METROPOLITAN COAL

SIX MONTHLY REPORT




1 JANUARY TO 30 JUNE 2017

Peabody

METROPOLITAN COAL

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1 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 north of Wollongong in New South Wales (NSW) (Figure 1).

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* on 22 June 2009. A copy of the Project Approval 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 Metropolitan Coal Environmental Management Structure is shown on Figure 2. In accordance with Condition 6, Schedule 3 of the Project Approval, Metropolitan Coal prepares Extraction Plans for specific mining domains as mining progresses. In accordance with Condition 9(c), Schedule 3 of the Metropolitan Coal Longwalls 23-27 Extraction Plan Approval, this Six Monthly Report has been prepared to report on impacts and environmental monitoring results associated with the Longwalls 23-27 Extraction Plan.

Condition 9(c), Schedule 3 states:

Monitoring and Reporting Requirements

9. The Proponent shall implement a monitoring and reporting procedure that contains the following elements:

...

c) six-monthly reporting of all impacts and environmental monitoring results, including:

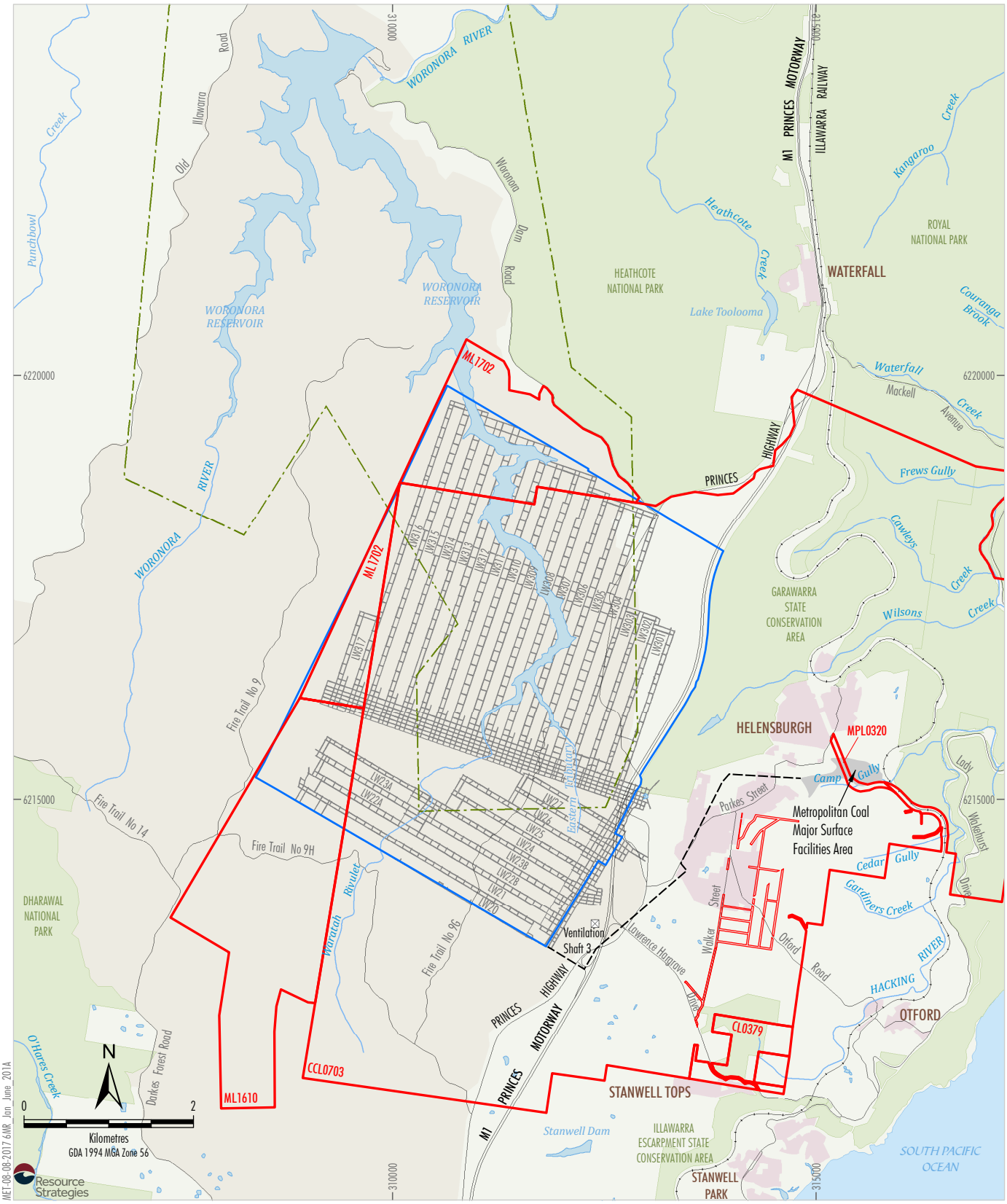
- *a comprehensive summary of all impacts, including a revised characterisation according to the relevant TARP(s);*
- *any proposed actions resulting from Triggers being met in the TARP, or other actions;*
- *assessment of compliance with all relevant performance measures and indicators;*
- *a comprehensive summary of all quantitative and qualitative environmental monitoring results, including landscape monitoring, water quality data, water flow and pool level data, piezometer readings, etc;*

...

Notes:

- *The Director-General may agree to a lesser frequency for the bi-monthly and six-monthly reporting set out above, if subsidence impacts and environmental consequences at the mine are relatively rare and benign in character.*
- *There is no need to include results of the monitoring of subsidence effects within bi-monthly and six-monthly reports to P&I. However, a summary of subsidence effects monitoring results should be included in the Annual Review.*
- *Other regular reports may be required by other agencies for their own purposes, such as reports to the Dams Safety Committee and regular reports assessing impacts of mining close to sensitive built features. P&I expects to receive copies of reports of these types.*

While Condition 9(c), Schedule 3 of the Project Approval is specific to the Metropolitan Coal Longwalls 23-27 Extraction Plan, Metropolitan Coal has also included reporting of impacts and environmental monitoring results associated with Longwalls 20-22 in this Six Monthly Report.



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 (2016); MSEC (2016)

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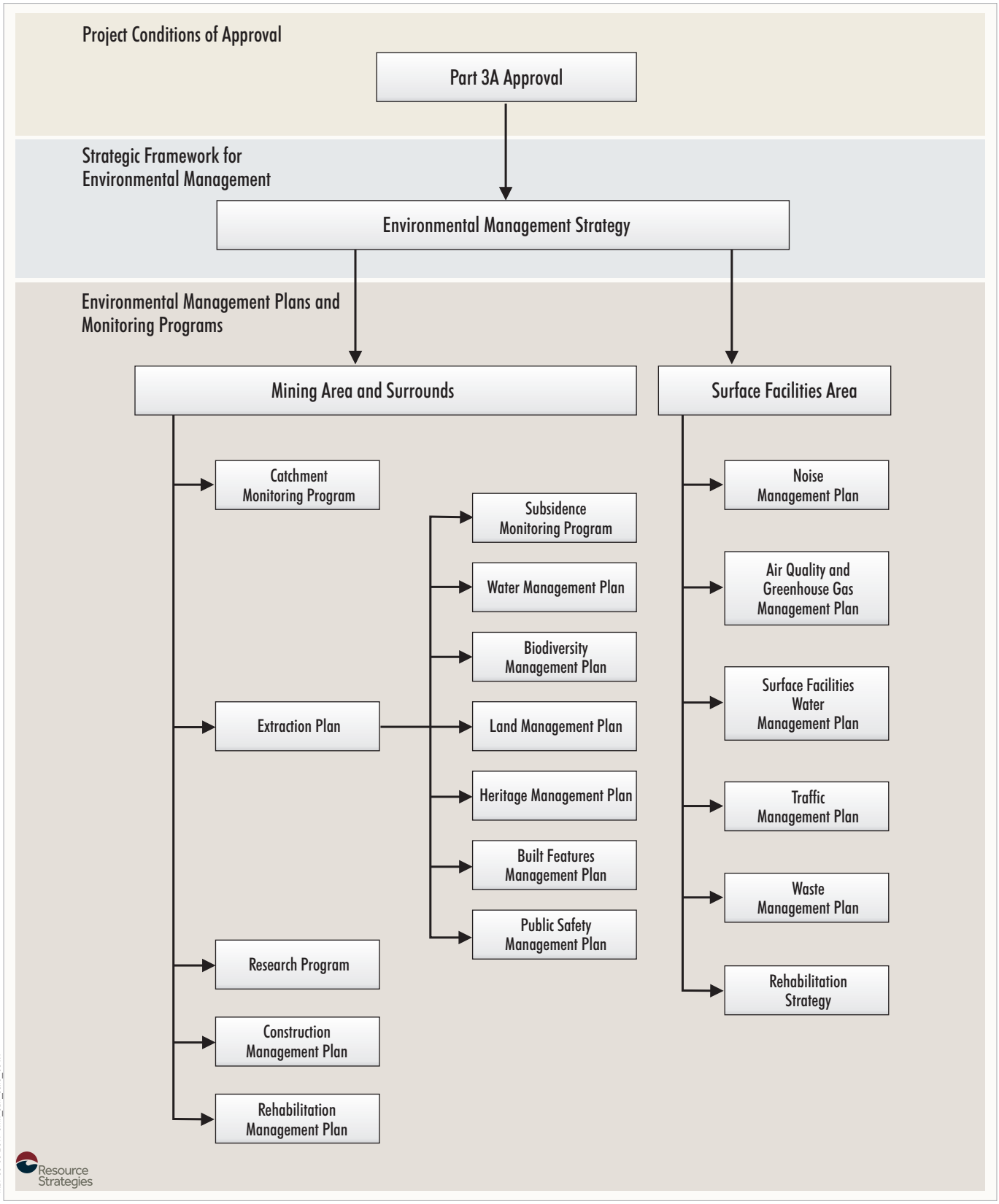
Project Longwalls 20 - 27 and Longwalls 301 - 317 Layout

Figure 1



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Environmental Management Structure

Figure 2

This report presents data for the period 1 January to 30 June 2017. The status of longwall development at the end of the reporting period is shown on Figure 3. Longwall 27 commenced in September 2016 and was completed in March 2017.

Longwalls 301, 302 and 303 (herein referred to as Longwalls 301-303) define the next mining sub-domain within the Project underground mining area (Figure 1). Metropolitan Coal submitted the Longwalls 301-303 Extraction Plan to the Department of Planning and Environment (DP&E) in November 2016. On the 11 May 2017, the DP&E granted approval for Longwalls 301 and 302 with conditions.

The Longwalls 301-303 Extraction Plan includes post-mining monitoring and management of potential subsidence impacts and environmental consequences, subject to the two previously approved Metropolitan Coal Extraction Plans for Longwalls 20-22 and Longwalls 23-27. That is, the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans will be superseded by the Longwalls 301-303 Extraction Plan following the commencement of Longwall 301. The extraction of Longwall 301 commenced on 28 June 2017.

Further to the receipt of DP&E's approval for Longwalls 301 and 302 and prior to commencement, the commencing (i.e. northern) end of Longwall 301 was shortened by 90 m due to the unexpected thinning of the seam (seam thickness reduced to approximately 2.5 m) and the carbon dioxide content in the coal (which posed safety challenges in order to drain below mining thresholds; the presence of tight coal conditions required drainage holes to be installed at an intensity not previously experienced at Metropolitan Coal). The updated longwall layout is shown on the Six Monthly Report figures.

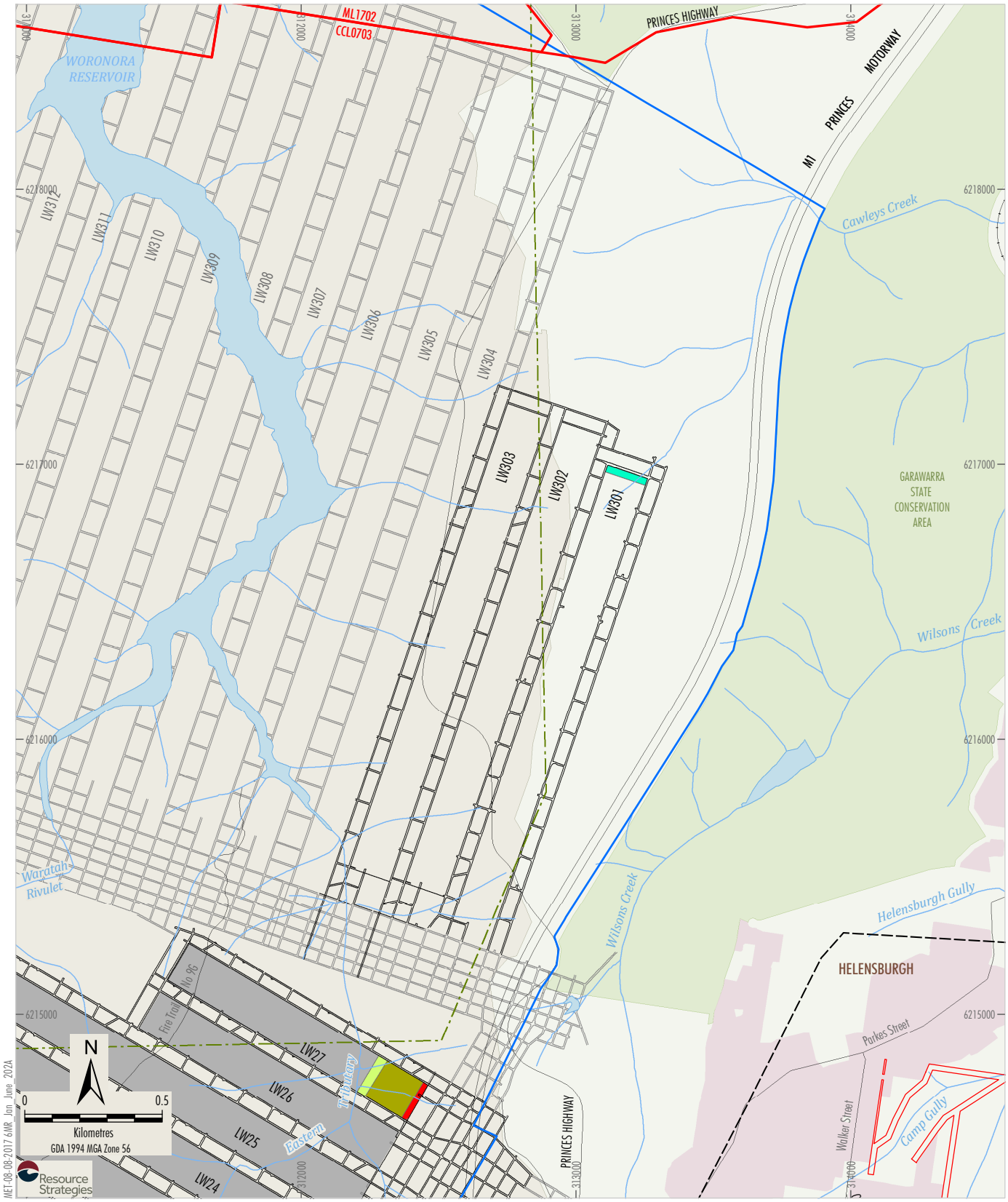
Further to consultation with the NSW Mine Safety Operations and conduct of risk assessments in relation to the contained gas levels and risk of outburst, operations for Longwall 301 commenced by remote mining techniques on 28 June 2017. Metropolitan Coal is undertaking further analysis of coal quality to inform the economical commencing (i.e. northern) end of Longwall 302. The observed deterioration in coal quality suggests an environmental/geological mechanism during coal deposition that has caused oxidisation and loss of coking properties.

2 SUBSIDENCE MONITORING

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Subsidence Monitoring Programs were prepared to validate subsidence predictions and analyse the relationship between the subsidence effects and subsidence impacts of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans in accordance with Condition 6(e), Schedule 3 of the Project Approval.

As reported previously, the Metropolitan Coal Longwalls 20-22 Subsidence Monitoring Program was effectively discontinued as the appropriate subsidence survey lines and points for ongoing monitoring were incorporated into the Metropolitan Coal Longwalls 23-27 Subsidence Monitoring Program.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Subsidence Monitoring Program. Subsidence movements are surveyed in three dimensions using a total station survey instrument. The subsidence parameter monitoring locations for Longwalls 23-27 and Longwalls 301-303 are shown on Figure 4.



LEGEND

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

Development

- January 2017
- February 2017
- March 2017
- June 2017

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

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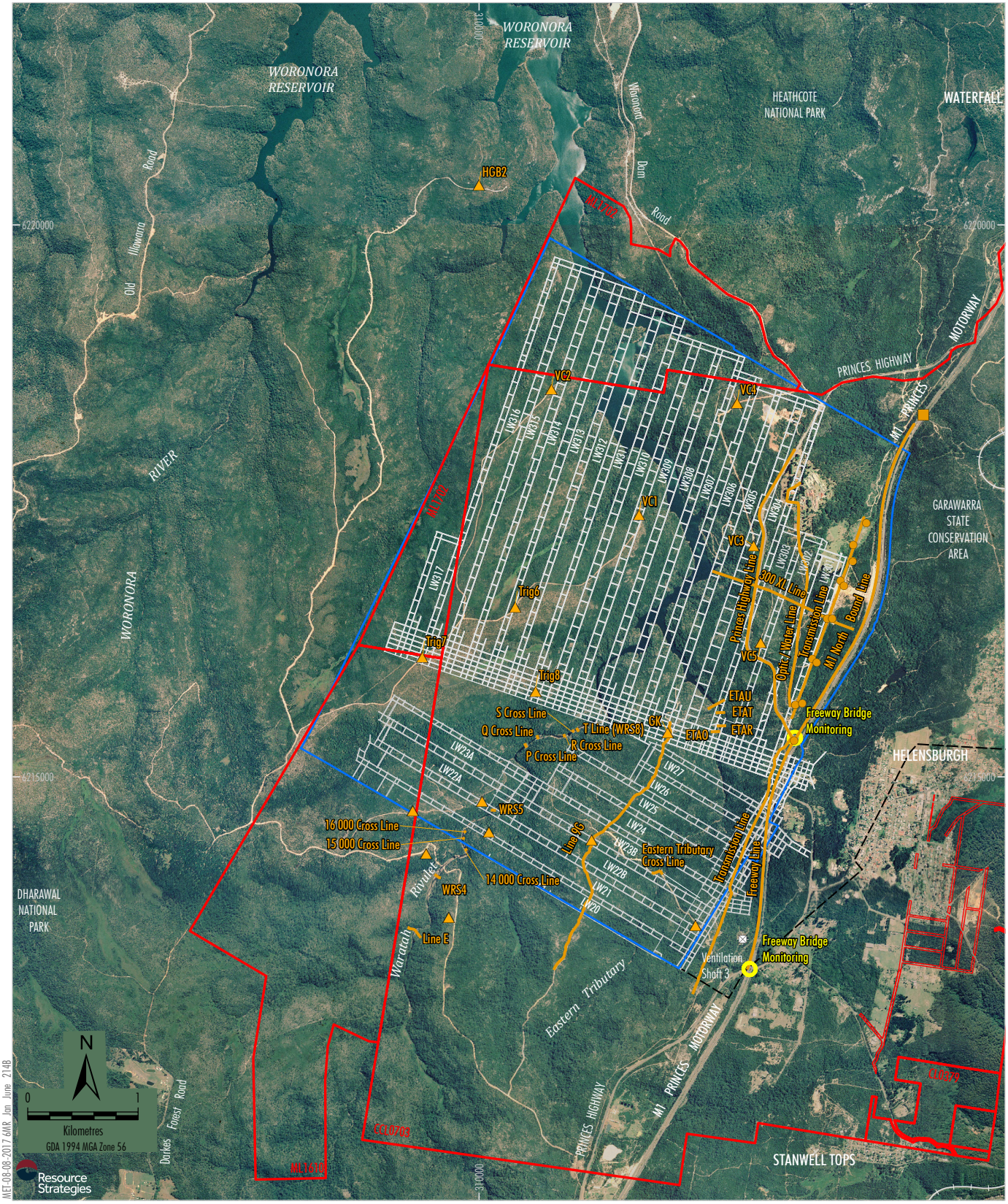
Monthly Production Plan
January to June 2017

Figure 3



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
- Freeway Bridge Subsidence Monitoring
- Cawley Road Overbridge
- Transmission Towers -
  Endeavour Energy and TransGrid

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2016); MSEC (2016)

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Subsidence Monitoring Locations

Figure 4

2.1 PREDICTED AND OBSERVED SUBSIDENCE MOVEMENTS

A review of the subsidence survey results and comparison between the predicted and observed subsidence movements for the reporting period has been conducted by Mine Subsidence Engineering Consultants (MSEC). The reporting period included the completion of Longwall 27. Details of the observed and predicted subsidence movements at the subsidence monitoring locations (D Line, Line 9G, Transmission Line, Freeway Line, Ridge to Ridge Monitoring Points, Waratah Rivulet Cross Lines and Eastern Tributary Cross Line, Figure 4) are provided in Appendix A. A summary of the key findings is provided below.

Consistent with prior reporting, the maximum observed total subsidence along Line 9G was slightly greater than predicted, above the previously extracted Longwalls 20 and 21. A review conducted following the completion of Longwall 24 indicated that the increased subsidence and steep subsidence profile may be the result of the localised geological conditions (a zone of small scale fracturing and increased jointing were identified from geological records) and pillar consolidation of the abandoned mains (B West Mains) from prior longwalls between Longwall 20 and Longwalls 1 to 18 due to increasing abutment load with successive longwalls.

The observed profile shapes and subsidence parameters at other subsidence monitoring locations were generally less than predicted or within the limits of survey accuracy (±20mm for vertical subsidence, ±0.5mm/m for tilt and ±0.5 mm/m for tensile and compressive strain).

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 is shown on Chart 1. The comparison of conventional subsidence effects excludes the valley cross lines which represent non-conventional subsidence movements.

Based on the results of survey data to date and comparison with predicted conventional subsidence parameters, the profile of vertical displacement adequately reflects the predictions and subsidence effects of the Project do not exceed predictions by more than 15%.

Some observed subsidence parameters, while small in magnitude, are greater than the quoted survey accuracy limits and have been attributed to survey accuracy in the MSEC report. Metropolitan Coal propose to address this issue by defining accuracy limits that better reflect the varying topographical conditions, and undertaking a review of surveying practices to improve consistency of monitoring data. This review will include a review of accuracy limits, and ways to further improve field survey procedures.

Comparison between the maximum observed and maximum predicted total subsidence for Longwalls 3 to 27 at Metropolitan Colliery

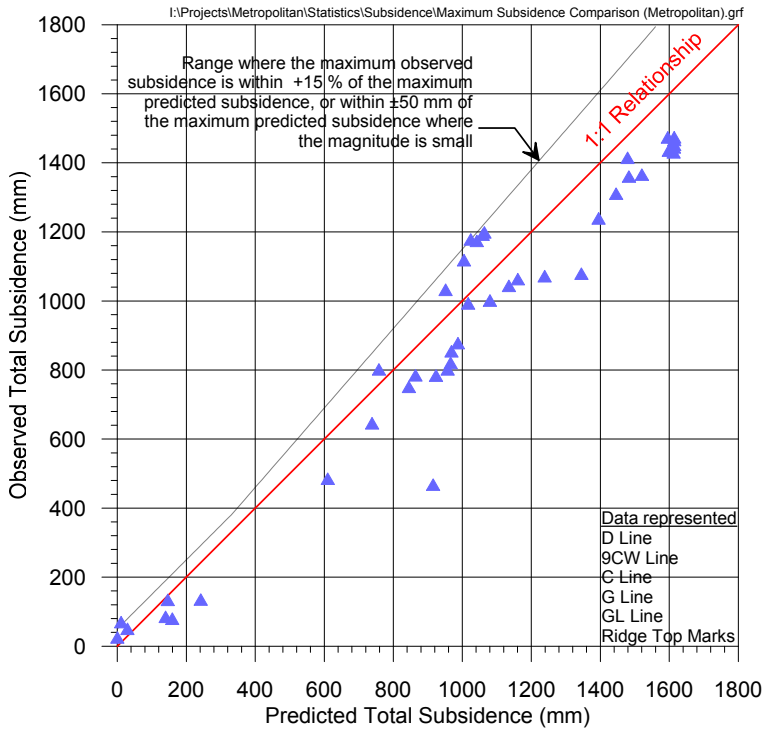


Chart 1 Comparison between the Maximum Observed and Maximum Predicted Total Conventional Subsidence for Longwalls 3 to 27 at Metropolitan Colliery

2.2 SUBSIDENCE MOVEMENTS AT THE WARATAH RIVULET GAUGING STATION

The Waratah Rivulet gauging station, owned by WaterNSW, is located at Pool Q. The primary purpose of the gauging station is the monitoring of stream flows. WaterNSW's use of the stream flow monitoring data includes the assessment of Woronora Reservoir environmental flow release requirements. Metropolitan Coal sources the stream flow monitoring data from WaterNSW to assess potential mining-related impacts on Waratah Rivulet stream flows.

Metropolitan Coal has monitored and assessed subsidence in the vicinity of the Pool Q gauging station in accordance with the Metropolitan Coal Longwalls 23-27 Subsidence Monitoring Program. The Waratah Rivulet Gauging Station Contingency Plan indicates that in the event the differential survey data indicates that vertical and horizontal movements exceed ±15 millimetres (mm) Metropolitan Coal will assess the extent of the movement and whether the movement has the potential to alter the stream flow rating curve. Differential vertical movements at the Q, QA and QB subsidence monitoring lines were less than 15 mm (Appendix A).

2.3 SOUTHERN SYDNEY SHELTERED FOREST ON TRANSITIONAL SANDSTONE SOILS IN THE SYDNEY BASIN BIOREGION ENDANGERED ECOLOGICAL COMMUNITY

In accordance with the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan, an assessment has been conducted of the subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion Endangered Ecological Community situated approximately 300 m to 500 m to the east of Longwalls 23-27.

The assessment of subsidence effects included assessment of the Freeway Line and the Transmission Line (Figure 4), which are located between the Endangered Ecological Community and Longwalls 23-27, and which are detailed in Appendix A. The results of the assessment indicate that the subsidence parameters to the east of Longwalls 23-27 were as predicted or less than those predicted for the reporting period.

3 WATER MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans were prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on watercourses (including the Woronora Reservoir), aquifers and catchment yield in accordance with Condition 6, Schedule 3 of the Project Approval.

Hydro Engineering & Consulting (2017) and HydroSimulations (2017) 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 reports are provided in Appendices B and C, respectively. The surface water, groundwater and meteorological monitoring locations are shown on Figures 5 to 10.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Water Management Plan (which includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27).

In accordance with Condition 1 of the Longwalls 301 and 302 approval, Metropolitan Coal will install a number of additional groundwater monitoring bores. Metropolitan Coal will also review and revise the Longwalls 301-303 Water Management Plan Trigger Action Response Plan (TARP) in accordance with Condition 4 of the Longwalls 301 and 302 approval.

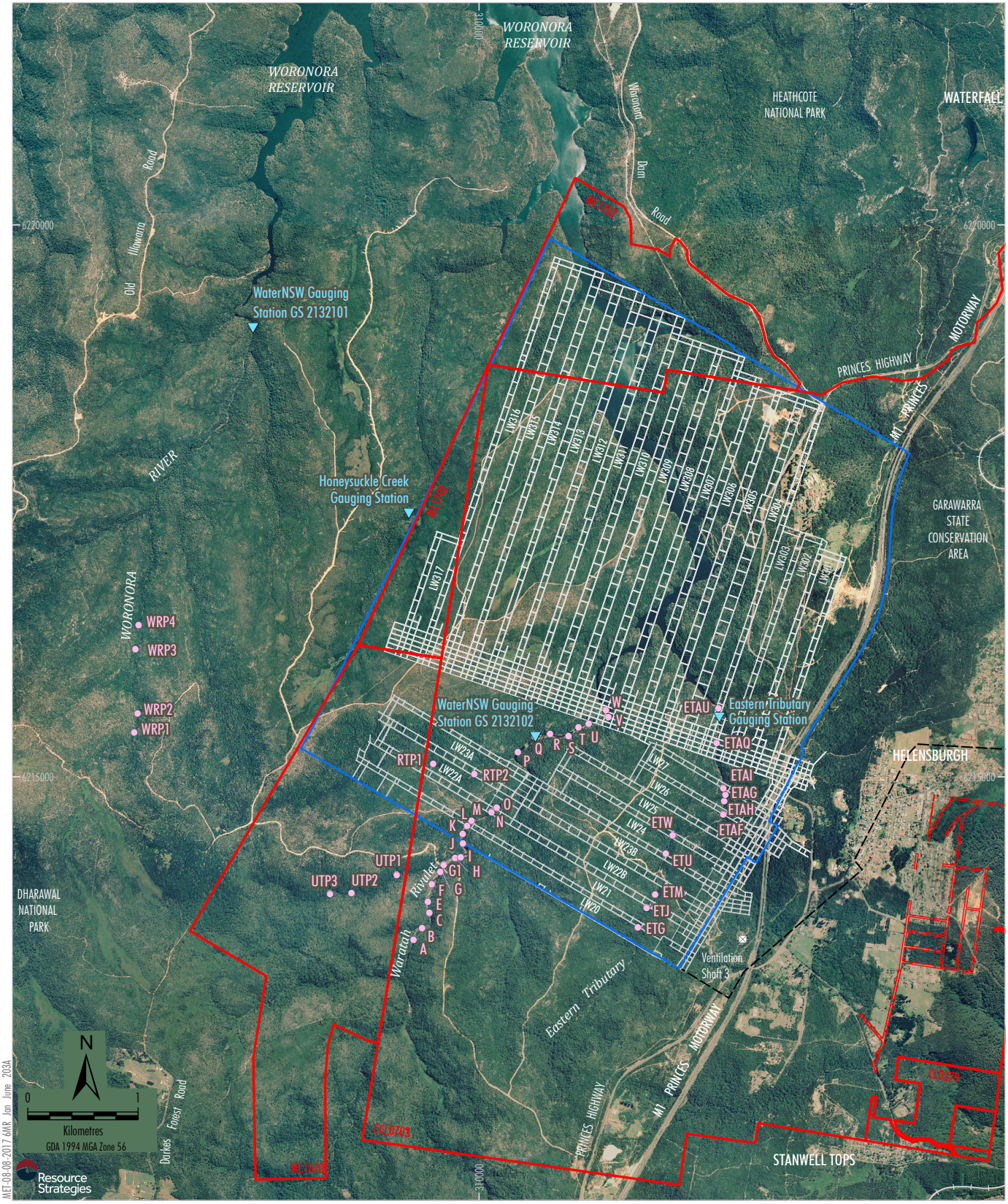
Condition 2 of the Longwalls 301 and 302 approval requires Metropolitan Coal to engage independent experts to prepare a Woronora Reservoir Impact Strategy to provide a staged plan of action for further investigations and a report into the impacts of mining near the reservoir. Professor Bruce Hebblewhite (B. K. Hebblewhite Consulting), Dr Frans Kalf (Kalf and Associates Pty Ltd) and Emeritus Professor Thomas McMahon (University of Melbourne) were engaged as the independent experts during the reporting period.

3.1 STREAM FEATURES

Visual and photographic surveys have been conducted monthly when Longwalls 20-22 and Longwalls 23-27 mining have been within 400 m of the Waratah Rivulet and Eastern Tributary, and within three months of the completion of each longwall. Visual and photographic surveys of Tributary A and Tributary B have also been conducted within three months of the completion of each longwall.

The visual and photographic surveys conducted at the end of each longwall provide a detailed photographic record of stream features. During the reporting period, a detailed photographic record of stream features was conducted at the end of Longwall 27.

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 (Tables 1 and 2), Eastern Tributary (Tables 3 and 4), Tributary A (Table 5) and Tributary B (Table 6). The location of mapped pools on the Waratah Rivulet, Eastern Tributary, Tributary A and Tributary B are provided in Appendix D.



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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

Note: Pool numbering is consistent with the detailed stream mapping for Waratah Rivulet and the Eastern Tributary provided in WMP Appendices 1 to 4.

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2016); MSEC (2008; 2016)

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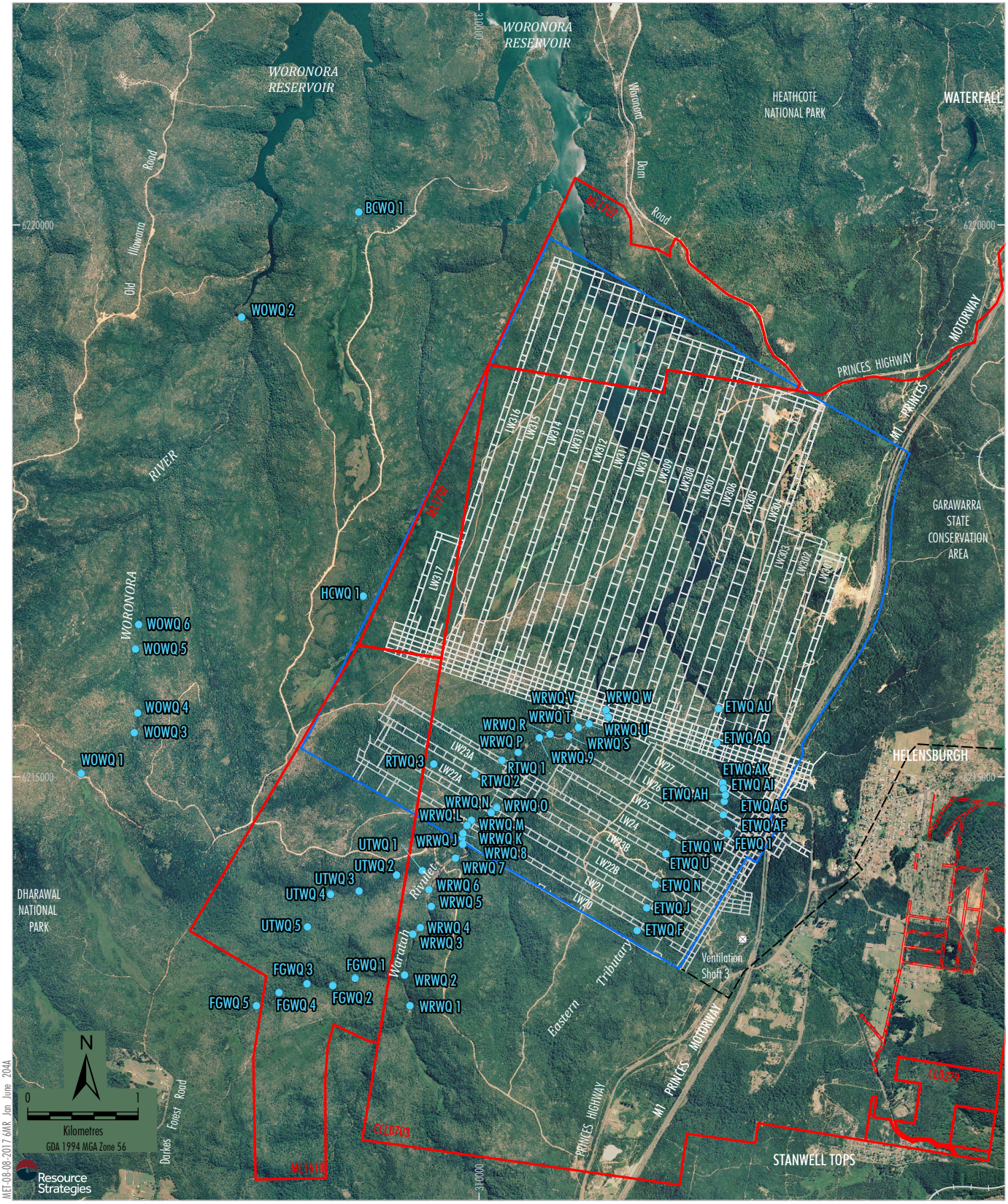
Surface Water Quantity Sites

Figure 5



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 (2016); MSEC (2016)

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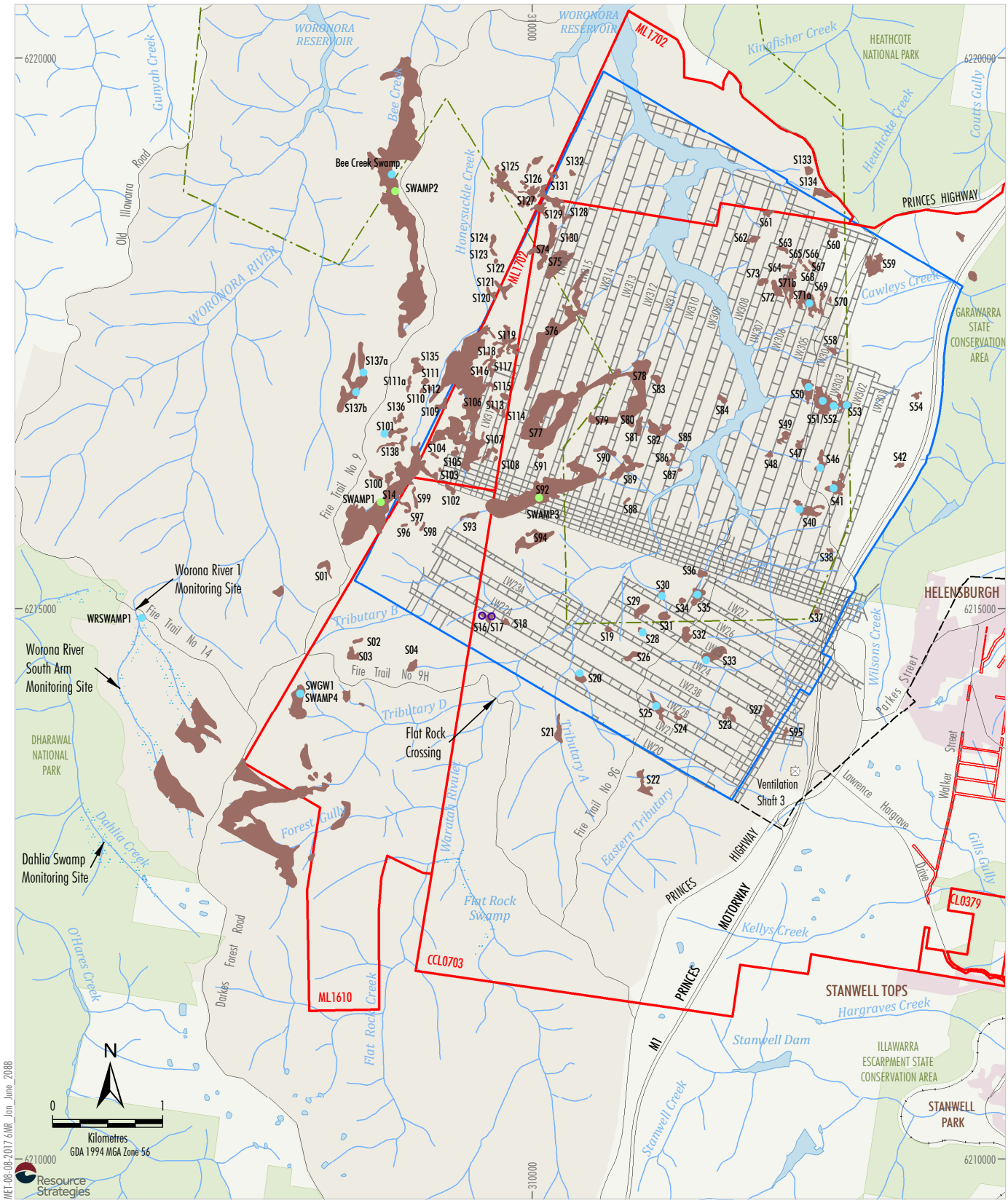
Surface Water Quality Sites

Figure 6



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)
- 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 (2016); MSEC (2016)

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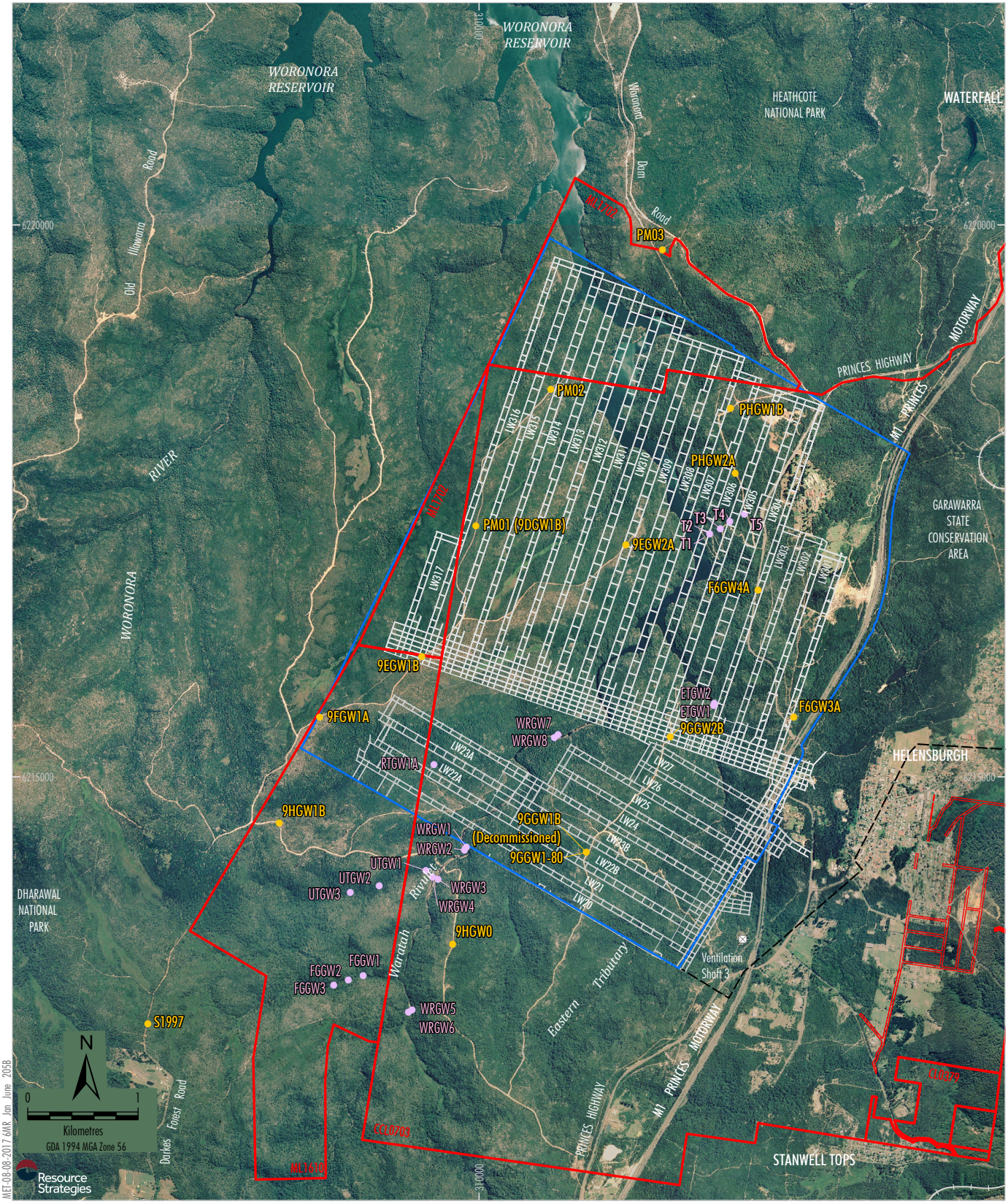
Upland Swamp and Upland Swamp Groundwater Piezometer Locations

Figure 7



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 (2016); MSEC (2016)

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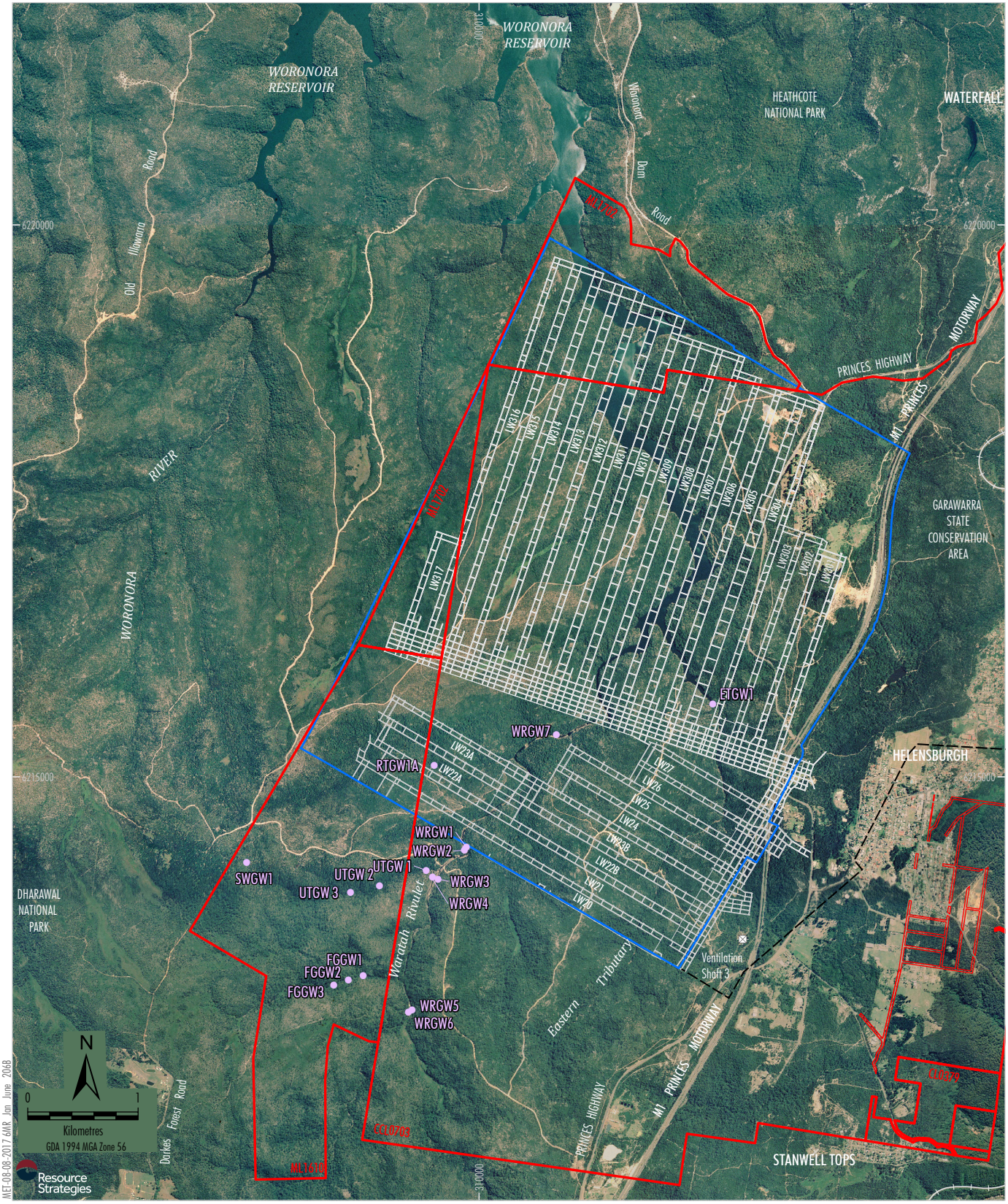
Groundwater Level
and/or Pressure Bore Locations

Figure 8



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LEGEND

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

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2016); MSEC (2016)

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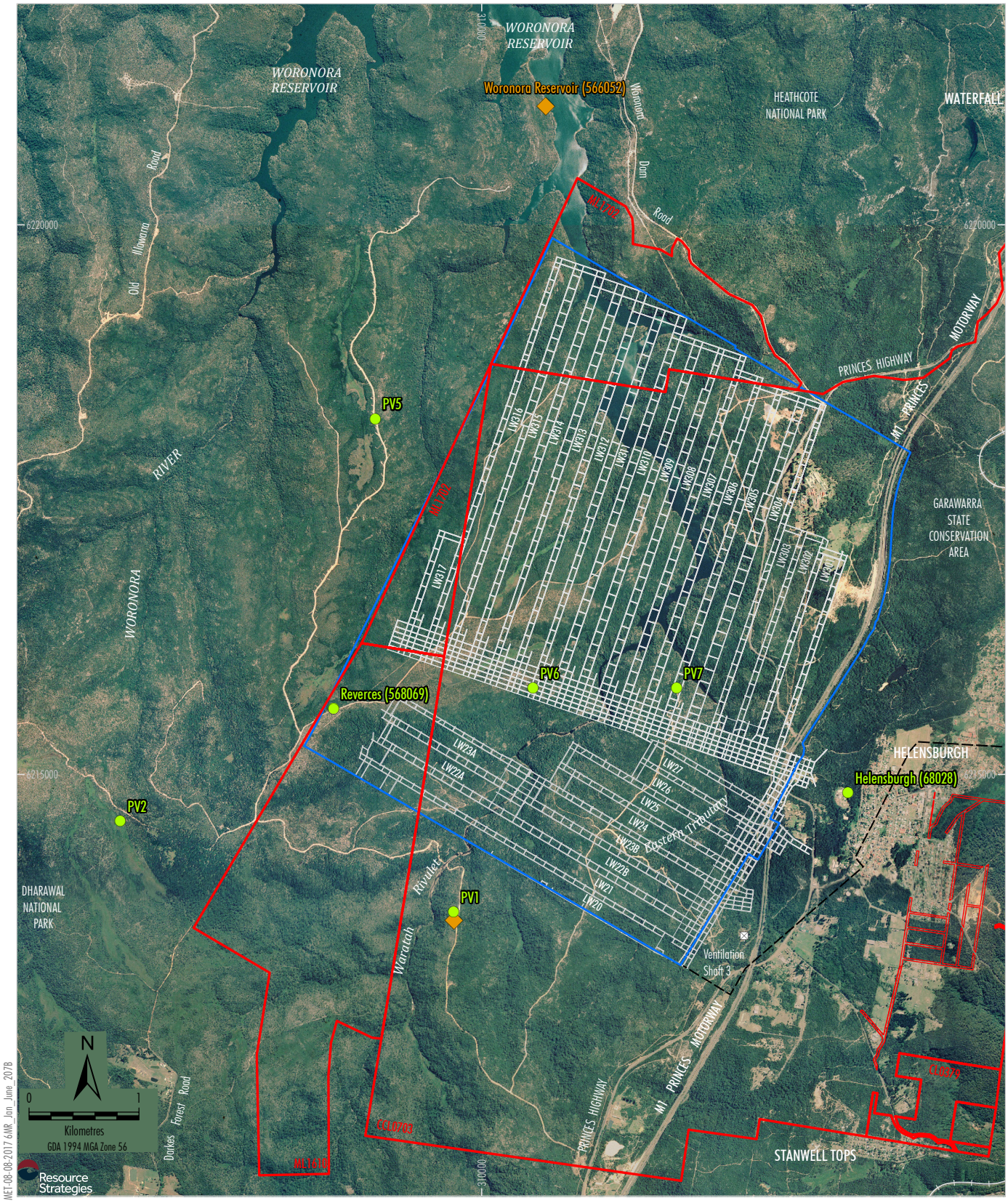
Groundwater Quality Sites

Figure 9



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LEGEND

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

Note: 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).

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2016); MSEC (2016)

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Meteorological Sites

Figure 10

The visual and photographic surveys noted continued scouring along streams with alluvial deposits, as a result of high water flows following heavy rainfall events.

Table 1
Monitoring of Stream Features
Waratah Rivulet, Upstream of the Longwall 23 Maingate (upstream of Pool P)

Stream Feature	Summary of Observations
Surface Cracking	Some widening of existing cracking was observed at the downstream end of the rock bar of Pool H on the Waratah Rivulet during the reporting period. No new cracking upstream of the Longwall 23 maingate on the Waratah Rivulet was observed during the reporting period.
Surface Flow/ Pool Water Levels	Compared to the October 2016 inspection (following the completion of Longwall 26), a reduction in surface flow/pool water levels was noted along the Waratah Rivulet during the visual inspections conducted in January/February 2017 as a result of the prevailing climatic conditions. Water levels in pools on the Waratah Rivulet upstream of Pool P (i.e. in Pools A, B, C, E, F, G, G1, H, I, J, K, L, M, N and O) have either been manually monitored or monitored using a continuous water level sensor and logger (Figure 5 and Appendix D). The monitoring results are discussed in Section 3.3 and Appendix B.
Iron Staining/ Flocculent	Iron staining/flocculent continues to be observed at rock bars and/or pools on Waratah Rivulet upstream of the Longwall 23 maingate consistent with prior reporting.
Gas Releases	Gas releases continued to be observed and monitored in Pool L (January to May 2017). Gas releases were also observed in Pool A from February to June 2017. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed.
Water Discoloration/ Opacity	Orange in colour where iron staining occurred. Pools along the Waratah Rivulet continue to be observed with a green opacity.

Table 2
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 reporting period.
Surface Flow/ Pool Water Levels	Compared to the October 2016 inspection (following the completion of Longwall 26), a reduction in surface flow/pool water levels was noted along the Waratah Rivulet in January/February 2017 as a result of the prevailing climatic conditions. 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 5 and Appendix D). The monitoring results are discussed in Section 3.3 and Appendix B.
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) continues to be recorded within this reach. Iron staining has also been recorded in Tributary B, near the confluence with the Waratah Rivulet at the upstream end of Pool P.
Gas Releases	Gas releases continued to be observed and monitored in Pool P (January to June 2017) and in Pool U (January to June 2017) on the Waratah Rivulet. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed. During the reporting period, the performance indicator, *No gas releases observed at Pools Q to W on the Waratah Rivulet,* continued to be exceeded for Pool U (also exceeded in the previous reporting period).

Table 2 (continued)
Monitoring of Stream Features
Waratah Rivulet, Downstream of Longwall 23 Maingate

Stream Feature	Summary of Observations
Gas Releases (continued)	The exceedance triggered an assessment against the performance measure for the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (emphasis added): *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**).* The assessment was conducted by Associate Professor Barry Noller and concluded the performance measure in relation to gas releases had been met (The University of Queensland, 2017). The assessment is provided in Appendix E. The performance measure assessment by Associate Professor Barry Noller has been subject to peer review in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans. The peer review conducted by Dr Ross Sadler (Griffith University, 2017) is provided in Appendix F. The peer review also concluded the Waratah Rivulet gas release performance measure had been met.
Water Discoloration/ Opacity	Pools along the Waratah Rivulet continue to be observed with a green opacity.

Table 3
Monitoring of Stream Features
Eastern Tributary, Upstream of Longwall 26 Maingate

Stream Feature	Summary of Observations
Surface Cracking	In the reporting period, new cracking was observed upstream of the Longwall 26 maingate on the Eastern Tributary at Rock bar ETY and the previously recorded cracking at Boulderfield ETX and Rock bar ETZ was observed to have increased (location of stream features shown in Appendix D).
Surface Flow/ Pool Water Levels	From January to February 2017, Pools ETH to ETZ were observed to be dry or without surface flow. At the time of the March/April 2017 visual inspections, all pools upstream of the Longwall 26 maingate on the Eastern Tributary contained water and surface flow (i.e. no pools were dry). Water levels in a number of pools on the Eastern Tributary upstream of the Longwall 26 maingate (i.e. in Pools ETG, ETJ, ETM, ETU, ETW and ETAF) have been monitored using a continuous water level sensor and logger (Figure 5). The monitoring results are discussed in Section 3.3 and in Appendix B.
Iron Staining/ Flocculent	Iron staining/flocculent continues to be observed at rock bars and/or pools on the Eastern Tributary upstream of the Longwall 26 maingate consistent with prior reporting. The extent of iron staining/flocculent was reduced at a number of pools, compared to the previous inspection, as a result of recent rain.
Gas Releases	No gas releases have been observed on the Eastern Tributary upstream of the Longwall 26 maingate during the reporting period.
Water Discoloration/ Opacity	Pools along the Eastern Tributary observed with a green opacity, and orange in colour where iron staining occurred. The water coloration of a number of pools was observed to be clearer in March/April 2017.

Table 4
Monitoring of Stream Features, Eastern Tributary, Downstream of Longwall 26 Maingate

Stream Feature	Summary of Observations
Surface Cracking	Monthly inspections undertaken since January 2017 have identified new and increased cracking at a number of stream features. As at 28 June 2017, 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, Rock bar ETAP, Pool ETAQ. Rock bar ETAQ, Pool ETAR and Rock bar ETAU. From March 2017 to June 2017, increased water levels in a number of pools resulted in the majority of previously recorded cracks being submerged and unable to be observed.
Surface Flow/ Pool Water Levels	The pools on the Eastern Tributary downstream of the Longwall 26 maingate have been visually inspected by Metropolitan Coal and photographed to observe whether any changes to the natural drainage behaviour of the pools has occurred. As at December 2016, changes in the natural drainage behaviour of pools had been observed at Pools ETAH, ETAI, ETAJ, ETAK, ETAL, ETAM, ETAN and ETAR (location of pools shown in Appendix D). [The Longwalls 23-27 Water Management Plan indicated that the valley closure subsidence predictions would likely result in the cracking and dilation of bedrock resulting in the localised diversion of flow at Pools ETAH, ETAI, ETAJ, ETAK, ETAL.] In January 2017, the natural drainage behaviour of additional pools on the Eastern Tributary was observed to be impacted by mine subsidence. The observed impacts to the 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 on 3 February 2017. A summary of the Eastern Tributary Incident was provided in the Metropolitan Coal 2016 Annual Review. Metropolitan Coal's actions in relation to the Eastern Tributary Incident are described in Section 3.12. Since heavy rainfall in March 2017, no pools on the Eastern Tributary downstream of the Longwall 26 maingate have been dry (as evident in the May 2017 visual inspections photographic record). No additional pools to those identified previously as being impacted (in terms of drainage behaviour) have been observed to be impacted by mine subsidence. Water levels in a number of pools on the Eastern Tributary downstream of the Longwall 26 maingate (i.e. in Pools ETAG, ETAH, ETAI, ETAQ and ETAU) have been monitored using a continuous water level sensor and logger (Figure 5 and Appendix D). The monitoring results are discussed in Section 3.3 and in Appendix B.
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. Metropolitan Coal's actions in relation to the Eastern Tributary Incident are described in Section 3.12. Since October 2016, inspections have been conducted monthly to record the extent of iron staining. A period of high rainfall in March 2017 resulted in a reduction in the previously recorded extent of iron staining in the Eastern Tributary. As at 28 June 2017, iron staining/flocculent remained present at a number of stream features between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir, including; Boulderfield ETAF, Rock bar ETAF(2), Pool ETAG, Boulderfield ETAG, Rock bar ETAH, Pool ETAK, Boulderfield ETAL, Rock bar ETAL, Boulderfield ETAM, Boulderfield ETAP, Rock bar ETAP, Rock bar ETAQ, Pool ETAR, Boulderfield ETAR and Rock bar ETAU.
Gas Releases	Gas releases were observed in Pool ETAG on 15 February 2017 and in Pool ETAI on 1 March 2017 (location of pools shown in Appendix D). No gas releases were observed on the Eastern Tributary for the remainder of the reporting period. The gas releases were predominantly comprised of methane. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed. The performance indicator for the Eastern Tributary, *Gas releases observed over less than 30% of the between the full supply level of the Woronora Reservoir and Pool ETAF,* was not exceeded, however consideration of the gas releases at Pools ETAG and ETAI was made in the assessment conducted for Pool U by Associate Professor Barry Noller (The University of Queensland, 2017) (provided in Appendix E).
Water Discoloration/ Opacity	Orange in colour where iron staining occurred. Pools along the Eastern Tributary observed with a green opacity.

Table 5
Monitoring of Stream Features – Tributary A

Stream Feature	Summary of Observations
Surface Cracking	No new cracking on Tributary A was recorded by the visual inspections.
Surface Flow/ Pool Water Levels	An increase in surface flow/pool water levels was observed along Tributary A by the visual inspections (May 2017), including at locations noted in the previous inspection (October 2016) to be dry.
Iron Staining/ Flocculent	Iron staining/flocculent continued to be present in sections of Tributary A, in particular, at Pool TA-H, Pool TA-L, Pool TA-M and in the boulderfield downstream of Pool TA-R (location of pools shown in Appendix D).
Gas Releases	No gas releases have been observed on Tributary A.
Water Discoloration/ Opacity	Orange in colour where iron staining occurred.

Table 6
Monitoring of Stream Features – Tributary B

Stream Feature	Summary of Observations
Surface Cracking	No new cracking on Tributary B was recorded by the visual inspections.
Surface Flow/ Pool Water Levels	At the time of the end of Longwall 27 stream mapping inspection, sections of Tributary B were dry with no surface flow; in particular in the reach between Pools TB-I and TB-Z (location of pool reach shown in Appendix D). Some of the visual inspections were conducted in May 2017, subsequent to heavy rainfall in March 2017. Water levels in a number of pools along Tributary B were noted to be higher compared to observations made in October 2016 (end of Longwall 26 visual observations). Water levels in pools on Tributary B (at water level sites RTP1 and RTP2, Figure 5) have been monitored using a continuous water level sensor and logger. The monitoring results are discussed in Section 3.3 and in Appendix B.
Iron Staining/ Flocculent	Iron staining/flocculent continued to be present in a number of pools/rock bars along Tributary B to its confluence with the Waratah Rivulet.
Gas Releases	No gas releases have been observed on Tributary B.
Water Discoloration/ Opacity	Orange in colour where iron staining occurred. Some pools with green opacity.

3.2 SURFACE WATER FLOW

Waratah Rivulet stream flow data (GS 2132102, Figure 5) 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' 1 year period does not fall below the 20th percentile of the baseline data. Chart 2 indicates that the 12 month sliding median has not fallen below the 20th percentile value.

Surface water flow monitoring at the Waratah Rivulet, Woronora River (Figure 5) and O'Hares Creek gauging stations indicates there has been a negligible reduction in the quantity of water resources reaching the Woronora Reservoir.

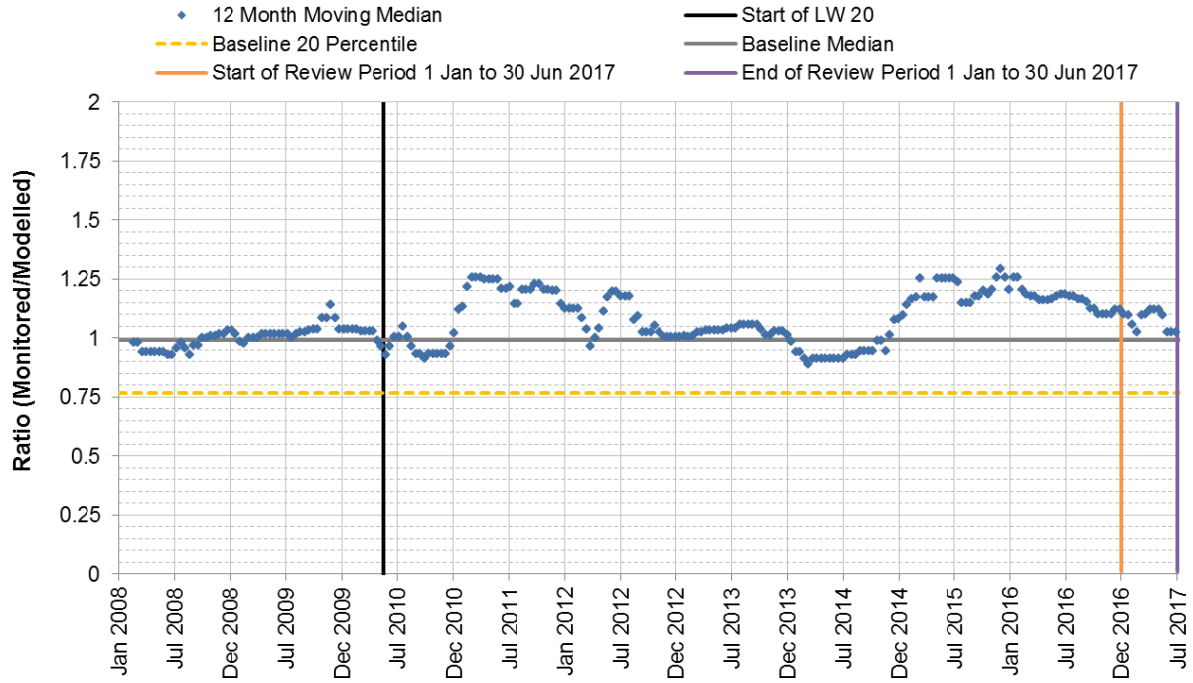


Chart 2 One Year Sliding Median for the Ratios of the 14 Day Sums of Monitored and Modelled Flow Rates at Waratah Rivulet (GS 2132102)

Analysis of Eastern Tributary stream flow data (GS 300078, Figure 5) for the reporting period indicates that flows reaching the Woronora Reservoir have not been affected by mining (Chart 3). Chart 3 shows the flow monitoring data that is available since gauging station construction in September 2012 compared to model predictions. The results indicate that flow has been continuous at the gauging station and that it has been consistent with model predictions. This indicates that flows reaching the Woronora Reservoir have not been affected by mining (Appendix B).

3.3 POOL WATER LEVELS

The water level in a number of pools on the Waratah Rivulet, Eastern Tributary, Tributary B and Woronora River (Figure 5) has been either manually monitored on a daily basis[1] or monitored using a continuous water level sensor and logger.

During the reporting period, all pools on the Waratah Rivulet remained above their cease to flow levels or exhibited natural behaviour (i.e. pools that do not have 'solid' rock-bar controls), with the exception of Pool A and Pool N. Water levels in Pool A were predominantly below the pool cease to flow level in January and early February (Figure 5, Chart 4). Water levels in Pool N fell below the cease to flow level for relatively short periods in January and February (Figure 5, Chart 5). Pool WRP2 on the Woronora River also stopped flowing in the same January-February period (Appendix B). Water levels in Pools A and N recovered and remained above the cease to flow level from late February.

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).

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

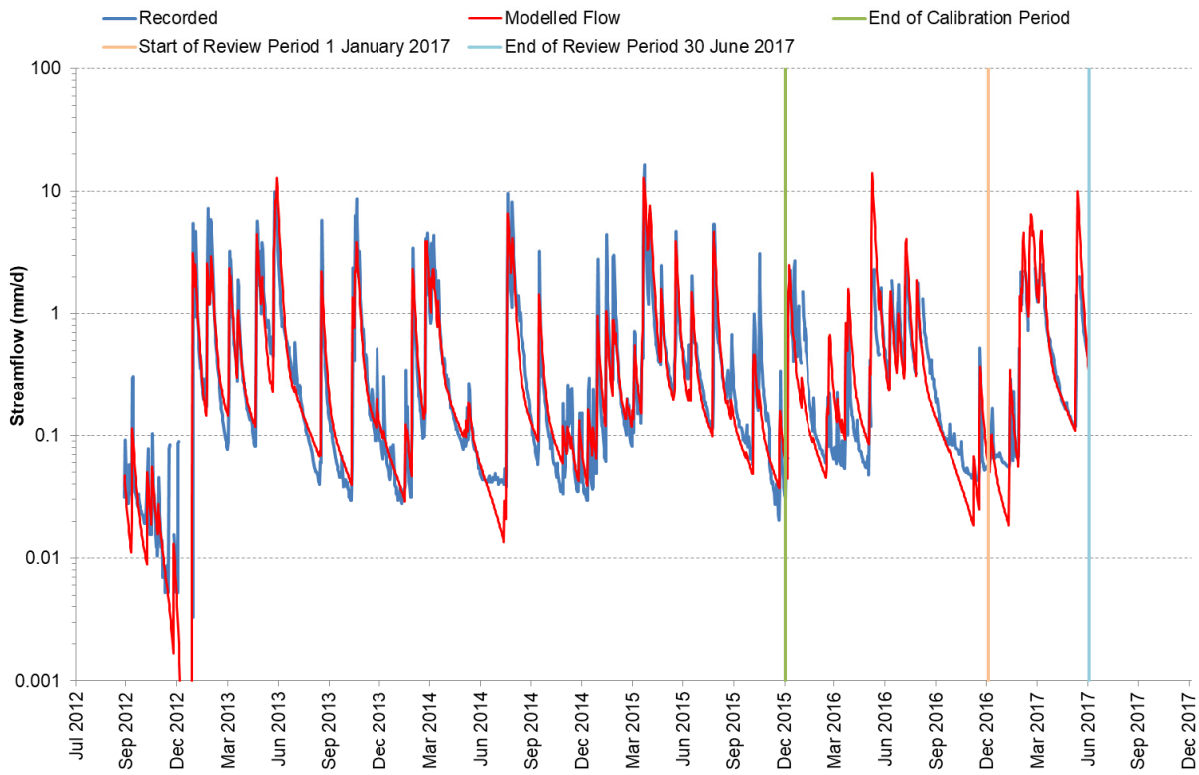


Chart 3 **Monitored and Model Predicted flows – Eastern Tributary Upstream of Woronora Reservoir**

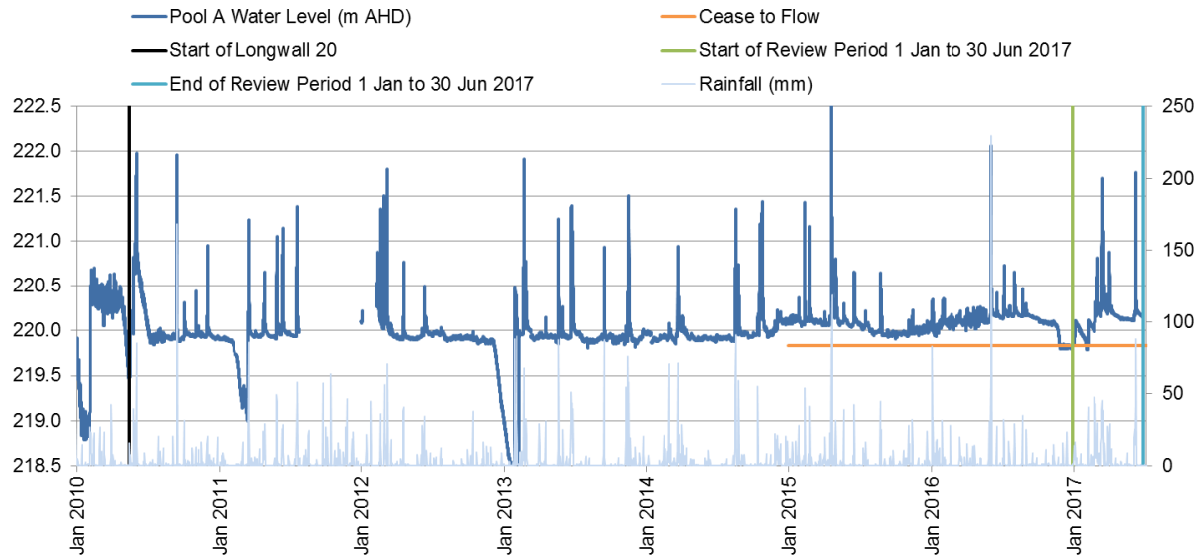


Chart 4 **Pool A Waratah Rivulet**

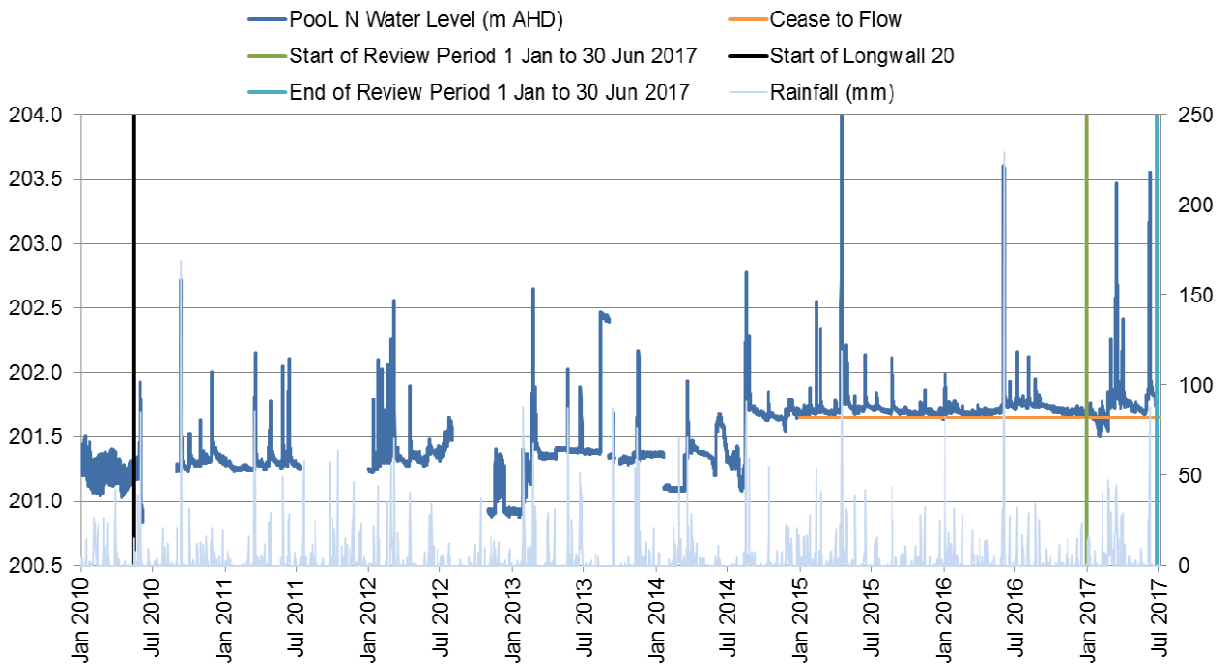


Chart 5 Pool N Waratah Rivulet

On the Eastern Tributary, water levels in Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI, ETAQ and ETAU are monitored using a continuous water level sensor and logger (Figure 5). Pools ETG, ETJ, ETM, ETU, ETW, ETAG, ETAH, ETAI and ETAQ on the Eastern Tributary were below their cease to flow levels or below their historical low water levels during the reporting period (Charts 6 to 14, respectively). Pools ETG, ETJ and ETM were impacted by mining during the 2015 reporting period. Pools ETU and ETW were impacted by mining in early 2016 and downstream pools ETAH, ETAI and ETAQ were impacted by mining in late 2016. Pool ETAG was impacted by mining during the review period.

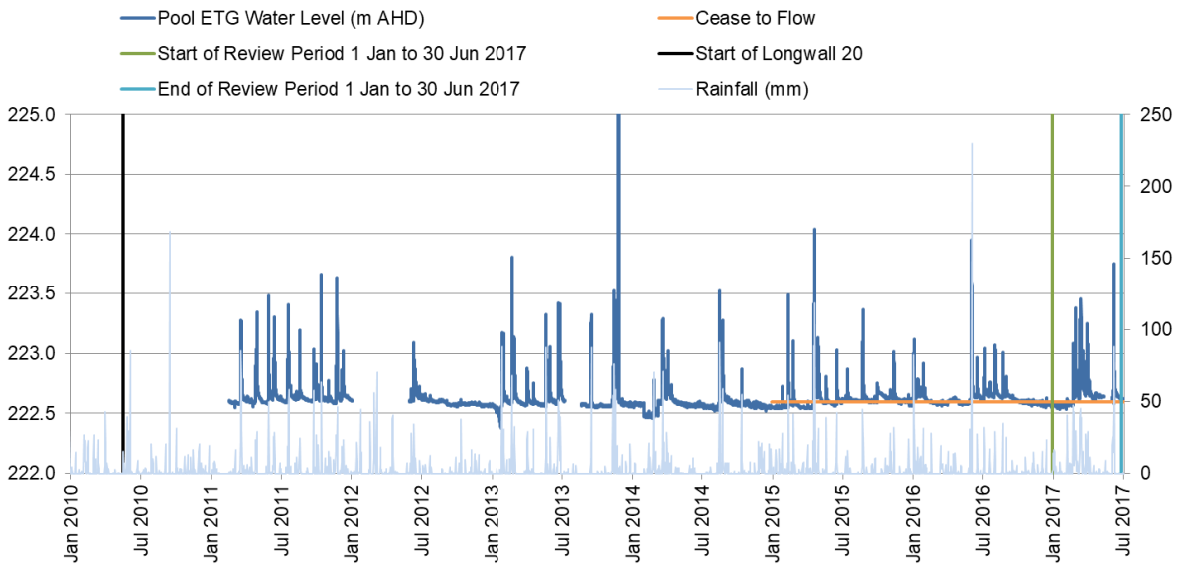


Chart 6 Pool ETG Eastern Tributary

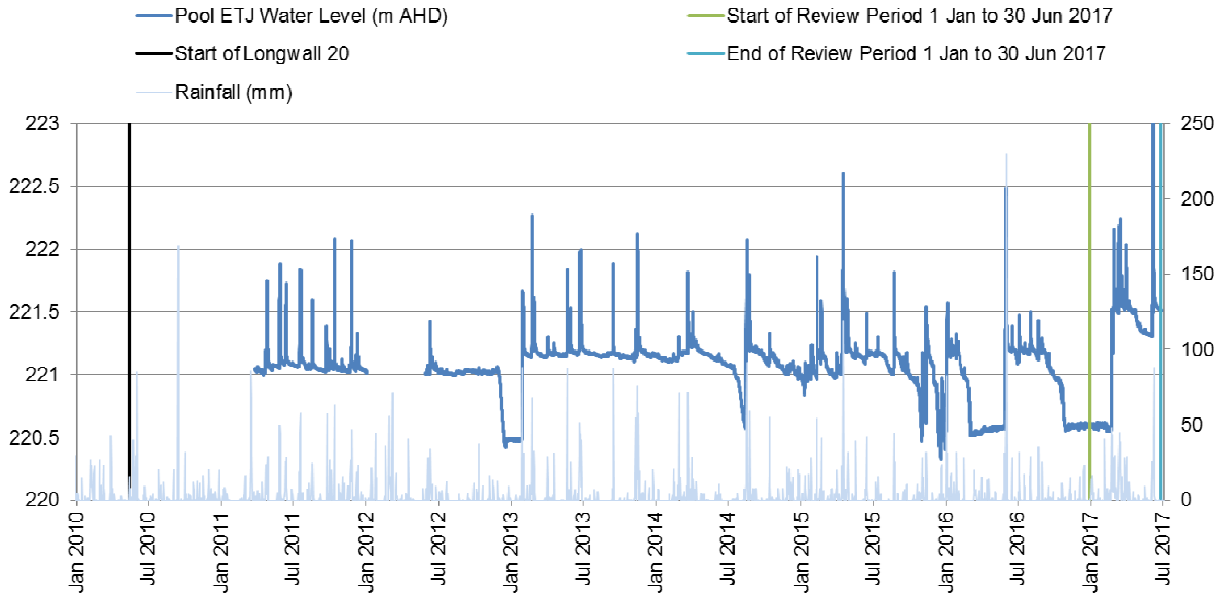


Chart 7 Pool ETJ Eastern Tributary

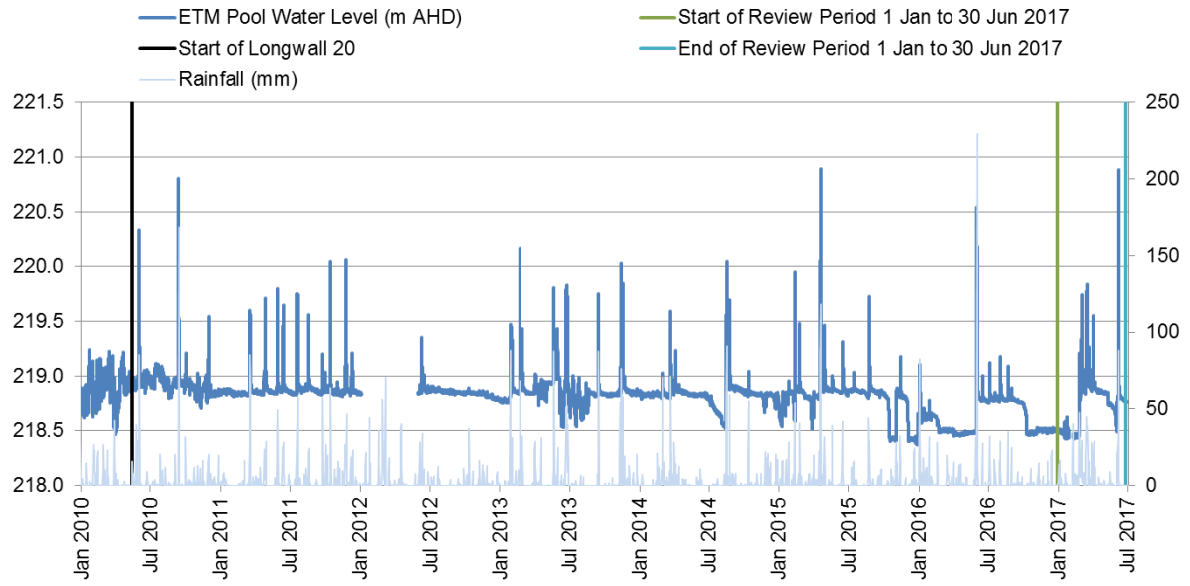


Chart 8 Pool ETM Eastern Tributary

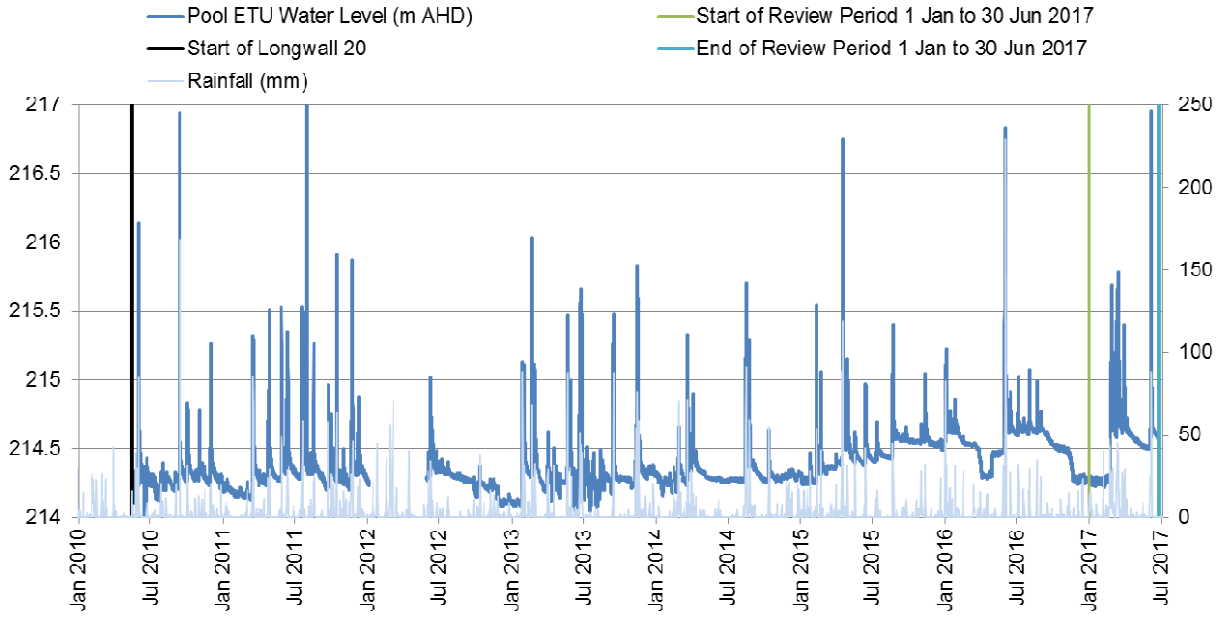


Chart 9 Pool ETU Eastern Tributary

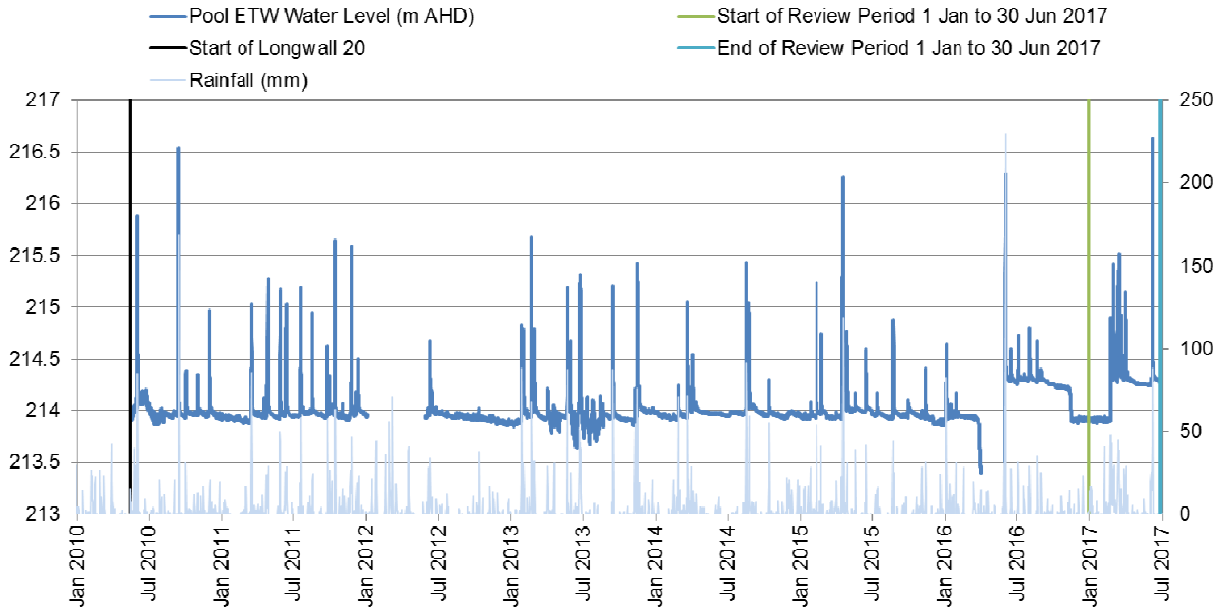


Chart 10 Pool ETW[2] Eastern Tributary

[2] Note, discrepancies in water levels caused by pool being dry and water level sensor being exposed at time of download (Appendix B).

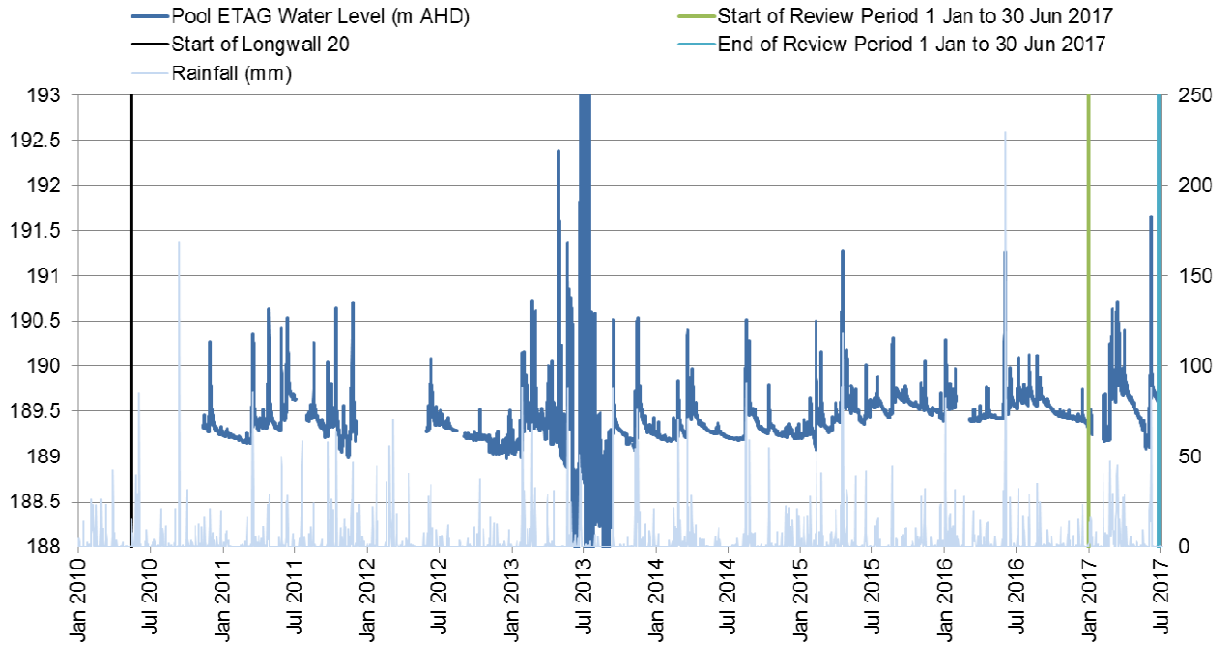


Chart 11 Pool ETAG Eastern Tributary

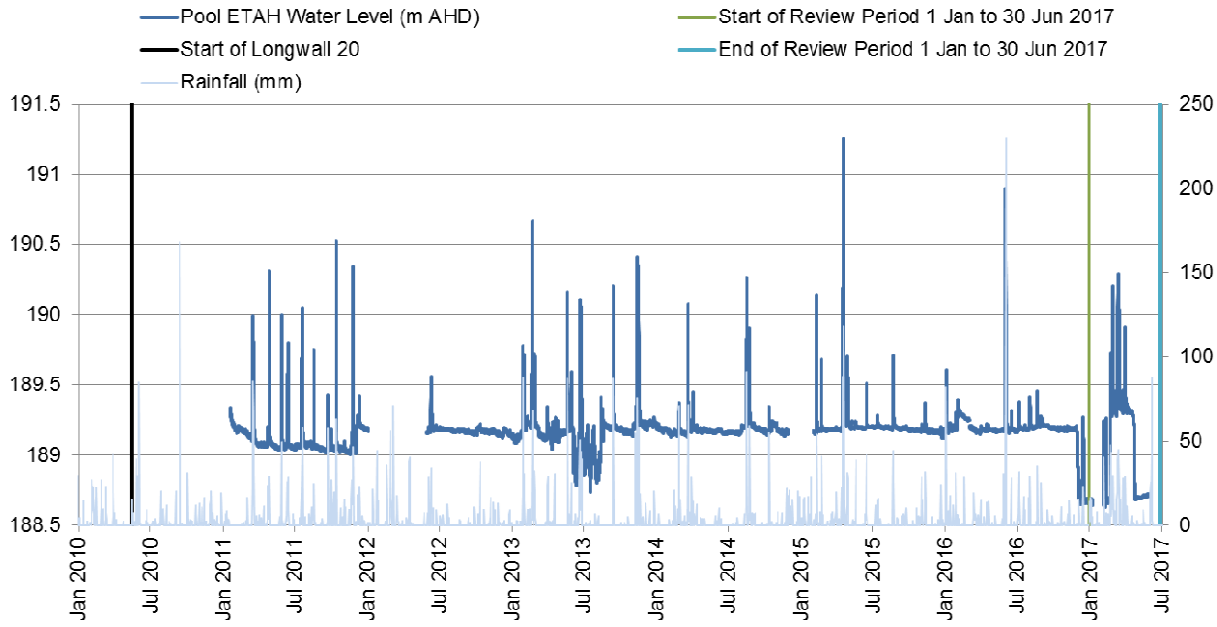


Chart 12 Pool ETAH Eastern Tributary

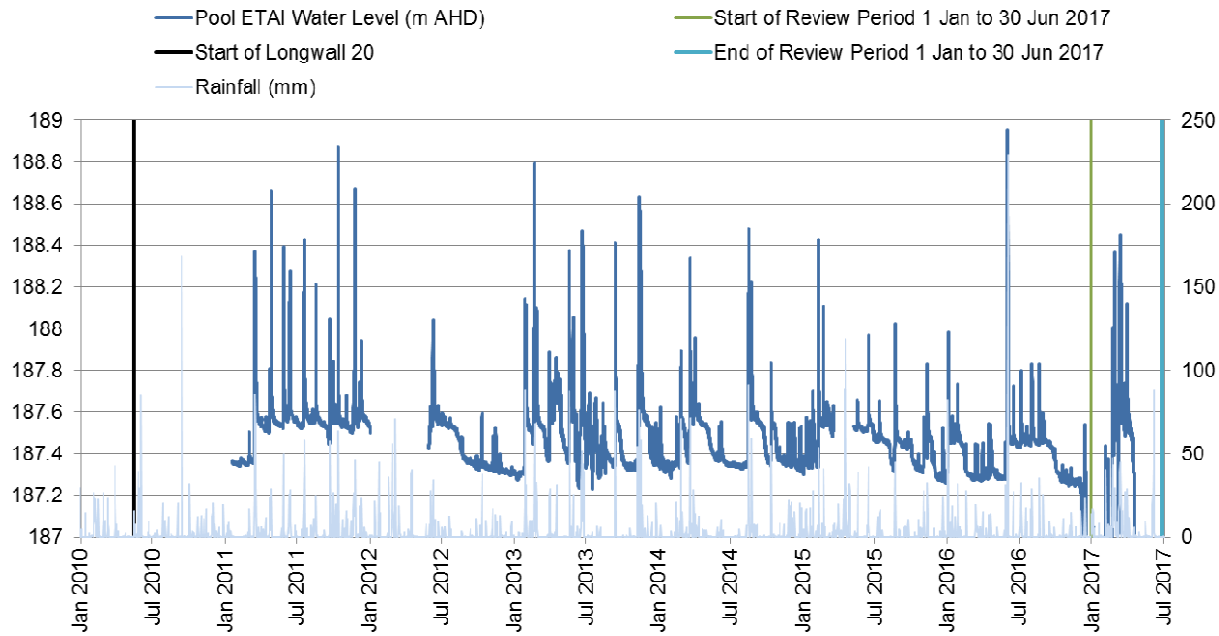


Chart 13 Pool ETAI Eastern Tributary

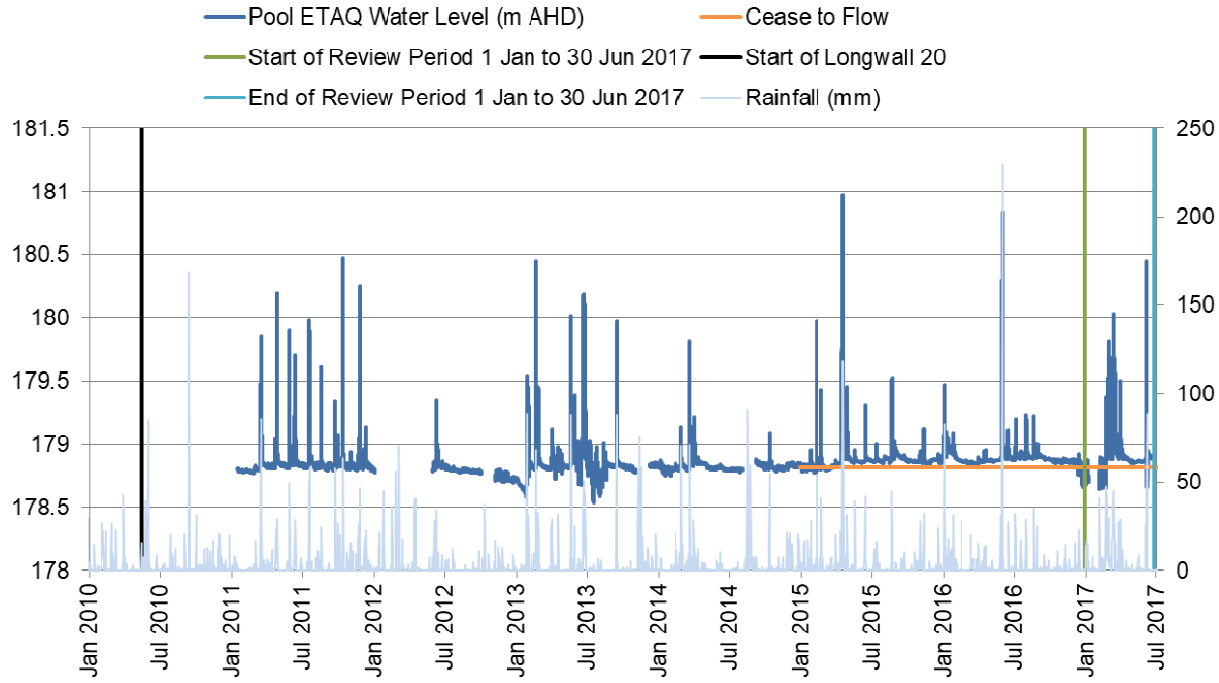


Chart 14 Pool ETAQ Eastern Tributary

Pool water levels steadily declined in Pool ETAF in January and early February to levels below historically low levels in response to the prevailing climatic conditions (Chart 15). Water levels rose in response to rainfall in late February 2017 and appear to have fully recovered after this event. Pool ETAU did not fall below its cease to flow level during the reporting period (Chart 16) (Appendix B).

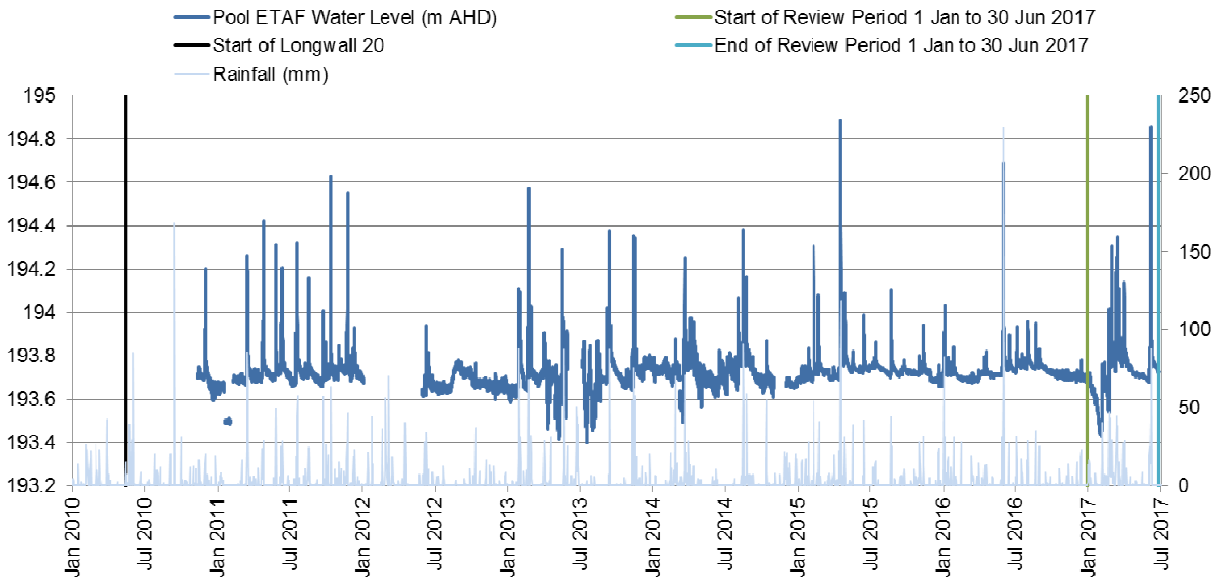


Chart 15 Pool ETAF Eastern Tributary

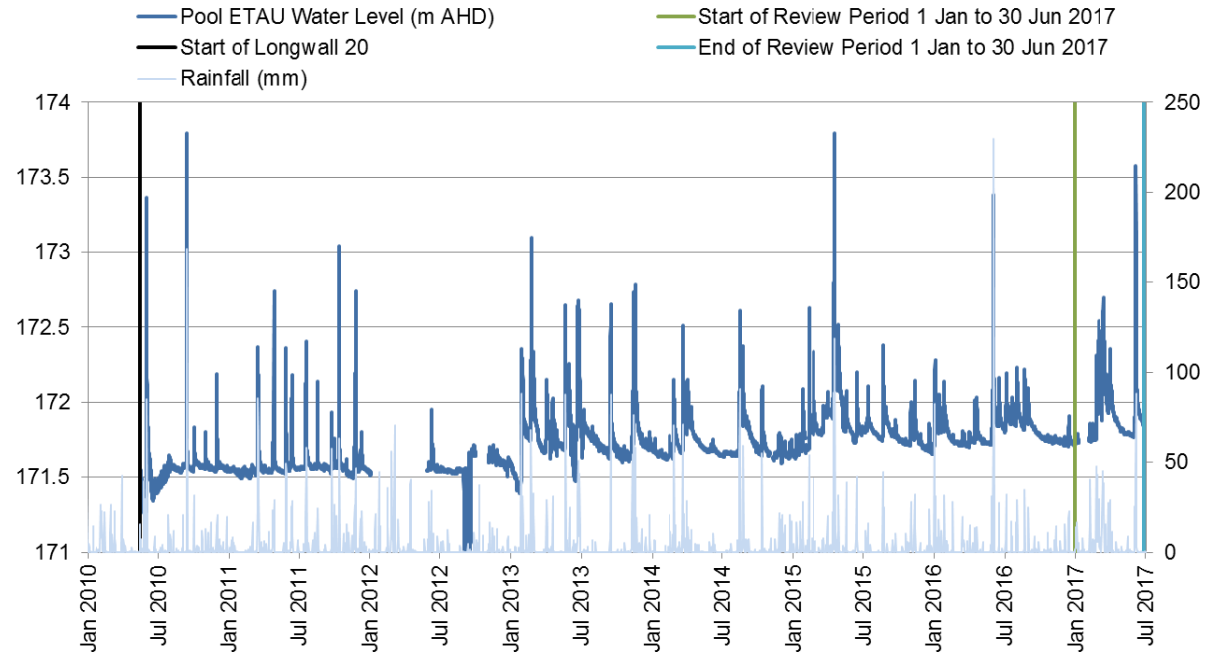


Chart 16 Pool ETAU Eastern Tributary

Pool RTP1 on Tributary B remains typically dry with overflow events limited to significant, wet periods (Chart 17). Since 2012 this section of Tributary B has been mostly dry with no surface flow. Pool RTP2 on Tributary B has continued to regularly fall below its cease to flow level, however generally overflows during and following rainfall events (Chart 18). Metropolitan Coal's visual inspections indicate Pool RTP2 has generally been flowing during inspections.

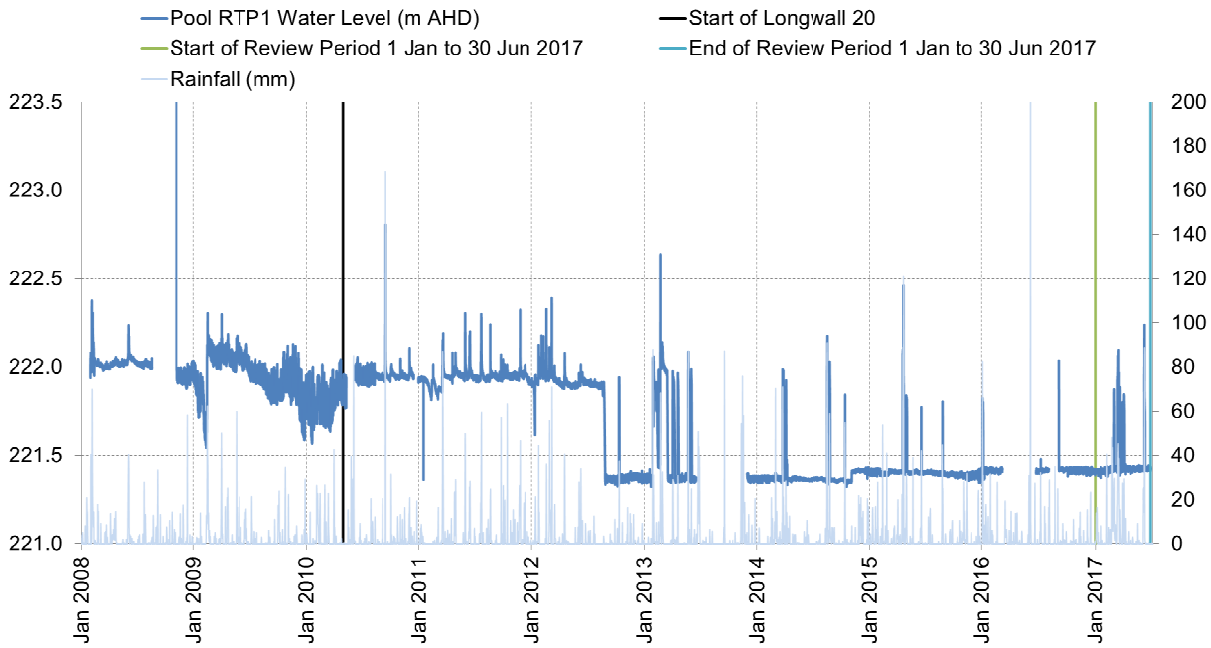


Chart 17 Pool RTP1 Tributary B[3]

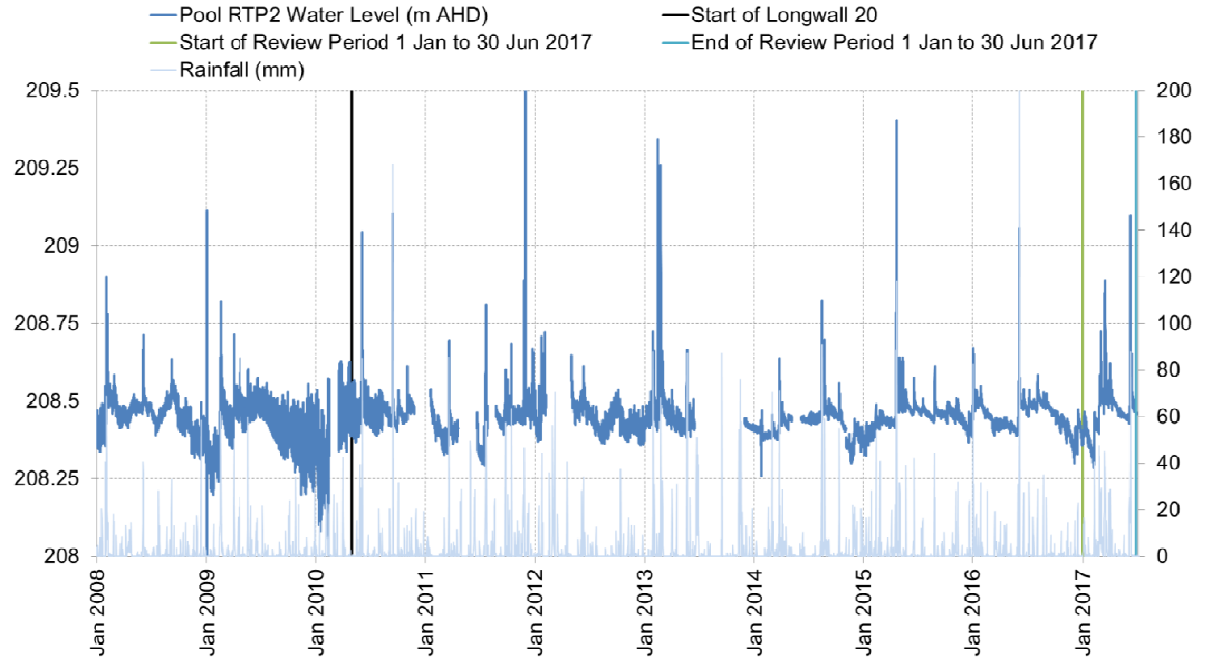


Chart 18 Pool RTP2 Tributary B

[3] Metropolitan Coal is not able to access the catchment during significant rain events and has been unable to reduce the recorded data to an equivalent water level (m AHD) because the pool has been invariably dry when the water level logger has been downloaded. The water level rises shown on the chart should be considered as being indicative of water level rises associated with rainfall-runoff events and should be regarded as being indicative of relative pool water level changes.

3.4 STREAM WATER QUALITY

Surface water quality sampling has been conducted monthly at the following sites on 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 the Woronora River (WOWQ1 and WOWQ2) in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans (Figure 6).

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 iron staining incident. The weekly sampling has continued throughout the reporting period.

Trends in the monitoring data to date for key parameters (pH, electrical conductivity, dissolved iron, dissolved manganese and dissolved aluminium) are summarised in Table 7 (Appendix B) and shown on Charts 19 to 43.

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[4]:

- 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 Waratah Rivulet during the reporting period. There was no exceedance of the measures at the control site on Woronora River at site WOWQ2.

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

Table 7
Summary of Results for Key Water Quality Parameters

Stream(s)	pH	Electrical Conductivity	Dissolved Iron	Dissolved Manganese	Dissolved Aluminium
Waratah Rivulet (sites WRWQ2, WRWQ6, WRWQ8, WRWQ9, WRWQM, WRWQN, WRWQP, WRWQR, WRWQT and WRWQW) (Charts 19 to 28)	• Upstream sites (e.g. sites WRWQ2 and WRWQ6) - slightly acidic to near neutral pH values. • Middle and lower reach sites (e.g. sites WRWQ8, WRWQR and WRWQT) - higher (slightly alkaline) pH values.	• Concentrations were generally consistent with historical trends. • The highest concentrations during the reporting period were recorded in February 2017 (305 µS/cm at WRWQW and 297 µS/cm at WRWQ9) and June 2017 (410 µS/cm at WRWQR).	• Typically low (below 0.5 mg/L) during the reporting period.	• Elevated concentrations (relative to historic levels) were recorded in February 2017 at WRWQ6 and WRWQM (0.54 mg/L and 0.36 mg/L, respectively). • Dissolved manganese concentrations at other sites were generally low and consistent with historical trends.	• Dissolved aluminium concentrations were either low or below the detection limit.
Woronora River (sites WOWQ1 and WOWQ2, control stream) (Charts 29 to 33)	• High variability in pH, typically slightly acidic, consistent with historical trends. • pH ranged from pH 4.8 to pH 5.4 at site WOWQ1 and from pH 5.2 to 7.2 at site WOWQ2.	• A slightly elevated concentration was recorded at WOWQ1 in January 2017 (313 µS/cm). • Concentrations were otherwise relatively low and consistent with historical trends. • Low concentrations were recorded following high rainfall in March 2017.	• Generally low and similar to values recorded in Waratah Rivulet.	• Typically low, with elevated (relative to historical levels) concentrations recorded at WOWQ1 and WOWQ2 in February 2017 (0.158 mg/L and 0.114 mg/L, respectively).	• Typically low concentrations.
Eastern Tributary (sites ETWQF, ETWQJ, ETWQN, ETWQU, ETWQW, ETWQAF, ETWQAH, ETWQAQ and ETWQAU) (Charts 34 to 38) (Note, a number of pools were dry and could not be sampled on occasions during the reporting period.)	• Near neutral to slightly acidic pH values, consistent with historical results. • An isolated, relatively low, pH 4.25 was recorded at ETWQAH in February 2017, corresponding to a period when pool levels were low and the pool was not overflowing.	• More variable during the reporting period. • Elevated concentrations recorded in February 2017 (483 µS/cm at ETWQAH, 423 µS/cm at ETWQAQ and 416 µS/cm at ETWQU) and in May 2017 (365 µS/cm and 348 µS/cm at ETWQAU) associated with low water levels.	• Large spikes in concentrations were recorded at ETWQAQ from January to March 2017 and in June 2017. Highest concentration of 8.42 mg/L in February 2017 at ETWQ AQ. • Elevated concentrations corresponded with a period of low flow and mine subsidence impacts to a number of pools.	• The higher concentrations recorded in mid to late 2016 continued to increase in January/February 2017; corresponding with an extended period of low flow/rainfall and mine subsidence impacts to a number of pools. • In particular, large spikes in concentrations were recorded in January and/or February 2017 at ETWQU, ETWQAH, ETWQ AQ and ETWQAU.	• Typically low concentrations. • Some spikes in concentrations were recorded during March/early April and June at ETWQF, ETWQAH and ETWQAU following rain. • Highest concentration recorded in March 2017 at ETWQF (0.14 mg/L) during the reporting period.

Table 7 (Continued)
Summary of Results for Key Water Quality Parameters

Stream(s)	pH	Electrical Conductivity	Dissolved Iron	Dissolved Manganese	Dissolved Aluminium
Eastern Tributary (sites ETWQF, ETWQJ, ETWQN, ETWQU, ETWQW, ETWQAF, ETWQAH, ETWQAQ and ETWQAU) (Cont.) (Charts 34 to 38)	(refer above)	(refer above)	(refer above)	• The highest concentrations recorded at these sites were: – 0.96 mg/L at ETWQU in February 2017; – 1.15 mg/L at ETWQAH in February 2017; – 1.31 mg/L at ETWQAQ in February 2017; and – 0.93 mg/L at ETWQAU in January 2017. • Elevated values (relative to historical levels) were also recorded in late May/early June following a period of low rainfall.	(refer above)
Bee Creek (site BCWQ1, control stream), Honeysuckle Creek (site HCWQ1, control stream), Far Eastern Tributary (site FEWQ1), Tributary B (site RTWQ1) and Un-named Tributary (site UTWQ1) (Charts 39 to 43)	• Bee Creek and Honeysuckle Creek - variable to slightly acidic pH levels. • Far Eastern Tributary, Tributary B and Tributary D - near neutral pH levels. • Since mid 2015, the pH at all sites has generally been less variable.	• Generally low, with the exception of Tributary B. • Tributary B - variable and periodically elevated since late 2013; this trend has continued.	• Generally low and consistent with historical values.	• Generally low and consistent with historical values.	• Low concentrations at Tributary B, Un-named Tributary and Far Eastern Tributary. • Bee Creek and Honeysuckle Creek - higher (in relation to other tributary sites) over the period of record. This trend continued during the reporting period. • Concentrations recorded at Bee Creek and Honeysuckle Creek during the reporting period were typically lower than historic values.

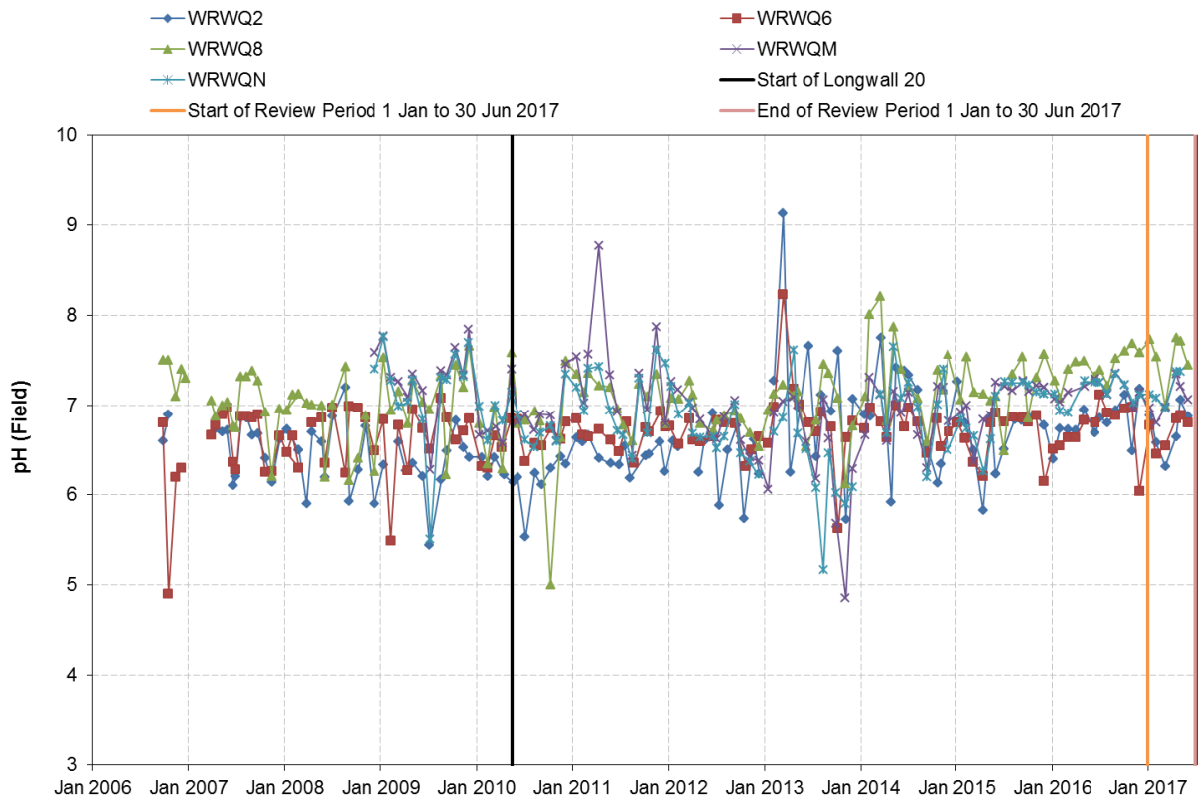


Chart 19 pH Levels Waratah Rivulet – Upper to Middle Reach Sites

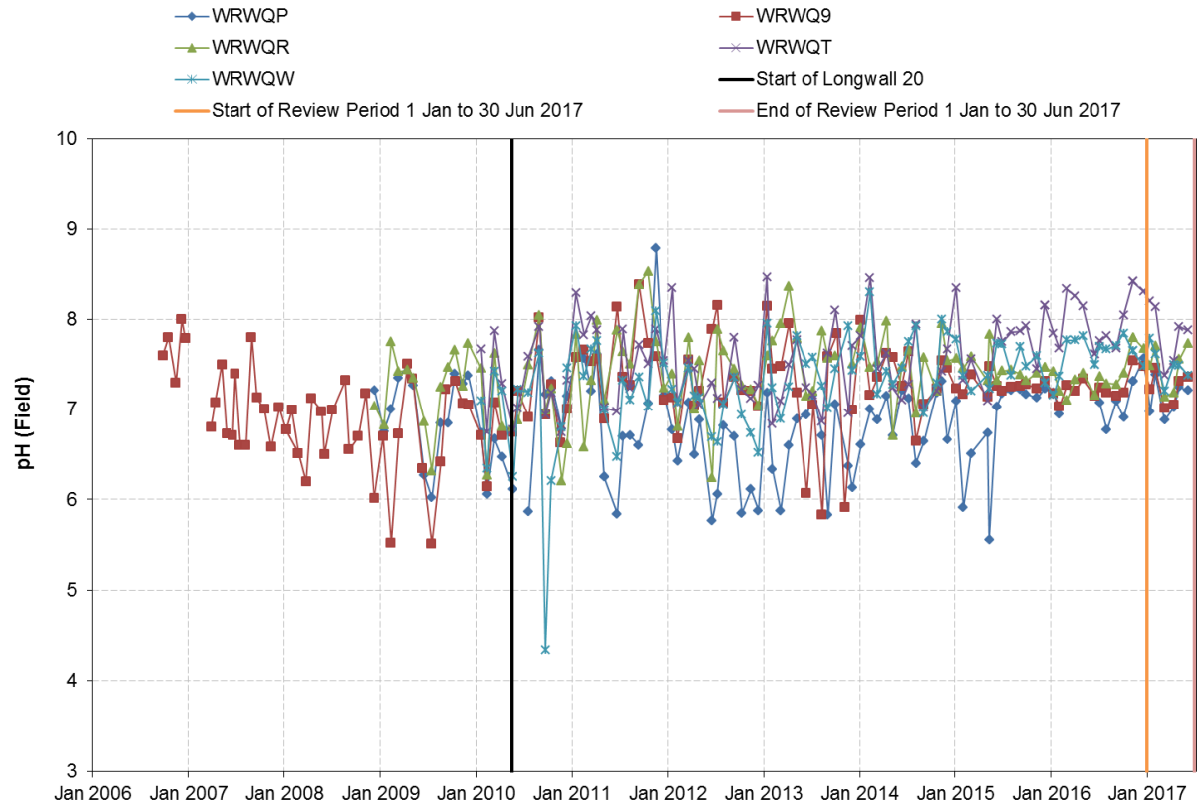


Chart 20 pH Levels Waratah Rivulet – Lower Reach Sites

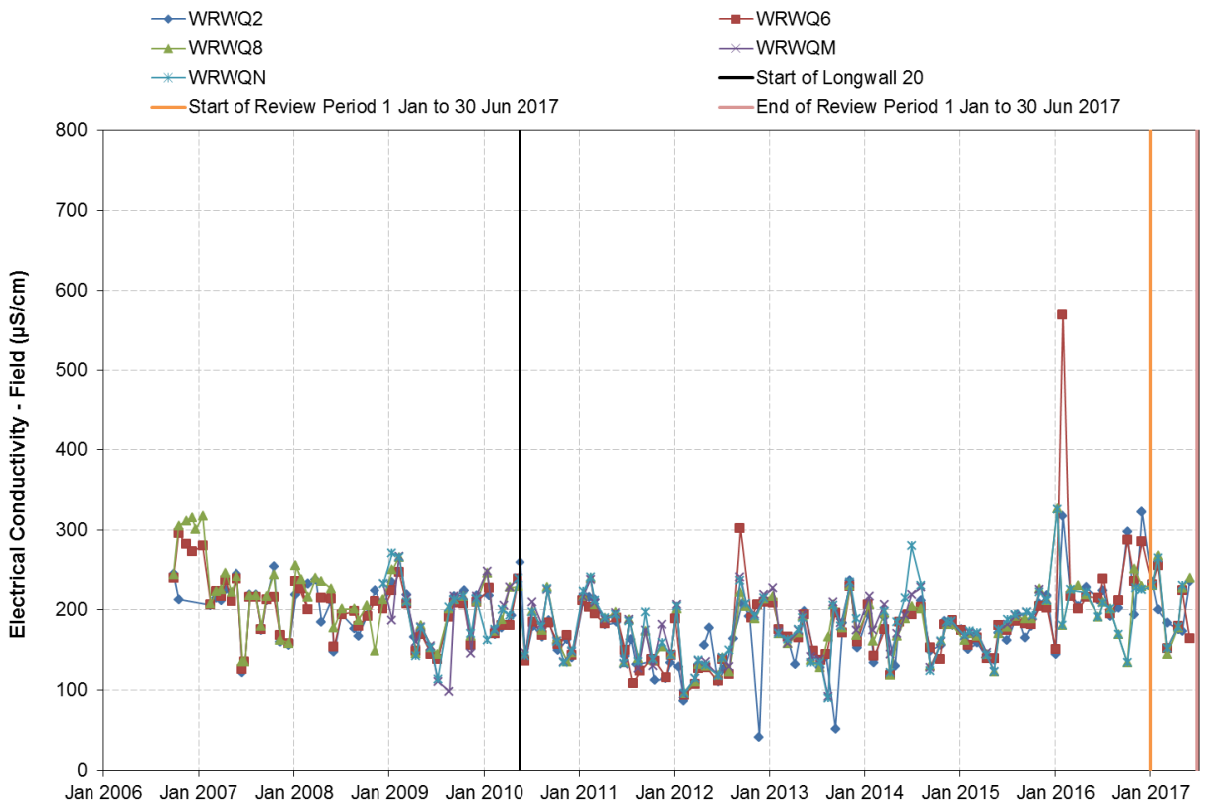


Chart 21 Electrical Conductivity (EC) Waratah Rivulet – Upper to Middle Reach Sites

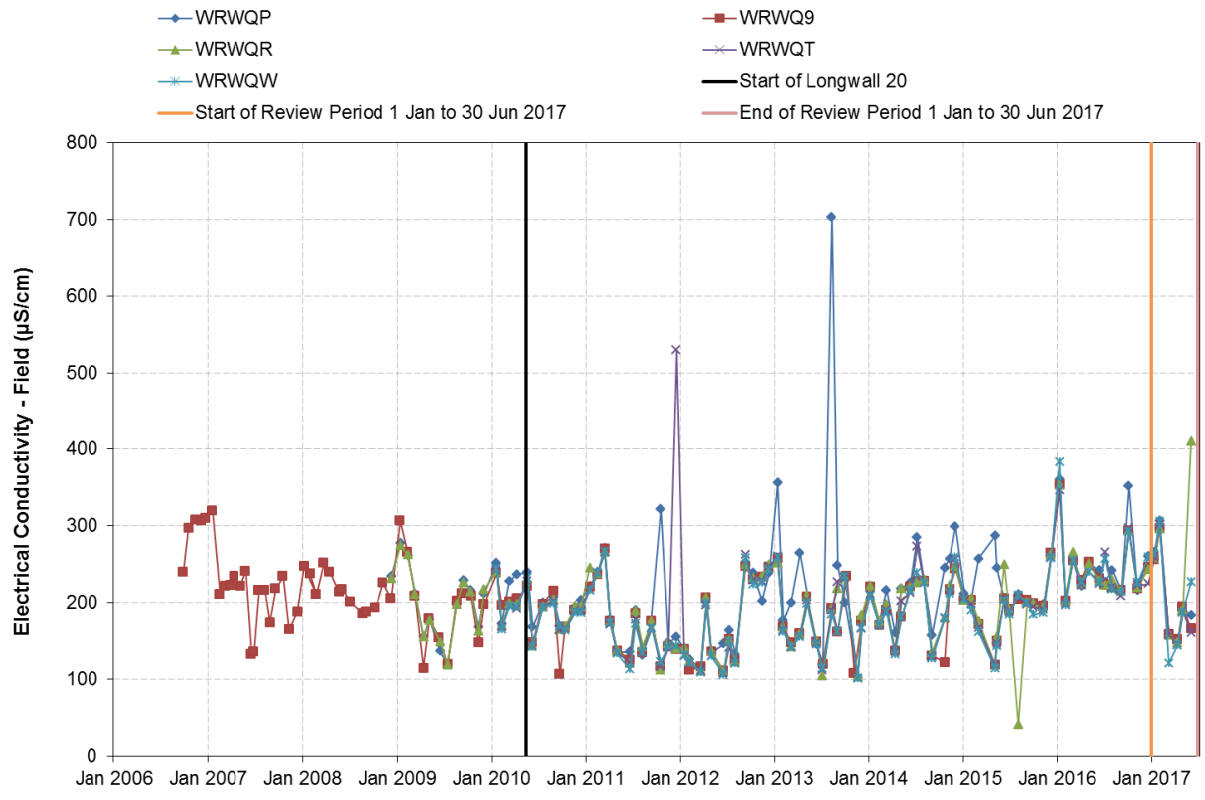


Chart 22 Electrical Conductivity (EC) Waratah Rivulet – Lower Reach Sites

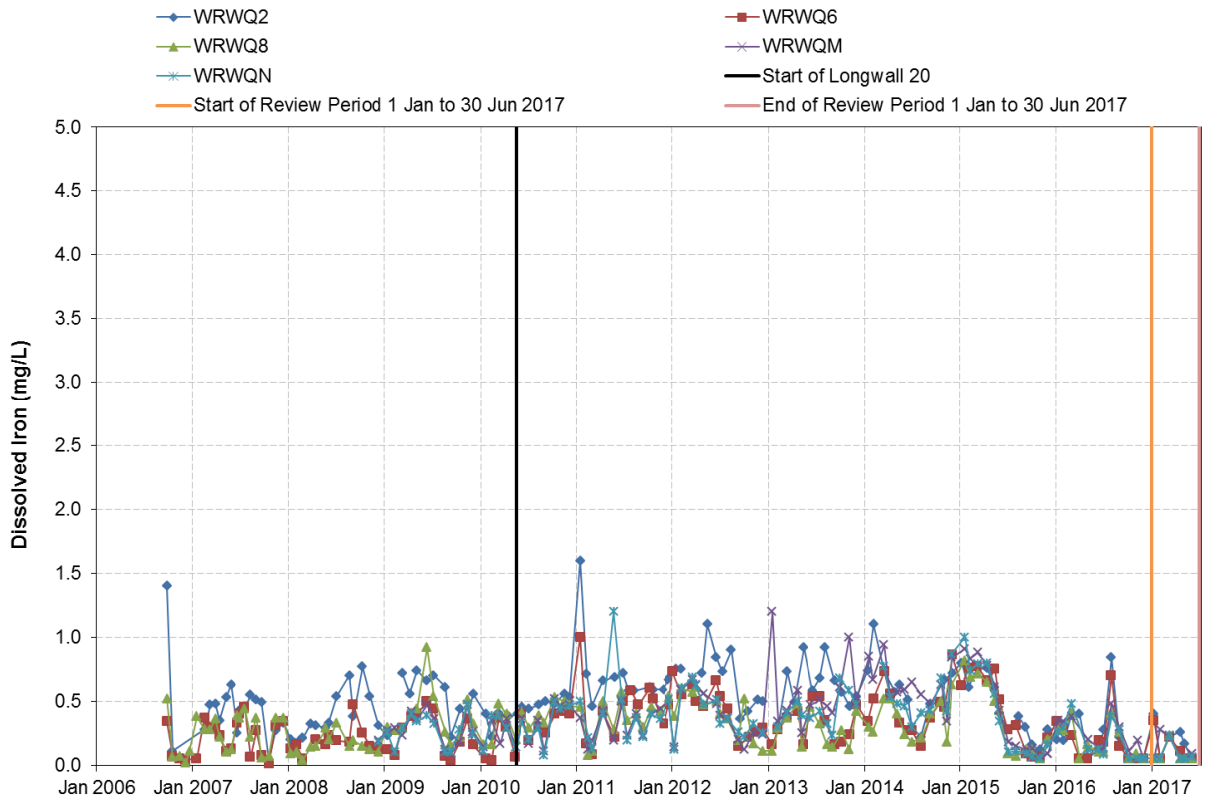


Chart 23 Dissolved Iron Waratah Rivulet – Upper and Middle Reach Sites

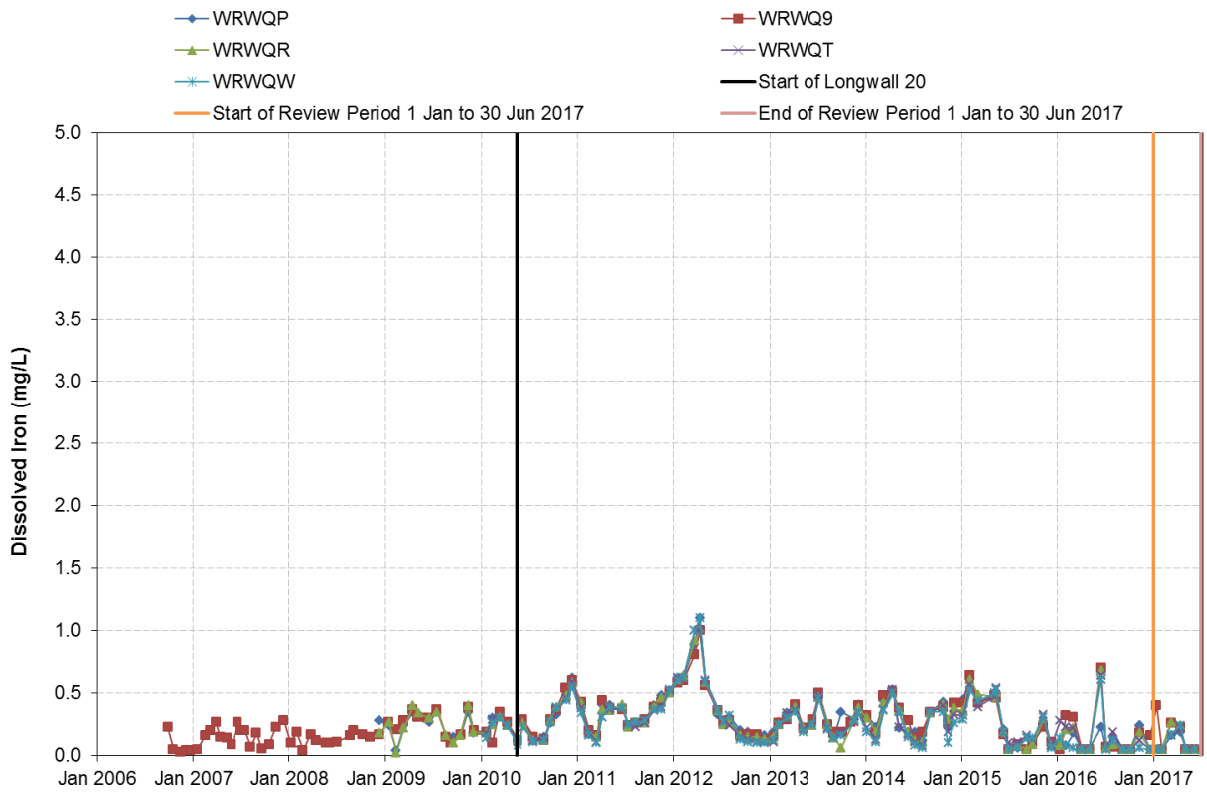


Chart 24 Dissolved Iron Waratah Rivulet – Lower Reach Sites

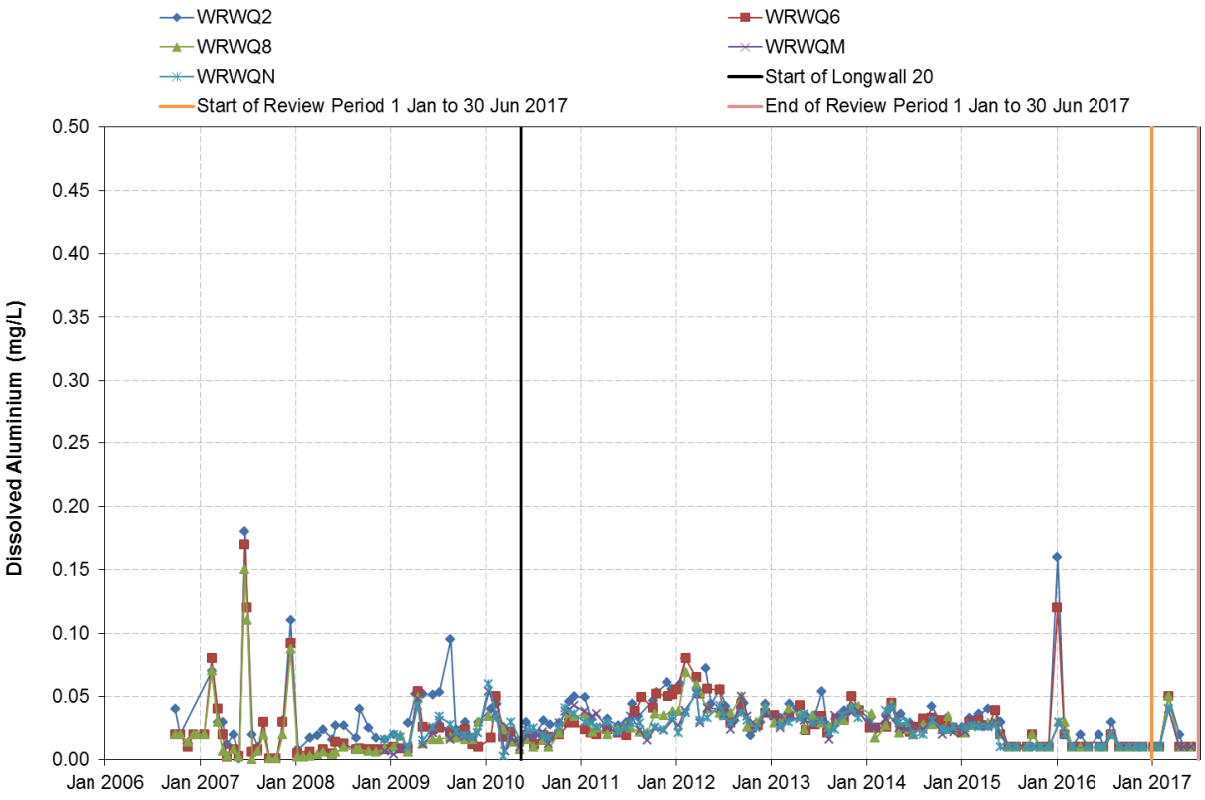


Chart 25 Dissolved Aluminium Waratah Rivulet – Upper to Middle Reach Sites

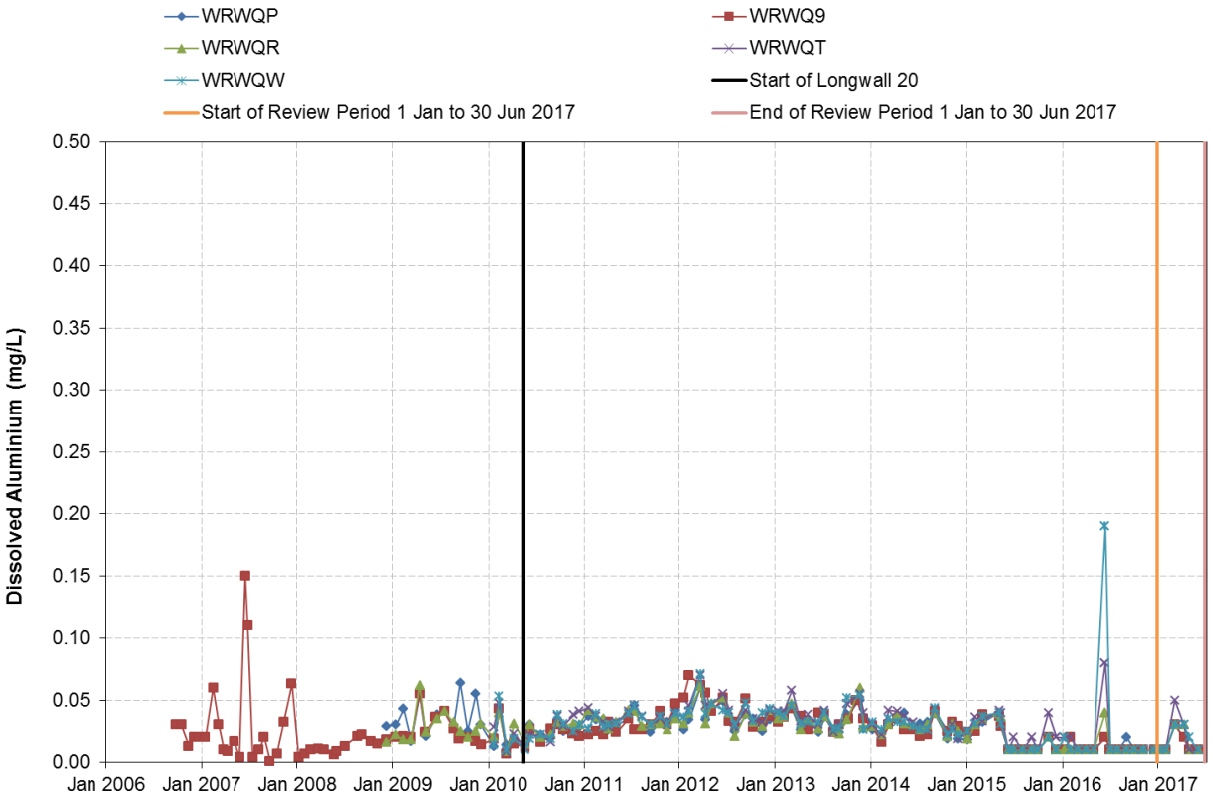


Chart 26 Dissolved Aluminium Waratah Rivulet – Lower Reach Sites

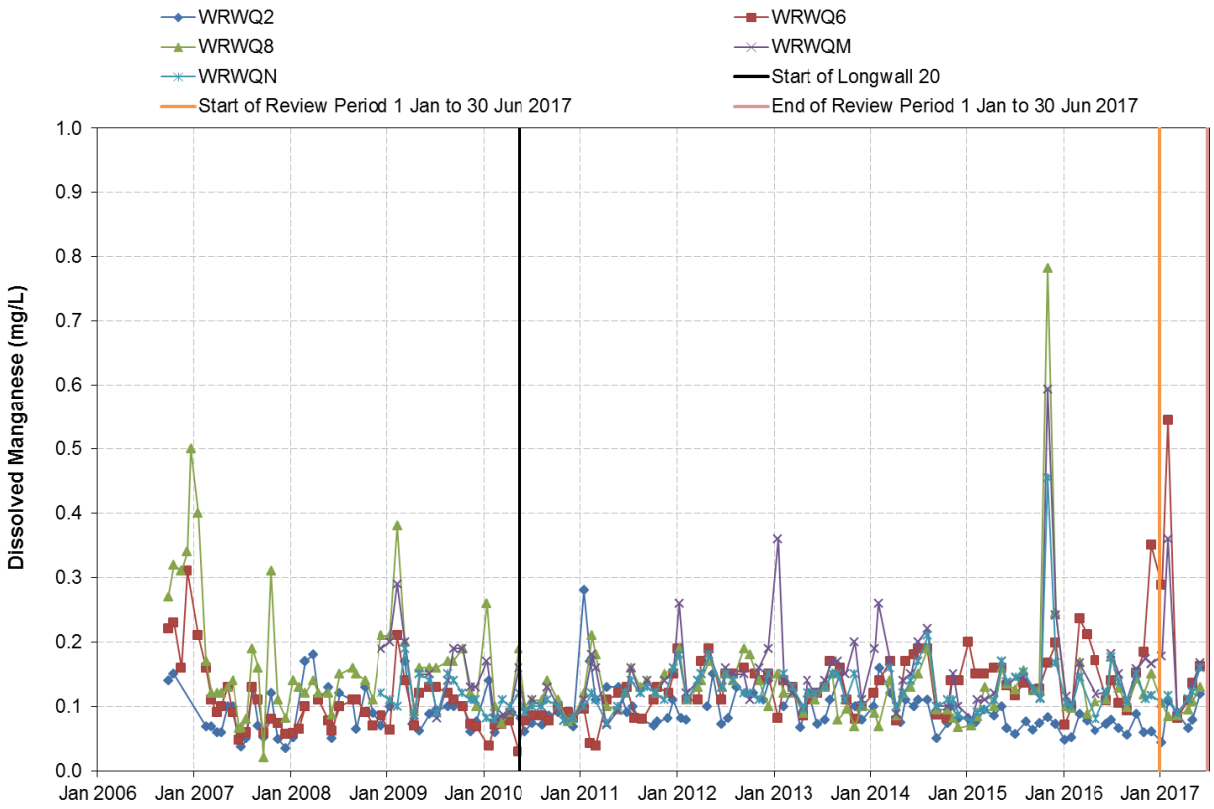


Chart 27 Dissolved Manganese Waratah Rivulet – Upper to Middle Reach Sites

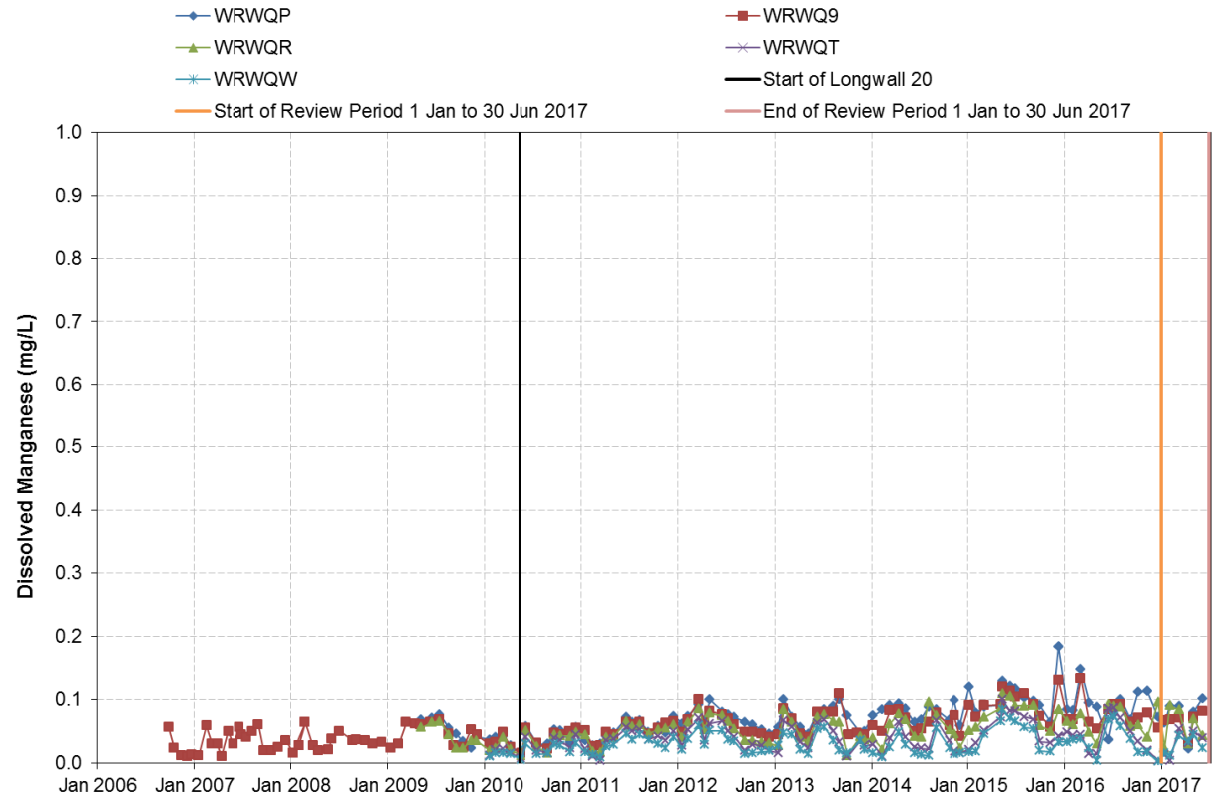


Chart 28 Dissolved Manganese Waratah Rivulet – Lower Reach Sites

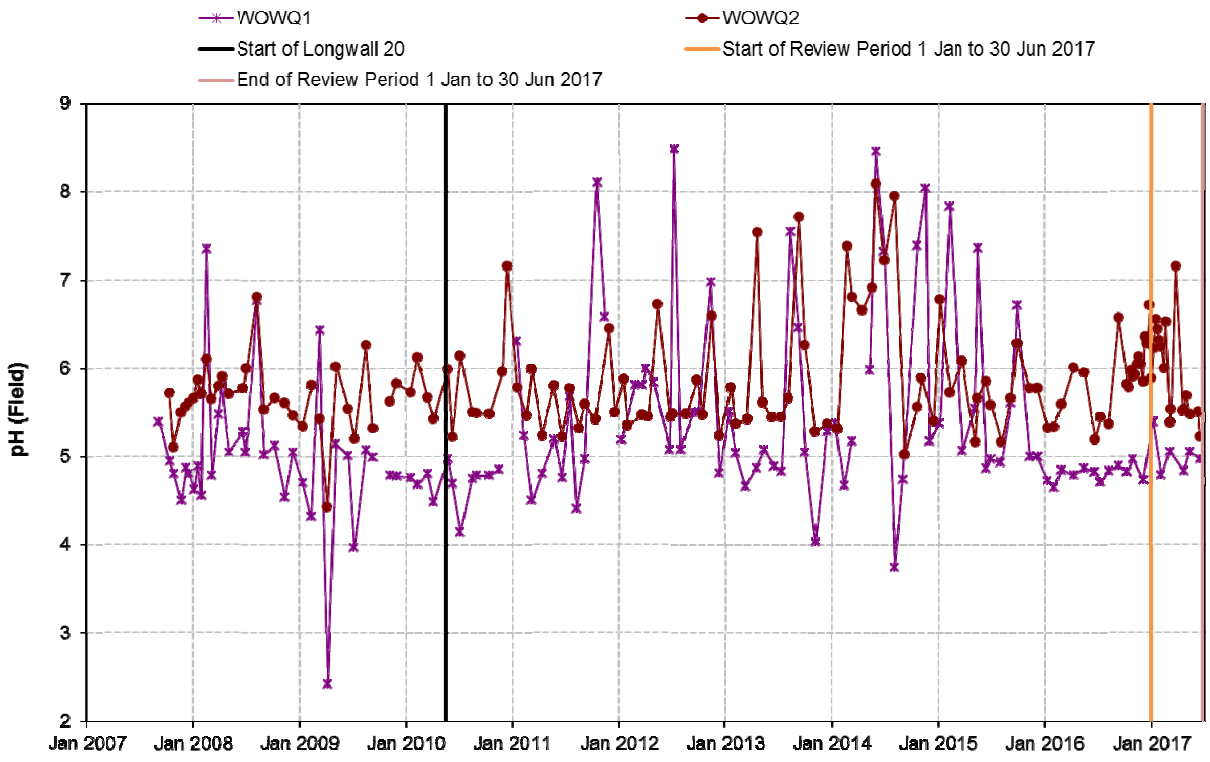


Chart 29 pH Levels Woronora River

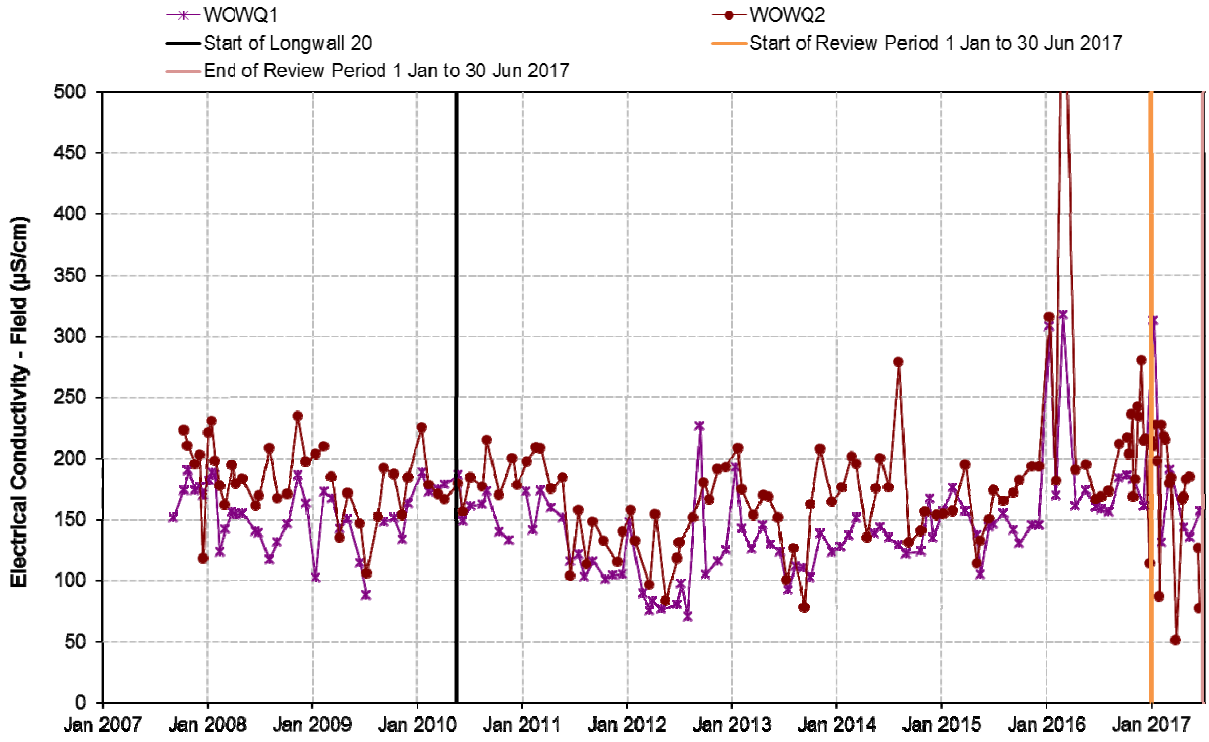


Chart 30a Electrical Conductivity (EC) Woronora River

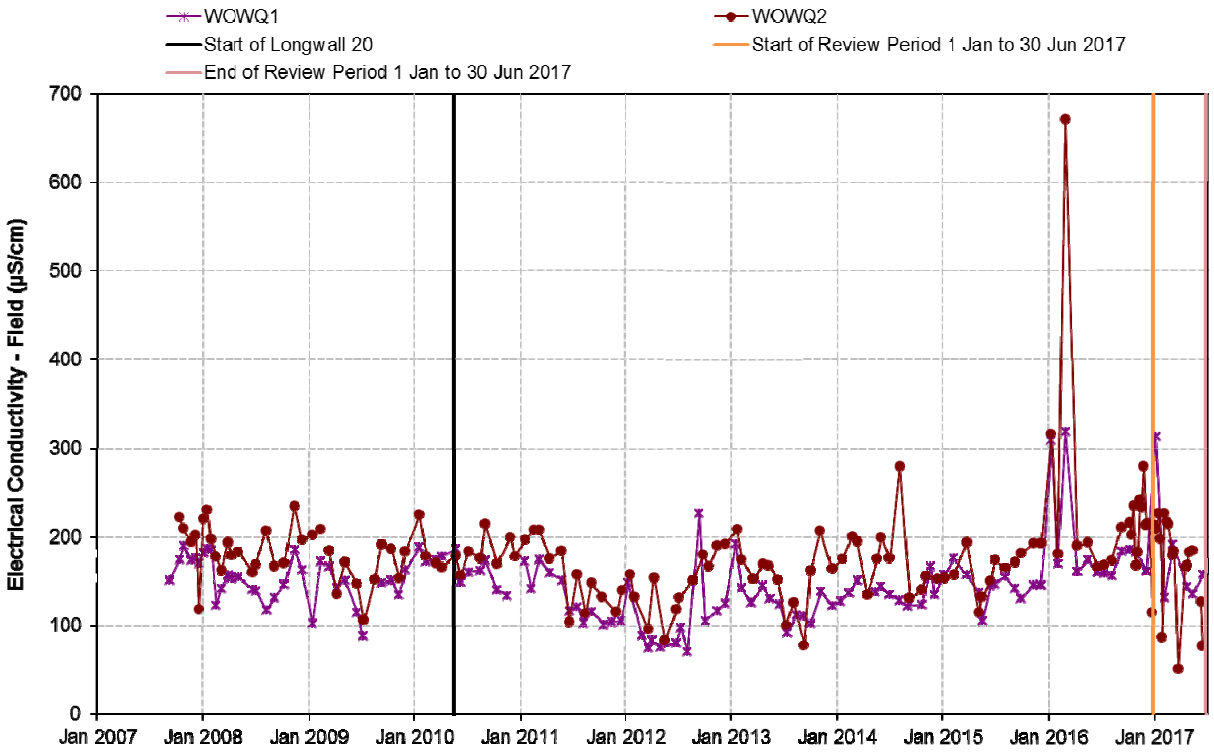


Chart 30b Electrical Conductivity (EC) Woronora River

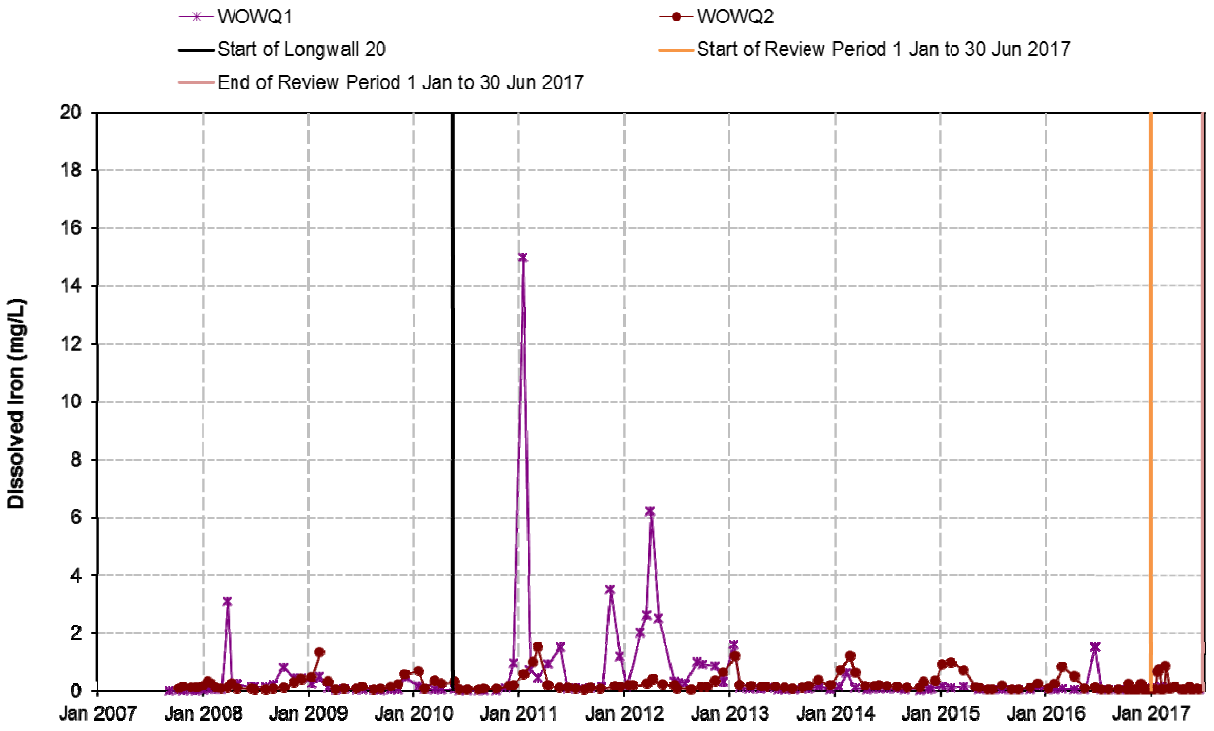


Chart 31 Dissolved Iron Woronora River

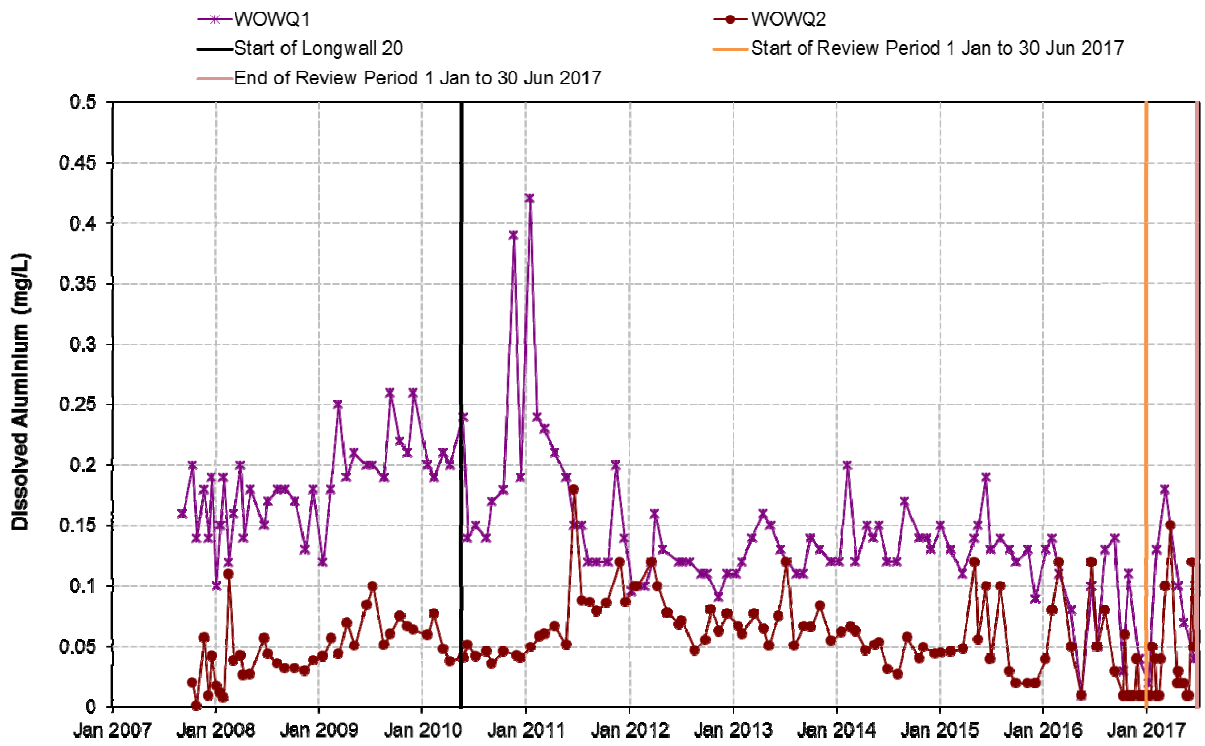


Chart 32 Dissolved Aluminium Woronora River

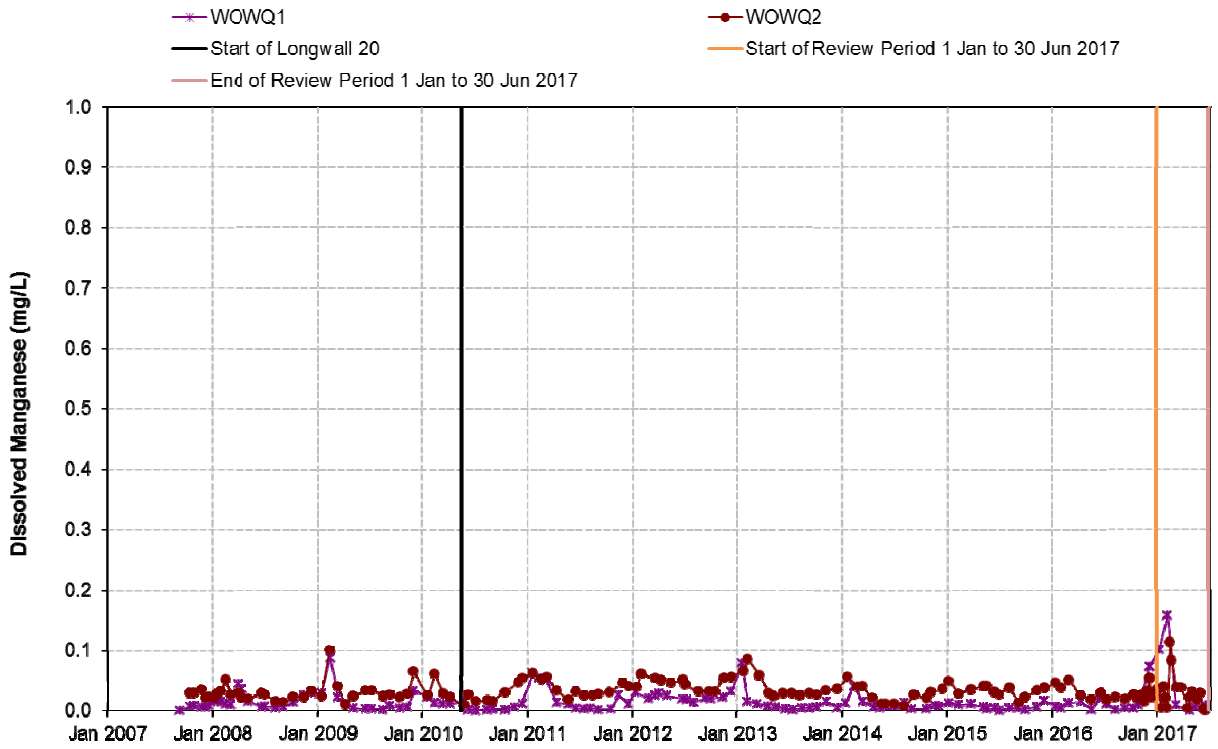


Chart 33 Dissolved Manganese Woronora River

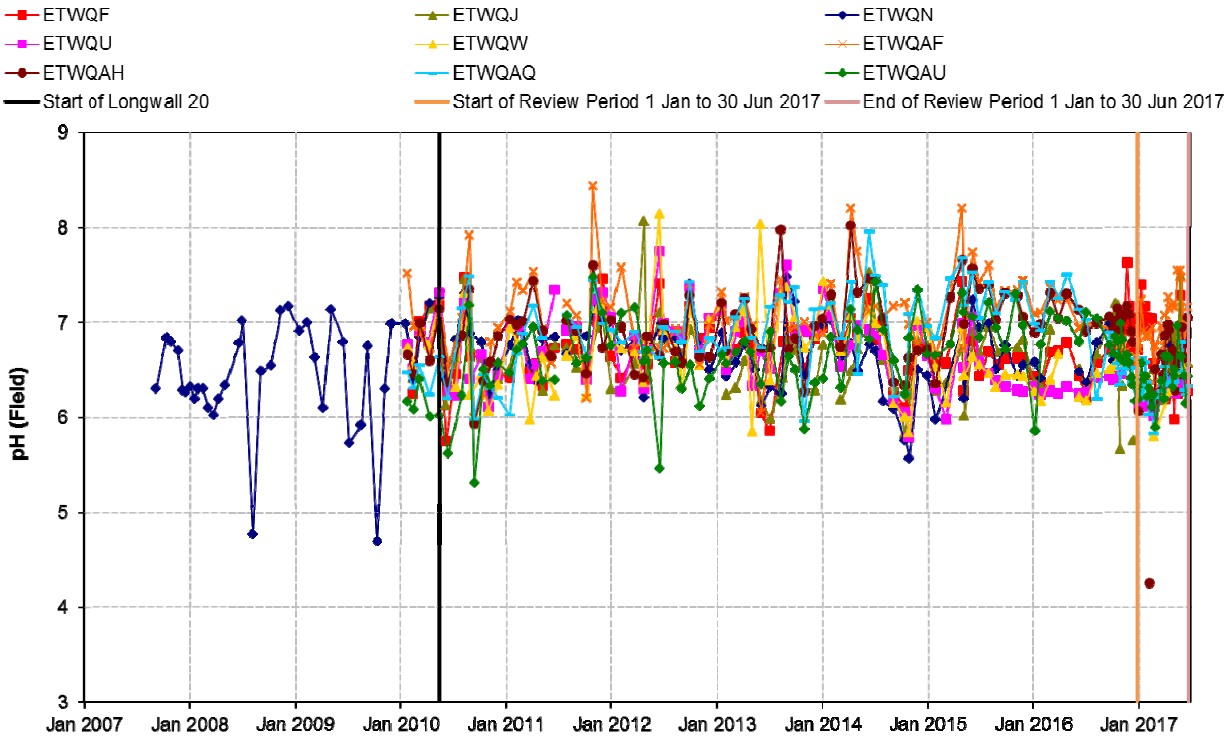


Chart 34 pH Levels Eastern Tributary

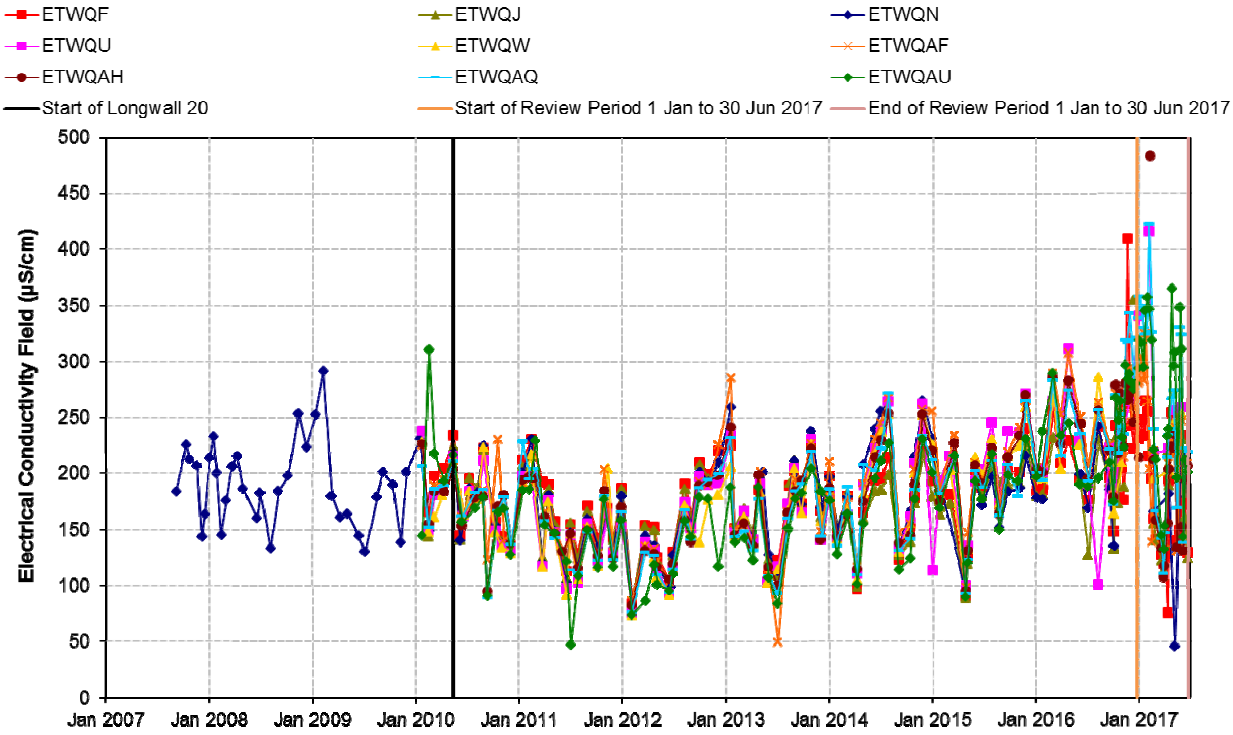


Chart 35 Electrical Conductivity (EC) Eastern Tributary

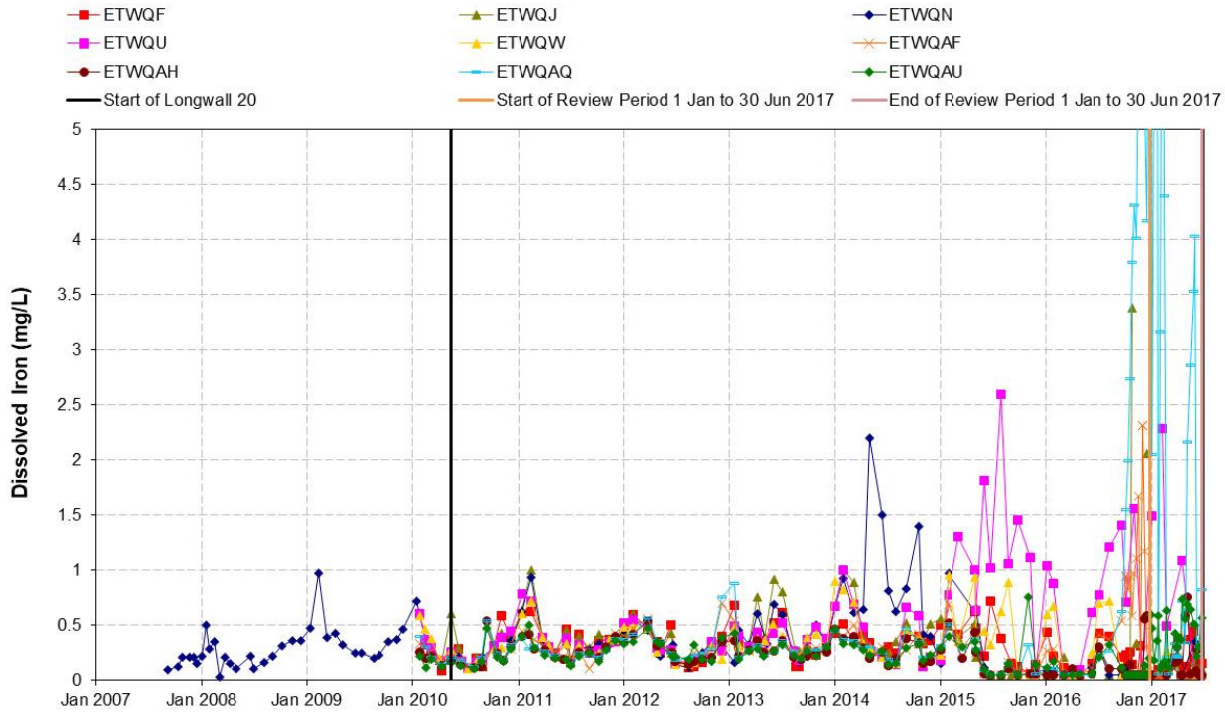


Chart 36a Dissolved Iron Eastern Tributary

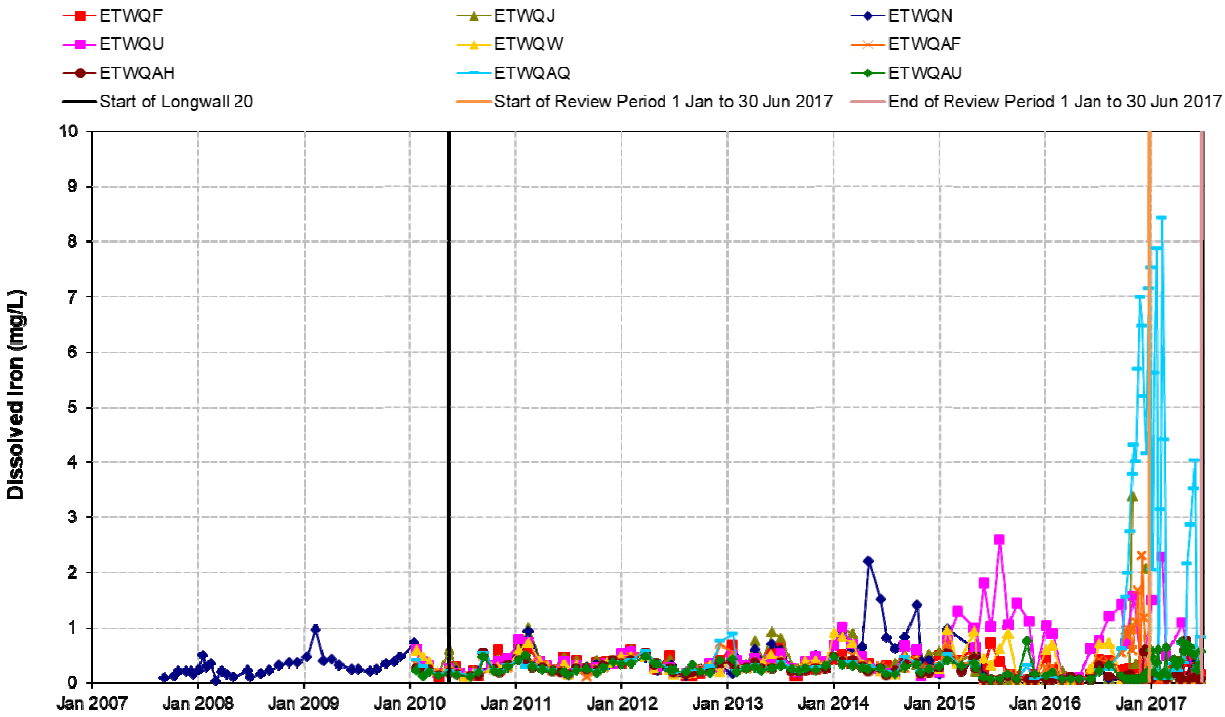


Chart 36b Dissolved Iron Eastern Tributary

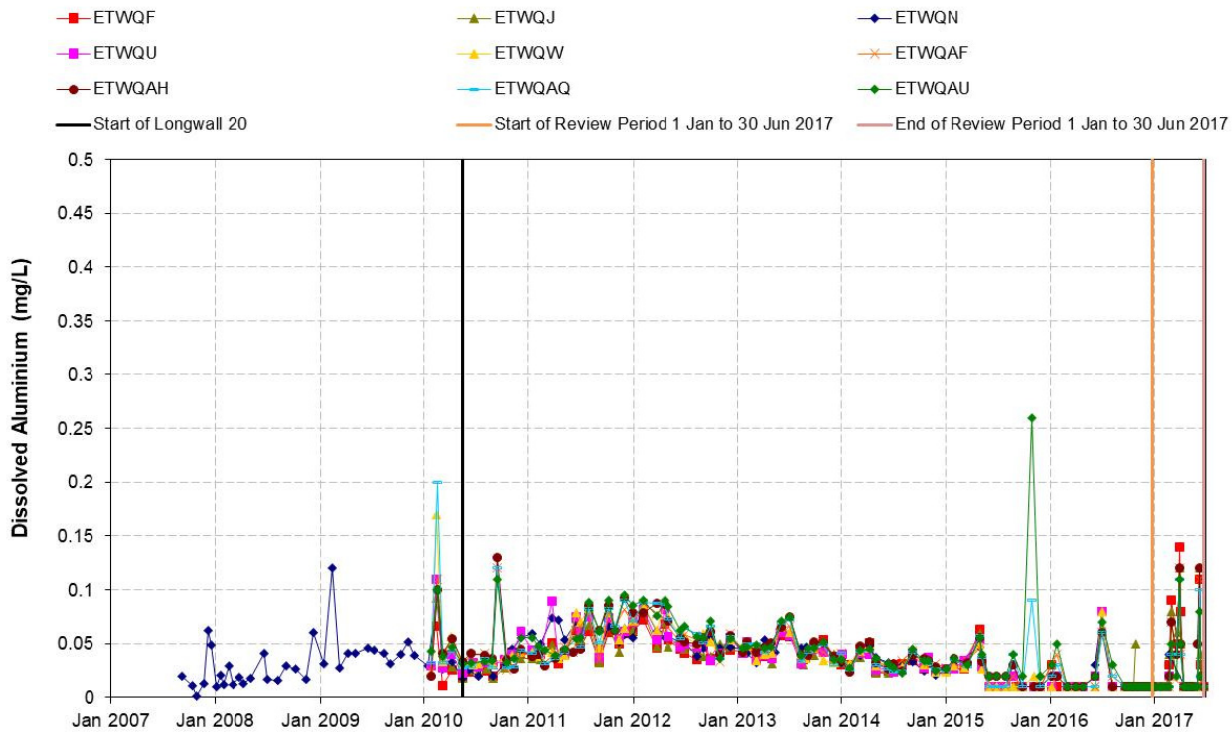


Chart 37 Dissolved Aluminium Eastern Tributary

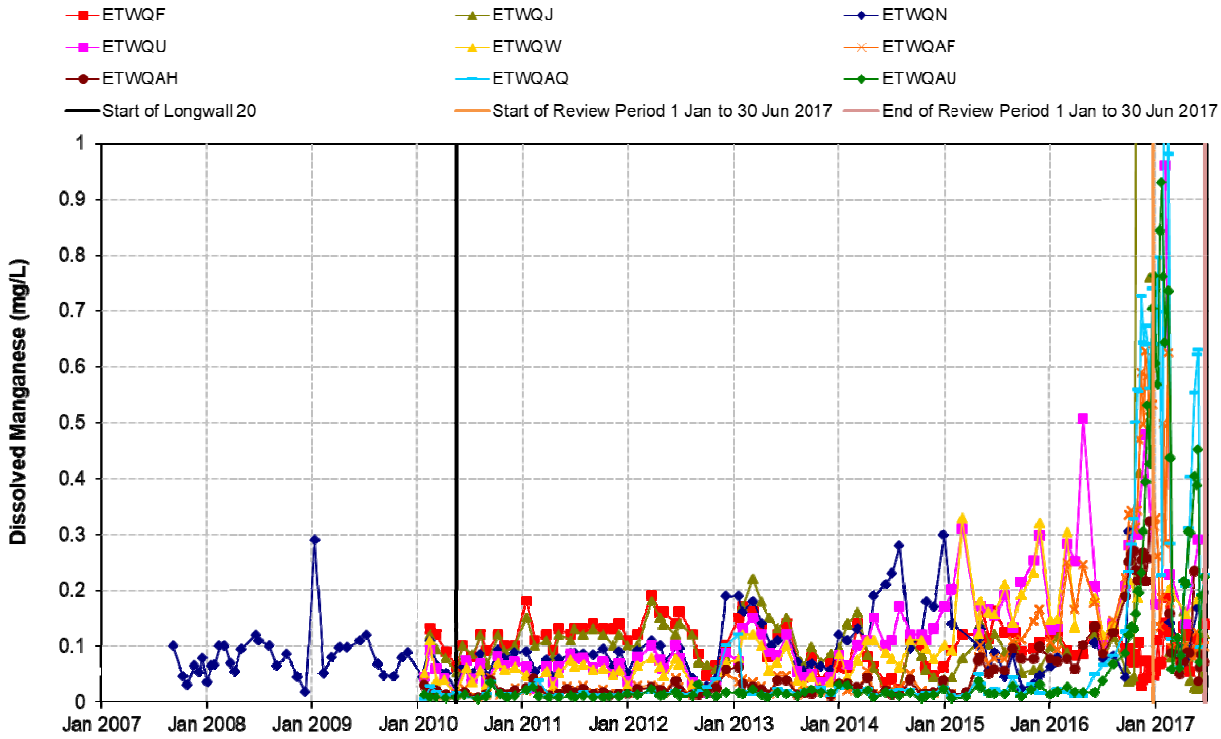


Chart 38a Dissolved Manganese Eastern Tributary

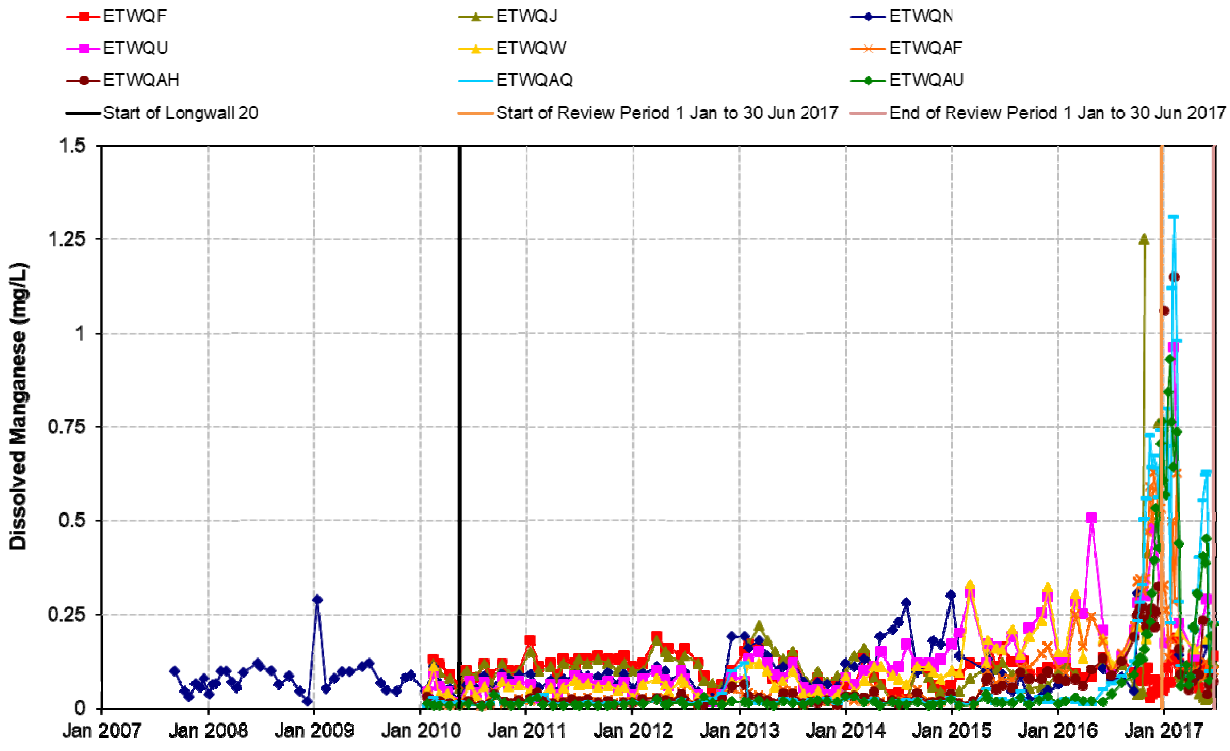


Chart 38b Dissolved Manganese Eastern Tributary

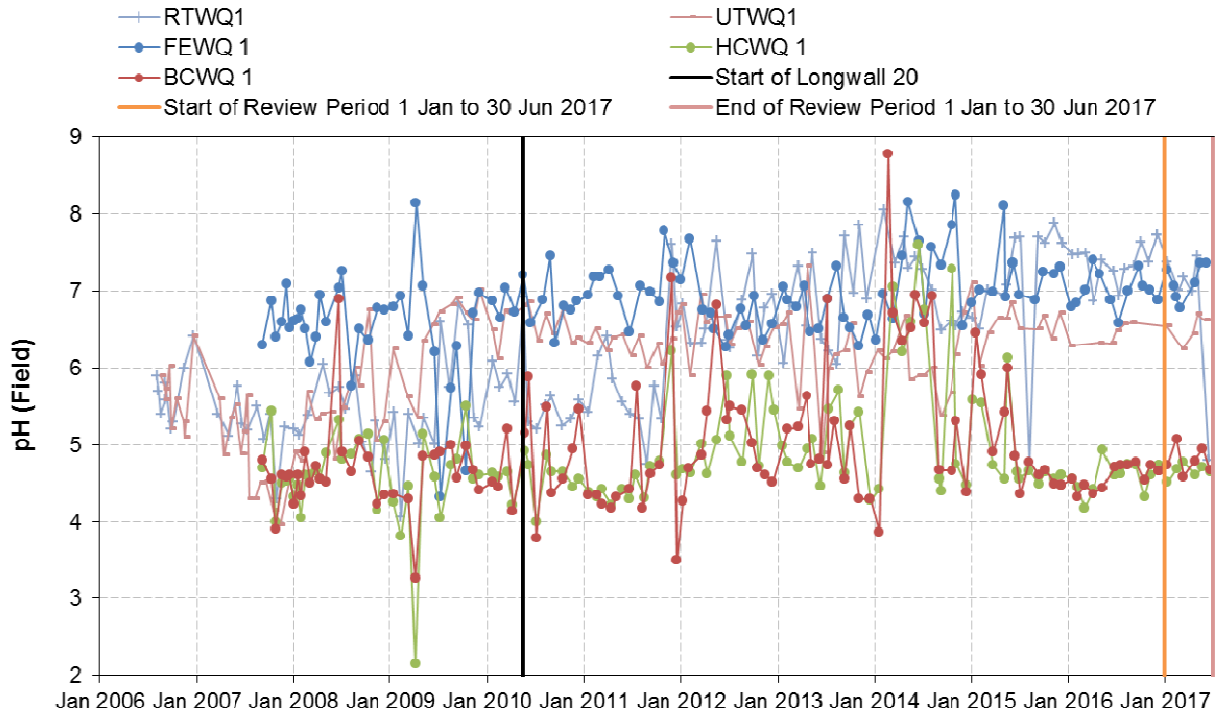


Chart 39 pH Levels Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

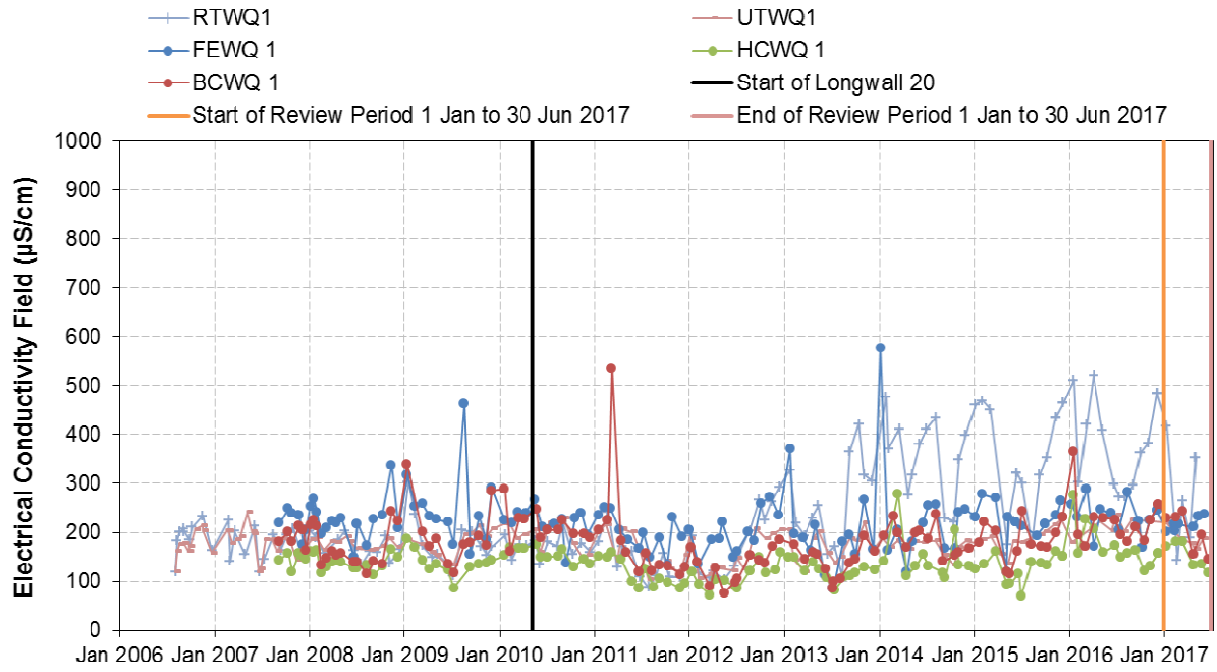


Chart 40 Electrical Conductivity (EC) Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

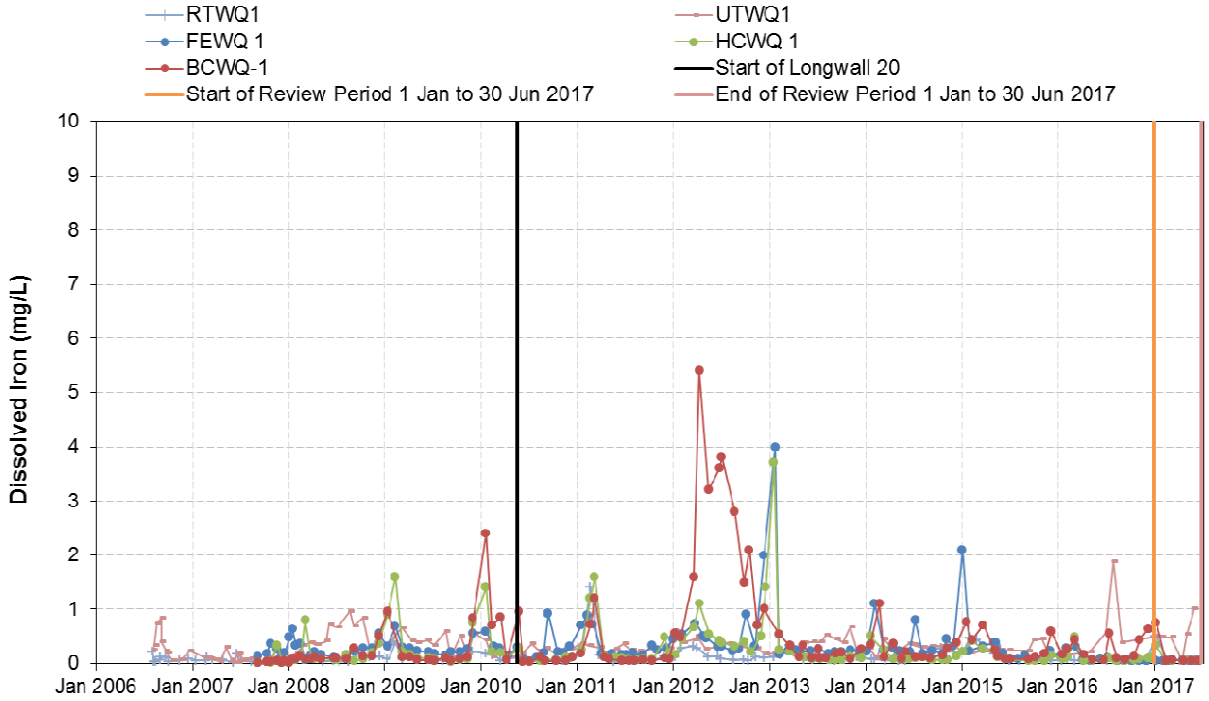


Chart 41 Dissolved Iron Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

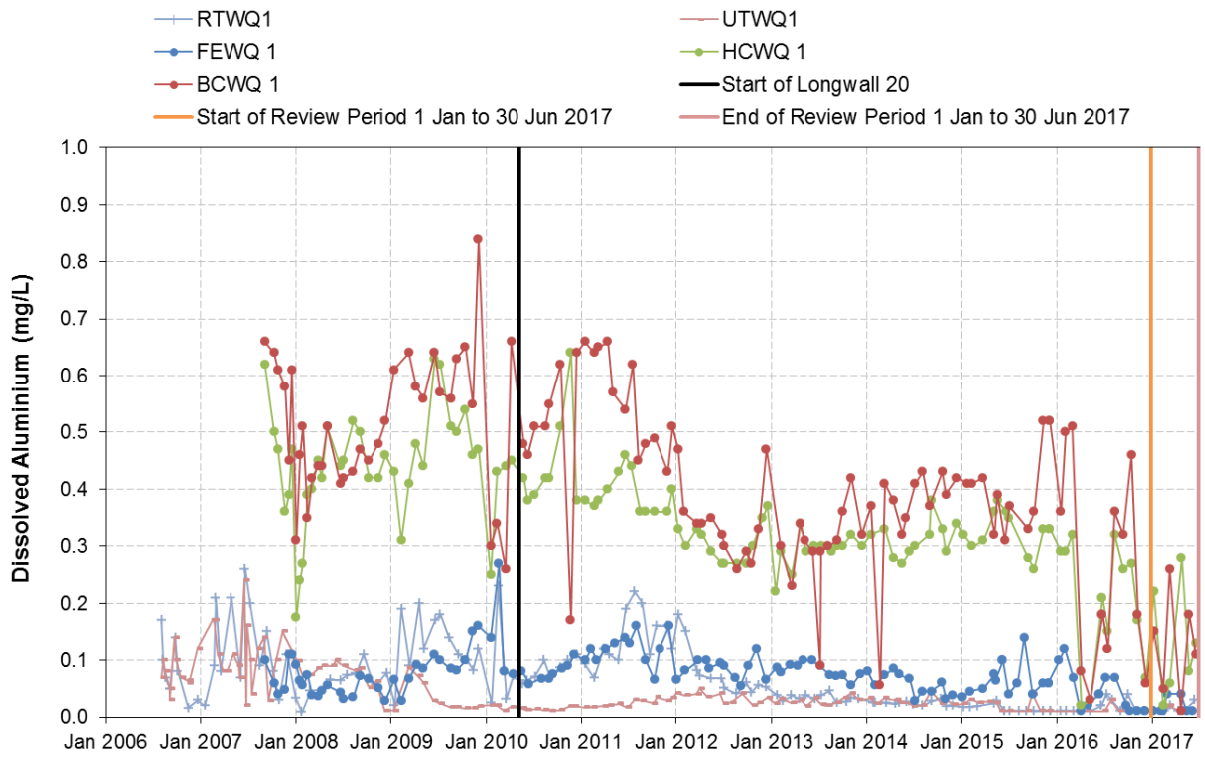


Chart 42 Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

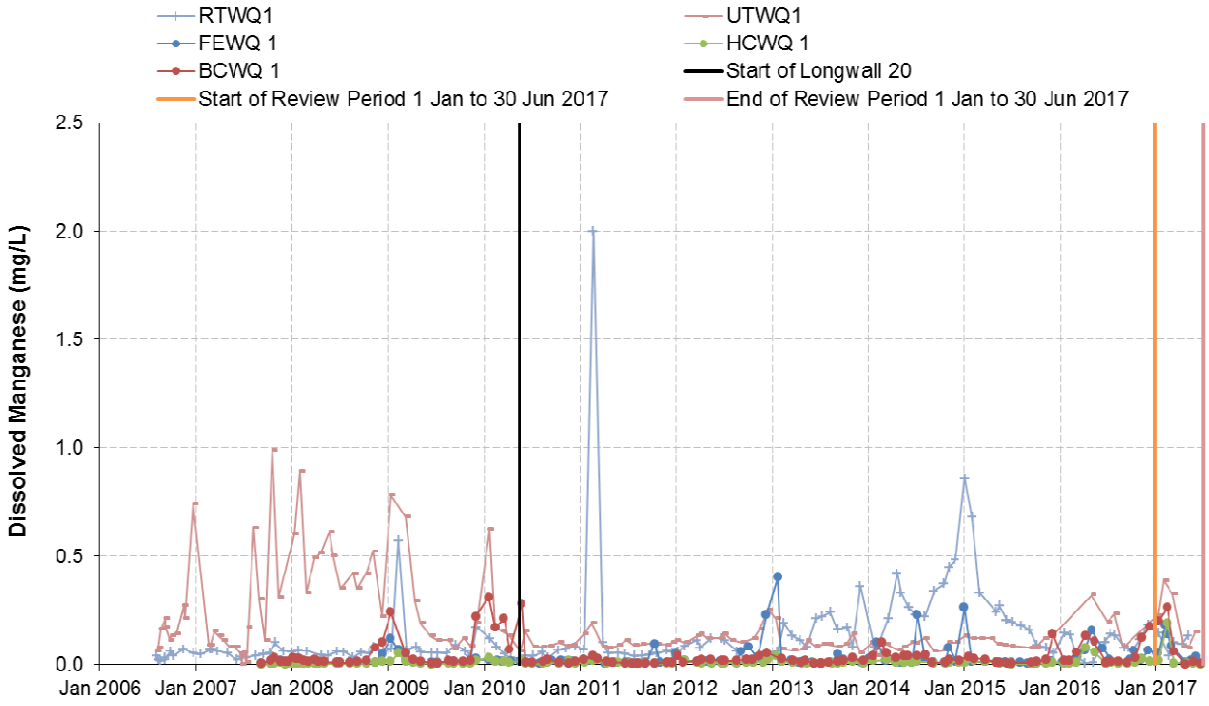


Chart 43 Dissolved Manganese Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

In the previous reporting period, there was an exceedance of the performance indicator for dissolved manganese at site WRWQ9 as a result of the six month mean exceeding the adjusted baseline mean plus one standard deviation for two consecutive assessment periods (Chart 44). Assessment of whether the associated subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir,* had been exceeded concluded that it had not (Hydro Engineering & Consulting, 2017). A peer review of the assessment has been conducted by Associate Professor Barry Noller (The University of Queensland, 2017), a specialist approved by the DP&E, and is provided in Appendix G. The peer review concurred with the assessment that the subsidence impact performance measure had been met.

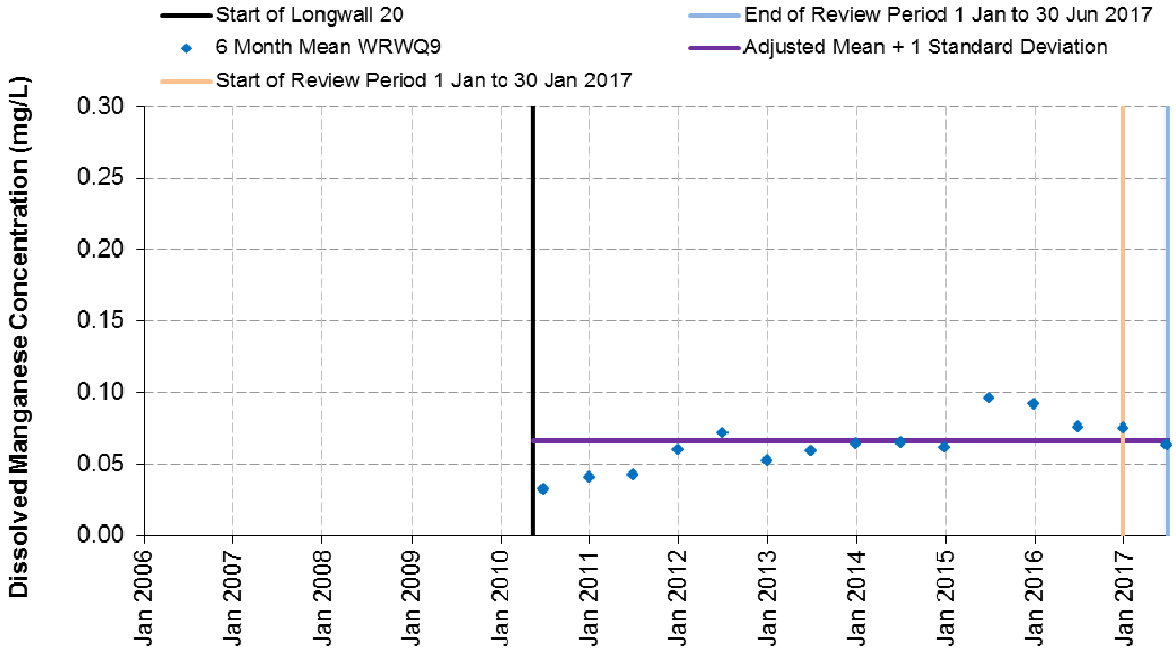


Chart 44 Six Monthly Means of Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

Assessment of Water Quality at Site ETWQ AU

There was no exceedance of the performance indicator as a result of the assessment methods for dissolved iron or dissolved aluminium at site ETWQ AU on Eastern Tributary. There were a series of consecutive monthly exceedances of the adjusted baseline mean plus two standard deviations of dissolved manganese in Eastern Tributary at site ETWQ AU from January to June 2017 (Chart 45). There was also an exceedance of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved manganese in Eastern Tributary at site ETWQ AU (Chart 46). There was no exceedance of the measures at the control site on Woronora River at site WOWQ2.

As a result, an assessment has been made against the subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir.* The assessment undertaken by Associate Professor Barry Noller (The University of Queensland, 2017) is provided in Appendix H. Assessment of the monitoring data concluded there has been a negligible reduction to the quality of water resources reaching the Woronora Reservoir.

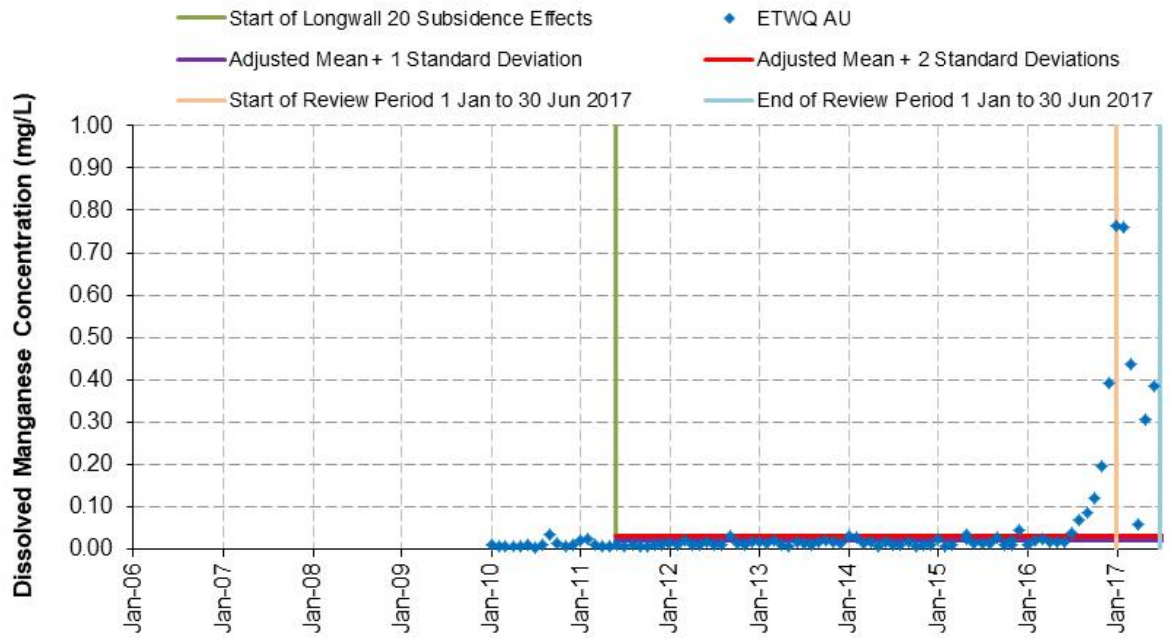


Chart 45 Monthly Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

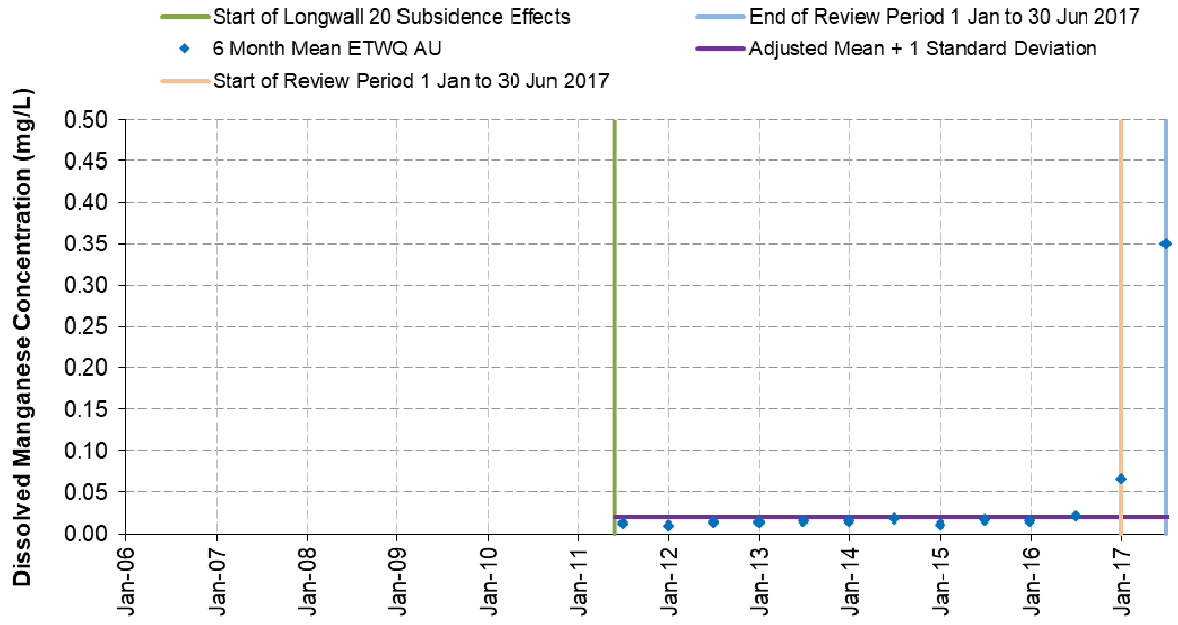


Chart 46 Six Month Means of Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

3.5 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 levels from 0 m to 9 m below the reservoir surface for Woronora Reservoir throughout the period of record are presented in Charts 47, 48 and 49.

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 performance indicator will be assessed in the Metropolitan Coal 2017 Annual Review.

In the previous reporting period, there was an exceedance of the Woronora Reservoir water quality performance indicator for total aluminium as the 20 year ARI exceedance curve was exceeded for the 0% to 20% exceedance durations (as reported in the Metropolitan Coal 2016 Annual Review). Assessment of whether the associated subsidence impact performance measure, *Negligible reduction to the quality of water of Woronora Reservoir,* had been exceeded concluded that it had not (Hydro Engineering & Consulting, 2017). A peer review of the assessment has been conducted by Associate Professor Barry Noller (The University of Queensland, 2017) and is provided in Appendix G. The peer review concurred with the assessment that the subsidence impact performance measure had been met.

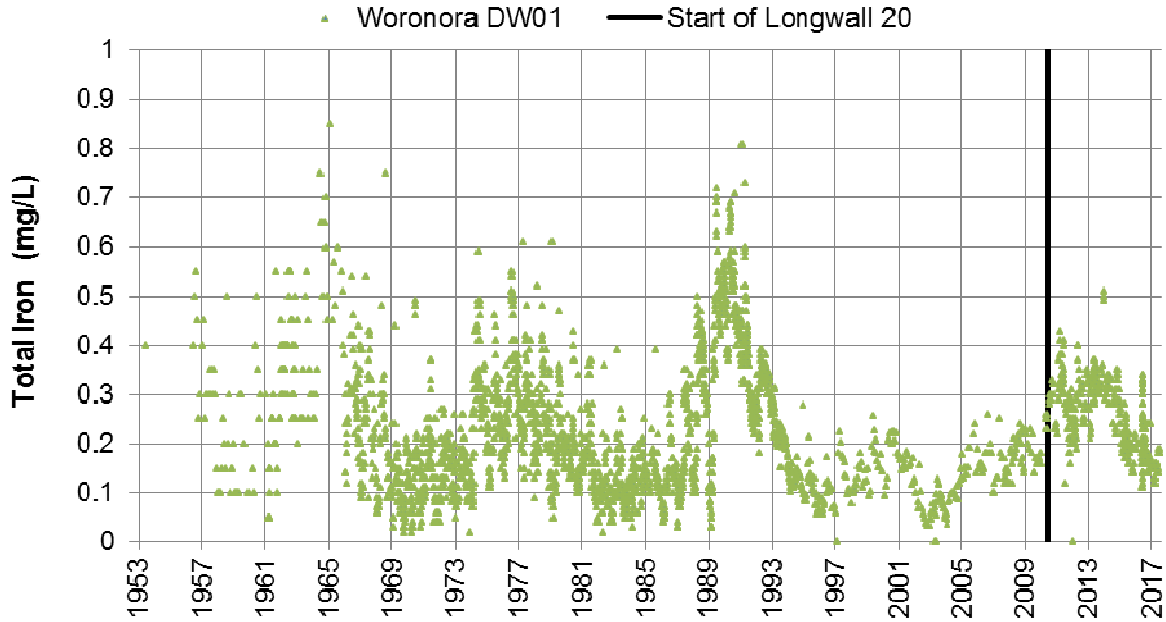


Chart 47 Total Iron Concentration Woronora Reservoir

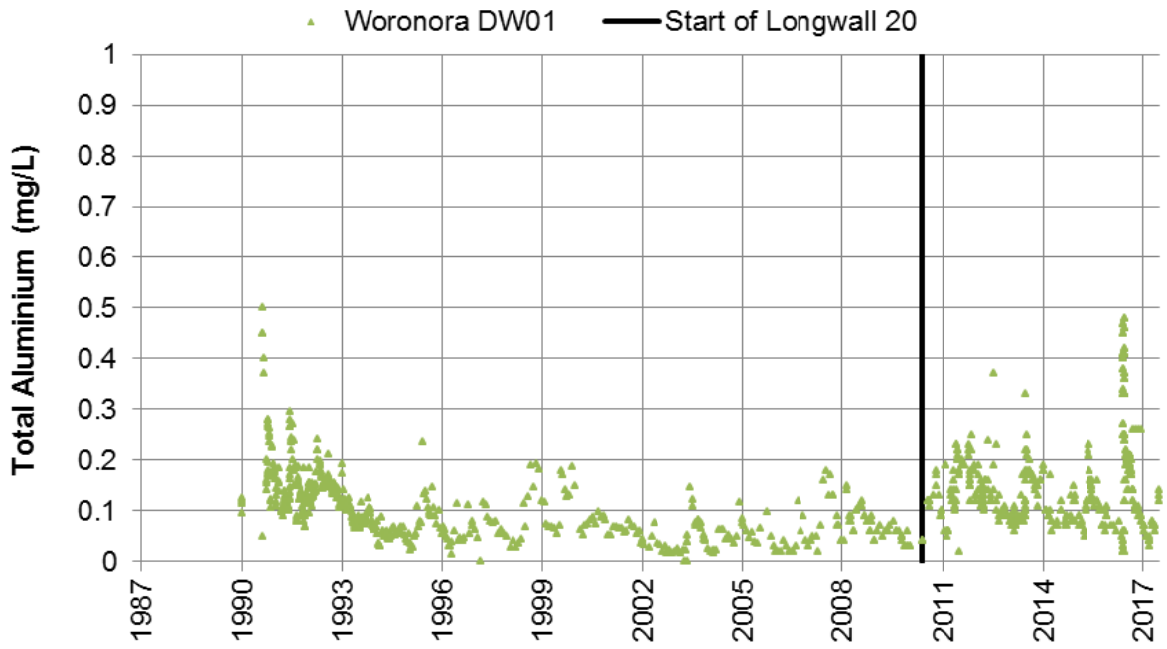


Chart 48 Total Aluminium Concentration Woronora Reservoir

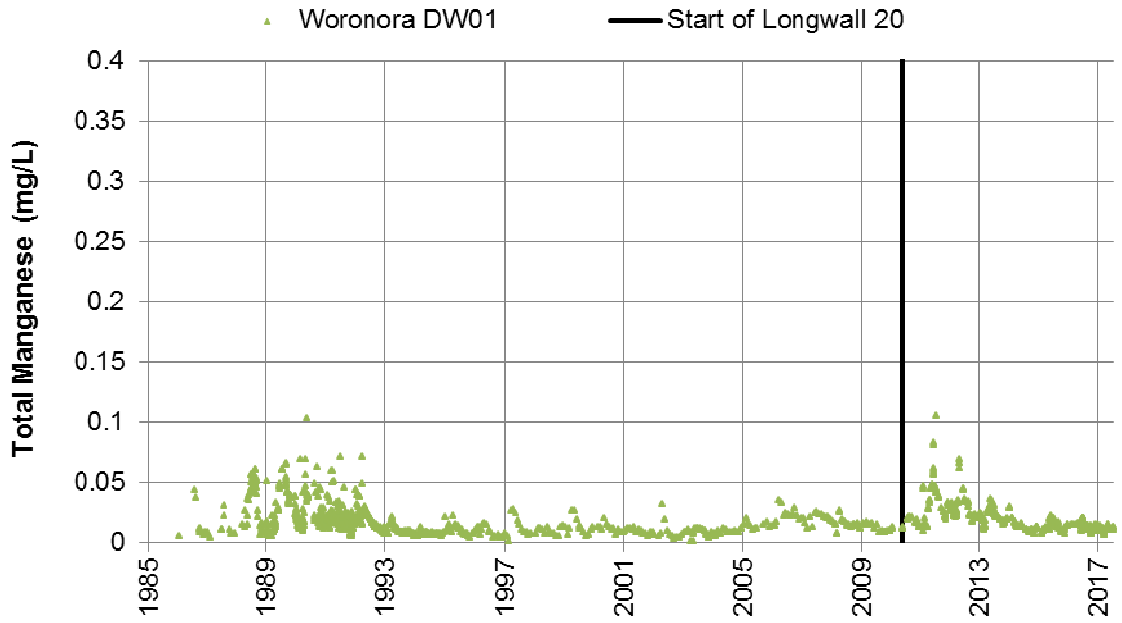


Chart 49 Total Manganese Concentration Woronora Reservoir

3.6 SWAMP GROUNDWATER LEVELS

Groundwater monitoring of upland swamps for Longwalls 20-22 and Longwalls 23-27 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 7). Specifically, 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 7). At Swamp 20 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 7).

The swamp substrate piezometer represents water levels within the swamp sediments, and the piezometer at approximate depths of 4 m and 10 m allows comparison with the shallow water table in the Hawkesbury Sandstone. 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*.

In summary, the swamp substrate water levels of Swamps 25, 30, 33 and 35 remained perched during the reporting period (Appendix C). Exceedances of the upland swamp groundwater performance indicator have continued to be recorded at Swamp 20 (since 2012) and Swamp 28 (since 2016), as described below.

Swamp 20

As reported previously, Swamp 20 substrate water levels changed from being permanently saturated to being periodically saturated as a result of the passing of Longwall 21 (Chart 50 and Appendix C). This trend continued to be observed throughout the reporting period (Chart 50). It is considered that Longwall 21 caused a mining effect at Swamp 20, but the effects have not been exacerbated by Longwalls 22-27 (Chart 50 and Appendix C).

Swamp 28

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 51 and Appendix C). 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 (Appendix C). For the first two months of the reporting period, readings in the swamp substrate piezometer continued to be dry (below sensor level since November 2016). In the latter half of the reporting period the substrate piezometer displayed a response to increased rainfall residual similar to that of the control swamps. However, there appears to be a permanent lowering of the upper height of saturation (Chart 51 and Appendix C).

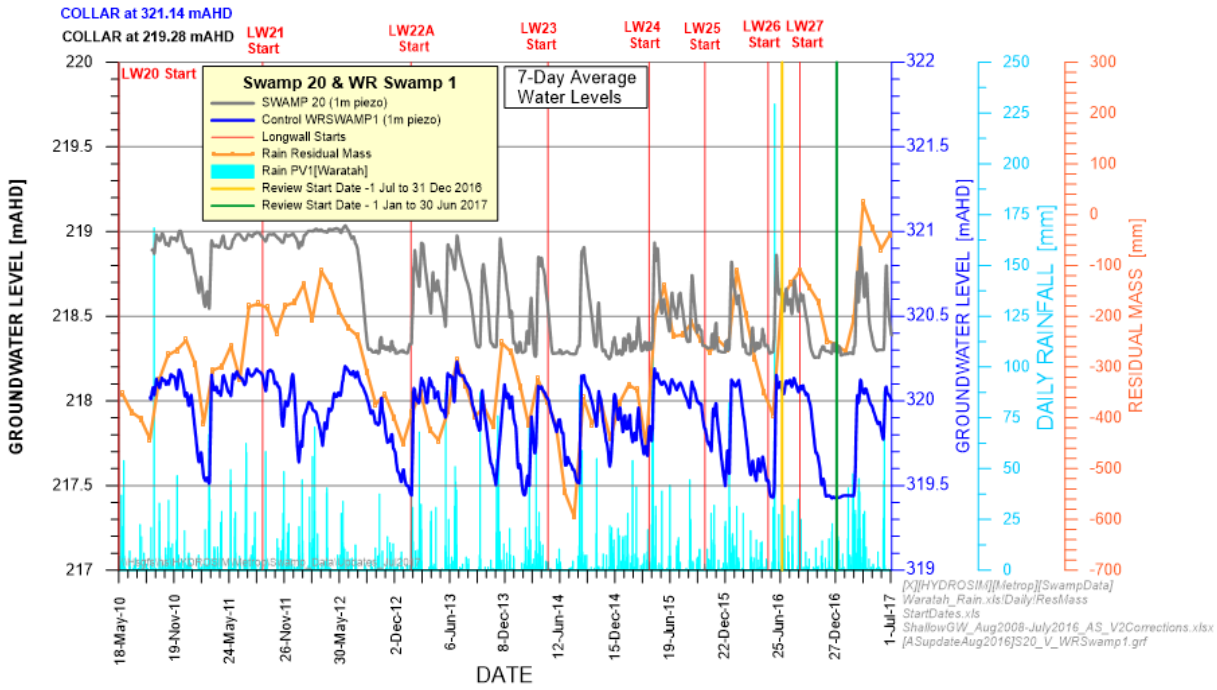


Chart 50 Comparison of Piezometer Responses at Swamp 20 and Woronora River 1 Control Swamp

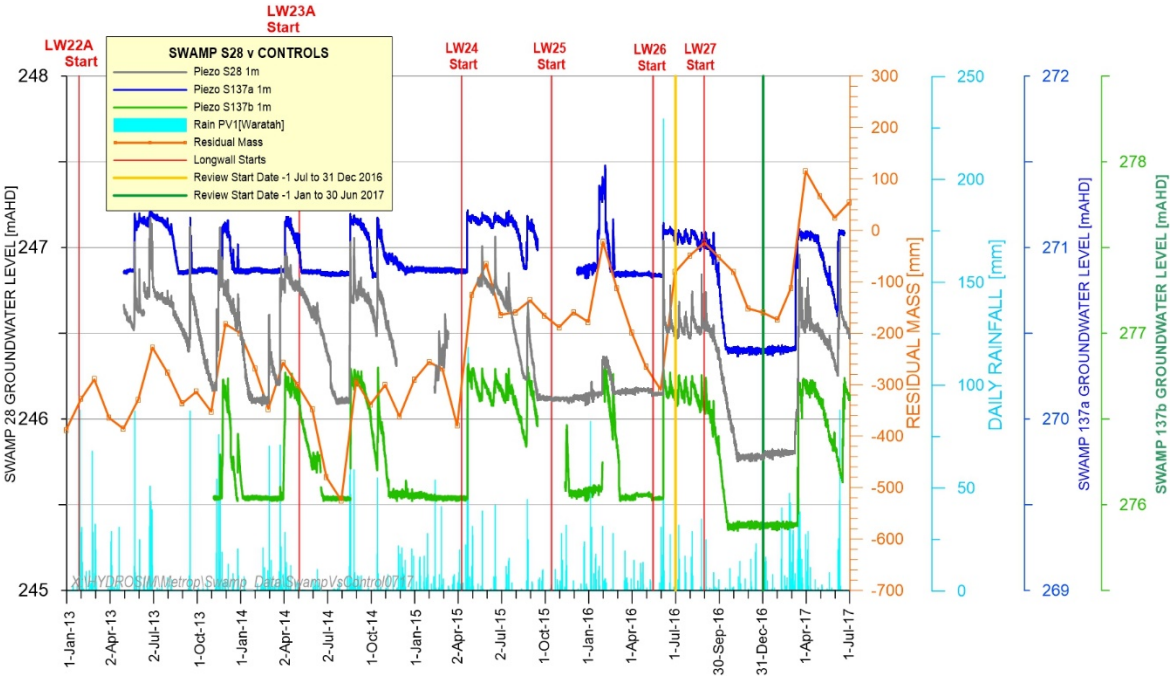


Chart 51 Groundwater Hydrographs at Swamp 28 and Two Control Swamps (137a and 137b)

3.7 SHALLOW GROUNDWATER LEVELS

Continuous water level monitoring of shallow groundwater levels has been conducted at sites WRGW1, WRGW2 and WRGW7 along Waratah Rivulet and sites ETGW1 and ETGW2 on the Eastern Tributary (Figure 8 and Charts 52, 53 and 54).

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 about 1 m (Chart 52). Since March 2012, groundwater levels recorded in 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. Although the water levels have not returned to pre-March 2012 levels, throughout the reporting period the water levels at sites WRGW1 and WRGW2 have correlated closely with rainfall trends (as indicated by the residual mass curve on Chart 52).

Shallow groundwater levels at site WRGW7 remained correlated with rainfall trends and unaffected by mining during the reporting period (Chart 53).

At the Eastern Tributary sites ETGW1 and ETGW2, shallow groundwater levels have previously followed the rainfall trends closely (Chart 54) and have continued to show a close correlation during the reporting period. The variations at these sites are unrelated to mining.

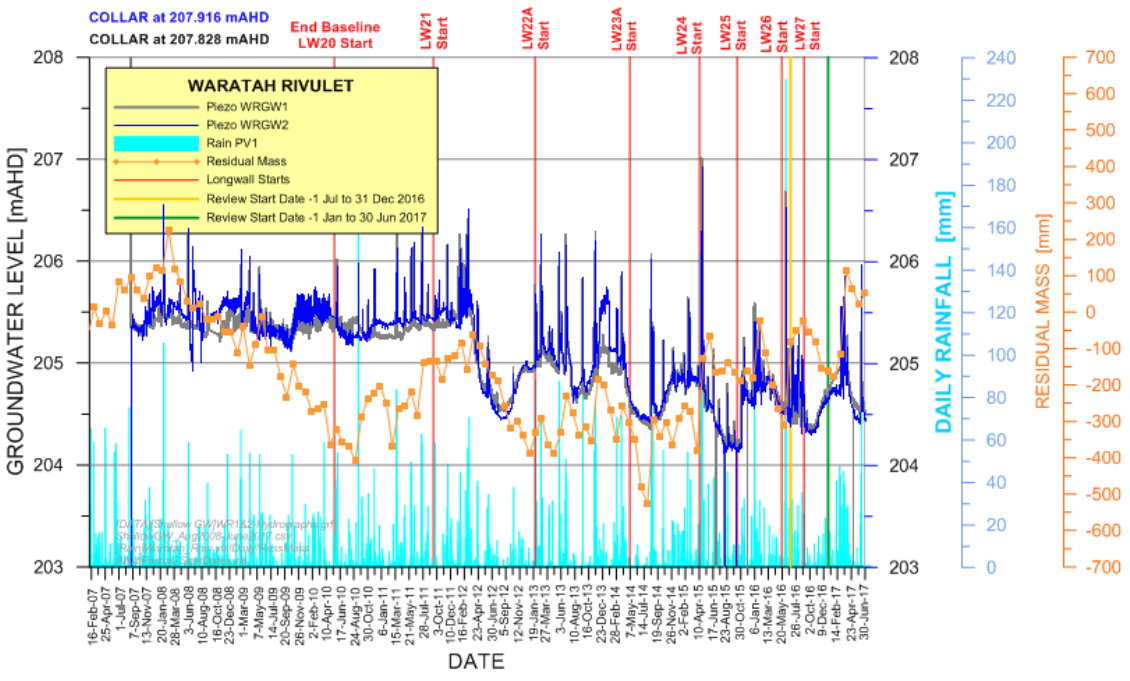


Chart 52 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW1 and WRGW2

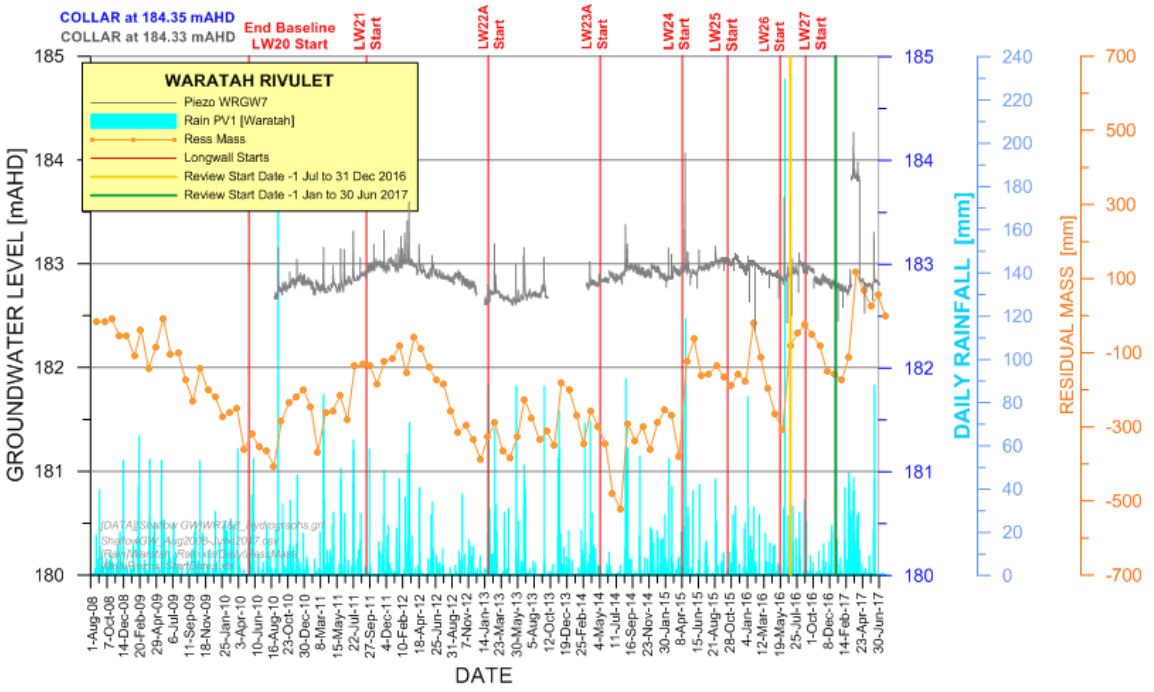


Chart 53 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW7

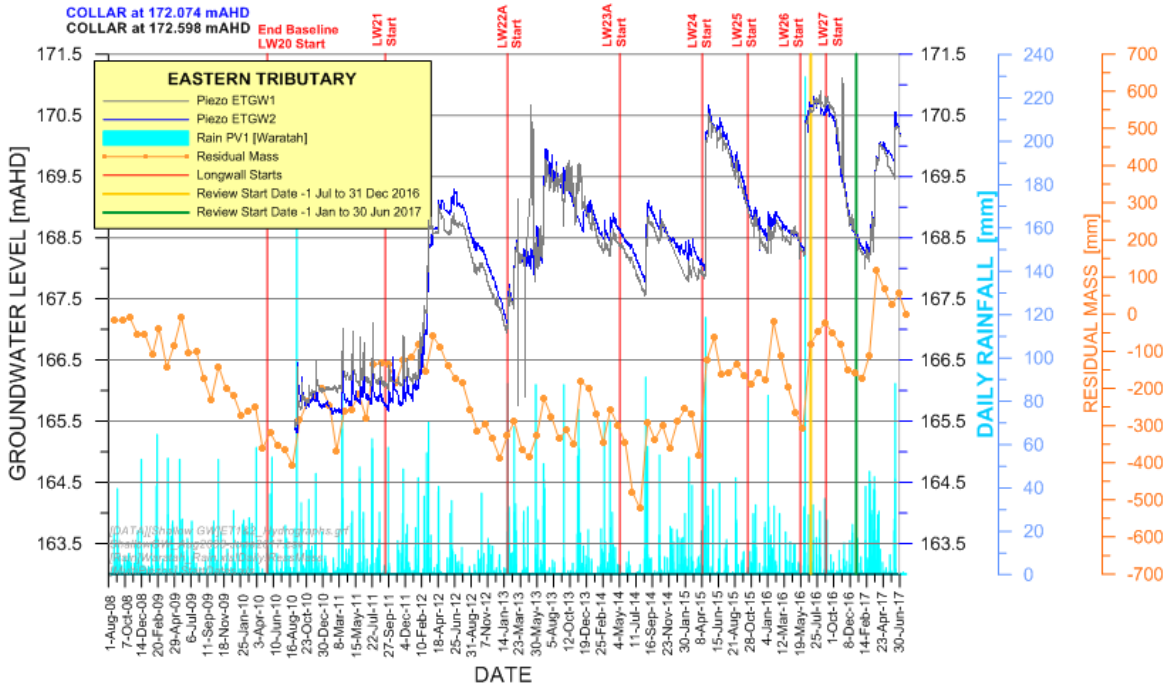


Chart 54 Shallow Groundwater Hydrographs on Eastern Tributary at ETGW1 and ETGW2

3.8 DEEP GROUNDWATER LEVELS/PRESSURES

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 for the mine and its surroundings prior to the commencement of Longwall 20. Since then, the model has been recalibrated and refined in the upper layers (Hawkesbury Sandstone) and extended from 13 to 15 layers. The groundwater model has been updated progressively as new multi-level piezometric data became available from the monitoring program. Model outputs have been examined every six months for review of environmental performance.

Transient calibration has been undertaken to incorporate Metropolitan Coal updates to the geological model. The revised model includes an update of the topographical surface and geological interfaces, the addition of two model layers below the Bulli seam and updated estimates of the fractured zone height. A draft report has been prepared for the updated model which is currently under review. The updated model has not been used for any Longwalls 20-27 assessments.

Continuous groundwater level/pressure monitoring has been conducted at bores 9HGW0 (Longwall 10 Goaf Hole), 9EGW1B, 9FGW1A, 9GGW1-80, 9GGW2B, 9HGW1B, PM02, PM01, 9EGW2A, PM03, PHGW1B, PHGW2A, F6GW3 and F6GW4 in accordance with the Longwalls 20-22 and/or Longwalls 23-27 Water Management Plans (Figure 8). The time-series head variations and vertical head differences for these bores have been examined (Charts 55 to 68).

The monitoring sites closest to Longwalls 23-27 are bore 9EGW1B (approximately 300 m north of Longwall 23A) and bore 9GGW2B (above Longwall 27 headings) (Figure 8).

The time-series record for bore 9EGW1B (Chart 56) shows fairly stable heads that decline with depth in a regular manner, except for piezometer 233 m in the upper Bulgo Sandstone whose head is out of sequence. The deepest piezometer (542 m in Coal Cliff Sandstone), which has been declining slowly since the commencement of Longwall 20 due to far-field depressurisation, changed from a declining to increasing trend of potentiometric head during the reporting period. Groundwater pressures were relatively stable during the reporting period in all other piezometers, with no sign of any effect from Longwalls 24 to 27 (Appendix C).

The time-series record for bore 9GGW2B is shown on Chart 59[5]. 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. 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[6] (Appendix C).

[5] As the hydrographs show inconsistent head variations with depth, some of the piezometers are unreliable.

[6] The 138 m, 163 m, 304 m and 474 m deep vibrating wire piezometers did not record data during the reporting period; all other piezometers showed stable trends.

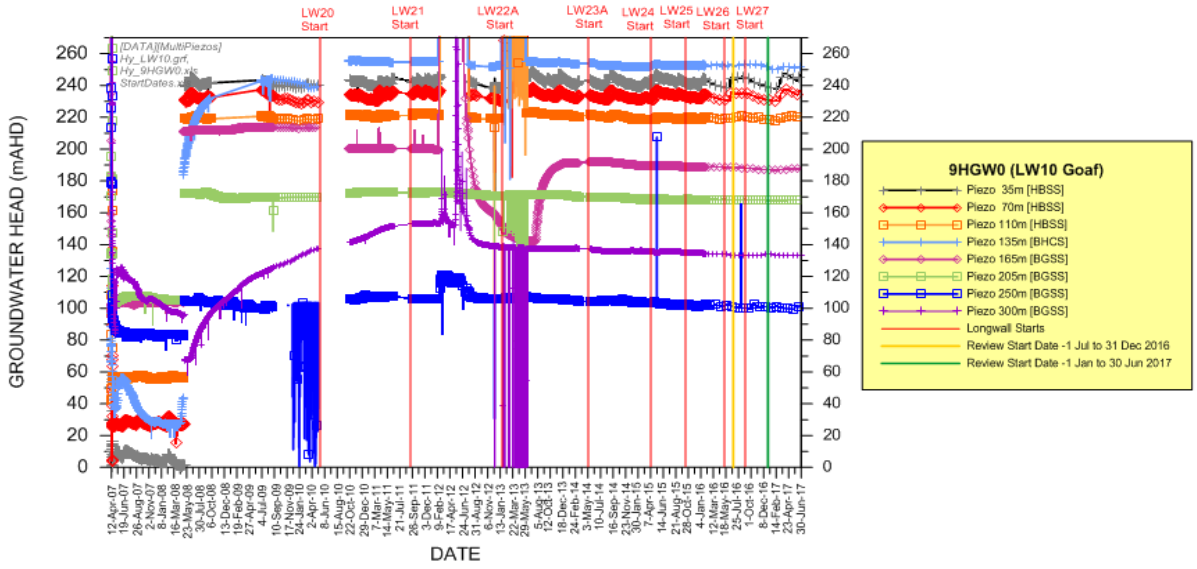


Chart 55 Time Variations in Potentiometric Heads at 9HGW0

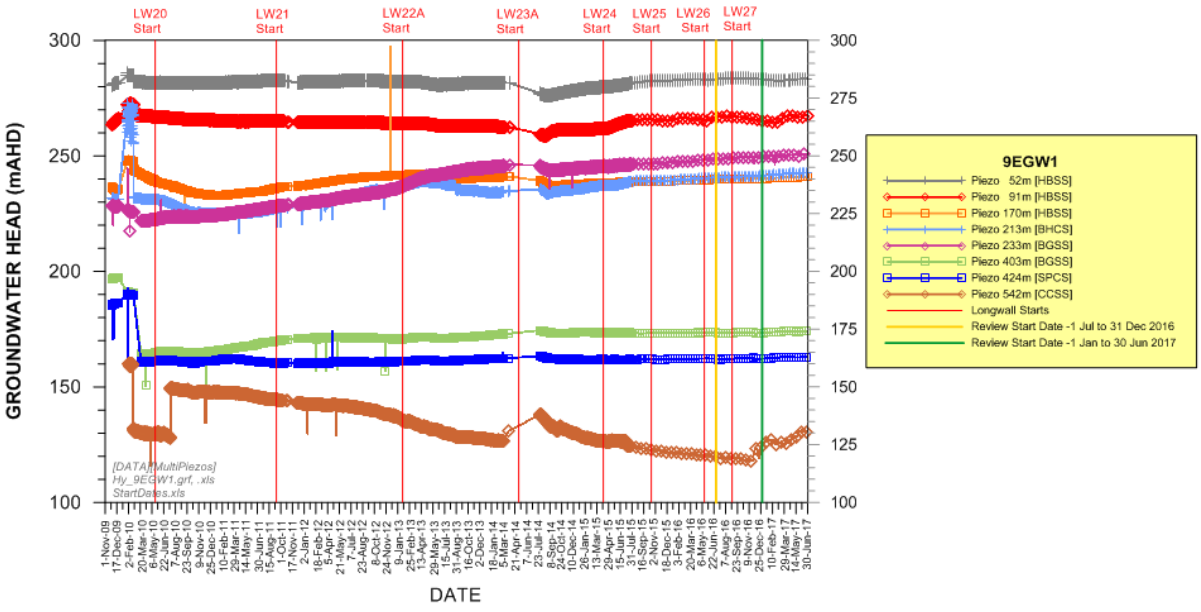


Chart 56 Time Variations in Potentiometric Heads at 9EGW1B

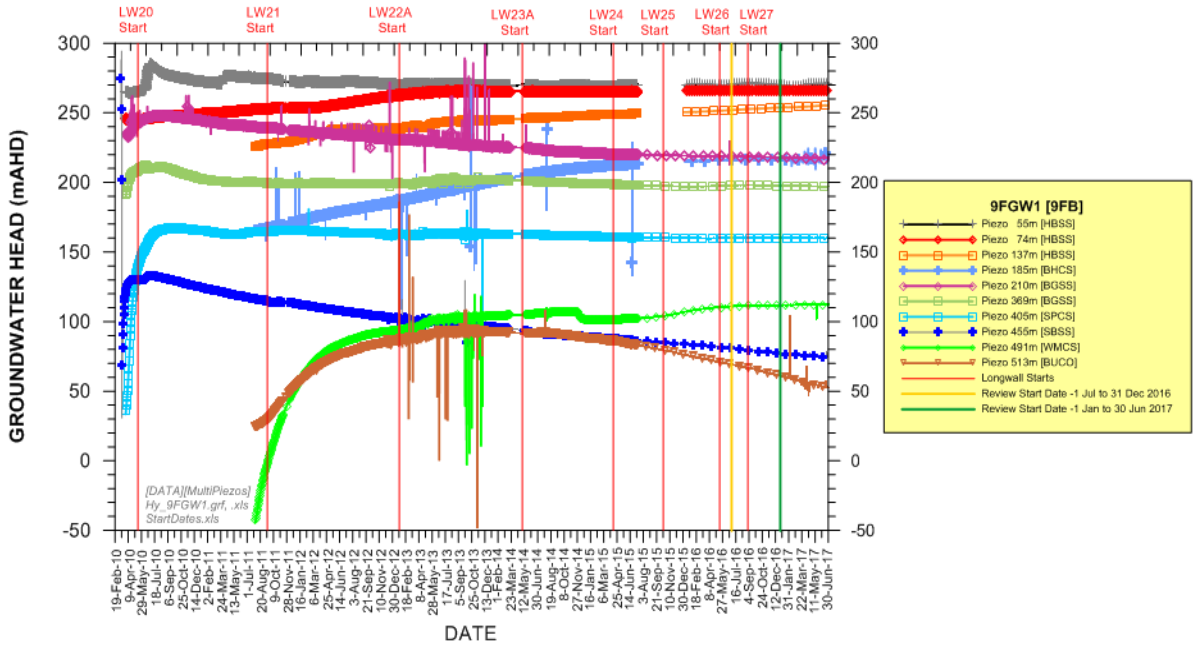


Chart 57 Time Variations in Potentiometric Heads at 9FGW1A

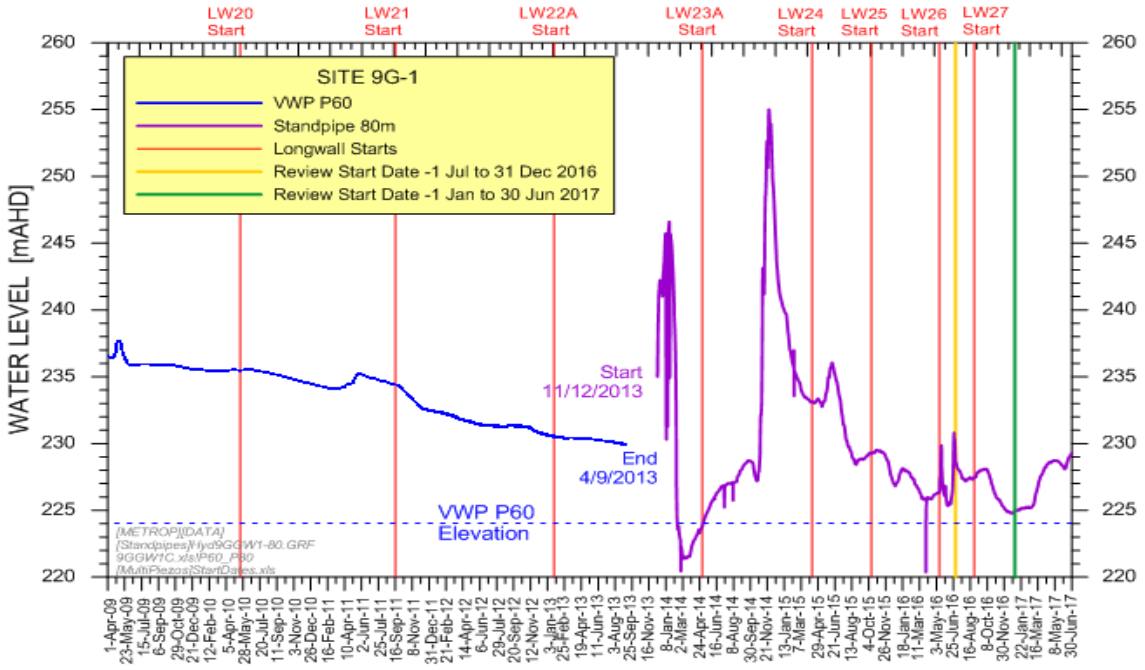


Chart 58 Time Variations in Water Table at Standpipe 9GGW1-80 and Decommissioned Vibrating Wire Piezometer 9GGW1-60

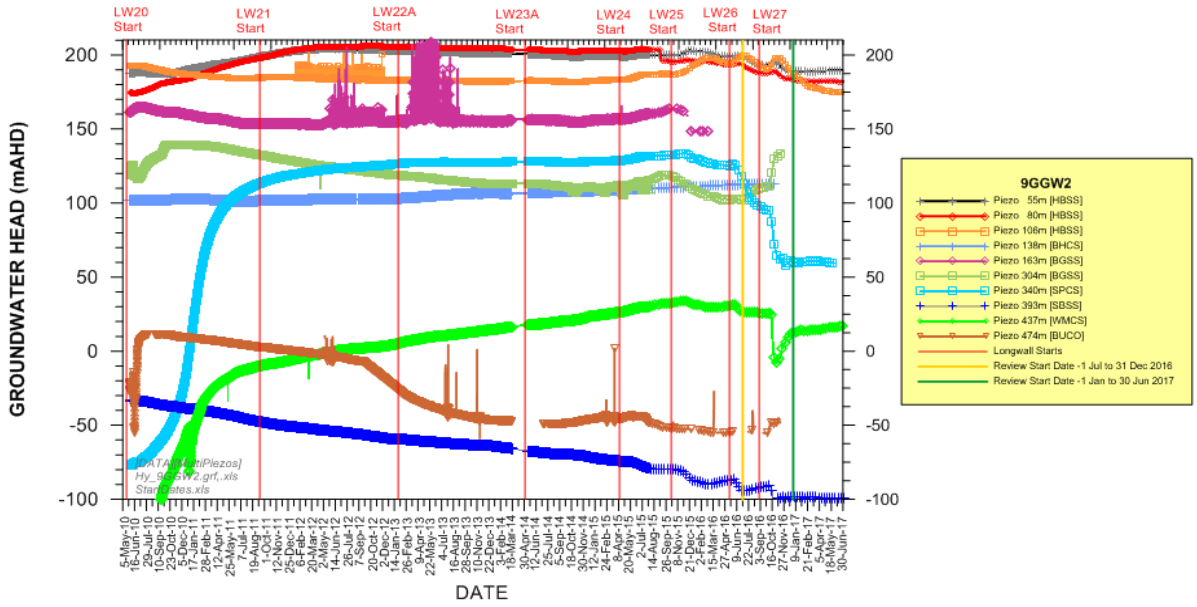


Chart 59 Time Variations in Potentiometric Heads at 9GGW2B

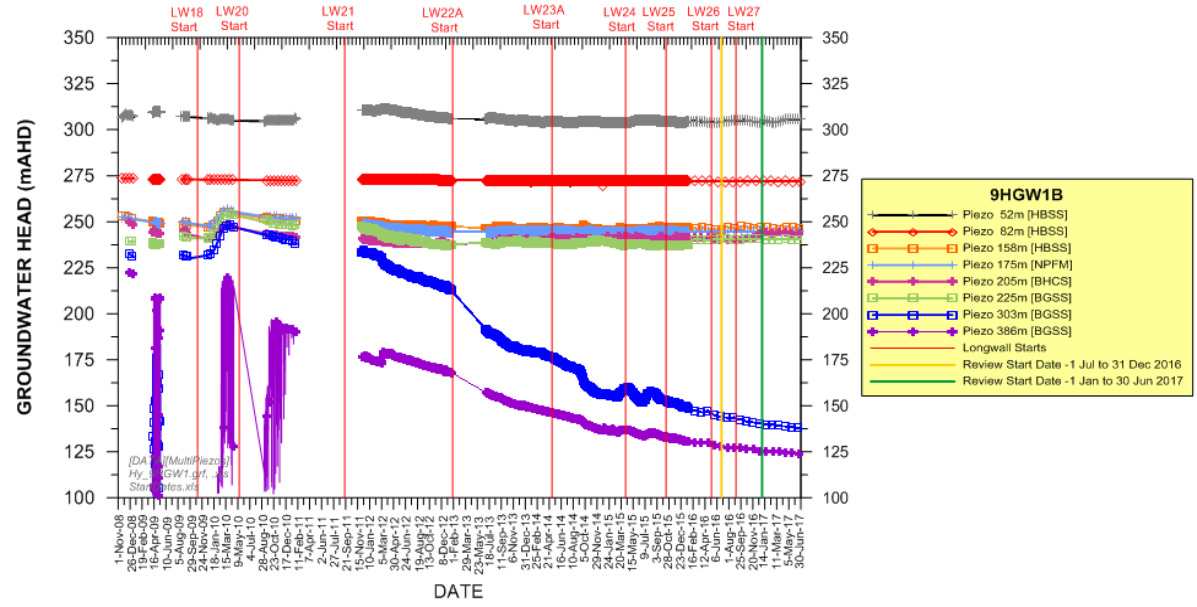


Chart 60 Time Variations in Potentiometric Heads at 9HGW1B

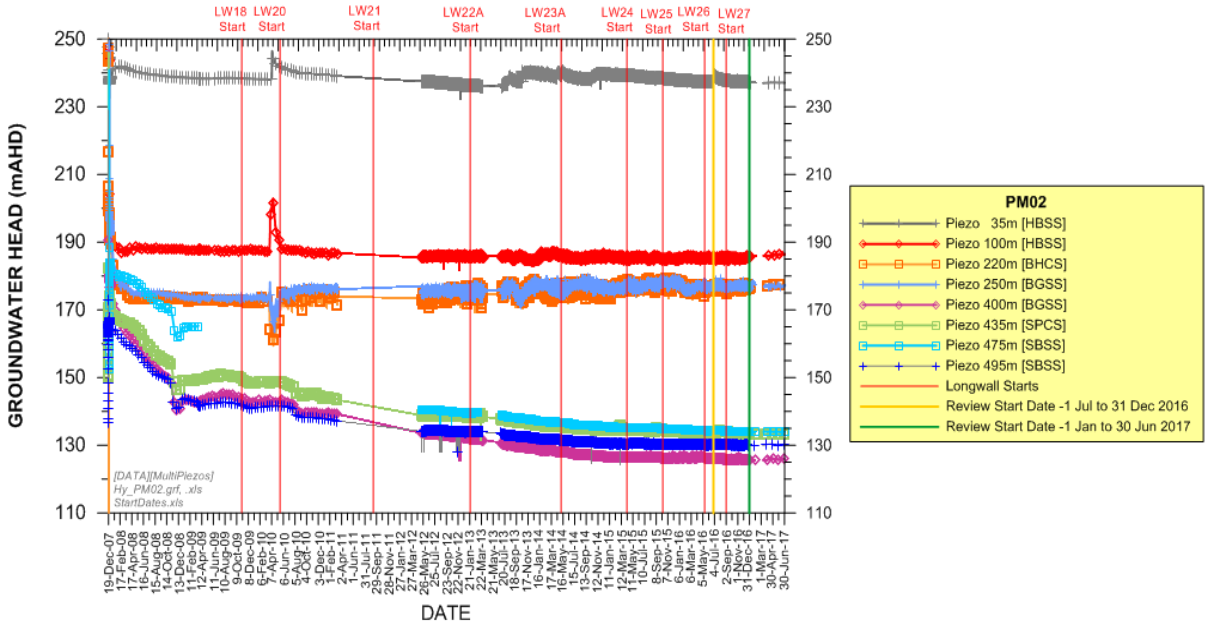


Chart 61 Time Variations in Potentiometric Heads at PM02

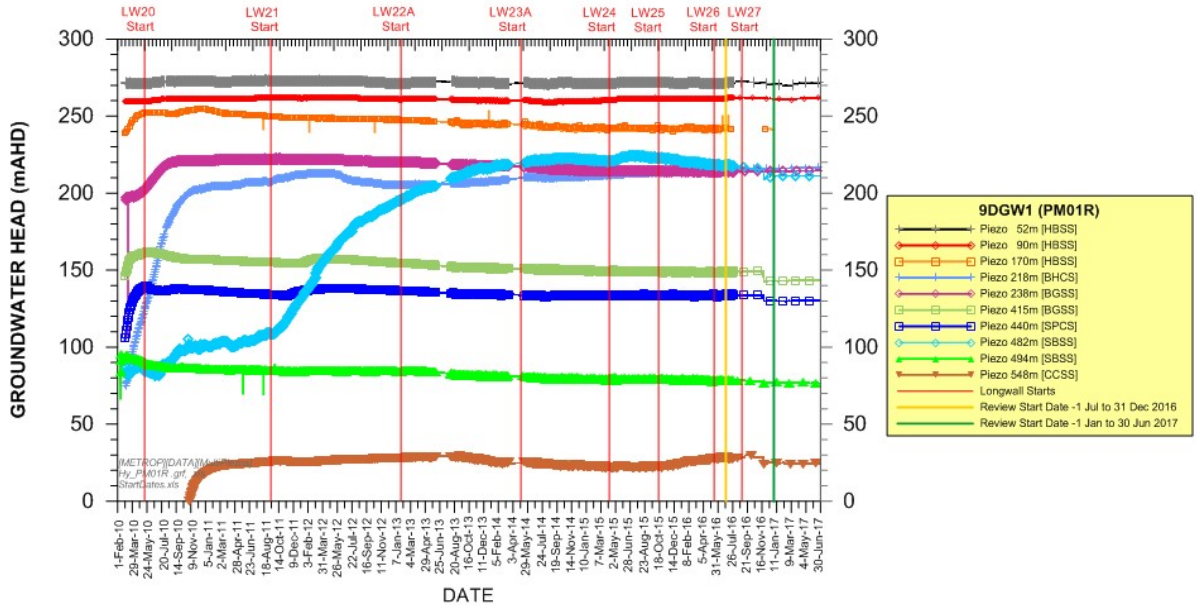


Chart 62 Time Variations in Potentiometric Heads at PM01

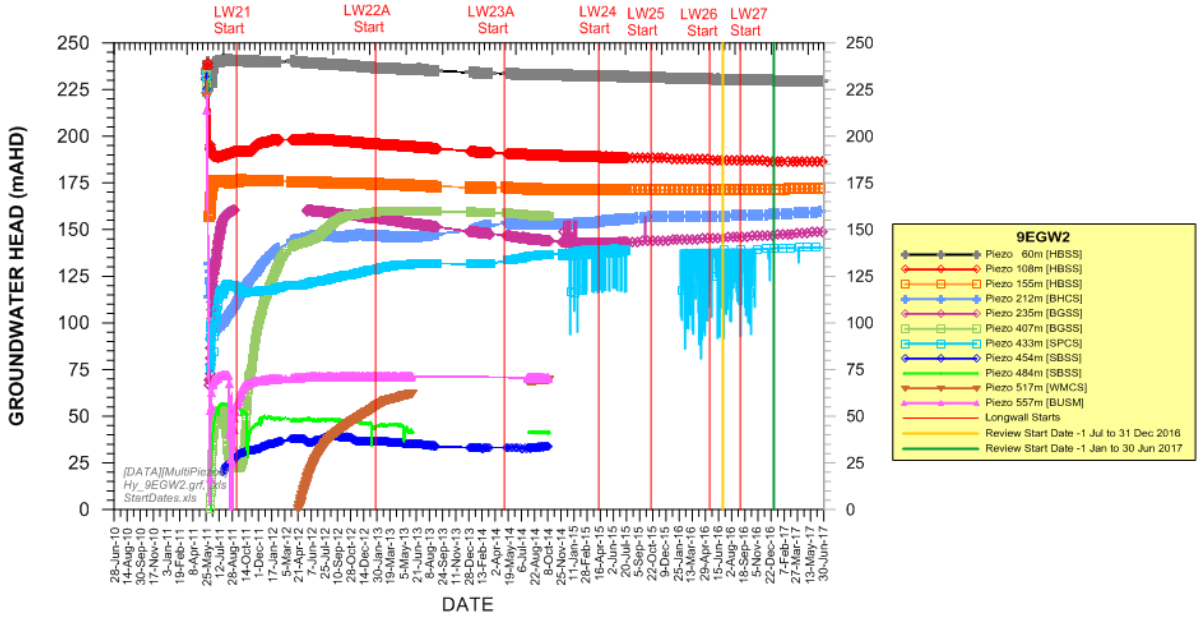


Chart 63 Time Variations in Potentiometric Heads at 9EGW2A

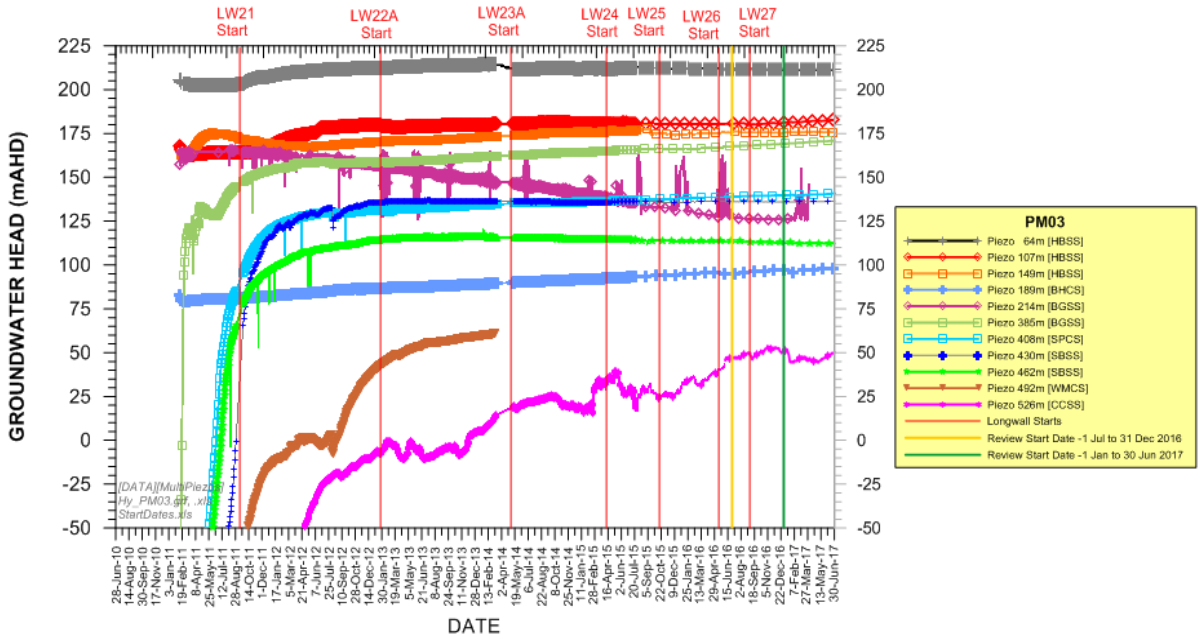
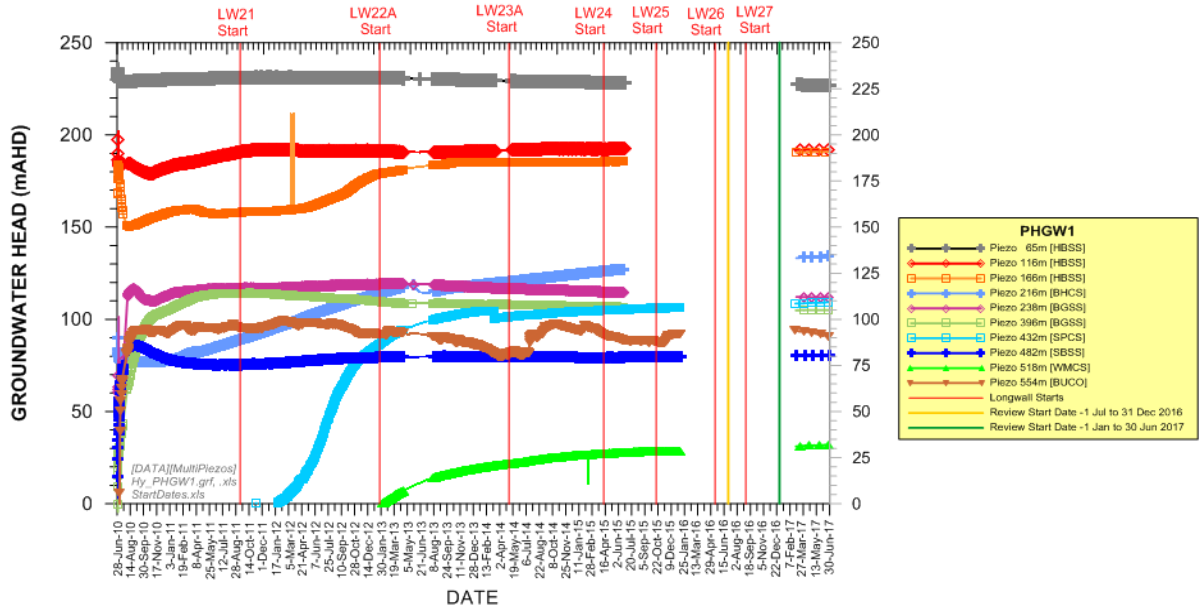
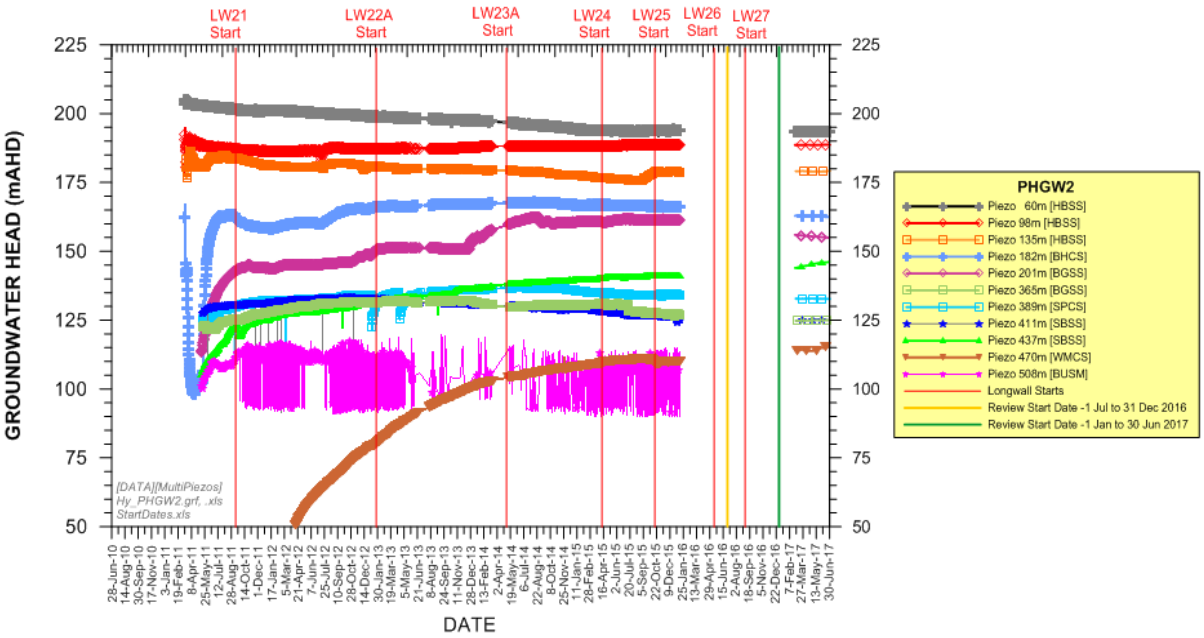


Chart 64 Time Variations in Potentiometric Heads at PM03



Note that a connection failure prevented upload of data for sensors in PHGW1B in 2016. Sensors have now been reinstated.

Chart 65 Time Variations in Potentiometric Heads at PHGW1B



Note that a connection failure prevented upload of data for sensors in PHGW2A in 2016. Sensors have now been reinstated.

Chart 66 Time Variations in Potentiometric Heads at PHGW2A

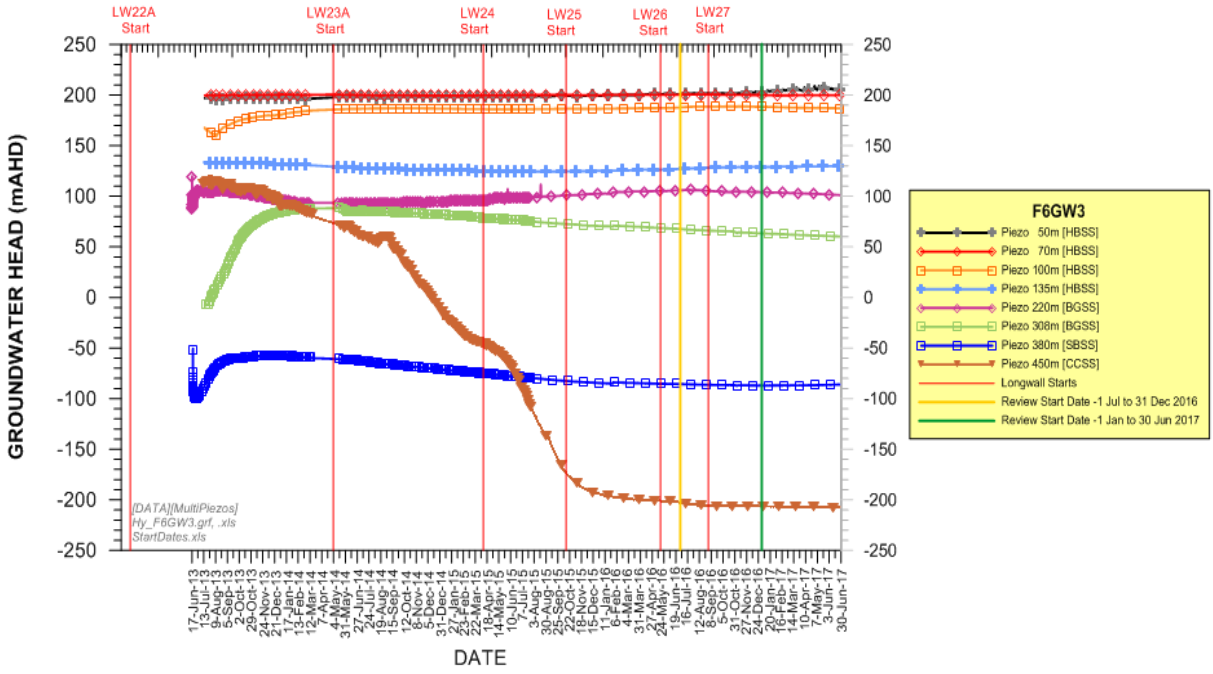


Chart 67 Time Variations in Potentiometric Heads at F6GW3

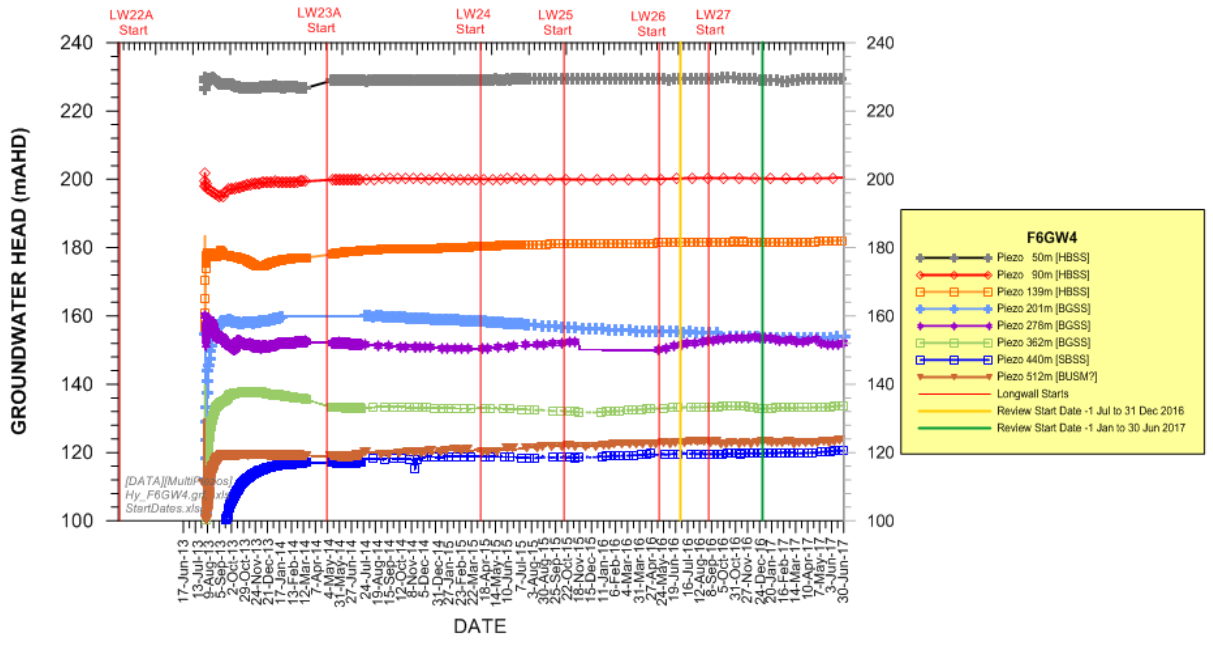


Chart 68 Time Variations in Potentiometric Heads at F6GW4

The water tables measured at Bores 9FGW1A and 9GGW1-80 at the 55 m and 80 m piezometers, respectively, are compared to the water levels of streams crossed by a transect along Longwall 22. The transect on Chart 69 provides an illustration of relative ground and water levels on transect A-A' along Longwall 22 through indicator sites 9FGW1A and 9GGW1-80. The transect from west to east crosses Tributary B (twice), Waratah Rivulet, Tributary A and the Eastern Tributary. The monitoring results indicate that the average water levels measured in the two piezometers are above the floor levels of the nearest streams (Chart 69).

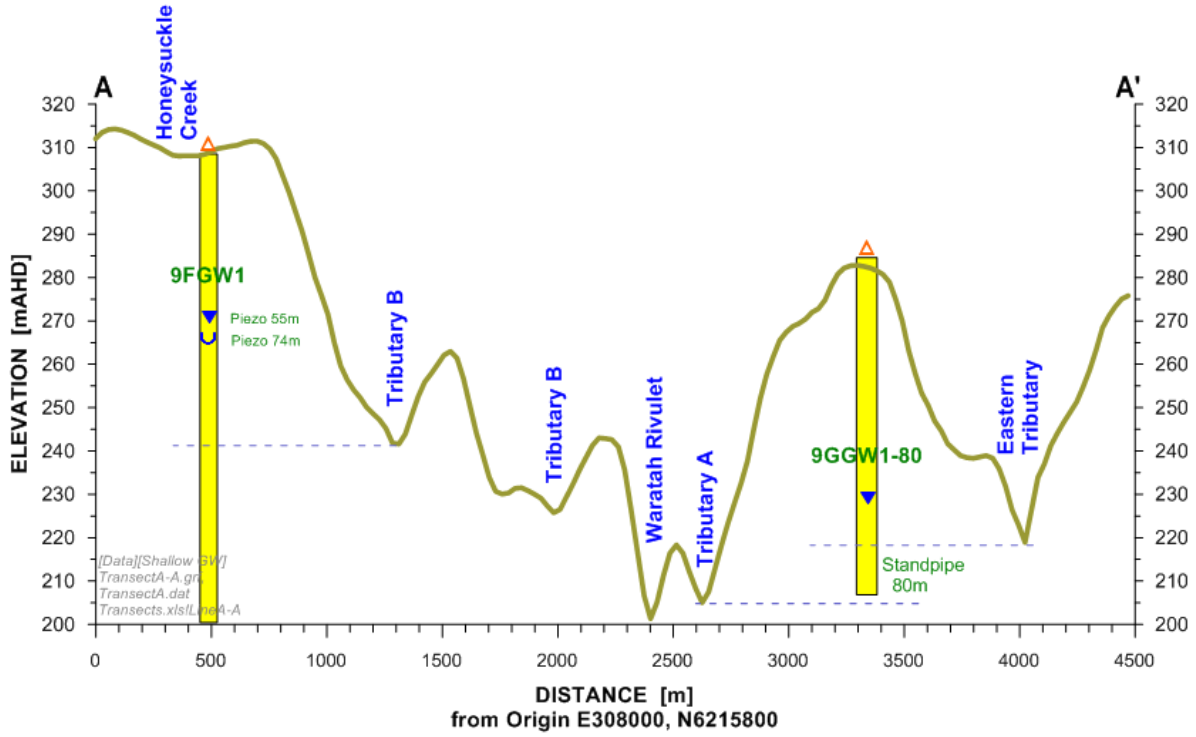


Chart 69 Topographic Transect A-A' along Longwall 22 and Hawkesbury Sandstone Water Levels (9GGW1-80 and 9FGW1A at 30 June 2017)

The groundwater levels measured at Bores 9GGW2B and PM02 at the 55 m and 35 m piezometers, respectively, are compared to the Woronora Reservoir at the level of the regional water table. Chart 70 indicates that the seven day average groundwater levels are well above the reservoir water level (i.e. a hydraulic gradient exists from the bores to the Woronora Reservoir).

The vertical potentiometric head profiles at Bores 9GGW2B and 9FGW1A also support the assessment of no connective cracking between the surface and the mine.

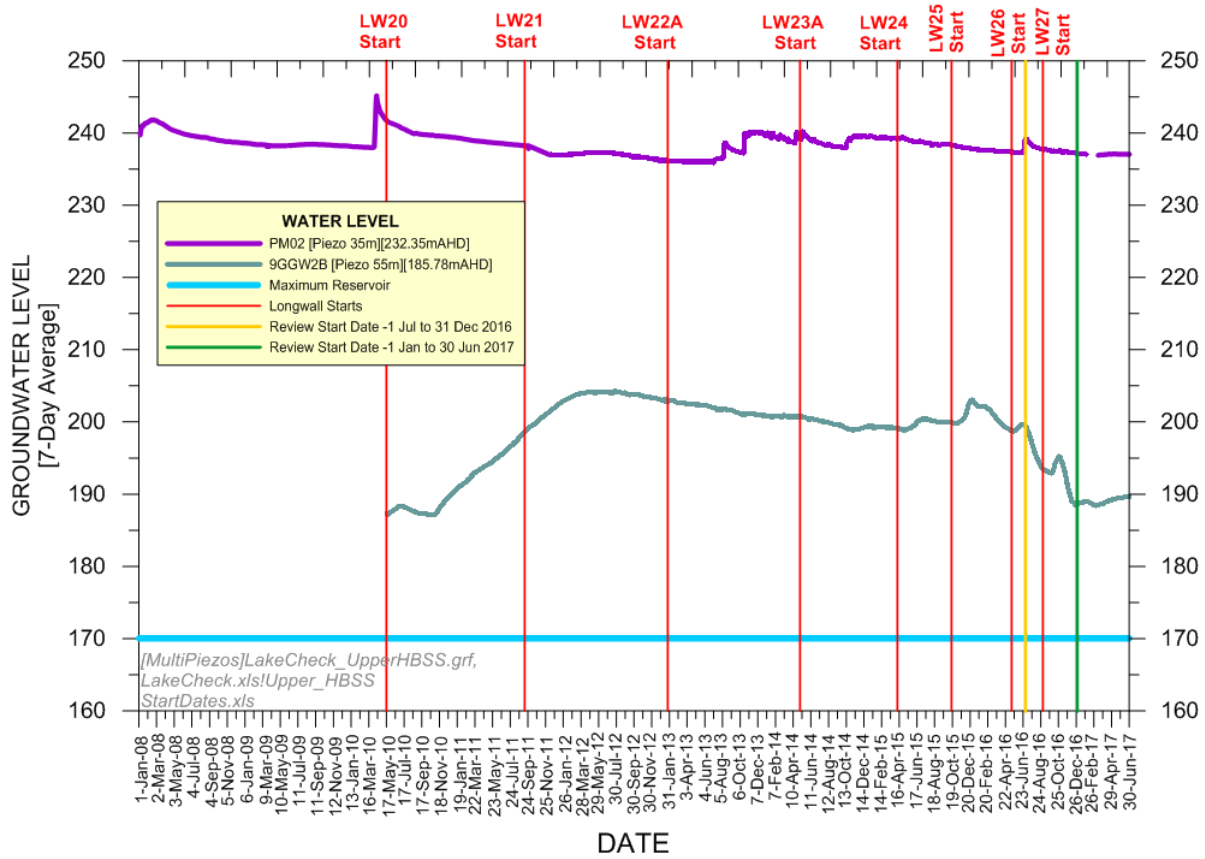


Chart 70 Seven Day Average Shallow Hawkesbury Sandstone Groundwater Levels at PM02 and 9GGW2B

3.9 GROUNDWATER QUALITY

Groundwater quality monitoring at sites WRGW1 to WRGW7 on Waratah Rivulet (Figure 9) 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 71). Dissolved iron concentrations have remained below 10 mg/L during the reporting period (Chart 71).

Dissolved manganese concentrations at the Waratah Rivulet sites have typically been less than 1 mg/L, with the exception of higher concentrations recorded at WRGW3 in June 2015 (3.36 mg/L) and September 2015 (1.47 mg/L) (Chart 72). Higher dissolved manganese concentrations were also recorded at WRGW3 (1.31 mg/L in March 2017 and 1.65 mg/L in April 2017) and WRGW6 (1.77 mg/L in April 2017) during the reporting period. The manganese concentrations returned to below 1 mg/L for the remainder of the reporting period (Chart 72).

Dissolved aluminium concentrations have been low, and largely below the detection limit.

pH 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. pH at all sites remained within the historical range during the reporting period (Chart 73).

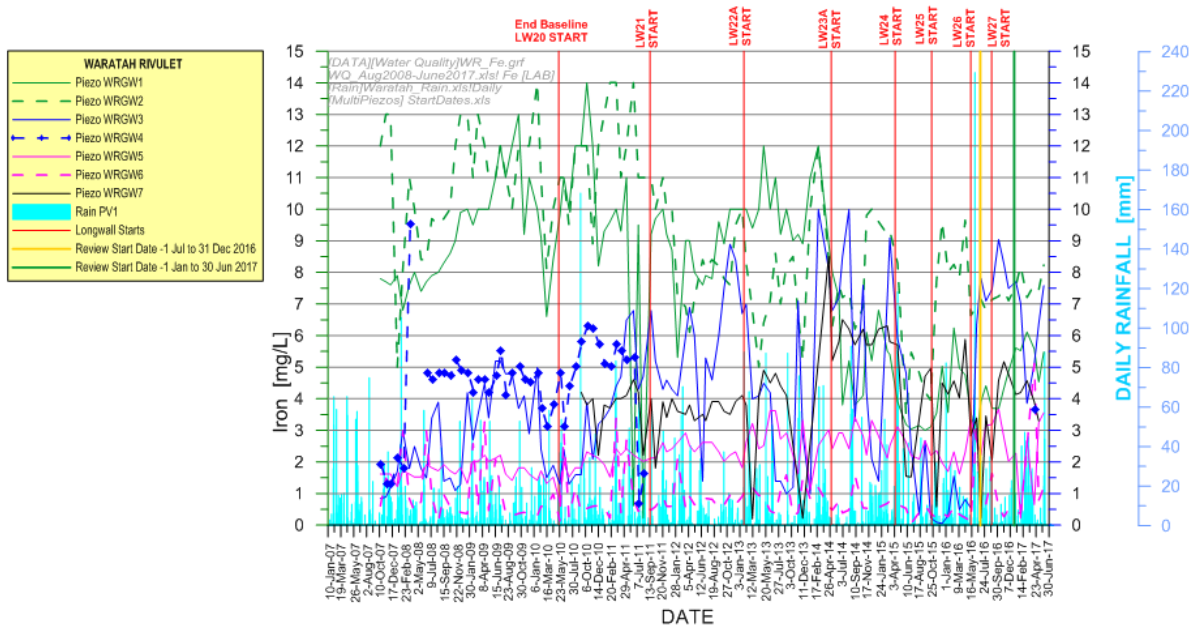


Chart 71 Iron Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

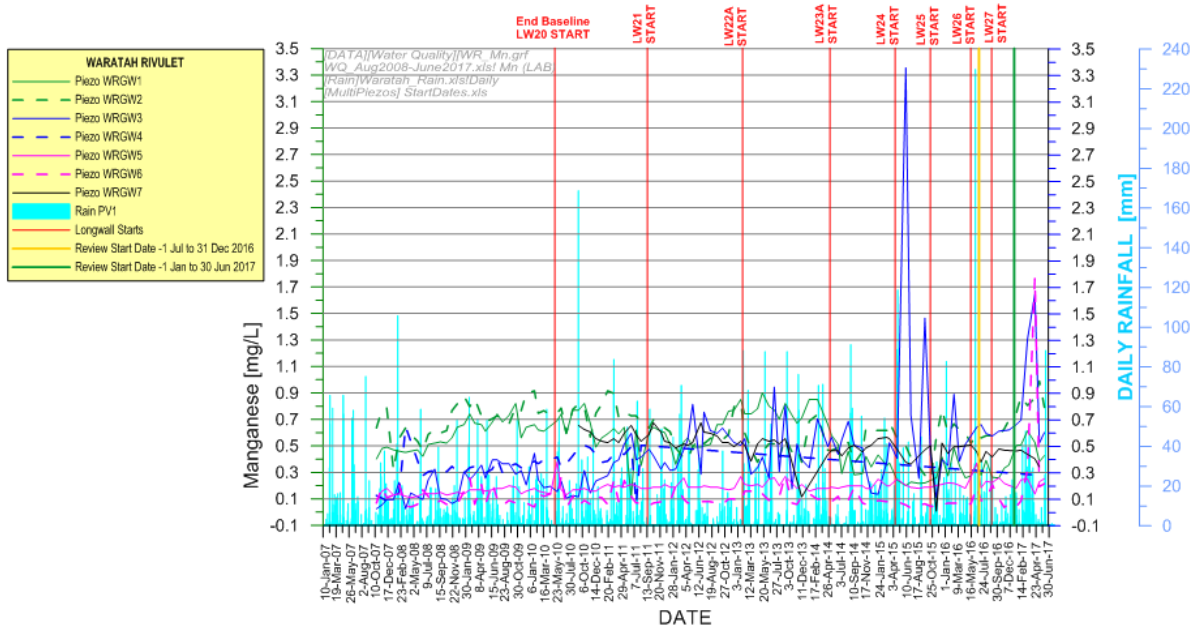


Chart 72 Manganese Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

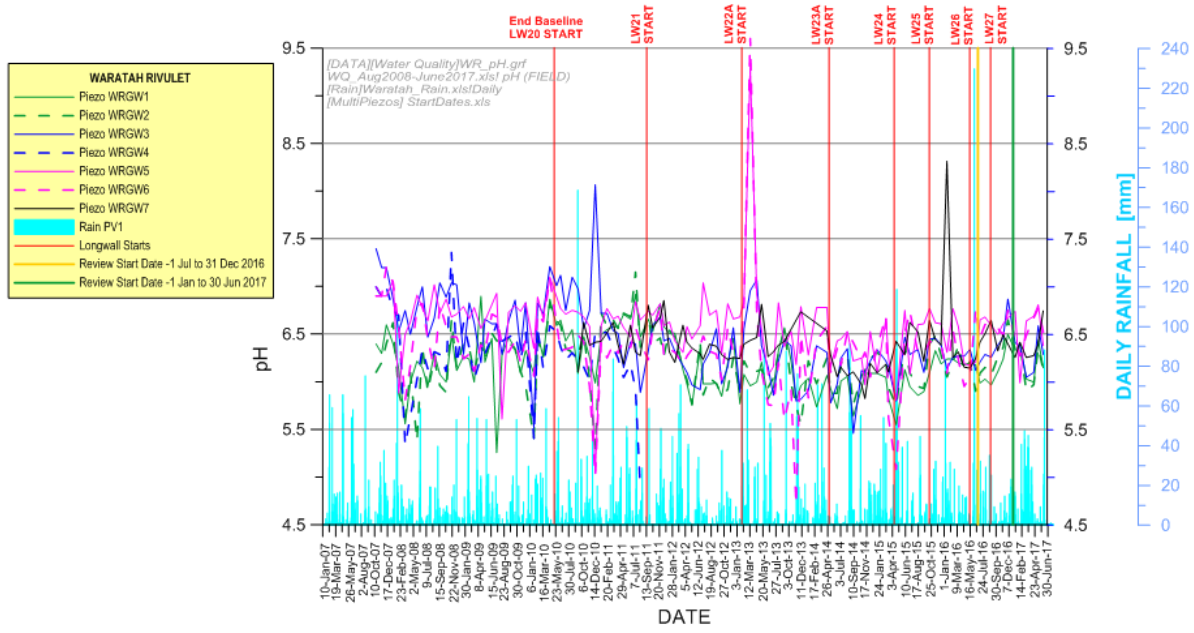


Chart 73 pH Levels at WRGW1 to WRGW7 on Waratah Rivulet

Groundwater quality monitoring at sites ETGW1 to ETGW2 on the Eastern Tributary (Figure 9) indicates the higher dissolved iron concentrations recorded in 2016 (17-18 mg/L) continued during the reporting period (Chart 74). Dissolved iron concentrations showed an increasing trend at site ETGW2, with the highest concentration for the period of record (21.5 mg/L) being recorded in June 2017 (Chart 74).

Although dissolved manganese concentrations remain low at both Eastern Tributary sites (below 1 mg/L), the values continue to be consistently higher than the historic recorded manganese concentrations at these sites (Chart 75). ETGW1 displayed a declining trend throughout the reporting period, while ETGW2 recorded its highest concentration of the period of record (0.97 mg/L) in February 2017 (Chart 75).

Aluminium was at or below 0.05 mg/L in all samples[7].

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 the beginning of the reporting period both sites continued the rising trend noted at the end of 2016, and then decreased following high rainfall in March 2017 (Chart 76).

[7] ETGW1 was not sampled in January, February and March 2017.

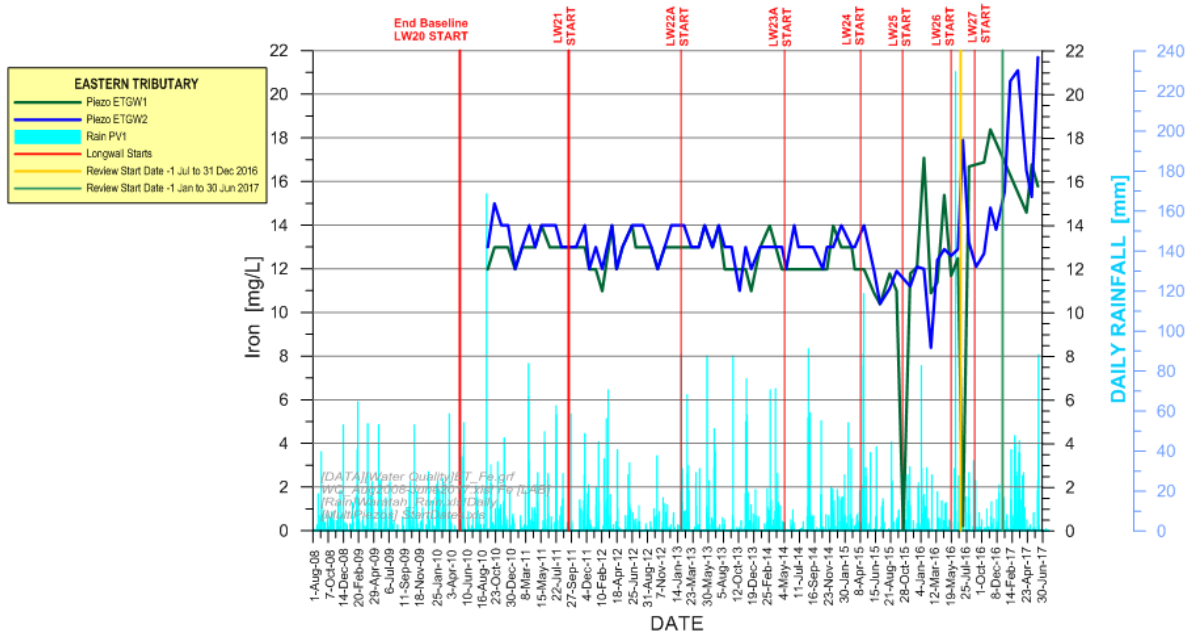


Chart 74 Iron Concentrations at ETGW1 and ETGW2 on Eastern Tributary

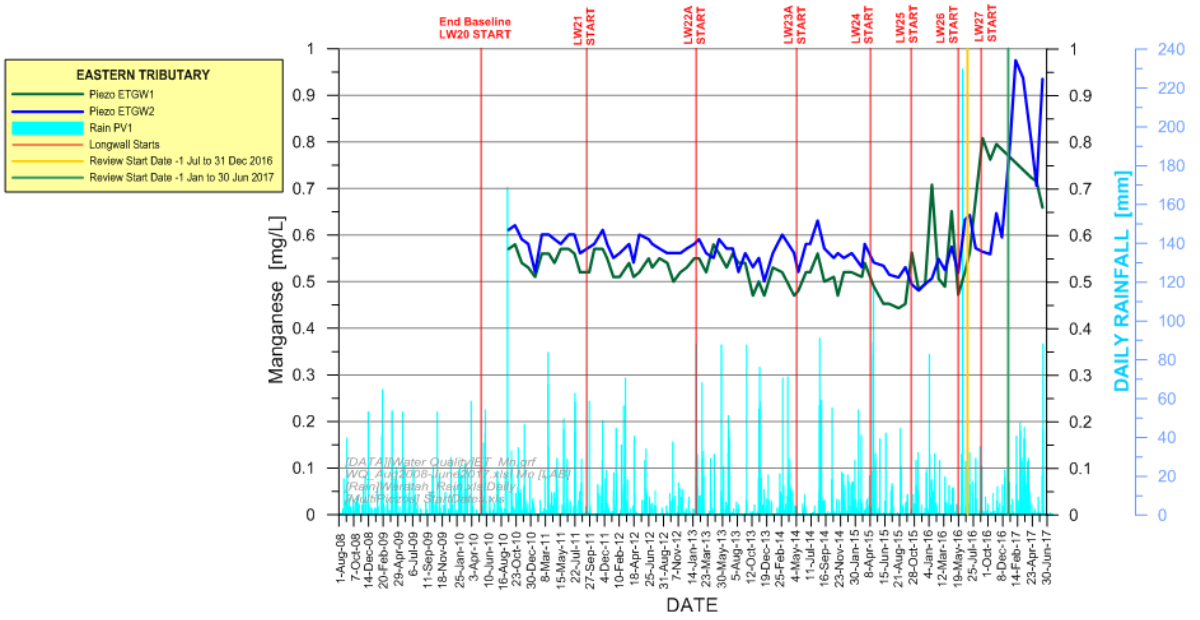


Chart 75 Manganese Concentrations at ETGW1 and ETGW2 on Eastern Tributary

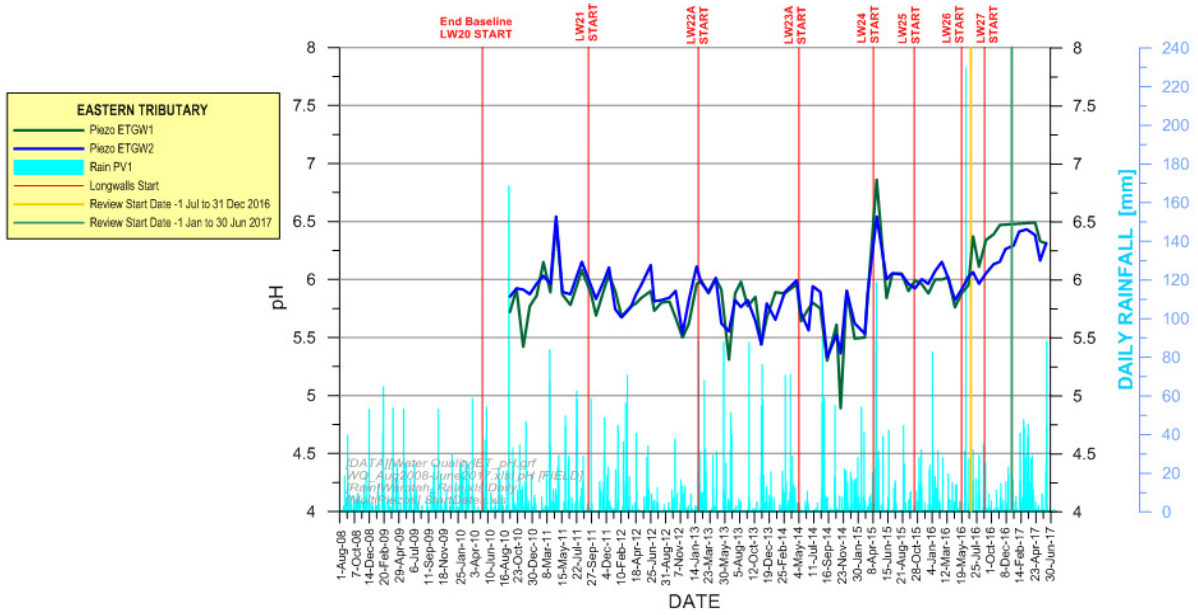


Chart 76 pH Levels at ETGW1 and ETGW2 on Eastern Tributary

3.10 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.

3.11 MINE WATER INTAKE

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 and total mine outflows. 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[8] is assessed against the subsidence impact performance indicator for mine water make of no more than 2 ML/day. The 20 day average daily mine water make was less than 0.5 ML/day during the reporting period (Chart 77).

[8] Water make was unable to be calculated from 17 January to 8 February and from 6 May to 23 May, due to equipment malfunctions.

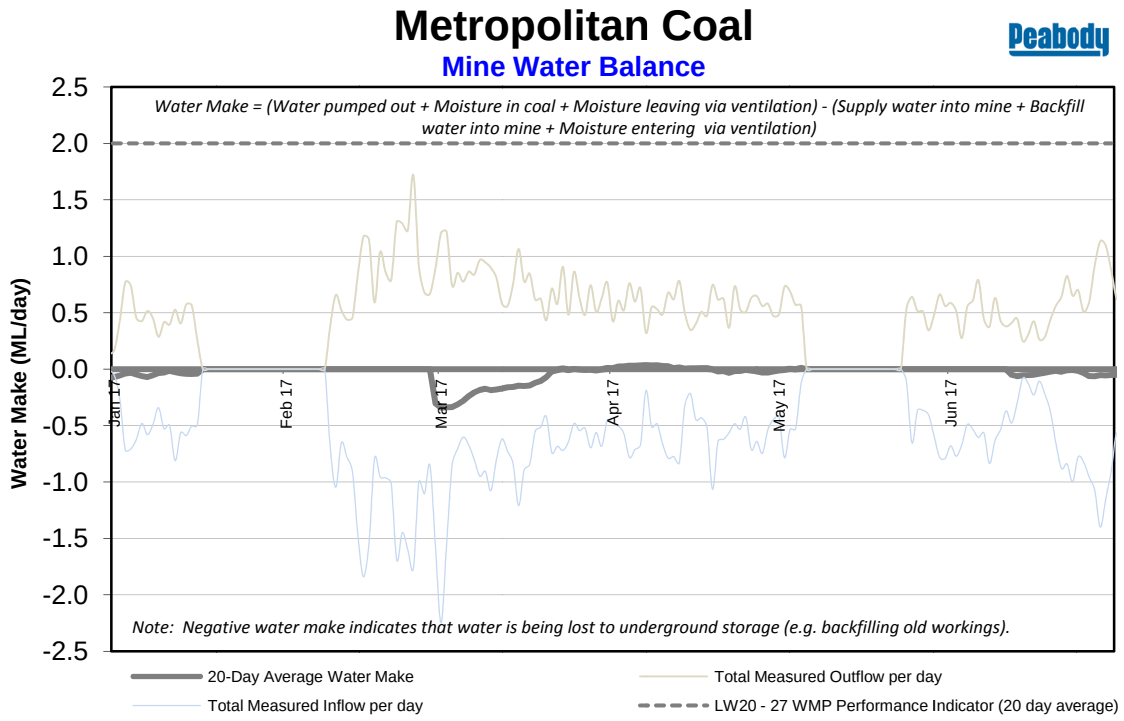


Chart 77 Estimated Daily Mine Water Make

3.12 EASTERN TRIBUTARY PERFORMANCE MEASURE EXCEEDANCE

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 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 iron staining in the previous reporting period. The exceedance was reported to the Secretary of the DP&E and other relevant agencies on the 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.

Since Incident Notification on 14 October 2016, Metropolitan Coal provided the DP&E and relevant agencies with:

- a detailed report on the incident within seven days of incident notification (21 October 2016);
- a schedule of key tasks to obtain information and develop contingency measures (28 October 2016); and
- regular status updates on the implementation of the key tasks (dated 25 November 2016, 21 December 2016 and 3 February 2017).

The 3 February 2017 status update reported that the *no diversion of flows, no change in the natural drainage behaviour of pools* component of the Eastern Tributary subsidence impact performance measure had also been exceeded in January 2017.

Metropolitan Coal provided the DP&E (21 February 2017) with a proposed course of action in relation to the exceedance of the Eastern Tributary subsidence impact performance measure, focussed on the implementation of stream remediation measures to restore surface flow and pool holding capacity as soon as reasonably practicable.

The proposed course of action is consistent with Condition 1, Schedule 6 (Table 11) of the Project Approval, which includes the following Rehabilitation Objective for the 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*. The rehabilitation objectives in Table 11 are to be achieved to the satisfaction of the Executive Director Mineral Resources.

In accordance with the proposed course of action, Metropolitan Coal conducted an aerial LIDAR survey of the Eastern Tributary to inform the preparation of the detailed stream remediation plans.

Metropolitan Coal also commissioned Golder Associates to prepare detailed stream remediation plans for Pools ETAH and ETAK on the Eastern Tributary. Metropolitan Coal considered the full range of available techniques in the design of stream remediation programs for individual rock bars on the Eastern Tributary. The injection of polyurethane (PUR) grouting products was considered to be the most appropriate technique for the stream remediation program.

Draft stream remediation plans have been prepared for Pool ETAH and Pool ETAK. Prior to stream remediation activities commencing, a number of other actions are required to be conducted in accordance with the Metropolitan Coal Rehabilitation Management Plan. This includes the implementation of the required vegetation and Aboriginal heritage management measures to inform and finalise the stream remediation plans. These measures will be conducted in the next reporting period.

In accordance with the Metropolitan Coal Rehabilitation Management Plan, the final draft stream remediation plans will be provided to the DP&E, Division of Resources and Geoscience (DRG) and WaterNSW for review and comment.

4 BIODIVERSITY MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Biodiversity Management Plans have been prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on aquatic and terrestrial flora and fauna, with a specific focus on swamps, in accordance with Condition 6, Schedule 3 of the Project Approval.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Biodiversity Management Plan (which includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27). In accordance with Condition 4 of the Longwalls 301 and 302 approval, Metropolitan Coal will review and revise the Longwalls 301-303 Biodiversity Management Plan TARP.

4.1 UPLAND SWAMP VEGETATION MONINTORING

4.1.1 Longwalls 20-22 and Longwalls 23-27

Upland swamp vegetation monitoring is conducted at a number of swamps overlying or adjacent to Longwalls 20-22 and Longwalls 23-27 and at a number of control swamps (Figure 7).

The spring 2016 Longwalls 20-22 and Longwalls 23-27 Vegetation Monitoring Reports prepared by Eco Logical Australia Pty Ltd (Eco Logical) are provided in Appendix I (I1 and I2, respectively).

The results of the Longwalls 20-22 and Longwalls 23-27 upland swamp vegetation monitoring programs (up to and including the spring 2016 survey) can be summarised as follows:

- No cracking of exposed bedrock areas or swamp sediments was observed in either longwall or control swamps, other than those recorded during the baseline surveys. Areas in which active erosion was observed were all minor and limited to access tracks, drainage lines and areas of bare earth without vegetation cover. Iron-stained groundwater seepage has been observed since spring 2012 on the terminal rocky step and/or a small rocky step of Swamp 20. In spring 2016 the iron staining associated with this seep was found to be much reduced in area compared to previous seasons.
- Visual inspections across all upland swamps identified that vegetation at both longwall and control sites was generally in good condition in spring 2016 with no unusual areas of vegetation senescence observed, and with new growth recorded on shrubs and ground layer species. Some isolated dieback and senescence of scattered individuals were recorded throughout most longwall and control swamps. For the Restioid Heath/Banksia Thicket swamps, this included individuals of *Petrophile pulchella, Banksia ericifolia* subsp. *ericifolia* and *Hakea teretifolia* in valley side swamps, and for the Tea Tree Thicket swamps the main species included *Banksia robur, Gleichenia microphylla* and *Acacia longifolia* subsp. *longifolia*.
- Consistent with previous observations including the baseline monitoring period, dieback of *Empodisma minus* and *Gleichenia microphylla* in longwall Swamp 28 appeared to be more common compared to control swamps, attributed to the dense mid-storey vegetation shading the understorey.
- No notable changes in vegetation structure, dominant species or estimated cover and abundance which could be attributed to impacts associated with the mining of Longwalls 20-27 were recorded within longwall or control swamps in spring 2016.
- 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 Restioid Heath/Banksia Thicket sites was variable but for most swamps, with the exception of some control swamps, was within ranges previously recorded (Charts 78 and 79). 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 spring 2016.
- In spring 2016 the mean species richness in Tea Tree Thicket longwall swamp 28 (Chart 80) was lower than in control swamps, and in previous years (16 species recorded) although the margin of the difference is small (18 species recorded in autumn 2014, autumn 2015 and spring 2015). Analysis of changes in species richness over time indicate the decrease in species richness has predominantly occurred prior to subsidence impacts occurring to Swamp 28 substrate groundwater levels in 2016. Rainfall during autumn and spring 2016 was well below average, although heavy rains fell in June 2016.

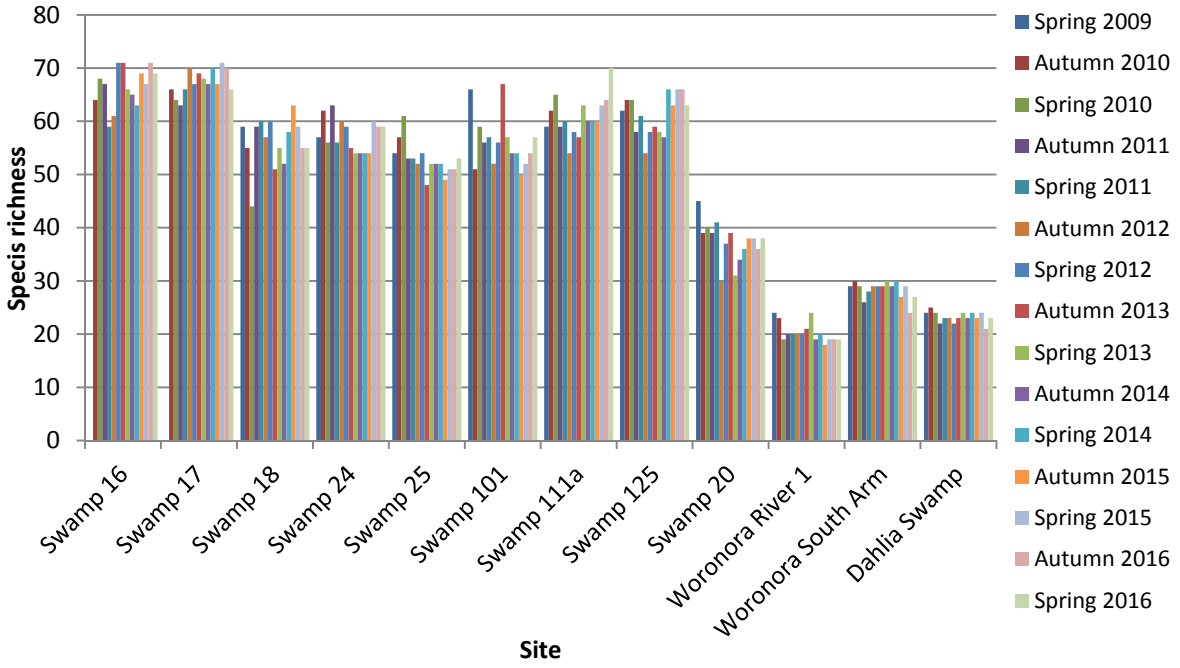


Chart 78 Native Species Richness in Longwalls 20-22 Upland Swamp Sites, Spring 2009 – Spring 2016

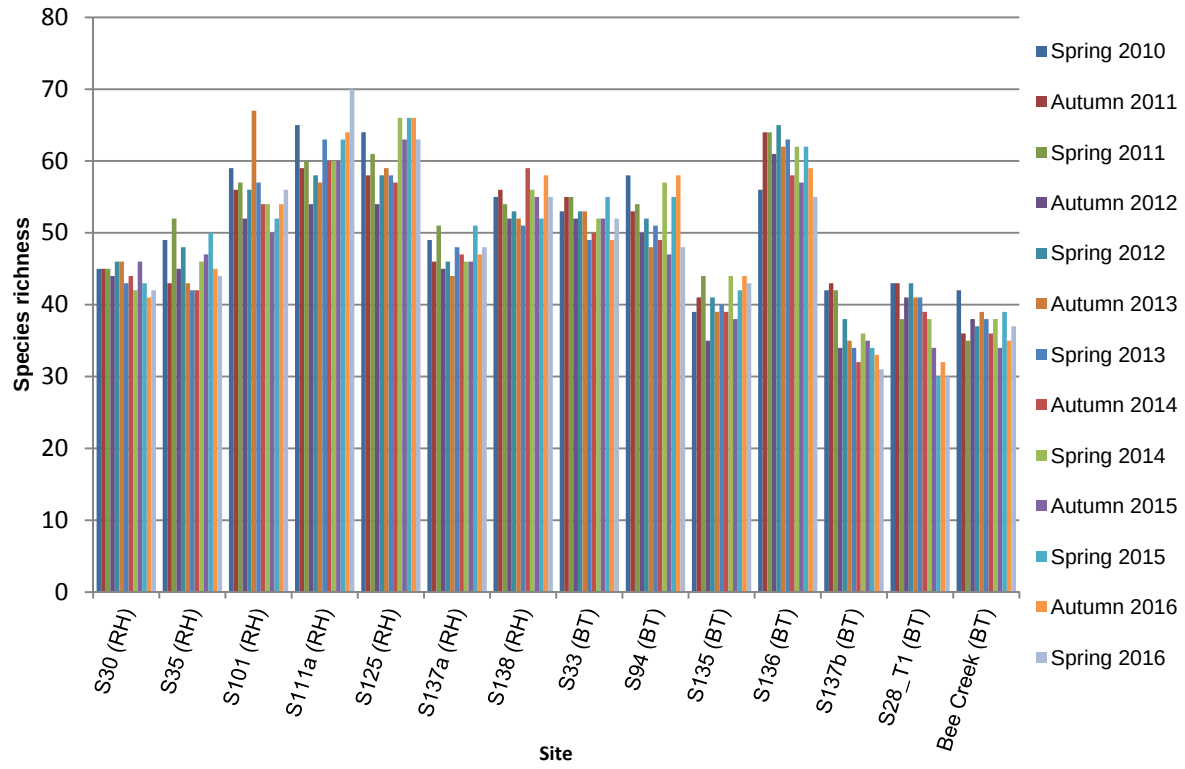


Chart 79 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Restioid Heath and Banksia Thicket, Spring 2010 – Spring 2016

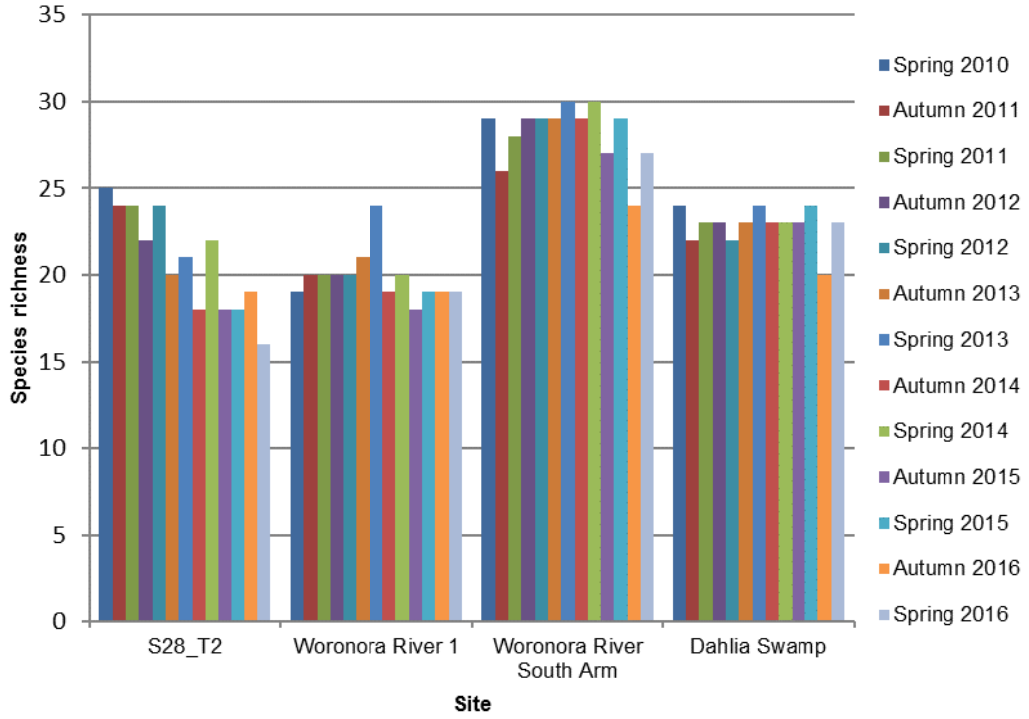


Chart 80 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Tea Tree Thicket, Spring 2010 – Spring 2016

Swamp 28 is very small, does not contain any internal drainage lines and free surface water has never been observed at this site since the inception of monitoring. Species richness in Woronora River 1 and the other control swamps (Woronora River South Arm, Dahlia Swamp) has remained similar throughout the monitoring period within these control swamps (Eco Logical Australia 2016b, and 2017a). Species richness in Transect 2 of Swamp 28 will continue to be closely monitored.

- For Longwalls 20-22, monitoring of indicator species in the Restioid Heath/Banksia Thicket swamps indicated that the mortality rate of swamp indicator species was greater at longwall sites than control sites for *Epacris obtusifolia* and *Sprengelia incarnata*, although the differences are small for all species (proportional differences of less than three individuals). The proportion of tagged *Pultenaea aristata* individuals was greater in control sites than in longwall sites, although the margin of difference was also small. The rate of increase in mortality has been similar between longwall and control swamps. For the Tea Tree Thicket Swamps (Swamp 20 and controls), monitoring of indicator species identified that the mortality rate of tagged indicator species was greater within control swamps than longwall swamps. The observed mortality at the Restioid Heath/Banksia Thicket and Tea Tree Thicket swamps is attributed to natural factors including predation, competition with other vegetation and abiotic factors.
- For Longwalls 23-27, monitoring of indicator species continued to identify higher mortality rates within longwall sites compared to control sites for *Epacris obtusifolia, Pultenaea aristata* and *Banksia robur* in spring 2016. Similar differences were observed during the baseline monitoring period and following the commencement of mining, indicating that the increased mortality does not appear to be related to the mining of Longwalls 23-27.

- Three species of conservation significance were recorded at upland swamp monitoring sites in spring 2016, namely *Pultenaea aristata, Darwinia diminuta* and *Eucalyptus luehmanniana*. These species were recorded in good condition (Condition 5) in all sites, with the exception of *Pultenaea aristata* where various degrees of dieback was recorded on scattered individuals within both longwall and control sites.
- No weed species were observed within any of the longwall upland swamps. Observations of weed species within upland swamps have been limited to a single control swamp, Dahlia Swamp, in autumn 2016, however no weeds species were recorded during the spring 2016 survey.
- The upland swamp vegetation performance indicator, *The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps*, has not been exceeded.

4.1.2 Longwalls 301-303

During the reporting period Metropolitan Coal continued to obtain baseline upland swamp vegetation monitoring data in accordance with the Longwalls 301-303 Biodiversity Management Plan. Baseline upland swamp vegetation surveys for Longwalls 301-303 have been conducted in spring 2015, autumn 2016, spring 2016 and autumn 2017. The survey methods used for the Longwalls 301-303 baseline surveys (visual, transect/quadrat and indicator species monitoring) are consistent with those used for the Longwalls 20-22 and Longwalls 23-27 upland swamp vegetation monitoring programs.

Baseline transect and quadrat data has been obtained for Swamps 40, 41, 46, 51/52 and 53 overlying Longwalls 301-303 and for control Swamps 101, 135, 136, 137a and 137b (Figure 7). Baseline data for the indicator species *Epacris obtusifolia* has been obtained in Swamps 40, 51/52 and 53 overlying Longwalls 301-303 and in control Swamps 101, 136 and 137a. Baseline data for the indicator species *Sprengelia incarnata* has been obtained in Swamps 40, 51/52 and 53 overlying Longwalls 301-303 and in control Swamps 101, 136 and 137b. The results of the Longwalls 301-303 upland swamp vegetation monitoring will be reported in the Metropolitan Coal 2017 Annual Review.

4.2 UPLAND SWAMP GROUNDWATER MONITORING

4.2.1 Longwalls 20-22 and Longwalls 23-27

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 3.6, the swamp substrate water levels of Swamps 25, 30, 33 and 35 remained perched during the reporting period (consistent with previous monitoring results).

Swamp 20 substrate water levels previously changed from being permanently saturated to being periodically saturated as a result of the passing of Longwall 21 (Chart 50 and Appendix C). As a result the upland swamp groundwater performance indicator continued to be exceeded at Swamp 20 during the reporting period.

A mining effect to the substrate water levels of Swamp 28 was also identified in 2016 based on the incomplete recovery of substrate water levels following rainfall events (Chart 51 and Appendix C). The upland swamp groundwater performance indicator has continued to be exceeded at Swamp 28 during the reporting period.

Exceedances of the performance indicator at 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 Eco Logical and Cenwest Environmental Services are provided in Appendix J (J1 and J2, respectively). The assessments conclude that the subsidence impact performance measure has been met.

4.2.2 Longwalls 301-303

During the reporting period Metropolitan Coal continued to obtain baseline upland swamp groundwater monitoring data. The monitoring for Longwalls 301-303 includes paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m) in Swamps 40, 41, 46, 51, 52 and 53 overlying Longwalls 301-303 (Figure 7). Each piezometer has been equipped with a data logger for continuous water level monitoring. The results of the Longwalls 301-303 upland swamp groundwater monitoring will be reported in the Metropolitan Coal 2017 Annual Review.

4.3 RIPARIAN VEGETATION MONITORING

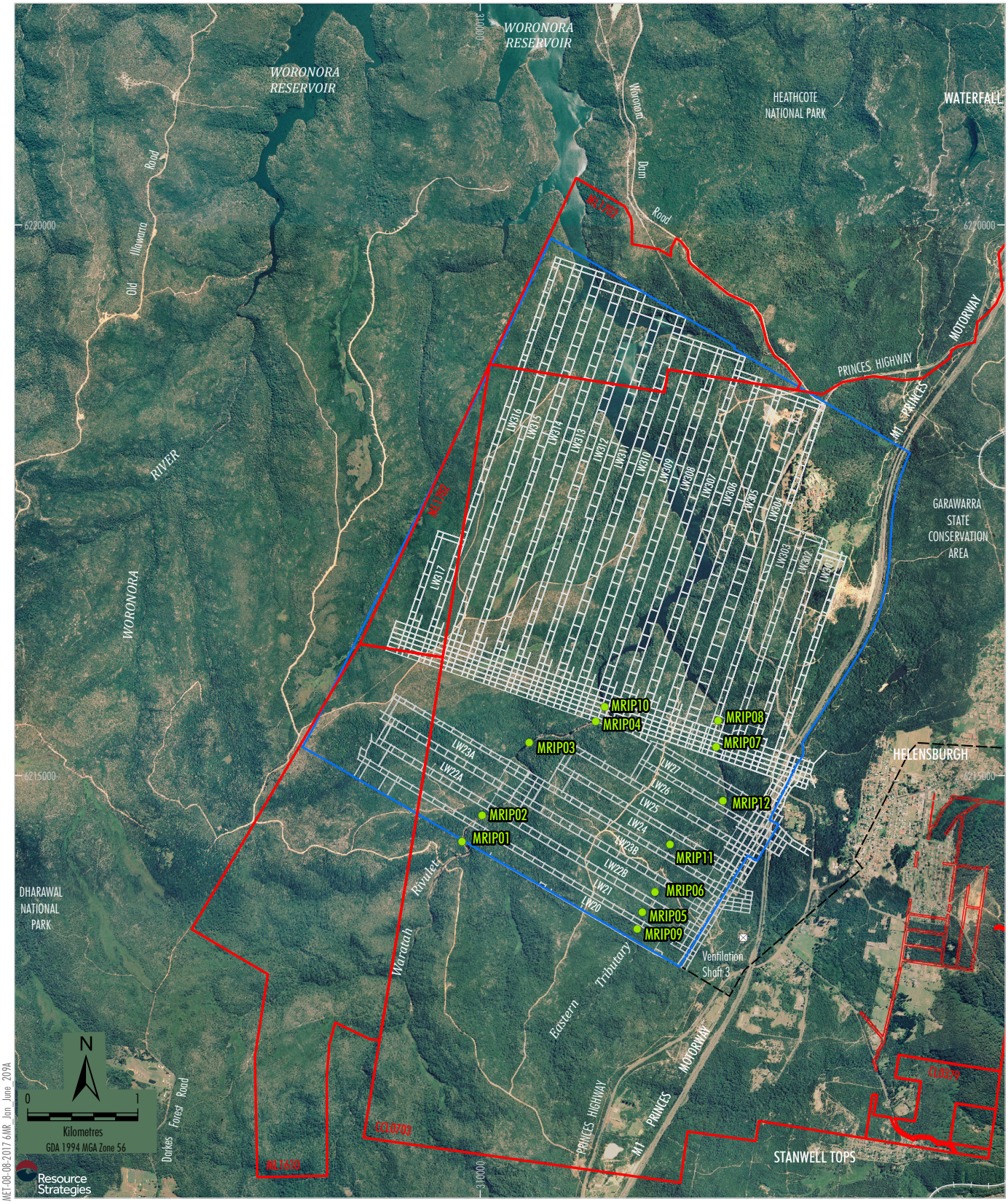
4.3.1 Longwalls 20-22 and Longwalls 23-27

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 11).

The spring 2016 Longwalls 20-22 and Longwalls 23-27 Vegetation Monitoring Reports prepared by Eco Logical are provided in Appendix I (I1 and I2, respectively).

The results of the Longwalls 20-22 and Longwalls 23-27 riparian vegetation monitoring programs (up to and including the spring 2016 survey) can be summarised as follows:

- Water levels along the Eastern Tributary at the time of the spring 2016 survey remained low with no major pooling of water observed at the time of the survey (October/November 2016) from site MRIP09 downstream to MRIP06 (including MRIP05), and also at MRIP12. Relatively large pools adjacent to MRIP09, MRIP05 and MRIP06 which have been present in previous seasons (excluding autumn 2016) were dry during surveys in spring 2016. Vegetation dieback along these sites is evident along the stream edge where water has receded exposing streamside vegetation and woody debris. Water levels at MRIP11 were higher in spring 2016 compared to autumn 2016, however no flow was present between upstream and downstream pools.
- Water levels at longwall monitoring sites along the Waratah Rivulet (MRIP01, MRIP02) were low compared to previous seasons however the significant reduction in water levels observed at sites on the Eastern Tributary was not observed along the Waratah Rivulet.
- Scouring of the stream bank and erosion of sediments continued to be observed across all riparian monitoring sites in spring 2016, attributed to high water flows following heavy rain events. The extent of bank scouring at most sites was generally minor to moderate and often associated with sandy areas where vegetation was lost during high water flows. At site MRIP02 bank scouring has resulted in a loss of soil and plant material between 10-17m along the transect reducing the available ground area for plant growth. Areas of sediment deposition were observed along both the Waratah Rivulet and the Eastern Tributary.
- In spring 2016, species richness was generally similar to previous seasons with values within the range of previous seasons for individual sites (Charts 81 and 82). Analysis of this data (ANOVA) indicated that throughout the monitoring period control sites had significantly lower species richness compared to the longwall sites, including in spring 2016.



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 (2016); MSEC (2016)

Peabody

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Riparian Vegetation Monitoring Locations

Figure 11

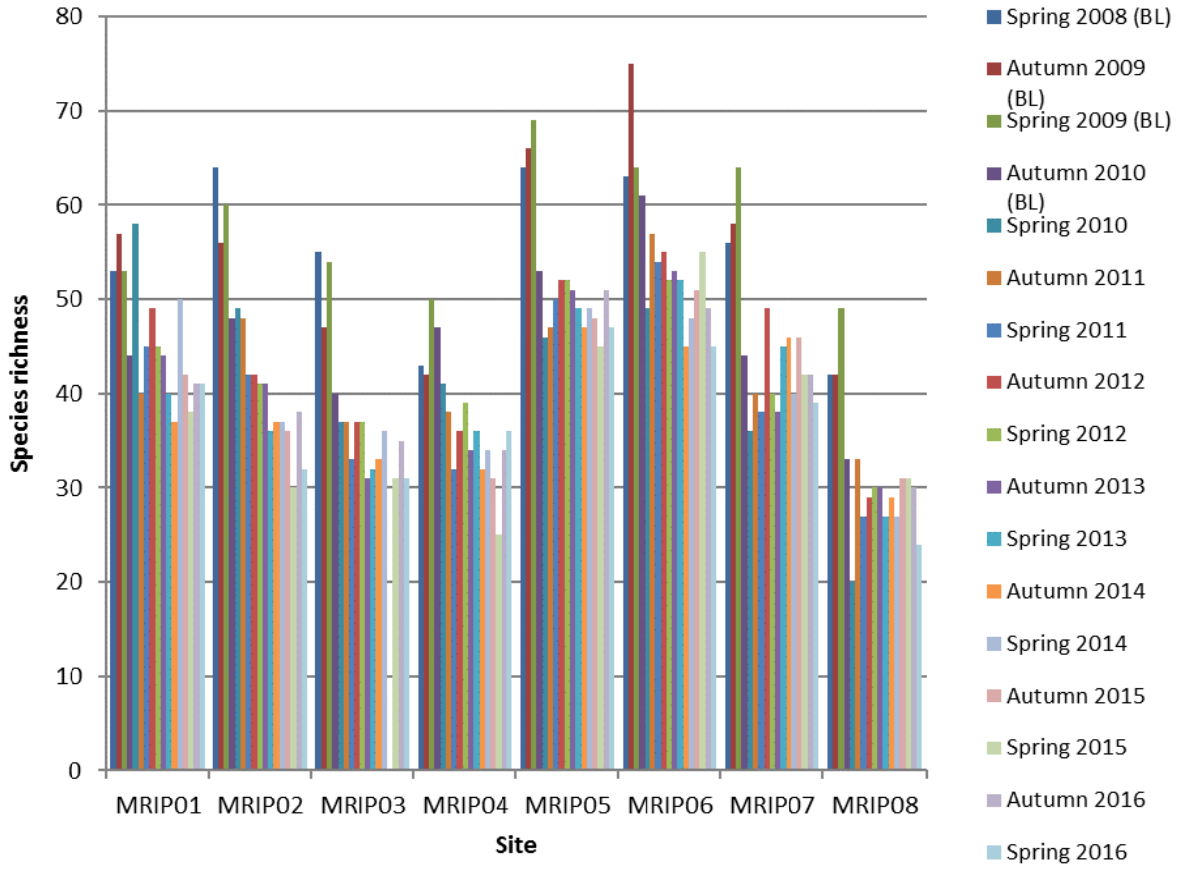


Chart 81 **Native Species Richness within Riparian Monitoring Sites Across All Seasons - Longwalls 20-22 Monitoring Program**

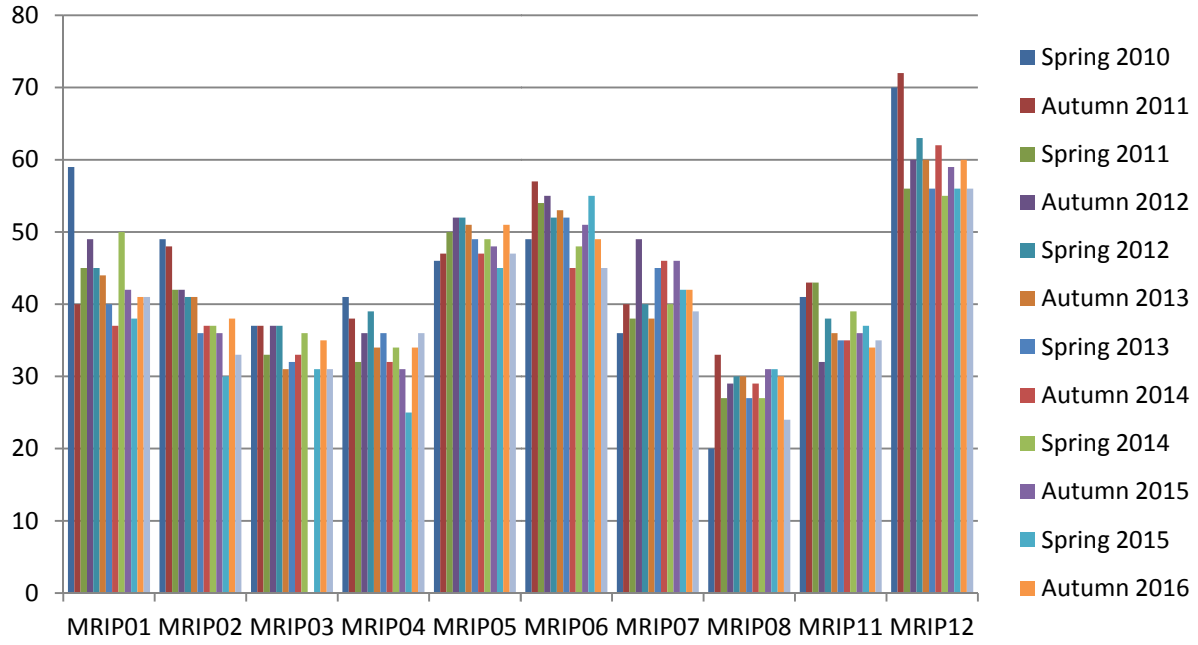


Chart 82 **Native Species Richness within Riparian Monitoring Sites Across All Seasons- Longwalls 23-27 Monitoring Program**

- Vegetation condition at riparian monitoring sites MRIP01, MRIP03, MRIP04, MRIP06, MRIP07, MRIP08, MRIP10 and MRIP12 was generally observed in good condition. 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.
- Visual inspections of riparian vegetation continued to identify dieback at MRIP02, MRIP05, MRIP09 and MRIP11 in spring 2016.
- As reported previously, increased ponding at site MRIP02 on the Waratah Rivulet and between sites MRIP05 and MRIP09 on the Eastern Tributary from subsidence resulted in prolonged inundation of streamside vegetation causing vegetation dieback. Vegetation dieback was first observed at site MRIP02 in spring 2012 and between sites MRIP09 and MRIP05 in autumn 2014. Areas of riparian vegetation at site MRIP02 previously observed to be inundated by water remained inundated in spring 2016. The level and areas of inundation at MRIP02 was generally similar to that observed in spring 2015 and autumn 2016. Small areas within sites MRIP05 and MRIP09, on the Eastern Tributary, which were previously inundated by water, were no longer inundated in autumn 2016 and spring 2016, with water levels having decreased (low to non-existent) along the Eastern Tributary between sites MRIP06 and MRIP09 at the time of the surveys. Vegetation dieback associated with previous inundation remains at MRIP05 and MRIP09.
- At site MRIP11 riparian vegetation was observed in a variable condition in the autumn 2016 survey, where dieback of groundcover species, including *Sporadanthus gracilis, Bauera rubioides* and *Gleichenia microphylla* and some shrub species was observed. Vegetation was observed in a similar condition in the current spring 2016 survey with senescence of *Gleichenia microphylla, Baumea juncea* and *Sporadanthus gracilis* observed on both sides of the Eastern Tributary. Significantly higher water levels were observed at this site in spring 2016 compared to autumn 2016. Some streamside vegetation was inundated, however the extent of dieback was confined primarily to understorey species. Some shrubs were found to be prone over the creek where inundated, with the access track on the western bank contributing to this.
- The observed vegetation dieback at site MRIP02 in spring 2016 was greater than 50 cm from the Waratah Rivulet and as a result the performance indicator '*impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at Metropolitan Coal*' continues to be exceeded. For sites MRIP05, MRIP09 and MRIP11 the observed dieback was less than 50 cm from the bank and as such the performance indicator has not been exceeded at these sites. Regeneration of shrub and ground layer species is occurring at sites MRIP05 and MRIP09.
- With the exception of indicator species at site MRIP02, the mortality rate for all riparian indicator species was greater at control sites than longwall sites, although the differences were relatively small. In spring 2016 the mean vegetation condition and reproductive status for tagged riparian indicator species was similar between longwall and control sites for *Lomatia myricoides*, *Prostanthera linearis* and *Schoenus melanostachys.*
- Two species of conservation significance were recorded at riparian vegetation monitoring sites in spring 2016, namely *Hibbertia nitida* and *Lomandra fluviatilis*. Both species were commonly recorded with minor dieback similar to that observed in previous monitoring periods within both control and longwall sites.
- Within riparian sites five weed species were recorded in spring 2016 (*Conyza* sp., *Andropogon virginicus, Senecio madagascariensis, Facelis retusa* and *Gamochaeta spicata*). These weed species were limited to isolated individuals.

- The riparian vegetation performance indicator, *Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at Metropolitan Coal*, continued to be exceeded at site MRIP02 on Waratah Rivulet, with vegetation dieback observed greater than 50 cm from the Waratah Rivulet. Continued exceedance of the performance indicator for site MRIP02 on Waratah Rivulet triggered ongoing assessment against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities*. Assessments conducted by Eco Logical and Cenwest Environmental Services for threatened flora and threatened fauna, respectively, concluded that the performance measure has been met. The threatened flora and fauna assessments are provided in Appendix J (J3 and J2, respectively).

4.3.2 Longwalls 301-303

No additional riparian vegetation monitoring sites have been established for Longwalls 301-303. Riparian areas along Waratah Rivulet and the Eastern Tributary will continue to be monitored at sites MRIP01 to MRIP12[9] for Longwalls 20-22 and/or Longwalls 23-27 (Figure 11). Sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 are situated over Longwalls 20-22 and sites MRIP11 and MRIP12 are situated over Longwalls 23-27. Sites MRIP03, MRIP04 and MRIP10 are situated downstream of Longwall 23A on the Waratah Rivulet. Sites MRIP07 and MRIP08 are situated on the Eastern Tributary downstream of Longwalls 23-27 and within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwalls 301-303.

4.4 AQUATIC BIOTA AND THEIR HABITATS

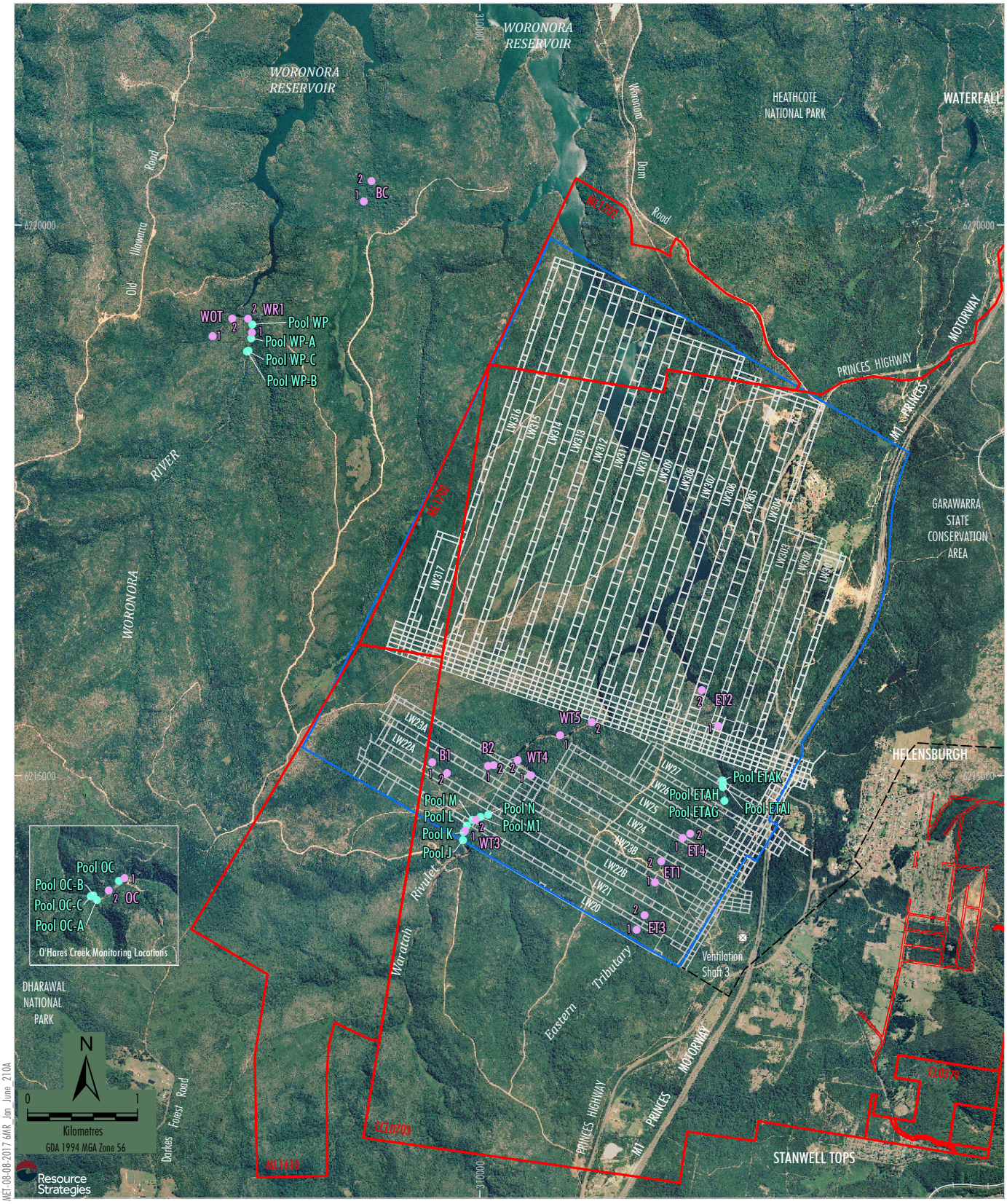
4.4.1 Longwalls 20-22 and Longwalls 23-27

The aquatic ecology monitoring programs for Longwalls 20-22 and Longwalls 23-27 have been 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 12.

Multivariate and univariate statistical procedures (Permutational Multivariate Analyses of Variance [PERMANOVA] and Plymouth Routines in Multivariate Ecological research [PRIMER] software packages) were used to examine temporal and spatial patterns in macroinvertebrates and macrophytes sampled within the study area. Specifically, PERMANOVA's were 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).

As indicated in Section 3.1, Metropolitan Coal reported the exceedance of the Eastern Tributary watercourse performance measure in relation to iron staining to the DP&E and other relevant agencies on 14 October 2016. In response to the exceedance of the Eastern Tributary iron staining performance measure, Bio-Analysis Pty Ltd (2016) prioritised the analysis of the spring 2016 aquatic ecology data for monitoring sites downstream of the Longwall 26 maingate (Figure 12). The key findings from this assessment were reported in the Metropolitan Coal 2016 Annual Review.

[9] Sites MRIP01, MRIP02, MRIP03, MRIP04 and MRIP10 are situated in the vicinity of pools J, N, Q, U and W, respectively on the Waratah Rivulet. Sites MRIP05, MRIP06, MRIP07, MRIP09, MRIP11 and MRIP12 are situated in the vicinity of pools ETJ, ETM, ETQ, ETS, ETF, ETV and ETAG, respectively, on the Eastern Tributary.



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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 (2016); MSEC (2016)

Peabody

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Aquatic Ecology Monitoring Locations

Figure 12

The spring 2016 Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Reports prepared by Bio-Analysis Pty Ltd are provided in Appendix K (K1 and K2, respectively). The spring 2016 monitoring results for all stream and pool sites are summarised below.

Stream Monitoring Program

Eastern Tributary – Aquatic Macroinvertebrates

In spring 2016, mining impacts to pool water levels continued to be observed on the Eastern Tributary[10] upstream of the Longwall 26 maingate. At the time of the spring 2016 survey, water levels had increased in some pools since autumn 2016 or were similar to autumn 2016 water levels. Iron staining/flocculent was observed for the first time since aquatic sampling commenced at Location C2[11] (downstream of the maingate of Longwall 26) in spring 2016.

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- vs After-mining of Longwall 20 (mining commenced in May 2010) and Longwall 23 (mining commenced in May 2014), in relation to Control locations.

Multivariate analyses indicate that any effect of longwall mining on assemblages of aquatic macroinvertebrates at Locations C2, C3 and C4 are within the range of natural variability in these assemblages in relation to the control locations. Macroinvertebrate taxa that have consistently contributed most to the structure of assemblages on the Eastern Tributary and the control locations were mayflies (Leptophlebiidae) and freshwater shrimp (Atyidae) (SIMPER).

Univariate analyses of macroinvertebrate data collected at Location C2 detected a significant before- (spring 2008 to autumn 2010) to after- (spring 2010 to autumn 2016) mining of Longwall 20 change in mean numbers of Atyidae in spring 2015, in relation to the control locations (T15 on Chart 83a). However, no detectable difference was found by the autumn 2016 or spring 2016 surveys (Chart 83a). There was a considerable increase in mean numbers of Atyidae at Location C2 after spring 2015 (Chart 83a).

Analyses for the Longwalls 23-27 mining area detected a significant before- (spring 2009 to spring 2013) to after- (autumn 2014 to spring 2016) mining change in mean numbers of Atyidae at Location C2 in autumn 2016 (T16) and spring 2016 (T17), in relation to the control locations (Chart 83a). Overall, fewer Atyidae have been collected at Location C2 within the after period, compared to the before period (Chart 83a).

Analyses of macroinvertebrate data collected at Location C1 did not detect any significant before- (spring 2008 to autumn 2010) to after- (spring 2010 to autumn 2016) mining of Longwall 20 changes in the structure of assemblages or their main components.

For the first time since the Longwalls 23-27 aquatic ecology monitoring program commenced, the multivariate analyses for spring 2016 detected a significant before-to-after change in the structure of the assemblage of aquatic macroinvertebrates at Location C1, compared to the control locations. Univariate analyses detected a significant before vs after mining change in numbers of Leptophlebiidae at Location C1 on this (spring 2016) and the past three sampling occasions (autumn 2016, spring 2015, autumn 2015), largely due to an increase in abundance of Leptophlebiidae at Location C1 in relation to control places (Chart 83b).

[10] The Eastern Tributary is also known as Tributary C. Locations ET1 to ET4 shown on Figure 12 are the same as Locations C1 to C4 discussed in this section of the Six Monthly Report, and in the Six Monthly Report Appendices K1 and K2.

[11] In spring 2016, Location C2 was sampled on 24 October 2016.

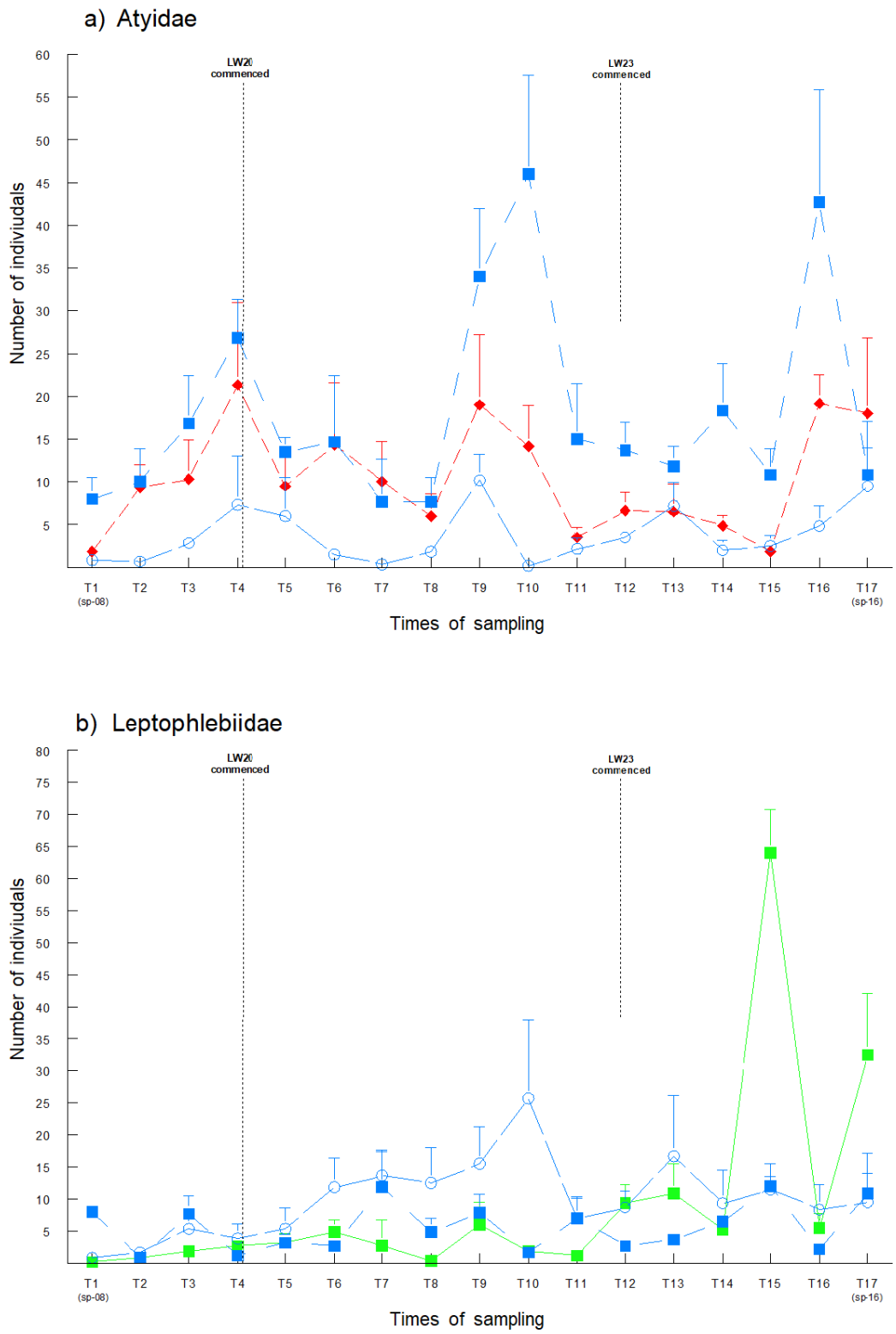


Chart 83 **Mean number (+SE) of a) Atyidae and b) Leptophlebiidae at locations on Eastern Tributary** (C1: inverted triangles; C2: triangles; C4: diamonds) and the control locations (Woronora River: squares; O'Hares Creek: circles) between spring 2009 (T1) and spring 2016 (T15) (*n* = 6)

Eastern Tributary – Aquatic Macrophytes

Multivariate and univariate analyses of monitoring data before- versus after-commencement of mining (of Longwall 20 and Longwall 23) indicates that any effect of longwall mining on assemblages of aquatic macrophytes at Locations C1, C2, C3 and C4 are within the range of natural variability in these assemblages in relation to the control locations.

Waratah Rivulet

To date, multivariate analyses comparing temporal changes in components of the aquatic macroinvertebrate and macrophyte assemblages at locations sampled along the Waratah Rivulet (Locations WT3, WT4 and WT5) with control locations have not detected significant changes from before- to after- commencement of mining of the Longwalls 20-22 underground mining area.

For the first time since sampling commenced (spring 2008), analyses detected a significant increase in mean diversity within the after-period, in relation to the control locations.

Tributary B - Location B1

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 from spring 2014 to spring 2016 due to insufficient habitat available for sampling.

Multivariate analyses indicate that assemblages of macroinvertebrates at Location B1 differed significantly from before- to after- spring 2012, in relation to the control locations. A significant decrease in mean diversity and numbers of Atyidae has also been detected at Location B1 from before- to after-spring 2012 in relation to the control locations.

The multivariate analyses for spring 2016 indicate that assemblages of macrophytes at Location B1 have not differed significantly from before to after spring 2012, in relation to the control locations. Univariate analyses have consistently found no significant differences in total diversity of macrophytes at Location B1. Significant differences in the total cover of macrophytes at Location B1 compared to the controls were identified in spring 2015 but not in autumn 2016 or spring 2016. However, considerable dieback of the fern, *Gleichenia dicarpa*, has occurred at Location B1 since spring 2012. It appears that while not statistically significant, aquatic macrophyte assemblages at Location B1 have experienced a degree of environmental stress since spring 2012 as a result of Longwalls 20-22.

Tributary B - Location B2

Mining impacts (i.e. iron staining) were first noted at Location B2 in spring 2014. Minor fracturing of the stream substratum was first noted at the most upstream site (Site B2-1) in autumn 2015 and in autumn 2016 at the downstream site (Site B2-2).

Multivariate analyses have found a significant change in the structure of the assemblage of aquatic macroinvertebrates at Location B2 before- to after- mining compared to the control locations since autumn 2014, including spring 2016.

Univariate analyses detected a significant decrease in mean numbers of Leptophlebiidae at Location B2 in relation to the control locations in spring 2015, autumn 2015 and spring 2014. However, no detectable difference was found by the autumn or spring 2016 surveys. Leptophlebiidae have increased at Location B2 since spring 2015.

For the first time since sampling commenced (spring 2009), analyses of Atyidae at Location B2 detected a significant decrease in mean numbers within the after mining period, in relation to the control locations.

Analyses examining changes in aquatic macrophytes found no evidence of impacts at Location B2 that could be related to mining activities.

Aquatic Ecology Performance Indicator

The aquatic ecology subsidence impact performance indicator: *The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence* has been assessed as being exceeded for Locations B1 and B2 on Tributary B for aquatic macroinvertebrates.

This has triggered an assessment against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations, or ecological communities.* The assessment against the biodiversity performance measure has been conducted in relation to threatened terrestrial flora and fauna; there are no threatened aquatic fauna or flora known, or considered likely to occur. Assessments conducted by Eco Logical and Cenwest Environmental Services for threatened flora and threatened fauna, respectively, concluded that the subsidence impact performance measure has been met. The threatened flora and fauna assessments are provided in Appendix J (J3 and J4, respectively).

Pool Monitoring Program

Pools on Eastern Tributary

Analyses indicated significant differences in the structure of aquatic macroinvertebrate assemblages in large Pool ETAH before- to after-mining in autumn 2015 and autumn 2016 compared to control locations, largely due to changes in the contribution that the families Atyidae and Leptophlebiidae made to the structure of the assemblage at Pool ETAH relative to the controls. However, there was no significant difference in the structure of the aquatic macroinvertebrate assemblage in Pool ETAH compared to control pools in spring 2015 or spring 2016.

Univariate analyses for Pool ETAH have consistently found no significant differences in total diversity, total abundance, numbers of Leptophlebiidae or Atyidae that could be associated with mining of the Longwalls 23-27 area. There have been no detectable impacts to macrophytes at Pool ETAH, in relation to the control locations, that could be associated with mining.

Analyses examining changes in aquatic macroinvertebrates and macrophytes in small pools (Pools ETAG, ETAI and ETAK) on Eastern Tributary found no evidence of impacts that could be related to mining activities within the Longwalls 23-27 underground mining area.

Pools on Waratah Rivulet

Multivariate analyses comparing temporal and spatial patterns of change in assemblages of aquatic macroinvertebrates and macrophytes 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 or their main components (i.e. Leptophlebiidae and Atyidae) when comparing the before- to after-mining periods.

Univariate analyses indicate there has been a significant increase in mean diversity of macroinvertebrates in two of the large pools sampled (Pools J and M1) and the small pools (K, L and M) in autumn 2015, spring 2015, autumn 2016 and spring 2016, in relation to the control pools since the commencement of Longwalls 20-22.

Multivariate analyses comparing temporal and spatial patterns of change in assemblages of aquatic macrophytes 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 when comparing the before- to after-mining periods.

In autumn and spring 2016, univariate analyses detected a significant change in the mean cover of macrophytes at Pool M1 after mining, in relation to the control pools. Mean cover decreased at Pool M1 but increased at the control pools within the after period. Univariate analyses indicated that mean diversity of macrophytes at Pool N in autumn 2016 and spring 2016 had changed significantly in relation to the control pools. Mean diversity at Pool N has changed little between periods but increased at the control pools within the after period.

4.4.2 Longwalls 301-303

No additional aquatic ecology monitoring sites have been established for Longwalls 301-303. The Longwalls 20-22 and Longwalls 23-27 aquatic ecology monitoring locations will continue to be monitored (Figure 12). Aquatic ecology monitoring Location ET2 is situated within the Longwalls 301-303 35° angle of draw and/or predicted 20 mm subsidence contour (Figure 12).

4.5 AMPHIBIAN SURVEYS

Monitoring programs have been developed for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 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 13.

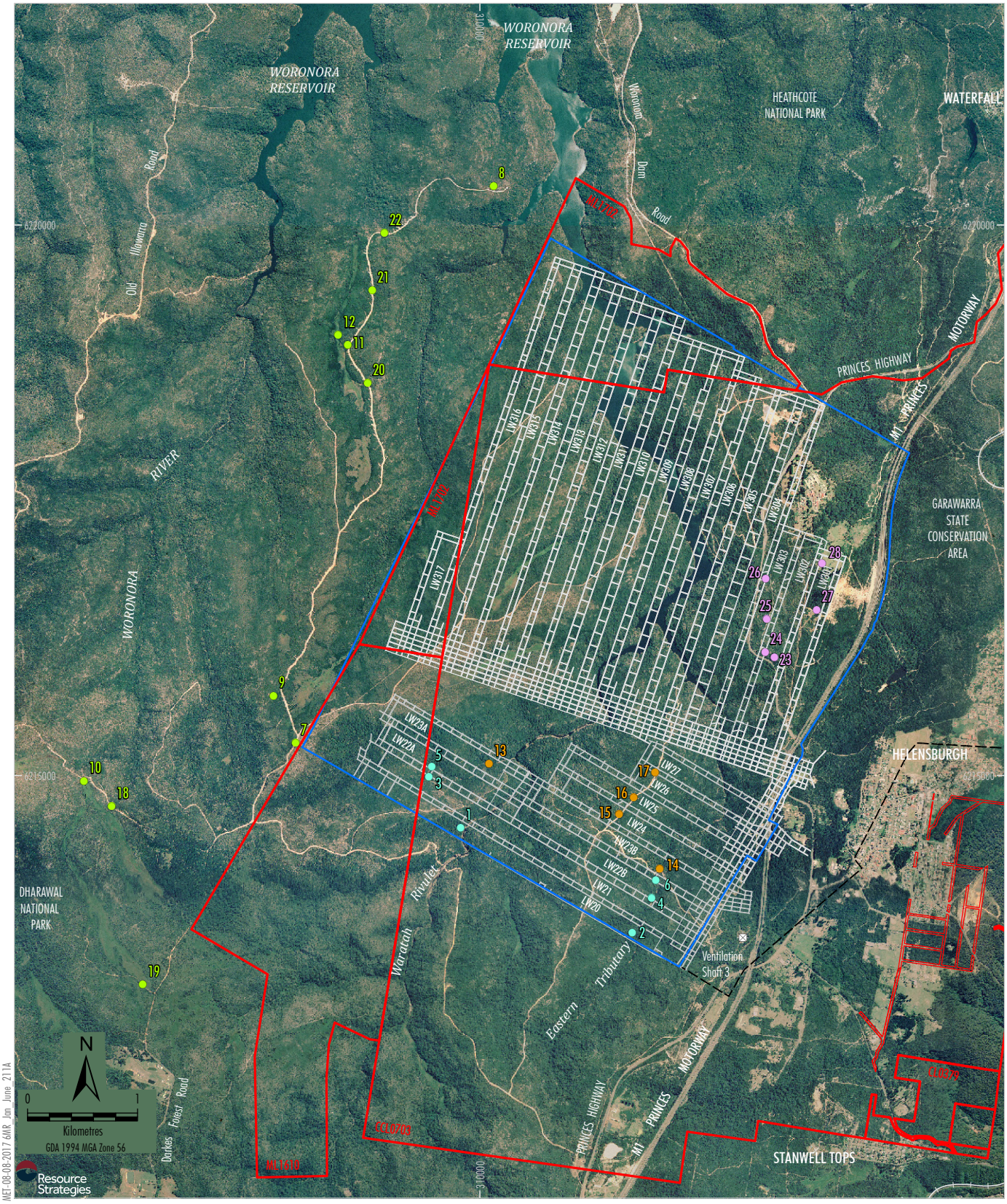
Sites are surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions. The 2016 spring/summer survey was carried out in three separate surveys, over ten days and ten nights in February 2017, March 2017 and April 2017. The first survey period was delayed due to the prevailing dry weather conditions from October 2016 to January 2017. The survey in March 2017 was conducted to provide additional breeding data, however, was cut short due to the exceptionally wet weather resulting in catchment closure. The amphibian survey was completed in April 2017.

4.5.1 Longwalls 20-22 Amphibian Monitoring

The Spring/Summer 2016 Longwalls 20-22 Amphibian Monitoring Report prepared by Cenwest Environmental Services is provided in Appendix L1.

The spring/summer 2016 survey is the eighth amphibian survey for Longwalls 20–22. At the time of the spring/summer 2016 survey six test sites above Longwalls 20-22 had been undermined for periods ranging from three to five years. Habitats of five test sites (1, 2, 4, 5 and 6) have been adversely impacted by longwall mining.

Six amphibian species were recorded by the spring/summer 2016 survey, including four in test sites and six in control sites, being representatives from the two families Myobatrachidae and Hylidae. The most species diverse sites in the spring/summer 2016 survey with four species were test site 6 and control sites 8 and 10 (Figure 13). The Red-crowned Toadlet was located at two test sites (site 5 and site 6) and three control sites (sites 7, 8 and 12). The Giant Burrowing Frog was observed calling and breeding at site 10. Individuals of the Giant Burrowing Frog have not been recorded at test or control sites in either the spring/summer 2010 or spring/summer 2012 to 2015 surveys.



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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
- Control Site

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2016); MSEC (2016)

Peabody

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Amphibian Monitoring Locations

Figure 13

Fourteen breeding events (five species) were recorded by the spring/summer 2016 survey in both test and control sites. No breeding events were recorded for the Red-crowned Toadlet. One breeding event was recorded for the Giant Burrowing Frog.

Since the commencement of the Longwalls 20-22 amphibian monitoring program, species diversity across all sites has varied between five (2013) and 11 (2009). At test sites, species diversity has varied between 4-9 species and at control sites, between 2-9 species.

4.5.2 Longwalls 23-27 Amphibian Monitoring

The Spring/Summer 2016 Longwalls 23-27 Amphibian Monitoring Report prepared by Cenwest Environmental Services is provided in Appendix L2.

The spring/summer 2016 survey is the seventh amphibian survey for Longwalls 23-27. Five test sites above Longwalls 23-27 had been undermined by the commencement of the 2016 spring/summer survey. Habitats of two sites (13 and 14) have been adversely impacted by longwall mining.

Four amphibian species were recorded by the spring/summer 2016 survey, including three in test sites and four in control sites, also being representatives from the two families Myobatrachidae and Hylidae. The most widespread frog was the Common Eastern Froglet, recorded at all monitoring sites. All other frog species were patchily distributed. Adults of the Red-crowned Toadlet were located at one test site (site 14) and three control sites (sites 20, 21 and 22). The Giant Burrowing Frog was not located during the survey.

Only two species (Common Eastern Froglet and the Southern Rocket Frog), were found breeding in the spring/summer 2016 survey. The Common Eastern Froglet was not breeding at test sites, but was found breeding in large numbers at control sites 18, 20, 21 and 22. The Southern Rocket Frog was located breeding in modest numbers only in control sites 18 and 20. No breeding events were recorded for the Red-crowned Toadlet or Giant Burrowing Frog.

Since the commencement of the Longwalls 23-27 amphibian monitoring program, species diversity across all sites has varied between four (2016) and eight (2010). At test sites, species diversity has varied between 3-7 species and at control sites, between 2-6 species.

4.5.3 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 13). The control sites for Longwalls 301-303 consist of the eleven existing sites associated with Longwalls 20-22 and Longwalls 23-27. The baseline spring/summer 2015 and spring/summer 2016 Longwalls 301-303 Amphibian Monitoring Reports prepared by Cenwest Environmental Services are provided in Appendices L3 and L4, respectively.

In the spring/summer 2015 survey, three amphibian species were recorded at the longwall test sites. Adults of the Common Eastern Froglet were located at five of the six test sites, one adult Broad-palmed Frog was observed at site 26, and one adult Red-crowned Toadlet was located at site 25. There was no evidence of breeding events for any species at the six test sites.

In the spring/summer 2016 survey, seven species were recorded at the longwall test sites. Species diversity varied across sites from zero to three. The number of sites used by each species varied between one and five. Two adult Red-crowned Toadlets were located, one at site 25 and one at site 26. No evidence of breeding for this species was observed at the six test sites. Neither adults, or evidence of breeding, were observed at the six test sites for the Giant Burrowing Frog.

One new species, the Littlejohn's Tree Frog (*Litoria littlejohni*), was located for the first time at site 24 (one adult) in the spring/summer 2016 survey. No evidence of breeding was observed for this species. Within the Greater Southern Sydney Bioregion, the Woronora Plateau and the higher rainfall areas of the Blue Mountains are considered two key areas that are important to this species (DECC, 2007). In the past, Littlejohn's Tree Frog has been reported to be common at Darkes Forest (A. White pers. comm. in DECC, 2007). This species has not been recorded by the Longwalls 20-22 or Longwalls 23-27 amphibian surveys and was not recorded in the pre-mining baseline surveys conducted for the Metropolitan Coal Project Environmental Assessment.

Metropolitan Coal has commissioned a targeted survey for the Littlejohn's Tree Frog to be carried out in August or September 2017[12] when adult calling is likely to be at its peak under wet conditions to determine the status of the species within the Project area.

4.5.4 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[13] 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 2016). The three data sets (Longwalls 20-22, 23-27 and 301-303) have been analysed together to increase the resolution of the analyses. No adverse impact from mining has been detected for the amphibian assemblage at the 95% confidence level.

The amphibian species distribution, diversity and abundance data appear to be consistent with expected population variations and cycles in response to seasonal variations. There are no significant differences between the test and control sites at the 95% confidence level. The amphibian 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 Longwalls 20-27.

5 LAND MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Land Management Plans were prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on cliffs, overhangs, steep slopes and land in general, in accordance with Condition 6, Schedule 3 of the Project Approval. Longwall 27 was completed in March 2017.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Land Management Plan (which includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27). In accordance with Condition 4 of the Longwalls 301 and 302 approval, Metropolitan Coal will review and revise the Longwalls 301-303 Land Management Plan TARP.

[12] The dry weather conditions experienced in August and September 2017 have not provided suitable weather conditions for the conduct of the targeted survey. The survey has had to be postponed until 2018.

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

5.1 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.

In February 2017, a surface tension crack was recorded on a rock platform located over Longwall 25 in the vicinity of Aboriginal heritage site FRC 301 (Figure 14). The surface crack was approximately 10 mm wide and 25 m in length and runs east to west along the rock platform into vegetation surrounding the rock platform.

Rock fall from a rock ledge was also observed in February 2017 in the vicinity of Aboriginal heritage site FRC 285 located over Longwall 22B (Figure 14). The fallen rock is approximately 60 cm wide and 80 cm in length, and has dislodged from the underside of the sandstone boulder overhang. The rock has landed on the uneven rock surface beneath the overhang, causing it to break into smaller sections.

The potential for environmental consequences or safety hazard were assessed and documented by Metropolitan Coal in the Land Management Plan – Subsidence Impact Register. No management measures were required to be implemented.

The subsidence impact assessment in the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Land Management Plans indicates that the size and extent of surface cracking at the steep slopes is expected to be similar to that observed during the extraction of previous longwalls at the Colliery (i.e. where surface cracking up to approximately 25 m long and 0.1 m wide has been observed).

The performance indicator, *Steep slopes and land in general are expected to experience surface tension cracking no greater than 0.1 m wide and 25 m in length,* was not exceeded during the reporting period.

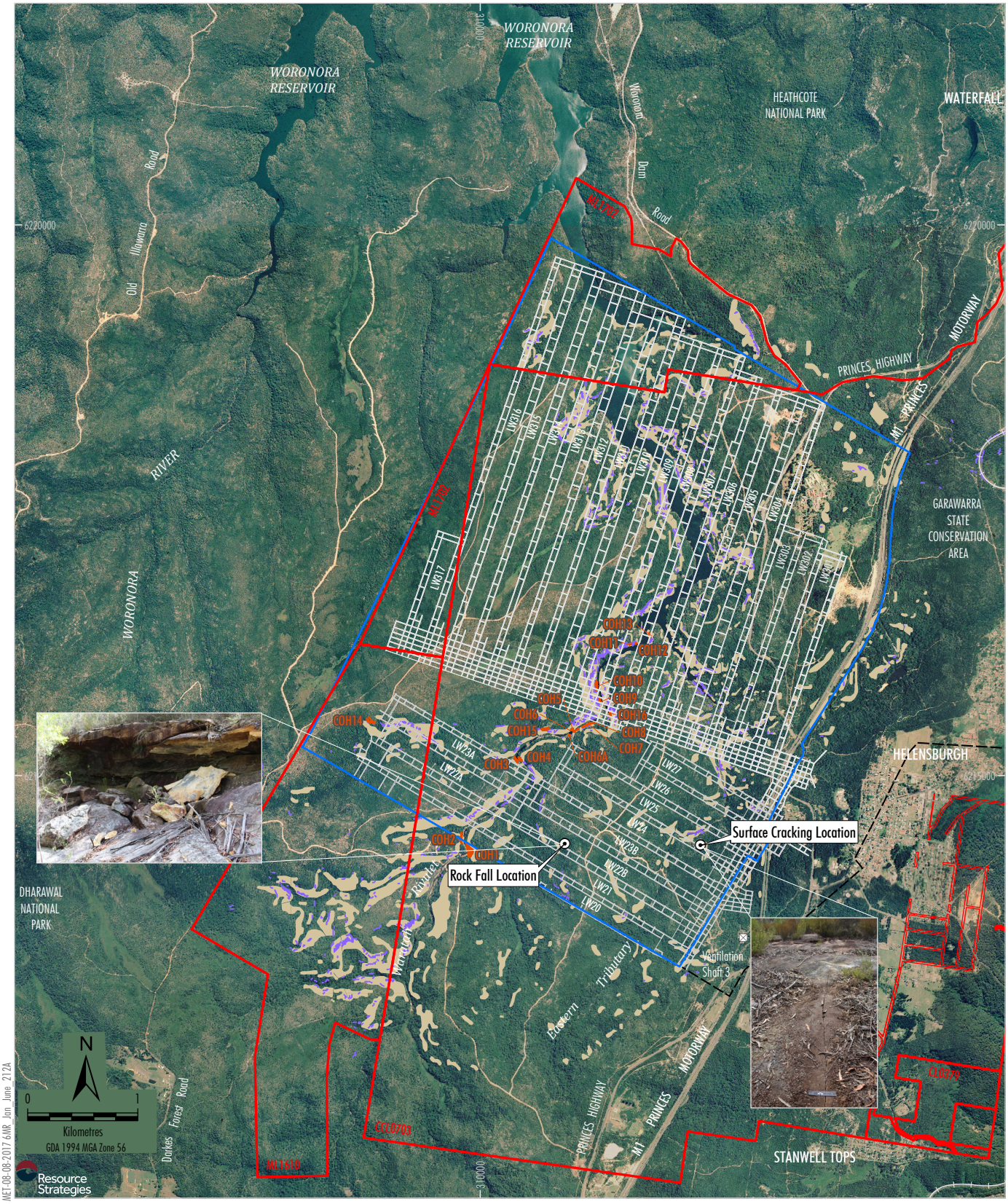
5.2 CLIFFS AND OVERHANGS

Visual inspections have been conducted monthly for the period of time Longwalls 23-27 extraction has been within 400 m of cliff and overhang sites COH2, COH3, COH4, COH5, COH6, COH6a, COH7, COH8, COH9, COH10, COH14, COH15 and COH16 (Figure 14) and following the completion of each longwall to record evidence of subsidence impacts.

During the reporting period Longwall 27 was not within 400 m of the cliff sites. Following the completion of Longwall 27, no new cliff instabilities (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) or areas of water seepage in excess of that expected to result from rainfall conditions were evident at the cliff and overhang sites.

A small rock fall at site COH2 had previously been recorded in December 2013. Following the completion of Longwall 27 and prior to the commencement of Longwall 301, only the one cliff site (COH2) located over Longwall 20 has been recorded with cliff instabilities, approximately 1.5 m in length.

No cliff and overhang sites have been identified within 600 m of Longwalls 301-303 secondary extraction. The nearest cliff and overhang sites are located more than 800 m to the west of Longwalls 301-303. At these distances, the cliff and overhang sites are not expected to experience any measurable vertical subsidence resulting from the extraction of Longwalls 301-303.



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 (2016); MSEC (2008; 2016)

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

Figure 14

6 HERITAGE MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Heritage Management Plans were prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on Aboriginal heritage sites or values in accordance with Condition 6, Schedule 3 of the Project Approval.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Heritage Management Plan (which includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27). In accordance with Condition 4 of the Longwalls 301 and 302 approval, Metropolitan Coal will review and revise the Longwalls 301-303 Heritage Management Plan TARP.

6.1 LONGWALLS 20-22 AND LONGWALLS 23-27

A monitoring program has been implemented to monitor the impacts and consequences of mine related subsidence on Aboriginal heritage sites located within the 35^{o} angle of draw of Longwalls 20-22 and Longwalls 23-27 (Figure 15). The Aboriginal heritage sites monitoring program is carried out by an archaeologist (with experience in rock art recording and management) and Aboriginal stakeholder representatives.

Seven heritage sites (FRC 15, FRC 176, FRC 275, FRC 281, FRC 283, FRC 284 and MET 1) were determined by the Longwalls 20-22 Rounds 1, 2 and 3 and Longwalls 23-27 Round 1, Round 2 and Round 3 Aboriginal heritage surveys to have changes due to mine subsidence from Longwalls 20-22 and Longwalls 23-27 (as reported in the Metropolitan Coal 2016 Annual Review).

The fourth round of monitoring for Longwalls 23-27 (Round 4) was conducted in February 2017 following the completion of Longwall 26 by Niche Environment and Heritage. The Round 4 monitoring report is provided in Appendix M and the results are summarised below.

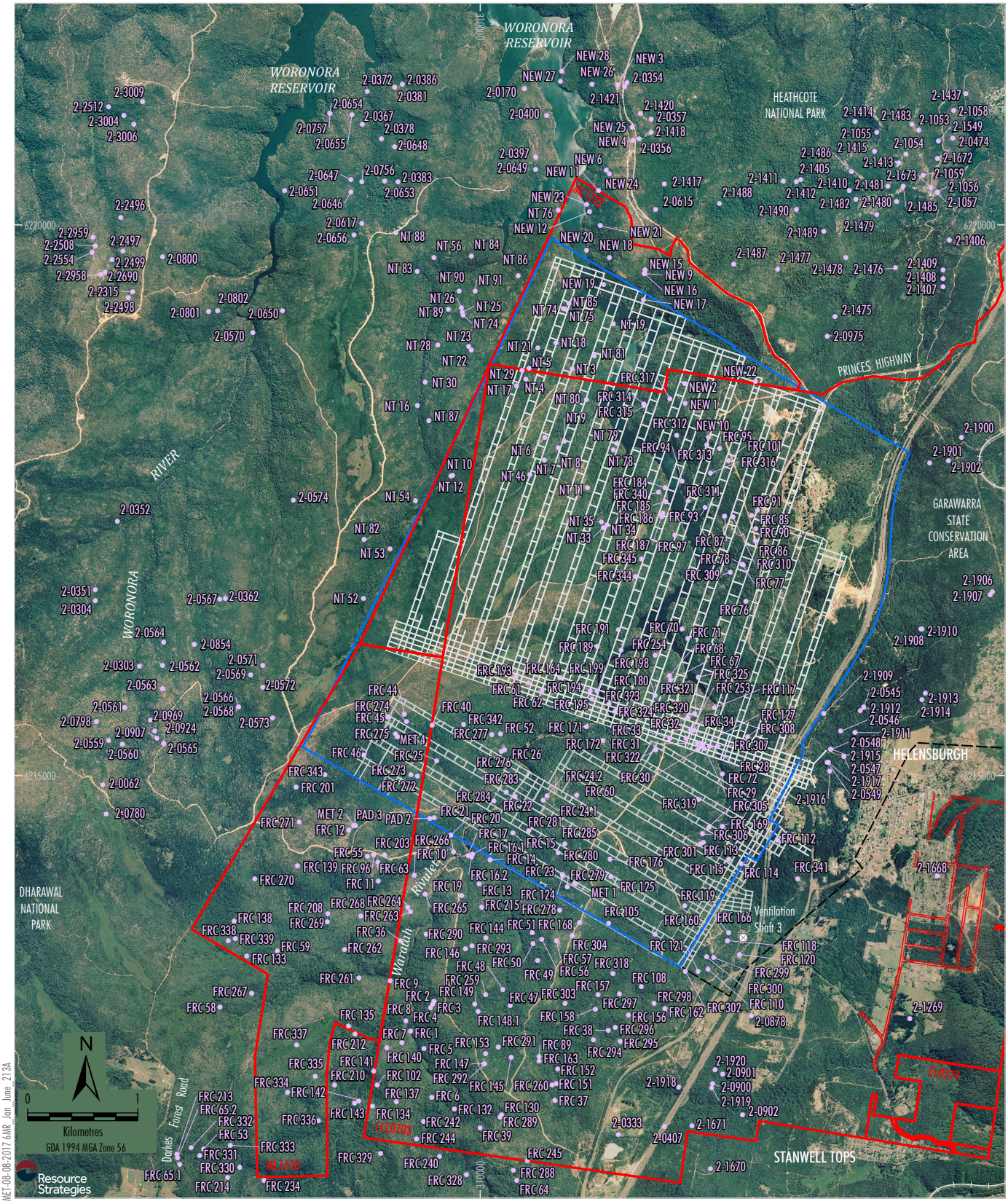
Changes due to mining were recorded at site FRC 301 (a grinding groove site) during the Round 4 survey. A surface crack was recorded on the rock platform, approximately 10 mm wide and 25 m in length, approximately 3 m to the north of the grinding groove (as described in Section 5.1). The grinding groove has not been affected by the cracking. No further changes to Aboriginal heritage sites as a result of mining were recorded during the Round 4 survey.

In accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Heritage Management Plans, Aboriginal heritage site monitoring results are used to assess the Project 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.



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 (2016); MSEC (2016); Illawarra Prehistory Group (2007; 2008); AHIMS (2007); Kayandel Archaeological Services (2006; 2007; 2008); Niche Environment and Heritage (2013)

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Known Aboriginal Heritage Sites Within Project Underground Mining Area and Surrounds

Figure 15

The mining area is defined by the Project Approval and is shown on Figure 1 of this report (labelled Project Underground Mining Area Longwalls 20-27 and 301-317). Of the sites at which changes due to mining induced subsidence have occurred, site FRC 281 has been affected by subsidence impacts as a result of cracking of sandstone that coincides with Aboriginal art. This means that less than 1% of sites within the mining area have been affected, which is within the approved performance measure.

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.

In the next reporting period, Round 5 of the Longwalls 23-27 monitoring program will be undertaken following the completion of Longwall 27 (within three to six months). The results of this survey will be reported in the Metropolitan Coal 2017 Annual Review.

6.2 LONGWALLS 301-303

The Round 5 monitoring survey for Longwalls 23-27 will be undertaken between 3 and 6 months following the completion of Longwall 27. The Aboriginal heritage sites that show continued change due to mining induced subsidence will be monitored within three months of the completion of Longwall 303.

All sites located within the Longwalls 301-303 35º angle of draw and/or predicted 20 mm subsidence contour, with the exception of sites FRC 76 and FRC 117, are predicted to experience maximum tilts, curvatures and strains that are less than typical magnitudes of subsidence survey accuracy (i.e. conventional tilt of less than 0.5 mm/m, conventional curvature of less than 0.01 km^{-1} hogging and sagging). The maximum predicted subsidence at these sites at the completion of Longwall 303 extraction is 125 mm at site FRC 76, with predicted subsidence being 60 mm or less at all other sites.

Monitoring of Aboriginal heritage site FRC 76 (sandstone overhang with art only) and site FRC 117 (sandstone overhang with art and PAD) will be undertaken for Longwalls 301-303, within three months of the completion of Longwall 303 (Figure 15).

7 BUILT FEATURES MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Built Features Management Plans were prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on built features in accordance with Condition 6, Schedule 3 of the Project Approval. The Metropolitan Coal Longwalls 20-22 Built Features Management Plan has effectively been discontinued as the appropriate monitoring for built features has been incorporated into the Metropolitan Coal Longwalls 23-27 Built Features Management Plan.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Built Features Management Plan. In accordance with Condition 3 of the Longwalls 301 and 302 approval, Metropolitan Coal will review and update the Garrawarra Centre Complex Built Features Management Plan, in consultation with the NSW Resources Regulator and NSW Health to include a mechanism for regular revise and revisions of the subsidence monitoring program at the Garrawarra Centre and implementation of contingency measures. Metropolitan Coal will also review and revise the Longwalls 301-303 Built Features Management Plan TARPs in accordance with Condition 4 of the Longwalls 301 and 302 approval,

7.1 LONGWALLS 20-22 AND LONGWALLS 23-27

During the reporting period, the Longwalls 23-27 monitoring program has been implemented to monitor subsidence impacts on infrastructure owned by Endeavour Energy, Nextgen, TransGrid, Optus, Telstra, Roads and Maritime Services, Sydney Water and Wollongong City Council. No subsidence impact to any built feature was evident over the reporting 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 reporting 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 Garrawarra Complex is located more than 2.5 km from Longwalls 23-27. The heritage/historical significance subsidence impact performance measure was not exceeded during the reporting period.

7.2 LONGWALLS 301-303

The following management and monitoring measures were implemented by Metropolitan Coal in the reporting period:

- Commenced the review and revision of the Built Features Management Plan TARPs.
- Consulted with the NSW Resources Regulator and NSW Health in regard to the review and update of the Garrawarra Centre Complex Built Features Management Plan, and established monthly meetings with NSW Health for regular consultation.
- Discussed the preparation of a Memorandum of Understanding with NSW Health in relation to the removal of nominated buildings.
- Installed approximately 12.5 km of new subsidence monitoring for built features associated with Longwalls 301-303.
- Continued baseline monitoring Bridge 2 (BN616 [southbound and BN617 [northbound]) using the high precision Fibre Bragg Grating (FBG) system prior to the commencement of Longwall 301.
- Deployed real-time Global Positioning Systems (GPS) to five TransGrid towers (T11-108 to T11-104), the Cawley Road overbridge and Bridge 2 (BN617) to track absolute movement and trigger detailed survey events.
- Completed a pre-mining audit of all marked grave sites at the Waterfall General (Garrawarra) Cemetery to document the baseline condition of each grave site, including photographs and commentary.
- Completed structural analysis of two culverts for Sydney Trains and installed subsidence survey marks to confirm the prediction of negligible movement.
- Designed and sourced replacement towers for the TransGrid 330 kV transmission line, consistent with the proposed contingency measures.

8 PUBLIC SAFETY MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Public Safety Management Plans were prepared to manage the potential consequences of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Extraction Plans on public safety within the underground mining areas in accordance with Condition 6, Schedule 3 of the Project Approval.

As described in Section 1, in the next reporting period Metropolitan Coal will implement the Longwalls 301-303 Public Safety Management Plan (which includes post-mining monitoring and management of potential subsidence impacts and environmental consequences associated with Longwalls 20-22 and Longwalls 23-27).

Monitoring of cliffs and overhangs, steep slopes and land in general has been conducted for subsidence impacts in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Land Management Plans, and of infrastructure items in accordance with the Metropolitan Coal Longwalls 23-27 Built Features Management Plan. 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.

9 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The subsidence impact performance indicators and performance measures in Table 8 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 EA, Preferred Project Report, Metropolitan Coal Longwalls 20-22 Extraction Plan and Longwalls 23-27 Extraction Plan. Assessment against the subsidence impact performance indicators and performance measures have been conducted for the reporting period (1 January to 30 June 2017) in Table 8.

Table 8
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT							
Surface Water Flow	*Changes in the quantity of water entering Woronora Reservoir is not significantly different post-mining compared to pre-mining, that is not also occurring in the control catchment(s)*	✓	✓	No	Continue monitoring	*Negligible reduction to the quantity of water resources reaching the Woronora Reservoir*	No
Water Quality Reaching 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*	✓	✓	Yes	Assessment against the performance measure conducted for the Eastern Tributary by Associate Professor Barry Noller (The University of Queensland, 2017) (Appendix H).	*Negligible reduction to the quality of water resources reaching the Woronora Reservoir*	No.
Connective Cracking	*Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally*	✓	✓	No	Continue monitoring	*No connective cracking between the surface and the mine*	No
	The 20-day average mine water make does not exceed 2 ML/day	✓	✓	No	Continue monitoring		No
	Significant departures from the predicted envelope of vertical potentiometric head profiles at Bores 9GGW2B and 9FGW1A do not occur	✓	×	No	Continue monitoring		No
	Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore 9GGW2B does not occur	×	✓	No	Continue monitoring		No
	The water tables measured at Bores 9FGW1A and 9GGW1-80 are higher than the water levels of streams crossed by a transect along Longwall 22 (i.e. a hydraulic gradient exists from each bore to the nearest watercourse)	✓	✓	No	Continue monitoring		No

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)							
Leakage from the Woronora Reservoir	*The groundwater head of Bores 9GGW2B and PM02 is higher than the water level of Woronora Reservoir (i.e. a hydraulic gradient exists from the bores to the Woronora Reservoir)*	✓	✓	No	Continue monitoring	*Negligible leakage from the Woronora Reservoir*	No
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*	✓	✓	To be assessed in the 2017 Annual Review	Continue monitoring	*Negligible reduction in the water quality of Woronora Reservoir*	No
Waratah Rivulet Environmental Consequences	*No change to the natural drainage behaviour of Pool P. Specific indicators include: no new cracking in the stream bed of Pool P or rock bar; continual flow through/below the rock bar of Pool P such that water is ponded upstream; and continual surface water flow along the length of Pool P*	✓	×	No	Continue monitoring	*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
	No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W. Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/ through/below the rock bars/terminal boulder fields of pools such that water is ponded upstream; and continual surface water flow along the length of the pools	×	✓	No	Continue monitoring		No
	Analysis of water depth data for Pool P (when mining is within 400 m of Pool P) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of Pool P)	✓	×	No	Continue monitoring		No

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)							
Waratah Rivulet Environmental Consequences (Continued)	*Analysis of water depth data for Pools P, T and V (when mining is within 400 m of the pools) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pools)*	×	✓	No	Continue monitoring	*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
	Analysis of water depth data for Pools Q, R and S on Waratah Rivulet indicates the water depths are above that required to maintain water over the downstream rock bar	✓	✓	No	Continue monitoring		No
	Visual inspection of the Waratah Rivulet between the full supply level of the Woronora Reservoir and Pool P does not show significant changes in the extent or nature of iron staining that isn't also occurring in the Woronora River (control site)	×	✓	No	Continue monitoring		No
	Visual observations of gas releases in Pool P on the Waratah Rivulet indicate the gas releases have increased beyond those observed up to 17 April 2014	✓	✓	No	Continue monitoring		No
	No gas releases observed at Pools Q to W on the Waratah Rivulet	×	✓	Yes (at Pool U)	Assessment against the performance measure conducted by Associate Professor Barry Noller (The University of Queensland, 2017) (Appendix E) Continue monitoring		No. Assessment subject to peer review (Appendix F).

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
WATER MANAGEMENT (Continued)							
Eastern Tributary Environmental Consequences	*No change to the natural drainage behaviour of at least 70% of the stream reach (from Pools ETAF to ETAU). Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/through/below the rock bar of pools/terminal boulder fields such that water is ponded upstream; and continual surface water flow along the length of pools*	×	✓	Yes (in January 2017)	Assessment against the performance measure. Contingency Plan process previously initiated by the exceedance of the iron staining component of the performance measure in October 2016 (see below)	*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*	Yes
	Analysis of water depth data for Pool ETAI on the Eastern Tributary (when mining is within 400 m of the pool) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pool)	×	✓	Yes (in December 2016)			Yes
	No significant change to the extent or nature of iron staining over more than 30% of the Eastern Tributary between maingate 26 and full supply level	×	✓	Yes (in October 2016)	Assessment against the performance measure. Contingency Plan and Incident Notification initiated.		Yes
	Gas releases observed over less than 30% of the Eastern Tributary between maingate 26 and full supply level, that is not also occurring in the Woronora River (control site)	×	✓	No	Continue monitoring		No

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT							
Upland Swamps Vegetation Monitoring	*The vegetation in upland swamps is not expected to experience changes significantly different to vegetation in control swamps*	✓	✓	No	Continue monitoring	*Negligible impact on threatened species, populations, or ecological communities*	No
Upland Swamps Groundwater Monitoring	*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*	✓	✓	Yes – continuation of performance indicator exceedance for Swamp 20 (Longwalls 20-22 upland swamps) (Appendix C) Yes – continuation of performance indicator exceedance for Swamp 28 (Longwalls 23-27 upland swamps) (Appendix C)	Assessments against the performance measure conducted by Eco Logical (threatened flora) and Cenwest Environmental Services (threatened fauna) (Appendices J1 and J2) Continue monitoring		No
Riparian Vegetation	*Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at Metropolitan Coal*[1]	✓	✓	Yes – continuation of performance indicator exceedance at site MRIP02 on the Waratah Rivulet (Appendices I1 and I2)	Assessment against the performance measure conducted by Eco Logical (threatened flora) and Cenwest Environmental Services (threatened fauna) (Appendices J3 and J2) Continue monitoring		No

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
BIODIVERSITY MANAGEMENT (Continued)							
Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC	*Subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated approximately 400 m to the east of Longwalls 20-22 are expected to be negligible*	✓	×	No	Continue monitoring	*Negligible impact on threatened species, populations, or ecological communities*	No
	Subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated approximately 300 to 500 m to the east of Longwalls 23-27 are expected to be negligible	×	✓	No	Continue monitoring		No
Aquatic Biota	*The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence*	✓	✓	Yes, at Locations B1 and B2 on Tributary B (macroinvertebrate assemblage component)	Assessments against the performance measure conducted by Eco Logical (threatened flora) and Cenwest Environmental Services (threatened fauna) (Appendices J3 and J4) Continue monitoring		No
Amphibian Monitoring	*The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites*	✓	✓	No	Continue monitoring		No

Table 8 (Continued)
Assessment of Environmental Performance – Underground Mining Area and Surrounds

Monitoring Components	Subsidence Impact Performance Indicator(s)	Longwalls 20-22 Extraction Plan*	Longwalls 23-27 Extraction Plan#	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
LAND MANAGEMENT							
Steep Slopes and Land in General	*Steep slopes and land in general are expected to experience surface tension cracking no greater than 0.1 m wide and 25 m in length*	✓	✓	No	Continue monitoring	-	-
Cliffs and Overhangs	-	✓	✓	-	-	*Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining-induced rock fall*	No
HERITAGE MANAGEMENT							
Aboriginal Heritage Sites	-	✓	✓	-	-	*Less than 10% of Aboriginal heritage sites within the mining area are affected by subsidence impacts*	No
BUILT FEATURES MANAGEMENT							
Built Features	-	✓	✓	-	-	*Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing*	No
Items of historical or heritage 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*	No
PUBLIC SAFETY MANAGEMENT							
Public Safety	*Public safety will be ensured in the event that any hazard to the general public arising from subsidence effects becomes evident*	✓	✓	No	Continue monitoring	*Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing*	No

* Performance indicator applicable to Longwalls 20-22 (✓) Yes; (✗) No.

\# Performance indicator applicable to Longwalls 23-27 (✓) Yes; (✗) No.

[1] This indicator is exceeded if visual inspections identify vegetation dieback greater than 50 cm from the stream.

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

APPENDIX A	2017 SIX MONTHLY REPORT SUBSIDENCE MONITORING RESULTS
APPENDIX B	SURFACE WATER REVIEW 1 JANUARY TO 30 JUNE 2017
APPENDIX C	SIX MONTHLY REVIEW - JUNE 2017 GROUNDWATER MONITORING AND ENVIRONMENTAL PERFORMANCE ASSESSMENT
APPENDIX D	MAPPED POOL LOCATIONS ON THE WARATAH RIVULET, EASTERN TRIBUTARY, TRIBUTARY A AND TRIBUTARY B
APPENDIX E	POOL U GAS RELEASES PERFORMANCE MEASURE ASSESSMENT
APPENDIX F	PEER REVIEW OF POOL U GAS RELEASES ASSESSMENT
APPENDIX G	PEER REVIEW OF ASSESSMENTS AGAINST WATER QUALITY PERFORMANCE MEASURES
APPENDIX H	ASSESSMENT AGAINST WATER QUALITY PERFORMANCE MEASURE
APPENDIX I1	LONGWALLS 20-22 SPRING 2016 VEGETATION MONITORING REPORT
APPENDIX I2	LONGWALLS 23-27 SPRING 2016 VEGETATION MONITORING REPORT
APPENDIX J1	SWAMP 20 AND SWAMP 28 THREATENED FLORA ASSESSMENTS
APPENDIX J2	SWAMP 20, SWAMP 28 AND RIPARIAN VEGETATION THREATENED FAUNA ASSESSMENTS
APPENDIX J3	RIPARIAN VEGETATION AND TRIBUTARY B THREATENED FLORA ASSESSMENTS
APPENDIX J4	TRIBUTARY B THREATENED FAUNA ASSESSMENT
APPENDIX K1	LONGWALLS 20-22 SPRING 2016 AQUATIC ECOLOGY MONITORING REPORT
APPENDIX K2	LONGWALLS 23-27 SPRING 2016 AQUATIC ECOLOGY MONITORING REPORT
APPENDIX L1	LONGWALLS 20-22 SPRING-SUMMER 2016 AMPHIBIAN SURVEY REPORT

APPENDIX L2 LONGWALLS 23-27 SPRING-SUMMER 2016 AMPHIBIAN SURVEY REPORT

APPENDIX L3 LONGWALLS 301-303 SPRING-SUMMER 2015 AMPHIBIAN SURVEY REPORT

APPENDIX L4 LONGWALLS 301-303 SPRING-SUMMER 2016 AMPHIBIAN SURVEY REPORT

APPENDIX M LONGWALLS 23-27 ROUND 4 MONITORING OF ABORIGINAL HERITAGE SITES