. concrete, timber, pipe, rope and rags), underground waste (e.g. packaging, cloths and pipe), oil/fuel filters, aerosol cans, absorbents (e.g. spent oil spill material) and food waste.

Metropolitan Coal monitors waste generated on a monthly basis through waste disposal receipts provided by Metropolitan Coal's waste contractors. Figure 21(a) shows the amount of general waste disposed of in 2019 compared with previous calendar years. Approximately 419,622 kilograms (kg) of general waste was disposed of at a licensed landfill facility in 2019. Approximately 39,020 kg of diesel particulate filters from underground mine equipment, was also disposed of at a licensed landfill facility during the review period.

Waste recycled by Metropolitan Coal during the review period included waste oil (6,500 kg), scrap metal (209,980 kg) and paper and cardboard (7,205 kg). Figure 21(b-e) shows the amount of waste oil, scrap wood, scrap metal and office waste recycled in 2019, respectively, compared with previous calendar years.

Figure 21(f) and Figure 21(g) show the amount of coal reject emplaced by Metropolitan Coal in underground workings, disposed of at the Glenlee Washery and beneficially reused at Albion Park Bypass, respectively, during the 2012 to 2019 calendar years. In 2019, 61,894 t of coal reject was emplaced underground, 63,669 t of coal reject was disposed of at the Glenlee Washery and 259,411 t of coal reject were beneficially re-used as engineered fill at the Albion Park Bypass project.

The coal reject backfill emplacement project continued in 2019 emplacing 61,894 t of coal reject underground.

The Wollongong City Council is continuing works to confirm the suitability of Metropolitan Coal rejects to be beneficially re-used at the Helensburgh Landfill in consultation with the EPA.

The education program continued to be implemented during the review period to increase the awareness of mine site personnel in relation to waste management and measures to minimise the generation of waste. Metropolitan Coal will continue to seek opportunities for additional waste minimisation and for the recycling and re-use of materials at the site.

7.5 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The performance indicators, impact assessment criteria and Project Approval conditions in Table 10 assess the performance of environmental management at the surface facilities area including those related to noise, air quality, greenhouse gases, odour, traffic, waste and visual impacts for the review period and reflect the predictions included in the Project EA, Preferred Project Report and the surface facilities management plans (Noise Management Plan, Air Quality and Greenhouse Gas Management Plan, Traffic Management Plan, Surface Facilities Water Management Plan and Waste Management Plan).

Table 10
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
NOISE			
Real-time Noise Performance Indicator	*The $L_{Aeq(5\ minute)}$ night-time noise level does not exceed 50 dB(A) for six consecutive 5 minute samples.*	No	The Real Time Noise Performance Indicator was triggered 52 times during the review period. In all cases, source was determined to be non-mine related.
Noise Impact Assessment Criteria (Project Approval Table 2, Condition 1, Schedule 4)	Day $L_{Aeq(15\ minute)}$ – 50 dBA	No	A sustained non-compliance with respect to the day-time Noise Impact Assessment Criterion was identified by monitoring at 16 Oxley Place as a result of consecutive exceedances in Quarter 4 2018 and Quarters 1 and 2 2019 (Appendix L). Consistent with the monitoring results, it can be inferred from noise modelling that sustained non-compliances with respect to the day-time Noise Impact Assessment Criteria at seven residences in Oxley Place (Appendix M).
	Evening $L_{Aeq(15\ minute)}$ – 45 dBA	No	No sustained exceedances of the evening Noise Impact Assessment Criterion were identified by monitoring during the review period (Appendix L). Modelling predicts that there may have been sustained exceedances of the evening Noise Impact Assessment Criterion at five residences in Oxley Place (Appendix M).
	Night $L_{Aeq(15\ minute)}$ – 45 dBA	No	No sustained exceedances of the night Noise Impact Assessment Criterion were identified by monitoring during the review period (Appendix L). Modelling predicts that there may have been sustained exceedances of the night Noise Impact Assessment Criterion at five residences in Oxley Place (Appendix M).
	Night $L_{A1(1\ minute)}$ – 50 dBA	No	A sustained non-compliance with respect to the night-time maximum Noise Impact Assessment Criterion was identified by noise monitoring at 16 Oxley Place as a result of consecutive exceedances in Quarter 4 2018, and Quarters 1 and 2 of 2019 (Appendix L). A conditional sustained non-compliance with respect to the night-time maximum Noise Impact Assessment Criterion was identified by noise monitoring at 16 Oxley Place as a result of consecutive exceedances in Quarters 3 and 4 (Appendix M).

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
NOISE (Continued)			
Noise Mitigation Criteria (Project Approval Table 4, Condition 3, Schedule 4)	Day $L_{Aeq(15\ minute)}$ – 53 dBA	No	A sustained non-compliance with respect to the day-time Noise Mitigation Criterion was identified by monitoring at 16 Oxley Place as a result of consecutive exceedances in Quarters 1 and 2 (Appendix L). Consistent with the monitoring results, it can be inferred from noise modelling that sustained non-compliances with respect to the day-time Noise Mitigation Criteria at seven residences in Oxley Place (in Quarter 4 2018 and Quarter 1 2019) (Appendix M).
	Evening $L_{Aeq(15\ minute)}$ – 48 dBA	No	No sustained exceedances of the evening Noise Mitigation Criterion were identified by monitoring during the review period (Appendix L). Modelling predicts that there may have been sustained exceedances of the evening Noise Mitigation Criteria occurred at two private residences in Oxley Place (in Quarter 4 2018 and Quarter 1 2019) (Appendix M).
	Night $L_{Aeq(15\ minute)}$ – 48 dBA	No	
Noise Acquisition Criteria (Project Approval Table 3, Condition 2, Schedule 4)	Day $L_{Aeq(15\ minute)}$ – 55 dBA	Yes	No sustained exceedances of the evening or night-time Noise Acquisition Criterion were identified by monitoring during the review period (Appendix L). Consistent with the monitoring results, it can be inferred from noise modelling that no sustained non-compliances with respect to the day-time Noise Impact Assessment Criteria occurred during the review period (Appendix M).
	Evening $L_{Aeq(15\ minute)}$ – 50 dBA	Yes	
	Night $L_{Aeq(15\ minute)}$ – 50 dBA	Yes	
Rail Noise (Project Approval Conditions 4, 5 and 6, Schedule 4)	*4. The Proponent shall only use locomotives that are approved to operate on the NSW rail network in accordance with noise limits L6.1 to L6.4 in RailCorp's EPL (No. 12208) and ARTC's EPL (No. 3142) or a Pollution Control Approval issued under the former Pollution Control Act 1970.*	Yes	All locomotives used by Metropolitan Coal are approved for operations in accordance with the noise limits in the relevant EPL.
	5. The Proponent shall use its best endeavours to minimise night-time movements of rolling stock on the Metropolitan rail spur.	Yes	Metropolitan Coal has endeavoured to minimise night-time movements of rolling stock on the Metropolitan rail spur.
Rail Noise (Project Approval Conditions 4, 5 and 6, Schedule 4) (Continued)	*6. In the event of any rail noise or vibration issues that may arise from the haulage of coal over the life of the Project, the Proponent shall liaise with the CCC and the rail service provider to facilitate resolution of these issues and implement additional noise reduction measures where appropriate.*	Yes	No issues with rail noise or vibration were identified during the review period.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
NOISE (Continued)			
Notification of Landowners (Project Approval Condition 1, Schedule 5)	1. *If the results of the monitoring required in schedule 4 identify that impacts generated by the project are greater than the relevant impact assessment criteria in schedule 4, except where a negotiated agreement has been entered into in relation to that impact, then the Proponent shall, within 2 weeks of obtaining the monitoring results, notify the Executive Director Mineral Resources, the affected landowners and tenants (including tenants of mine owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the criteria in schedule 4.*	Yes	In August 2019 and March 2020 (i.e. following conclusive identification of the sustained non-compliances and review of associated noise modelling), Metropolitan Coal notified a number of nearby residents that the most recent noise modelling continues to predict are experiencing noise levels exceeding the Noise Impact Assessment Criteria contained in the Project Approval. The notifications also advised the residents of the current process underway to re-assess noise impacts (Section 13.2).
AIR QUALITY			
Air Quality Performance Indicators [1,2]	PM_{10} indicator = 150 µg/m^3 (10 minute averaging period assessed using TEOM data)	Yes	The maximum 10-minute average PM_{10} concentration recorded by the TEOM was 857.8 µg/m^3 on 19 December 2019. However, this concentration is considered to be a result of bushfire going across the NSW. There were several other exceedances as well. Exceedances on 27 to 31 January 2019 and 10 March 2019 were due to TEOM maintenance outage. Exceedances on 17 April, 2 May and 7 August 2019 coincide with the hazard reduction burns in the region while higher readings on 12 February 2019 were noted to be related to a dust storm affecting eastern Australia. Similarly, exceedances of the 24-hour average performance indicator concentration on 26 October 2019, 30 October to 1 November 2019, 12 November 2019, 21 November 2019, 22 November 2019, 26 November 2019, 29 November 2019, 6 December 2019, 10 December 2019, 19 December 2019, 21 December 2019 and 31 December 2019 coincided with bushfires in NSW. There were a number of days (15 to 18 January 2019, 22 January 2019 and 25 January 2019) when exceedances were from undocumented sources, however prevailing wind direction at the time of the exceedances, as well as coinciding elevated PM_{10} levels at the regional (Wollongong) air quality station maintained by the NSW Office of Environment & Heritage suggests a larger scale source of PM_{10}, likely as a result of drought conditions in western NSW.
	PM_{10} indicator = 37.5 µg/m^3 (24-hour averaging period assessed using TEOM data)	Yes	All observed exceedances of the performance indicator concentration noted to have coincided with bushfire / hazard reduction burning events as well as dust storm event and as such are not considered to be a result of the Project.
	PM_{10} indicator = 37.5 µg/m^3 (24-hour averaging period assessed using HVAS data)	Yes	All observed exceedances of the performance indicator concentration noted to have coincided with bushfire / back burning events and as such are not considered to be a result of the Project.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
AIR QUALITY (Continued)			
Air Quality Performance Indicators [1,2] (Continued)	PM10 indicator = 25 µg/m^3 (Annual averaging period assessed using HVAS data)	Yes	An annual average of PM_{10} concentration of 16.4 µg/m^3 was recorded by the HVAS.
	Maximum total deposited dust level = 3 g/m^2/month (Annual averaging period)[3]	Yes	The annual average dust deposition rates for all monitoring sites indicate that compliance with the performance indicator was achieved for DG1 to DG2 and DG4 to DG10 during the reporting period. DG3 is exceeding the performance indicator criteria, however, based on the review of laboratory analysis documentation, this exceedance was not due to the mine.
Air Quality Impact Assessment Criteria (Project Approval Condition 11, Schedule 4)	TSP Criteria[4] = 90 µg/m^3 (Annual averaging period)	Yes	Based on the annual average PM_{10} concentrations recorded by the HVAS, the annual average TSP is estimated to be less than 32.8 µg/m^3
	PM_{10} Criteria[4] = 30 µg/m^3 (Annual averaging period)	Yes	An annual average of PM_{10} concentration of 16.4 µg/m^3 was recorded by the HVAS.
	PM_{10} Criteria[4] = 50 µg/m^3 (24 hour averaging period)	Yes	Twelve exceedances of the 24-hour average PM_{10} impact assessment criterion of 50 µg/m^3 were observed using the TEOM instrument. However, all of these events are noted to be associated with bushfires in the NSW. Compliance with the 24-hour average PM_{10} impact assessment criterion was observed using the HVAS instrument during the reporting period.
	Maximum total deposited dust level = 4 g/m^2/month (Annual averaging period)	Yes	The maximum annual average dust deposition rate was below 4 g/m^2/month or less during the reporting period at all dust gauges.
ODOUR			
Odour (Project Approval Condition 9, Schedule 4)	*9. The Proponent shall not cause or permit the emission of offensive odours from the site, as defined under Section 129 of the POEO Act.*	Yes	No odour complaints were received during the review period.
GREENHOUSE GASES			
Greenhouse Gas Emissions (Project Approval Condition 10, Schedule 4)	*10. The Proponent shall implement all reasonable and feasible measures to minimise:* *(a) energy use on site; and* *(b) the scope 1, 2 and 3 greenhouse gas emissions produced on site,* *to the satisfaction of the Director-General.*	Yes	Metropolitan Coal has implemented the viable energy saving measures contained within their Energy Savings Action Plan.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
TRAFFIC			
Annual Road Maintenance Performance Indicators	*When annual road maintenance contribution negotiations are required, the negotiations should commence with the relevant councils and/or DP&I by 31 August.*	Yes	No negotiations with the Wollongong City Council, Campbelltown City Council and Wollondilly Shire Council were required during the review period.
	Annual road maintenance contributions to relevant councils are made by 30 November.	Yes	Metropolitan Coal made contributions to the Wollongong City Council, Campbelltown City Council and Wollondilly Shire Council by 30 November 2019.
Coal Transport Off-site Performance Indicators	*Coal transported off-site by road in a calendar year does not reach 150,000 tonnes prior to 31 October.*	Yes	Metropolitan Coal did not transport any product coal from the site by road in the 2019 calendar year.
Coal Transport Off-site Performance Indicators (Continued)	*Product coal truck movements to the Corrimal Cokeworks and Coalcliff Cokeworks do not exceed 22 and 27 movements respectively in any one day.*	Yes	Metropolitan Coal has ceased the transport of product coal to Corrimal Cokeworks and Coalcliff Cokeworks. No product coal was transported by road during the review period.
Limits on Approval (Project Approval Condition 6[b], Schedule 2)	• *The Proponent shall not:* *(a) ...* *(b) transport more than 2.8 million tonnes of product coal from the site in a calendar year.*	Yes	Metropolitan Coal transported a total of 1,310,600 t of product coal from site by rail in the 2019 calendar year.
Transport (Project Approval Conditions 17, 18, 19, 20 and 21, Schedule 4)	*17. By the end of 2010, the Proponent shall:* *(a) undertake a road safety audit of the Parkes Street and Colliery Road intersection, in consultation with the RTA and WCC; and* *(b) implement any recommendations of this audit,* *to the satisfaction of the Director-General[5].*	Yes, the road safety audit has been undertaken. Further actions required in relation to the audit recommendations.	The Road Safety Audit of the Mine Access Road and Parkes Street intersection was conducted in September 2010 in accordance with Condition 17(a), Schedule 4 of the Project Approval. The Road Safety Audit recommended an upgrade of the Parkes Street and Colliery Road intersection. However, Metropolitan Coal was unable to address all of the recommended intersection upgrades due to the inability to obtain a mutually acceptable outcome with the Wollongong City Council. Metropolitan Coal engaged a road safety expert to review whether the works undertaken are sufficient to address the original risk identified, or whether alternative/additional actions can be undertaken to address the risk. The review indicated that the civil works associated with the full intersection upgrade were not achievable within the Colliery Road Crown Land lease area. Metropolitan Coal met with Wollongong City Council in 2019 to continue discussions regarding Council's previous position and will continue to consult further in relation to the intersection upgrade.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
TRAFFIC (Continued)			
Transport (Project Approval Conditions 17, 18, 19, 20 and 21, Schedule 4) (Continued)	18. *From the end of 2009, the Proponent shall make a suitable annual contribution to WCC, WSC, and CC for the maintenance of local roads that are used as haulage routes by the project. If there is any dispute over the amount of the contribution, the matter must be referred to the Director-General[5] for resolution.*	Yes	Metropolitan Coal has made a suitable annual contribution to the Wollongong City Council, Campbelltown City Council and Wollondilly Shire Council.
	19. *The Proponent shall not:* *(a) load coal or coal reject onto trucks, or transport it off site by road, outside the hours of 7am and 6pm Monday to Friday;* *(b) transport more than 170,000 tonnes of coal off site by road in a calendar year;* *(c) transport any coal off site to the Port Kembla Coal Terminal by road;* *(d) permit the departure of more than 25 trucks containing product coal for delivery to the Corrimal Cokeworks on any given day; or* *(e) permit the departure of more than 30 trucks containing product coal for delivery to the Coalcliff Cokeworks on any given day.*	Yes	The loading and transport of coal product and coal reject has been undertaken in accordance with Condition 19, Schedule 4 of the Project Approval.
	20. *During emergencies (such as the disruption of rail services) the Proponent may exceed the restrictions in condition 19 above with the written approval of the Director-General[5].*	Yes	No emergencies requiring amendments to Condition 19 occurred during the review period.
	21. *The Proponent shall monitor the amount of coal and coal reject transported from the site by road and rail each year, and report the results of this monitoring on its website every six months.*	Yes	The results of coal and coal reject transport monitoring have been provided on Metropolitan Coal's website and updated every six months.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
WASTE			
Waste Generation Performance Indicator	*Waste generation has been minimised, as evidenced by:* • *an increase in the amount or type of waste recycled;* • *a decrease in the amount of waste generated that is disposed of to licensed landfill facilities; and/or* • *no practicable opportunities for additional waste minimisation have been identified to those currently being implemented.*	Yes	Metropolitan Coal has minimised waste generation during the review period. The underground emplacement project reduced the off-site disposal of coal reject by approximately 61,894 t during the review period. Beneficial reuse of coal rejects as engineered fill at residential developments in the Illawarra region reduced the disposal of coal reject by 259,410 t during the review period. Beverage container recycling bins were installed on-site in 2019. No further practicable opportunities for waste minimisation were identified.
Storage of Waste Performance Indicator	*Waste has been separated and stored according to type in appropriate storage facilities (e.g. sealed containers for liquid waste).*	Yes	Waste on-site is adequately sorted and stored according to waste type prior to collection. Weekly site inspections are conducted by the site Environment & Community Coordinator to ensure waste is separated and stored in accordance with the Metropolitan Coal Waste Management Plan.
Handling and Disposal of Waste Performance Indicator	*The transport of particular waste types has been tracked in accordance with NSW EPA waste tracking requirements.* *Metropolitan Coal's waste management contracts, where relevant, specify that the waste is to be transported by an appropriately licensed contractor and disposed of at an appropriately licensed facility.*	Yes	All transport of waste from the Metropolitan Coal site has been tracked in accordance with the NSW Office of Environment and Heritage waste tracking requirements. Metropolitan Coal's waste management contracts specify waste is to be removed by an appropriately licensed contractor and disposed of at an appropriately licensed facility.
Waste Generation (Project Approval Condition 24, Schedule 4)	*24. The Proponent shall:* *(a) minimise the waste (including coal reject) generated by the project; and* *(b) ensure that the waste generated by the project is appropriately stored, handled, and disposed of,* *to the satisfaction of the Director-General.*	Yes	Metropolitan Coal has minimised waste (including coal reject) generated during the review period. The underground emplacement project had reduced the off-site disposal of coal reject by approximately 61,894 t during the review period. Beneficial reuse of coal rejects as engineered fill at residential developments in the Illawarra region reduced the disposal of coal reject by 259,410 t during the review period. Waste on-site is adequately sorted and stored according to waste type prior to collection. Weekly site inspections are conducted by the site Environment & Community Coordinator to ensure waste is separated and stored in accordance with the Metropolitan Coal Waste Management Plan. Metropolitan Coal's waste management contracts specify waste is to be removed by an appropriately licensed contractor and disposed of at an appropriately licensed facility.

Table 10 (Continued)
Assessment of Environmental Performance – Surface Facilities Area

Monitoring Aspect	Performance Indicator, Impact Assessment Criteria and/or Project Approval Condition	Indicator, Criteria or Condition Met?	Comments
VISUAL			
Visual Impacts (Project Approval Condition 23, Schedule 4)	*23. The Proponent shall minimise the visual impacts, and particularly the off-site lighting impacts, of the surface facilities area and two ventilation shaft sites to the satisfaction of the Director-General.*	Yes	

Note: $L_{Aeq(15\ minute)}$ = intrusive equivalent noise level; $L_{A1(1\ minute)}$ = short-term noise level; dBA = A-weighted decibels; PM_{10} = Particulate matter less than 10 microns; HVAS1 = High Volume Air Sampler 1; TEOM1 = Tapered Element Oscillating Microbalance 1; $\mu g/m^3$ = micrograms per cubic metre; g/m^2/month = grams per square metre per month; TSP = total suspended particulate matter.

1 Total measured level excluding extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities.

2 Background PM_{10} concentrations due to all other sources plus the incremental increase in PM_{10} concentrations due to the mine alone.

3 Dust deposition assessment criteria are to be measured using DG1 to DG10 excluding DG4, which is a control dust gauge that is located at the Helensburgh Golf Course some 2 km from the mine's surface facilities area.

4 PM_{10} air quality impact assessment criteria are to be measured using HVAS data.

8 WATER MANAGEMENT

A Metropolitan Coal Surface Facilities Water Management Plan has been prepared for the surface facilities area and ventilation shaft site in accordance with Condition 15, Schedule 4 of the Project Approval.

This section details the water use, licensed discharge and water quality monitoring results for the surface facilities area and the management measures implemented during the review period. The environmental performance of water management in the underground mining area and surrounds is described in Section 6.2.

The surface facilities area is located in a steep-sided valley adjacent to the town of Helensburgh and next to Camp Gully (Figure 2). The site water management system comprises a series of collection dams, sumps and treatment systems. The system is operated to avoid the mixing of clean water runoff and mine water, minimise off-site release of runoff, and to provide water supply requirements on-site.

Water Use

The main uses of water on site are to supply underground mining operations and the coal washery. Metropolitan Coal draws its water from three main sources, namely, Camp Gully, the potable town water supply and water captured on-site.

Camp Gully runs adjacent to the southern edge of Metropolitan Coal's surface facilities area (Figure 22). Metropolitan Coal's extraction of water from Camp Gully is specifically regulated by the Camp Creek Weir Surface Water Certificate of Title and more generally by the *Water Act, 1912* and the *Water Management Act, 2000*.

Metropolitan Coal's annual entitlement under the Camp Gully extraction licence is 130 megalitres (ML). A concrete weir was historically constructed on Camp Gully (approximately 1930s) to facilitate the extraction of water for the mine. Metropolitan Coal did not source any water from Camp Gully during the review period or in 2018. In comparison, Metropolitan Coal sourced 39 ML of water from Camp Gully in the 2017 calendar year, 70 ML of water in the 2016 calendar year, 47 ML of water in the 2015 calendar year, 77 ML of water in the 2014 calendar year, 99 ML in the 2013 calendar year and 94 ML in the 2012 calendar year.

The use of potable water (sourced from Sydney Water) for mine purposes occurs when insufficient water is available from Camp Gully and/or on-site harvesting. Potable water is sourced from two mains, one of which supplies the bathhouses and drinking water utilities and one that supplements water supplies for mining purposes. Use of potable water is recorded and minimised in accordance with the site's commitments under the Water Savings Action Plan. Metropolitan Coal used approximately 387 ML of potable town water (as recorded by the Sydney Water meters) during 2019 (a monthly average of approximately 32.25 ML), in comparison to 365 ML in 2018, 513 ML in 2017, 386 ML in 2016, 378 ML in 2015 and 388 ML in 2014.

The use of potable water per tonne of ROM coal produced is variable and is generally higher during periods of low rainfall (Chart 96). Ongoing site auditing during the review period has not identified incidences of potable water being used where there is a viable alternative. In 2019 potable water consumption correlated well with ROM production throughout the year.

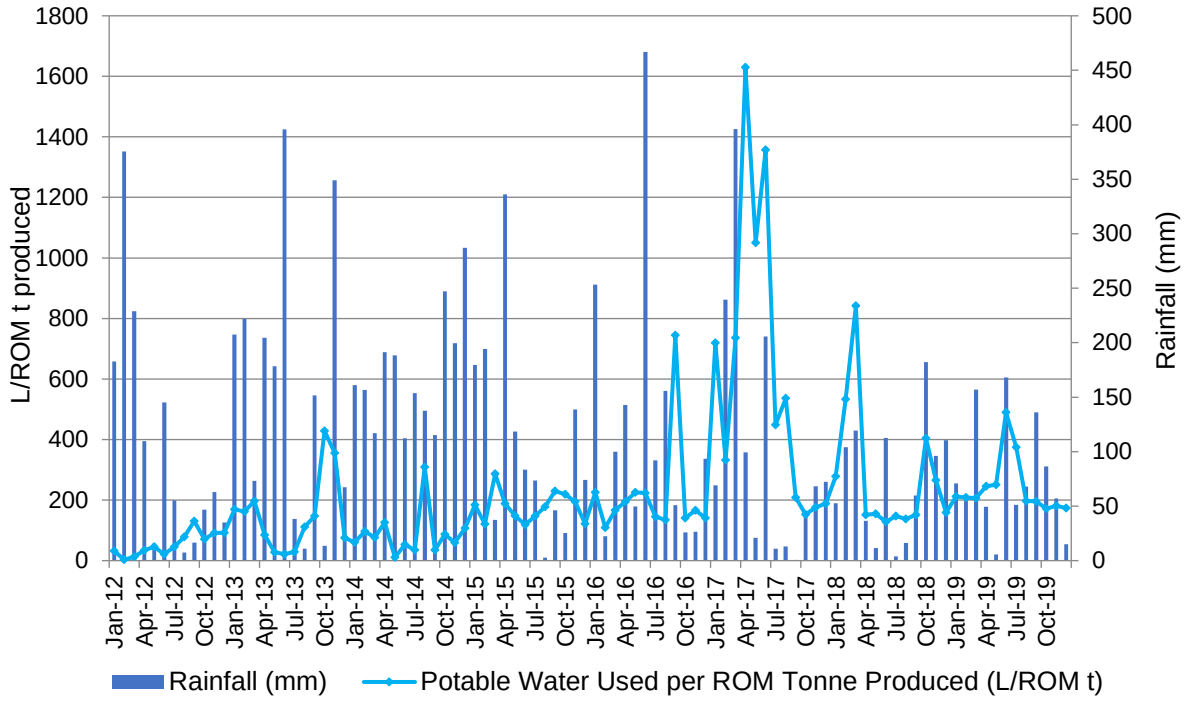


Chart 96 Potable Water Used per ROM Tonne Produced vs Rainfall

Licensed Discharge

Water discharged from the Water Treatment Plant to Camp Gully is monitored in accordance with EPL No. 767, which requires Metropolitan Coal to continuously monitor the volume (kilolitres per day) of water discharged from the clean water tank in the Water Treatment Plant to Camp Gully. The total amount of water discharged from the Water Treatment Plant to Camp Gully during the review period was approximately 55 ML, in comparison to 67 ML in 2018, 133 ML in 2017, 166 ML in 2016, 96 ML in 2015, 109 ML in 2014, 151 ML in 2013 and 98 ML in 2012.

Water Quality

Surface water quality monitoring of pH, oil and grease and total suspended solids is conducted at the Water Treatment Plant in accordance with EPL No. 767.

The water quality monitoring results indicate that pH levels (8.35 pH), oil and grease (less than 5 mg/L) and total suspended solids (12 mg/L) were within the water quality limits prescribed by EPL No. 767 (i.e. 6.5 to 8.5 pH, less than 10 mg/L for oil and grease, and less than 30 mg/L for total suspended solids) during the review period. Similarly, no exceedances of the EPL No. 767 concentration limits were recorded by Metropolitan Coal in the 2011 to 2018 calendar years.

The Project EA predicted there would be no material effect to downstream water quality as a result of water releases from the major surface facilities area to Camp Gully (which are constrained by EPL No. 767). The monitoring results are consistent with the Project EA predictions in relation to water quality.

Overall System Integrity

Surface facilities water management items (such as pipelines and pumps, bunded areas, main water storages, signs of discharge of site runoff, upslope diversions and erosion control measures) are visually inspected by Metropolitan Coal and reported in accordance with the mine's maintenance system.

During the review period, erosion and sediment controls continued to be maintained around the perimeter of the Turkey's Nest Dam (which was upgraded during the 2016 review period) while revegetation works of the Turkey's Nest outer batters have been conducted. Erosion and sediment controls will continue until the revegetation works have been completed.

The Turkey's Nest Dam and Sediment Ponds were de-silted during the review period to increase the available water capacity of the storages. De-silting of the storages will continue in the next reporting period.

Assessment of Environmental Performance

In accordance with the Metropolitan Coal Surface Facilities Water Management Plan, an assessment of the environmental performance of water management at the surface facilities area is provided in Table 11.

Table 11
Assessment of Environmental Performance – Surface Facilities Water Management

Monitoring Aspect	Performance Indicator or Project Approval Condition	Indicator or Condition Met?	Comments
SURFACE FACILITIES WATER MANAGEMENT			
Water Use Performance Indicator	*The use of potable water (i.e. megalitres of town water used per tonne of coal produced) does not increase over time, after taking into consideration climatic conditions.* *Potable water has not been used in circumstances where there is a viable alternative.*	Yes	Ongoing site auditing during the review period has not identified incidences of potable water being used where there is a viable alternative.
Erosion Control Performance Indicator	*Inspections of the major surface facilities area and ventilation shaft(s) indicate the measures implemented are effectively controlling erosion.*	Yes	Weekly inspections of the surface facilities area and ventilation shaft(s) indicate that the erosion control measures implemented during the review period have effectively controlled erosion.
Containment of Contaminants Performance Indicator	*Effective containment and/or isolation measures are in place for potential contaminants on site.*	Yes	Weekly inspections have confirmed that effective containment and isolation measures have been in place for potential contaminants on-site.
Licensed Discharge Performance Indicator	*Surface water discharges comply with the requirements of EPL No. 767.*	Yes	All water discharge criteria were met during the review period.
System Integrity Performance Indicator	*Inspections of system components indicate the integrity of the system is not at risk of being compromised.*	Yes	Daily and weekly inspections of the water management system confirmed the integrity of the system was not at risk.
Discharges (Project Approval Condition 14, Schedule 4)	*14. The Proponent shall ensure that all surface water discharges from the site comply with the discharge limits (both volume and quality) set for the project in any EPL.*	Yes	The water discharge volume and quality limits were met during the review period.

9 CONSTRUCTION MANAGEMENT

A Metropolitan Coal Construction Management Plan has been prepared for surface construction works (excluding remediation or rehabilitation works) in the Woronora Special Area in accordance with Condition 11, Schedule 3 of the Project Approval. During the review period, Metropolitan Coal commenced the review and revision of the Metropolitan Coal Construction Management Plan to be consistent with the Longwall 304 Extraction Plan.

As the requirement for surface construction works arise, Metropolitan Coal provide the specific details of the proposed surface construction works (in the form of a completed Surface Works Assessment Form) to the DPIE and WaterNSW for comment. The Surface Works Assessment Form details the specific management measures that will be implemented to minimise potential impacts associated with surface construction works, including management measures relevant to vegetation, Aboriginal heritage, erosion and sediment control, fuel and spill management, transport, waste, bushfire preparedness, pest management and site clean-up.

During the reporting period, Metropolitan Coal submitted a Construction Management Plan Surface Works Assessment Form to the DP&E for the proposed installation of piezometers on Fireroad 9G on either side of the Eastern Tributary crossing, as well as installation of a polyurethane grout curtain to restore surface water flows at Pool ETO. The piezometers and grout curtain were installed during the review period.

No other construction activities in the underground mining area were conducted during the review period.

In the next reporting period, Metropolitan Coal will install small surface water flow gauges immediately downstream of Swamps 92 and 76. Metropolitan Coal will also install additional upland swamp groundwater piezometers and soil moisture probes in select swamps over and/or proximal to Longwalls 310-313.

10 REHABILITATION

10.1 REHABILITATION SUMMARY

Metropolitan Coal has prepared a Rehabilitation Strategy for the surface facilities area in accordance with Condition 2, Schedule 6 of the Project Approval. The surface facilities area includes roads, facilities (e.g. the CHPP, administration buildings and workshops), stockpiles (coal and reject stockpiles), railroads, water storages and infrastructure. Rehabilitation of the surface facilities area is described in Section 10.2.

A Metropolitan Coal Rehabilitation Management Plan has been prepared for underground mining areas requiring rehabilitation or remediation measures, in accordance with Condition 4, Schedule 6 of the Project Approval. Rehabilitation of the underground mining area is described in Section 10.3. In addition, the Metropolitan Coal Stream Remediation Plan has been prepared specifically for stream pool/rock bar remediation activities and was approved by the DPIE on 1 November 2019. The Stream Remediation Plan superseded the pool/rock bar remediation aspects of the RMP (Section 10.3.2).

A summary of the rehabilitation status at Metropolitan Coal for the previous, current and forecast review periods is provided in Table 12.

An assessment of rehabilitation environmental performance is provided in Section 10.5.

Table 12
Rehabilitation Status

Mine Area Type	As at December 2017	As at December 2018	As at December 2019 (Forecast)
A. Total mine footprint[1]	~ 17 ha	~ 17 ha	~ 17 ha
B. Total active disturbance[2]	~ 17 ha	~ 17 ha	~ 17 ha
C. Land being prepared for rehabilitation[3]	0	0	0
D. Land under active rehabilitation[4]	0	0	0
E. Completed rehabilitation[5]	0	0	0

1 ***Total mine footprint:*** *includes all areas within a mining lease that either have at some point in time, or continue to, pose a rehabilitation liability due to mining and associated activities. As such, it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in the DRE (now DRG) MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.*

2 ***Total active disturbance:*** *includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).*

3 ***Land being prepared for rehabilitation:*** *includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE (now DRG) MOP/RMP Guidelines).*

4 ***Land under active rehabilitation:*** *includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE (now DRG) MOP/RMP Guidelines – "ecosystem and land use establishment" (area seeded OR surface developed in accordance with final land use) and "ecosystem and land use sustainability" (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).*

5 ***Completed rehabilitation:*** *requires formal sign-off by DRE (now DRG) that the area has successfully met the rehabilitation land use objectives and completion criteria.*

The total mine footprint includes the Metropolitan Coal surface facilities, the No. 3 Ventilation Shaft facilities, the temporary cable runway and electricity cable, disturbance associated with exploration boreholes and monitoring equipment installation in the underground mining area.

Two Catchment Improvement Works Projects have been conducted in accordance with Condition 5(b), Schedule 6 of the Project Approval, which requires Metropolitan Coal to carry out catchment improvement works in the Woronora catchment area. Catchment improvement works conducted in the review period are described in Section 10.4.

10.2 REHABILITATION STRATEGY – SURFACE FACILITIES AREA

The Metropolitan Coal Rehabilitation Strategy has been developed to be a concise framework document which describes the development of rehabilitation objectives and completion criteria for the preferred future landuse for the surface facilities area following the completion of mining activities. Detailed rehabilitation plans for the surface facilities area will be developed over the life of the Project and will be presented in the Mine Closure Plan and future revisions of the Rehabilitation Strategy.

As various factors will influence the landuse options available for the surface facilities area following the completion of mining activities, it is not possible for Metropolitan Coal to define a final landuse option (and associated final rehabilitation objectives and completion criteria) at this stage of the Project life. The final landuse and associated final rehabilitation objectives and completion criteria will be documented in future Metropolitan Coal MOP and the Mine Closure Plan as part of the Mining, Rehabilitation and Environmental Management Process. The Metropolitan Coal MOP has been prepared for the operating period 2012 to 2020.

Disturbance areas at the Metropolitan Coal surface facilities area are minimal and have remained relatively unchanged for many years. The surface facilities area includes roads, facilities (e.g. the CHPP, administration buildings and workshops), stockpiles (coal and reject stockpiles), railroads, water storages and infrastructure. The surface facilities area is an active operational area which will be required for the entire mine life.

Figure 23 shows the designated rehabilitation zones (1 to 7) that are currently available for rehabilitation at the surface facilities area. Rehabilitation activities undertaken during the review period included control of introduced and environmental weeds across the designated rehabilitation zones (in particular Lantana [*Lantana camara*], Ginger Lily [*Hedychium gardnerianum*], Crofton Weed [*Agerantina adenophora*] and Mistflower [*Ageratina riparia]*). Control works were also undertaken on noxious weeds identified on Camp Creek (namely Pampas Grass [*Cortaderia selloana*] and Senegal Tea Plant [*Gymnocoronis spilanthoides*]).

No buildings were renovated or removed during the review period.

10.3 REHABILITATION MANAGEMENT – UNDERGROUND MINING AREA

10.3.1 Rehabilitation of Surface Disturbance Areas

Some surface disturbance areas will be able to be rehabilitated during the life of the Project (e.g. monitoring sites no longer required), while other surface disturbance areas will likely remain until after the completion of mining operations.

No surface disturbance areas in the underground mining area were rehabilitated during the review period as the majority of disturbance pertains to the installation and ongoing maintenance of environmental monitoring sites which are a life of mine asset. These sites will be rehabilitated to appropriate standards following cessation of mining.

10.3.2 Stream Remediation Measures

Metropolitan Coal is required to achieve the rehabilitation objective specified in Table 11 of Condition 1, Schedule 6 of the Project Approval for the Waratah Rivulet and the Eastern Tributary watercourses.

Table 11: Rehabilitation Objectives

Domain	***Rehabilitation Objective***
Waratah Rivulet, between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir *Eastern Tributary, between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir*	*Restore surface flow and pool holding capacity as soon as reasonably practicable*

Metropolitan Coal is also required to achieve the subsidence impact performance measures specified in Table 1 of Condition 1, Schedule 3 of the Project Approval in relation to the Waratah Rivulet and Eastern Tributary watercourses.

Table 1: Subsidence Impact Performance Measures

Watercourses	
Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)	*Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases)*
Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	*Negligible environmental consequences over at least 70% of the stream length (that is no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases)*

Waratah Rivulet

Stream remediation is initiated at pools/rock bars on Waratah Rivulet between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir (i.e. Pools A to W) if the water level in a pool falls below its cease to overflow level (i.e. stops overflowing), except as a result of climatic conditions.

As a result of previous mining, the water levels in pools upstream of Flat Rock Crossing (i.e. Pools A to G) and immediately downstream of Flat Rock Crossing (Pool G1) have previously been impacted by mine subsidence (i.e. the pool water level has fallen below its cease to flow level). Metropolitan Coal identified that the water level in Pool N fell below its cease to flow level in early September 2012.

Stream remediation activities have been undertaken at Pools A, F and G. The rock bars at Pools A and F are considered to largely control the pools located upstream of these rock bars. As a result, Metropolitan Coal anticipated that the restoration of surface flow and pool holding capacity at Pools A, and F would restore the surface flow and pool holding capacity of pools between Flat Rock Swamp and Pool F. Metropolitan considers the pool remediation efforts to have largely been successful but continues to monitor the performance of these works.

Mining has not resulted in the diversion of flows or change to the natural drainage behaviour of pools on the Waratah Rivulet downstream of the maingate of Longwall 23 (i.e. Pools P to W).

Eastern Tributary

Monitoring conducted in accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan identified that the Eastern Tributary watercourse performance measure was exceeded in relation to *minimal iron staining* and *no diversion of flows, no change in the natural drainage behaviour of pools*. The exceedance of the Eastern Tributary watercourse performance measure (referred to as the Eastern Tributary Incident) was reported to the DP&E and other relevant agencies in October 2016.

Metropolitan Coal provided the DP&E with a proposed course of action in relation to the exceedance of the Eastern Tributary subsidence impact performance measure, focused on the implementation of stream remediation measures.

Metropolitan Coal is committed to stream remediation at the earliest opportunity. Metropolitan Coal will conduct stream remediation works in accordance with the Metropolitan Coal Stream Remediation Plan. The Metropolitan Coal Stream Remediation Plan was provided to the DP&E and relevant agencies in November 2018 and approved on 1 November 2019. The Metropolitan Coal Stream Remediation Plan outlines the process for assessing remediation success, which involves utilising a weight of evidence approach to enable a determination of whether surface flows and pool holding capacity has been restored.

During the reporting period, Metropolitan Coal conducted stream remediation on the Eastern Tributary at Pool ETO (immediately upstream of the Fire Road 9J crossing and upstream of the Longwall 26 maingate) in July to September 2019. Permeability testing has confirmed a significant reduction in hydraulic conductivity of rock bar ETO and both pool level data and visual observations have confirmed that pool holding capacity has been restored (Plate 1) and water is flowing over the rock bar for significantly longer periods post remediation.

Plate 1: Eastern Tributary Pool O (ETO), 23 September 2019

10.4 CATCHMENT IMPROVEMENT WORKS

Two Catchment Improvement Works Projects in the Woronora catchment area have been conducted in accordance with Condition 5(b), Schedule 6 of the Project Approval. The catchment improvement works include:

- the rehabilitation of a former quarry on Fire Road 9H; and
- the rehabilitation of a disused access track to the Darkes Forest Mine (a historic mine located to the south of Metropolitan Coal).

Rehabilitation activities at the former quarry on Fire Road 9H during the review period included supplementary brush matting in areas of low regeneration potential and the direct seeding of local native plant species. Weed control activities at the former quarry and along Fire Road 9H were also undertaken.

Rehabilitation activities along the disused access track to the Darkes Forest Mine during the review period included supplementary brush matting and weed control measures targeting Crofton Weed (*Ageratina adenophora*), Fleabane (*Conyza spp.*), Whiskey Grass (*Andropogon virginicus*) and introduced grass species.

Additional catchment improvement works conducted by Metropolitan Coal during the review period included the implementation of weed control measures along Fire Road 9J targeting Crofton Weed, Fleabane, Scotch Thistle (*Onopordum acanthium*) and Whiskey Grass.

10.5 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

An assessment of the environmental performance of rehabilitation management during the review period is provided in Table 13.

Table 13
Assessment of Environmental Performance – Rehabilitation

Monitoring Component		Performance Indicator, Rehabilitation Objective and/or Project Approval Condition	Indicator, Objective or Condition Met?	Comments
Other land affected by the Project Performance Indicator		*Redundant equipment/infrastructure items have been removed.* *The site is neat and tidy (i.e. it does not contain any rubbish).* *No weed management measures are required.* *No erosion or sediment control measures are required.* *Where appropriate, native vegetation is naturally regenerating or active revegetation is establishing.* *No further active revegetation measures are required.*	Not currently applicable	Not applicable during the review period as no rehabilitation of surface distribution areas in the underground mining area has been conducted. Once a surface disturbance area is no longer being utilised, Metropolitan Coal will use the Rehabilitation Management Plan – Surface Disturbance Register to monitor the performance of the measures implemented to rehabilitate surface disturbance areas.
Stream Remediation Performance Indicator		*Analysis of water level recession rates for a pool indicates a similar pool behaviour to that which existed prior to being impacted by subsidence.*	To be determined	While stream remediation activities have been conducted at Pools A, F and G on the Waratah Rivulet, assessment against the rehabilitation performance indicator has not been made to date. Assessment following the stream remediation works was delayed until a significant period of drier climatic conditions had been experienced and an updated Stream Remediation Management Plan including proposed pool remediation success assessment criteria, which was approved in November 2019.
Rehabilitation Objectives (Project Approval Table 11, Condition 1 Schedule 6)	*Surface Facilities Area*	*Set through condition 2 below.*	Yes	The rehabilitation objective for the surface facilities area is addressed in the Metropolitan Coal Rehabilitation Strategy.
	Waratah Rivulet, between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir	*Restore surface flow and pool holding capacity as soon as reasonably practicable.*	To be determined	Metropolitan Coal will assess surface flow and pool holding capacity using the results of the assessment of the stream remediation performance indicator for the completed stream remediation activities at Pools A, F and G once a significant period of drier climatic conditions has been experienced.
	Eastern Tributary, between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir		To be determined	Metropolitan will commence remediation of pools on Eastern Tributary in Q2 2020. Monitoring data will be collected throughout the program to inform assessment of the stream remediation performance indicator.
	Cliffs	*Ensure that there is no safety hazard beyond that existing prior to mining.*	Yes	No safety hazard associated with cliffs was identified during the review period.

Table 13 (Continued)
Assessment of Environmental Performance – Rehabilitation

Monitoring Component		Performance Indicator, Rehabilitation Objective and/or Project Approval Condition	Indicator, Objective or Condition Met?	Comments
Rehabilitation Objectives (Project Approval Table 11, Condition 1 Schedule 6) (Continued)	*Other land affected by the Project*	*Restore ecosystem function, including maintaining or establishing self sustaining native ecosystems:* • *comprised of local native plant species; with* • *a landform consistent with the surrounding environment.*	Not currently applicable	The Rehabilitation Management Plan – Surface Disturbance Register will be used to manage the implementation of rehabilitation measures. The performance indicator for other land affected by the Project will be used to monitor the performance of rehabilitation measures being implemented.
	Built features	*Repair/restore to pre-mining condition or equivalent.*	Yes	Assessed through the Metropolitan Coal Built Features Management Plans. No impacts to built features were recorded during the review period.
	Community	*Minimise the adverse socio-economic effects associated with mine closure including the reduction in local and regional employment.*	Not currently applicable	The socio-economic effects associated with mine closure will be addressed in the Metropolitan Coal Mine Closure Plan and will be considered in consultation with the local community (through the Community Consultative Committee [CCC]) when determining the final landuse option.
		Ensure public safety.	Yes	Assessed through the Metropolitan Coal Public Safety Management Plan for the underground mining area and in the Metropolitan Coal Rehabilitation Strategy for the surface facilities area.
Rehabilitation Strategy – Surface Facilities Area (Project Approval Condition 2, Schedule 6)		*2. By the end of October 2011, the Proponent shall prepare a Rehabilitation Strategy for the surface facilities area to the satisfaction of the Director-General. This strategy must:* *(a) be prepared by a team of suitably qualified and experienced experts whose appointment has been endorsed by the Director-General;* *(b) be prepared in consultation with relevant stakeholders, including the WCC and the CCC;* *(c) investigate options for the future use of the area upon the completion of mining;* *(d) describe and justify the proposed rehabilitation strategy for the area; and* *(e) define the rehabilitation objectives for the area, as well as the proposed completion criteria for this rehabilitation.*	Yes	-

Table 13 (Continued)
Assessment of Environmental Performance – Rehabilitation

Monitoring Component	Performance Indicator, Rehabilitation Objective and/or Project Approval Condition	Indicator, Objective or Condition Met?	Comments
Progressive Rehabilitation (Project Approval Condition 3, Schedule 6)	*3. To the extent that mining operations permit, the Proponent shall carry out rehabilitation progressively, that is, as soon as reasonably practicable following the disturbance.*	Yes	-
Rehabilitation Management Plan (Project Approval Condition 4, Schedule 6)	*4. The Proponent shall prepare and implement a Rehabilitation Management Plan for the project to the satisfaction of the Executive Director Mineral Resources. This plan must be prepared in consultation with the relevant stakeholders, and submitted to DRE for approval prior to carrying out any second workings in the mining area.* *Note: In accordance with condition 12 of schedule 2, the preparation and implementation of Rehabilitation Management Plans is likely to be staged, with each plan covering a defined area (or domain) for rehabilitation. In addition, while mining operations are being carried out, some of the proposed remediation or rehabilitation measures may be included in the detailed management plans that form part of the Extraction Plan. If this is the case, however, then the Proponent will be required to ensure that there is good cross-referencing between the various management plans.*	Yes	-
Catchment Improvement Works (Project Approval Condition 5, Schedule 6)	*5. The Proponent shall:* *(a) pay SCA $100,000 by the end of 2011 to carry out catchment improvement works within the Woronora catchment area; or* *(b) carry out catchment improvement works within this area that have an equivalent value to the satisfaction of SCA.*	Yes	Metropolitan Coal conducts catchment improvement works in the Woronora catchment area in accordance with Condition 5(b), Schedule 6 of the Project Approval (refer Section 10.4).

Table 13 (Continued)
Assessment of Environmental Performance – Rehabilitation

Monitoring Component	Performance Indicator, Rehabilitation Objective and/or Project Approval Condition	Indicator, Objective or Condition Met?	Comments
Offsets (Project Approval Condition 6, Schedule 6)	*6. If the Proponent exceeds the performance measures in Table 1 of this approval, and either* *(a) The contingency measures implemented by the Proponent have failed to remediate the impact; or* *(b) The Director-General determines that it is not reasonable or feasible to remediate the impact,* *then the Proponent shall provide a suitable offset to compensate for the impact to the satisfaction of the Director-General.* *Note: Any offsets required under this condition must be proportionate with the significance of the impact.*	To be determined	In October 2016 Metropolitan Coal identified the subsidence impact performance measure for the Eastern Tributary, between the full supply level of the Woronora Reservoir and the Longwall 26 maingate in Table 1, Condition 1, Schedule 3 of the Project Approval had been exceeded in relation to iron staining. In early 2017 the same performance measure was identified as being exceeded in relation to pool drainage behaviour (refer to Sections 6.2, 10.3 and 13.1). Metropolitan Coal proposed to conduct stream remediation measures on the Eastern Tributary in accordance with the Longwalls 23-27 Water Management Plan Contingency Plan. In 2018 Metropolitan submitted a Stream Remediation Plan to relevant stakeholders prior to commencement of any stream remediation. The plan was approved in November 2019 with remediation to commence in Q2 2020.

11 COMMUNITY

Metropolitan Coal engages with the Helensburgh community and strives to maintain positive relationships with stakeholders given the extensive history shared between the mine and township. Generations of locals have worked at the mine and it is widely accepted that the operation is an integral component of the Helensburgh community.

The majority of workers reside in the local area or within 50 km of the mine. As far as practicable, the mine seeks to employ local contractors, supply companies and services during the course of its operations.

Metropolitan Coal has also continued to provide sponsorship and/or donations to the local community during the review period. Metropolitan Coal's proactive community engagement program aims to work in partnership with the community for mutually beneficial and sustainable outcomes, and achieves this through the development of specific community programs as discussed below.

11.1 COMMUNITY ENGAGEMENT ACTIVITIES AND INITIATIVES

Community Consultative Committee

Three CCC meetings were held during the review period (17 April, 10 July and 11 December 2019). These meetings facilitated Metropolitan Coal consultation and engagement with community members on matters of general business and the environmental performance of the operation. Discussions during the review period included the Longwalls 301-303 and 304 Extraction Plans, monitoring of the Eastern Tributary, noise mitigation, CWR management and community funding.

11.2 COMMUNITY CONTRIBUTIONS

In addition to the community engagement activities and initiatives discussed above, Metropolitan Coal has made a number of significant donations to support the community of Helensburgh and the greater Illawarra region throughout 2019. All donation requests were assessed on their individual merit and funding was distributed accordingly.

In total, community donations and sponsorship during 2019 amounted to over $100,000 and included the following:

- Donation to the Era Surf Life Saving Club.
- Donation to the Helensburgh & District Citizens Tennis Club
- Donation to the Helensburgh Christmas Carols Fireworks display.
- Donation to the Helensburgh Tigers Rugby League Club.
- Donation to the Helensburgh Tigers Junior Rugby League Club.
- Donation to Helensburgh Netball Club.
- Donation to Helensburgh Thistles Soccer Club.
- Ongoing sponsorship of the Helensburgh Public School and Holy Cross Primary School environment programs.
- Donation to the Otford Public School for their Colour Run fundraiser.
- Donation to the Rotary Club of Fairy Meadow for the Razzamatazz Annual Children's Festival.
- Donation to Helensburgh Lions Club.

- Donation to the Lions Club of Woonona for their World Festival of Magic fundraiser.
- Ongoing Sponsorship of local BMX athletes.

11.3 COMMUNITY COMPLAINTS

A protocol for the management and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy. A dedicated telephone number for the provision of comments or complaints is maintained by Metropolitan Coal (1800 115 003) and is displayed on signage at an entrance to the mine. Metropolitan Coal records and responds to all complaints and maintains a complaints register on its website.

During the review period, five complaints were received in 2019. Three complaints pertained to temporary nuisance noises onsite. In each case an investigation was carried out and actions implemented to eliminate or reduce the noise source, with these actions communicated to the resident. One complaint pertained to black dust on a property neighbouring the mine. The resident was contacted to outline the extensive dust mitigation program operating onsite, as well as previous work done to characterise the proportion of offsite dust originating from the mine which is typically less than 20%. A complaint was also received regarding loading of trains in the early morning. The resident was advised of the site's ongoing efforts to minimise train loading during this period, with a relatively small number of trains loaded at this time compared to daytime loading.

A summary of community complaints received since January 2006 is provided on Figure 24. Very few complaints have been received on an annual basis since the Project was approved in June 2009, and have typically related to noise, dust and/or traffic.

12 INDEPENDENT ENVIRONMENTAL AUDIT

In accordance with Condition 8, Schedule 7 of the Project Approval, an Independent Environmental Audit of the Project is to be commissioned by the end of December 2011, and every three years thereafter, and be conducted by a team of experienced and independent experts endorsed by the Director-General (now Secretary) of the DPIE.

Metropolitan Coal commissioned the 2017 Independent Environmental Audit by 31 December 2017 and received the final report in June 2018. In accordance with Condition 9, Schedule 7 of the Project Approval, Metropolitan Coal provided a copy of the Independent Environmental Audit to the Secretary of the DP&E on 26 June 2018, with Metropolitan Coal's response to the Audit recommendations provided on 31 July 2018. All recommendations made in the 2017 Independent Environmental Audit have been closed out.

Three Independent Environmental Audits have been completed to date (as reported in previous Annual Reviews). The next Independent Environmental Audit is to be commissioned by 31 December 2020 and will be submitted to the DPIE by 30 June 2021.

13 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

13.1 EASTERN TRIBUTARY PERFORMANCE MEASURE

The Metropolitan Coal Project Approval (08_0149) requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3.

The subsidence impact performance measure for the Eastern Tributary watercourse is:

> *Negligible environmental consequences over at least 70% of the stream length (that is no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases)*

Monitoring conducted in accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan in 2016 identified that the Eastern Tributary watercourse performance measure for the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26 was exceeded in relation to *minimal iron staining* in October 2016. The exceedance was reported to the Secretary of the DP&E and other relevant agencies on 14 October 2016 in accordance with Condition 6, Schedule 7 of the Project Approval and the Metropolitan Coal Longwalls 23-27 Water Management Plan Contingency Plan.

The *no diversion of flows, no change in the natural drainage behaviour of pools* component of the Eastern Tributary subsidence impact performance measure was exceeded in January 2017 and reported to the DP&E and other relevant agencies.

Metropolitan Coal is committed to stream remediation at the earliest opportunity. Metropolitan Coal will conduct stream remediation works in accordance with the Metropolitan Coal Stream Remediation Plan. The draft Metropolitan Coal Stream Remediation Plan was provided to the DP&E and relevant agencies in November 2018 and was approved in November 2019. The Metropolitan Coal Stream Remediation Plan has been included as an addendum to the Metropolitan Coal Longwall 304 Water Management Plan. Stream remediation will commence in Q2 2020.

13.2 NOISE

Sustained Non-compliances – Attended Noise Monitoring and Modelling

Conclusive identification of the Quarter 1 and 2 sustained noise non-compliances in 2019 were determined in August 2019. The Quarter 3 and 4 sustained non-compliances were identified in March 2020.

As described in Section 7.1, during 2019 Metropolitan Coal identified sustained non-compliances at one representative noise monitoring location (16 Oxley Place) with respect to the Noise Impact Assessment Criteria (Condition 1, Schedule 4 of the Project Approval).

As part of the Noise Mitigation Strategy and as a result of the continuation of the monitored non-compliances, modelling of predicted noise levels for nearby residences was conducted and identified non-compliances with the Noise Impact Assessment Criteria at seven residences in Oxley Place during the day-time, evening and night-time. Exceedances of the Noise Mitigation Criteria were also predicted at the seven residences in Oxley Place during the day-time, evening and night-time. The modelling also predicted compliance with the Noise Acquisition Criteria at all residences (Appendix M).

It is noted that the locations modelled to be experiencing exceedances were experiencing daytime, evening and night-time operational noise levels from the Metropolitan Coal Mine prior to the approval of the Project in June 2009 that were materially higher than the levels recorded in the current review period, and a range of operational noise control measures have been implemented since Project Approval (Section 7.1).

It should also be noted that all of the residences modelled to be experiencing sustained exceedances of the Noise Mitigation Criteria have previously been offered noise mitigation measures on a voluntary basis by Metropolitan Coal (in the form of double glazing). Of the nine residences predicted to exceed the Noise Mitigation Criteria, only one has not accepted an offer of noise mitigation by Metropolitan Coal (Appendix L).

The extensive and long running noise control program at Metropolitan Coal has reduced noise emissions at nearby residences, however, the number of remaining material, reasonable and feasible noise controls is diminishing and the Noise Impact Assessment Criteria may not be achievable in the medium to long term.

In 2017, in consultation with the DP&E, Metropolitan Coal prepared a technical review of remaining available feasible noise mitigation measures and an associated evaluation of the reasonableness of these options (Noise Mitigation Strategy). This assessment was independently peer reviewed.

Following DP&E's review of the Noise Mitigation Strategy, Metropolitan Coal signed a Voluntary Undertaking which formalised the implementation of the mitigation measures identified by the Mitigation Strategy. The Voluntary Undertaking also outlined a process for re-assessing predicted noise levels and reasonable and feasible noise controls in accordance with the Noise Policy for Industry released in 2017.

During the review period, Metropolitan Coal completed an assessment of Metropolitan Coal's noise levels under the Noise Policy for Industry (released in 2017) and provided to DP&E in April 2018. Metropolitan Coal completed replacement of all conveyor idlers at the surface facilities area by 31 December 2018.

Metropolitan Coal anticipates that, during implementation of the Voluntary Undertaking, sustained non-compliances with respect to the Noise Impact Assessment Criteria and, to a lesser extent, exceedances of the Noise Mitigation Criteria, will continue to be observed. Metropolitan Coal will continue to consult with the DPIE, DRG, EPA and the local community and implement all identified reasonable and feasible mitigation options.

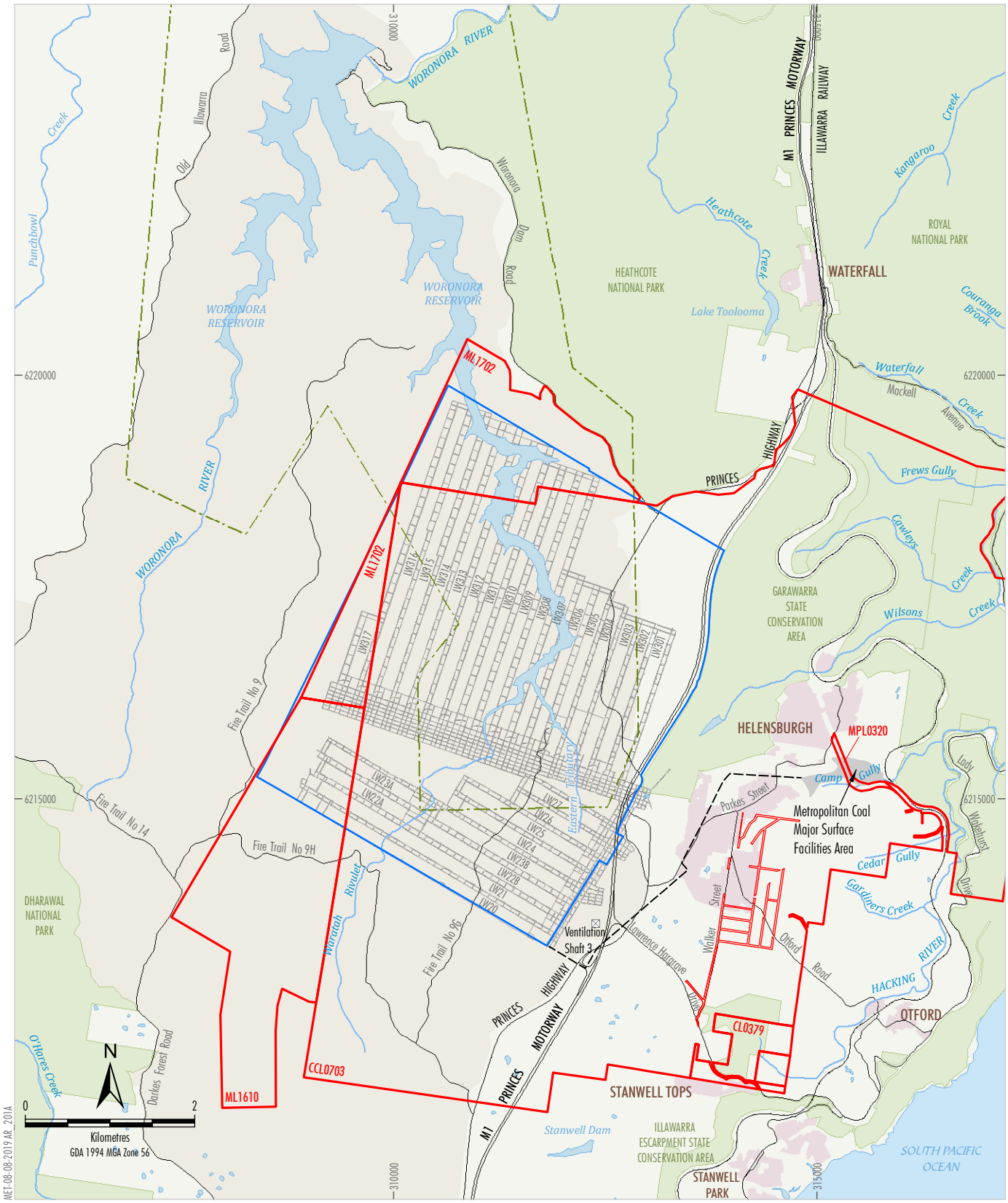
14 ACTIVITIES PROPOSED IN THE NEXT REPORTING PERIOD

In the next reporting period, Longwall 304 is anticipated to be completed in January 2020, Longwall 305 is anticipated to commence in April 2020 and be completed in September 2020 (Figure 5).

In the next reporting period, the following activities will be conducted:

- Metropolitan Coal will continue to consult with stakeholders and the Independent Expert Panel for Mining in the Catchment in relation to the Longwall 305-307 Extraction Plan in the first quarter of 2020.
- As a result of the Noise Mitigation Assessment and commencement of the Voluntary Undertaking throughout 2020:
  - All crusher and washer doors will be closed at all times (except when being accessed).
  - Metropolitan Coal will continue to consult with the DPIE, DRG and EPA and to notify relevant residences of noise exceedances.
- Metropolitan Coal will continue its ongoing consultation with the Wollongong City Council regarding the potential for coal rejects to be beneficially re-used at the Helensburgh Landfill.
- The coal reject backfill emplacement project will also continue throughout 2020.
- Metropolitan Coal will continue to consult with the Wollongong City Council in relation to the upgrade of the Mine Access Road and Parkes Street intersection.
- Metropolitan Coal will install small surface water flow gauges immediately downstream of Swamps 92 and 76.
- Metropolitan Coal will install additional upland swamp groundwater piezometers and soil moisture probes in select swamps over and/or proximal to Longwalls 309-313.
- Metropolitan Coal will continue to revegetate/rehabilitate the outer batters of the Turkey's Nest Dam.
- Metropolitan Coal will conduct stream remediation on the Eastern Tributary at Pools ETAH and ETAK.
- Catchment improvement works will continue in the Woronora catchment area, namely, rehabilitation of the former quarry on Fire Road 9H and rehabilitation of the disused access track to the Darkes Forest Mine. Weather permitting, catchment improvement works in the Woronora catchment area will be undertaken as required throughout 2020.

FIGURES



MET-08-08-2019 AR_201A

LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

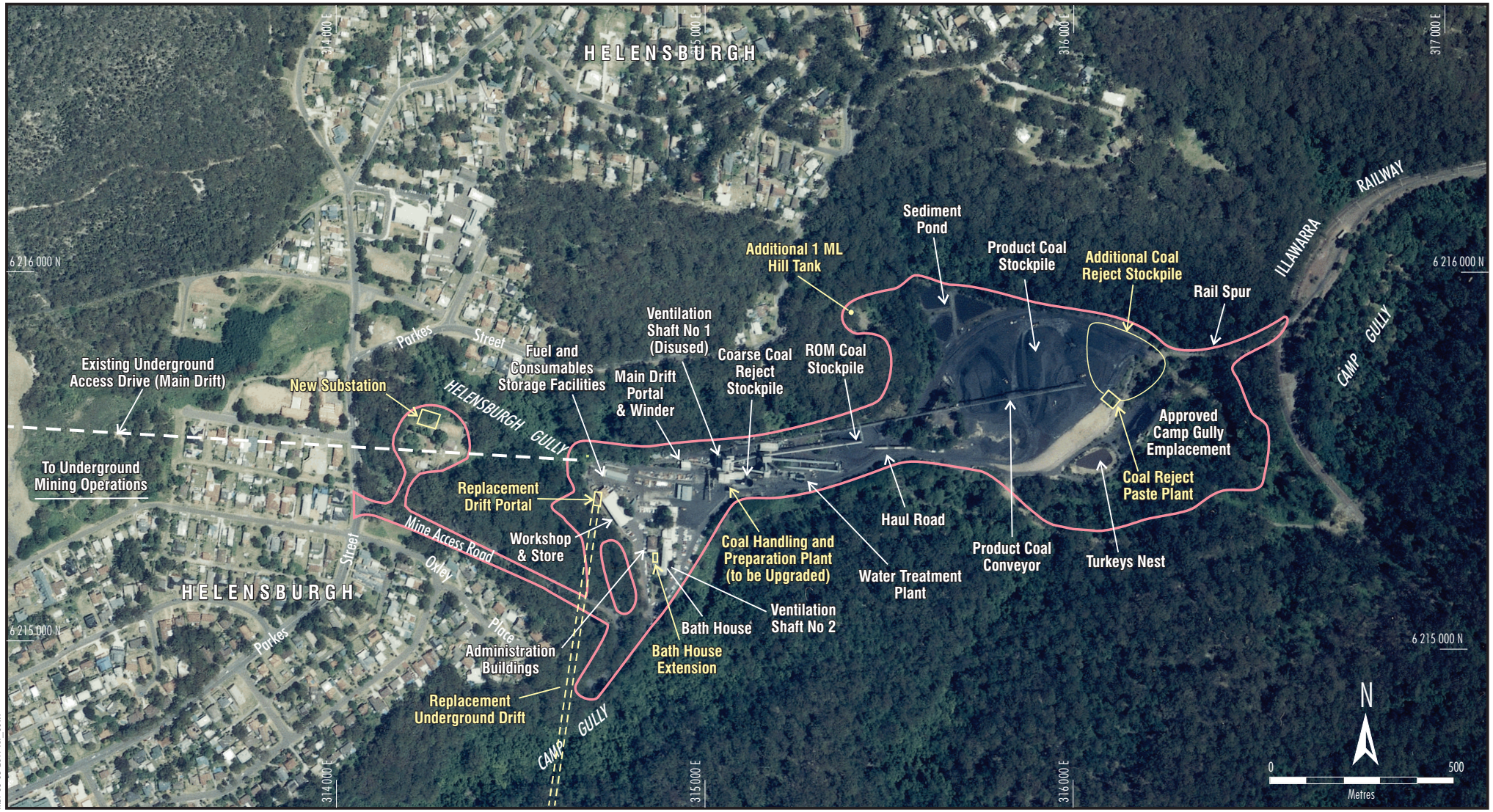
Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Project Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



MET-08-06-2019 AR_001A

LEGEND

Additional/Upgraded Project Infrastructure

Approximate Extent of Major Surface Facilities Area

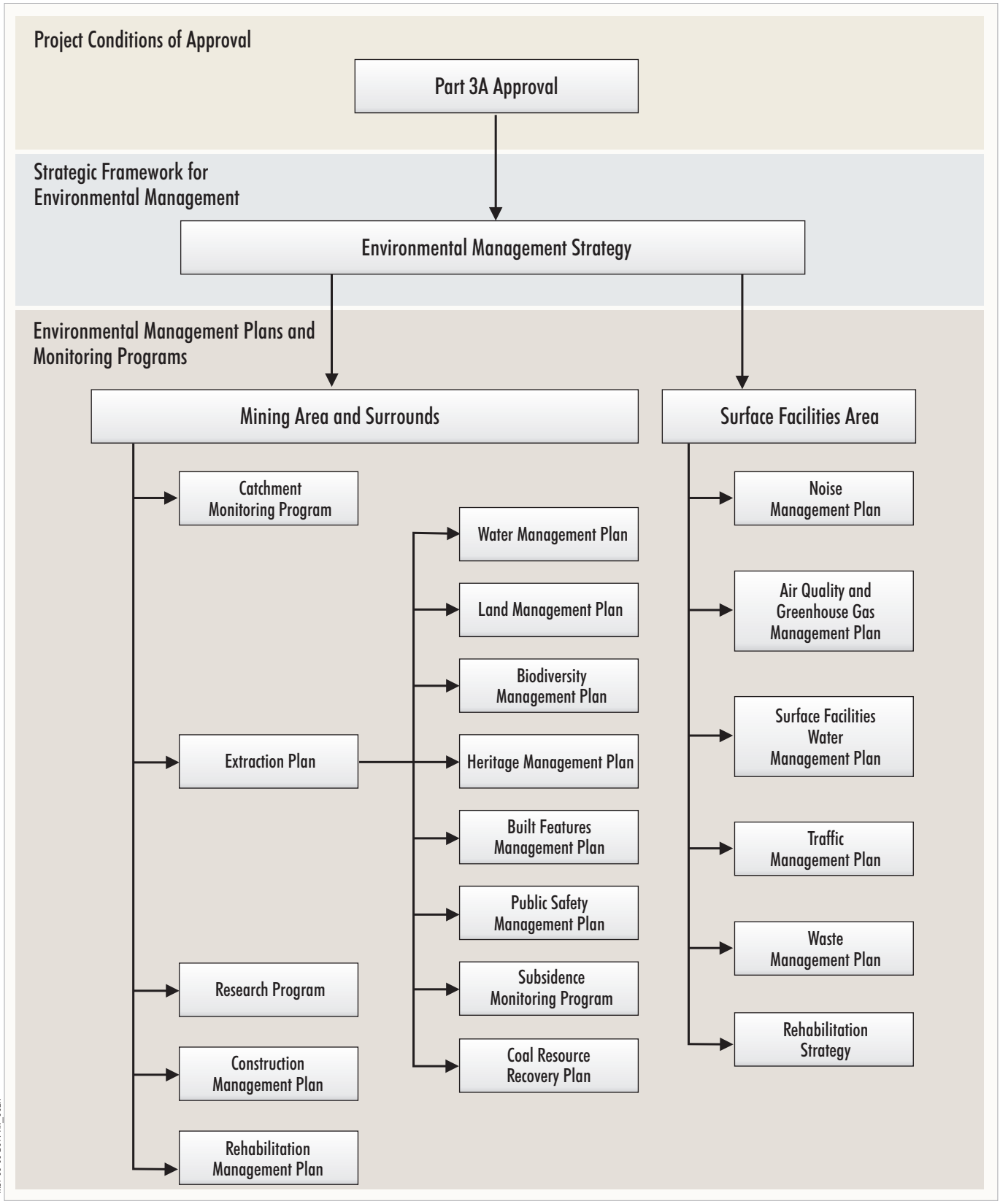
Source: Aerial Photography (2005)

Peabody

METROPOLITAN COAL

General Arrangement of the Major Surface Facilities Area

Figure 2

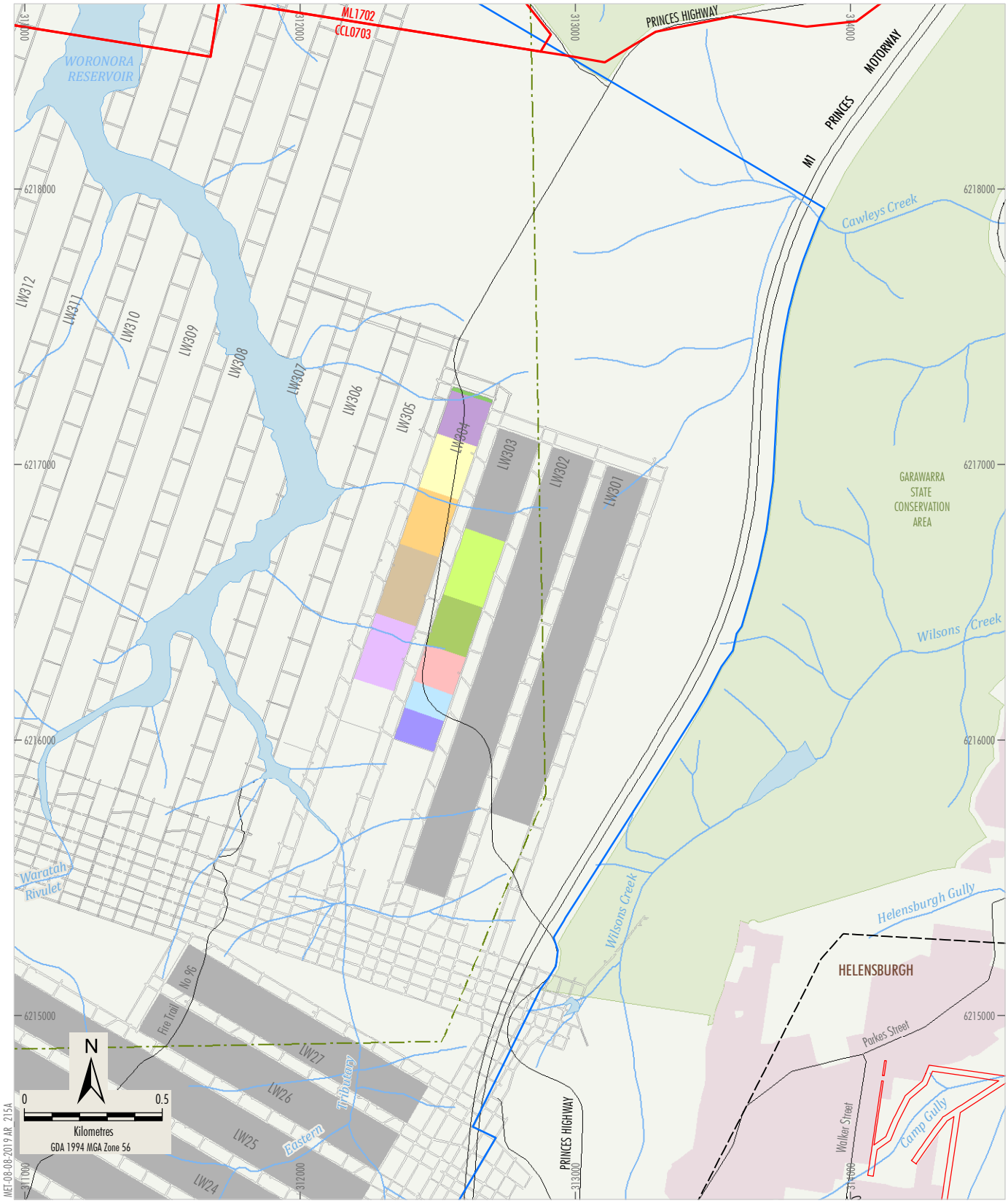


MET-08-08-2019 AR_002A

Peabody
METROPOLITAN COAL

Environmental Management Structure

Figure 3



LEGEND

- Mining Lease Boundary
- Previous Extraction
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Monthly Development 2019

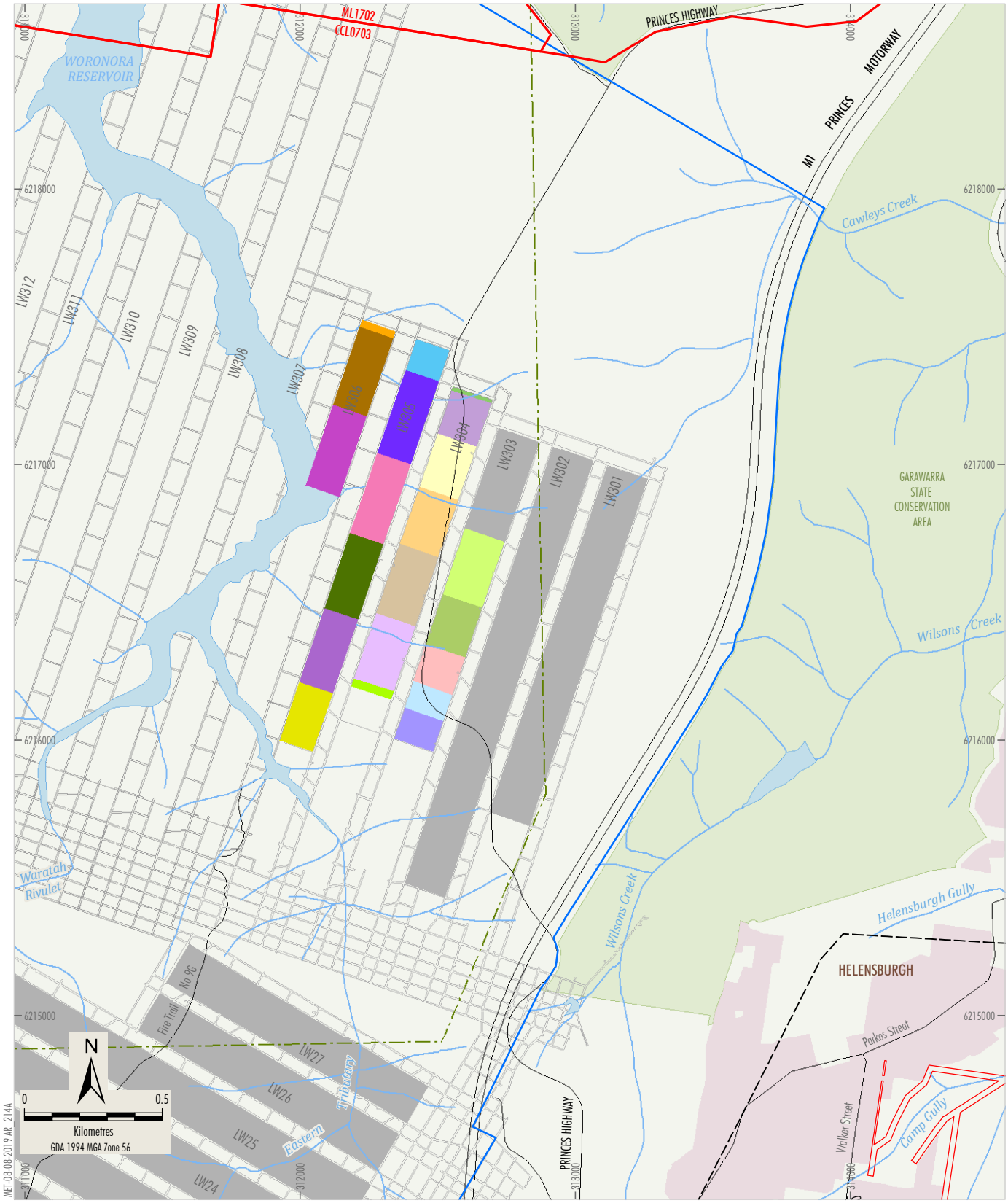
- January
- February
- March
- April
- May
- July
- August
- September
- October
- November
- December

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2016)

Peabody
METROPOLITAN COAL

Monthly Production Plan
January to December 2019

Figure 4



LEGEND

- Mining Lease Boundary
- Previous Extraction
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Monthly Development 2019

- January
- February
- March
- April
- May
- July
- August
- September
- October
- November
- December

Monthly Development 2020

- January
- April
- May
- June
- July
- August
- September
- October
- November
- December

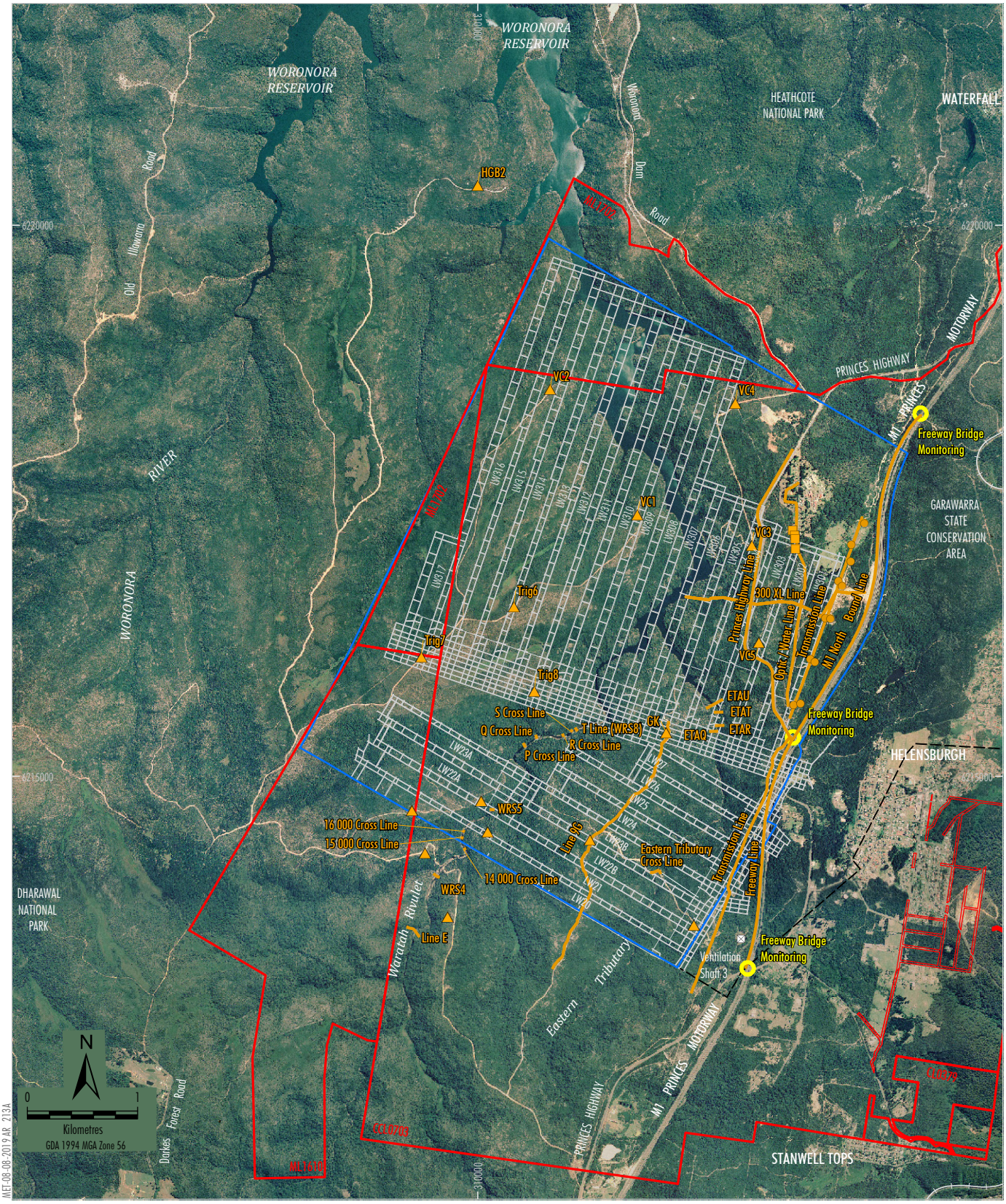
Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2020)

Peabody

METROPOLITAN COAL

Production Plan Forecast
January to December 2020

Figure 5



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Ridge Survey Point
- Subsidence Line
- Transmission Towers -
  Endeavour Energy and TransGrid
- Communications Towers
- Freeway Bridge Subsidence Monitoring

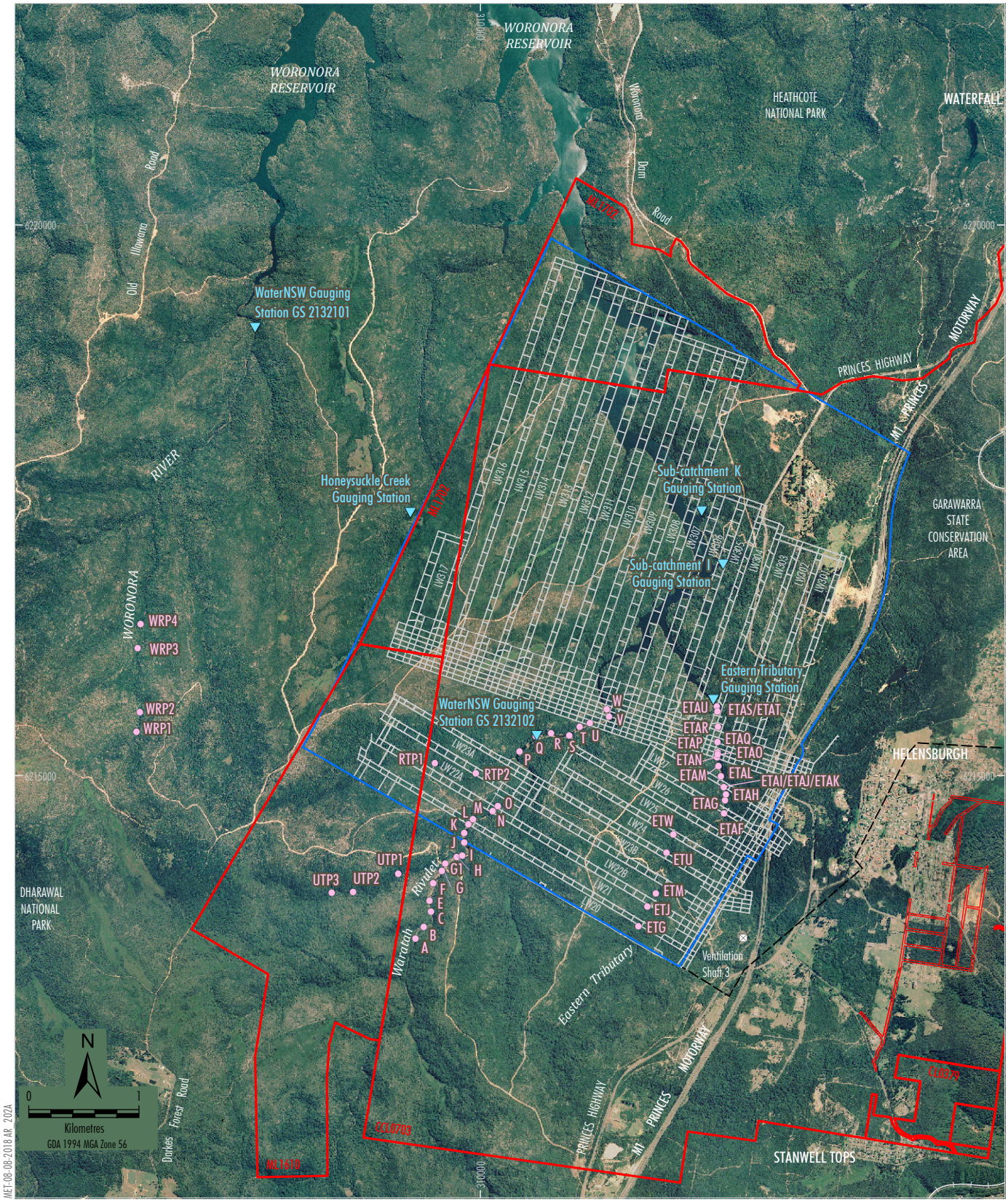
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2018); MSEC (2018)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Locations

Figure 6



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Gauging Station
- Pool Water Level Site

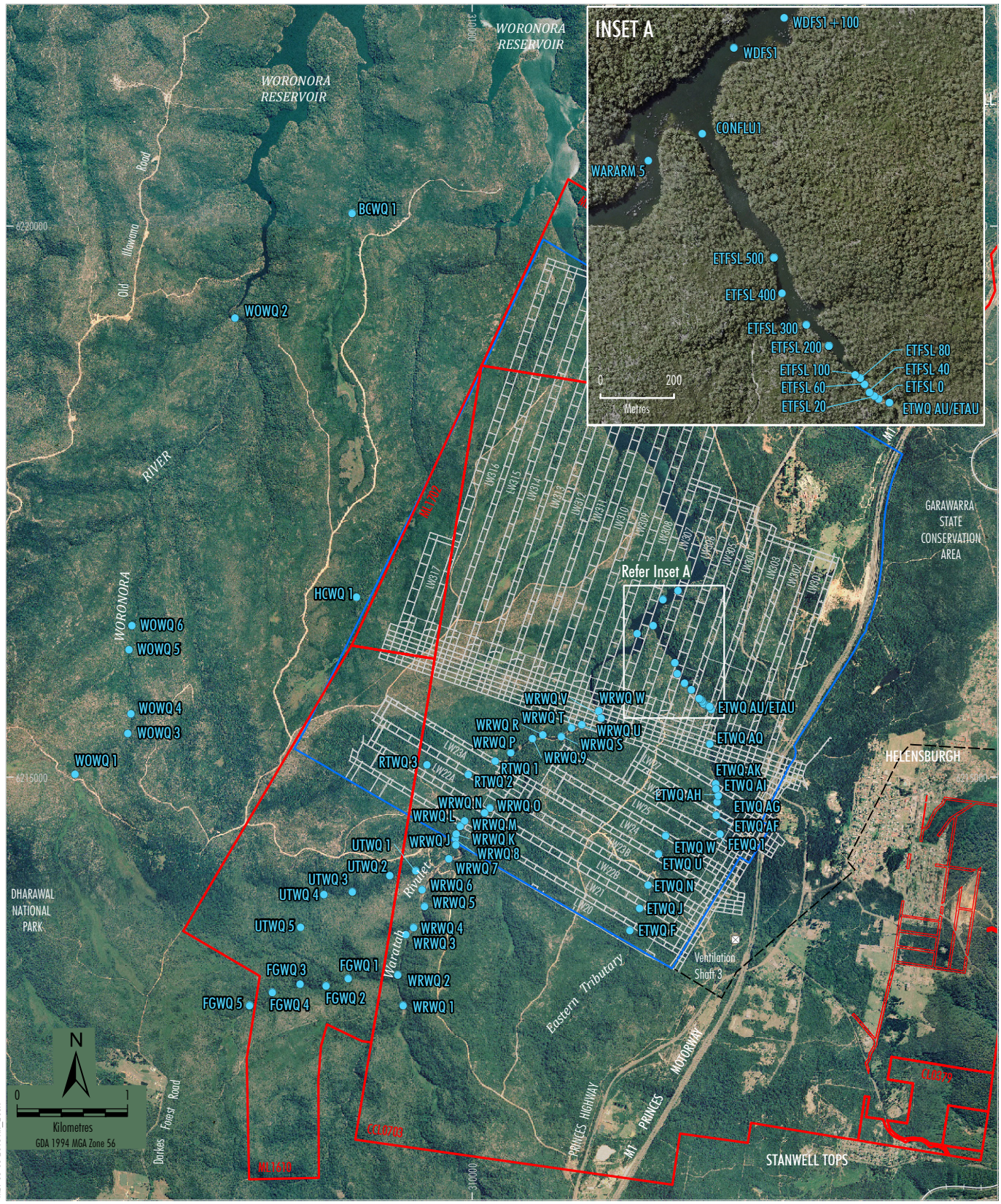
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Surface Water Quantity Sites

Figure 7



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Surface Water Quality Site

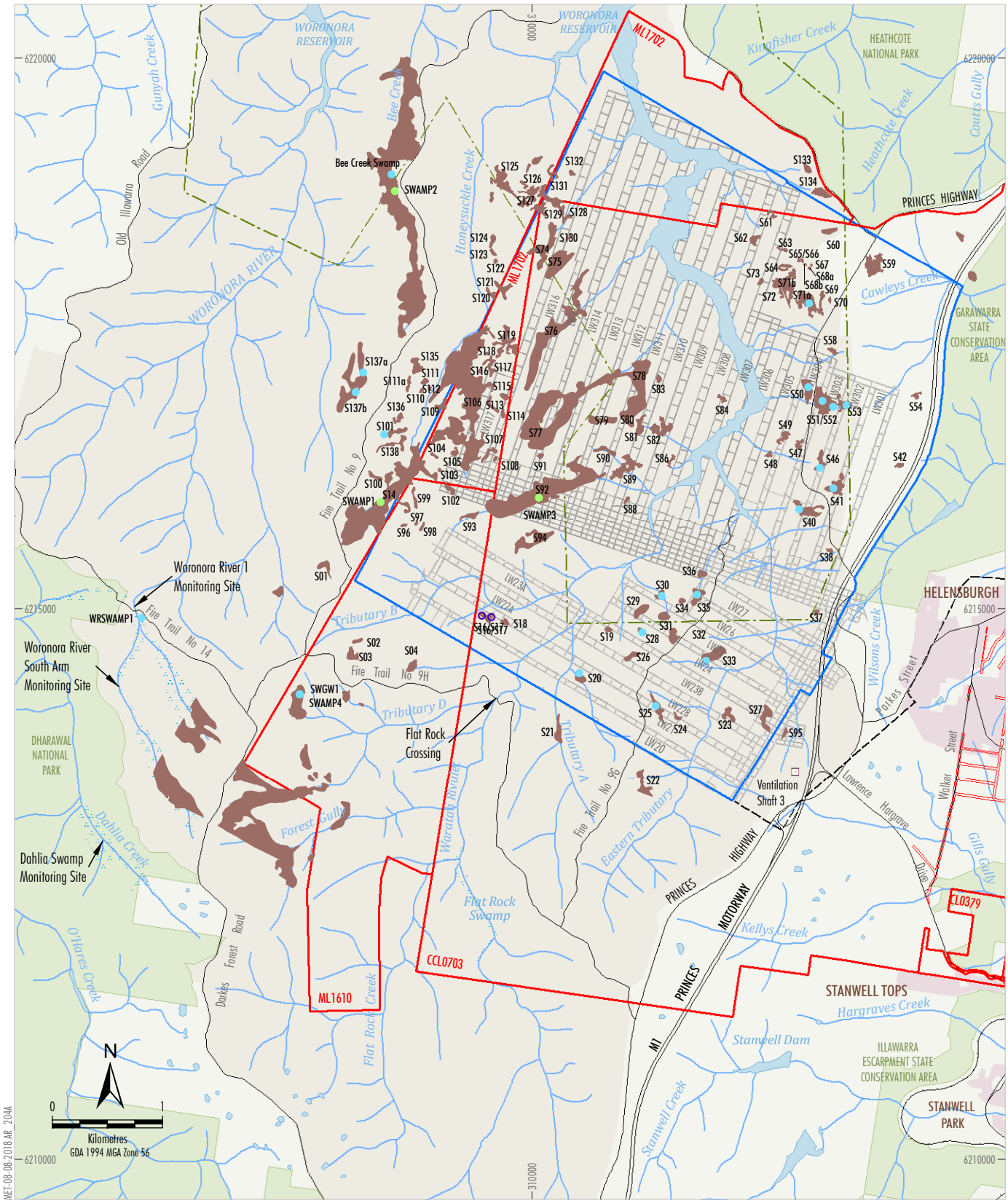
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Surface Water Quality Sites

Figure 8



LEGEND

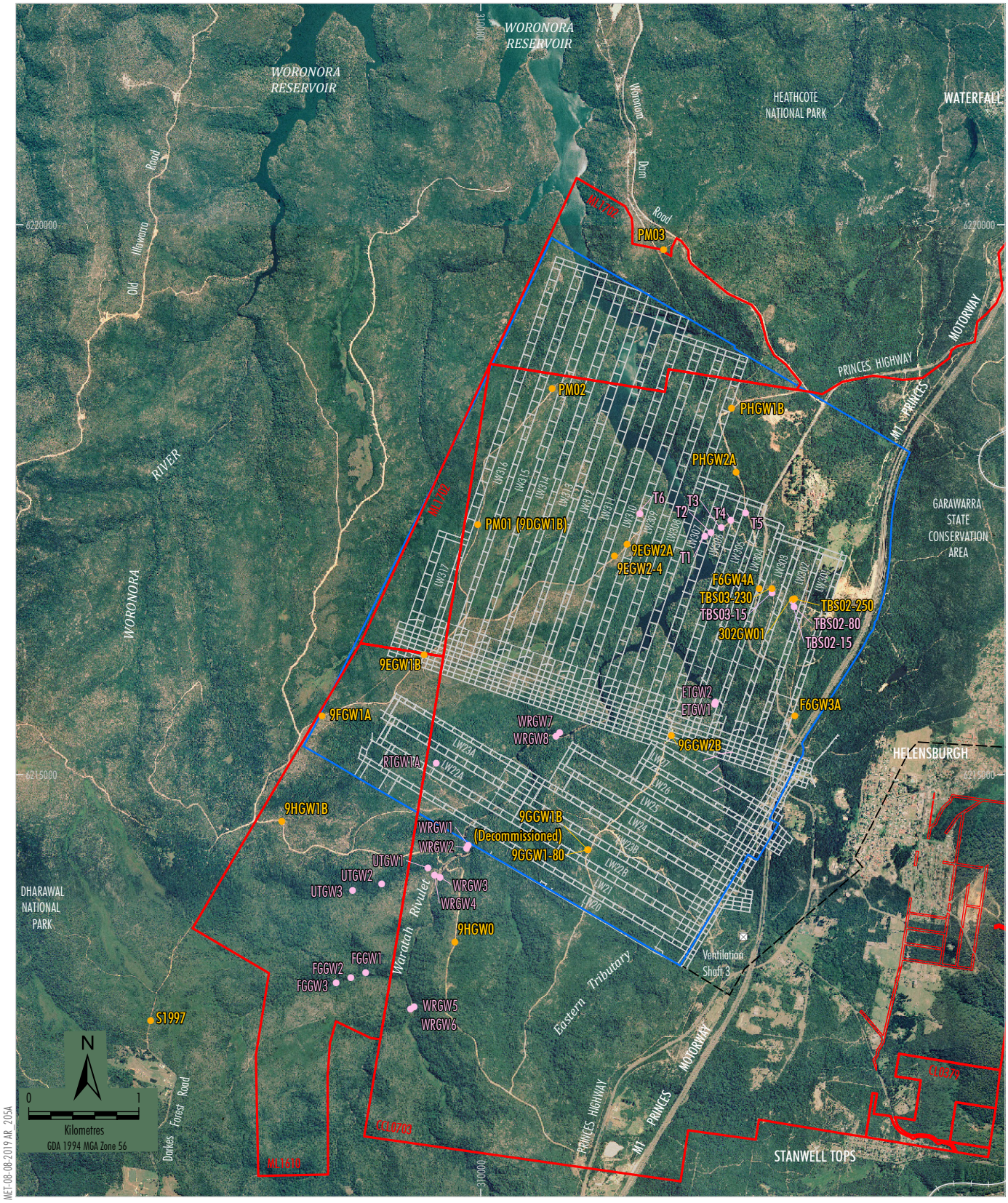
- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Woronora Notification Area
- Upland Swamp
- Swamp Substrate and Shallow Groundwater Piezometer
- Swamp Substrate Groundwater Piezometer
- Swamp Shallow Groundwater Piezometer

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); after NPWS (2003), Bangalay Botanical Surveys (2008) and Eco Logical Australia (2015; 2016; 2018)

Peabody
METROPOLITAN COAL

Upland Swamp Groundwater Piezometer Locations

Figure 9



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Groundwater Level/Pressure Bore
- Groundwater Level Bore

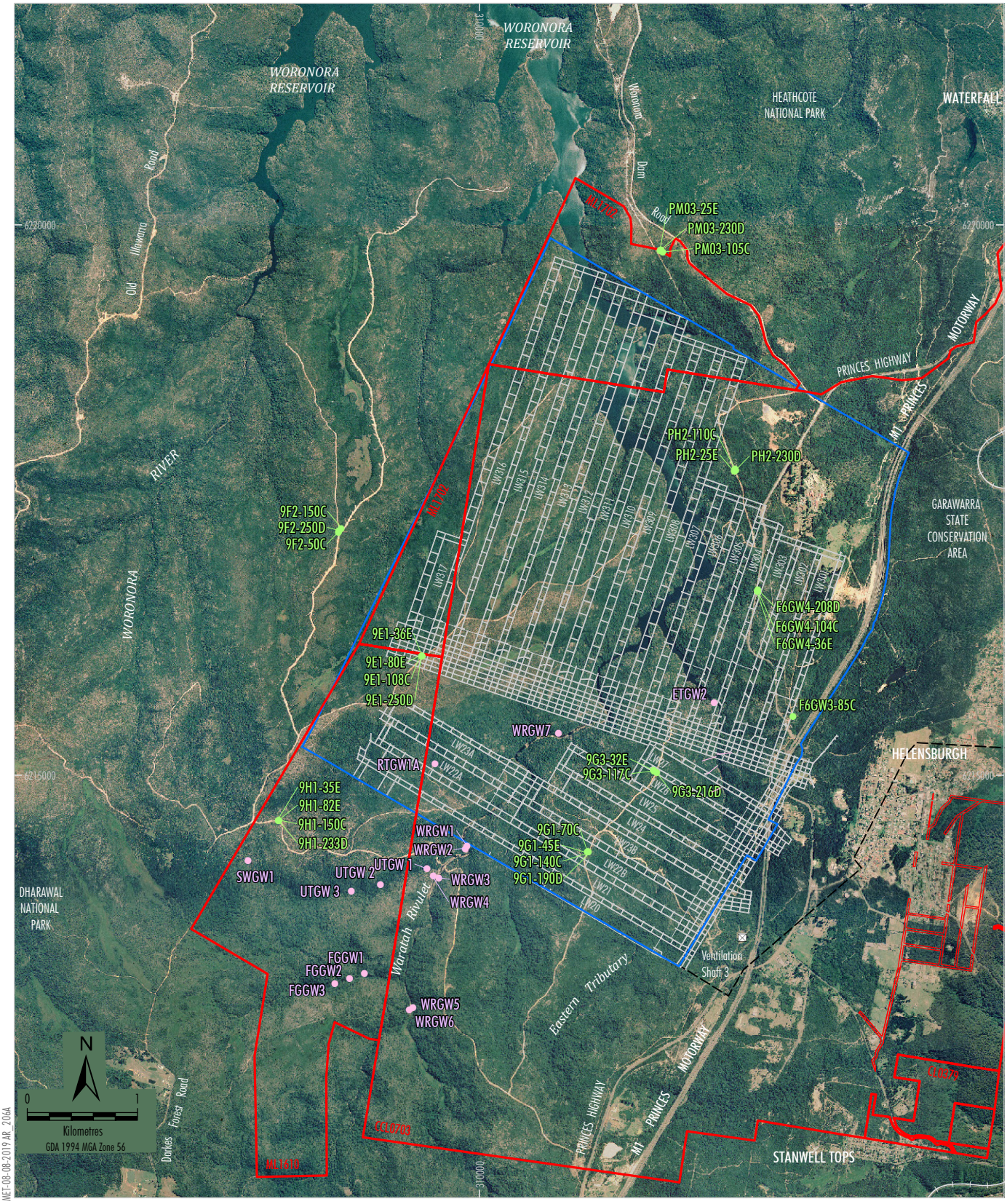
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Groundwater Level
and/or Pressure Bore Locations

Figure 10



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Deep Groundwater Chemistry Monitoring Site
- Stream Shallow Groundwater Quality Monitoring Site

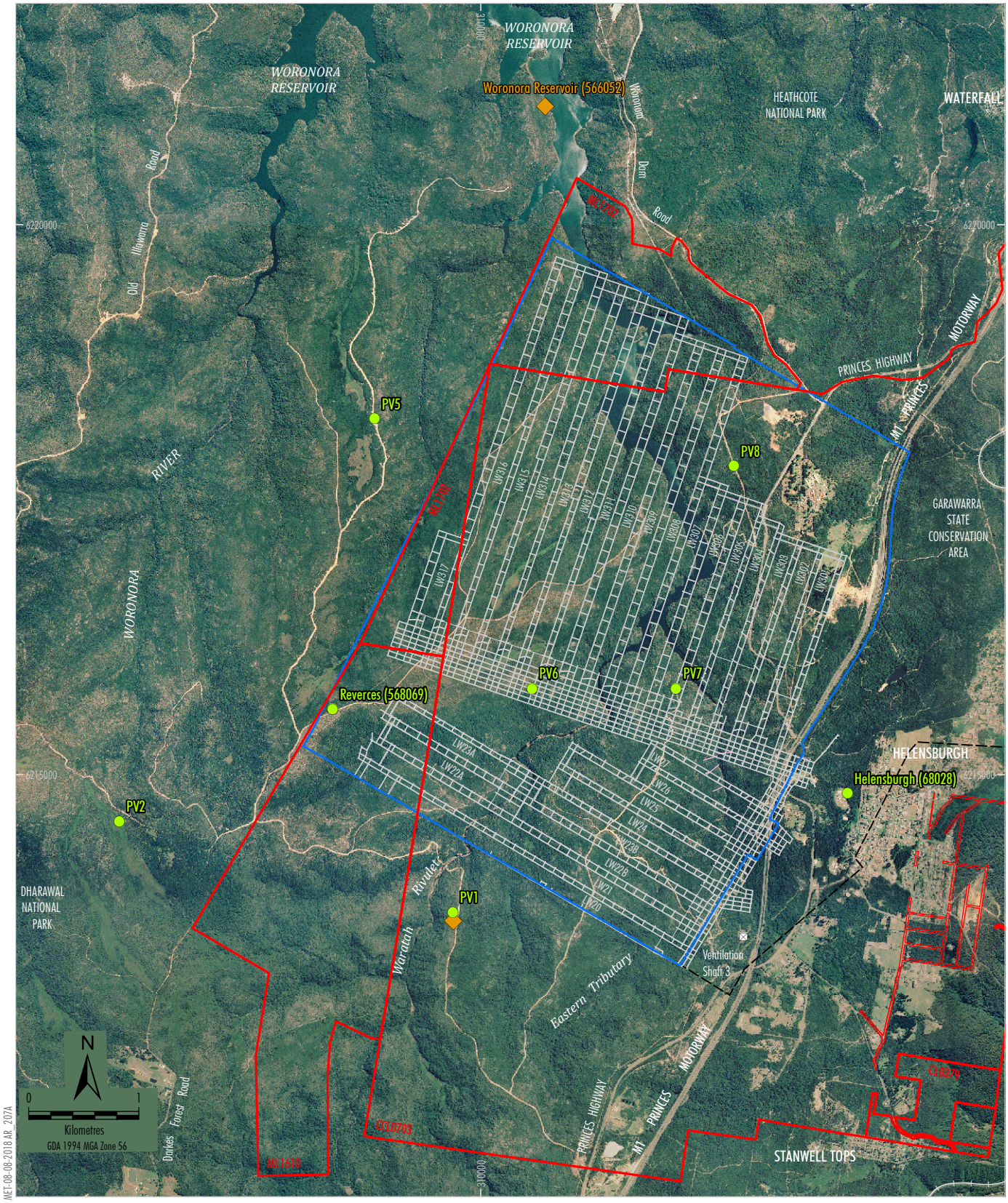
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Groundwater Quality Sites

Figure 11



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Evaporimeter
- Pluviometer

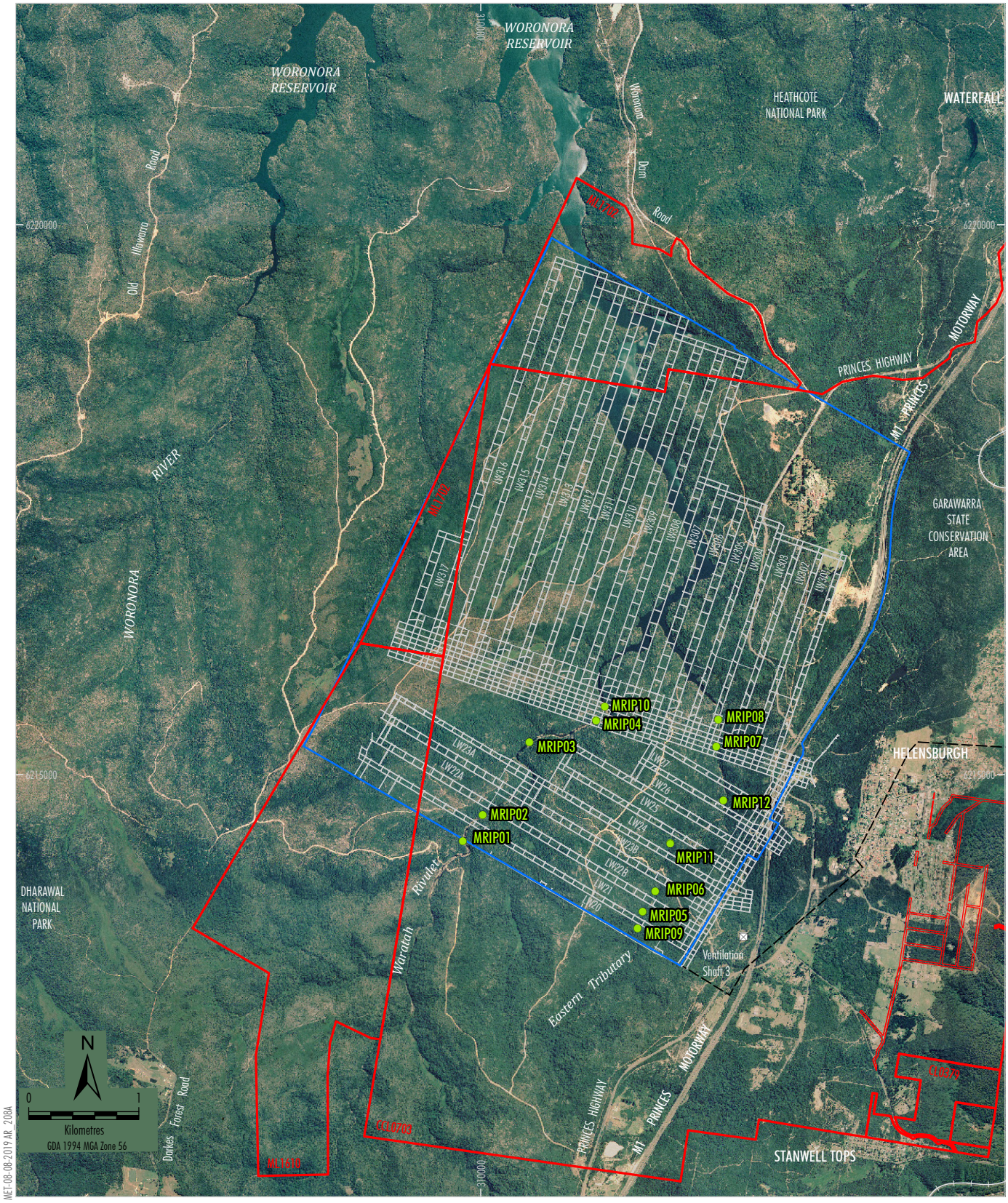
Notes:
1. The Bureau of Meteorology pluviometer at Darkes Forest (68024) is not shown. It is located approximately 3.75 km south of the Metropolitan Coal pluviometer (PV2).
2. The Bureau of Meteorology pluviometer at Lucas Heights (66078) is not shown. It is located approximately 12.5 km north of the Metropolitan Coal pluviometer (PV8).

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody
METROPOLITAN COAL

Meteorological Sites

Figure 12



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)

Monitoring Site

- Riparian Vegetation Monitoring Site

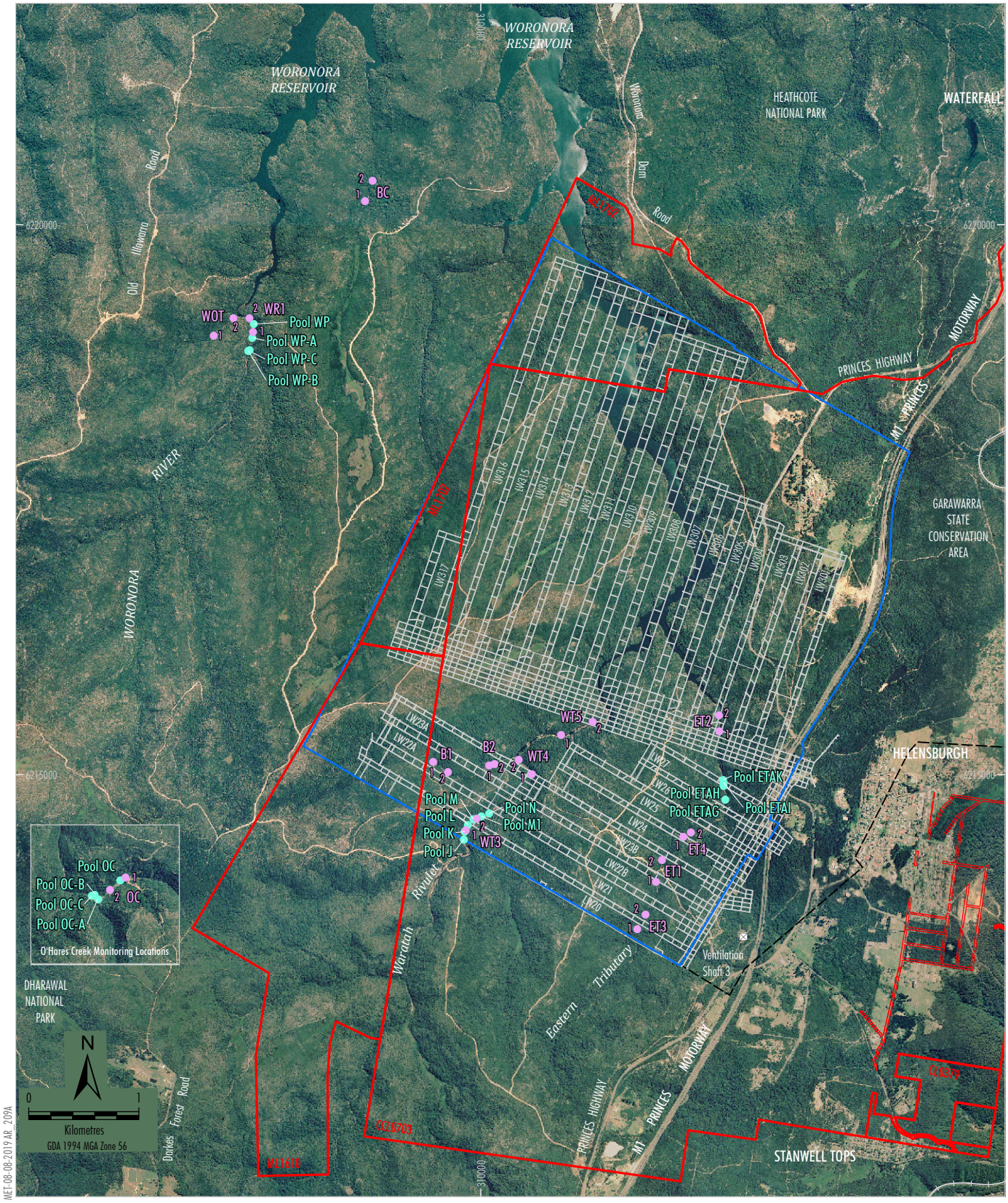
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Riparian Vegetation Monitoring Locations

Figure 13



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)

Monitoring

- Pool Aquatic Ecology Sampling Site
- Stream Aquatic Ecology Sampling Site

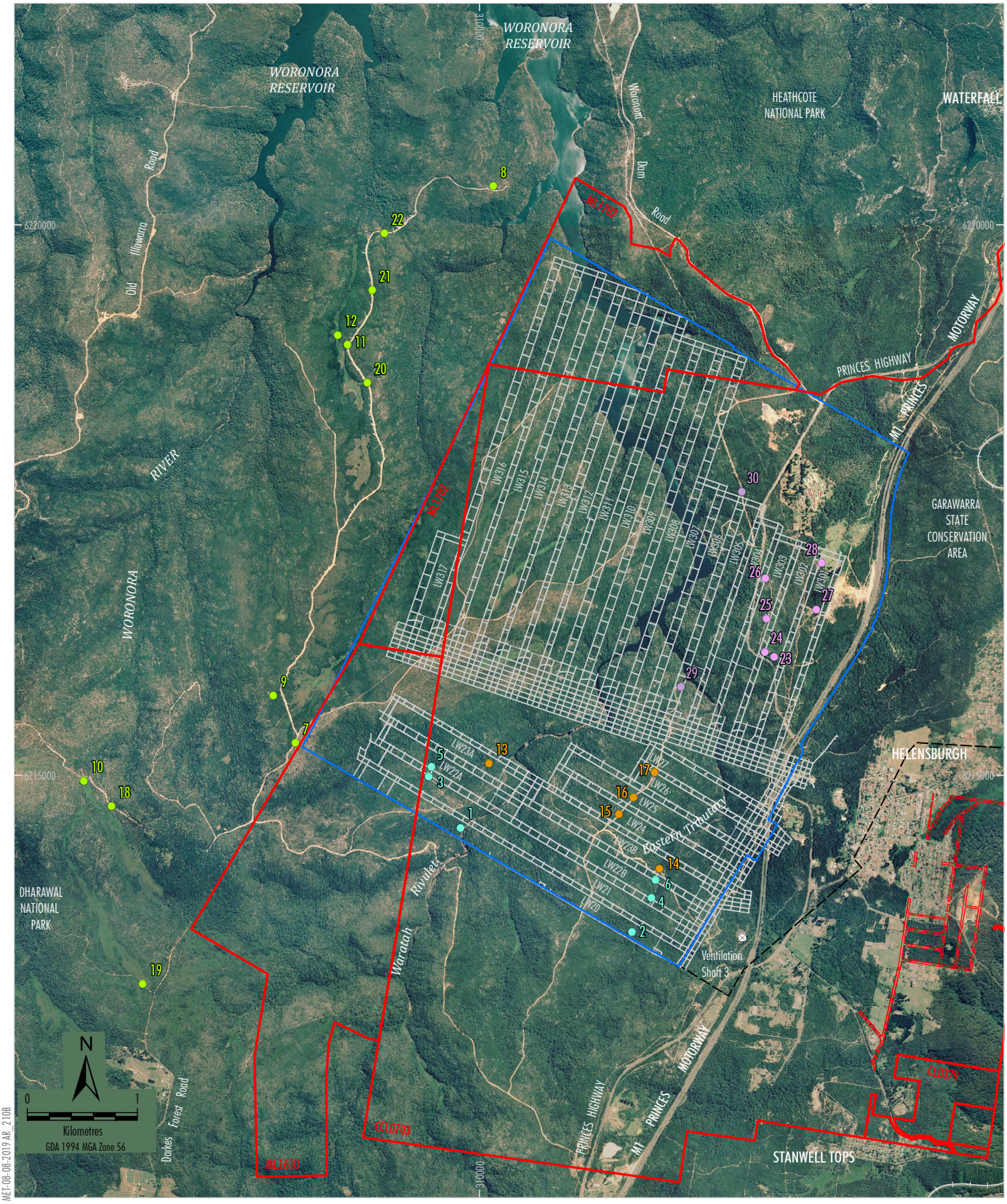
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Aquatic Ecology Monitoring Locations

Figure 14



MET-08-08-2019 AR_2108

LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)

Monitoring Sites

- Longwalls 20-22 Amphibian Monitoring
- Longwalls 23-27 Amphibian Monitoring
- Longwalls 301-303 Amphibian Monitoring
- Longwalls 305-306 Amphibian Monitoring
- Control Site

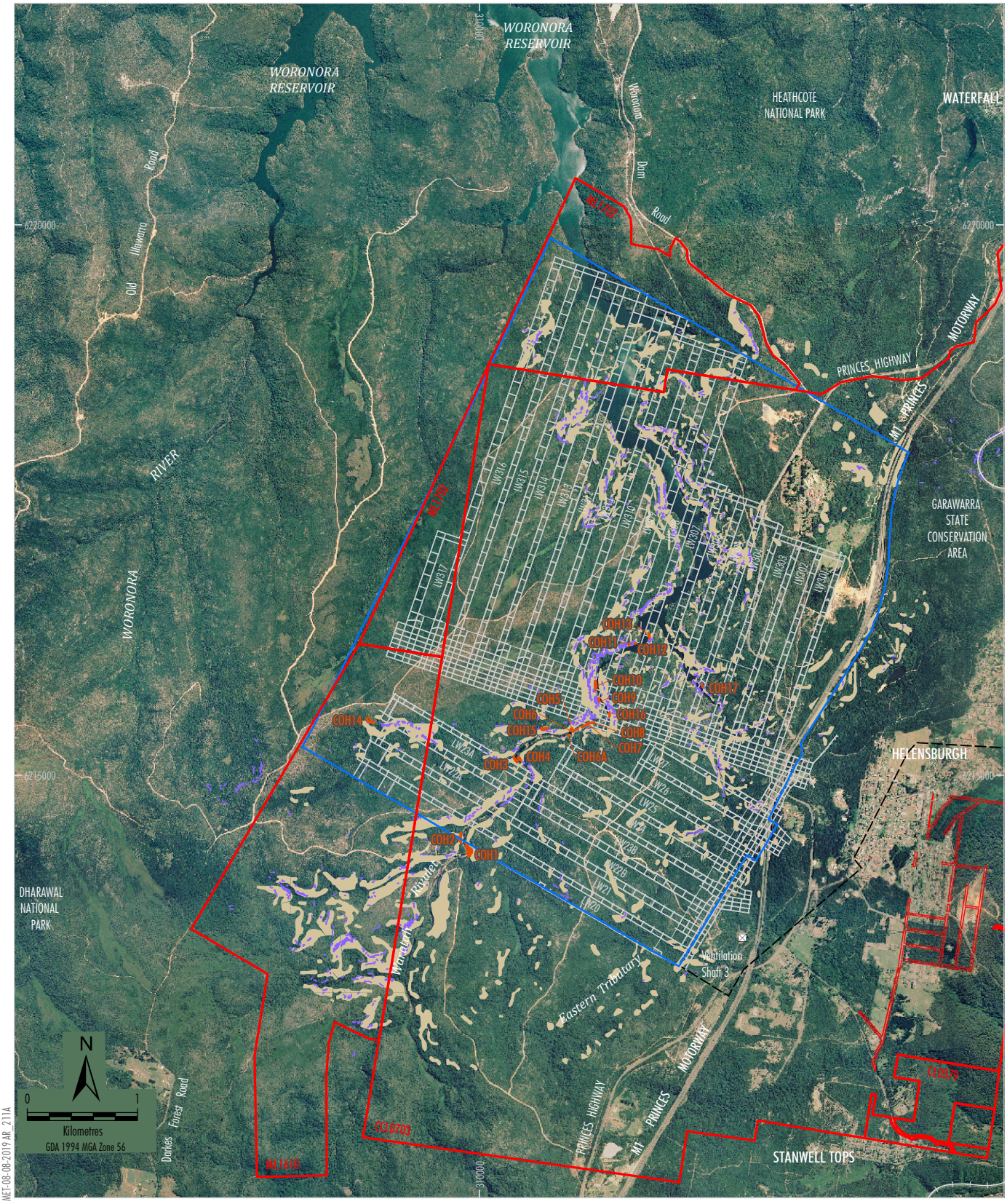
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019)

Peabody

METROPOLITAN COAL

Amphibian Monitoring Locations

Figure 15



MET-08-08-2019 AR 211A

LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Cliffs and Overhangs
- Steep Slopes (Project Approval)
- Steep Slopes (Project Environmental Assessment)

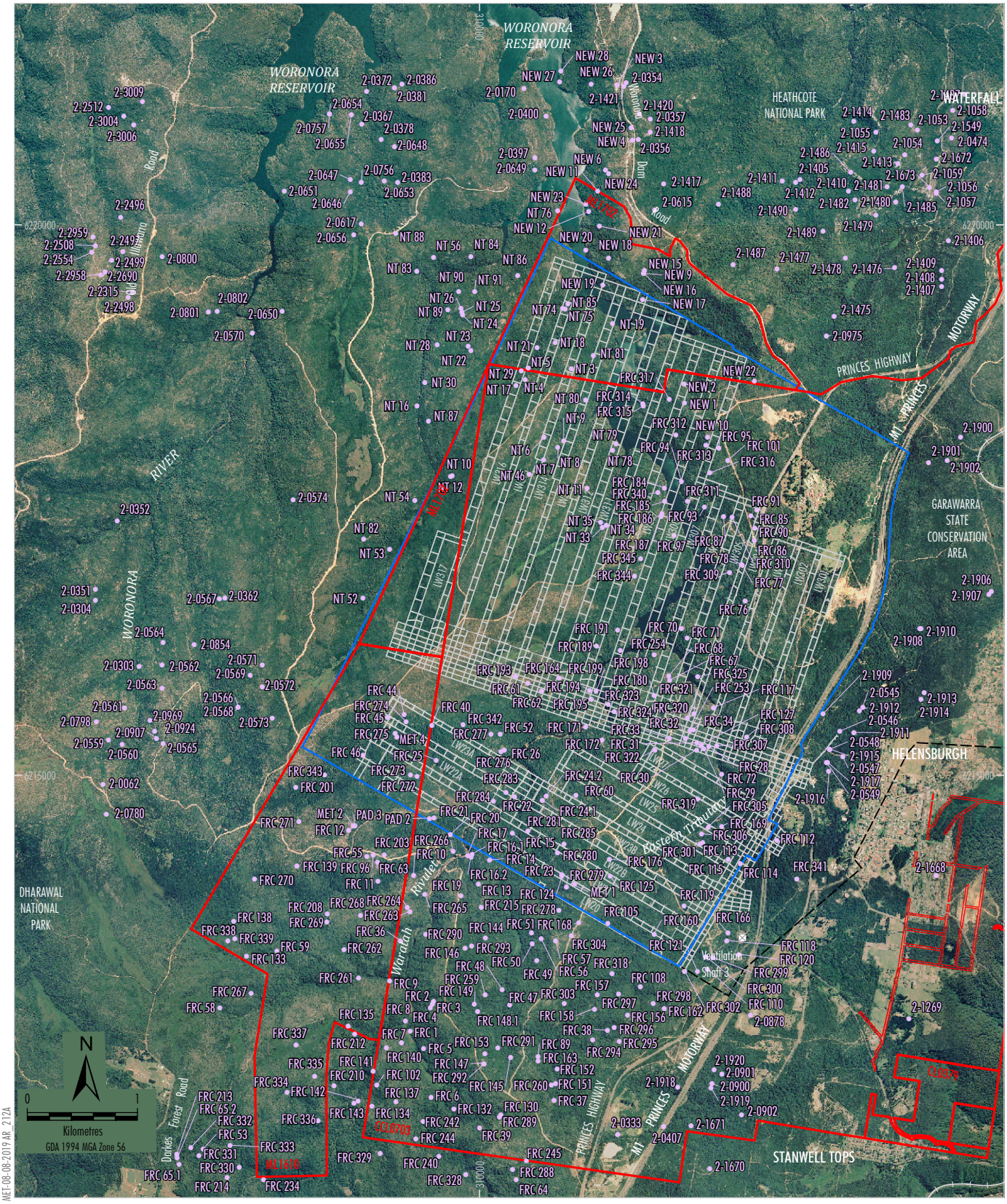
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2008; 2019)

Peabody

METROPOLITAN COAL

Cliffs and Overhangs, Steep Slopes and Land in General within the Project Underground Mining Area and Surrounds

Figure 16



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area
  Longwalls 20-27 and 301-317
- Existing Underground Access Drive (Main Drift)
- Aboriginal Heritage Site

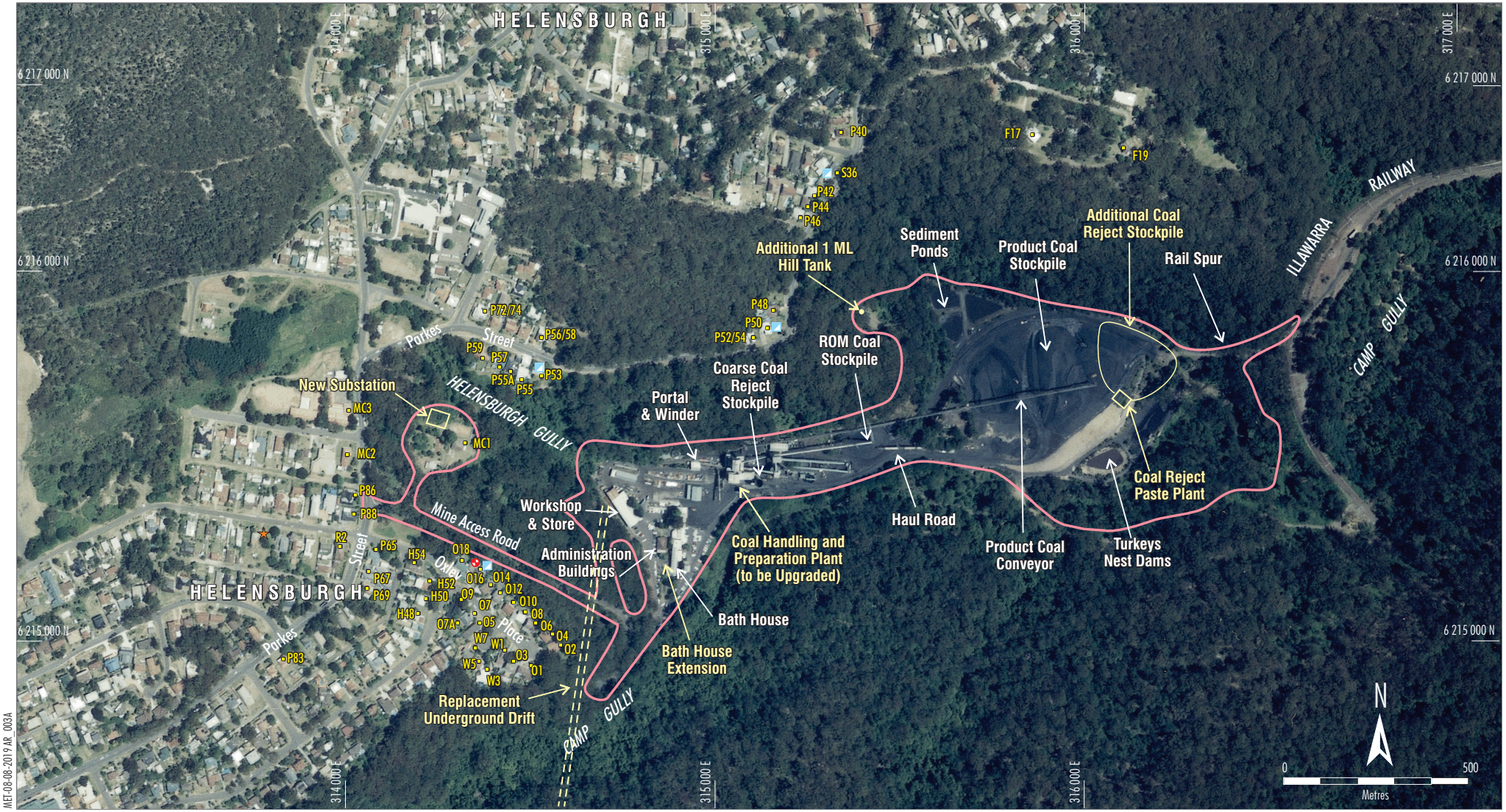
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019) Illawarra Prehistory Group (2007; 2008); AHIMS (2007); Kayandel Archaeological Services (2006; 2007; 2008); Niche Environment and Heritage (2013)

Peabody
METROPOLITAN COAL

Known Aboriginal Heritage Sites Within Project Underground Mining Area and Surrounds

Figure 17

MET-08-08-2019 AR 212A



MET-08-08-2019 AR_003A

LEGEND

- P40 Receiver Location
- Approximate Extent of Major Surface Facilities Area
- Real-time Noise Monitoring Site
- Attended Noise Monitoring Site
- Automatic Weather Station

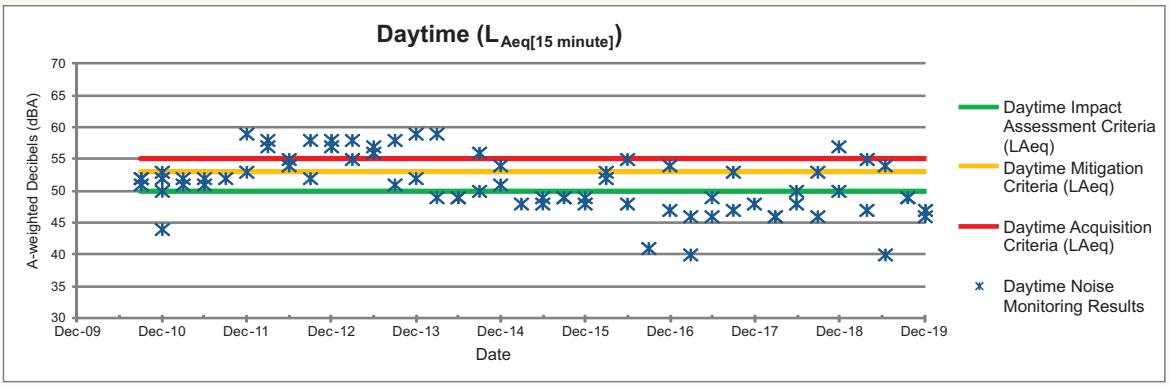
Peabody

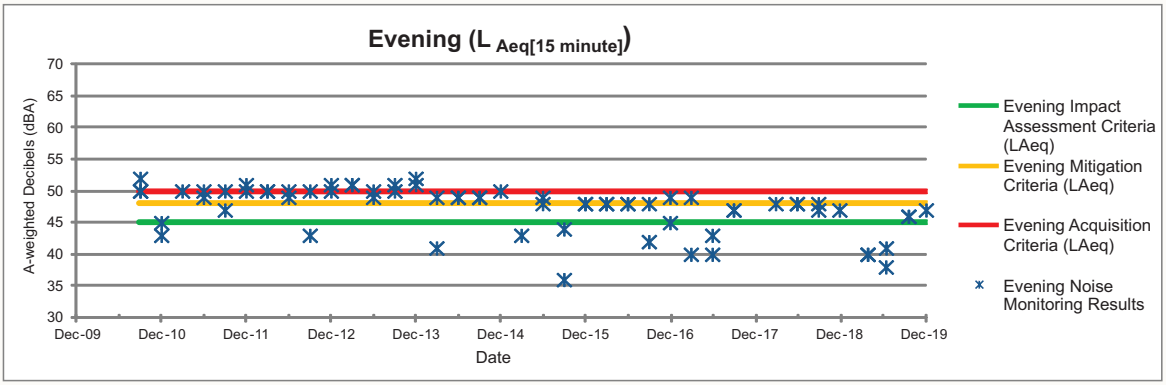
METROPOLITAN COAL

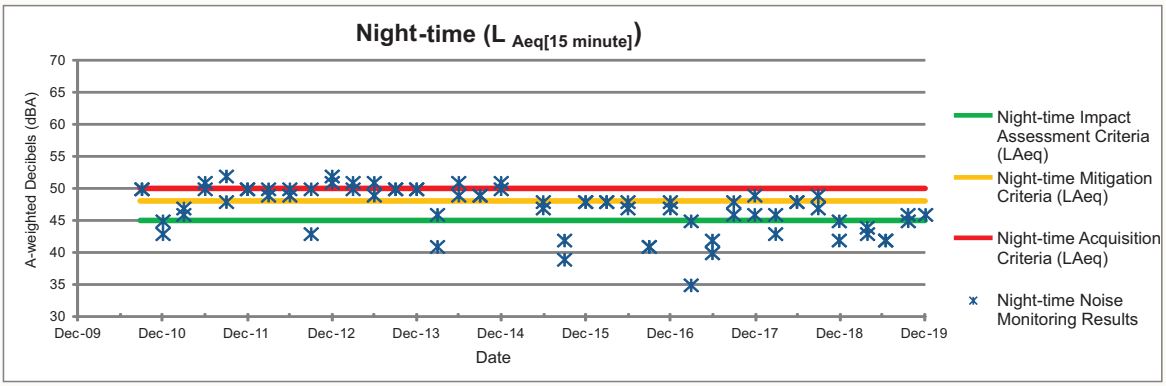
Noise Monitoring Locations

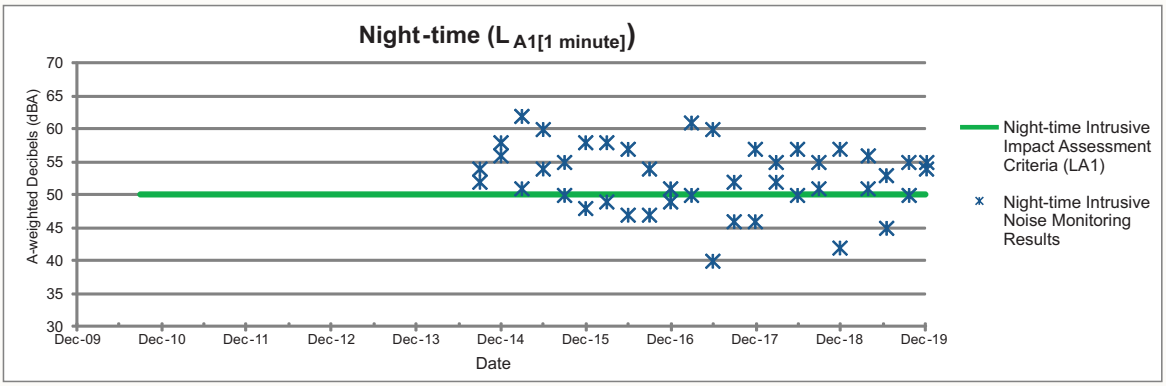
Source: Aerial Photography 2005

Figure 18









MET-08-08-2019 AR_004B

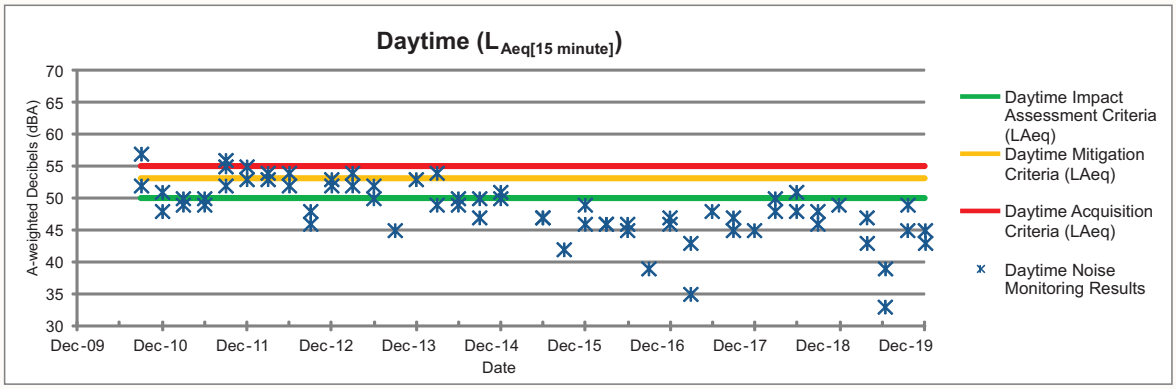
Note: In accordance with Conditions 1, 2 and 3, Schedule 4 of the Project Approval, the assessment, acquisition and mitigation criteria are only applicable from the end of 2014

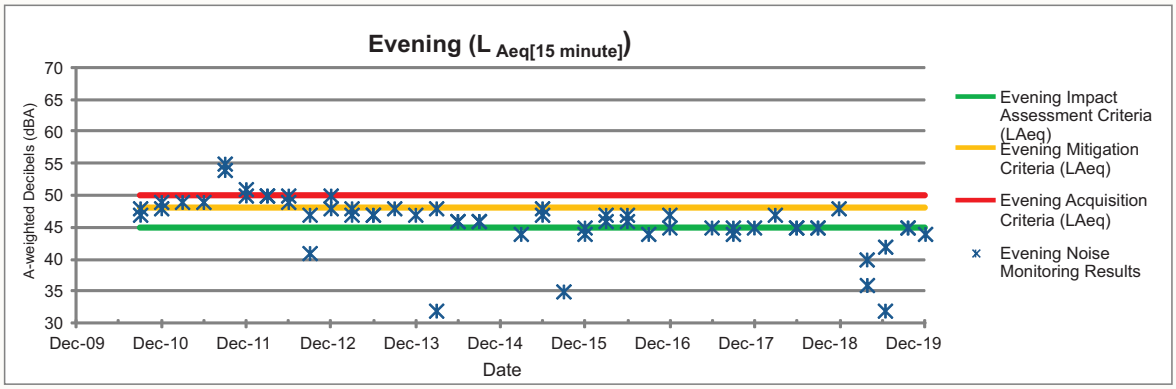
Peabody

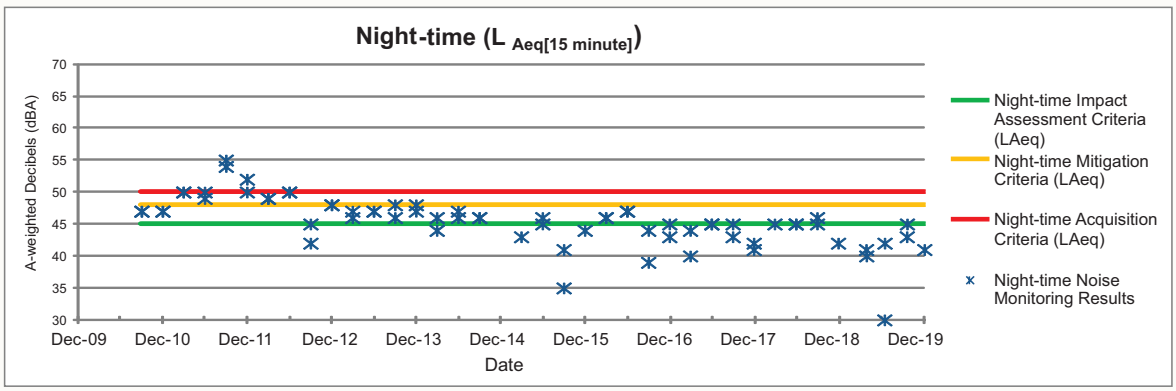
METROPOLITAN COAL

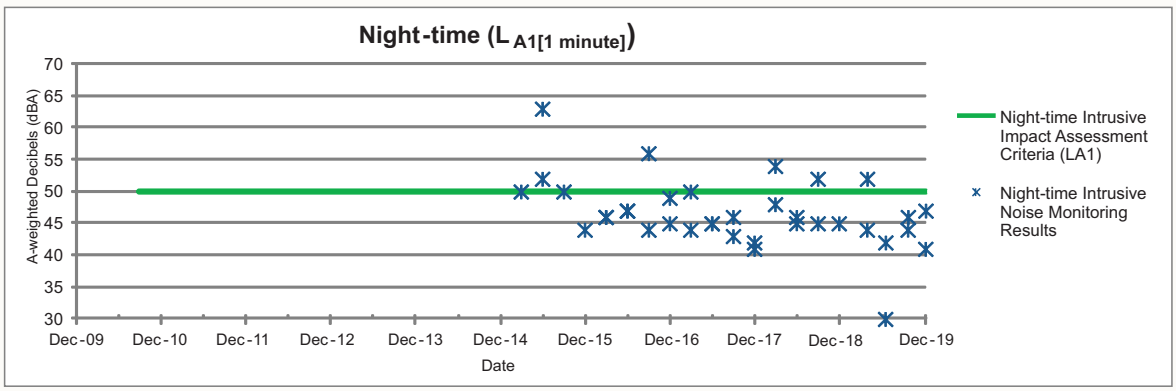
Quarterly Operator Attended Noise Monitoring Results at 16 Oxley Place (September 2010 to December 2019)

Figure 19a









MET-08-08-2019 AR_0058

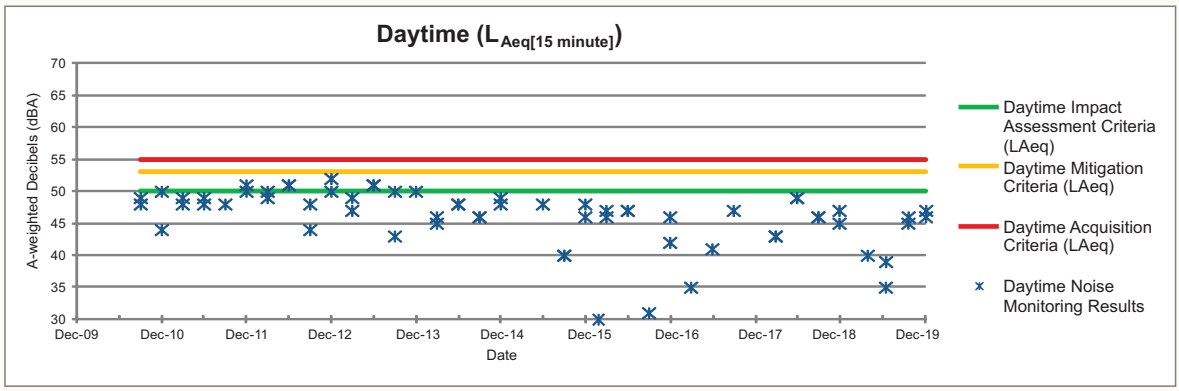
Note: In accordance with Conditions 1, 2 and 3, Schedule 4 of the Project Approval, the assessment, acquisition and mitigation criteria are only applicable from the end of 2014

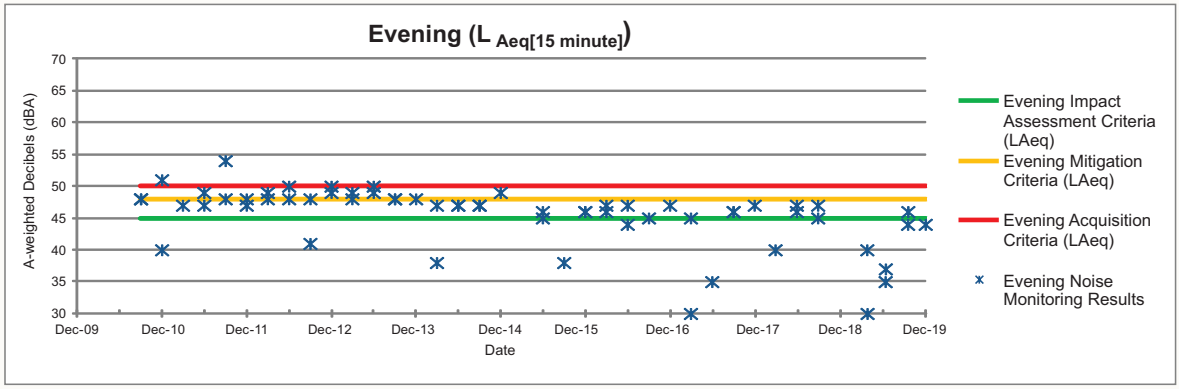
Peabody

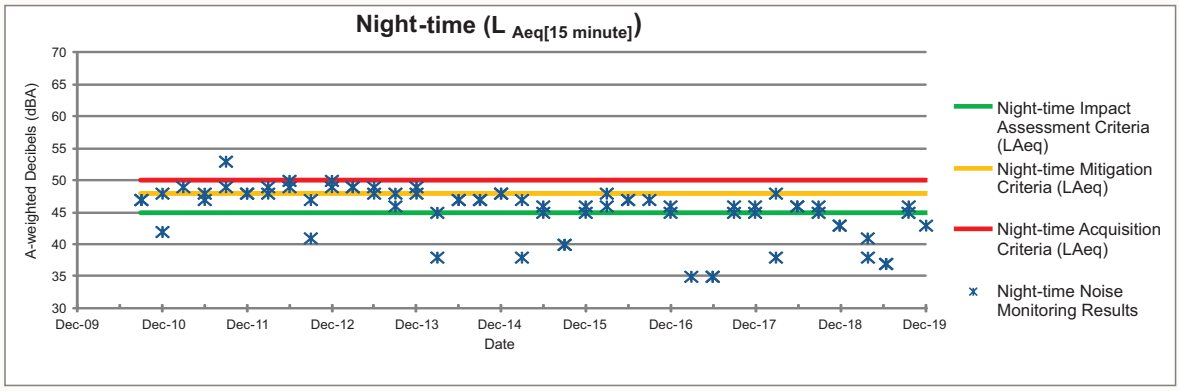
METROPOLITAN COAL

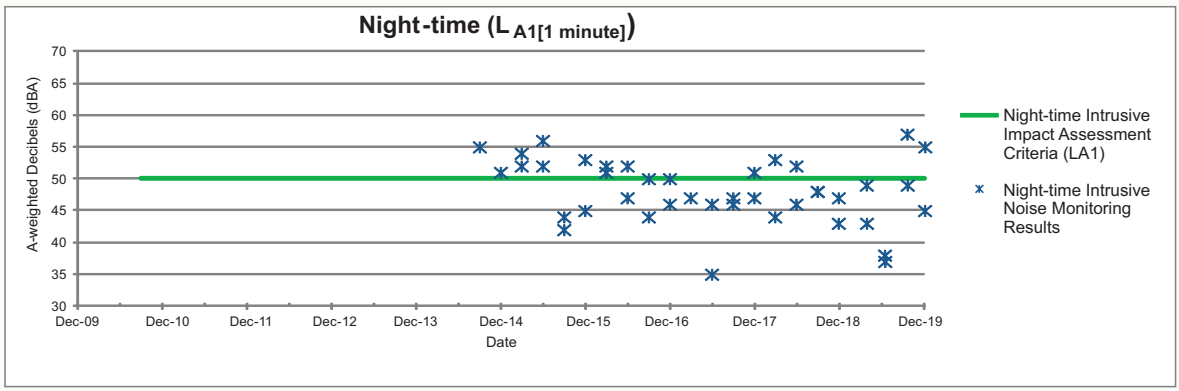
Quarterly Operator Attended Noise Monitoring Results at 53 Parkes Street (September 2010 to December 2019)

Figure 19b









MET-08-08-2019 AR_006B

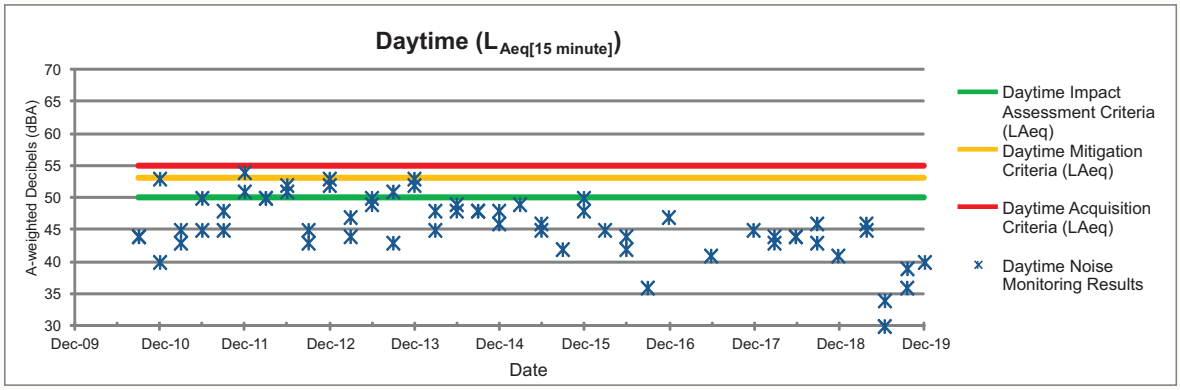
Note: In accordance with Conditions 1, 2 and 3, Schedule 4 of the Project Approval, the assessment, acquisition and mitigation criteria are only applicable from the end of 2014

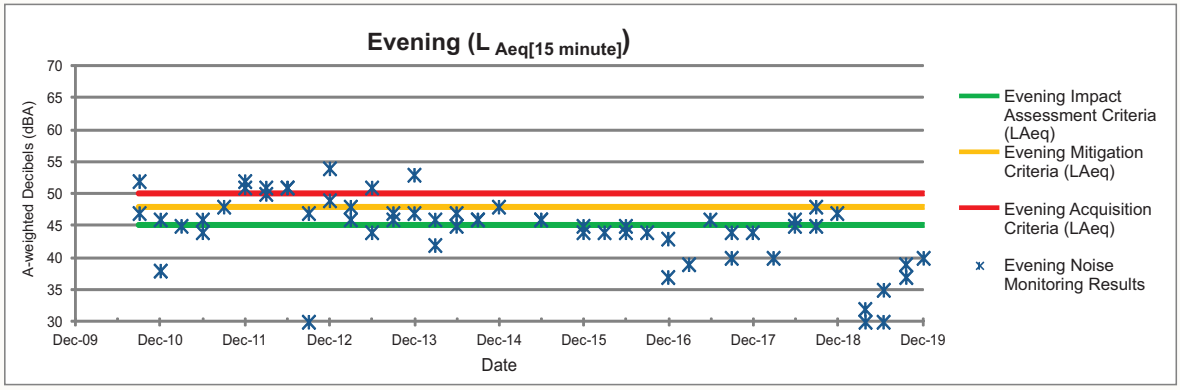
Peabody

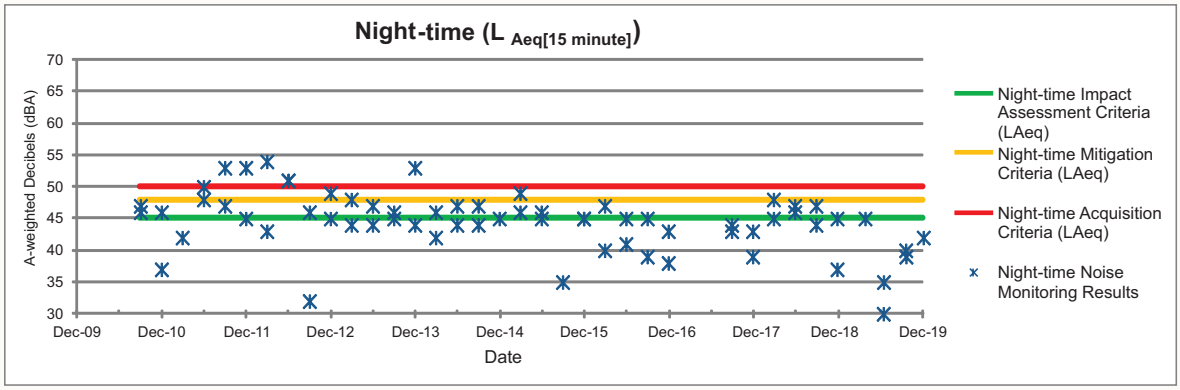
METROPOLITAN COAL

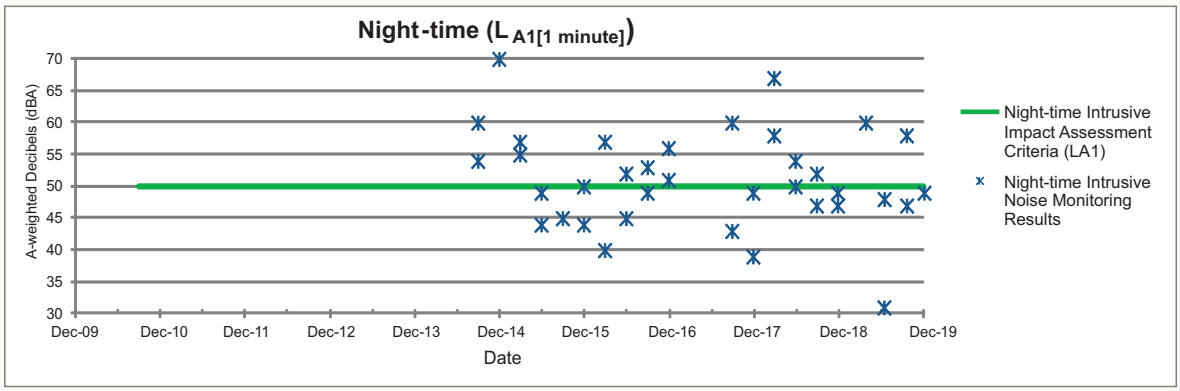
Quarterly Operator Attended Noise Monitoring Results at 50 Parkes Street (September 2010 to December 2019)

Figure 19c









MET-08-08-2019 AR_0078

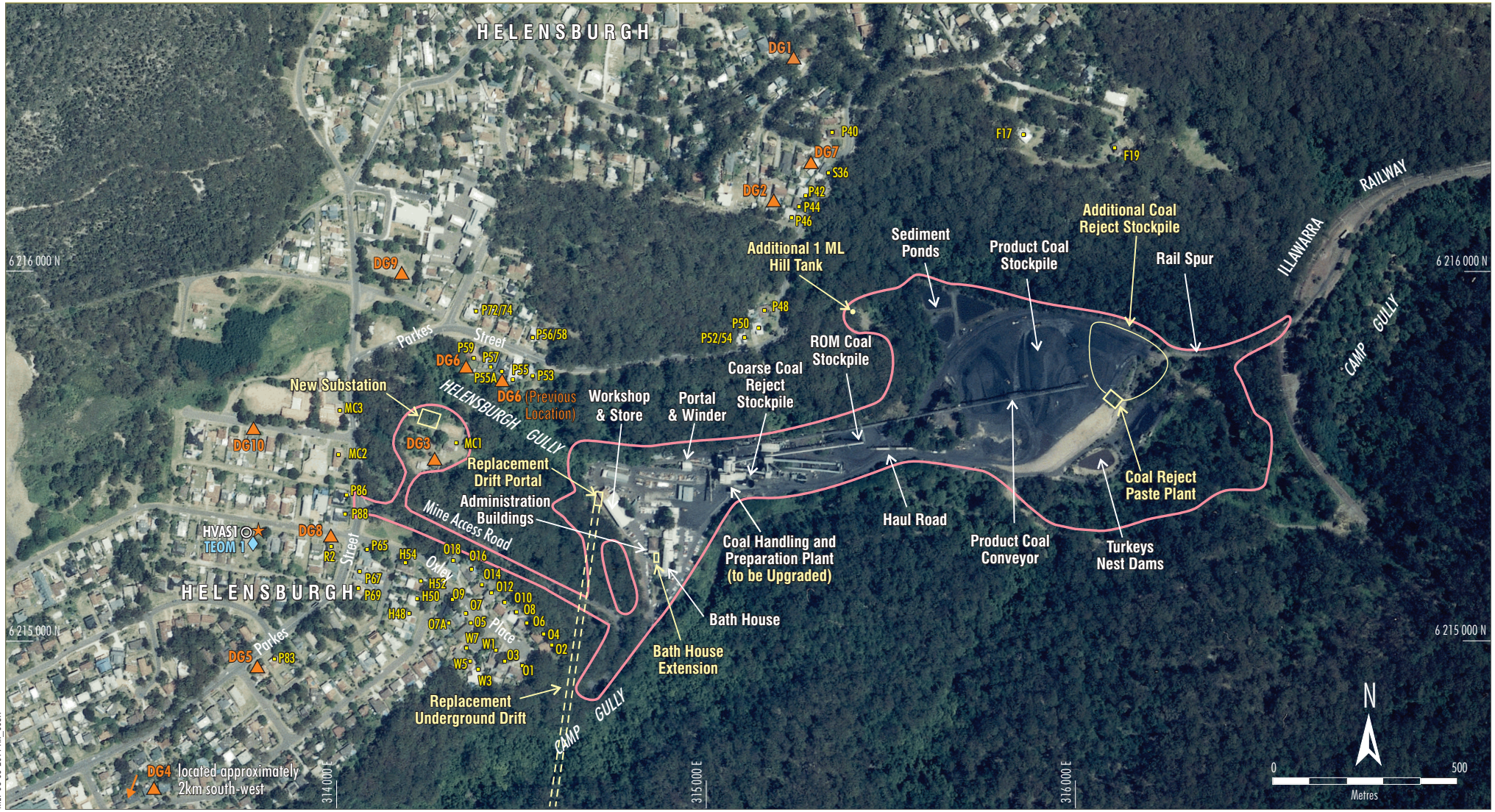
Note: In accordance with Conditions 1, 2 and 3, Schedule 4 of the Project Approval, the assessment, acquisition and mitigation criteria are only applicable from the end of 2014

Peabody

METROPOLITAN COAL

Quarterly Operator Attended Noise Monitoring Results at 36 Old Station Road (September 2010 to December 2019)

Figure 19d



MET-08-08-2019 AR 008A

LEGEND

- Approximate Extent of Major Surface Facilities Area
- P40 Receiver Location
- EPA Licenced Dust Deposition Gauge
- Automatic Weather Station
- High Volume Air Sampler
- TEOM Real Time Dust Monitor

Source: Aerial Photography 2005

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Air Quality Monitoring Sites

Figure 20

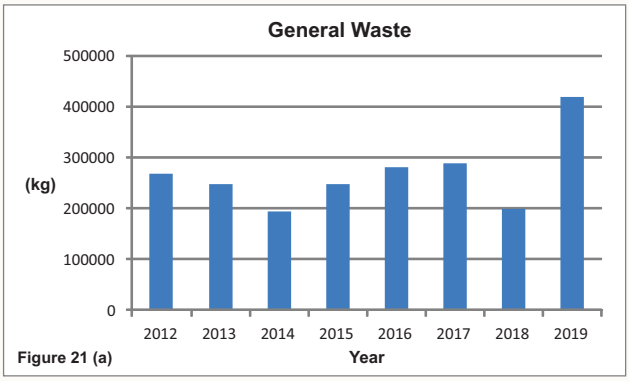

Figure 21 (a)

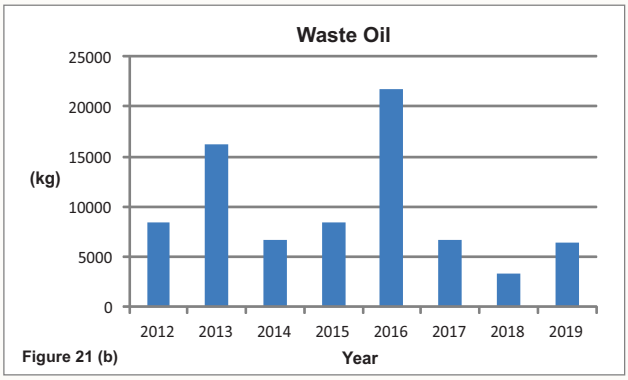

Figure 21 (b)

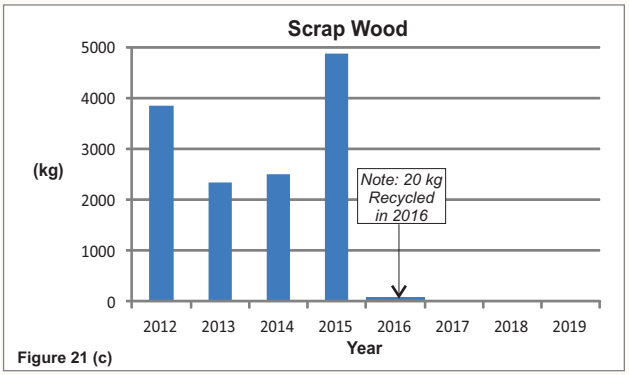

Figure 21 (c)

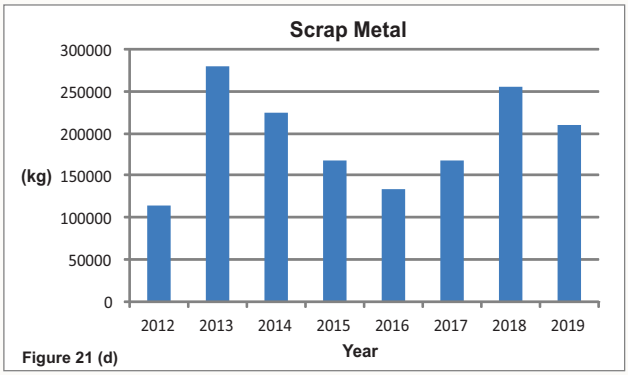

Figure 21 (d)

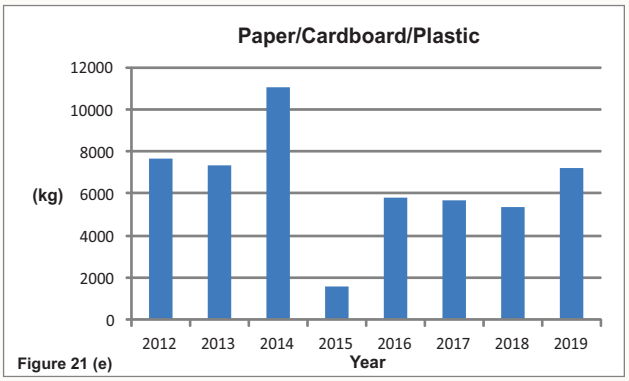

Figure 21 (e)

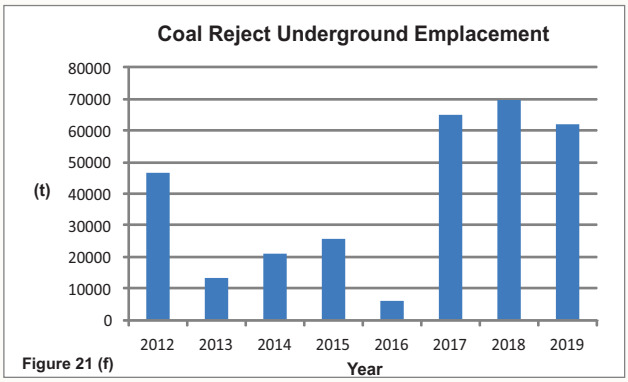

Figure 21 (f)

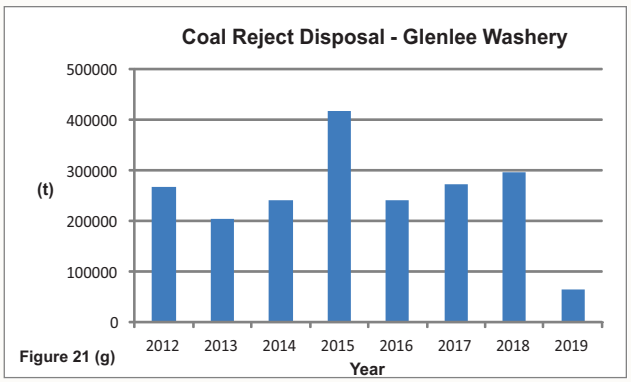

Figure 21 (g)

MET-08-08-2019 AR_013B

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Comparison of Waste Generated and Recycled in 2019 with Previous Years

Figure 21

MET-08-08-2019 AR_010A

LEGEND

- Water Pipeline
- Camp Gully Water Extraction Pipeline
- Licensed Discharge Point
- Water Quality Monitoring
- Volume Monitoring

Note: Site D is located approximately 2.3 km upstream of Site A

Source: Metropolitan Coal (2014) Date of Aerial Photography October 2014

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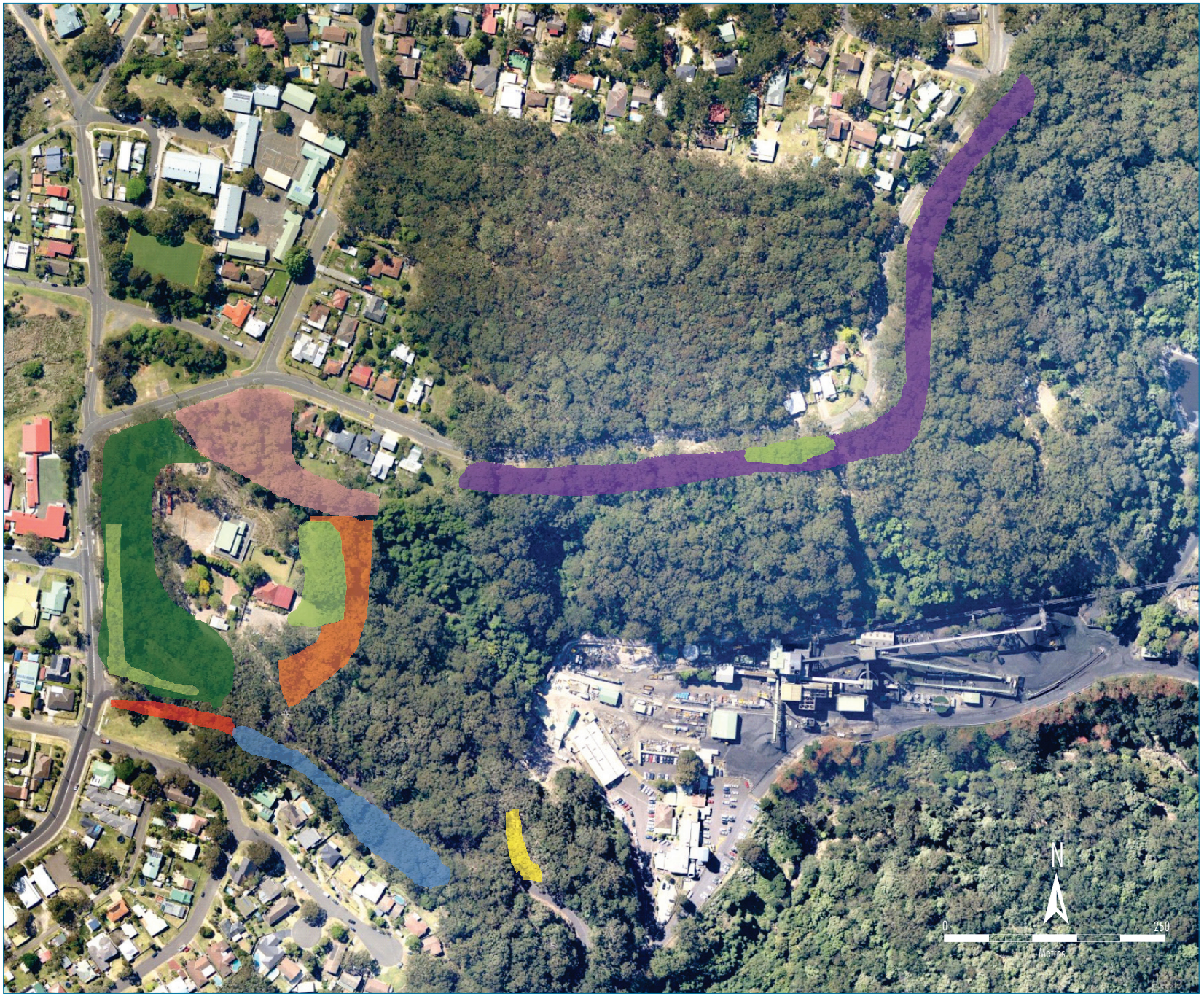
Surface Facilities Area
Water Monitoring Sites

Figure 22



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Rehabilitation Zones Currently Available at the Surface Facilities Area

Figure 23

MET-08-08-2019 AR_011A

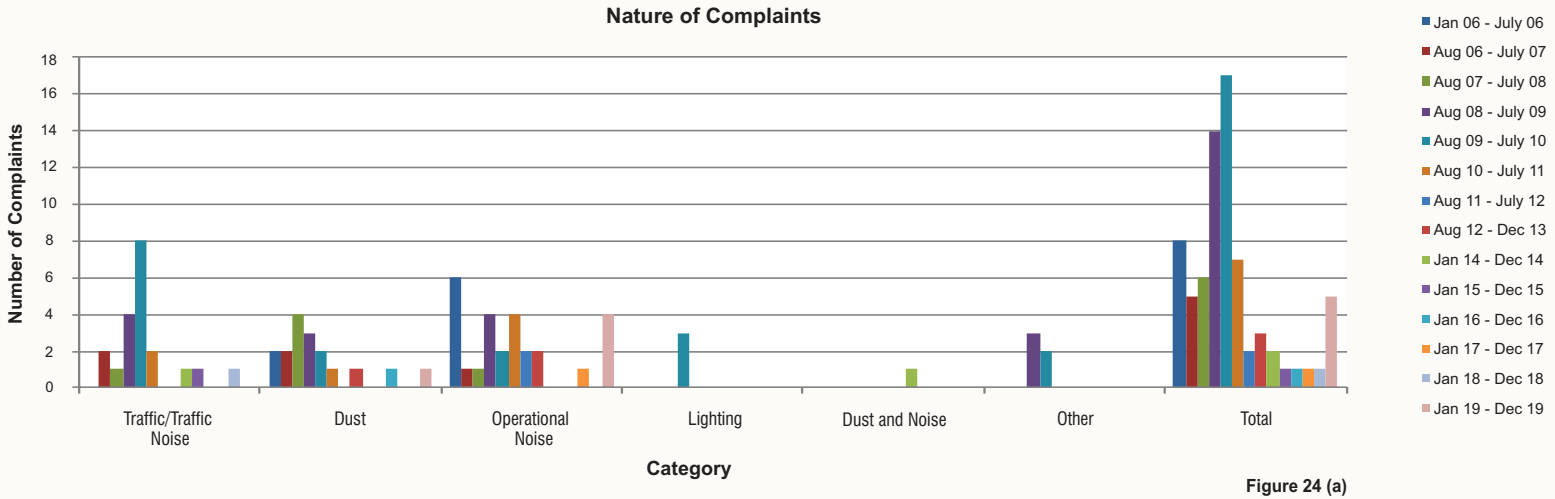

Figure 24 (a)

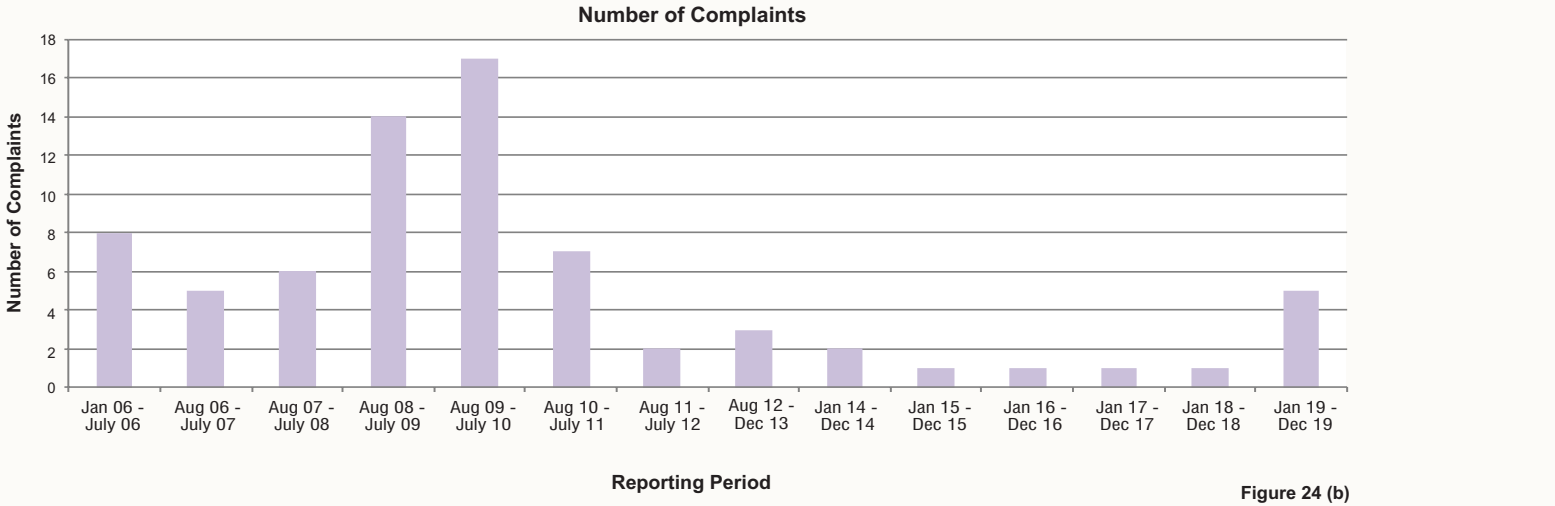

Figure 24 (b)

MET-08-08-2019 AR_012A

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Summary of Complaints Recorded,
January 2006 to December 2019

Figure 24

APPENDICES

APPENDICES A TO N ARE AVAILABLE ON CD (AS LISTED BELOW):

Appendix A	2019 Annual Review Subsidence Monitoring Results
Appendix B1	Metropolitan Coal Six Monthly Surface Water Review 1 January to 30 June 2019
Appendix B2	Metropolitan Coal Six Monthly Surface Water Review 1 July to 31 December 2019
Appendix C1	Metropolitan Coal Six Monthly Review Groundwater Monitoring and Environmental Performance Assessment 1 January to 30 June 2019
Appendix C2	Metropolitan Coal Six Monthly Review Groundwater Monitoring and Environmental Performance Assessment 1 July to 31 December 2019
Appendix D	Mapped Pool Locations on The Waratah Rivulet, Eastern Tributary, Tributary A and Tributary B
Appendix E	Assessment of Performance Measure for Negligible Environmental Consequences on the Waratah Rivulet
Appendix F1	Pools P and U Gas Release Performance Measure Assessment – July to September 2019
Appendix F2	Pool U Gas Release Performance Measure Assessment – October 2019
Appendix F3	Eastern Tributary Assessment Against Water Quality Performance Measure for Manganese and Iron – January to December 2019
Appendix G1	Metropolitan Mine – Groundwater Transect Bore T3 Investigation Report
Appendix G2	Metropolitan Mine – 9EGW2A Investigation Report
Appendix G3	Metropolitan Mine – F6GW4A Investigation Report
Appendix H1	Longwalls 20-22 Spring 2018 Vegetation Monitoring Report
Appendix H2	Longwalls 23-27 Spring 2018 Vegetation Monitoring Report
Appendix H3	Longwalls 301-303 Spring 2018 Vegetation Monitoring Report
Appendix H4	Longwalls 20-22 Autumn 2019 Vegetation Monitoring Report
Appendix H5	Longwalls 23-27 Autumn 2019 Vegetation Monitoring Report
Appendix H6	Longwalls 301-303 Autumn 2019 Vegetation Monitoring Report
Appendix I1	Swamp 20 and Swamp 28 Threatened Flora Assessments
Appendix I2	Waratah Rivulet and Eastern Tributary Threatened Flora Assessments
Appendix I3	Swamp 20, Swamp 28, Waratah Rivulet and Eastern Tributary Threatened Fauna Assessments
Appendix J1	Longwalls 20-22 Spring 2018 Aquatic Ecology Monitoring Report
Appendix J2	Longwalls 23-27 Spring 2018 Aquatic Ecology Monitoring Report
Appendix J3	Longwalls 20-22 Autumn 2019 Aquatic Ecology Monitoring Report
Appendix J4	Longwalls 23-27 Autumn 2019 Aquatic Ecology Monitoring Report

Appendix K1	Longwalls 20-22 Spring-Summer 2018 Amphibian Survey Report
Appendix K2	Longwalls 23-27 Spring-Summer 2018 Amphibian Survey Report
Appendix K3	Longwalls 301-307 Spring-Summer 2018 Amphibian Survey Report
Appendix K4	Supplementary Survey Targeting Littlejohn's Tree Frog, a Threatened Species, in the Metropolitan Coal Underground Mining Area and Surrounds in the Woronora Catchment
Appendix L	2019 Quarterly Attended Noise Monitoring Results
Appendix M	Quarter 1, Quarter 2, Quarter 3 And Quarter 4 Noise Modelling Predictions
Appendix N	Air Quality Monitoring and Environmental Performance Assessment Report