METROPOLITAN COAL

SIX MONTHLY REPORT




1 JULY TO 31 DECEMBER 2016

Peabody ENERGY

METROPOLITAN COAL

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1 JULY TO 31 DECEMBER 2016

Project No. MET-08-08
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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).

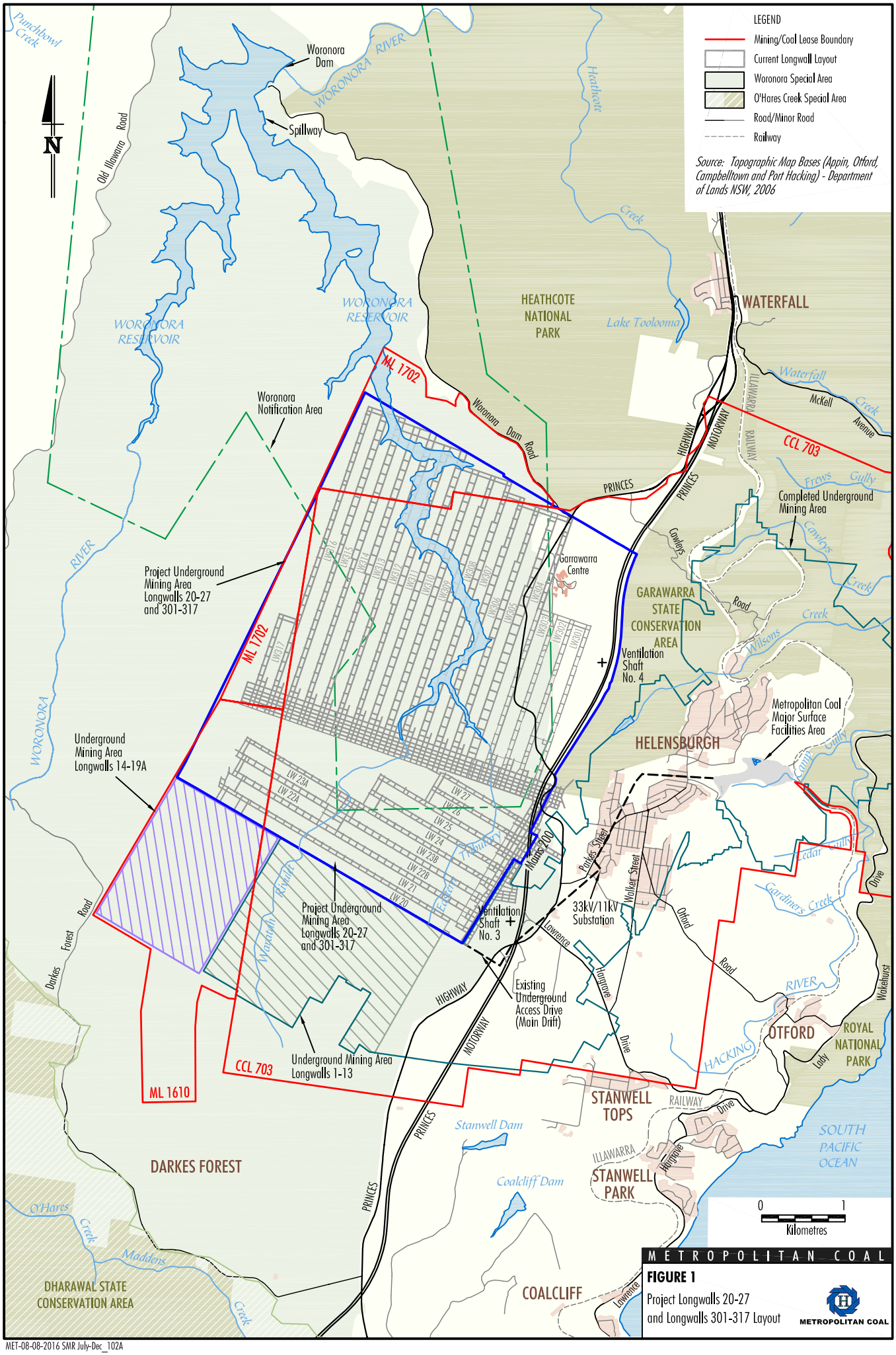
The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1.

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.



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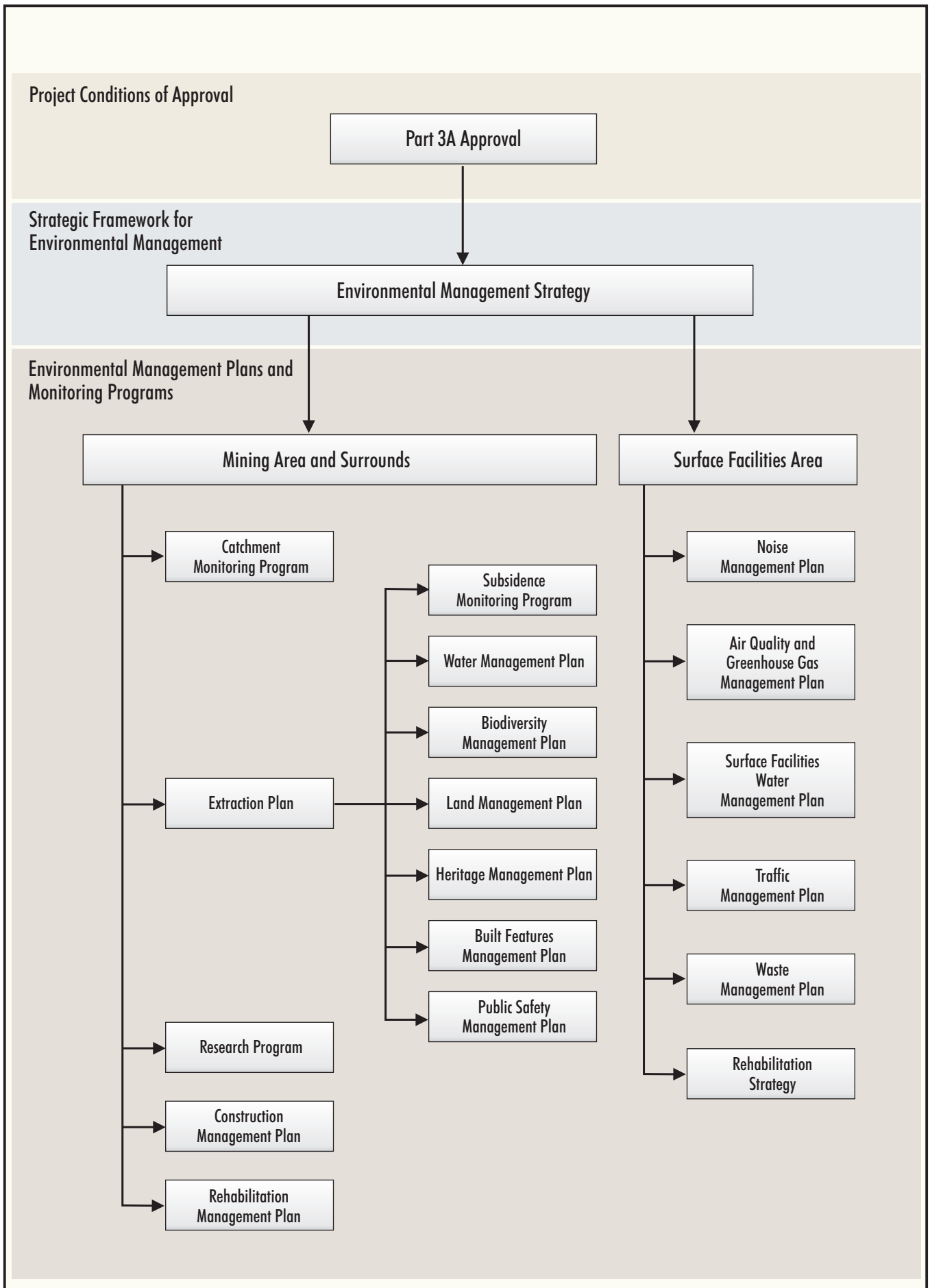

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FIGURE 2
Environmental Management Structure

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This report presents data for the period 1 July to 31 December 2016. The status of longwall development at the end of the reporting period is shown on Figure 3. Longwall 26 extraction commenced in May 2016 and was completed in August 2016. Longwall 27 commenced in September 2016 and continued for the remainder of the reporting period. Longwall 27 will be completed in the next reporting period in March 2017.

2 WATER MANAGMENT

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.

Revisions of the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans were submitted to the DP&E and approved during the reporting period.

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 A and B, respectively. The surface water and groundwater monitoring locations are shown on Figures 4 to 7.

2.1 STREAM FEATURES

Visual and photographic surveys are conducted monthly when mining is 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 are also conducted within three months of the completion of each longwall.

The visual and photographic surveys conducted within three months of the completion of each longwall provide a detailed photographic record of stream features. A detailed photographic record of the Waratah Rivulet, Eastern Tributary, Tributary A and Tributary B was conducted within three months of Longwall 26 completion.

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 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 C.

In October 2016, the negligible environmental consequences performance measure for the Eastern Tributary was exceeded in relation to iron staining (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).* Subsequent to the reporting period, the diversion of flows and drainage behaviour component of the same performance measure was also exceeded. A description of the Eastern Tributary Incident is provided in Section 2.12.

The visual and photographic surveys also noted minor scouring along streams with alluvial deposits, as a result of high water flows following a heavy rainfall event in June 2016.

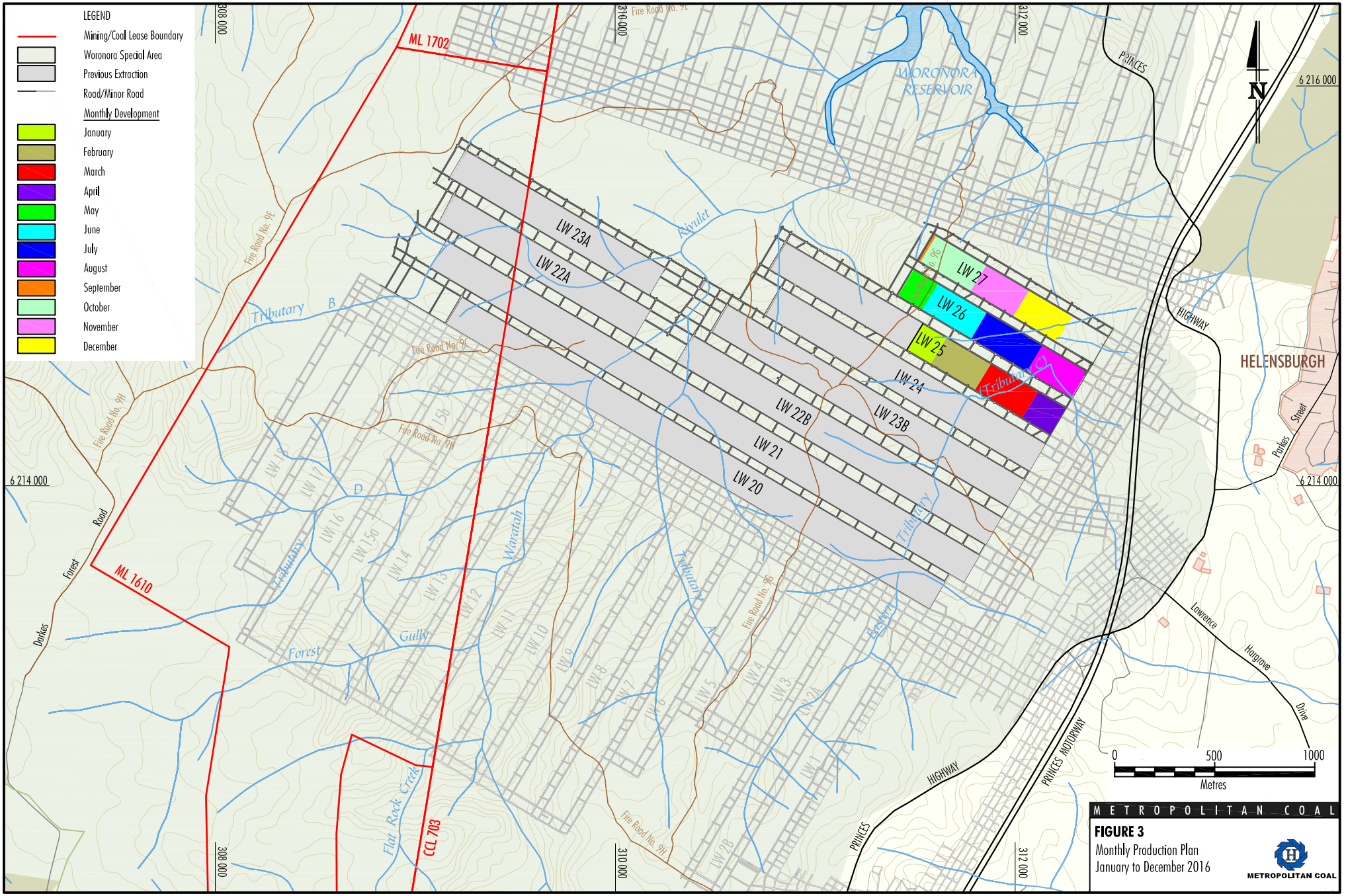

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FIGURE 3

Monthly Production Plan
January to December 2016

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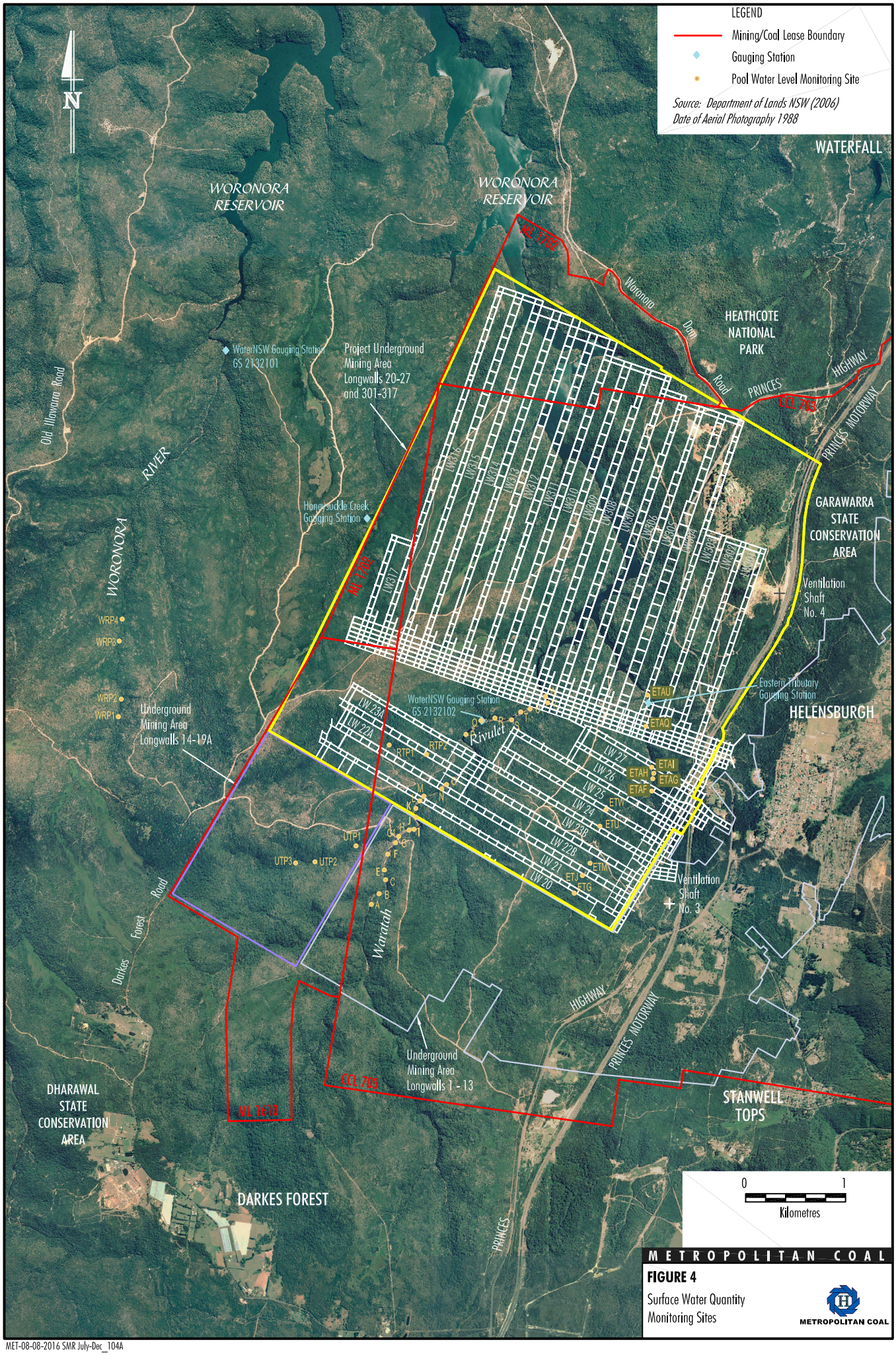

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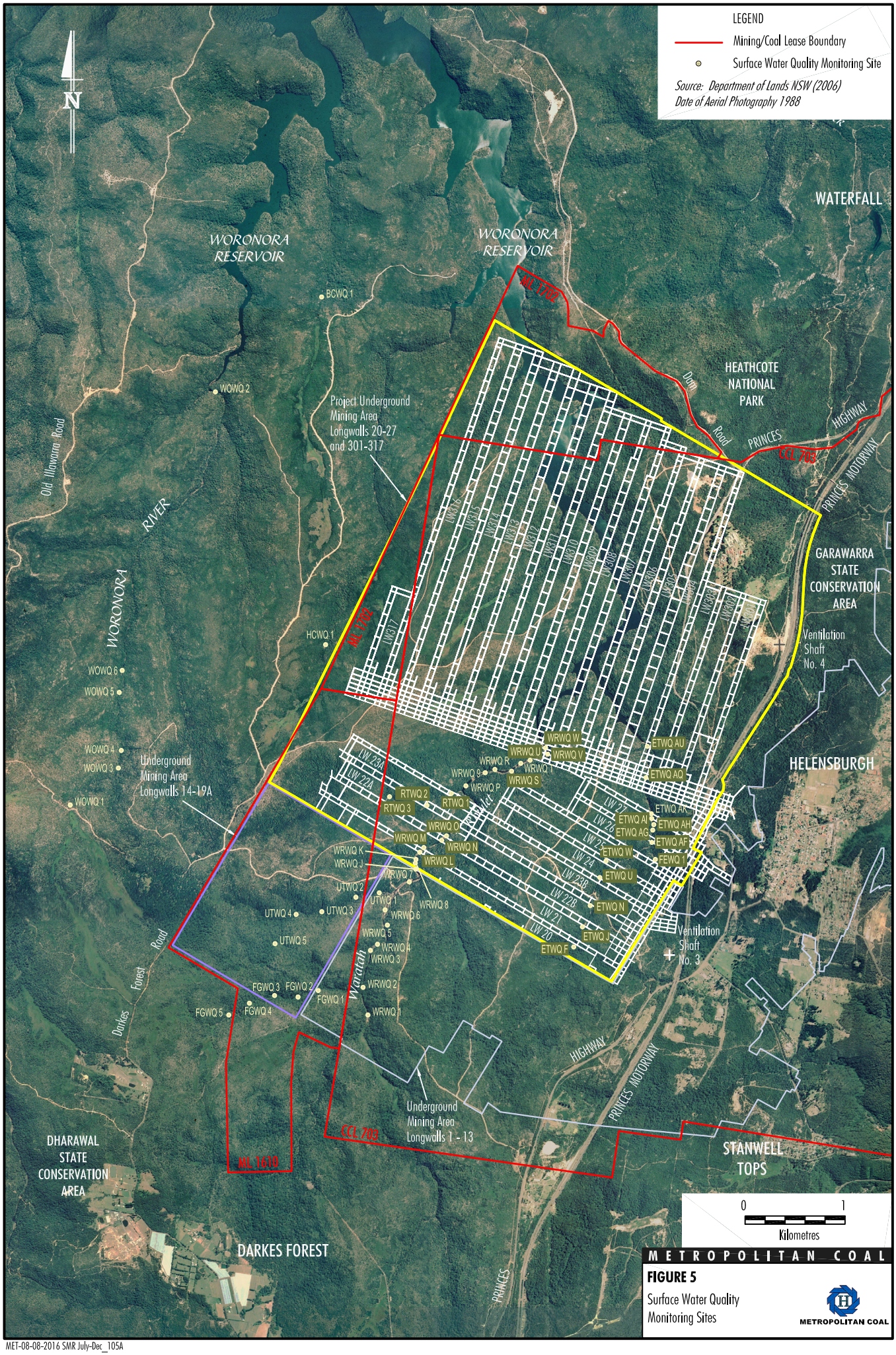

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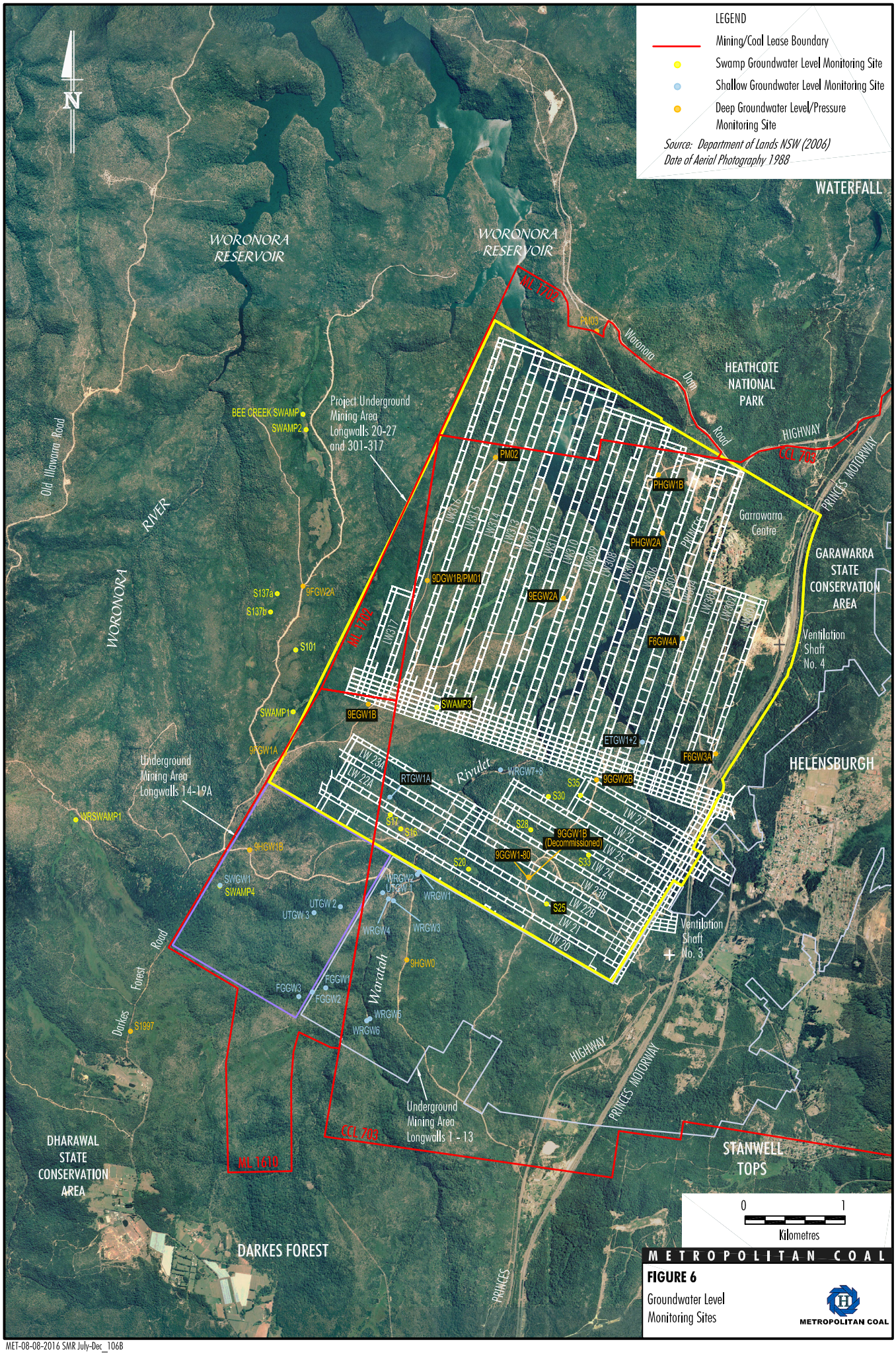

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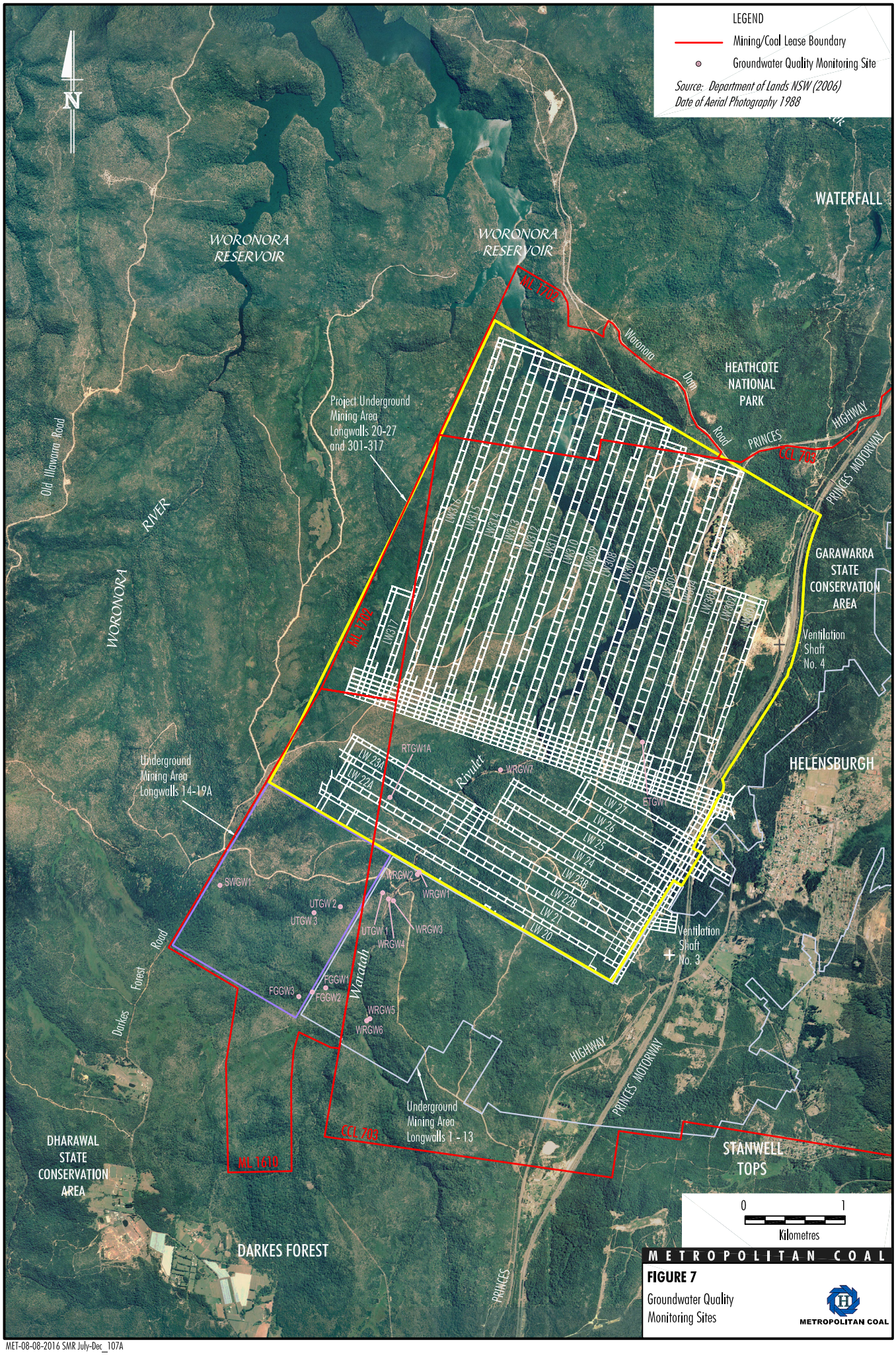

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Table 1
Monitoring of Stream Features
Waratah Rivulet, Upstream of the Longwall 23 Maingate (upstream of Pool P)

Stream Feature	Summary of Observations
Surface Cracking	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 May 2016 inspection (following the completion of Longwall 25), a reduction in surface flow/pool water levels was noted along the Waratah Rivulet in October 2016 (following the completion of Longwall 26) 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 4 and Appendix C). The monitoring results are discussed in Section 2.3 and Appendix A.
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 (July to December 2016). 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 May 2016 inspection (following the completion of Longwall 25), a reduction in surface flow/pool water levels was noted along the Waratah Rivulet in October 2016 (following the completion of Longwall 26) 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 4 and Appendix C). The monitoring results are discussed in Section 2.3 and Appendix A.
Iron Staining/ Flocculent	No change in iron staining 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 (July to December 2016). Gas releases were observed for the first time in Pool U (August to December 2016) and in Pool W (October 2016) 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,* was exceeded for Pools U and W.

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

Stream Feature	Summary of Observations
Gas Releases (continued)	The exceedances 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 (The University of Queensland, 2017) and concluded the performance measure in relation to gas releases had been met (The University of Queensland, 2017). The assessment is provided in Appendix D. 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 E. 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	From July to December 2016, additional cracking was observed at Pool ETN, Pool ETO and rock bar ETZ, and cracking was observed for the first time at boulderfield ETX, rock bar ETY and rock bar ETAD (location of stream features shown in Appendix C).
Surface Flow/ Pool Water Levels	A number of pools were observed to be dry on occasions upstream of the Longwall 26 maingate on the Eastern Tributary (in particular, in November/December 2016). At the time of the October 2016 visual inspection (following the completion of Longwall 26), many of the pools contained water, however, Pools ETL, ETM and ETZ were noted to be dry (location of pools shown in Appendix C). 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 4). The monitoring results are discussed in Section 2.3 and in Appendix A.
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. In particular, iron staining was observed to increase over the reporting period in the reach from Pool ETU to Pool ETAF (locations of pools shown in Appendix C).
Gas Releases	No gas releases have been observed on the Eastern Tributary upstream of the Longwall 26 maingate.
Water Discoloration/ Opacity	Orange in colour where iron staining occurred. Pools along the Eastern Tributary observed with a green opacity.

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

Stream Feature	Summary of Observations
Surface Cracking	Cracking downstream of maingate 26 was observed from September to December 2016 on pool and rock bar ETAH, on rock bars ETAN and ETAO, and in pool ETAM (location of stream features shown in Appendix C). As at 17 January 2017, cracking of stream features had been recorded from Pool ETAH downstream to rock bar ETAQ (location of stream features shown in Appendix C).
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. Prior to the reporting period, there were no observed changes in the natural drainage behaviour of pools. 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 C). [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 is provided in Section 2.12. 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 4 and Appendix C). The monitoring results are discussed in Section 2.3 and in Appendix A.
Iron Staining/ Flocculent	Iron staining/flocculent progressively increased on the Eastern Tributary downstream of the Longwall 26 maingate over the reporting period. 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 is provided in Section 2.12.
Gas Releases	No gas releases were observed on the Eastern Tributary from July to December 2016.
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	On Tributary A, some additional surface cracks were recorded by the visual inspections and photographic mapping. The cracking observed did not appear to be recent (i.e. likely to have occurred prior to 2016). Some of the cracking was not previously evident due to higher pool water levels. Cracking on Tributary A is documented in the end of longwall stream mapping.
Surface Flow/ Pool Water Levels	Compared to the December 2015 inspection (following the completion of Longwall 24), a reduction in surface flow/pool water levels was noted along Tributary A in May 2016 (following the completion of Longwall 25) and in October 2016 (following the completion of Longwall 26). No surface flow was observed (i.e. standing water was present) at a number of locations including at Pools TA-F, TA-G, TA-J, TA-K and TA-O and at the rock bars and/or boulderfields downstream of Pools TA-J and TA-O (location of pools shown in Appendix C). In addition to reduced surface flow, some locations were noted to be dry, including Pools TA-I and TA-L and the boulderfield downstream of Pool TA-I (location of pools shown in Appendix C).
Iron Staining/ Flocculent	Iron staining/flocculent continued to be present in sections of Tributary A, in particular at the boulderfields downstream of Pools TA-H and TA-R (location of pools shown in Appendix C).
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	On Tributary B, new cracking was observed on the rock bar of Pool TB-AL during the reporting period (by the end of Longwall 26 stream mapping) (location of Pool TB-AL shown in Appendix C). Surface cracking observed on Tributary B is documented in the end of longwall stream mapping.
Surface Flow/ Pool Water Levels	At the time of the end of Longwall 26 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 C). Water levels in pools on Tributary B (at water level sites RTP1 and RTP2, Figure 4) have been monitored using a continuous water level sensor and logger. The monitoring results are discussed in Section 2.3 and in Appendix A.
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.

2.2 SURFACE WATER FLOW

Waratah Rivulet stream flow data (GS 2132102, Figure 4) 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 1 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 4) and O'Hares Creek gauging stations indicates there has been a negligible reduction in the quantity of water resources reaching the Woronora Reservoir.

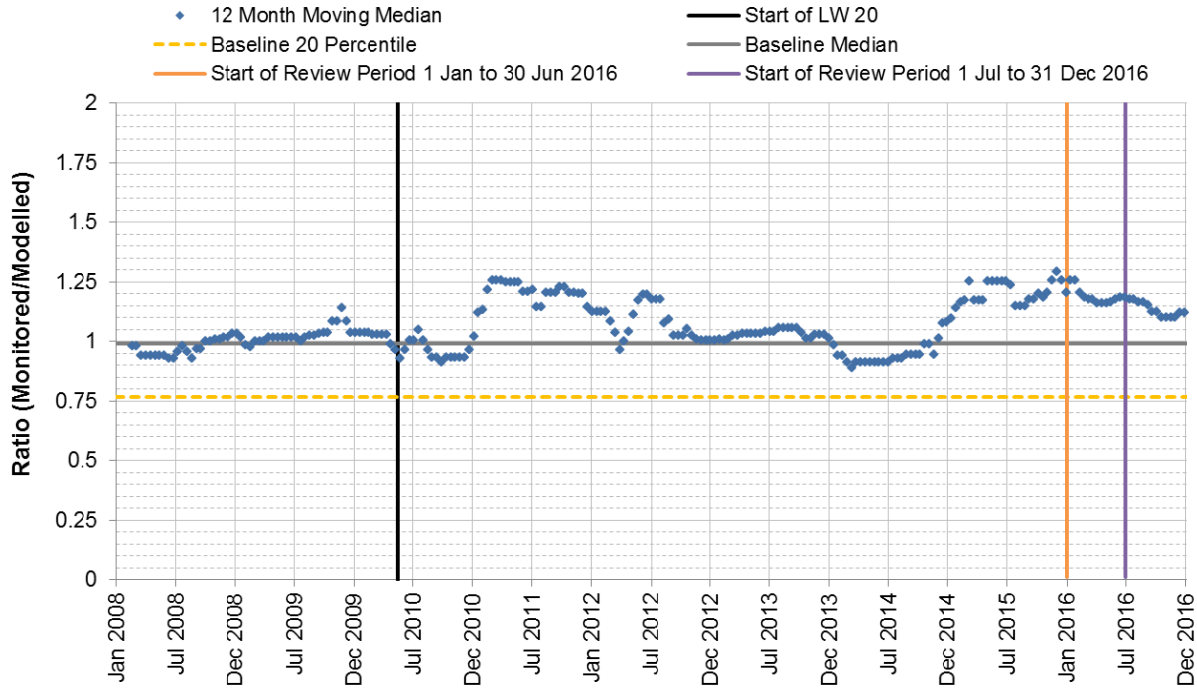


Chart 1 One Year Sliding Median for the Ratios of the 14 Day Sums of Monitored and Modelled Flow Rates at Waratah Rivulet (GS 2132102)

Analysis of Eastern Tributary stream flow data (GS 300078, Figure 4) for the reporting period indicates that flows reaching the Woronora Reservoir have not been affected by mining (Chart 2). Chart 2 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 A).

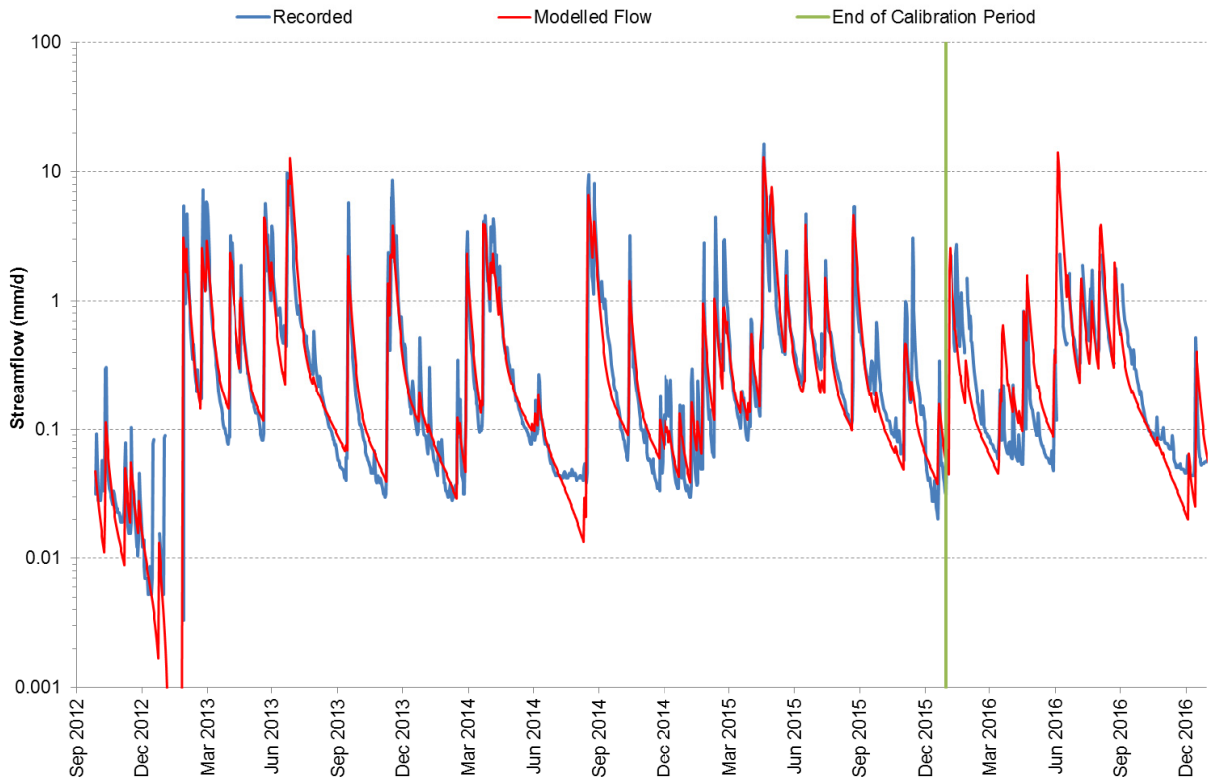


Chart 2 Monitored and Model Predicted flows – Eastern Tributary Upstream of Woronora Reservoir

2.3 POOL WATER LEVELS

The water level in a number of pools on the Waratah Rivulet, Eastern Tributary, Tributary B and Woronora River (Figure 4) 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[2]. Pool A water levels fell to or below the pool's cease to flow level for the period 24 November to 31 December 2016 (Figure 4, Chart 3). Metropolitan Coal's visual inspections indicate Pool A ceased overflowing on most occasions it was inspected during December 2016. To date, 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.

2 As indicated in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2016, the water level in Pool P on the Waratah Rivulet fell below historically recorded water levels during the previous reporting period, however analysis of recession rates and the shape of the water level hydrograph indicate pool water levels were consistent with natural behaviour (Appendix A). Metropolitan Coal's visual inspections indicate Pool P water levels appeared consistent with natural behaviour on all inspection occasions. It appears there has been a change in the datum levels associated with a change in water level logger housing (Appendix A).

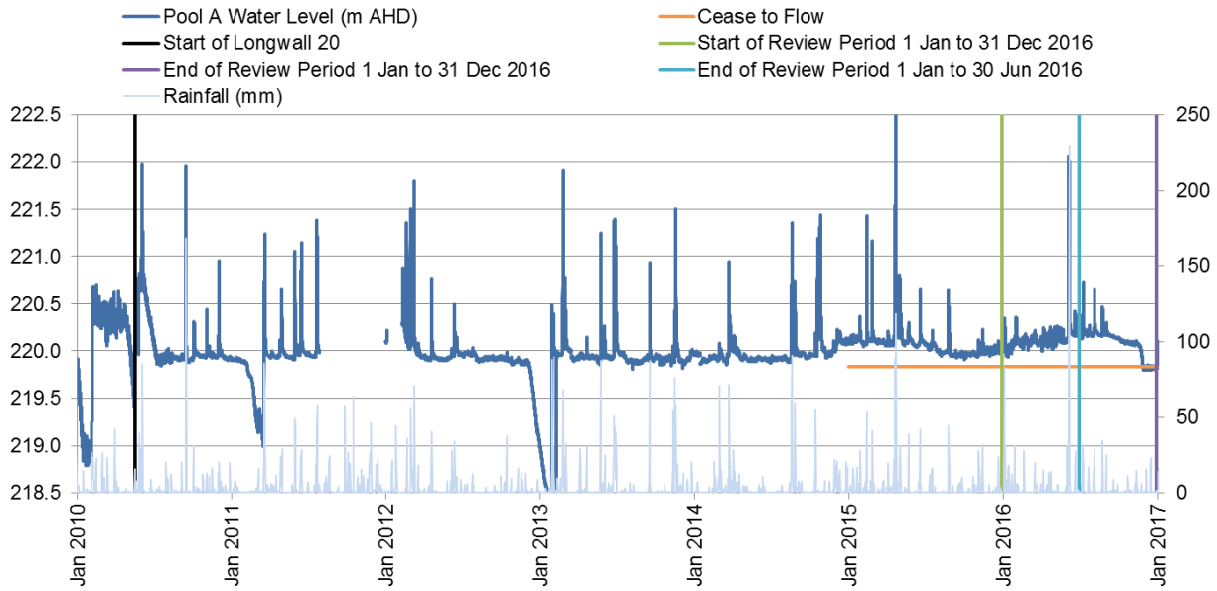


Chart 3 Pool A Waratah Rivulet

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 4). Pools ETG, ETJ, ETM, ETU, ETW, 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 4 to 11, 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. Pools ETAF and ETAU water levels were consistent with natural behaviour during the reporting period (Appendix A).

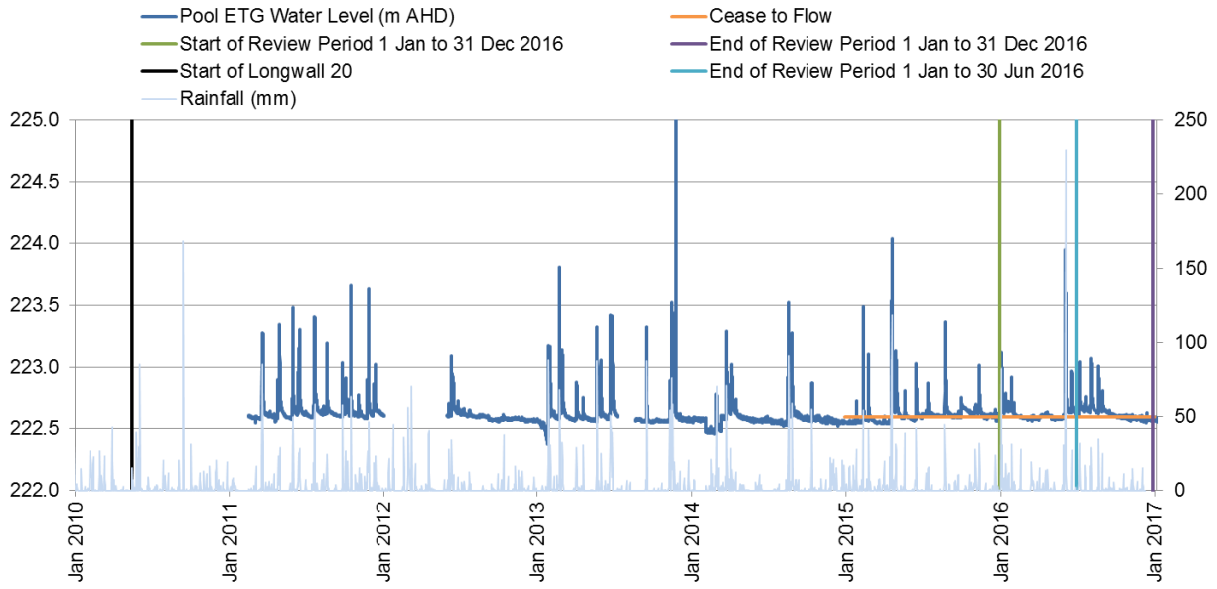


Chart 4 Pool ETG Eastern Tributary

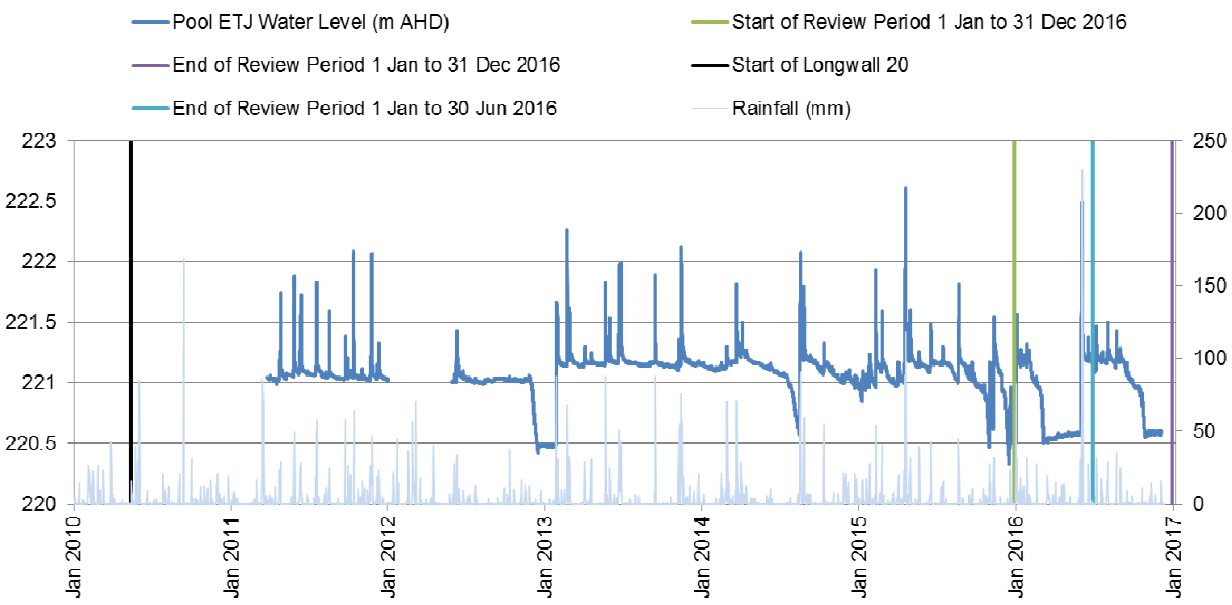


Chart 5 Pool ETJ Eastern Tributary

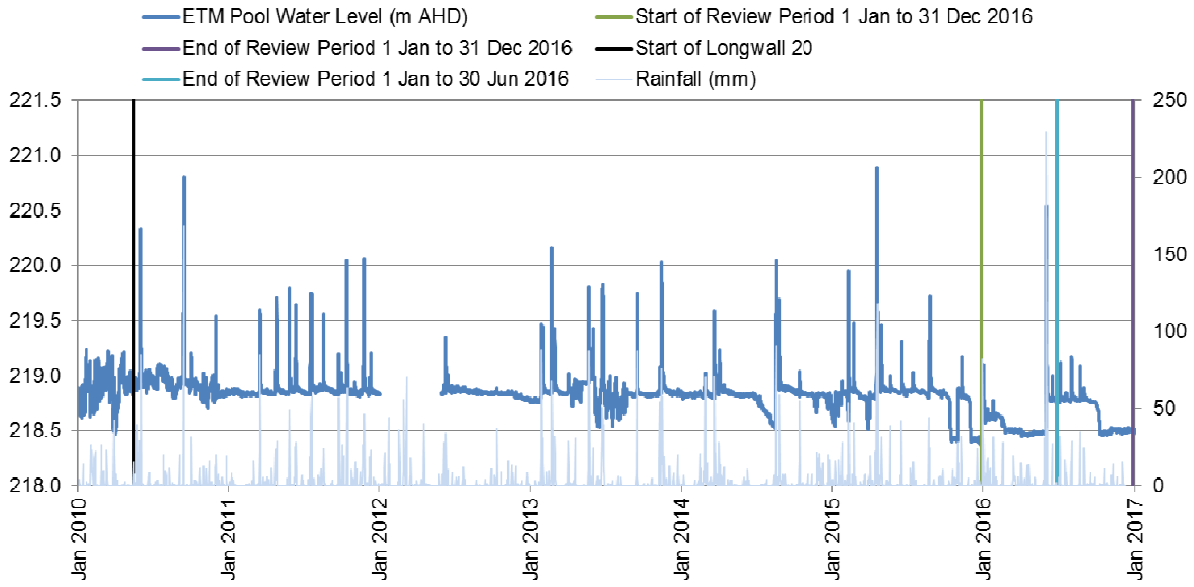


Chart 6 Pool ETM Eastern Tributary

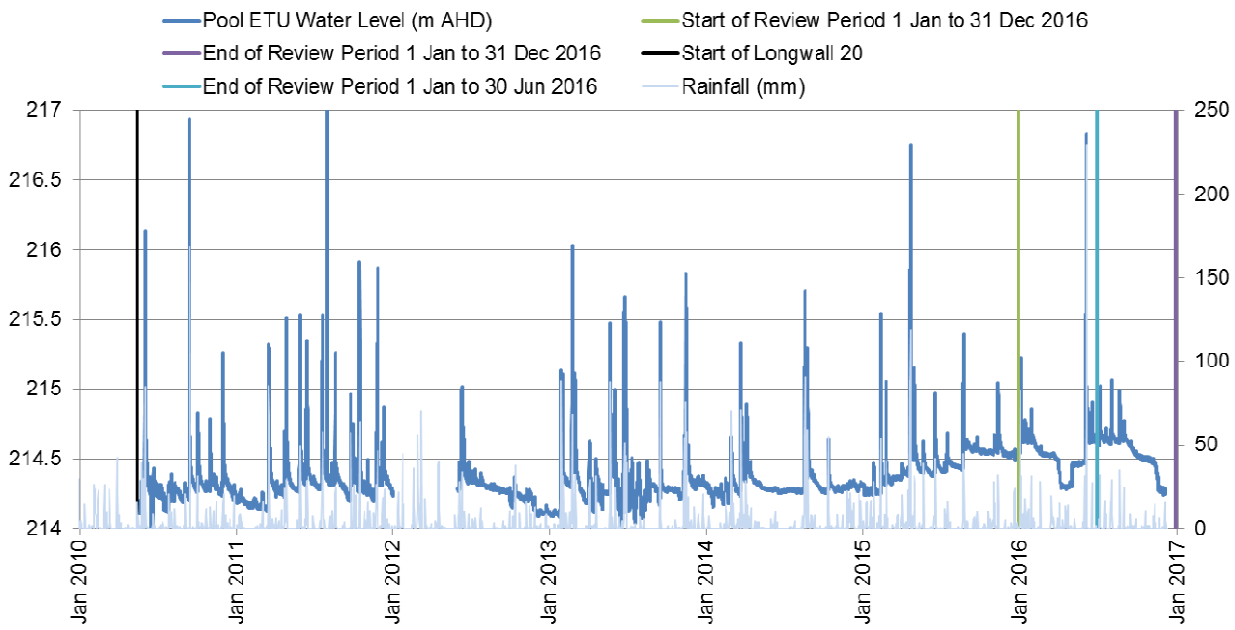


Chart 7 Pool ETU Eastern Tributary

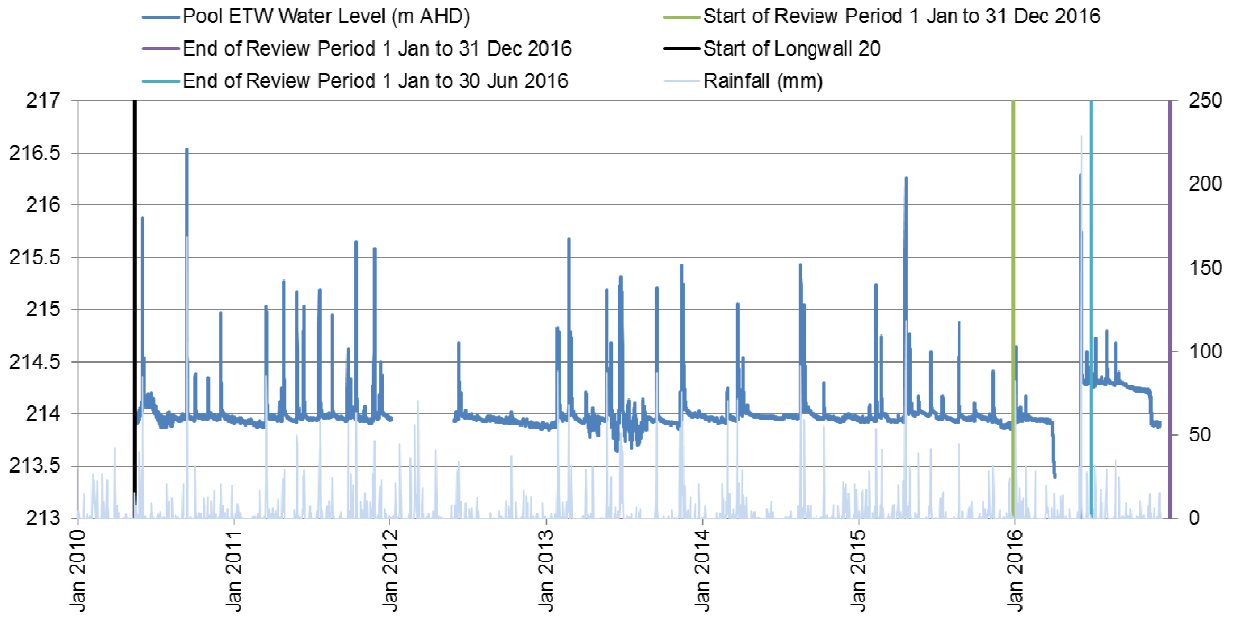


Chart 8 Pool ETW[3] Eastern Tributary

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

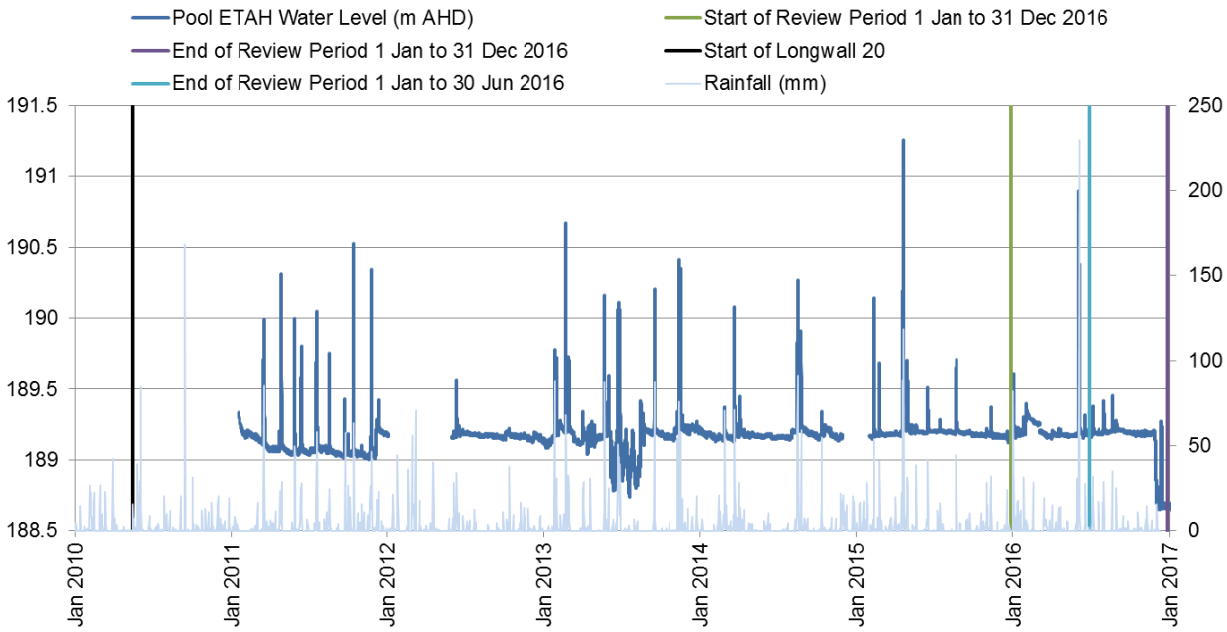


Chart 9 Pool ETAH Eastern Tributary

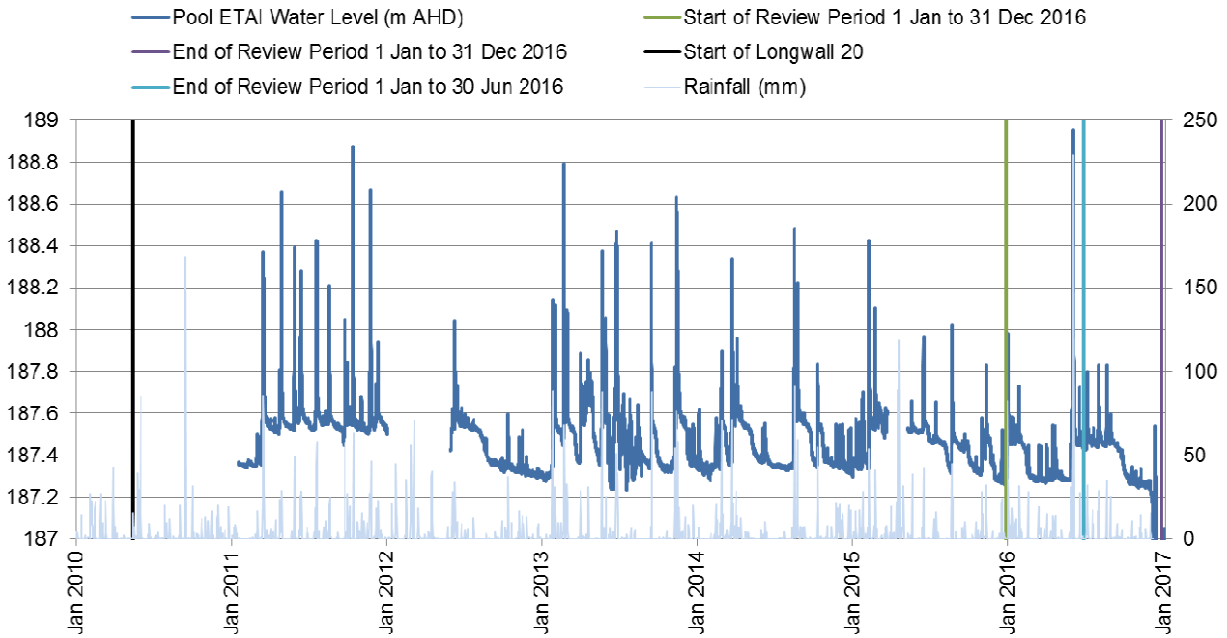


Chart 10 Pool ETAI Eastern Tributary

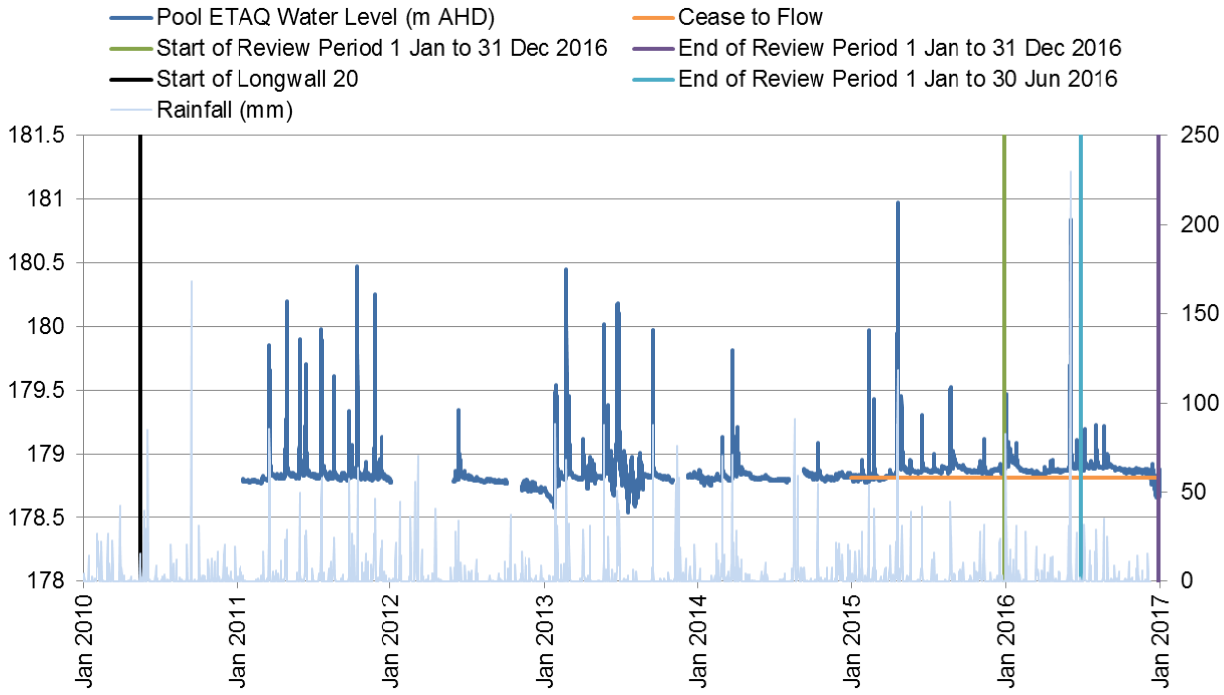


Chart 11 Pool ETAQ Eastern Tributary

Pool RTP1 on Tributary B remains typically dry with overflow events limited to significant, wet periods (Appendix A). 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 12). Metropolitan Coal's visual inspections indicate Pool RTP2 has generally been flowing during inspections.

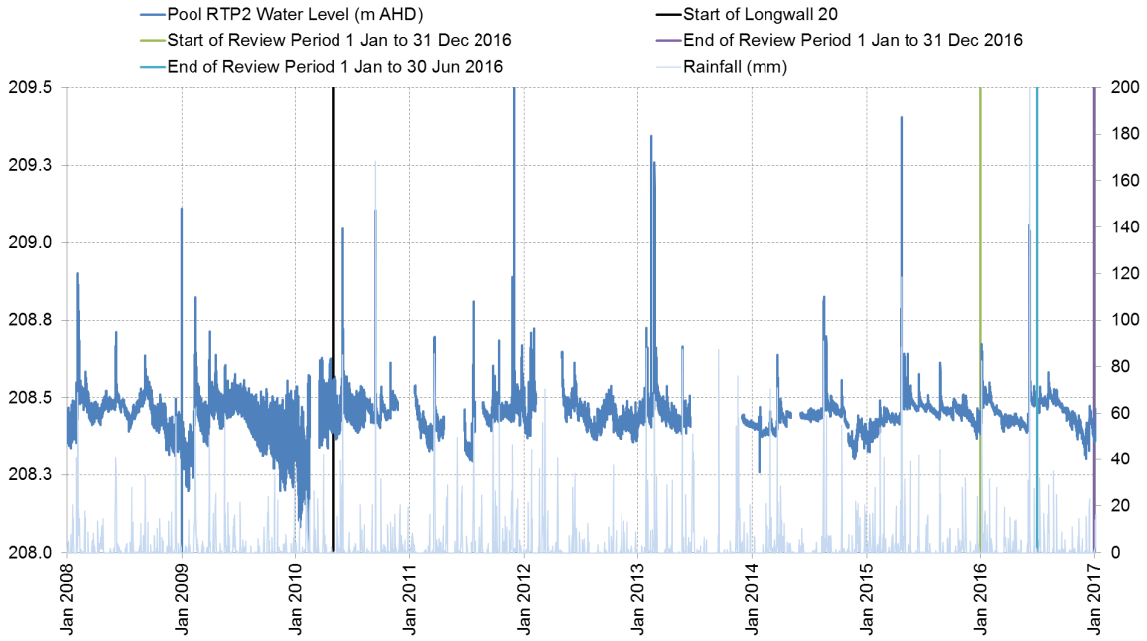


Chart 12 Pool RTP2 Tributary B

2.4 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 23-27 Water Management Plans (Figure 5).

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.

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 A) and shown on Charts 13 to 39.

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 13 to 22)	• 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.	• Some higher concentrations recorded in January 2016 (e.g. 383 µS/cm at WRWQW; 361 µS/cm at WRWQP; 346 µS/cm at WRWQT and 353 µS/cm at WRWQ9). • Spikes were also recorded at WRWQ6 in February 2016 (570 µS/cm) and at WRWQ2 in December 2016 (322 µS/cm). • Concentrations were otherwise generally low and consistent with earlier values.	• Typically low (below 0.5 mg/L) during the reporting period. • Slightly higher concentrations were recorded at some upper and middle reach sites (up to 0.7 mg/L) and at some lower reach sites (up to 0.84 mg/L) in mid 2016.	• Relatively low at upper and middle reach sites during the reporting period. Elevated concentrations were recorded at WRWQ6 in March 2016 (0.24 mg/L) and December 2016 (0.35 mg/L). • Slightly elevated values were recorded at two downstream sites (WRWQP, 0.148 mg/L and WRWQ9, 0.134 mg/L) in March 2016.	• A spike in concentration was recorded in January 2016 at WRWQ2 (0.16 mg/L) and WRWQ6 (0.12 mg/L). • An elevated value was also recorded at WRWQW (0.19 mg/L) in June 2016.
Woronora River (sites WOWQ1 and WOWQ2, control stream) (Charts 23 to 28)	• High variability in pH, typically slightly acidic.	• Elevated concentrations recorded at WOWQ1 and WOWQ2 in January (308 µS/cm and 316 µS/cm, respectively) and March 2016 (318 µS/cm and 671 µS/cm, respectively).	• Generally low and similar to values recorded in Waratah Rivulet.	• Typically low concentrations.	• Typically low concentrations.

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) (Charts 29 to 34)	• Variable but typically near neutral pH values.	• Some elevated concentrations, with the highest concentration of 410 µS/cm recorded at ETWQF in November 2016.	• Concentrations generally increased over the second half of 2016, particularly at ETWQAQ (6.99 mg/L and 6.47 mg/L in November and December 2016, respectively). • Lesser, but elevated values of 3.38 mg/L and 2.31 mg/L recorded at ETWQJ and ETWQAF in November and December 2016, respectively. • Elevated concentrations in mid to late 2016 corresponded with a period of low flow and mine subsidence impacts to a number of pools.	• Concentrations increased in 2016, with elevated concentrations recorded at a number of sites. • The elevated manganese concentrations from mid to late 2016 corresponded with a period of low flow and mine subsidence impacts to a number of pools. • The highest concentrations recorded (in order of upstream to downstream) were: – 0.508 mg/L at ETWQU in May 2016; – 0.304 mg/L at ETWQW in March 2016; – 0.269 mg/L at ETWQAH in October 2016; – 0.63 mg/L at ETWQAF in December 2016; – 0.727 mg/L at ETWQAQ in November 2016; and – 0.394 mg/L at ETWQAU in December 2016.	• Typically low concentrations.
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 35 to 39)	• Bee Creek and Honeysuckle Creek - variable to slightly acidic pH levels. • Far Eastern Tributary, Tributary B and Tributary D - near neutral pH levels.	• Generally low, with the exception of Tributary B. • Tributary B - variable and periodically elevated since late 2013; this trend has continued. • A higher value was recorded at BCWQ1 in January 2016 (365 µS/cm).	• Generally low and consistent with or lower than historical values, with the exception of UTWQ1 in August 2016 (1.88 mg/L).	• Generally low concentrations.	• 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 most of the reporting period. • Highest concentration at Bee Creek in March 2016 (0.51 mg/L).

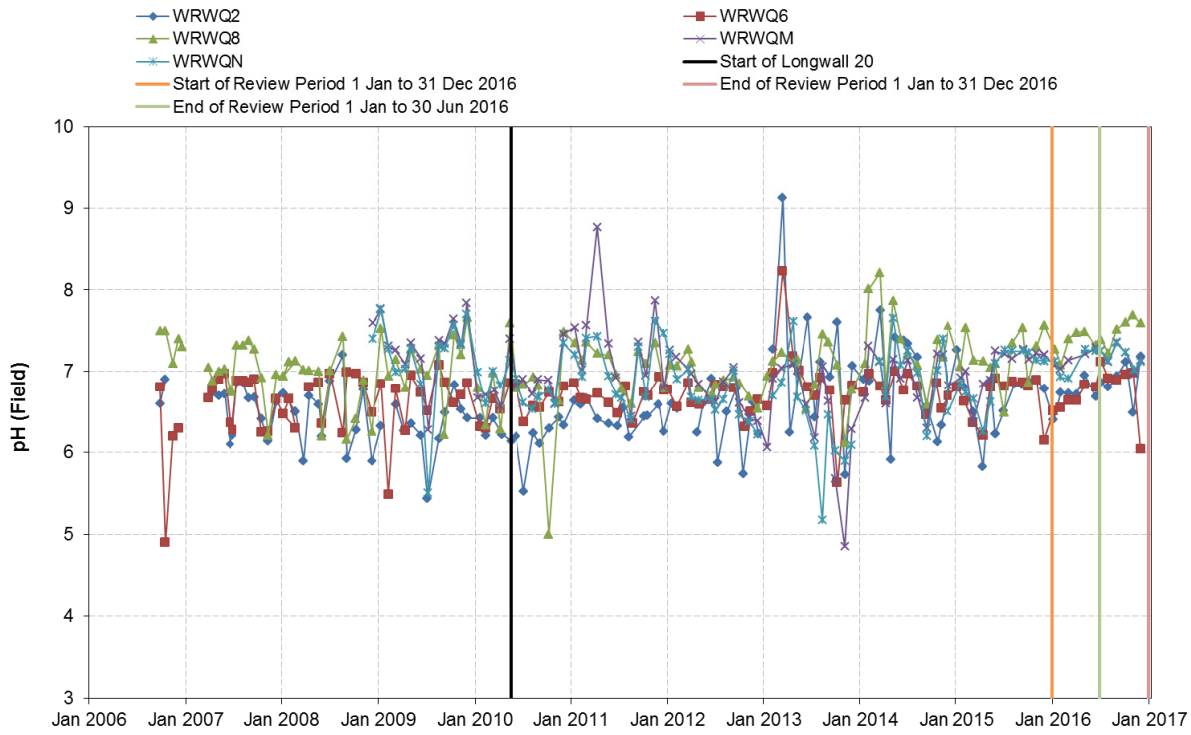


Chart 13 pH Levels Waratah Rivulet – Upper to Middle Reach Sites

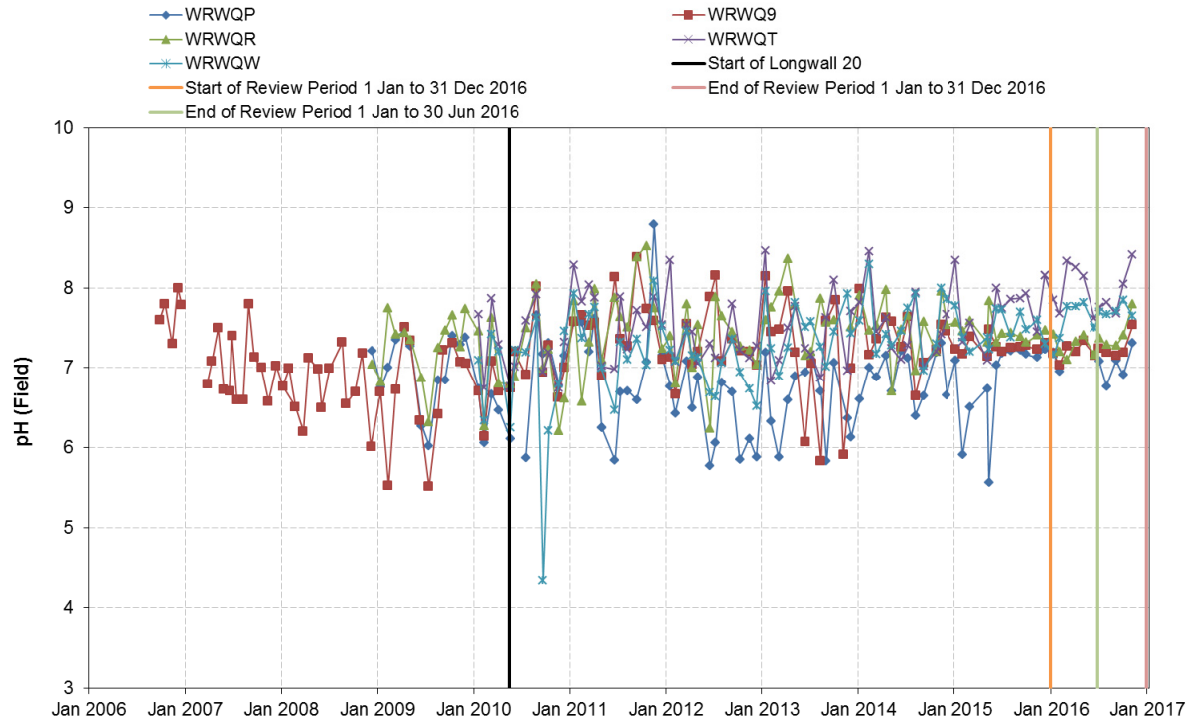


Chart 14 pH Levels Waratah Rivulet – Lower Reach Sites

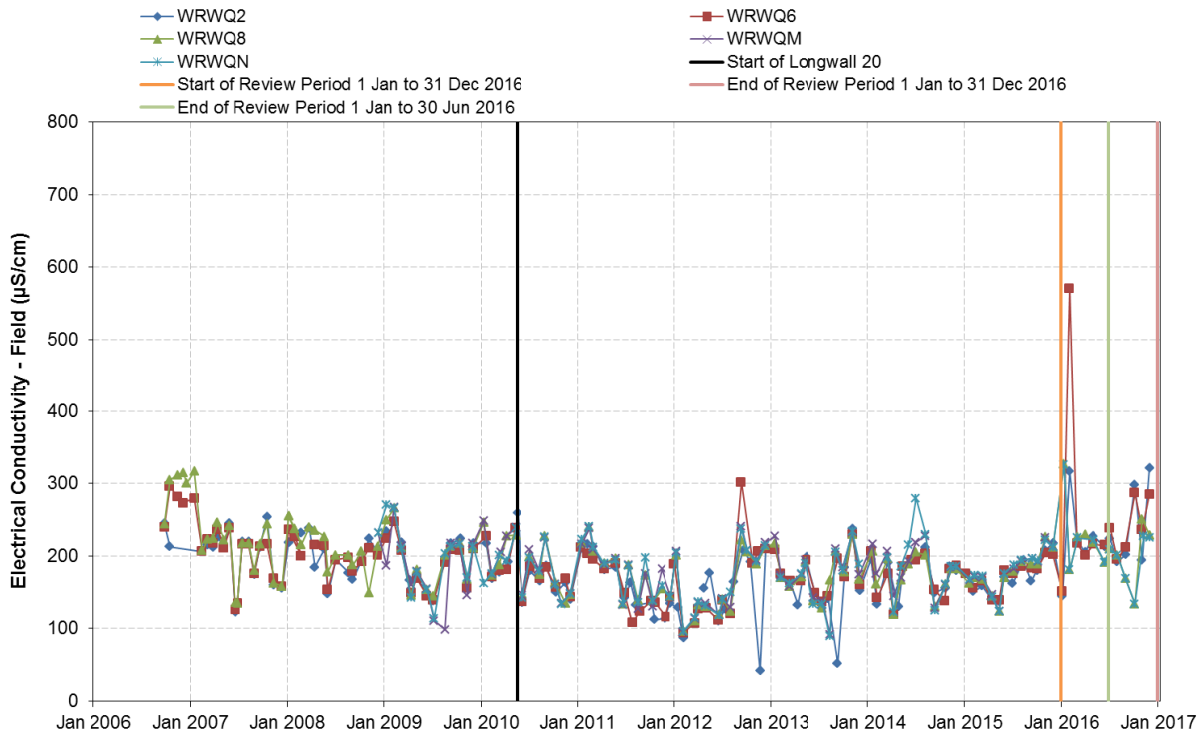


Chart 15 Electrical Conductivity (EC) Waratah Rivulet – Upper to Middle Reach Sites

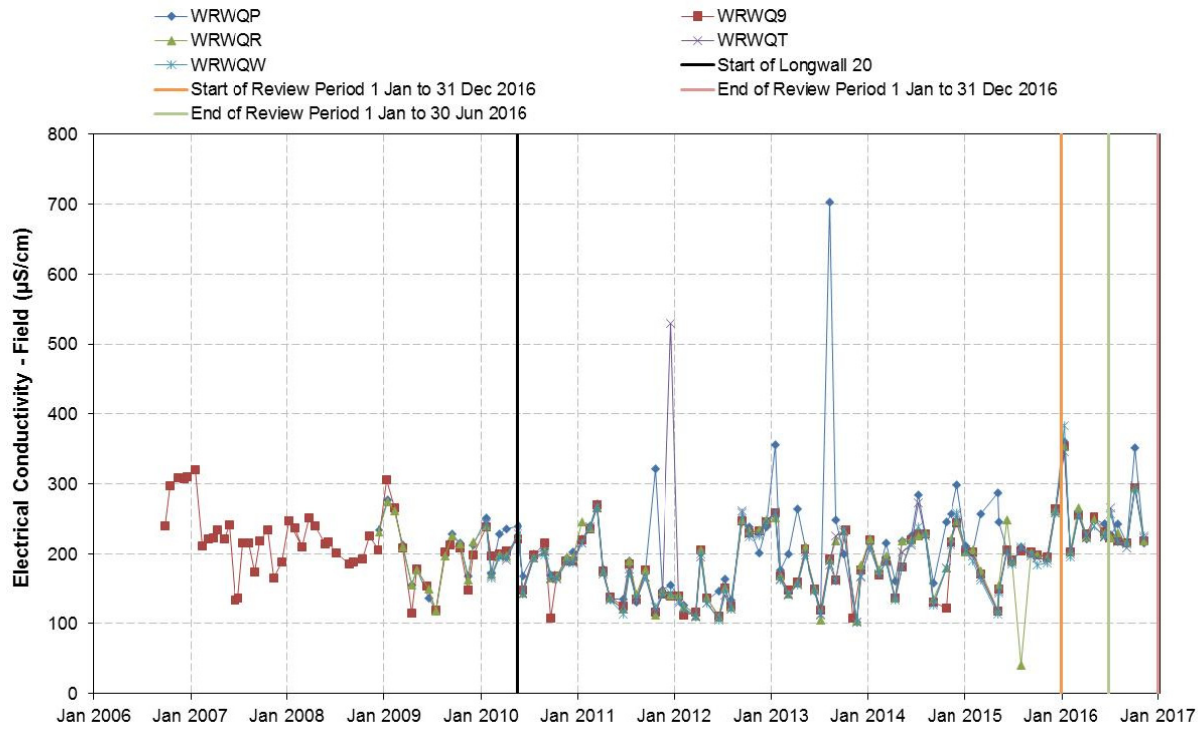


Chart 16 Electrical Conductivity (EC) Waratah Rivulet – Lower Reach Sites

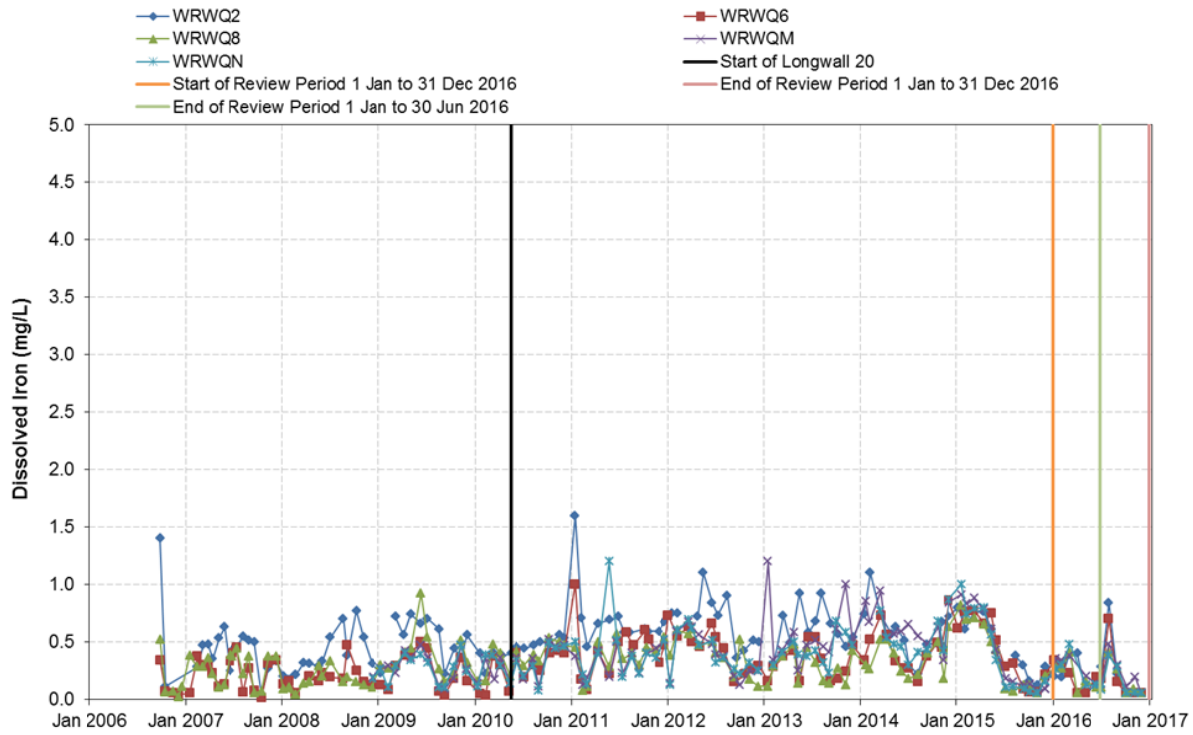


Chart 17 Dissolved Iron Waratah Rivulet – Upper and Middle Reach Sites

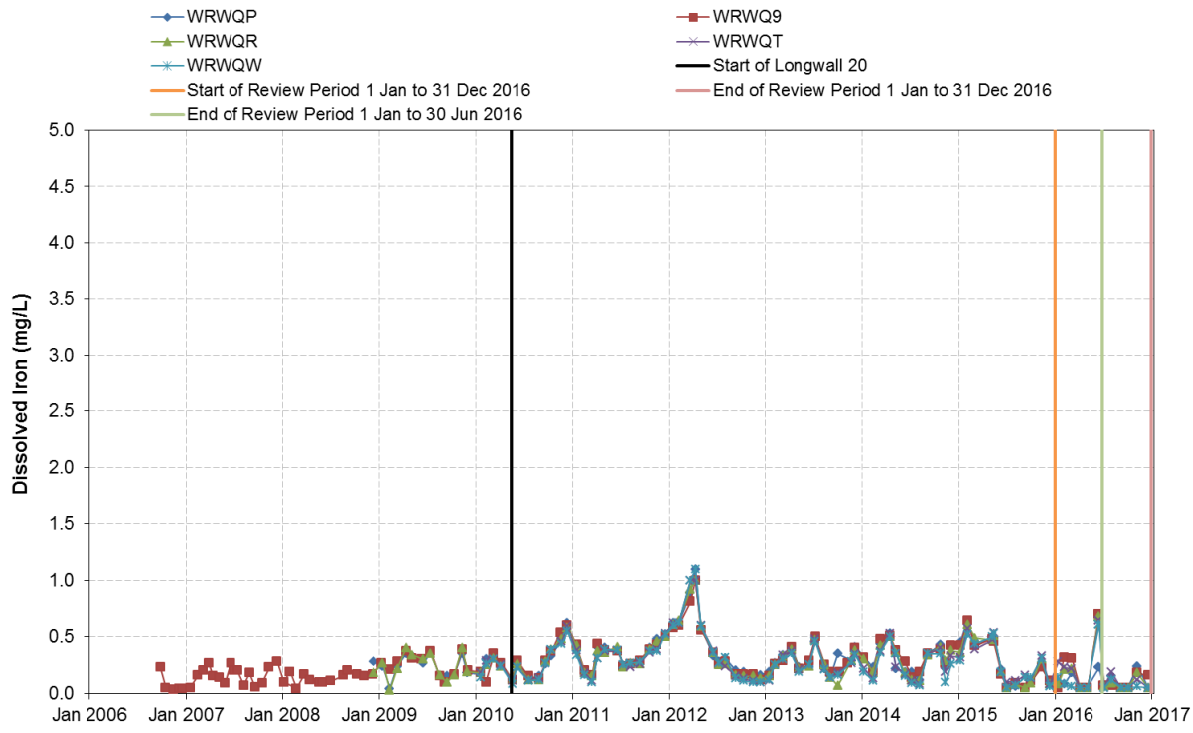


Chart 18 Dissolved Iron Waratah Rivulet – Lower Reach Sites

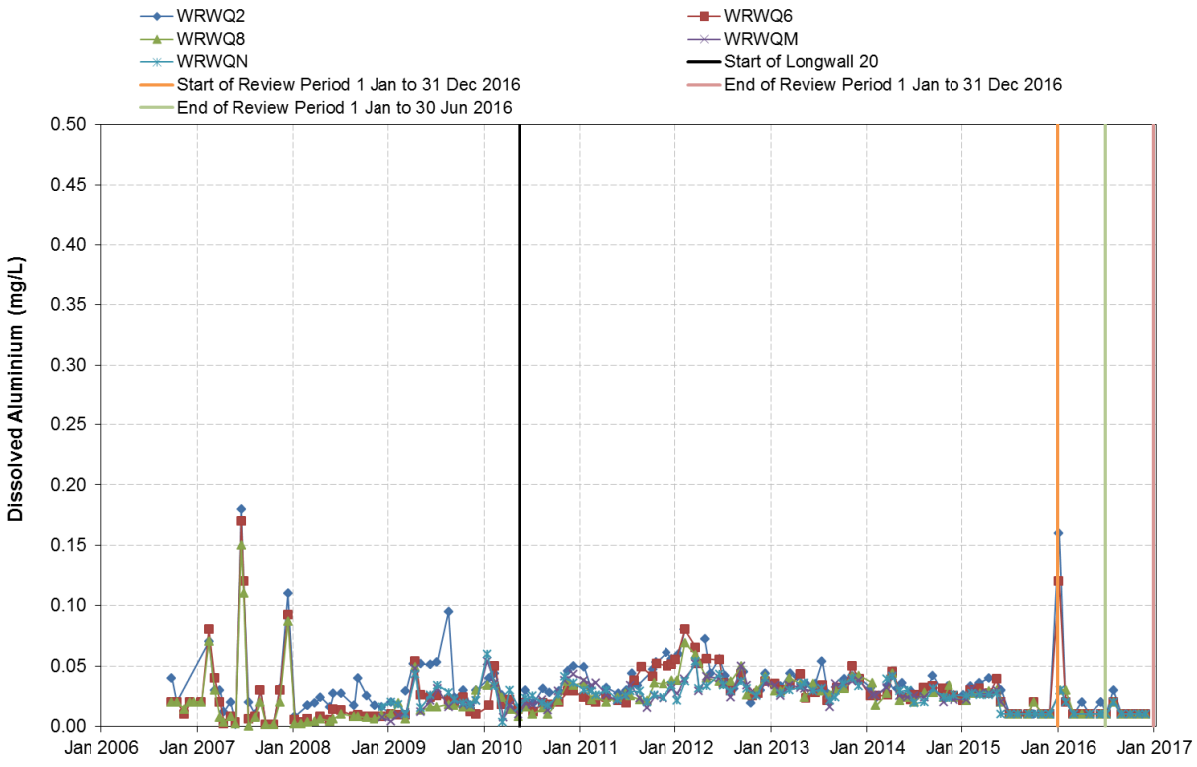


Chart 19 Dissolved Aluminium Waratah Rivulet – Upper to Middle Reach Sites

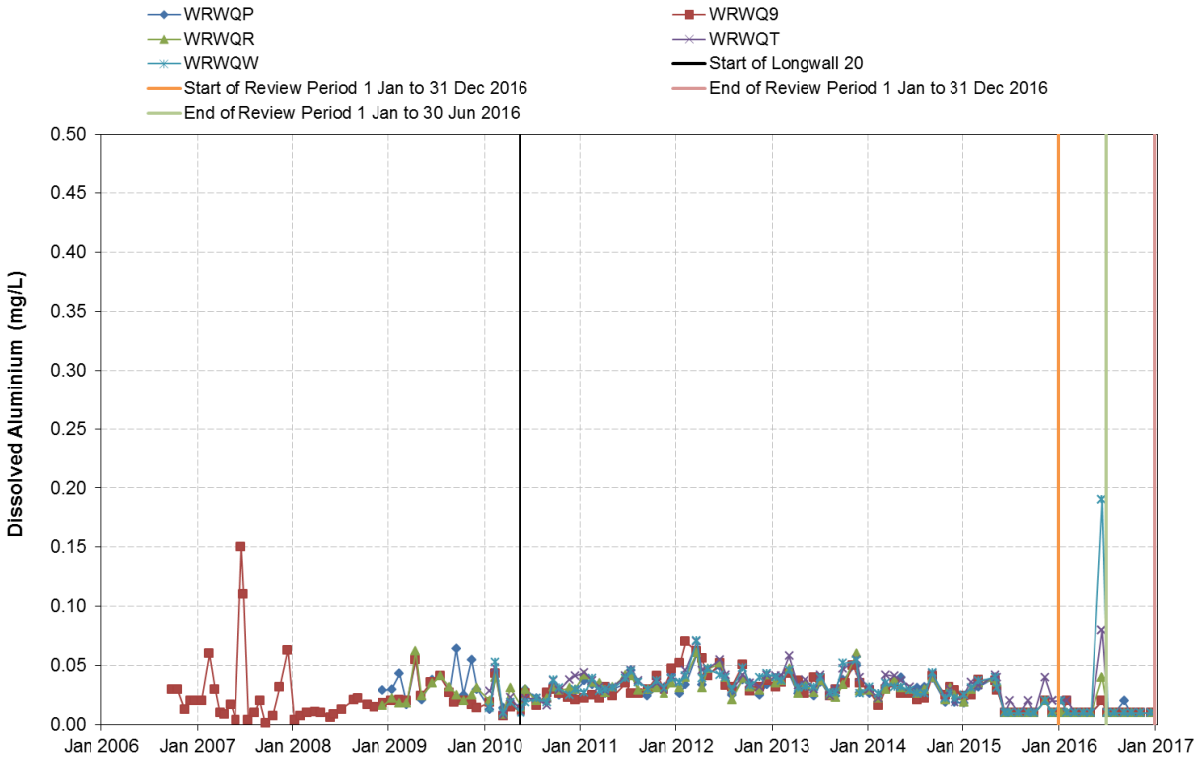


Chart 20 Dissolved Aluminium Waratah Rivulet – Lower Reach Sites

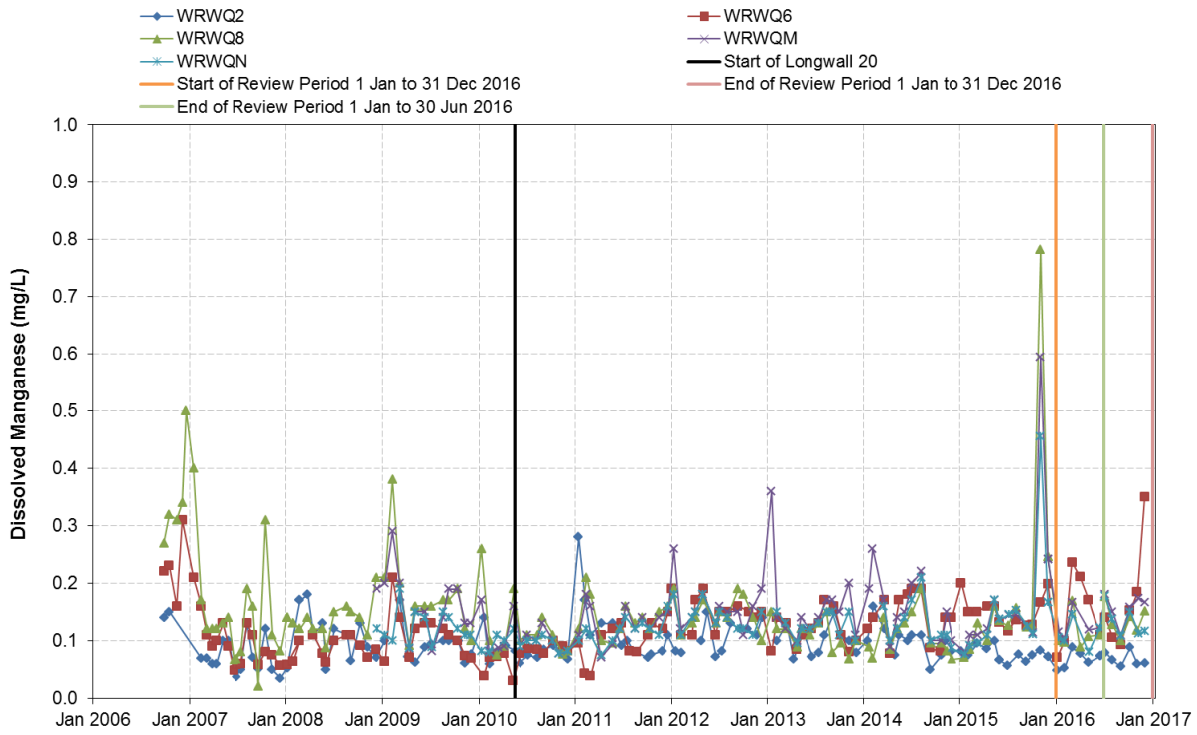


Chart 21 Dissolved Manganese Waratah Rivulet – Upper to Middle Reach Sites

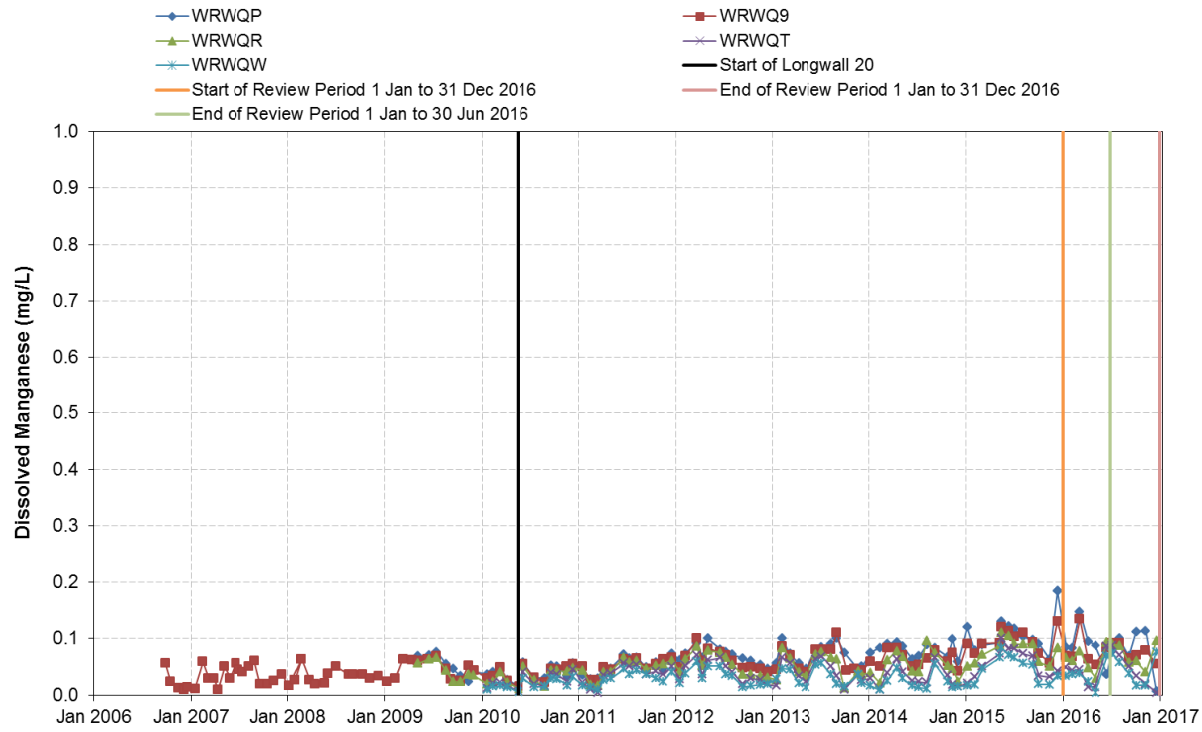


Chart 22 Dissolved Manganese Waratah Rivulet – Lower Reach Sites

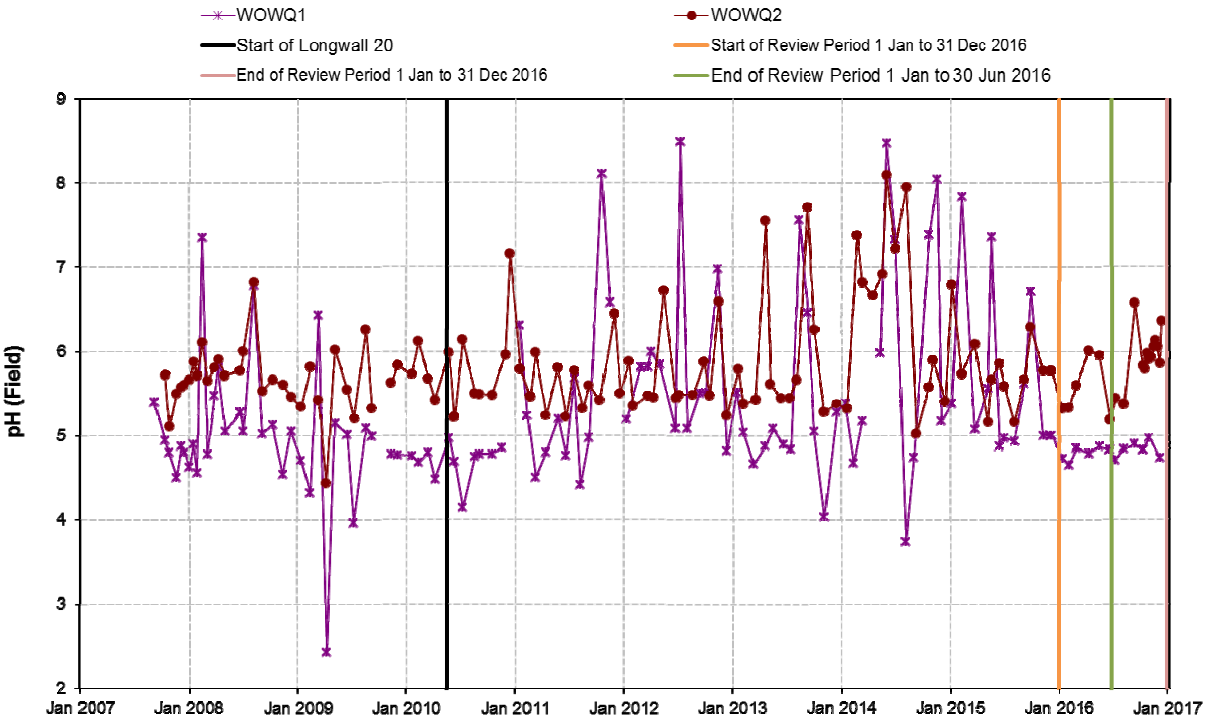


Chart 23 pH Levels Woronora River

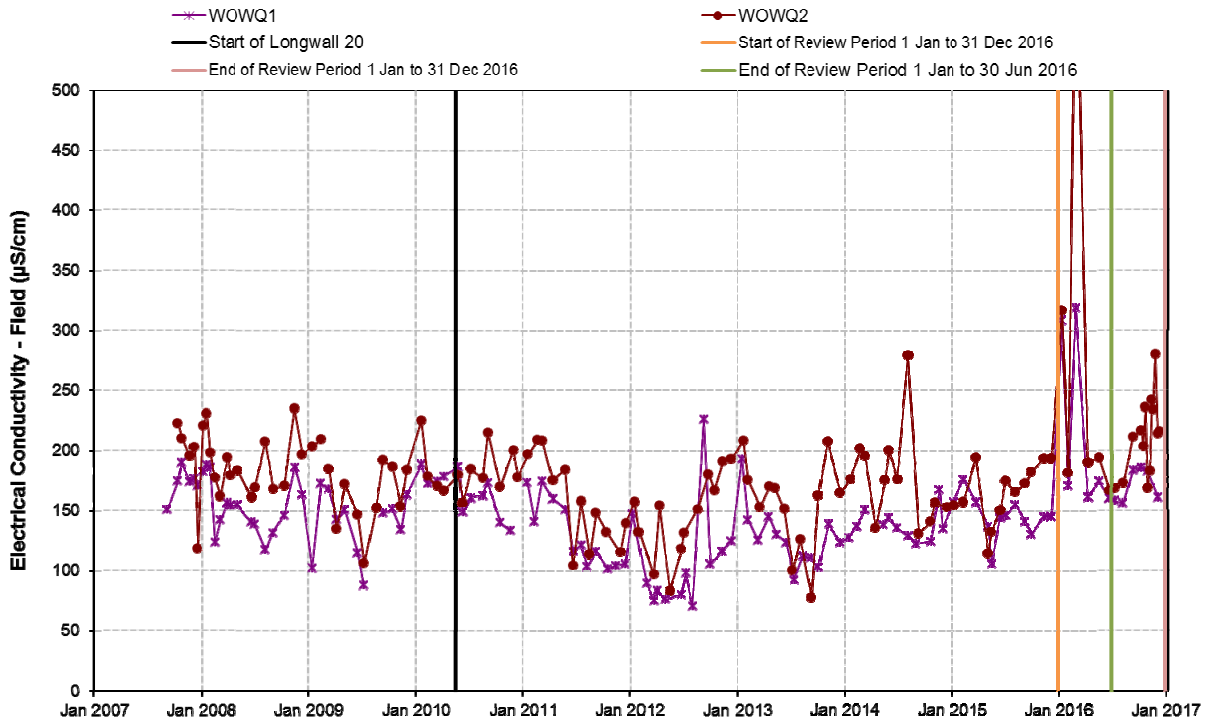


Chart 24 Electrical Conductivity (EC) Woronora River

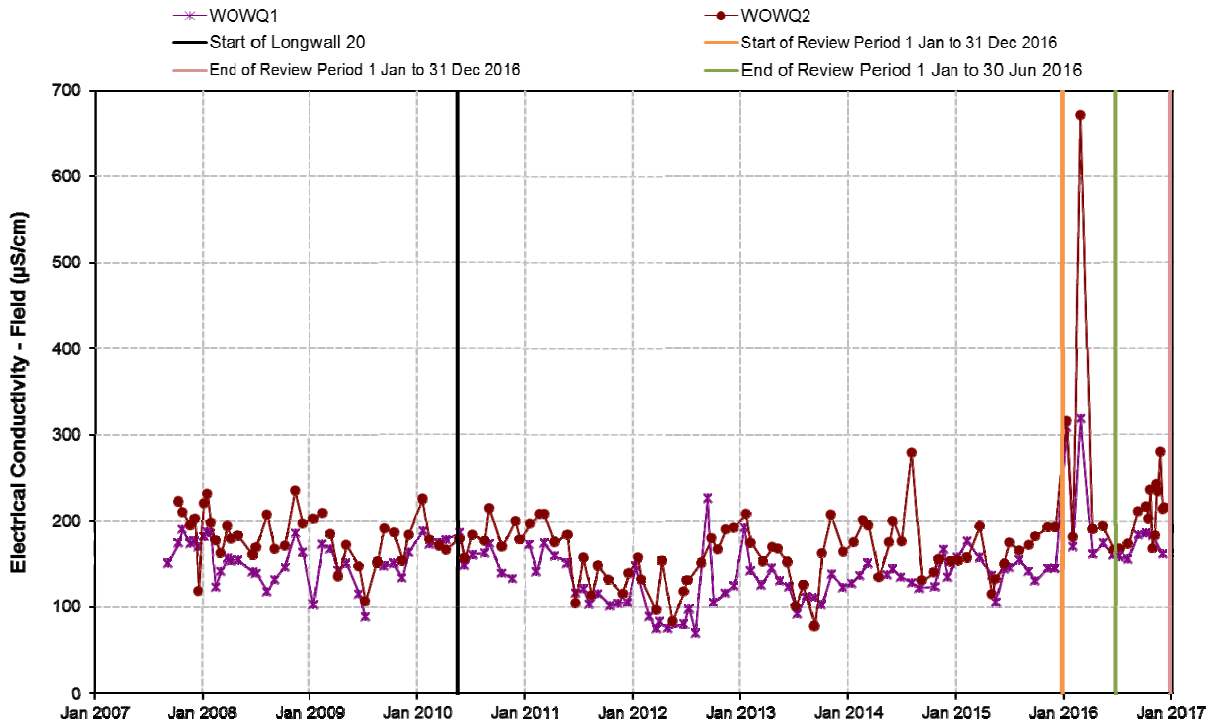


Chart 25 Electrical Conductivity (EC) Woronora River

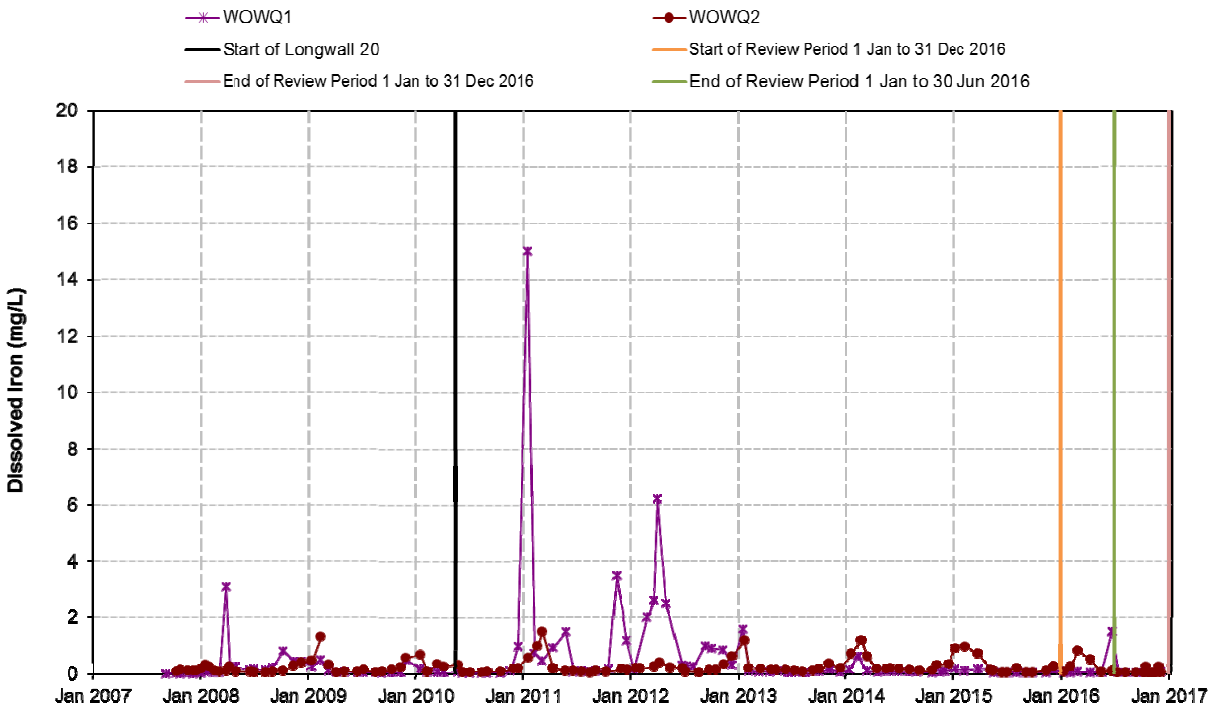


Chart 26 Dissolved Iron Woronora River

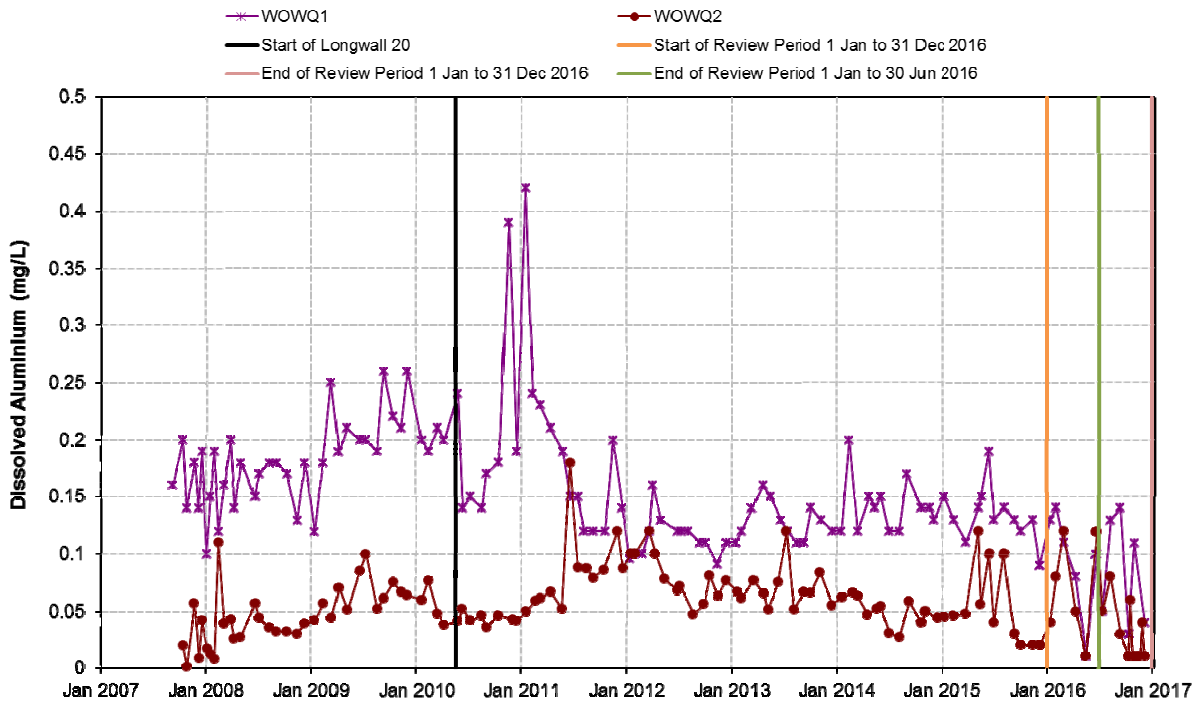


Chart 27 Dissolved Aluminium Woronora River

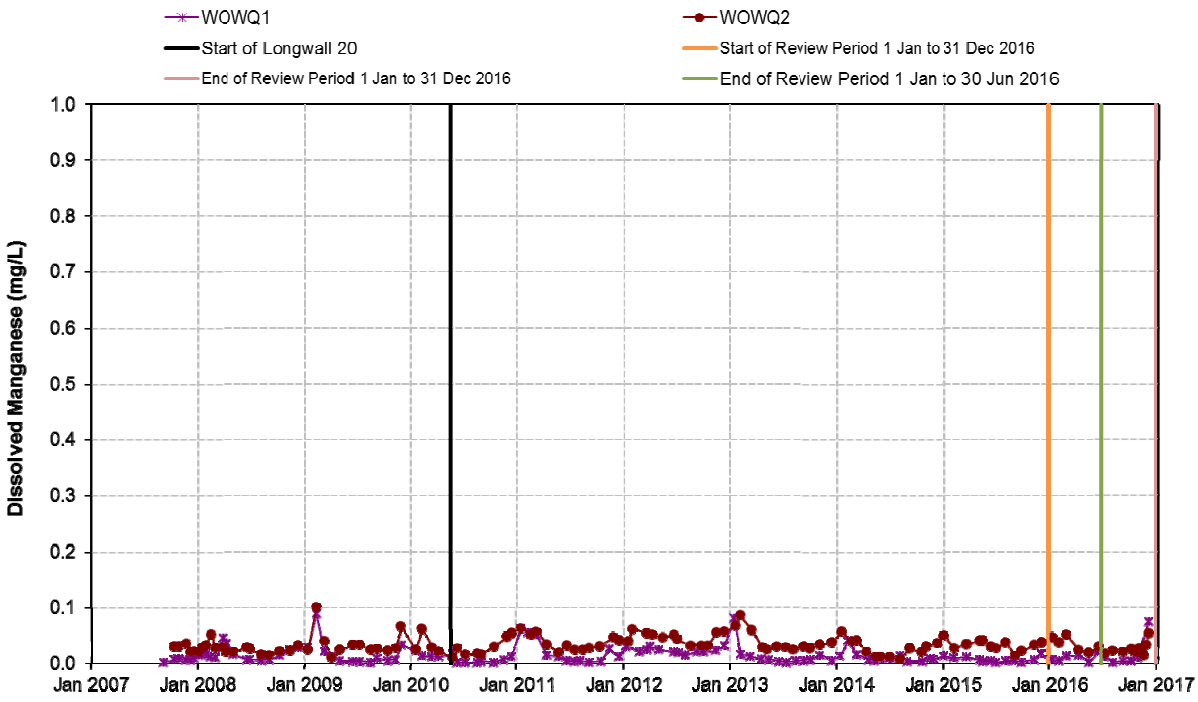


Chart 28 Dissolved Manganese Woronora River

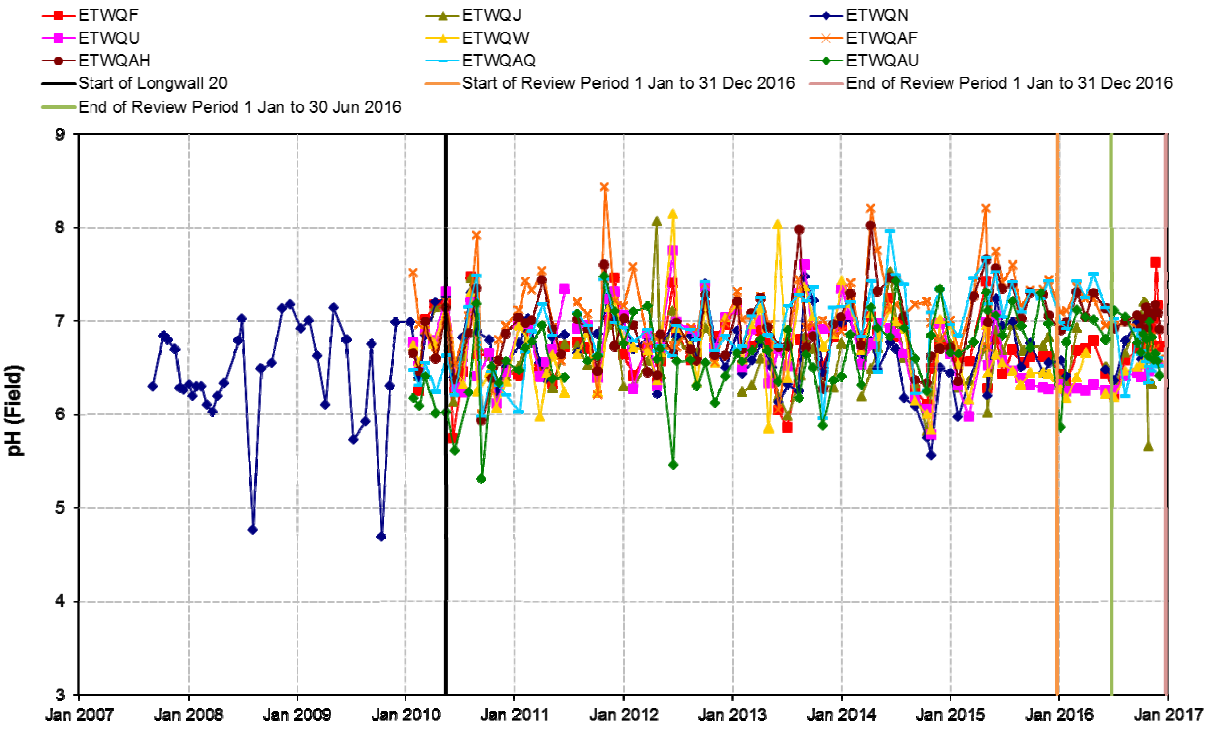


Chart 29 pH Levels Eastern Tributary

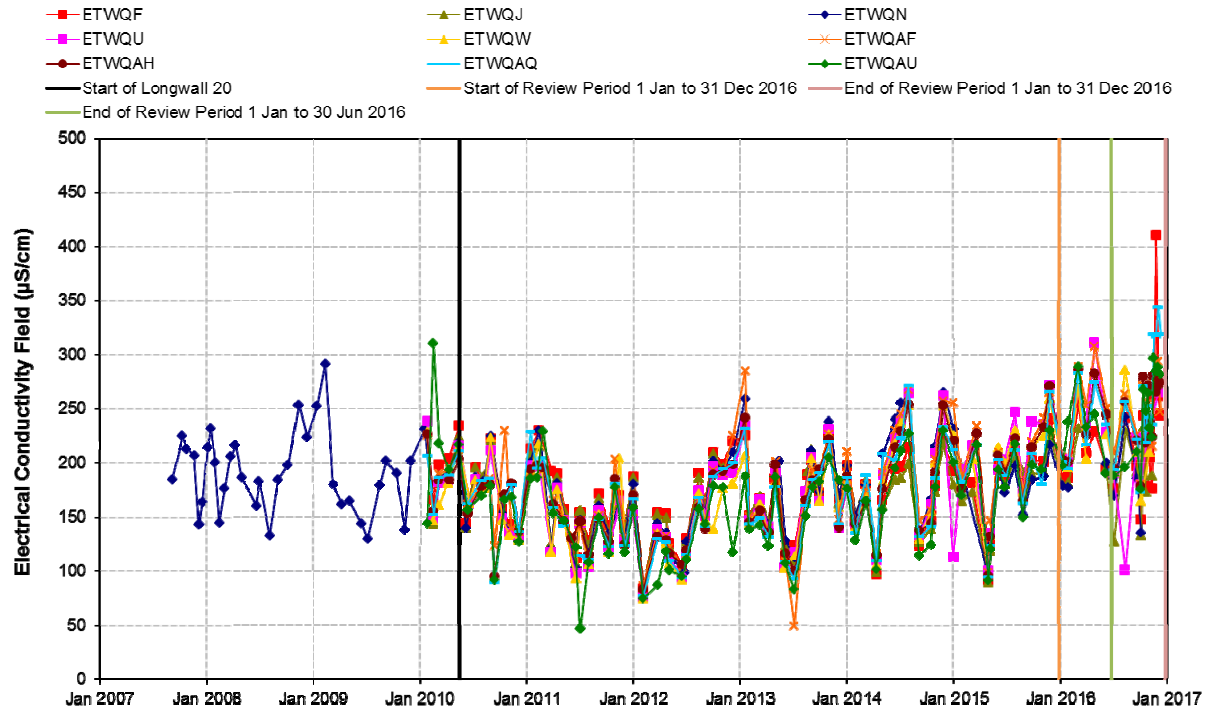


Chart 30 Electrical Conductivity (EC) Eastern Tributary

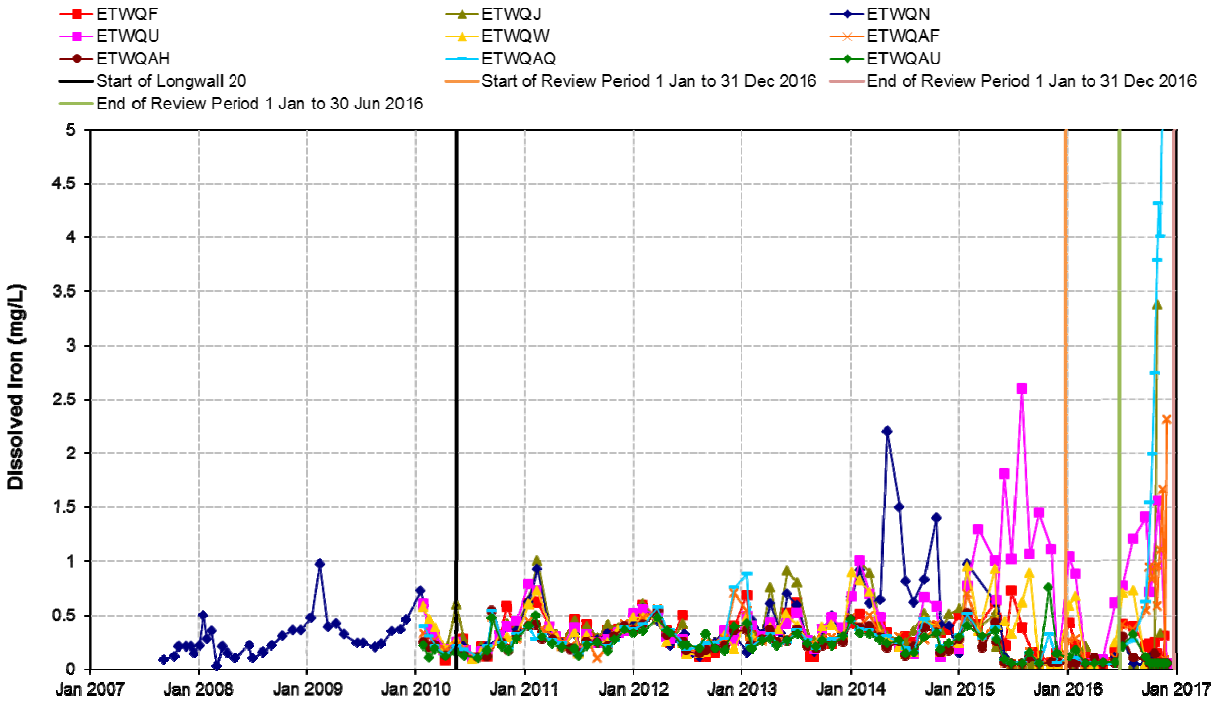


Chart 31 Dissolved Iron Eastern Tributary

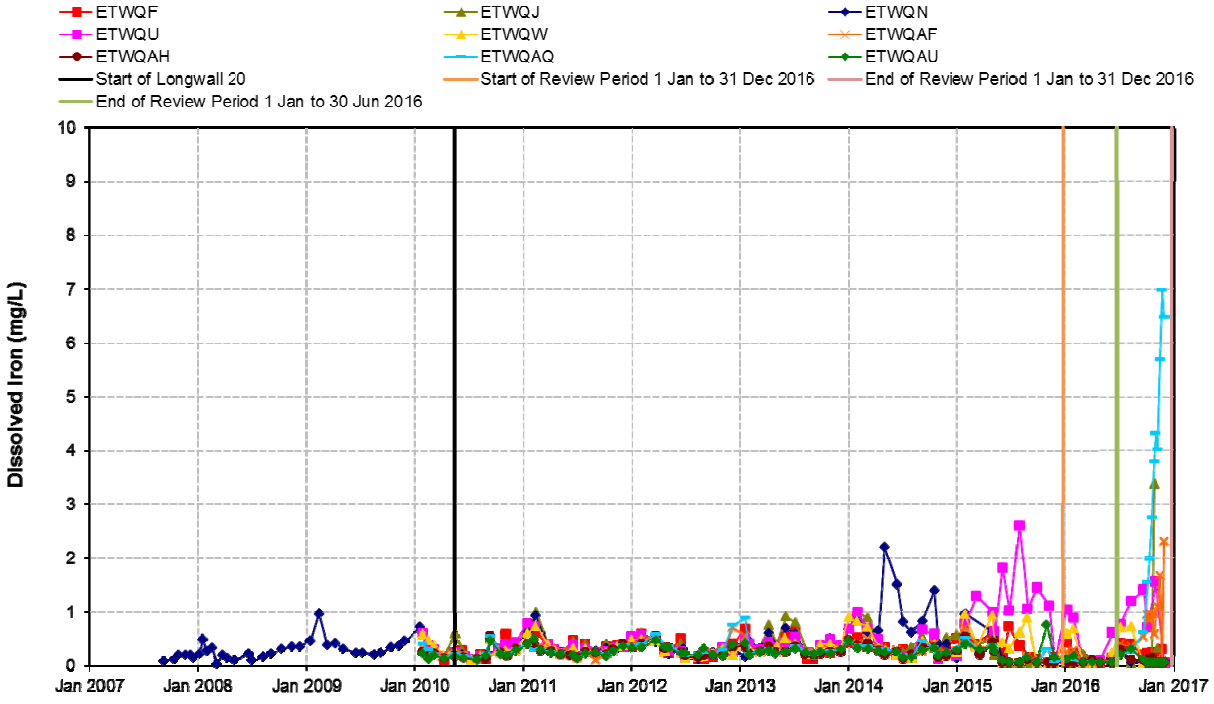


Chart 32 Dissolved Iron Eastern Tributary

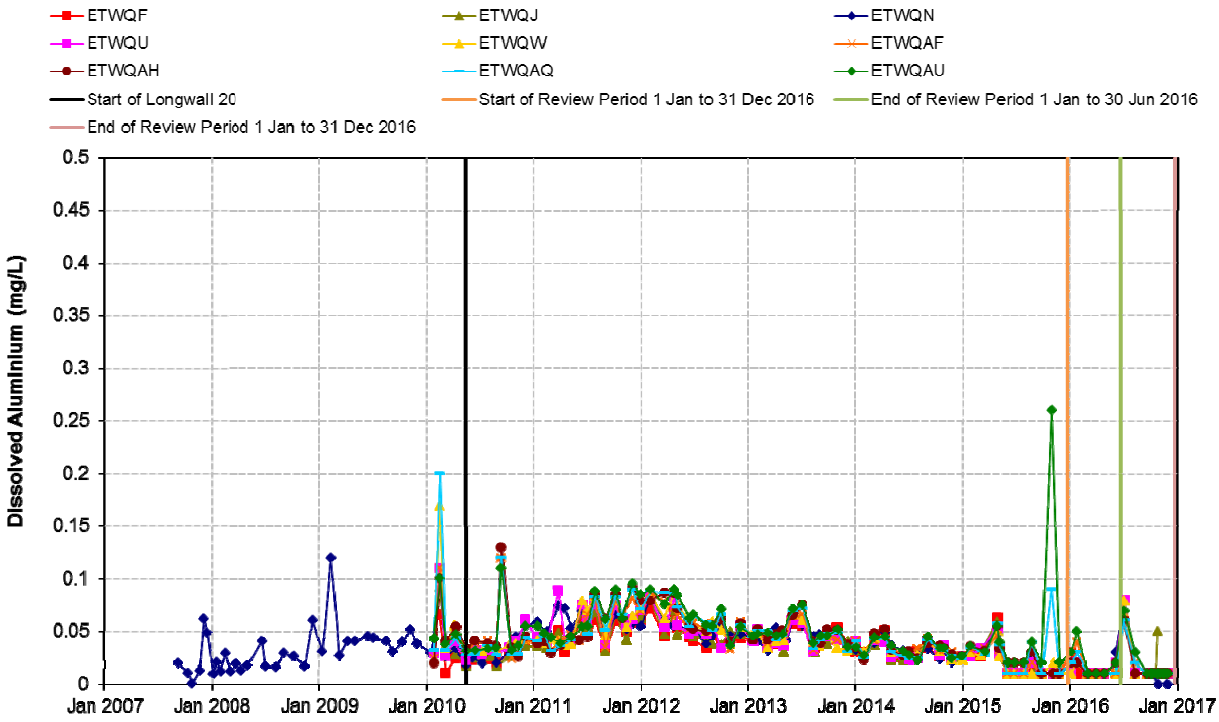


Chart 33 Dissolved Aluminium Eastern Tributary

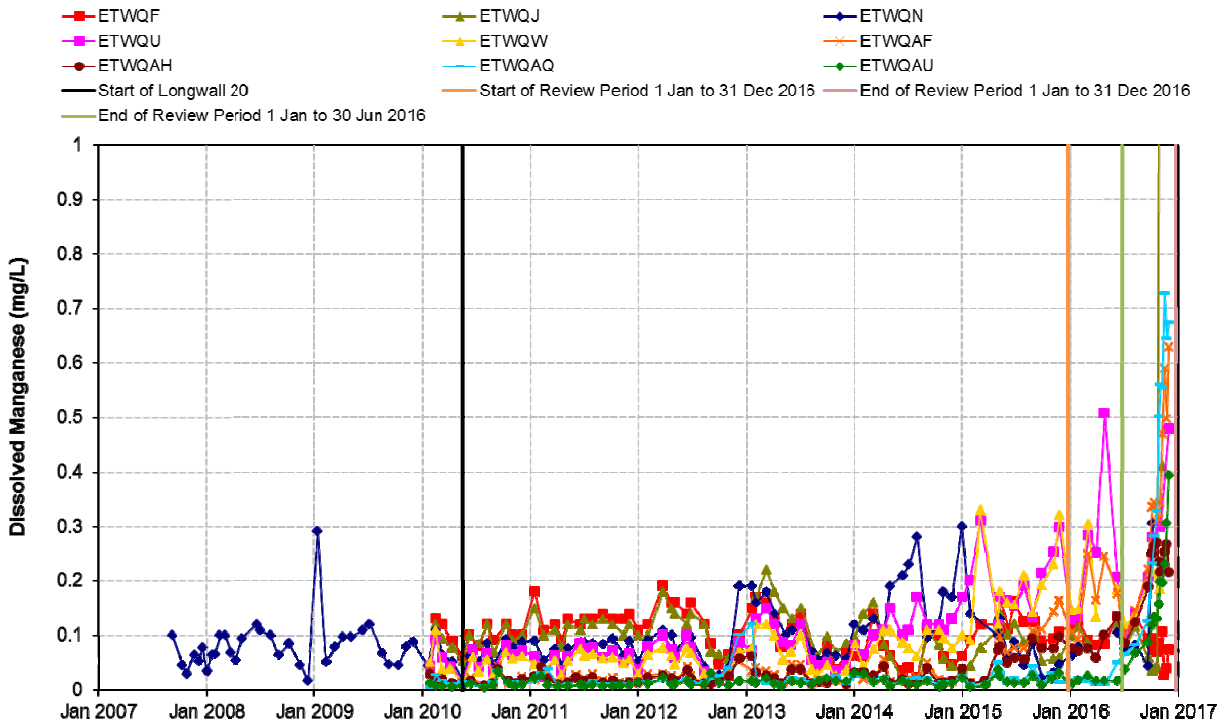


Chart 34a Dissolved Manganese Eastern Tributary

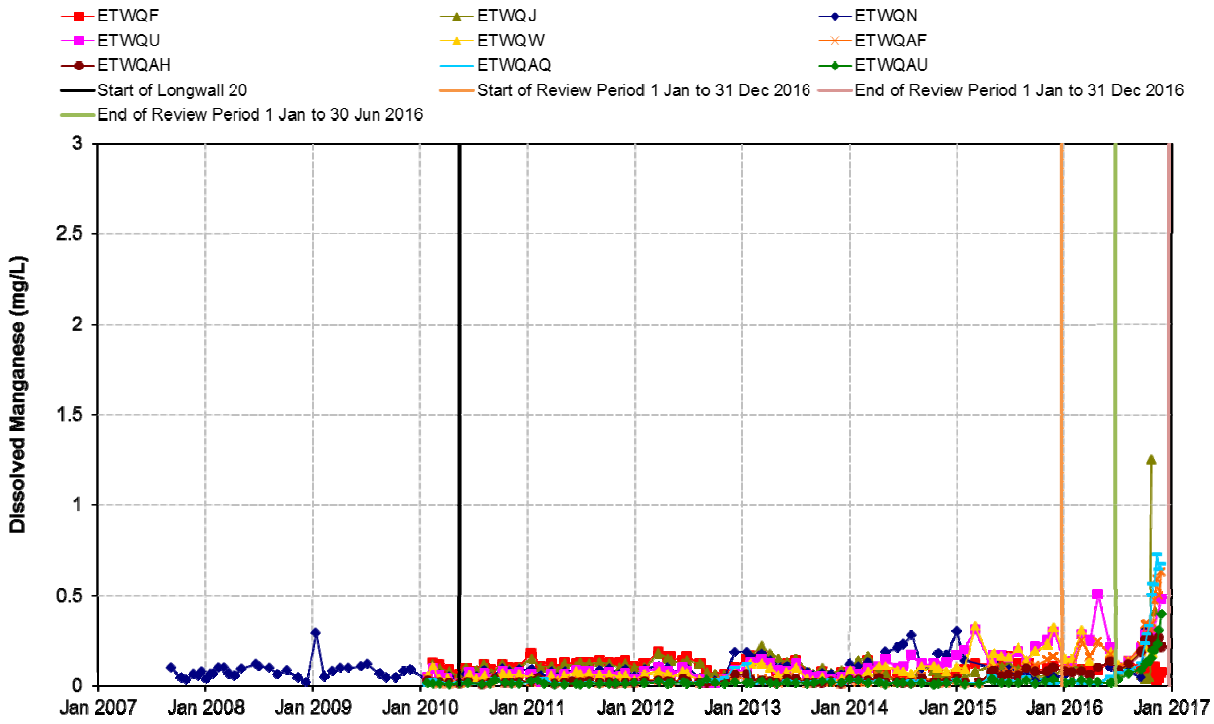


Chart 34b Dissolved Manganese Eastern Tributary

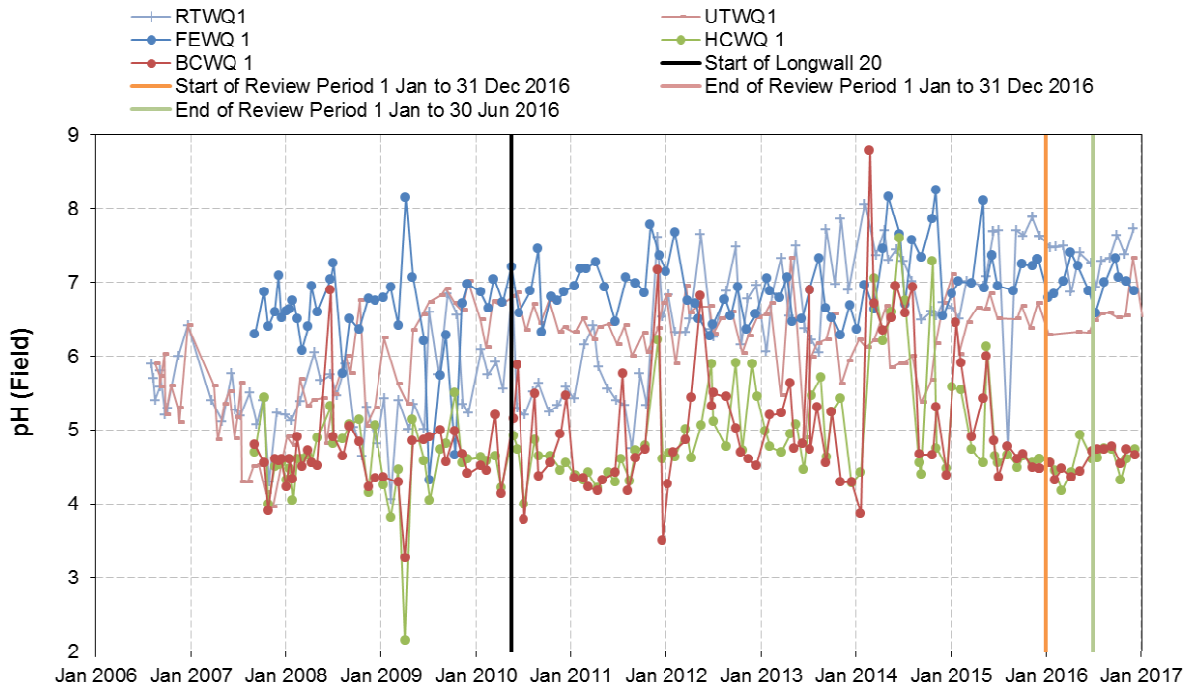


Chart 35 pH Levels Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

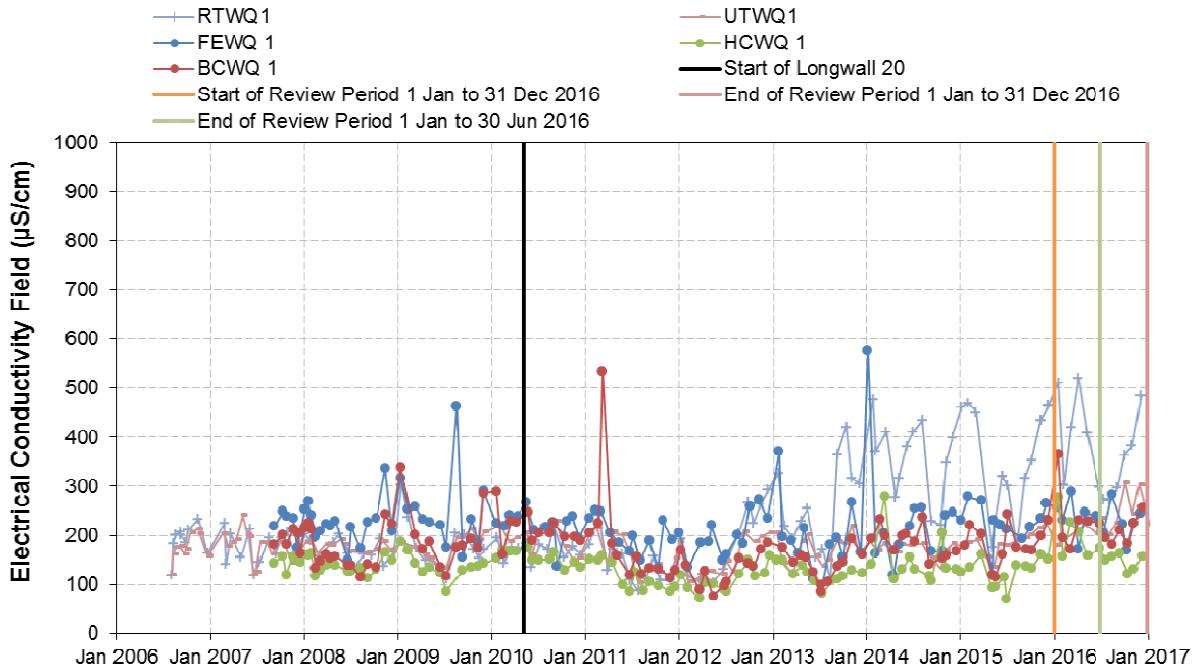


Chart 36 Electrical Conductivity (EC) Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

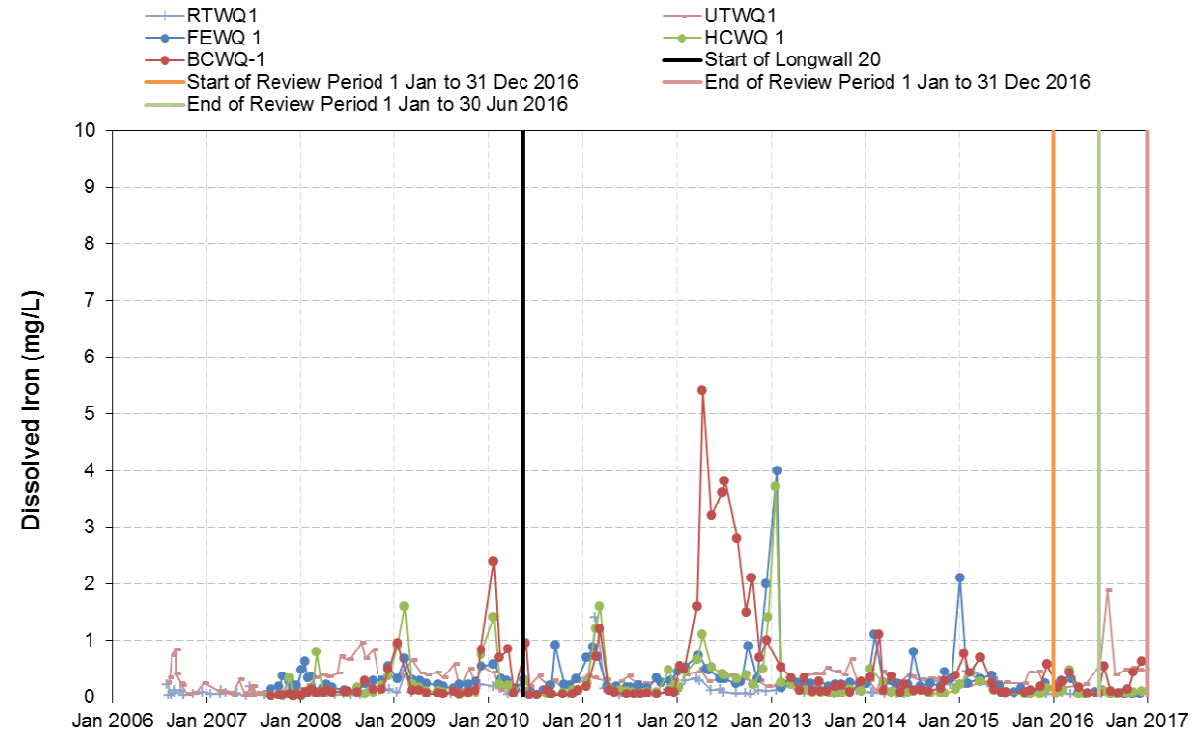


Chart 37 Dissolved Iron Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

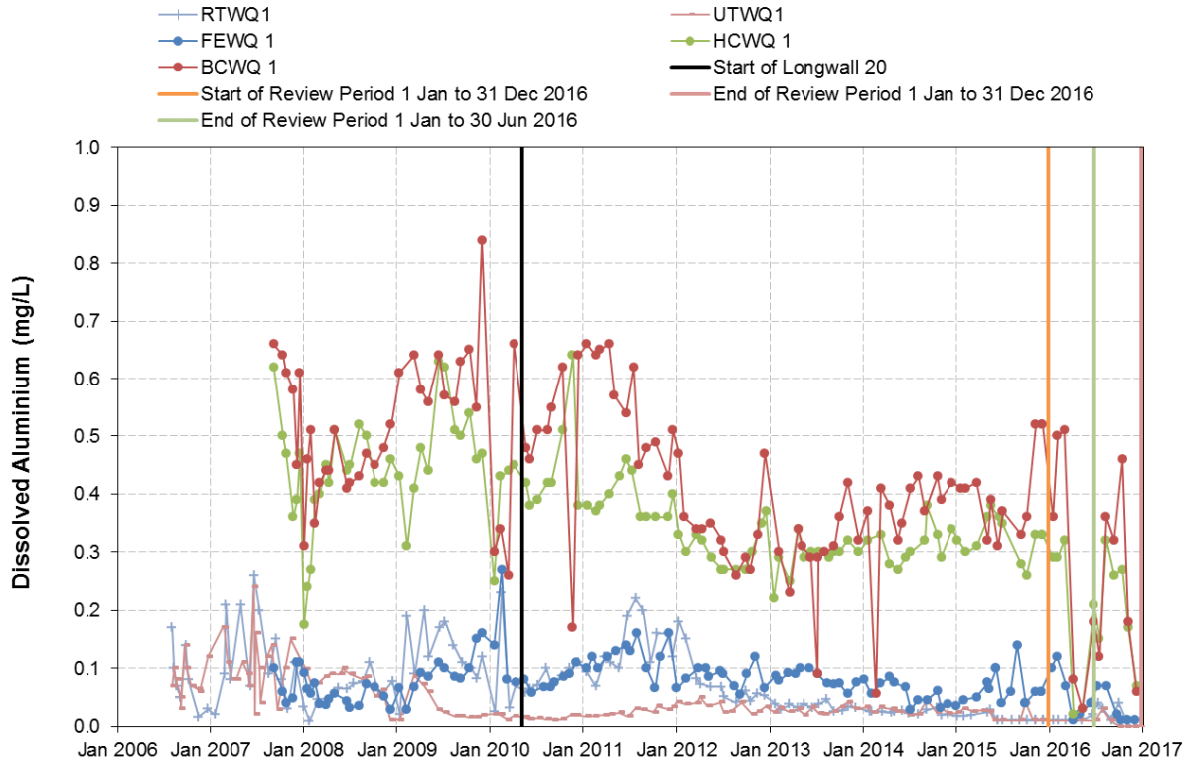


Chart 38 Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

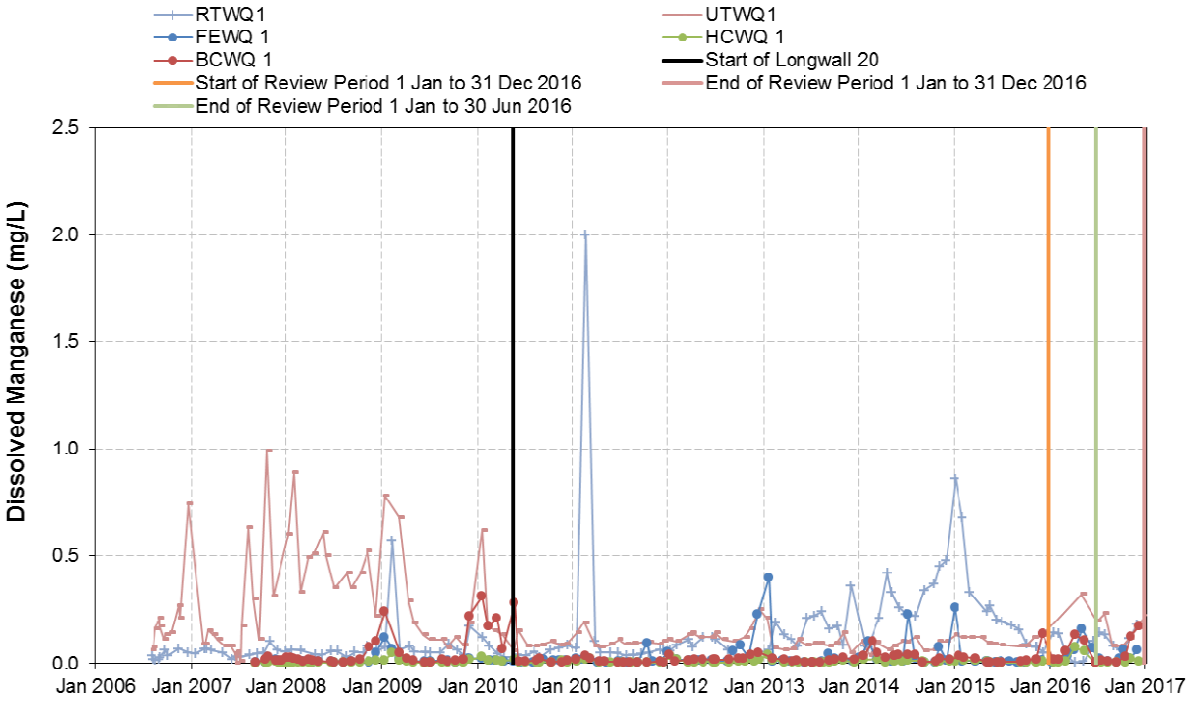


Chart 39 Dissolved Manganese Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

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 or dissolved aluminium at site WRWQ9 on Waratah Rivulet.

There was also no exceedance of the performance indicator as a result of the assessment methods for dissolved manganese at site WRWQ9, with the exception of the six month mean exceeding the adjusted baseline mean plus one standard deviation for two consecutive assessment periods at site WRWQ9 (Chart 40). There was no exceedance of this measure at the control site on Woronora River at site WOWQ2.

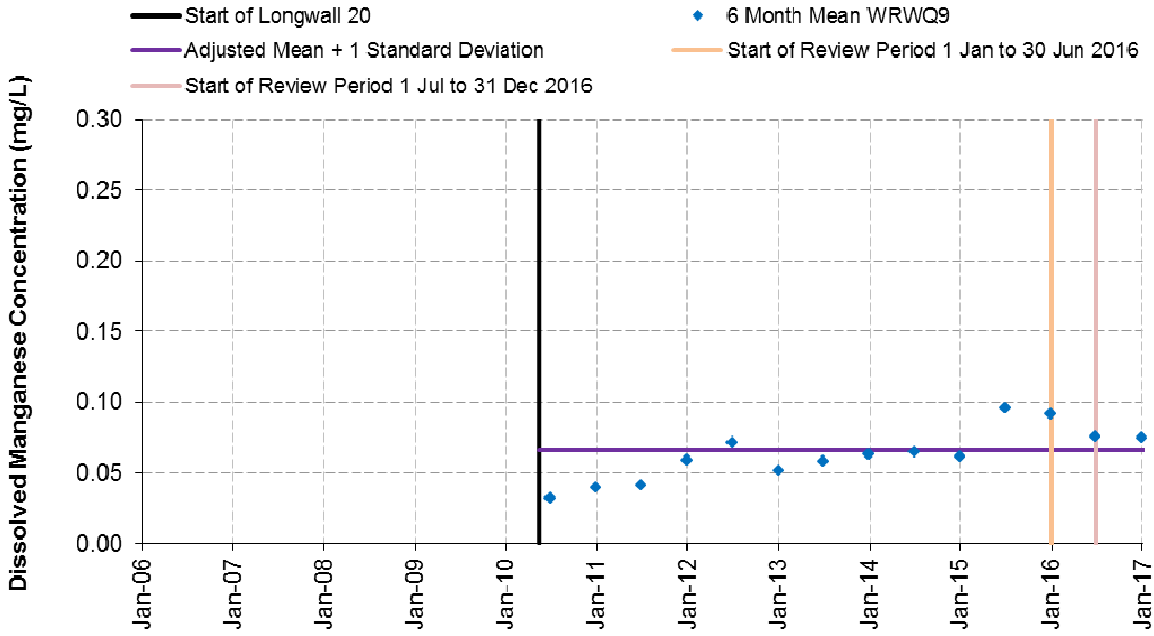


Chart 40 Six Monthly Means of Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

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

The same indicator (two consecutive six month means exceeding the adjusted baseline mean plus one standard deviation) was exceeded for manganese at site WRWQ9 during the July to December 2015 and January to June 2016 review periods (Hydro Engineering & Consulting, 2016a; Hydro Engineering & Consulting, 2016b). Assessments 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, 2016a; Hydro Engineering & Consulting, 2016b). Independent peer reviews of those assessments have been conducted by Dr Steve Perrens (Advisian, 2016; 2017), a specialist approved by the DP&E. The Advisian (2017) peer review report is provided in Appendix F. The peer reviews have concurred with the assessments that the subsidence impact performance measure had been met.

The current exceedance of the performance indicator for dissolved manganese is a continuation of the previous exceedance events. Dissolved manganese concentrations have decreased in the latter part of the reporting period (Chart 40 and Chart 41). Notwithstanding, an updated assessment has been undertaken by Hydro Engineering & Consulting (2017) against the subsidence impact performance measure and is provided in Appendix A. Assessment of the monitoring data indicates there has been a negligible reduction to the quality of water resources reaching the Woronora Reservoir. The assessment by Hydro Engineering & Consulting will be subject to peer review in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans.

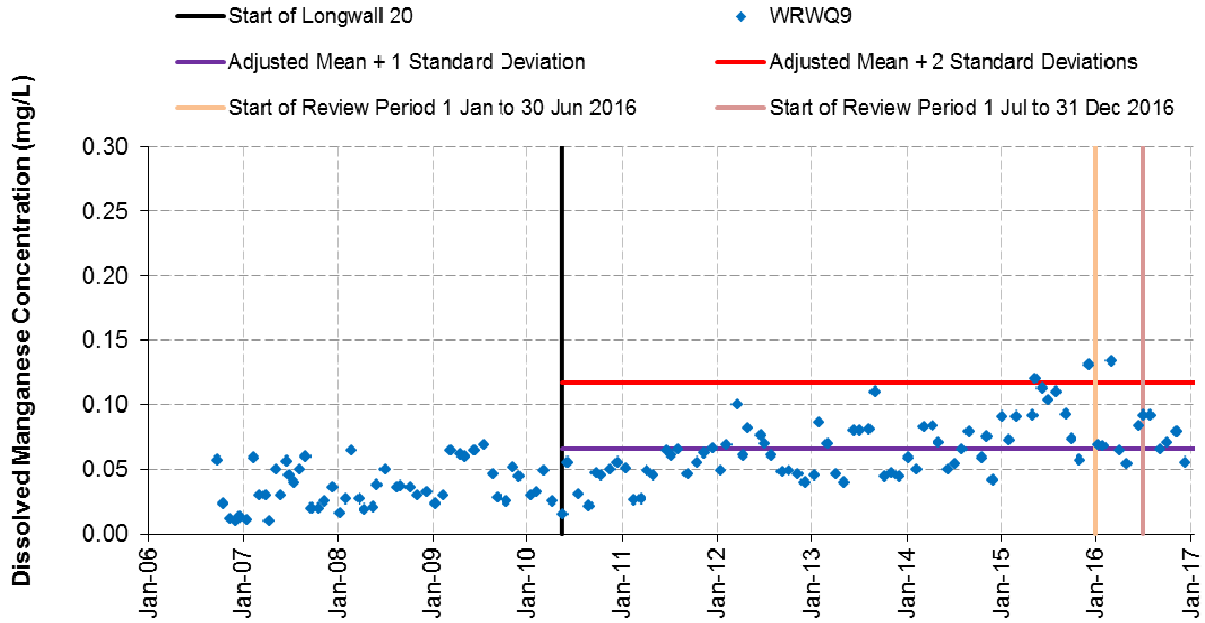


Chart 41 Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

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 July to December 2016 (Chart 42).

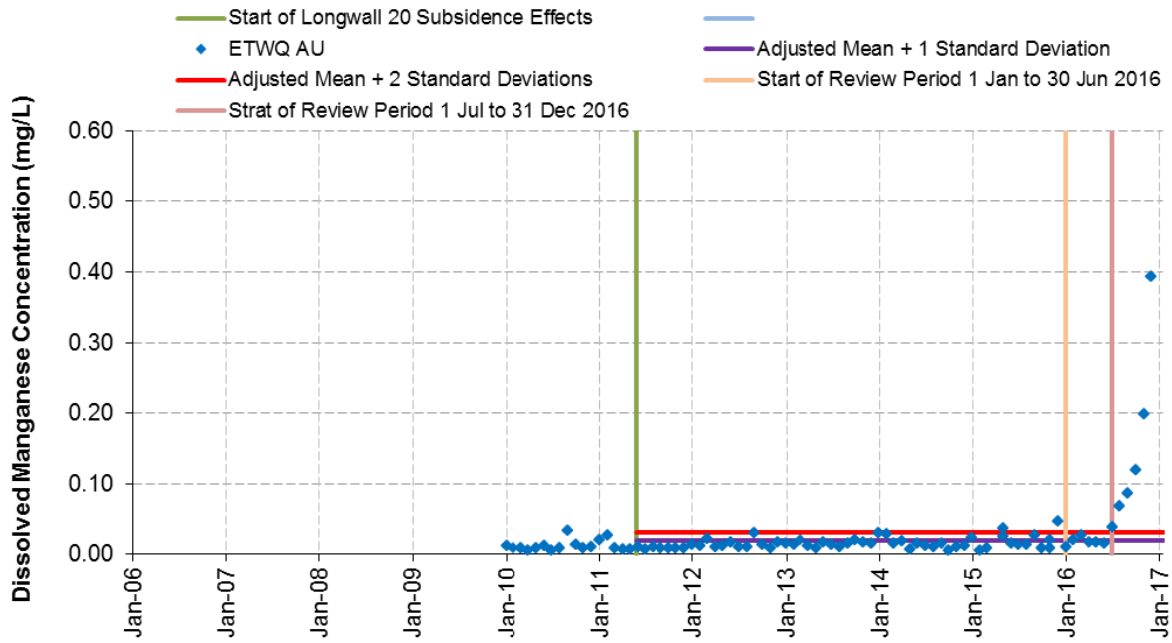


Chart 42 Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

There were no exceedances of this measure at the control site on Woronora River at site WOWQ2 during the reporting period. As a result, an assessment was made against the subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir.*

The assessment undertaken by Hydro Engineering & Consulting (2017) is provided in the report in Appendix A. Assessment of the monitoring data indicates there has been a negligible reduction to the quality of water resources reaching the Woronora Reservoir. The assessment by Hydro Engineering & Consulting will be subject to peer review in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans.

2.5 WORONORA RESERVOIR WATER QUALITY

Metropolitan Coal has sourced water quality data for the Woronora Reservoir from WaterNSW in accordance with a data exchange agreement. Results in relation to total iron, aluminium and manganese levels from 0 m to 9 m below the reservoir surface for Woronora Reservoir throughout the period of record are presented in Charts 43, 44 and 45.

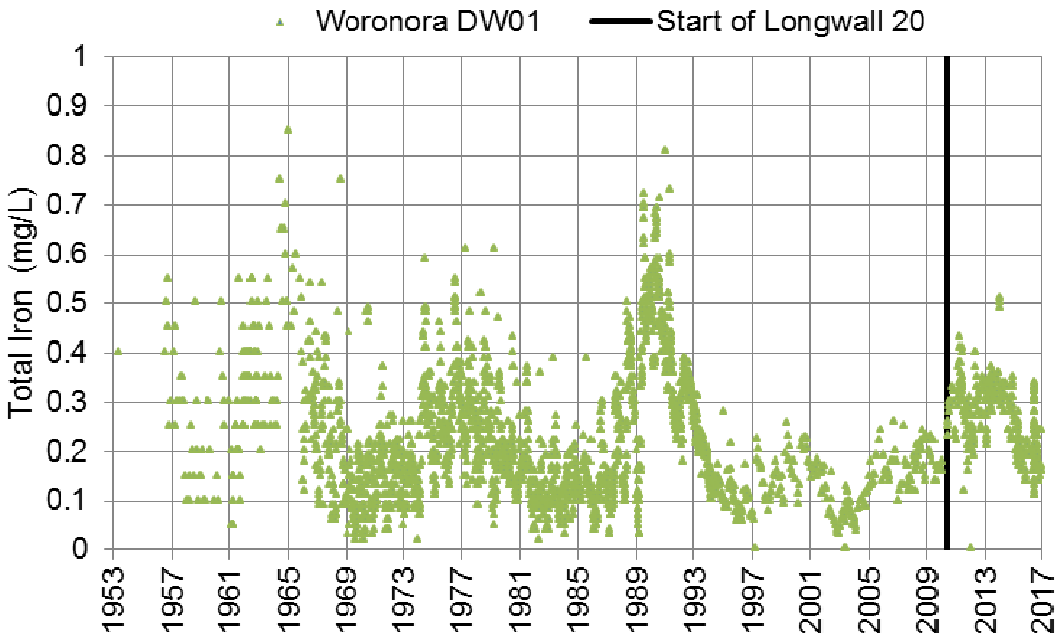


Chart 43 Total Iron Concentration Woronora Reservoir

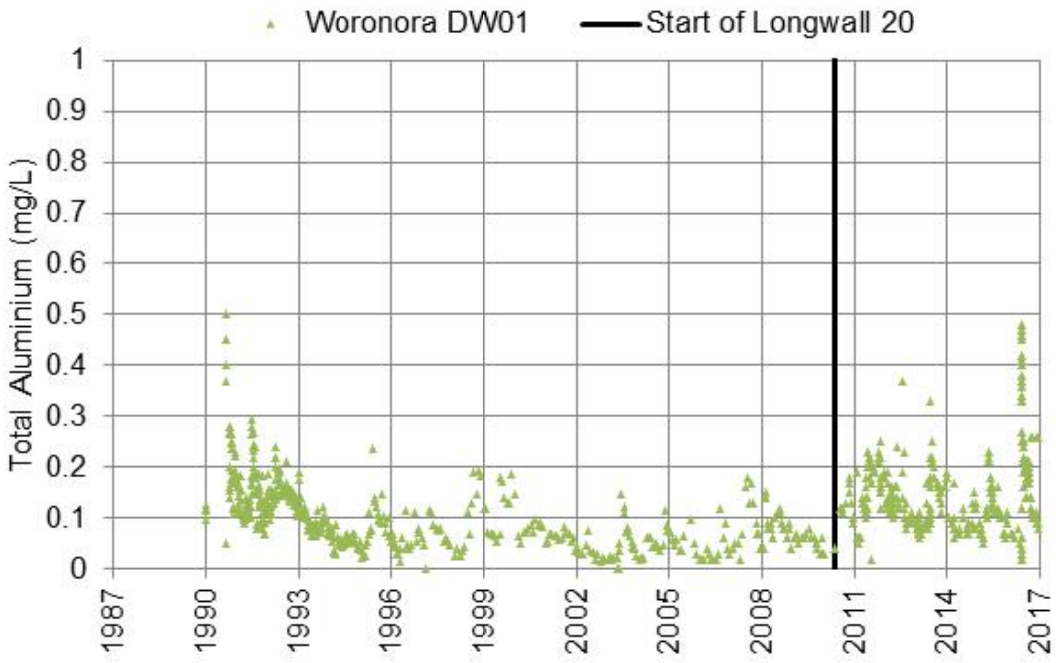


Chart 44 Total Aluminium Concentration Woronora Reservoir

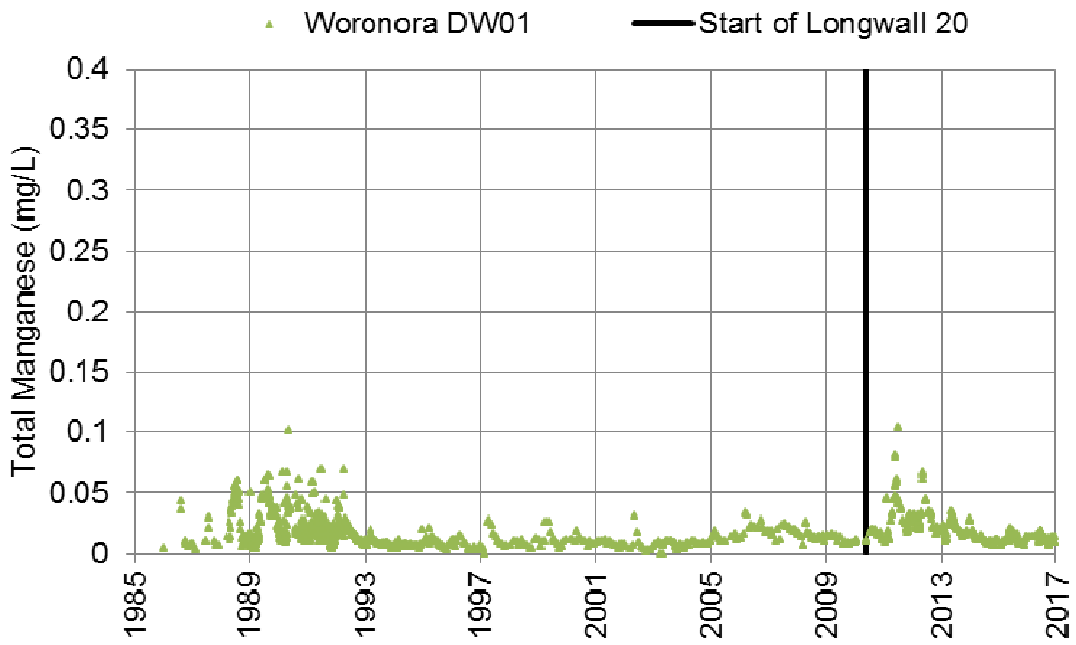


Chart 45 Total Manganese Concentration Woronora Reservoir

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

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

The performance indicator is considered to have been exceeded if data analysis indicates a significant change in the quality of water post-mining, specifically if the current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is above the baseline 20 year average recurrence interval (ARI) exceedance curve for any range of the duration percentages from 0% to 75%. The results of this assessment are shown on Charts 46 to 48.

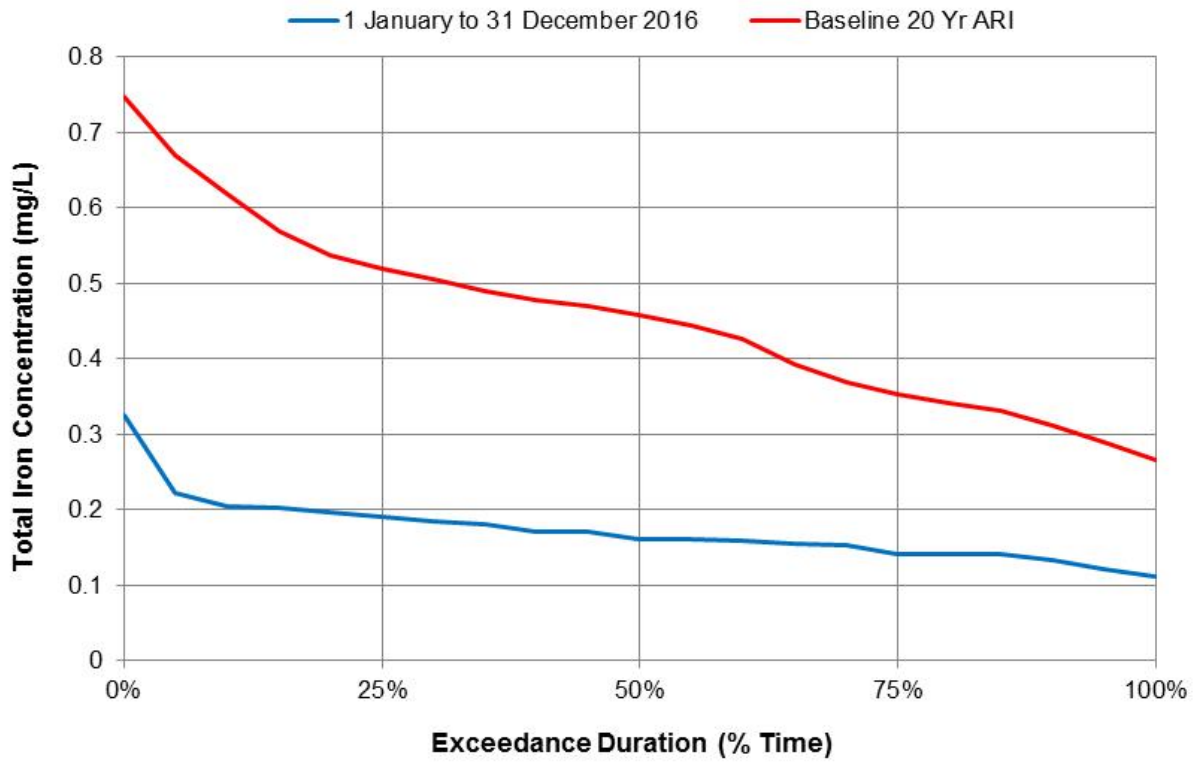


Chart 46 Total Iron Performance Indicator Woronora Reservoir 2016

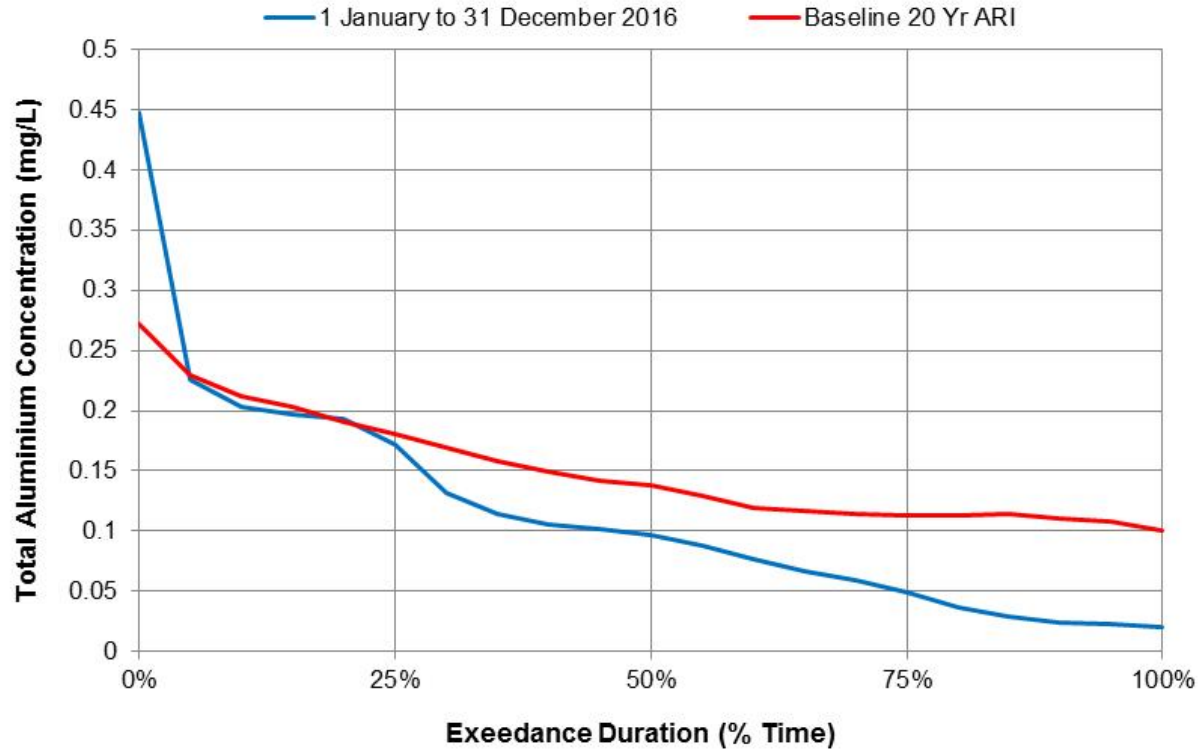


Chart 47 Total Aluminium Performance Indicator Woronora Reservoir 2016

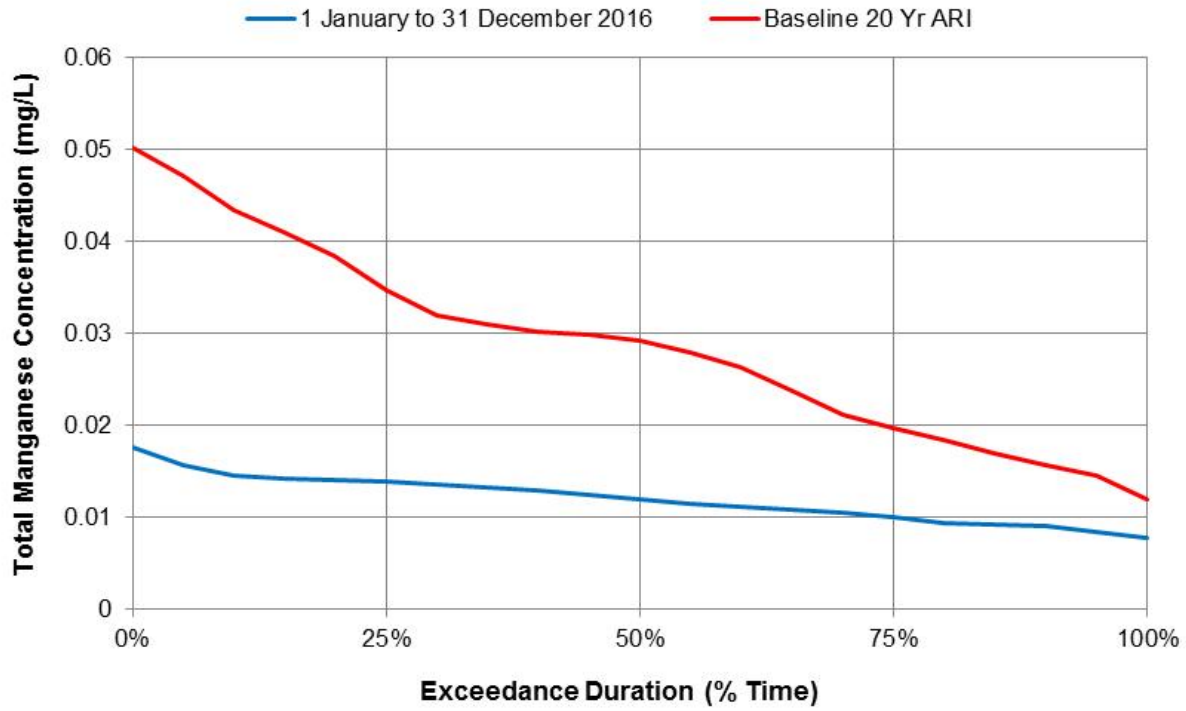


Chart 48 Total Manganese Performance Indicator Woronora Reservoir 2016

There were no exceedances of the Woronora Reservoir water quality performance indicator for total iron or total manganese during the reporting period (Charts 46 and 48). There was an exceedance of the Woronora Reservoir water quality performance indicator for total aluminium during the reporting period as the 20 year ARI exceedance curve was exceeded for the 0% to 20% exceedance durations (Chart 47). As a result, an assessment was undertaken against the subsidence impact performance measure, *Negligible reduction to the quality of water of Woronora Reservoir.*

The assessment undertaken by Hydro Engineering & Consulting (2017) is provided in the report in Appendix A. While analyses for aluminium in streams reaching the Woronora Reservoir are conducted using field filtered samples, the data for dissolved aluminium at site WRWQ9 on the Waratah Rivulet and site ETWQ AU on the Eastern Tributary indicate that concentrations have been low. Similarly, whilst dissolved aluminium concentrations were significantly higher at Bee Creek (site BCWQ1) and Honeysuckle Creek (site HCWQ1) there was no change evident in aluminium during the period prior to, during or after the reported elevated total aluminium levels in the Woronora Reservoir which would link them to inflow concentrations.

Comparison of total aluminium concentrations in the Nepean, Cataract and Woronora Reservoirs indicated there is a similar pattern between the three storages and that aluminium concentrations increased rapidly (which was able to be captured by the frequent sampling conducted during the period of elevated aluminium), followed by a relatively rapid partial fall, and subsequent slow decline. These changes suggest limnological processes rather than mining or changes in catchment inflows.

Comparison of the water quality data with the Woronora Reservoir Bulk Water Supply Agreement indicates that the bulk water supply value of 0.4 mg/L for total aluminium was exceeded for a short period based on the results of samples collected during the period 14 - 20 June 2016. A maximum total aluminium value of 0.47 mg/L was recorded. Total aluminium concentrations of 0.4 mg/L have rarely been exceeded previously in the Woronora Reservoir.

Hydro Engineering & Consulting (2017) concluded that the performance measure, *Negligible reduction in the water quality of Woronora Reservoir*, has been met. The assessment by Hydro Engineering & Consulting will be subject to peer review in accordance with the Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Water Management Plans.

2.6 SWAMP GROUNDWATER LEVELS

Groundwater monitoring of upland swamps for Longwalls 20-22 and 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 6). 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 6). 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 6).

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 B). Exceedances of the upland swamp groundwater performance indicator have occurred at Swamp 20 (since 2012) and at Swamp 28, as described below.

During the previous reporting period, several quantitative methods were investigated to assess potential impacts of mining on swamp substrate water levels; however, none was found to be consistently reliable. Instead, analysis of upland swamp groundwater levels is based on a qualitative comparison of behaviour against control swamps in relation to the rate of recession from high to low water levels, the duration of dry swamp conditions compared to the rainfall record, and relative amplitudes of groundwater responses to rainfall events.

Swamp 20

Consistent with previous reporting, 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 49 and Appendix B). This trend continued to be observed throughout the reporting period (Chart 49). 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 49 and Appendix B).

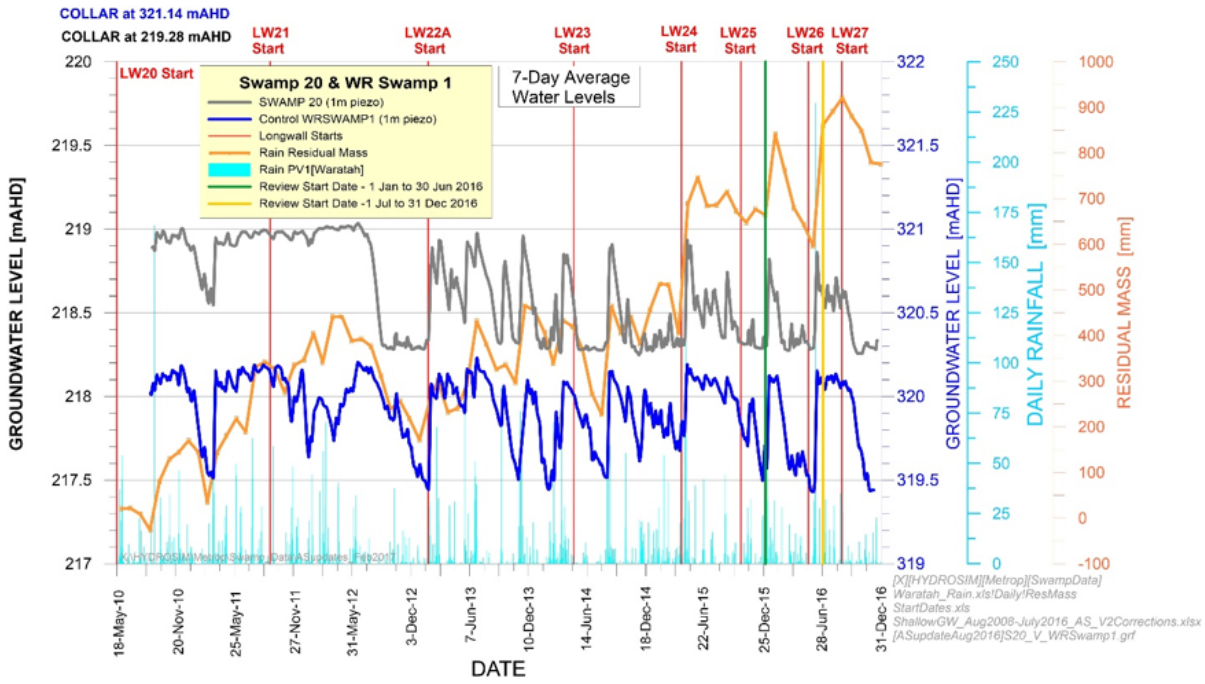


Chart 49 Comparison of Piezometer Responses at Swamp 20 and Woronora River 1 Control Swamp

Swamp 28

The substrate groundwater levels in Swamp 28 increase in response to rainfall events in February 2016 and June 2016, and remain high until late September 2016 (Chart 50). To assess whether there had been a mining effect on the substrate water levels, the Swamp 28 hydrograph in the previous reporting period was compared with the responses at the two relevant control swamps (137a and 137b) (Chart 50). Unlike the control swamps, the water level recovery in Swamp 28 was incomplete during the previous reporting period, being about 60% of full recovery for the January-February 2016 rain events and about 80% for the June 2016 superstorm (Appendix B). As nearby swamp responses (at Swamps 30, 33 and 35) show full recovery at these times, Swamp 28 was 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.

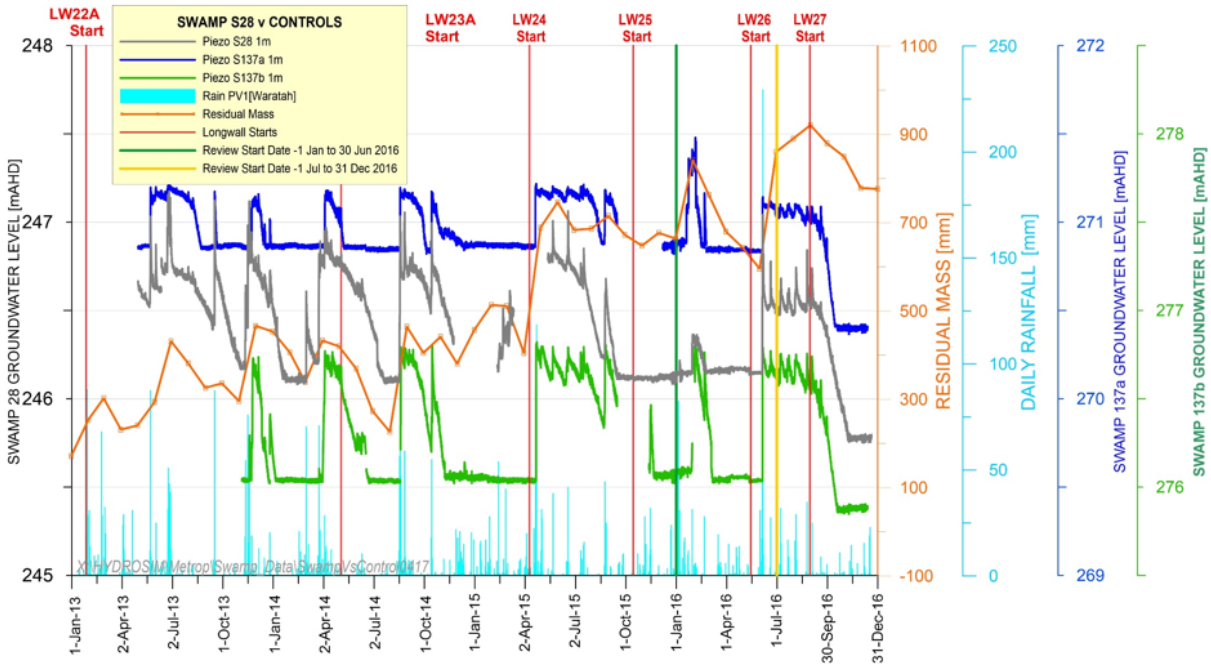


Chart 50 Groundwater Hydrographs at Swamp 28 and Two Control Swamps (137a and 137b)

2.7 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 6 and Charts 51, 52 and 53).

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 51). 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. The water levels at sites WRGW1 and WRGW2 have correlated closely with rainfall trends (as indicated by the residual mass curve on Chart 51) and show a general declining trend in groundwater level from January 2016 until June 2016 when groundwater levels increase in response to above average rainfall. Since then, water levels again declined in response to the lack of rainfall, with a slight increase in the last few months of the reporting period.

Shallow groundwater levels at site WRGW7 remained correlated with rainfall trends and unaffected by mining during the reporting period (Chart 52). At the Eastern Tributary sites, ETGW1 and ETGW2, shallow groundwater levels have previously followed the rainfall trends closely (Chart 53) and show a particularly close correlation during the reporting period. The variations at these sites are unrelated to mining.

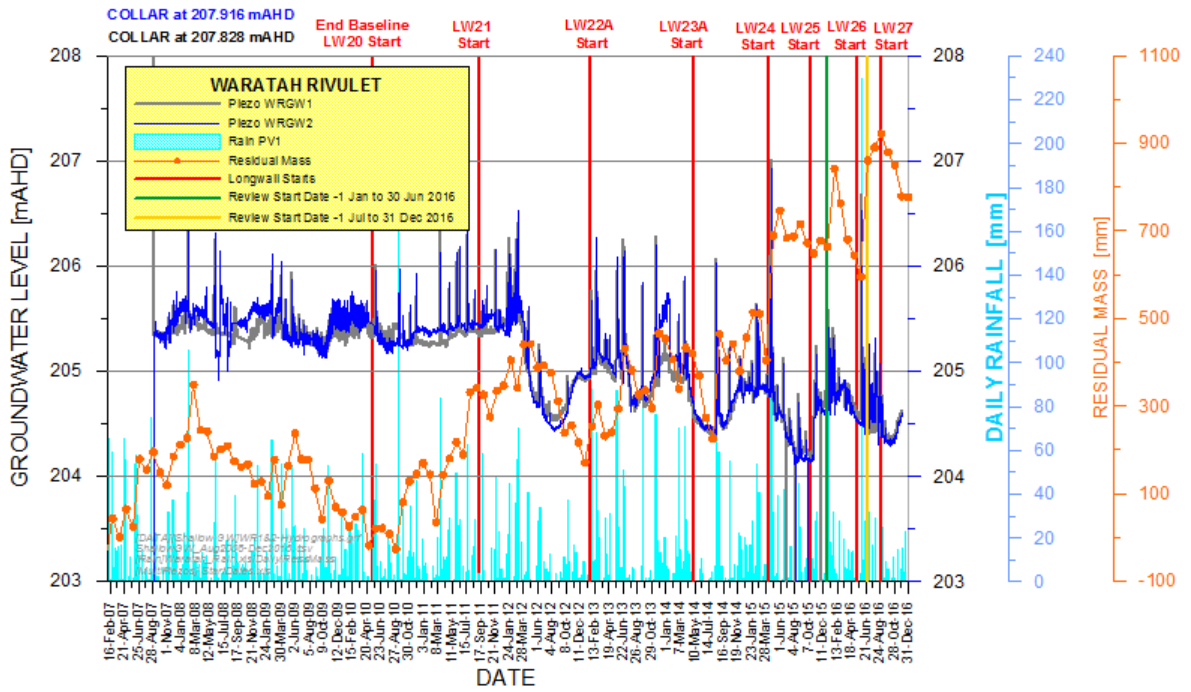


Chart 51 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW1 and WRGW2

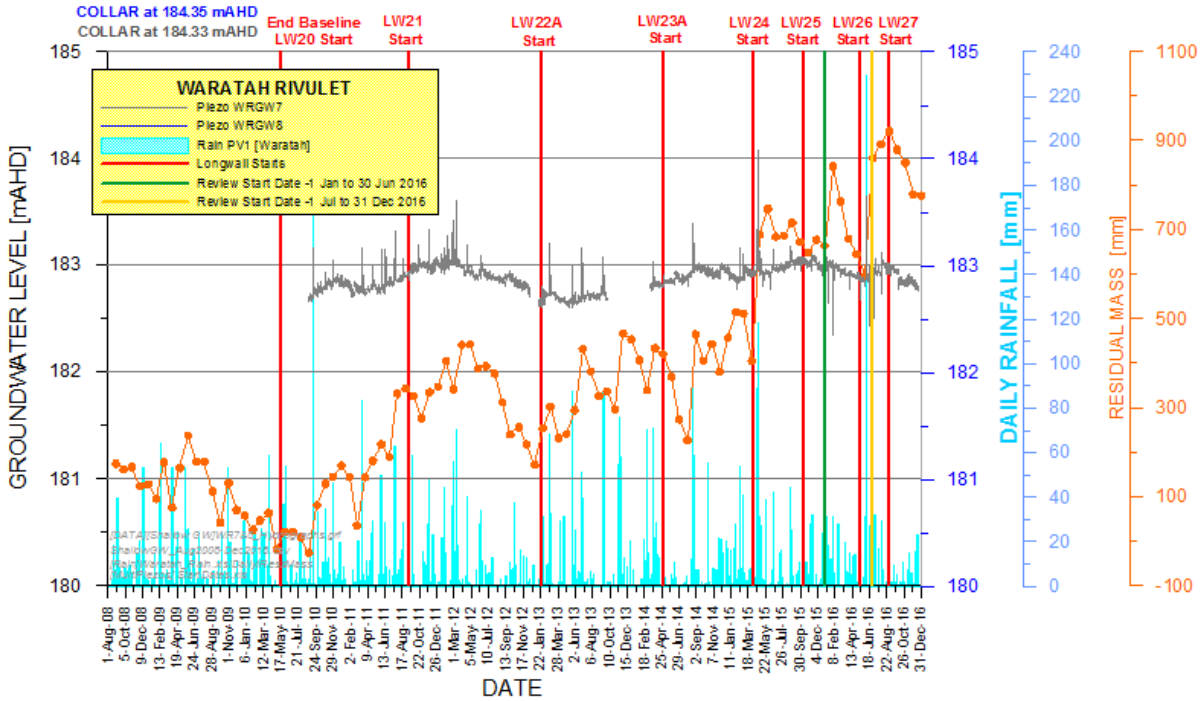


Chart 52 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW7

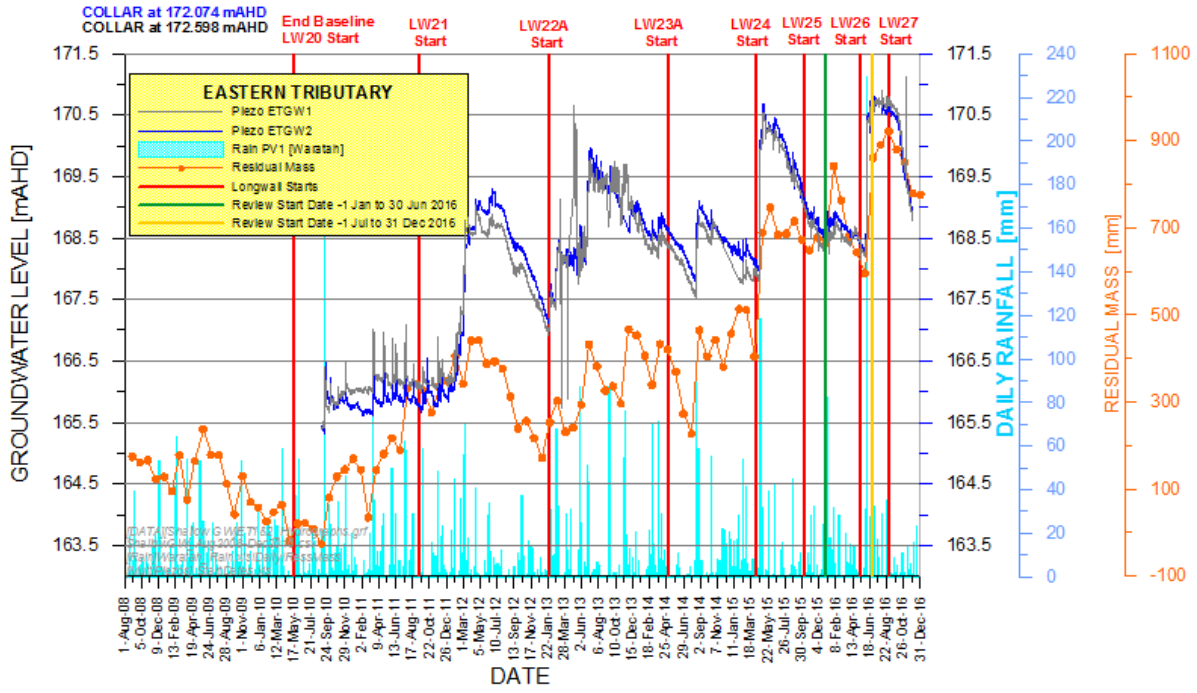


Chart 53 Shallow Groundwater Hydrographs on Eastern Tributary at ETGW1 and ETGW2

2.8 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 during the reporting period 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.

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 6). The time-series head variations and vertical head differences for these bores have been examined (Charts 54 to 67).

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 6).

The time-series record for bore 9EGW1B on Chart 55 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) retains about 350 m pressure head, which has been declining slowly since the commencement of Longwall 20 due to far-field depressurisation. 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 B).

The time-series record for bore 9GGW2B is shown on Chart 58[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 B).

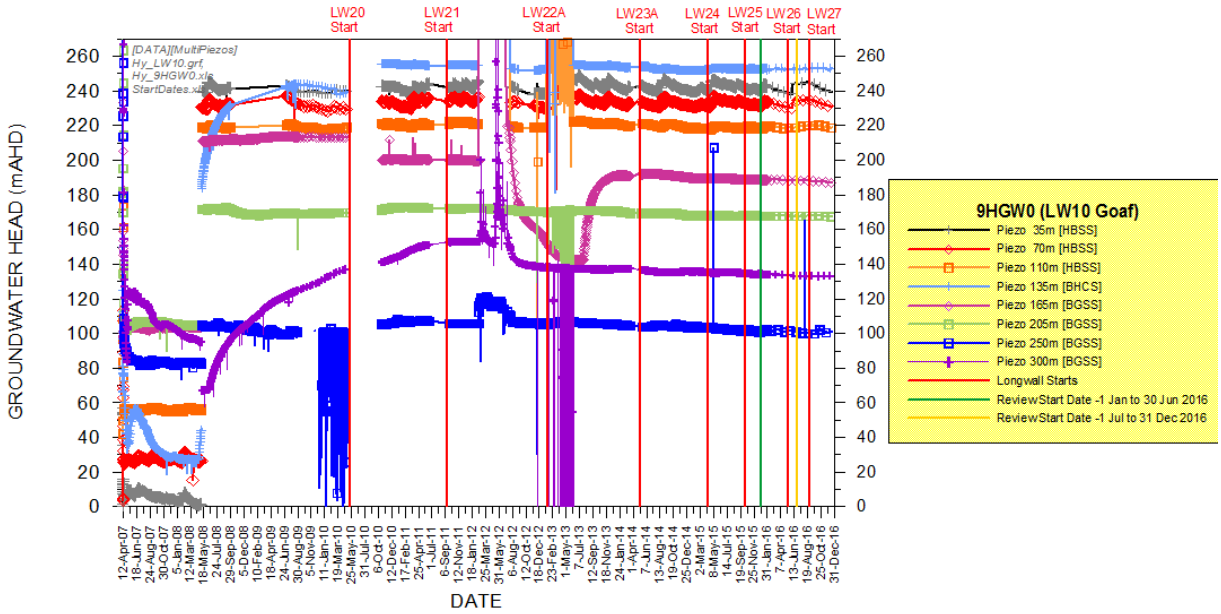


Chart 54 Time Variations in Potentiometric Heads at 9HGW0

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

6 The sensor at 106 m depth in the Hawkesbury Sandstone showed an increase in pressure in the previous reporting period which is inconsistent with the other sensors.

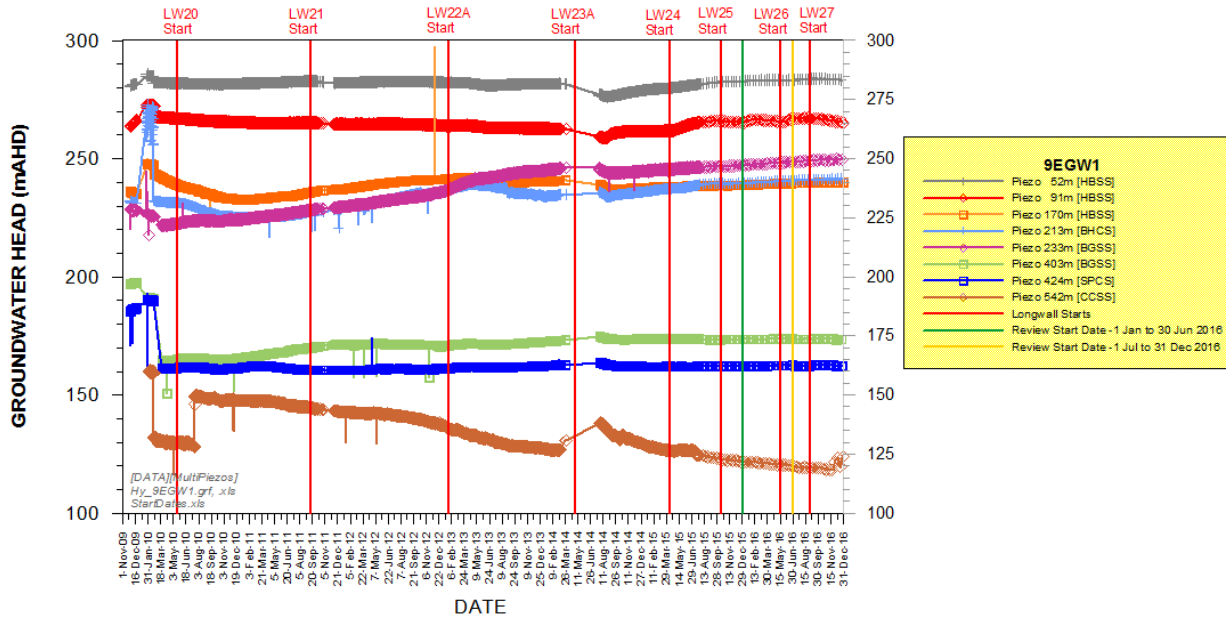
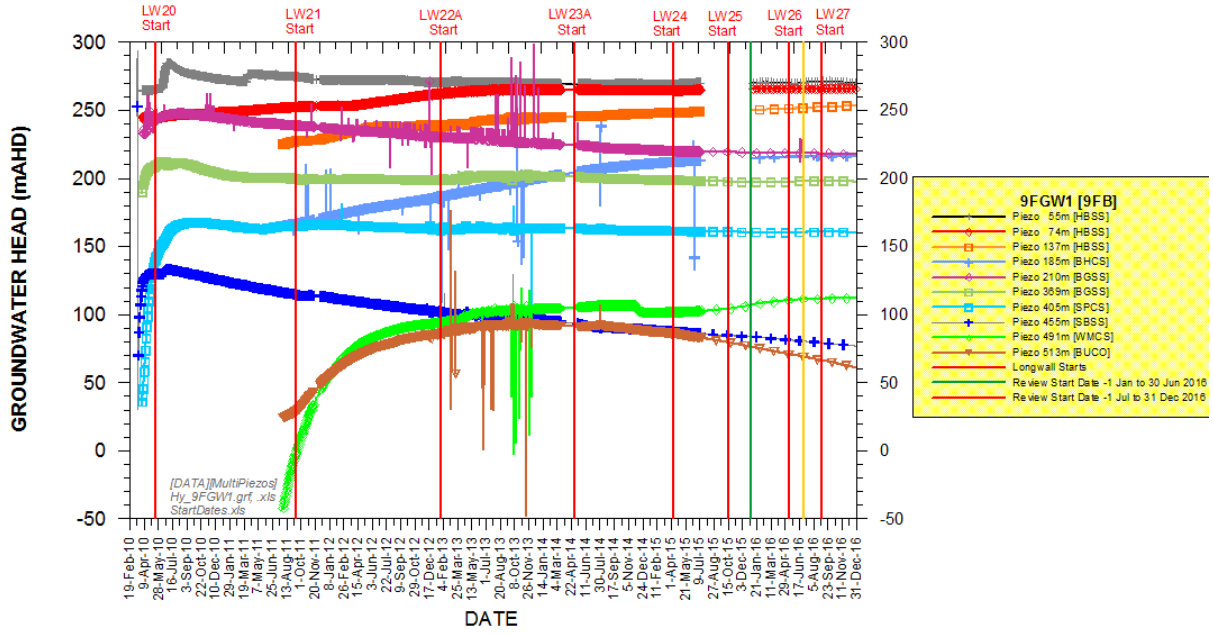


Chart 55 Time Variations in Potentiometric Heads at 9EGW1B



Due to a connection failure, previously “lost” data from mid-2015 have now been recovered.

Chart 56 Time Variations in Potentiometric Heads at 9FGW1A

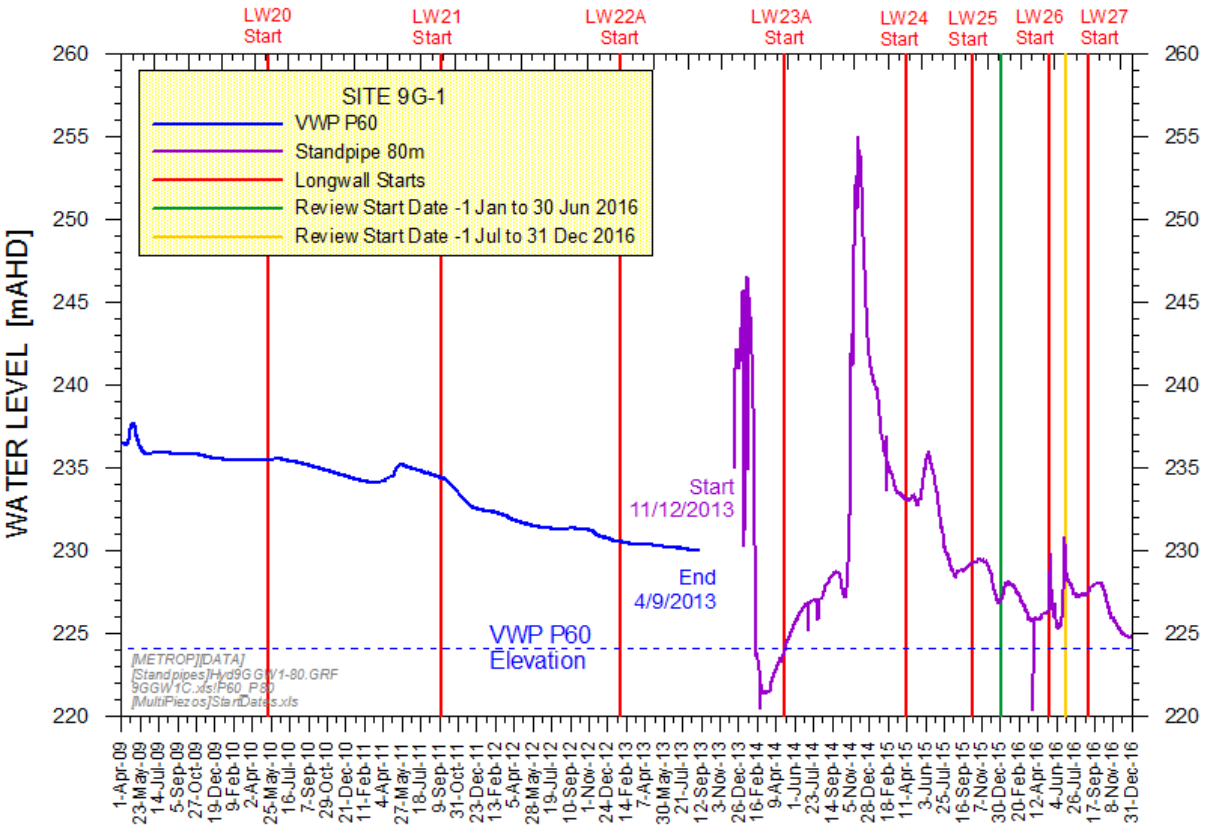


Chart 57 Time Variations in Water Table at Standpipe 9GGW1-80 and Decommissioned Vibrating Wire Piezometer 9GGW1-60

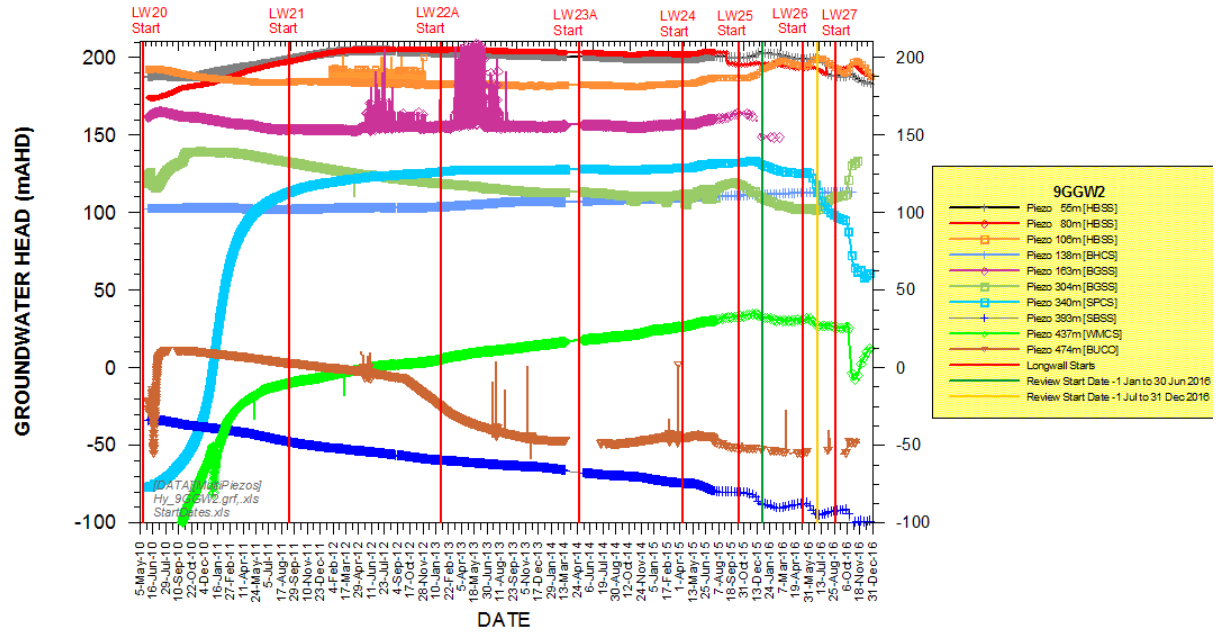


Chart 58 Time Variations in Potentiometric Heads at 9GGW2B

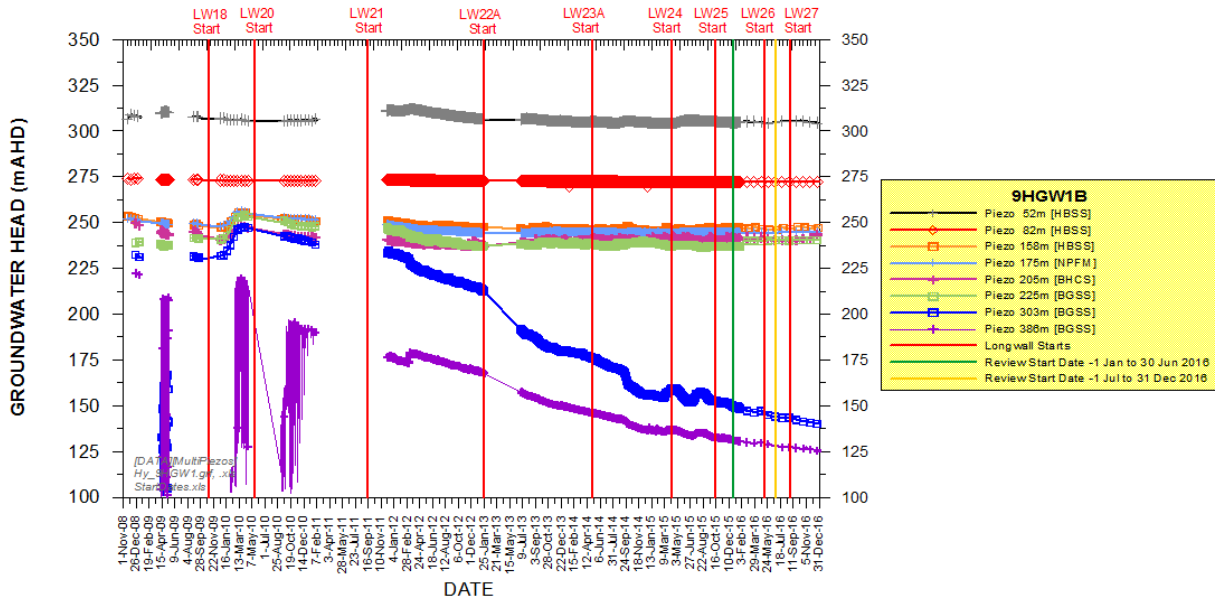


Chart 59 Time Variations in Potentiometric Heads at 9HGW1B

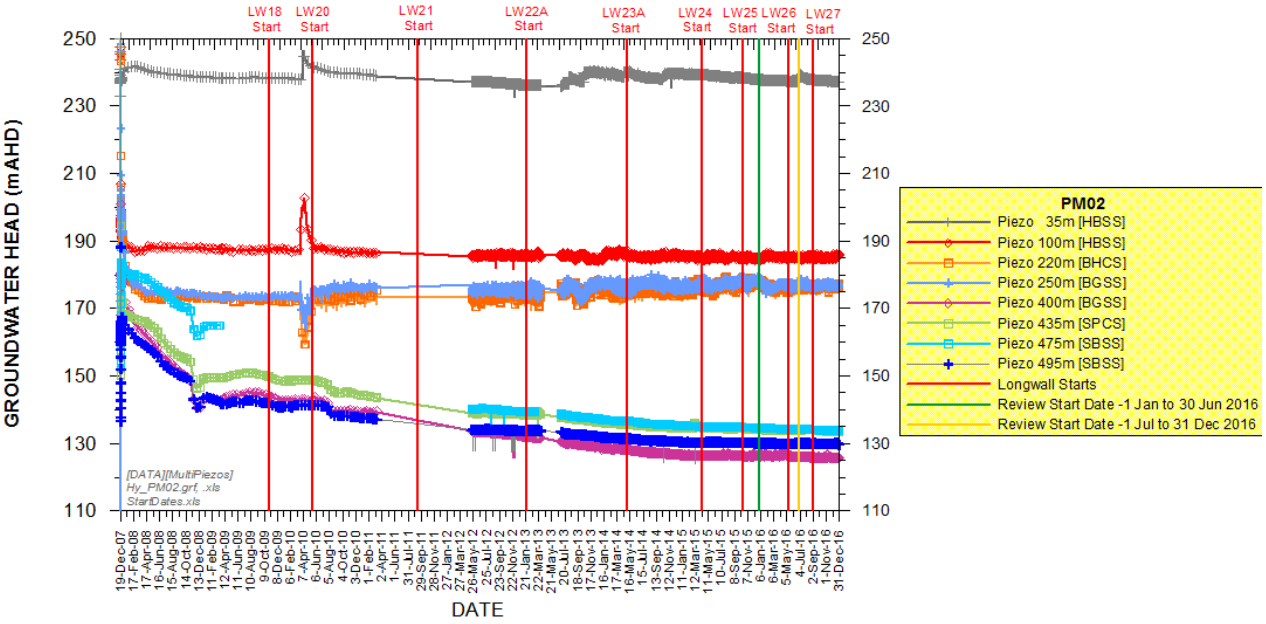


Chart 60 Time Variations in Potentiometric Heads at PM02

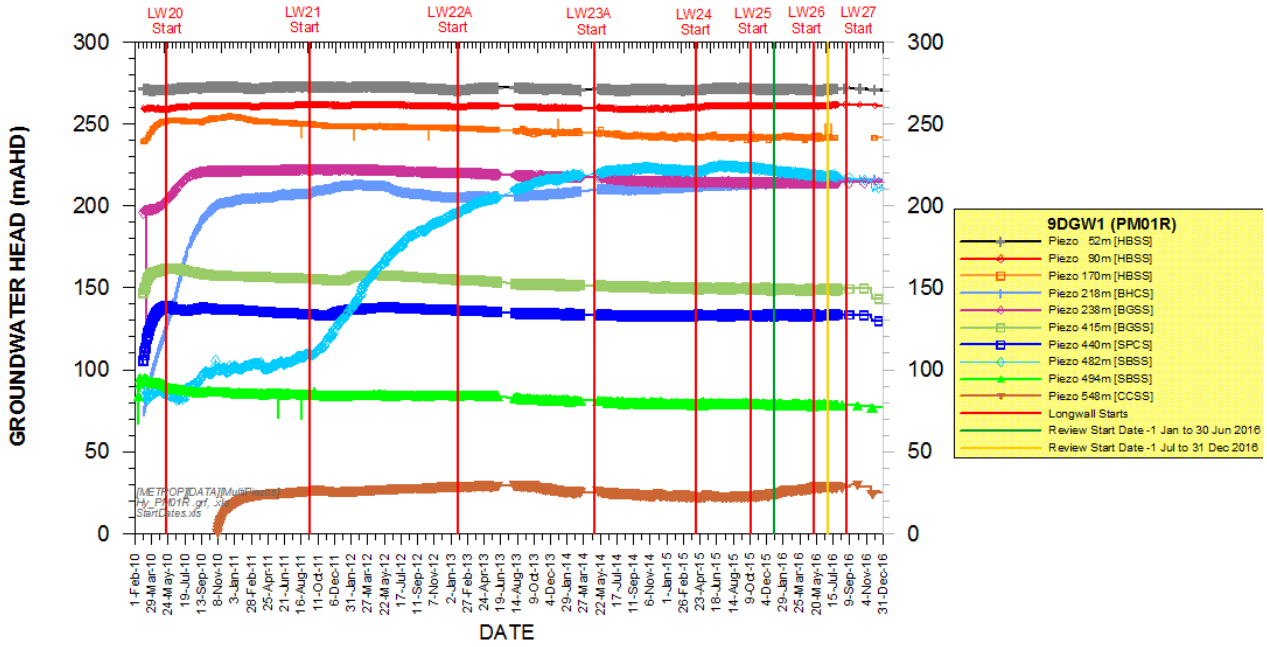


Chart 61 Time Variations in Potentiometric Heads at PM01

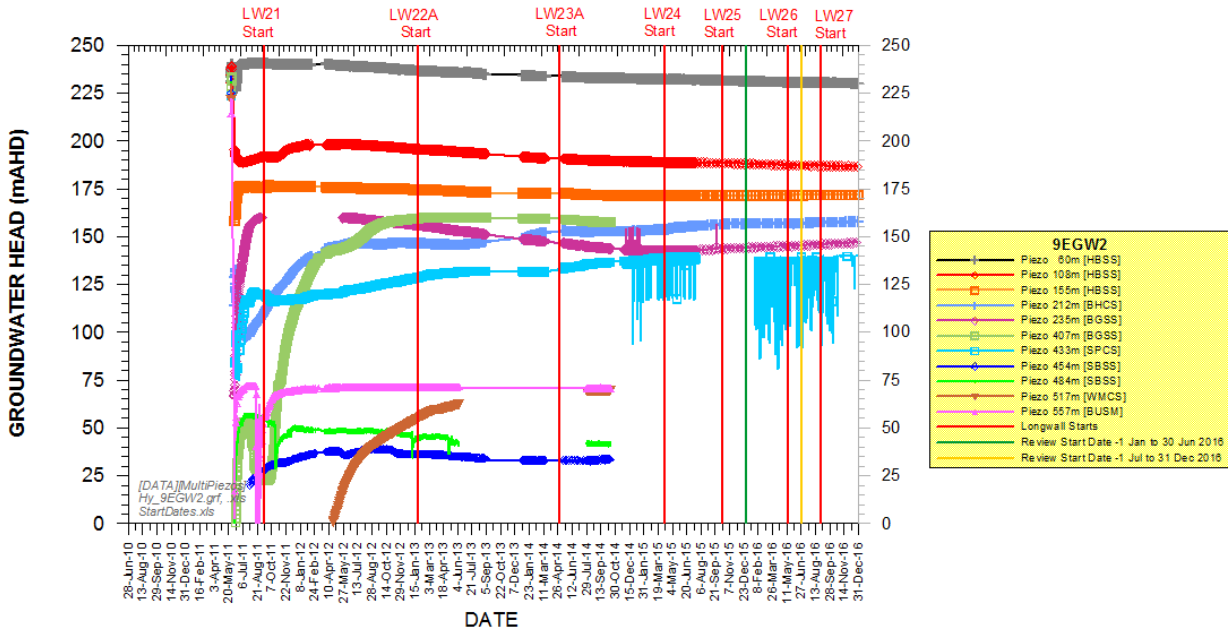


Chart 62 Time Variations in Potentiometric Heads at 9EGW2A

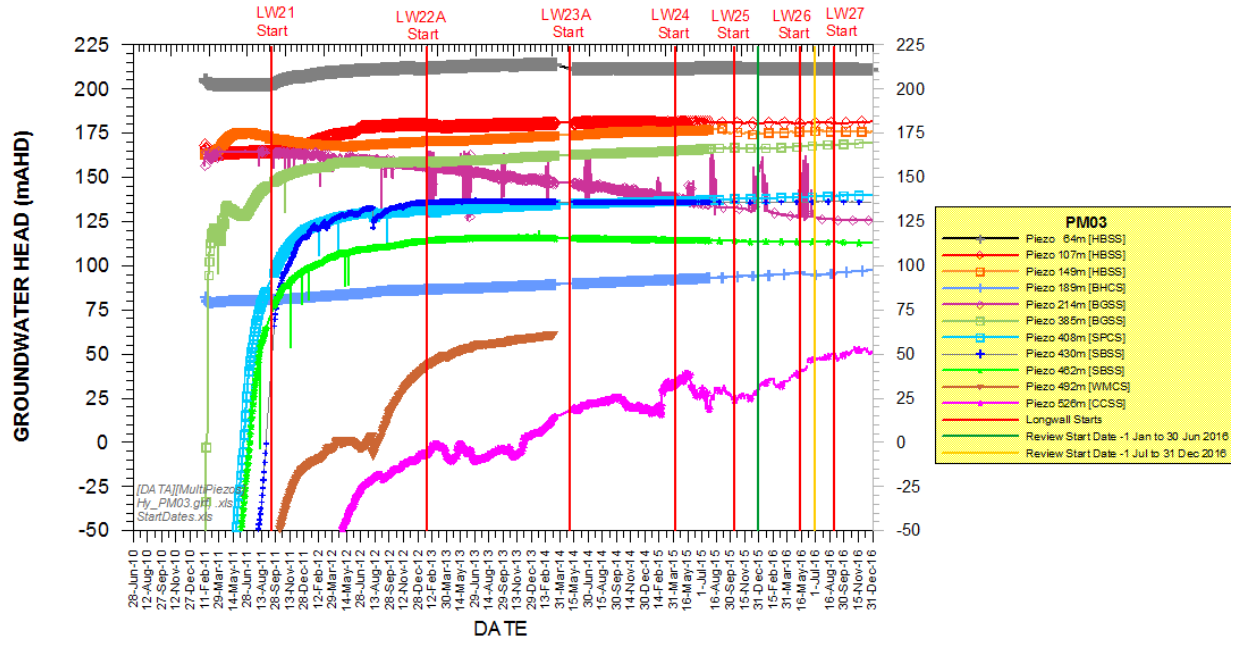
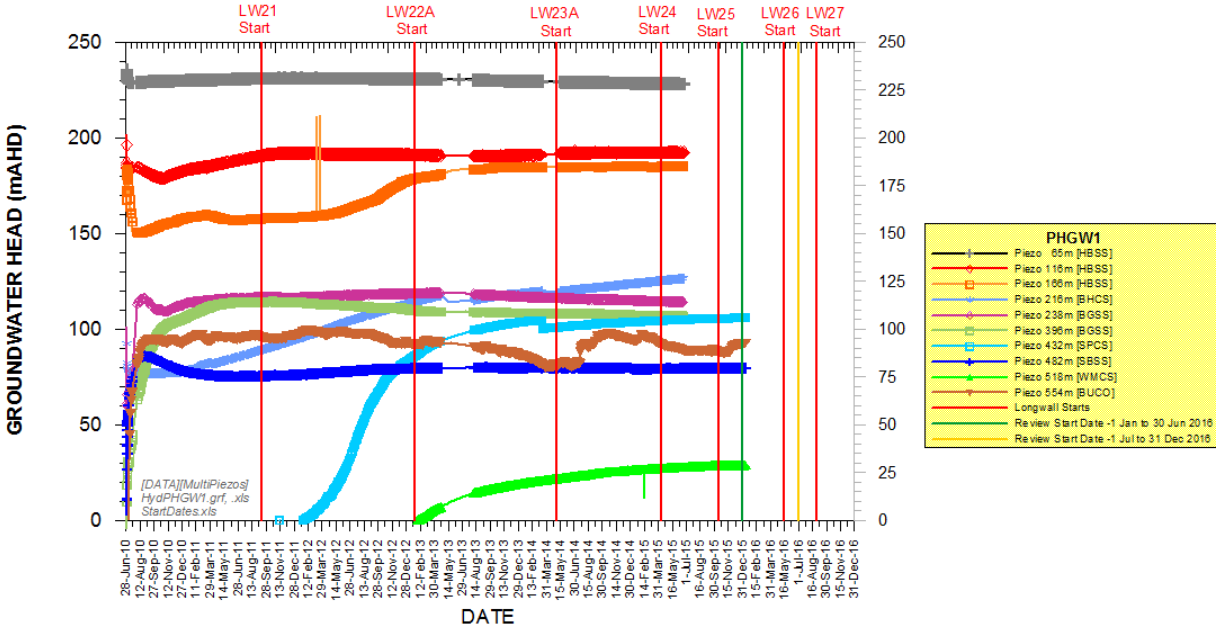
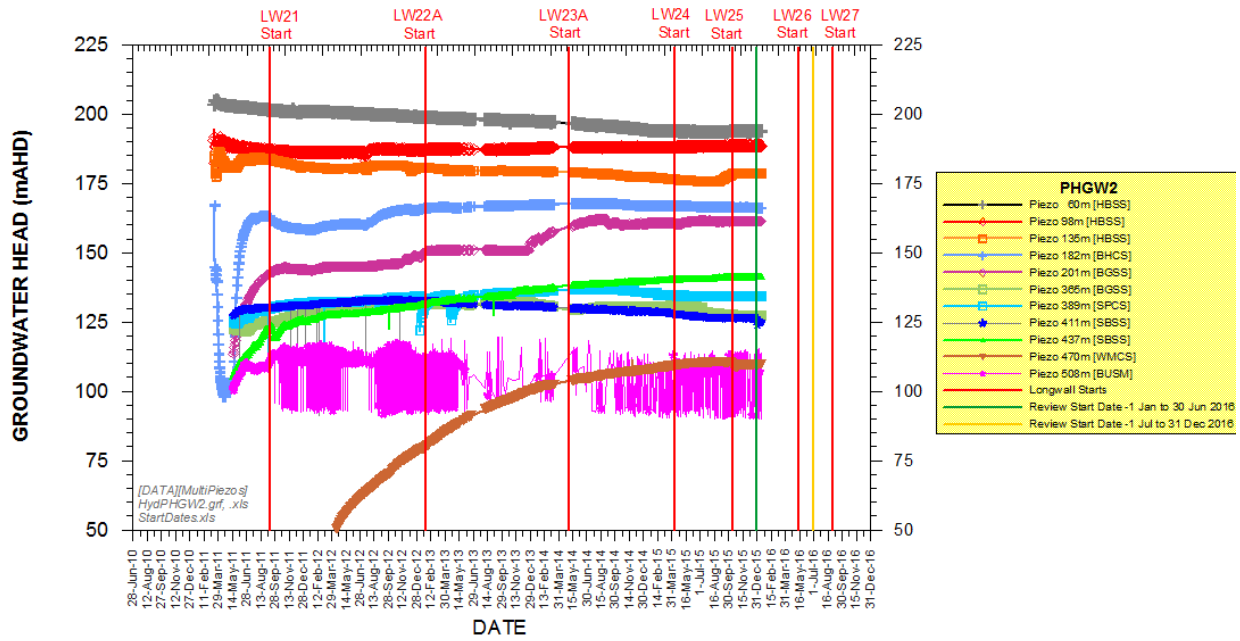


Chart 63 Time Variations in Potentiometric Heads at PM03



Note that a connection failure prevented upload of data for sensors in PHGW1B. The equipment supplier has not been able to recover the data.

Chart 64 Time Variations in Potentiometric Heads at PHGW1B



Note that a connection failure prevented upload of data for sensors in PHGW2A. The equipment supplier has not been able to recover the data.

Chart 65 Time Variations in Potentiometric Heads at PHGW2A

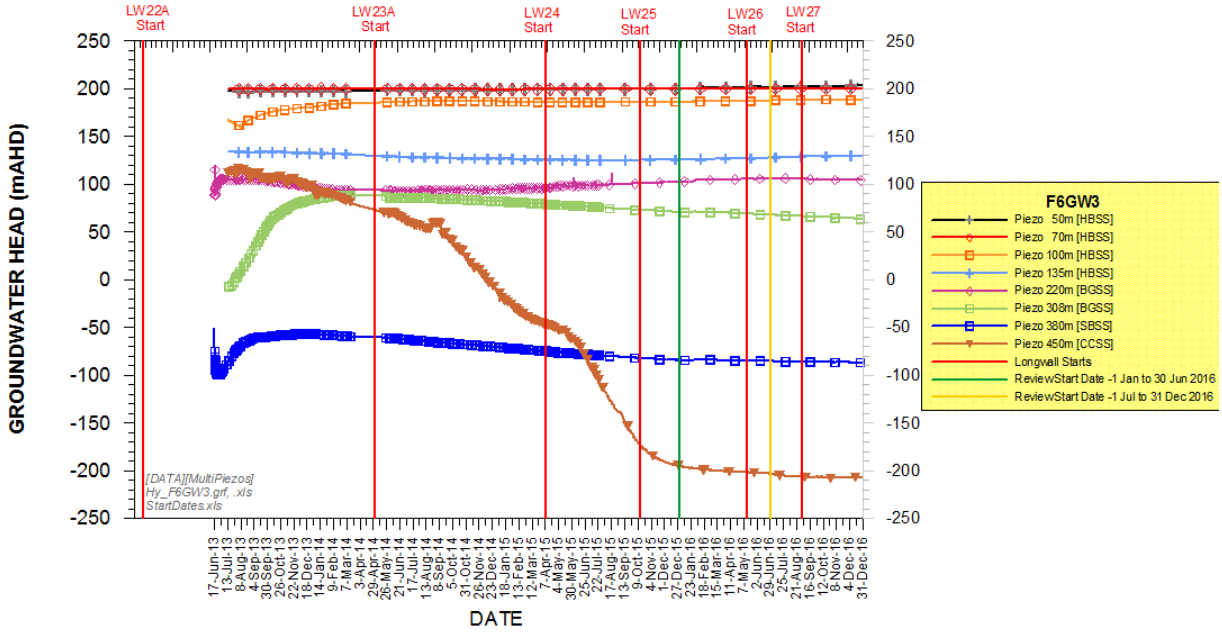
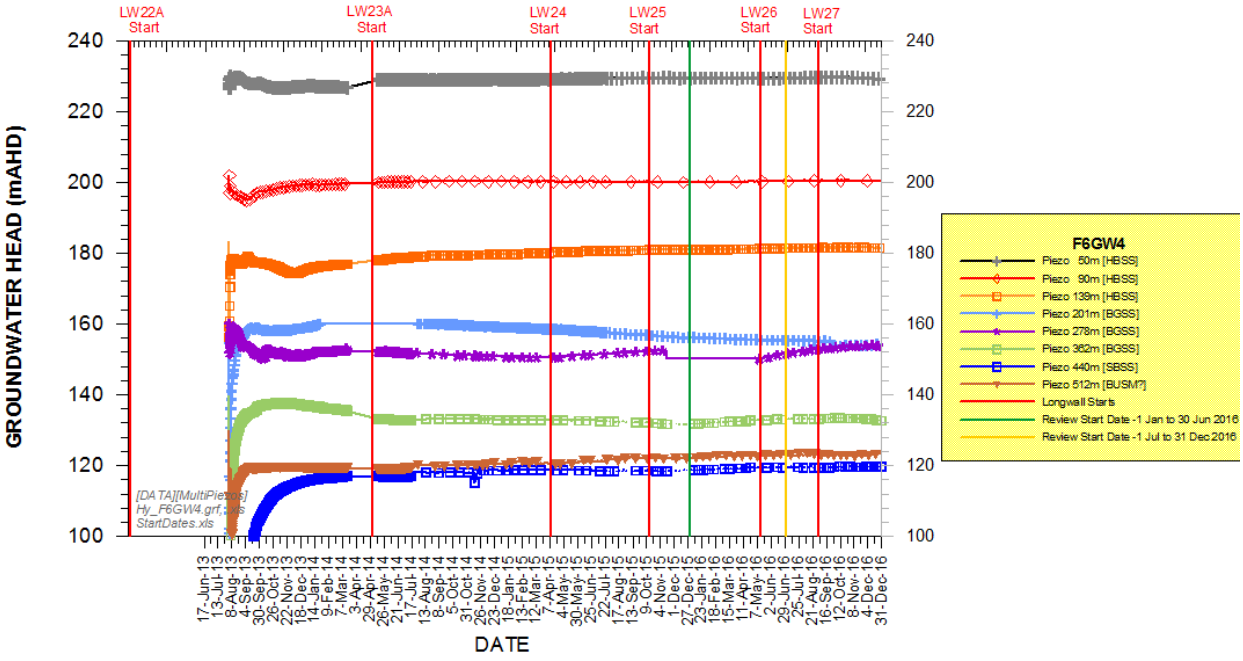


Chart 66 Time Variations in Potentiometric Heads at F6GW3



Due to a connection failure, previously "lost" data from October 2015 have now been recovered.

Chart 67 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 68 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 a hydraulic gradient is maintained between piezometers and the floor levels of the nearest streams (Chart 68).

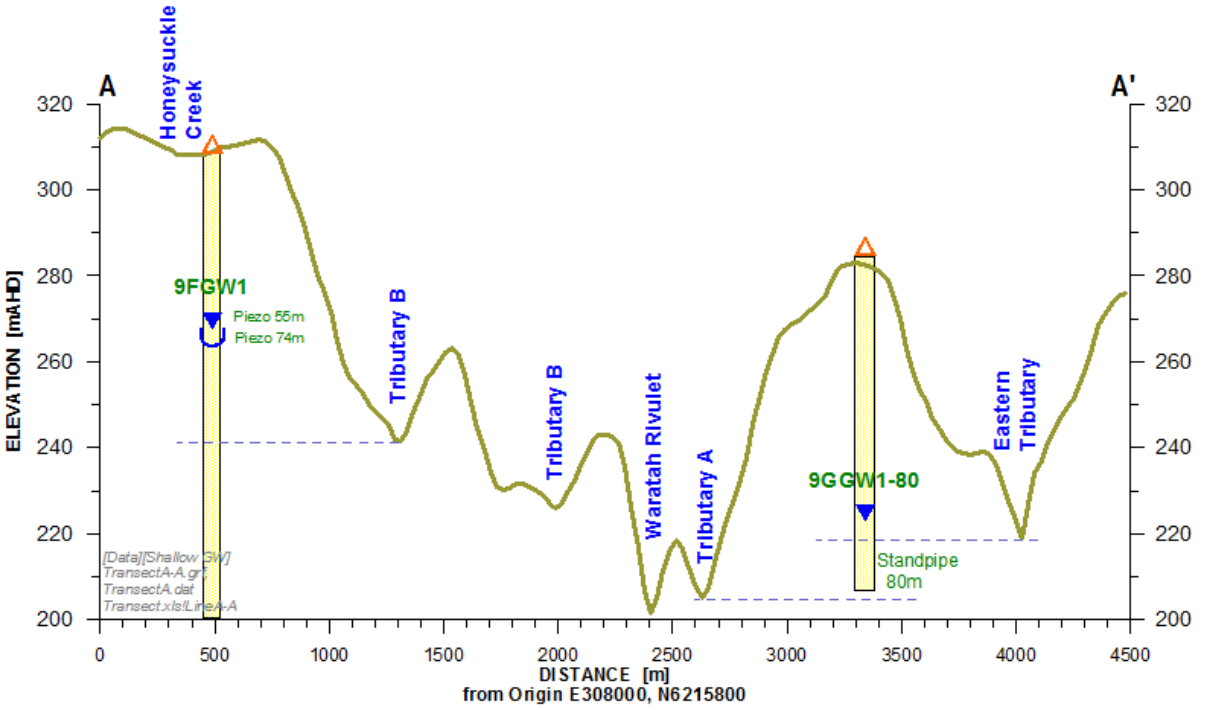


Chart 68 Topographic Transect A-A' along Longwall 22 and Hawkesbury Sandstone Water Levels (9GGW1-80 at 31 December 2016 and 9FGW1A at 31 December 2016)

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 69 indicates that the seven day average groundwater levels have not fallen below 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.

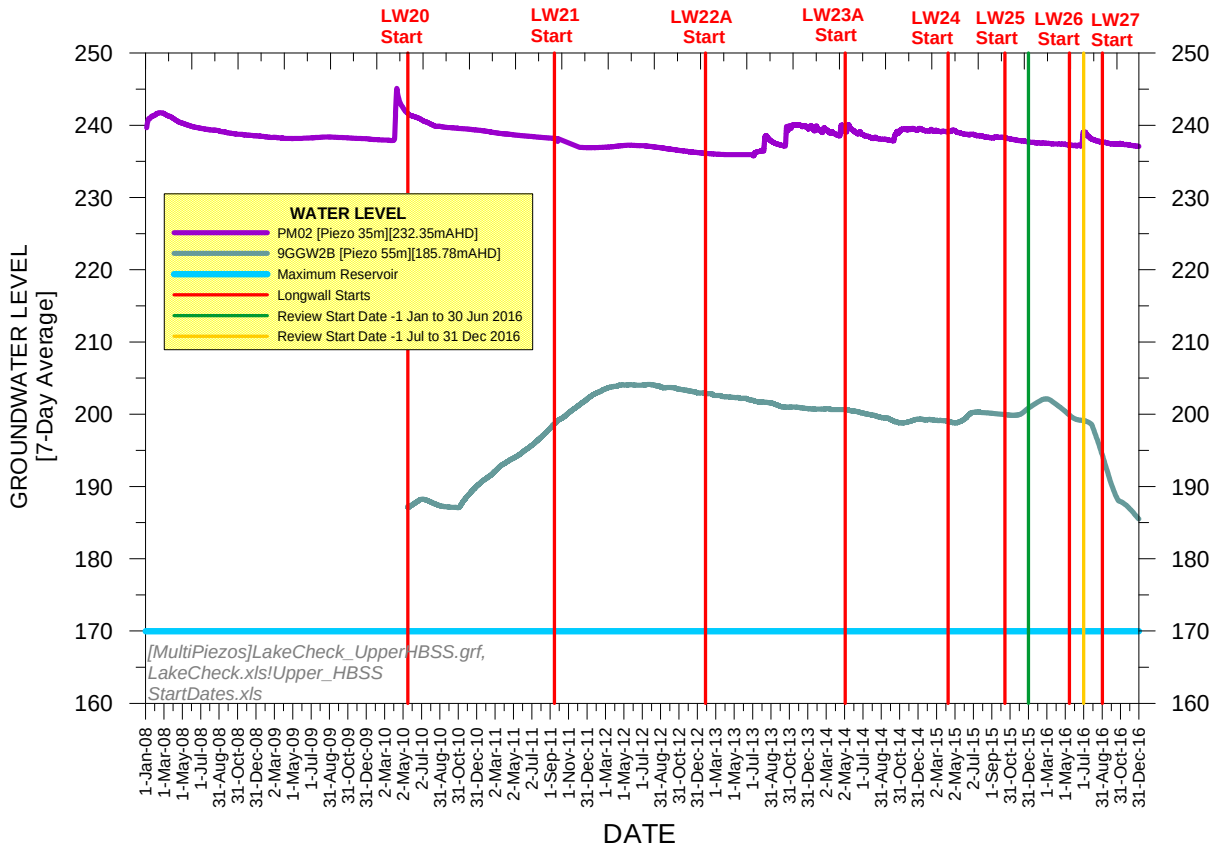


Chart 69 Seven Day Average Shallow Hawkesbury Sandstone Groundwater Levels at PM02 and 9GGW2B

2.9 GROUNDWATER QUALITY

Groundwater quality monitoring at sites WRGW1 to WRGW7 on Waratah Rivulet (Figure 7) during the reporting period indicates iron concentrations have remained below 10 mg/L (Chart 70) consistent with the previous reporting period. Manganese concentrations at the Waratah Rivulet sites have typically been less than 1 mg/L during the reporting period (Chart 71) and aluminium concentrations have been low. pH at the Waratah Rivulet sites has been generally acidic and usually between pH 5.5 and 7 (Chart 72). The observations are consistent with those reported previously.

Groundwater quality monitoring at sites ETGW1 to ETGW2 on the Eastern Tributary (Figure 7) during the reporting period indicates higher iron concentrations (17.1 mg/L and 15.4 mg/L) recorded at ETGW1 in January 2016 and April 2016, respectively, were sustained in the second half of the reporting period (about 17-18 mg/L), despite an excursion to less than 1 mg/L after the June 2016 high rainfall event (Chart 73). Iron concentrations at ETGW2 were consistent with previously recorded concentrations (Chart 73). The higher manganese concentrations (0.71 mg/L and 0.65 mg/L) recorded at ETGW1 in January 2016 and April 2016, respectively, have been sustained in the reporting period (about 0.8 mg/L) (Chart 74). The values are now consistently higher than the previously recorded manganese concentrations at this site. Aluminium was at or below 0.05 mg/L in all samples. The groundwater at the Eastern Tributary sites is generally acidic, predominantly between pH 5.7 and pH 6.2 with some indication of a rising trend in latter months (Chart 75).

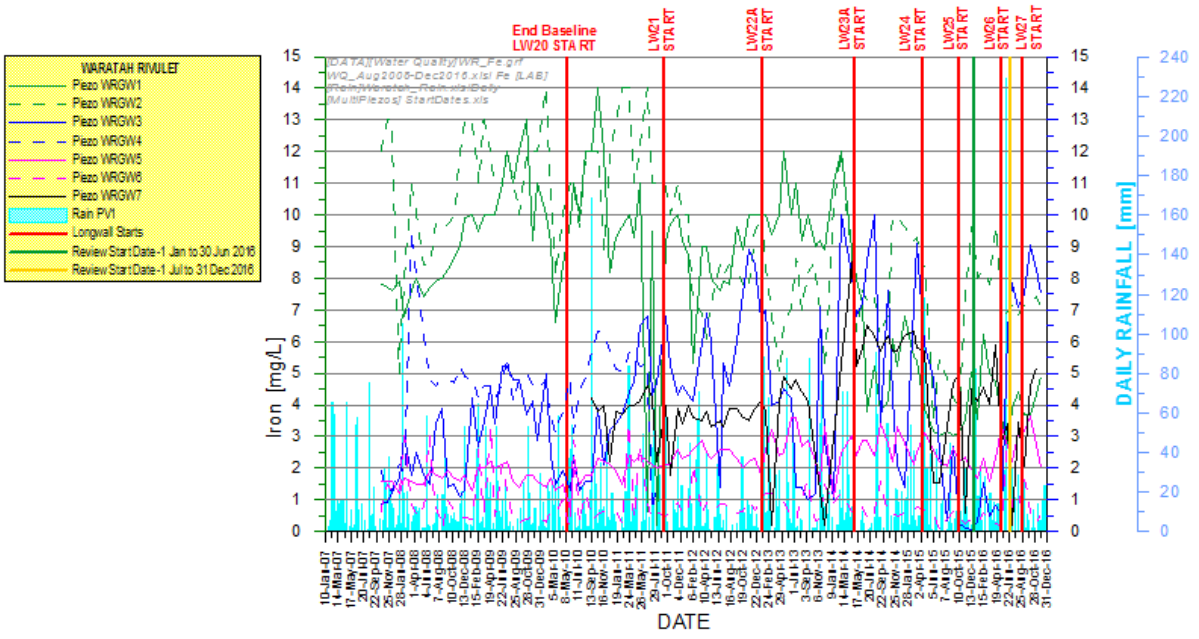


Chart 70 Iron Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

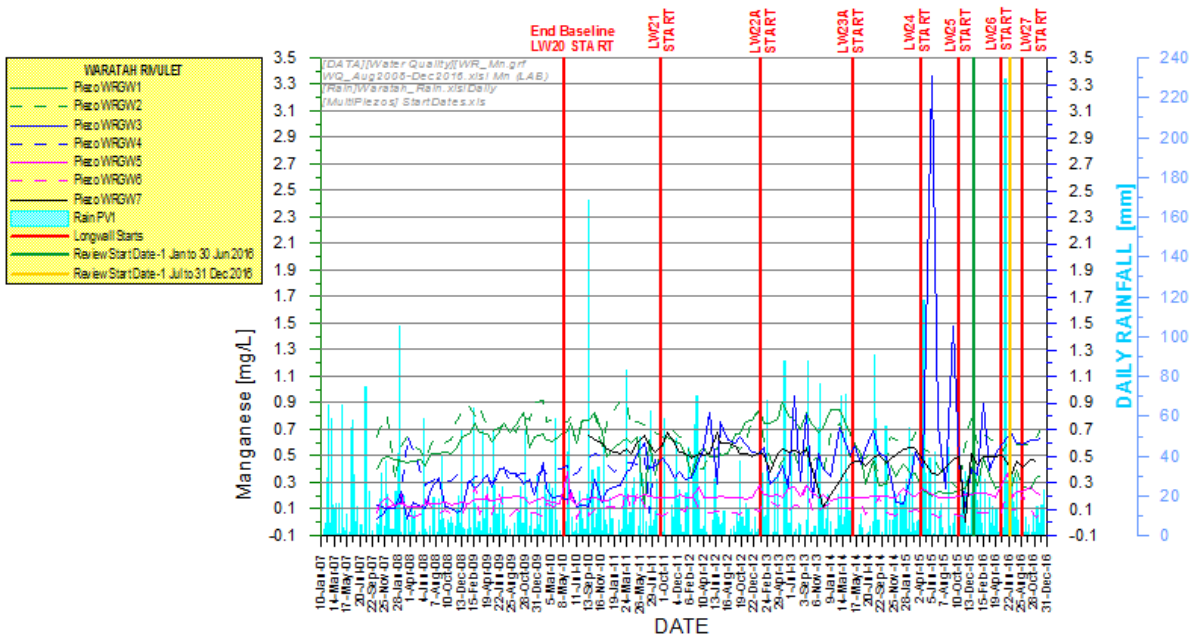


Chart 71 Manganese Concentrations at WRGW1 to WRGW7 on Waratah Rivulet

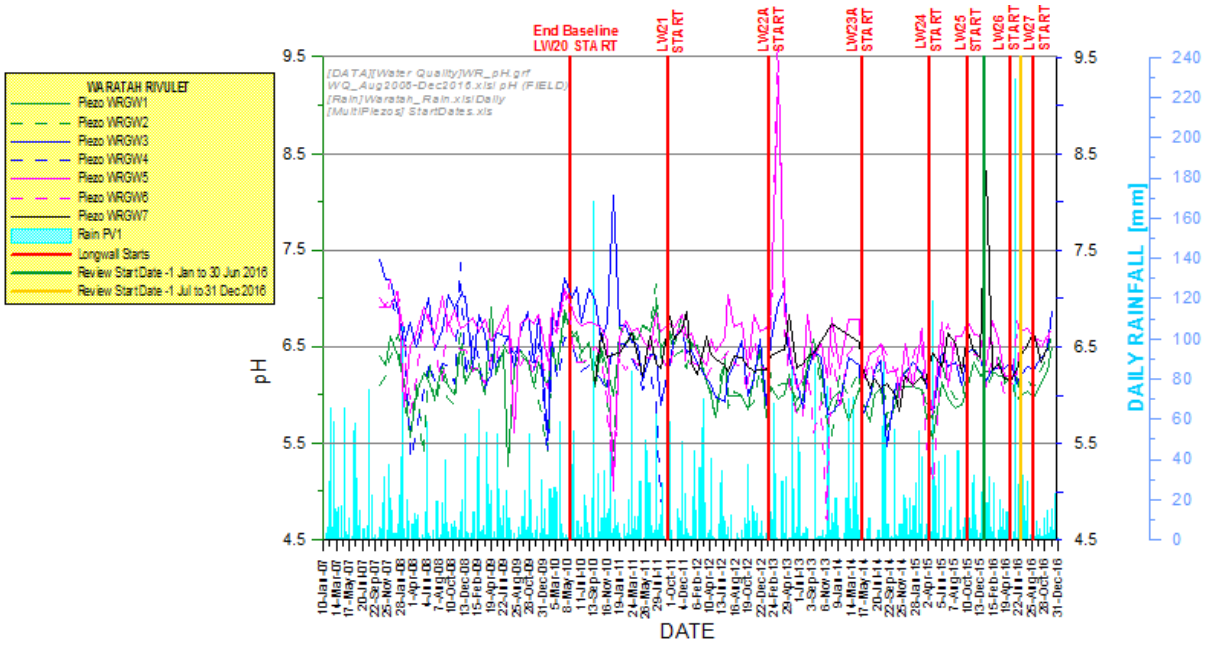


Chart 72 pH Levels at WRGW1 to WRGW7 on Waratah Rivulet

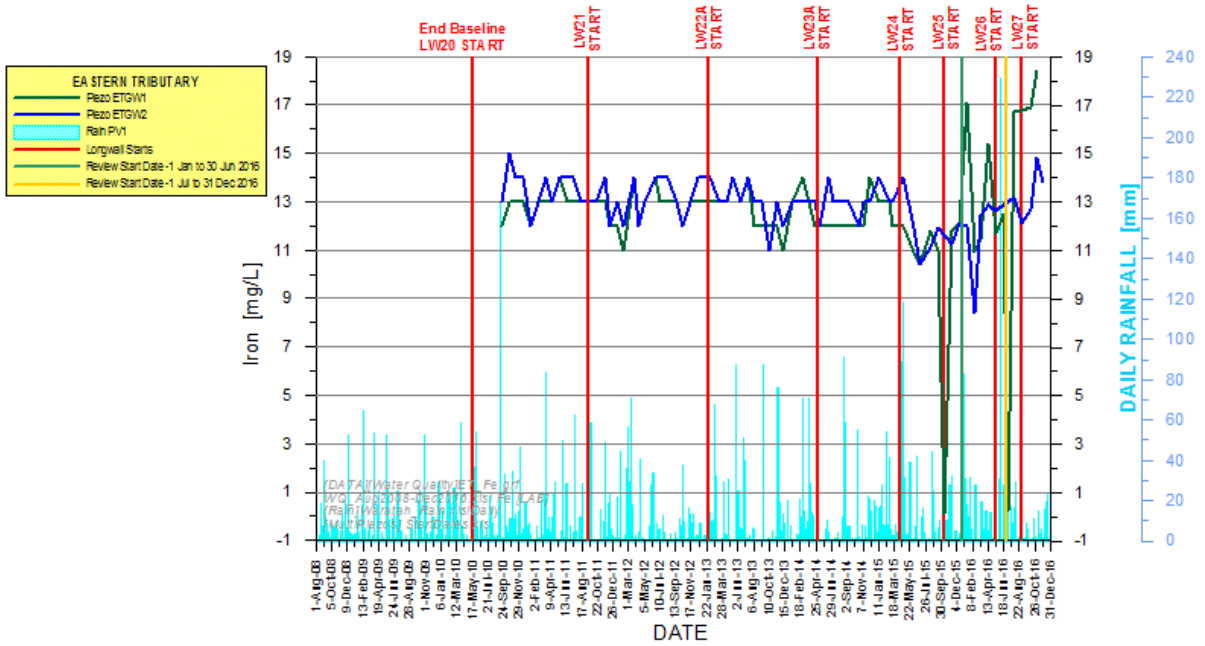


Chart 73 Iron Concentrations at ETGW1 and ETGW2 on Eastern Tributary

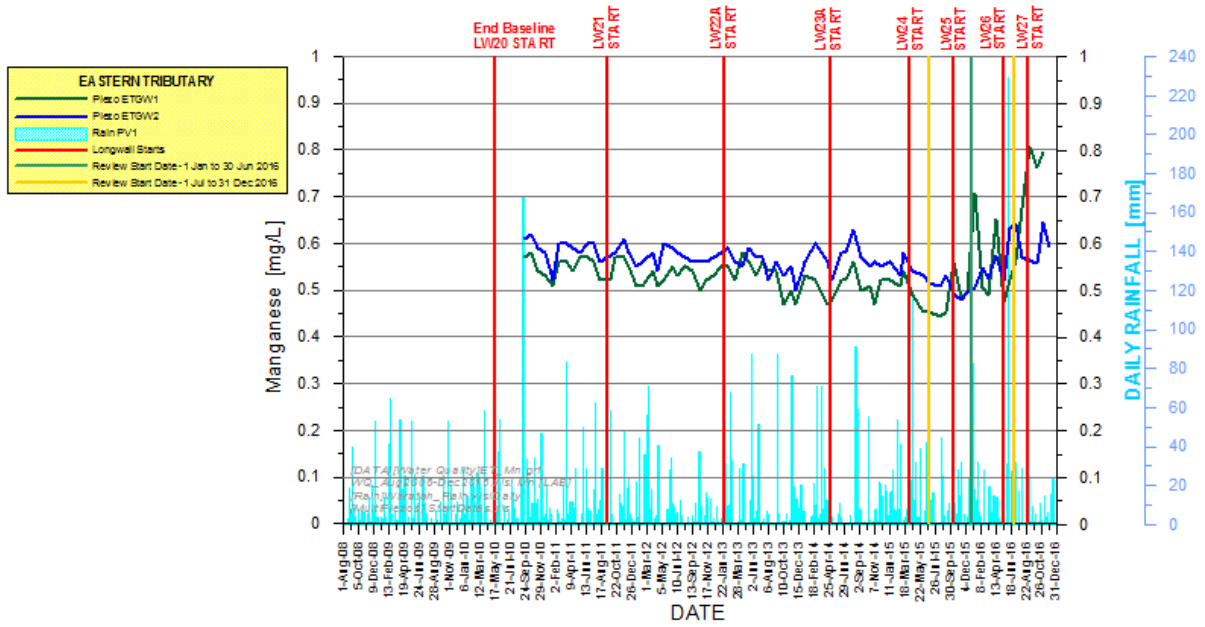


Chart 74 Manganese Concentrations at ETGW1 and ETGW2 on Eastern Tributary

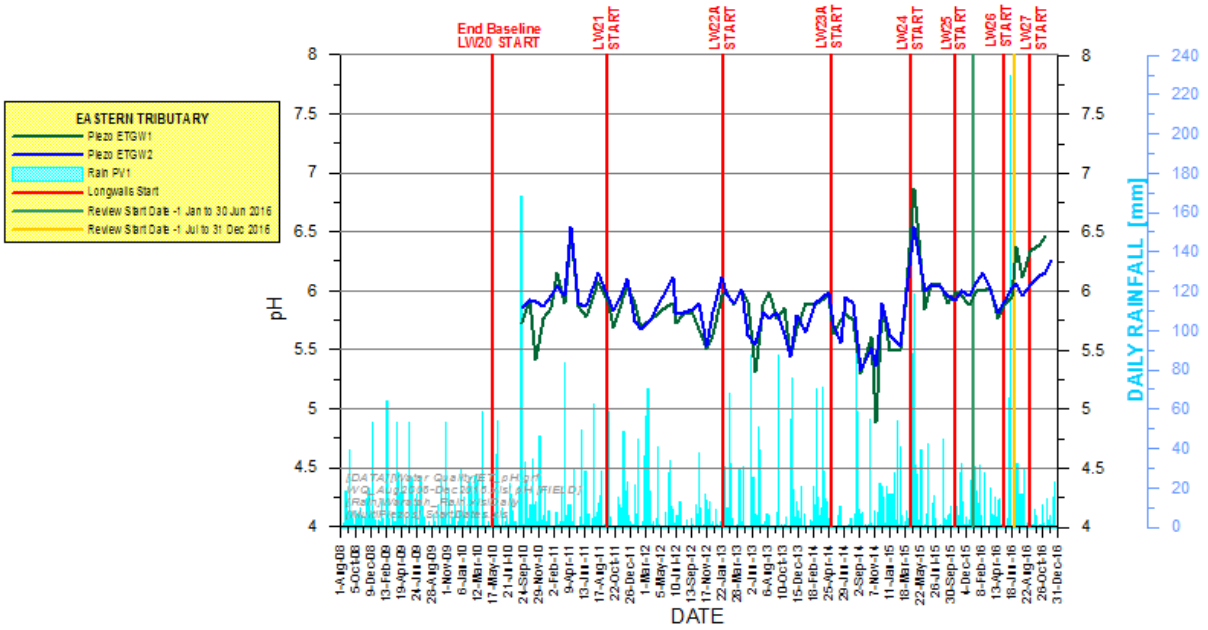


Chart 75 pH Levels at ETGW1 and ETGW2 on Eastern Tributary

2.10 INSPECTIONS OF MINE WORKINGS

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

2.11 MINE WATER MAKE

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 is assessed against a subsidence impact performance indicator for mine water make of no more than 2 ML/day. The 20 day average daily mine water make has been less than 0.5 ML/day during the reporting period (Chart 76).

The reduction in total mine inflows and outflows recorded in September 2016 (Chart 76) reflect the limited production while underground mining operations moved to the next longwall (Longwall 27).

The net water inflow recorded in November and December 2016 reflects the commencement of the coal reject emplacement backfill plant pumping coal reject directly to the goaf of Longwall 27. There is a net loss of water into the caved zone as not all water is able to be returned to the surface.

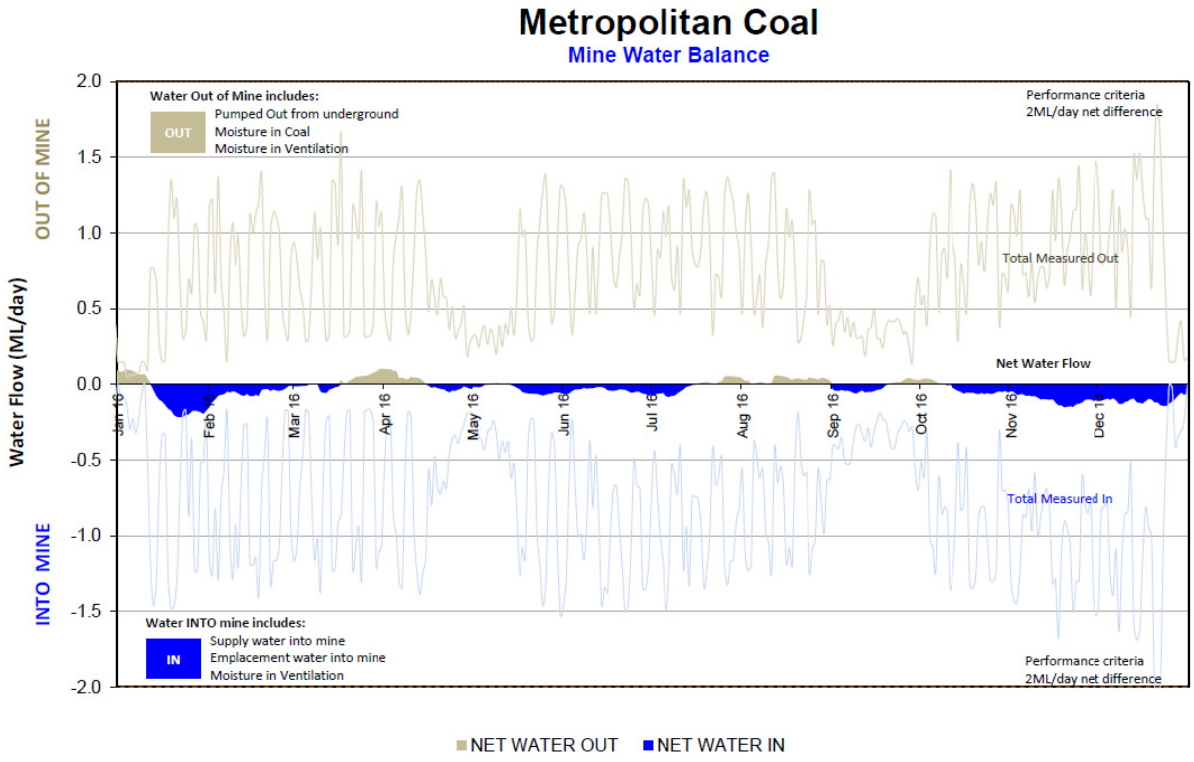


Chart 76 Estimated Daily Mine Water Make

2.12 EASTERN TRIBUTARY PERFORMANCE MEASURE

Incident Notification and Reporting

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.

Monitoring conducted in accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan identified that the following subsidence impact performance measure for the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26 had been exceeded in relation to iron staining (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 the subsidence impact performance measure 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.

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. Metropolitan Coal will prepare detailed stream remediation plans for the Eastern Tributary, starting with Pools ETAH and ETAK. The detailed stream remediation plans will be developed in consultation with the DRE, WaterNSW and DP&E.

Minimal Iron Staining Exceedance

The extent of iron staining on the Eastern Tributary was observed to increase after the completion of Longwall 25 in April 2016. Longwall 25 is located approximately 250 m upstream of the maingate of Longwall 26.

An Eastern Tributary Performance Indicator Iron Staining Register was developed to record the results of the visual inspections and to assist in the assessment of the Longwalls 23-27 Water Management Plan iron staining performance indicator:

> *Visual inspection of the Eastern Tributary between the full supply level of the Woronora Reservoir and Pool ETAF does not show significant changes in the extent or nature of iron staining to more than 30% of the Eastern Tributary that isn't also occurring in the Woronora River (control site).*

The regular visual inspections conducted by Metropolitan Coal during the reporting period identified a progressive increase in iron staining on the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir. In June 2016, iron staining was observed at Boulderfield ETAF, Rock bar ETAF(2), Pool ETAH, Rock bar ETAH and Rock bar ETAK downstream of the Longwall 26 maingate (Appendix C). As at December 2016, as a result of Longwalls 23-27 extraction, iron staining extends along the majority of the relevant reach of the Eastern Tributary.

Iron staining/flocculent material is associated with the flushing of iron from sandstone fractures created by upsidence and valley closure. Experience at Metropolitan Coal prior to the Project Approval indicated that areas of the substratum in the Waratah Rivulet and other watercourses had been observed to be affected by orange-red iron staining for several hundred metres downstream of mine subsidence fractures.

'*Negligible environmental consequences'* for a watercourse are considered in the Project Approval conditions to mean … *minimal iron staining*, and was assumed incorrectly by the Metropolitan Coal Project Planning Assessment Commission to be achieved in circumstances where predicted valley closure is less than 200 millimetres (mm). This presented an inconsistency with previous observations at Metropolitan Coal of iron staining occurring several hundred metres downstream of mine subsidence fractures (i.e. for several hundred metres downstream of sections of stream where the predicted closure exceeded 200 mm) and where impacts occurred.

Following the exceedance of the iron staining component of the Eastern Tributary subsidence impact performance measure in October 2016, Metropolitan Coal implemented a number of tasks from October 2016 to January 2017 to inform the development of contingency measures. The tasks included:

- Increasing the frequency of water quality sampling at sites ETWQF, ETWQN, ETWQAF, ETWQAG, ETWQAH, ETWQAI, ETWQAK, ETWQAQ and ETWQAU on the Eastern Tributary and at site WOWQ2 on the Woronora Reservoir from monthly to weekly.
- Specialist assessment of the available Eastern Tributary water quality data.
- Continued monitoring of iron staining and other stream attributes (such as gas releases, the natural drainage behaviour of pools and stream flows) on the Eastern Tributary in accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan.
- Field inspections of the upper reaches of the Woronora Reservoir (i.e. downstream of the full supply level) to identify the presence/absence of iron staining.
- Specialist assessment against the subsidence impact performance measure for biodiversity of *Negligible impact on threatened species, populations, or ecological communities* in accordance with the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan.
- Analysis of the spring 2016 aquatic ecology monitoring data for the Eastern Tributary and relevant reference pools.
- Consideration of the subsidence effects associated with Longwall 26 compared to Longwall 27.

The available water quality data was regularly reviewed by Associate Professor Barry Noller (The University of Queensland) and Hydro Engineering & Consulting. The source of the iron and manganese is from carbonate minerals in the Hawkesbury sandstone. Reducing conditions in the groundwater has solubilised iron and manganese. The soluble iron and manganese, which is able to enter the Eastern Tributary via cracking from longwall mining has resulted in the increase in iron staining and dissolved manganese concentrations. While dissolved manganese concentrations have increased in the Eastern Tributary since July 2016, analysis of water quality data indicates the watercourse subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir*, had not been exceeded.

Inspection of the upper reaches of the Woronora Reservoir (i.e. downstream of the full supply level) for iron staining indicated that some iron staining/flocculent was observed in the upper-most reaches of the Woronora Reservoir full supply level within the boulderfield, however, the water in the inundated area was observed to be clear.

In accordance with the Longwalls 20-22 and 23-27 Biodiversity Management Plans, an exceedance of a watercourse subsidence impact performance measure triggers an assessment against the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations or ecological communities*. On the basis that the environmental consequences of the incident relate to in-stream habitats, and that there are no threatened aquatic fauna or flora known, or considered likely to occur, an assessment against the biodiversity performance measure was conducted in relation to threatened terrestrial fauna (namely, the Red-crowned Toadlet, *Pseudophryne australis,* and the Giant Burrowing Frog, *Heleiporus australiacus*) by Cenwest Environmental Services. The assessment indicated the biodiversity subsidence impact performance measure, *Negligible impact on threatened species, populations or ecological communities,* had not been exceeded as a result of the identified impacts to the Eastern Tributary.

The results of analysis of the aquatic ecology monitoring data are summarised in Section 3.4. Analysis of the aquatic ecology data indicates that the aquatic ecology performance indicator, *Aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence*, has not been exceeded at sites on the Eastern Tributary. 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 stream remediation works (referred to as pool monitoring). These monitoring programs will continue to be conducted bi-annually in autumn and spring.

Subsidence assessments completed by MSEC for the Metropolitan Coal Project Environmental Assessment (Project EA) and Metropolitan Coal Longwalls 23-27 Extraction Plan indicated that predicted conventional strains resulting from the extraction of Longwalls 23 to 27 would be of sufficient magnitude to result in fracturing of the uppermost bedrock. Fracturing and dilation of the uppermost bedrock could also occur along the alignments of streams due to valley related movements. MSEC's assessment of subsidence effects in November 2016 indicated that the observed subsidence movements and observed impacts to date were consistent with the predictions and impact assessments for the Eastern Tributary outlined in the Project EA and Longwalls 23-27 Extraction Plan.

As indicated above, Metropolitan Coal will prepare detailed stream remediation plans for the Eastern Tributary. In the development of the stream remediation plans, Metropolitan Coal will consider, with advice from a geotechnical engineer, whether strategic additional polyurethane injection (i.e. additional to the remediation of specific rock bars) may assist in reducing the extent of iron staining.

No Diversion of Flows/Change in the Natural Drainage Behaviour of Pools Exceedance

Up until December 2016, the monitoring of water levels/drainage behaviour of pools on the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir was consistent with predictions.

'*Negligible environmental consequences'* for a watercourse was assumed by the Metropolitan Coal Project Planning Assessment Commission to be achieved in circumstances where predicted valley closure is less than 200 mm. In the Longwalls 20-22 Extraction Plan Subsidence Assessment it was recognised that fracturing resulting in surface flow diversion could be observed at a site where the predicted total closure is less than 200 mm, although none had been observed to date. The report also noted that reference to the 200 mm predicted total closure value should be viewed as an indication of low probability (10%) of impact rather than certainty. In the Longwalls 23-27 Extraction Plan Subsidence Assessment, additional case studies were added to the pool impact model, including cases where loss of pool water levels had occurred at less than 200 mm predicted total closure. Similar to the previous database for Longwalls 20-22, the updated database showed that based on a maximum predicted total closure of 200 mm, the proportion of pools that experienced loss of pool water levels was around 10%.

In December 2016 and January 2017, a number of pools with predicted closure values of less than 200 mm experienced loss of pool water levels. This resulted in the exceedance of the negligible environmental consequences performance measure for the Eastern Tributary in relation to diversion of flows and drainage behaviour. The impacts are considered to be anomalous in that more than 15% of pools on the Eastern Tributary have experienced loss of pool water levels at predicted closure values of less than 200 mm.

However, the combined data that is available to MSEC for the Southern Coalfield (including the Waratah Rivulet and Eastern Tributary results) (to January 2017) indicates that less than 10% of all pools have experienced the diversion of flow at predicted closure values of less than 200 mm, consistent with previous assessments of potential pool impacts. On their own, the impacts for the Eastern Tributary are outside of the predictions of the empirical based model.

Metropolitan Coal will prepare detailed stream remediation plans for the Eastern Tributary, starting with Pools ETAH and ETAK. The detailed stream remediation plans will be developed in consultation with the DRE, WaterNSW and DP&E in accordance with the Metropolitan Coal Rehabilitation Management Plan.

3 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.

3.1 UPLAND SWAMP VEGETATION MONITORING

Upland swamp vegetation monitoring is conducted at a number of swamps overlying or adjacent to Longwalls 20-27 and at a number of control swamps (Figures 8 and 9).

The results of the Longwalls 20-22 and Longwalls 23-27 upland swamp vegetation monitoring programs (up to and including the autumn 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 autumn 2016, the level of iron staining associated with this seep was reduced 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 autumn 2016 with no unusual areas of vegetation senescence observed. Some isolated dieback and senescence of scattered individuals were recorded throughout most longwall and control swamps. For the Restioid Heath/Banksia Thicket swamps the main species included *Petrophile pulchella* and *Banksia ericifolia* subsp. *ericifolia* in valley side swamps, and for the Tea Tree Thicket swamps the main species included *Banksia robur* and *Gleichenia microphylla*.
- 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 autumn 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 was within ranges previously recorded (Charts 77 and 78). Analysis of species richness within Restioid Heath/Banksia Thicket sites using analysis of variance (ANOVA) did not detect significant differences between longwall and control sites in any season including autumn 2016.
- Species richness within individual Tea Tree Thicket sites in autumn 2016 was also within the range of previous seasons, with the exception of two control swamps (Woronora River south arm and Dahlia Swamp), where a small decrease in species was recorded (Charts 77 and 79). In autumn 2016, a small decrease in species richness from spring 2015 was observed in longwall Swamp 20. In autumn 2016, an increase in species richness from spring 2015 was observed in longwall Swamp 28 (by a single species). The changes in species richness recorded in autumn 2016 are consistent with the fluctuations observed within the baseline monitoring period. All observed changes in species richness are considered to be within the range of natural fluctuations in response to weather, population dynamics, seasonality of survey and natural disturbances including grazing by fauna species.

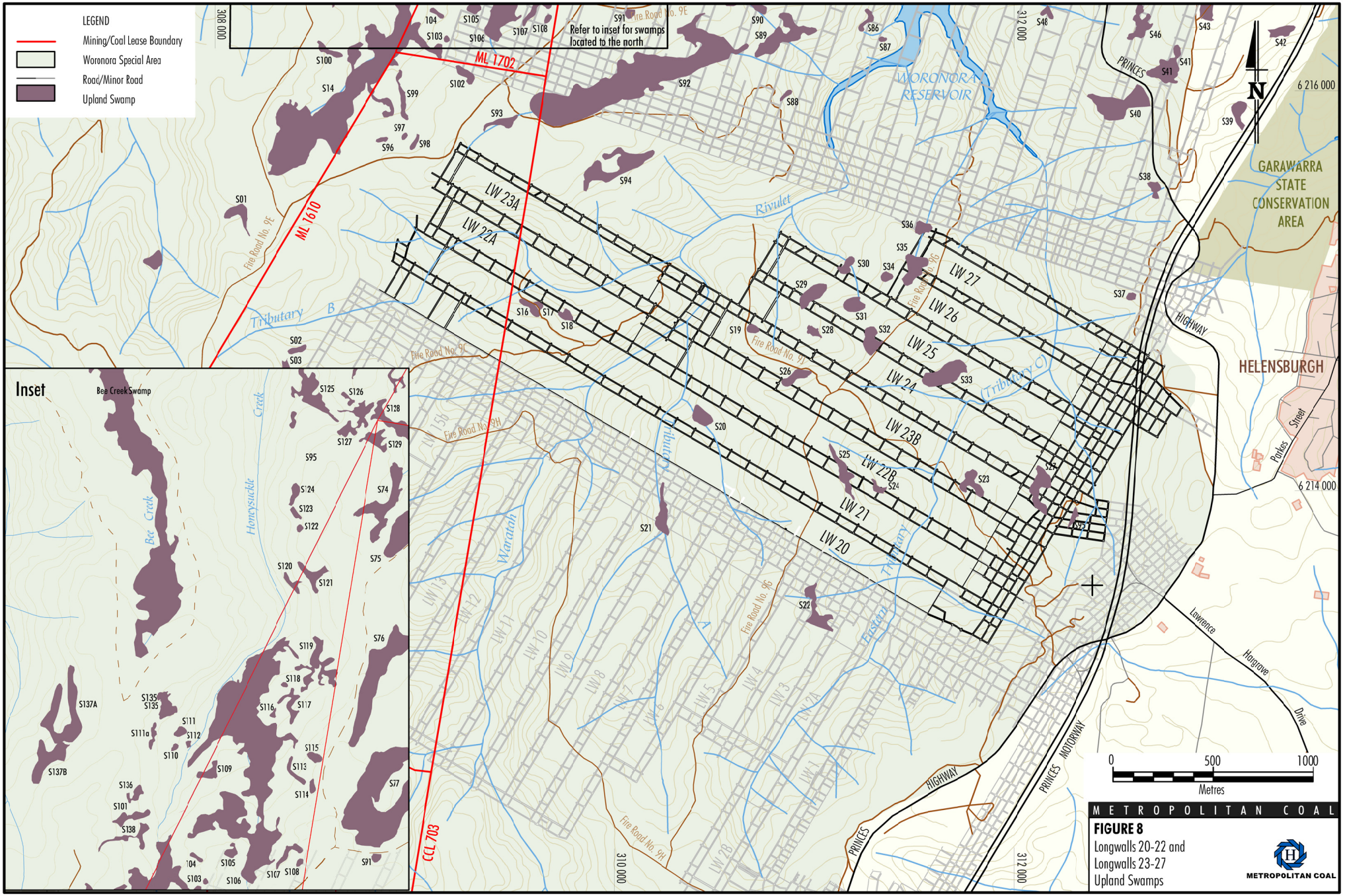


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FIGURE 8

Longwalls 20-22 and
Longwalls 23-27
Upland Swamps

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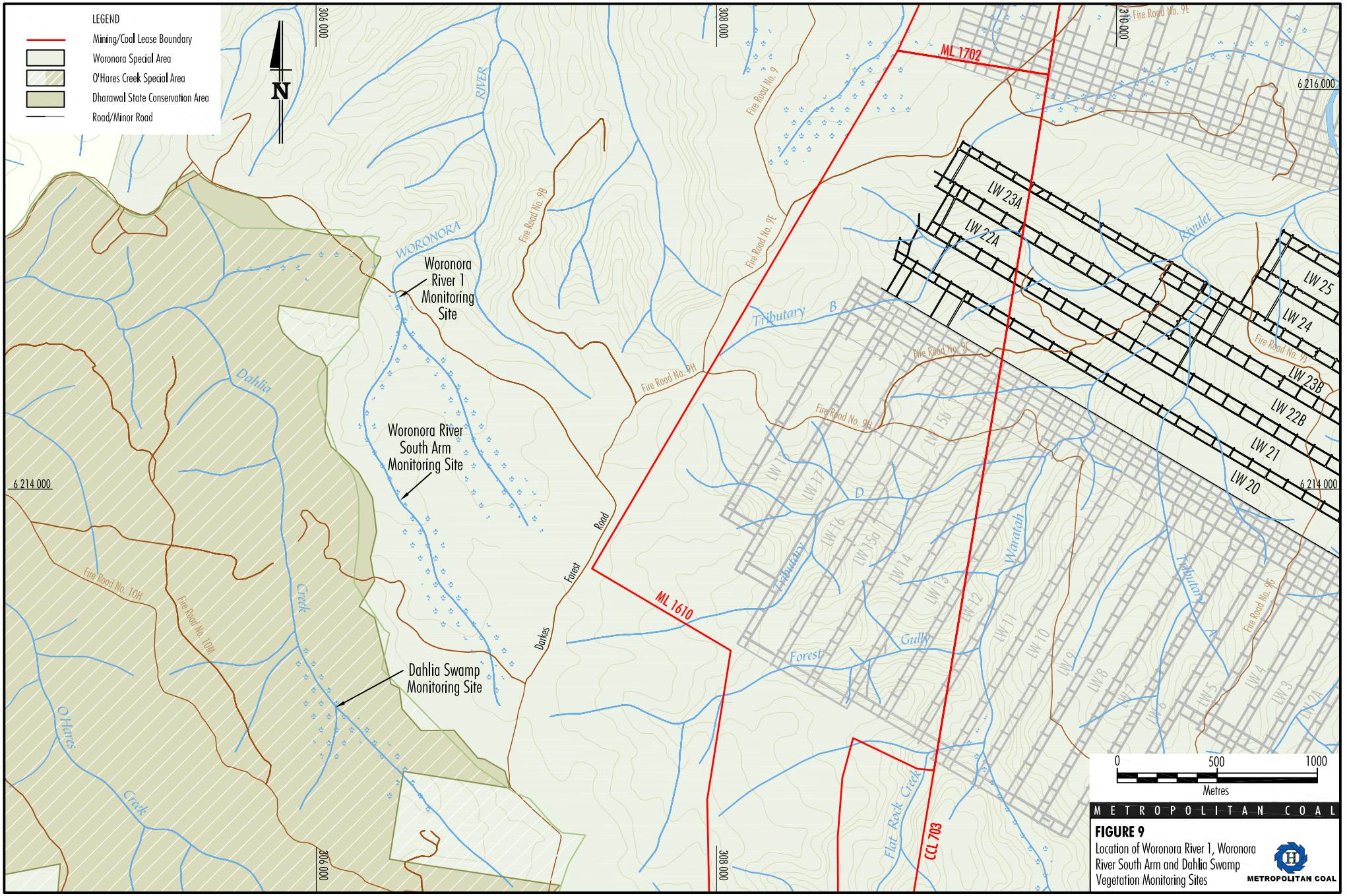

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- Analysis of quadrat/transect data indicates that the vegetation in upland swamps overlying longwall mining has not experienced changes significantly different to changes in control swamps.
- For Longwalls 20-22, monitoring of indicator species in the Restioid Heath/Banksia Thicket swamps indicated that the mortality rate of swamp indicator species was greater at longwall sites than control sites, although the differences are small for all species (proportional differences of less than three individuals) and 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.

  In autumn 2016 the mean vegetation condition of tagged indicator species within Restioid Heath/Banksia Thicket swamps and Tea Tree Thicket swamps was similar between longwall and control swamps, with the exception of *Leptospermum juniperinum* where mean vegetation condition was greater at the single longwall swamp than control swamps. The mean reproductive status of tagged indicator species was also similar at longwall and control sites in autumn 2016.
- 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 autumn 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. Similarly, lower mean vegetation condition of *Epacris obtusifolia* and *Banksia robur* was recorded within longwall swamps compared to control swamps in autumn 2016. Similar differences were observed during the baseline monitoring period and following the commencement of mining, indicating that the lower mean vegetation condition does not appear to be related to the mining of Longwalls 23-27.

  Monitoring of indicator species recorded similar mean reproductive status within longwall and control swamps for all indicator species, indicating the reproductive status of tagged indicator species within longwall swamps has not been altered as a result of the mining of Longwalls 23-27.
- No weed species were observed within any of the longwall upland swamps. Observations of weed species within upland swamps were limited to a single control swamp, Dahlia Swamp.
- 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.

The autumn 2016 Longwalls 20-22 and Longwalls 23-27 Vegetation Monitoring Reports prepared by Eco Logical Australia Pty Ltd are provided in Appendix G.

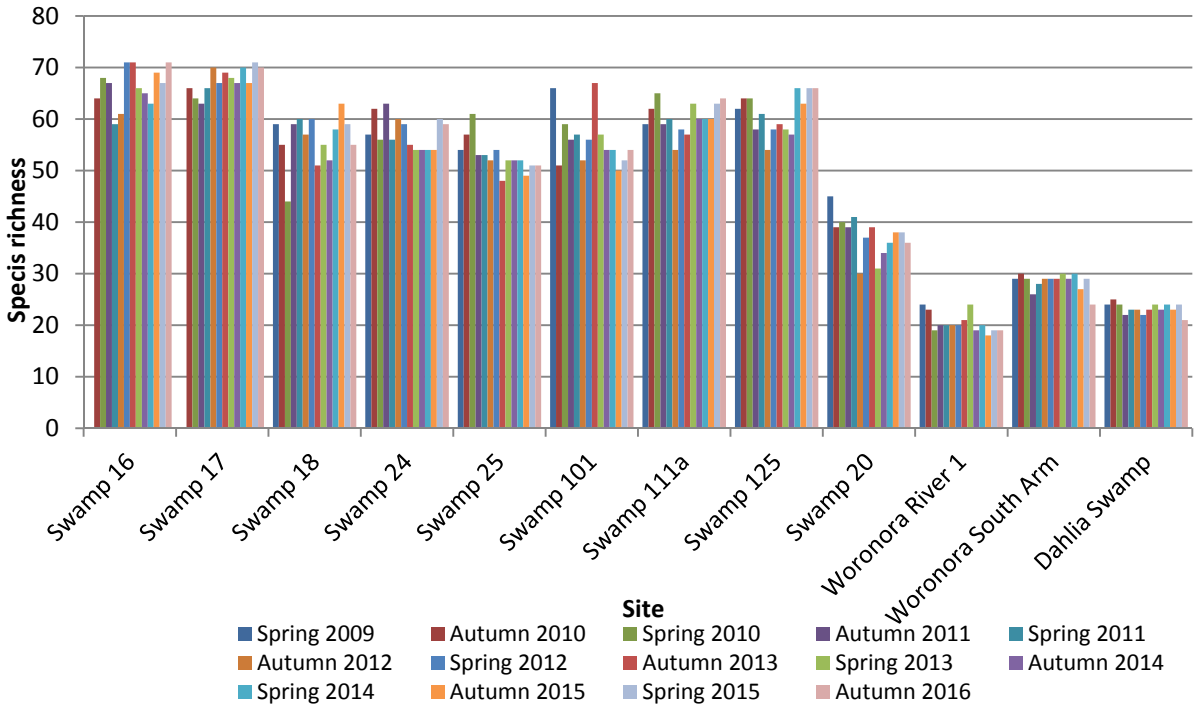

Chart 77 Native Species Richness in Longwalls 20-22 Upland Swamp Sites, Spring 2009 – Autumn 2016

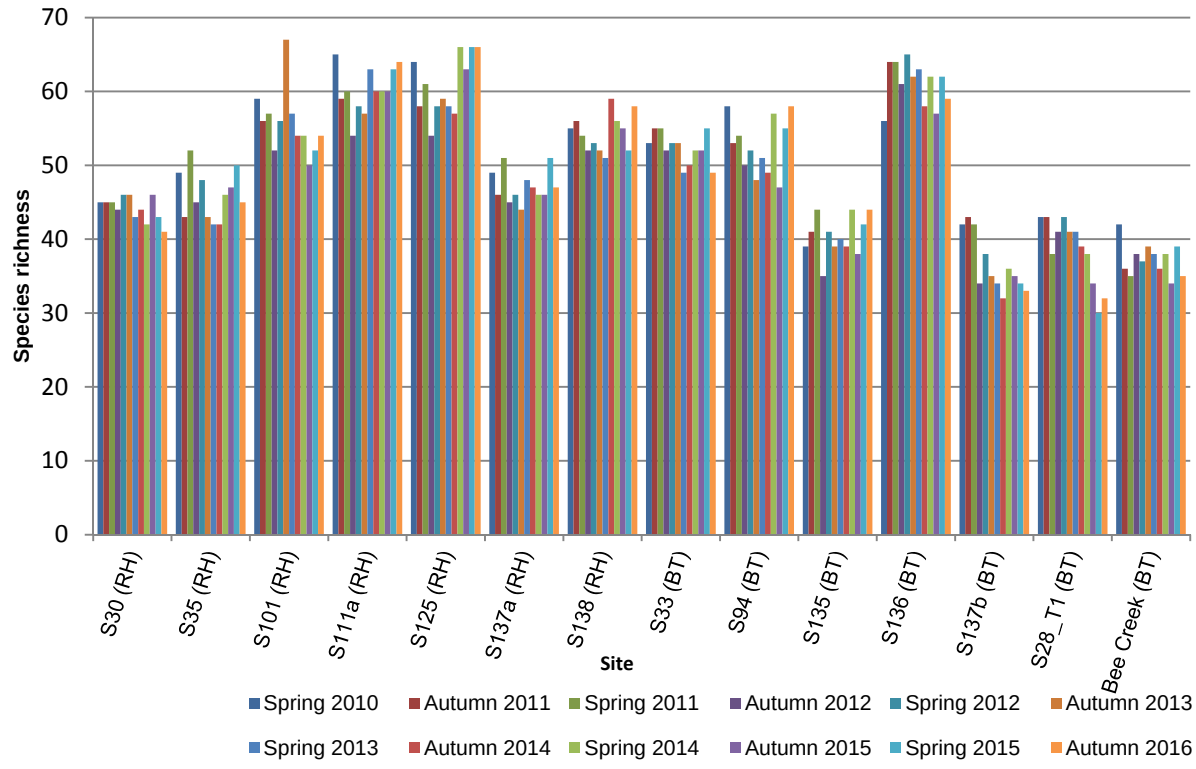

Chart 78 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Restioid Heath and Banksia Thicket, Spring 2010 – Autumn 2016

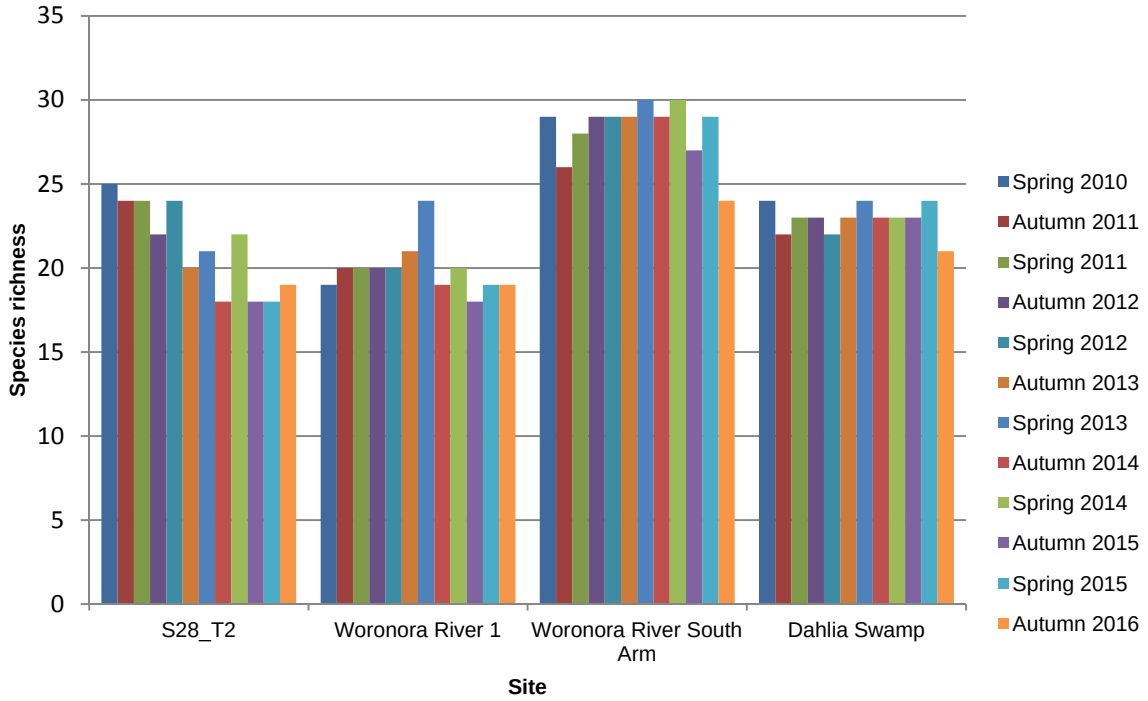

Chart 79 Native Species Richness within Longwalls 23-27 Upland Swamp Sites Supporting Tea Tree Thicket, Spring 2010 – Autumn 2016

3.2 UPLAND SWAMP GROUNDWATER MONITORING

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

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

As described in Section 2.6, 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 49 and Appendix B). 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 during the previous reporting period based on the incomplete recovery of substrate water levels following rainfall events (Chart 50 and Appendix B). As a result the upland swamp groundwater performance indicator 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 performance measure, *Negligible impact on threatened species and populations*. The Swamp 20 assessments by FloraSearch and Cenwest Environmental Services are provided in Appendix H. The Swamp 28 assessments by FloraSearch and Cenwest Environmental Services are provided in Appendix I. The assessments conclude that the subsidence impact performance measure has not been exceeded.

3.3 RIPARIAN VEGETATION MONITORING

Riparian vegetation monitoring is conducted at a number of sites on the Waratah Rivulet and Eastern Tributary, overlying Longwalls 20-27 and downstream of Longwalls 20-27 (Figure 10).

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

- Water levels along the Eastern Tributary at the time of the autumn 2016 survey were lower than in any previous season. At the time of the survey (April 2016), no water was observed at sites MRIP05, MRIP06 and MRIP09, or along stretches between these monitoring sites. Inspections of these sites (MRIP05, MRIP06 and MRIP09) in early May 2016 observed standing water within pools adjacent to these sites, although the water levels were low compared to all previous seasons. At the time of survey, waters levels had only recently dropped at these sites and no vegetation dieback, additional to that observed in previous seasons, was observed.
- In autumn 2016, species richness within all riparian monitoring sites was variable, however no sites recorded species richness outside the range of all previous seasons (Charts 80 and 81). Analysis of this data (ANOVA) identified that throughout the monitoring period control sites had significantly lower species richness compared to the longwall sites, including in autumn 2016.
- 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.
- At site MRIP11 some dieback of groundcover and shrub layer vegetation was recorded at isolated locations immediately adjacent to the water's edge (less than 50 cm from the water's edge). The extent of dieback on the western bank was confined primarily to the understorey due to the height of the bank, with very few shrubs occurring close to the waterline. Water levels were greatly reduced with areas of dry creek bed observed.
- As reported previously, increased ponding at site MRIP02 on the Waratah Rivulet and between sites MRIP05 and MRIP09 on the Eastern Tributary from subsidence has 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 autumn 2016. The level and areas of inundation at MRIP02 was generally similar to that observed in spring 2015. Small areas within sites MRIP05 and MRIP09, on the Eastern Tributary, which were previously inundated by water, were no longer inundated with water levels having decreased along the Eastern Tributary between sites MRIP06 and MRIP09 at the time of survey.
- In autumn 2016, the extent and level of dieback within site MRIP02 and between sites MRIP09 and MRIP05 was considered to be generally similar to that observed in spring 2015, however, some improvement was observed in *Gleichenia microphylla* sites MRIP02 and MRIP05, and some regeneration of shrubs at site MRIP09. Notwithstanding, dieback remains evident and many areas remain bare.
- In autumn 2016, increased mortality of the indicator species, *Lomatia myricoides* and *Schoenus melanostachys* was driven by the mortality of these species at site MRIP02 (accounting for 64% and 76% of the dead individuals of *Lomatia myricoides* and *Schoenus melanostachys,* respectively).

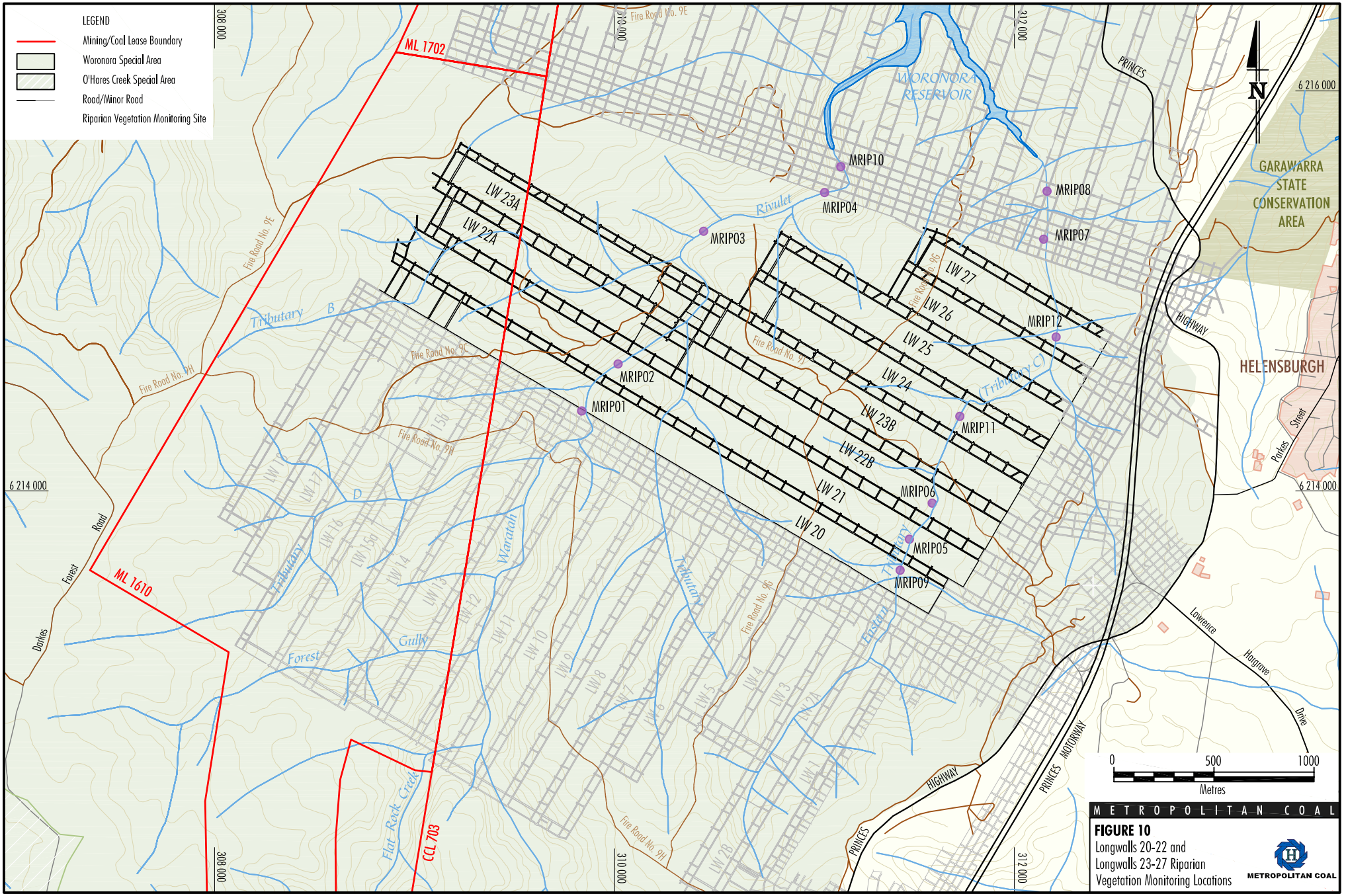

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FIGURE 10
Longwalls 20-22 and Longwalls 23-27 Riparian Vegetation Monitoring Locations

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- 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 and between sites MRIP09 and MRIP05 on the Eastern Tributary, with vegetation dieback observed greater than 50 cm from the Waratah Rivulet/Eastern Tributary.
- Continued exceedance of the performance indicator for site MRIP02 on Waratah Rivulet and between sites MRIP09 and MRIP05 on the Eastern Tributary triggered ongoing assessment against the performance measure, *Negligible impact on threatened species and populations*. Assessments conducted by Dr. Colin Bower (FloraSearch, 2016) and Dr. David Goldney (Cenwest Environmental Services, 2016) for threatened flora or threatened fauna, respectively, concluded that the impact performance measure had not been exceeded. The 2016 threatened flora and fauna assessments are provided in Appendix H.

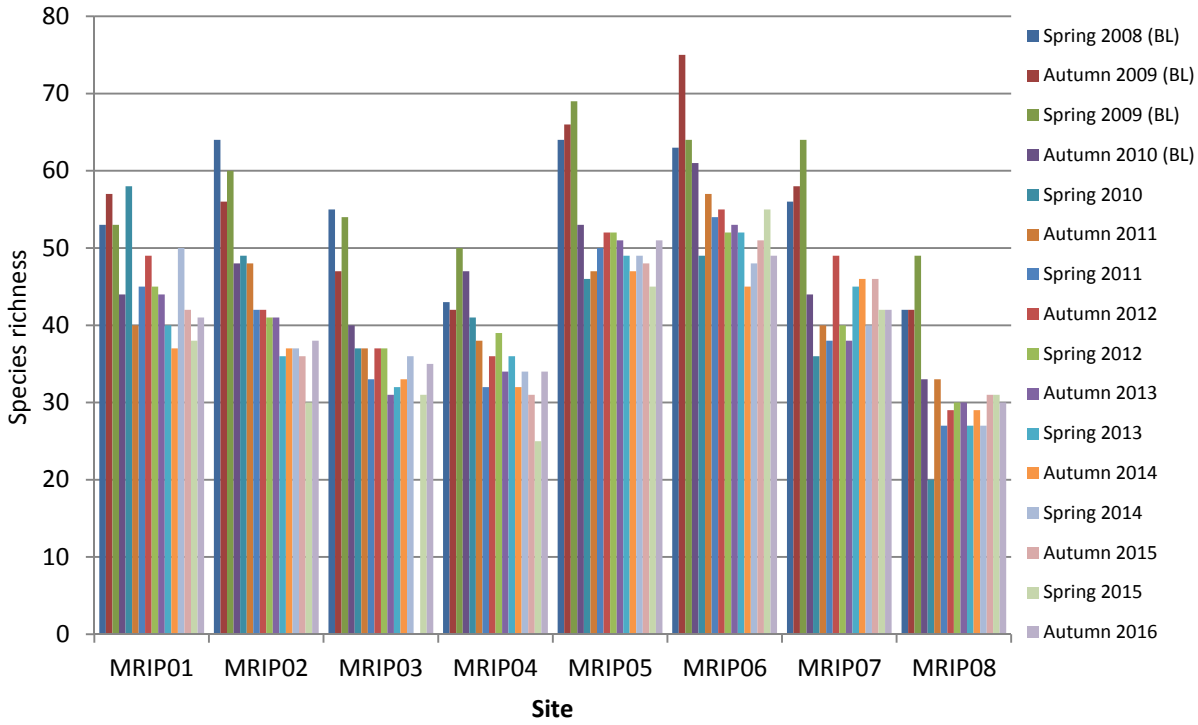

Chart 80 Species Richness within Riparian Monitoring Sites Across All Seasons - Longwalls 20-22 Monitoring Program

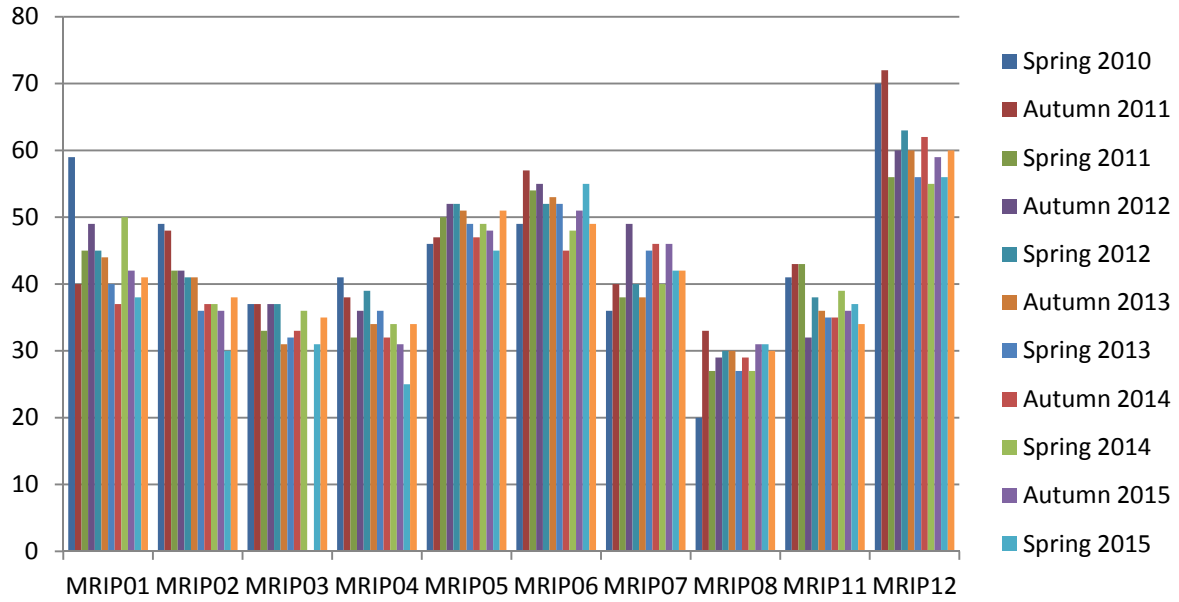

Chart 81 Species Richness within Riparian Monitoring Sites Across All Seasons-Longwalls 23-27 Monitoring Program

3.4 AQUATIC BIOTA AND THEIR HABITATS

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 11.

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).

The autumn 2016 monitoring results are summarised below.

Stream Monitoring Program

Eastern Tributary

In autumn 2016, mining impacts continued to be observed on the Eastern Tributary. At the time of the autumn 2016 survey, a reduction in pool water levels and surface flow had occurred (since the spring 2015 survey) and some sections of the stream were observed to be dry.

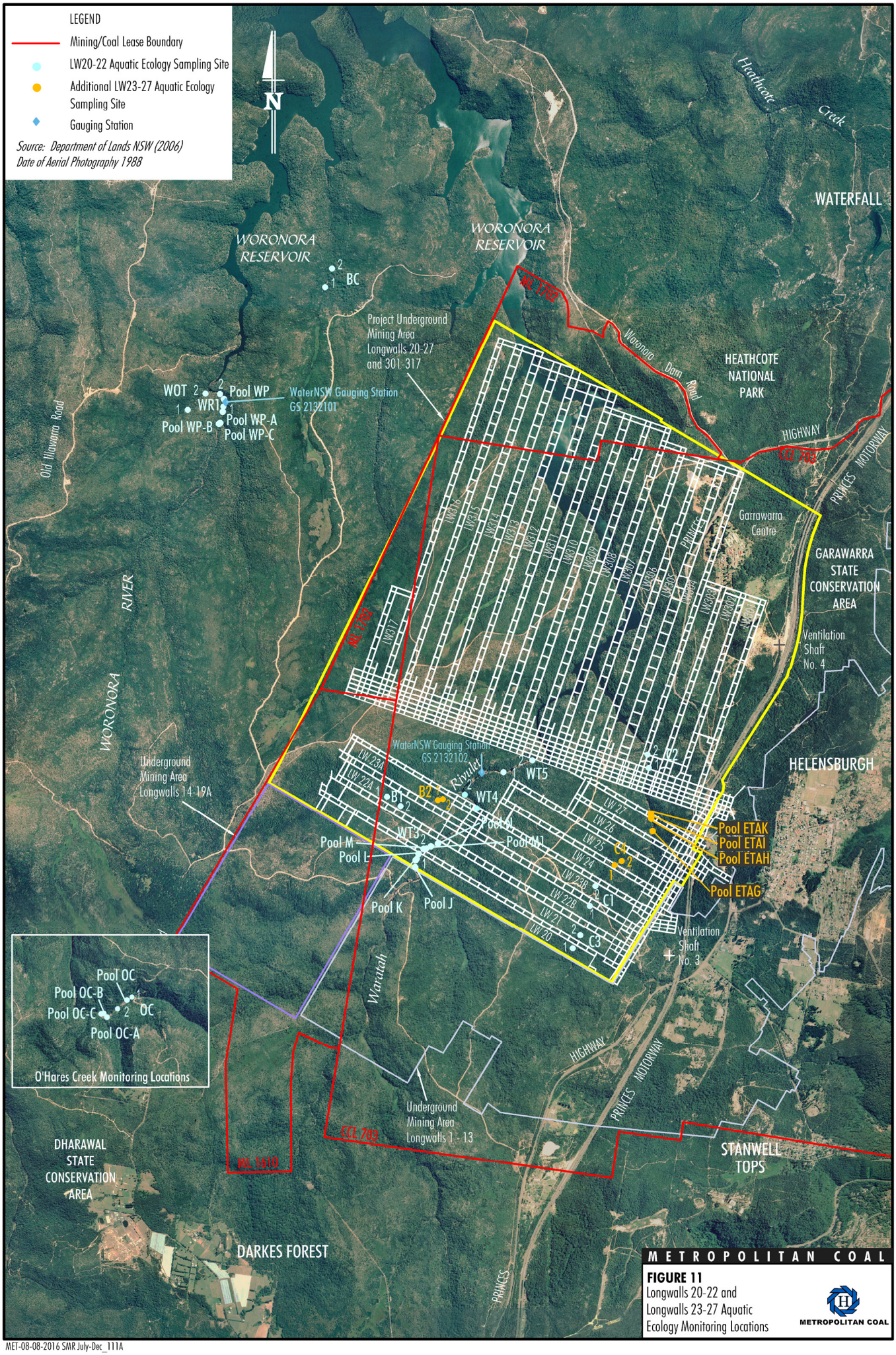

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FIGURE 11
Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Locations

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Multivariate analyses of the monitoring data before versus after commencement of mining indicates that any effect of longwall mining on assemblages of aquatic macroinvertebrates and macrophytes at Locations C1, C2, C3 and C4 are within the range of natural variability in these assemblages as measured by the control locations. Macroinvertebrate taxa that contributed most to the structure of assemblages at the locations sampled along Tributary C/Eastern Tributary were mayflies (Leptophlebiidae) and freshwater shrimp (Atyidae).

Univariate analyses for Longwalls 23-27 detected a significant before (spring 2009 to spring 2013) to after (autumn 2014 to autumn 2016) mining change in mean numbers of Atyidae at Location C2 in relation to the control locations in autumn 2016. It is likely that this result is mostly due to a small decrease in abundance of Atyidae at Location C2 in relation to the control locations. Analyses of macroinvertebrate data collected since spring 2008 for Longwalls 20-22 at Location C2 detected a significant before (spring 2008 to autumn 2010) to after (spring 2010 to autumn 2016) mining change in mean numbers of Atyidae in relation to the control locations in spring 2015, however, no detectable difference was found by the autumn 2016 survey.

Similar to the findings at Location C2, univariate analyses also detected a significant before to after mining change in mean number of Atyidae at Location C4 compared to the control locations in autumn 2016.

Waratah Rivulet

To date, 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 the commencement of mining.

Tributary B

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 autumn 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. There has been no evidence of any significant impact to mean total abundance of macroinvertebrates or mean numbers of Leptophlebiidae. Considerable dieback of the fern, *Gleichenia dicarpa*, has occurred at Location B1 since spring 2012 indicating aquatic macrophyte assemblages at the Tributary B location have experienced a degree of environmental stress since spring 2012 as a result of Longwalls 20-22.

Subsidence impacts on Tributary B have resulted in no surface flow along the stream in the vicinity of Location B1 for an extended period of time. This change in aquatic habitat/hydrology has resulted in long term impacts to the aquatic macroinvertebrate assemblage at this location. 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 Location B1 on Tributary B. This will trigger an assessment against the biodiversity subsidence impact performance measure. The assessment against the biodiversity performance measure will be conducted in relation to threatened terrestrial flora and fauna; there are no threatened aquatic fauna or flora known, or considered likely to occur.

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). Flow diversion and reductions in pool water level were apparent at both sites in autumn 2016. Multivariate analyses have found a significant difference, before to after mining, in the structure of the assemblage of aquatic macroinvertebrates at Location B2 compared to the control locations since autumn 2014, including autumn 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 detected by the autumn 2016 survey. Leptophlebiidae have increased at Location B2 since spring 2015. No significant changes in mean diversity, abundance or numbers of Atyidae were detected before to after mining at Location B2 in relation to the control locations. Atyidae, however, do appear to have decreased at Location B2 within the after period. Analyses examining changes in aquatic macrophytes found no evidence of impacts at Location B2 that could be related to mining activities within the Longwalls 23-27 underground mining area.

Pool Monitoring Program

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, however, 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 relation to the control pools since the commencement of Longwalls 20-22 in autumn 2015, spring 2015 and autumn 2016.

Analyses comparing temporal and spatial patterns of change in assemblages of aquatic macrophytes in large pools (J, M1 and N) sampled on the Waratah Rivulet with the control pools have not detected significant differences in the structure of assemblages or mean diversity and cover when comparing the before to after mining periods.

To date, any effect of subsidence on aquatic macrophytes in Pools J, M1, K, L and M on the Waratah Rivulet appears to be within the range of natural variability as measured by the control locations.

Pools on Eastern Tributary

Analyses indicated significant differences in the structure of aquatic macroinvertebrate assemblages in large Pool ETAH before to after mining compared to control locations in autumn 2015 and autumn 2016, 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. 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.

The autumn 2016 Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Reports prepared by Bio-Analysis Pty Ltd are provided in Appendix J.

Assessment of Aquatic Ecology Data in response to Eastern Tributary Iron Staining Performance Measure Exceedance

In response to the exceedance of the Eastern Tributary iron staining performance measure (discussed in Section 2.12), Bio-Analysis Pty Ltd (2016) analysed the recent spring 2016 aquatic ecology data collected at monitoring sites on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26. Monitoring by Metropolitan Coal has indicated a progressive increase in the extent of iron staining on the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir. Iron staining was first observed at Location C2 and Pools ETAG, ETAH, ETAI and ETAK sampled by the aquatic ecology surveys during the spring 2016 survey. These aquatic ecology monitoring locations are situated between the full supply level of the Woronora Reservoir and the maingate of Longwall 26 and are shown on Figure 11.

The key findings from examination of the aquatic ecology data sampled at Location C2 and Pools ETAG, ETAH, ETAI and ETAK on the Eastern Tributary up until spring 2016, are summarised below:

- The aquatic ecology results to date (spring 2016) indicate aquatic macroinvertebrate assemblages on the Eastern Tributary have experienced a degree of environmental stress since spring 2015 as a result of mining. In autumn 2016 and spring 2016, there were significant differences in the numbers of Atyidae at Location C2 compared to the control sites. However, multivariate analysis of the aquatic macroinvertebrate data found no significant difference between the structure of assemblages at Location C2 and the control locations that would indicate an impact from mining. Similarly, univariate analyses found no significant difference to total diversity or abundance of macroinvertebrates or numbers of Leptophlebiidae at Location C2 compared to the control sites.
- Significant differences in the structure of the macroinvertebrate assemblage at Pool ETAH compared to the controls were identified in autumn 2015 and autumn 2016 (largely due to changes in the contribution that particular families made to the structure of the assemblage at Pool ETAH relative to the controls), however were not significantly different 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 Pools ETAG, ETAI and ETAK on Eastern Tributary found no evidence of mining-related impacts.
- The significant differences that have been identified in the macroinvertebrate assemblage (described above), occurred prior to the appearance of iron staining/iron floc at the sampling locations in spring 2016.

Bio-Analysis' analysis of the aquatic ecology data indicates that the aquatic ecology performance indicator, *Aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence*, has not been exceeded.

3.5 AMPHIBIAN SURVEYS

Monitoring programs have been developed for Longwalls 20-22 and Longwalls 23-27 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 12.

The Spring-Summer 2015 Longwalls 20-22 and Longwalls 23-27 Amphibian Monitoring Reports prepared by Cenwest Environmental Services were provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2016.

A Poisson regression analysis was used to analyse the amphibian survey results obtained to date (i.e. to spring/summer 2015). No adverse impact from mining has been detected for any frog species including the Giant Burrowing Frog and Red-crowned Toadlet, at the 95% confidence level.

4 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.

4.1 STEEP SLOPES AND LAND IN GENERAL

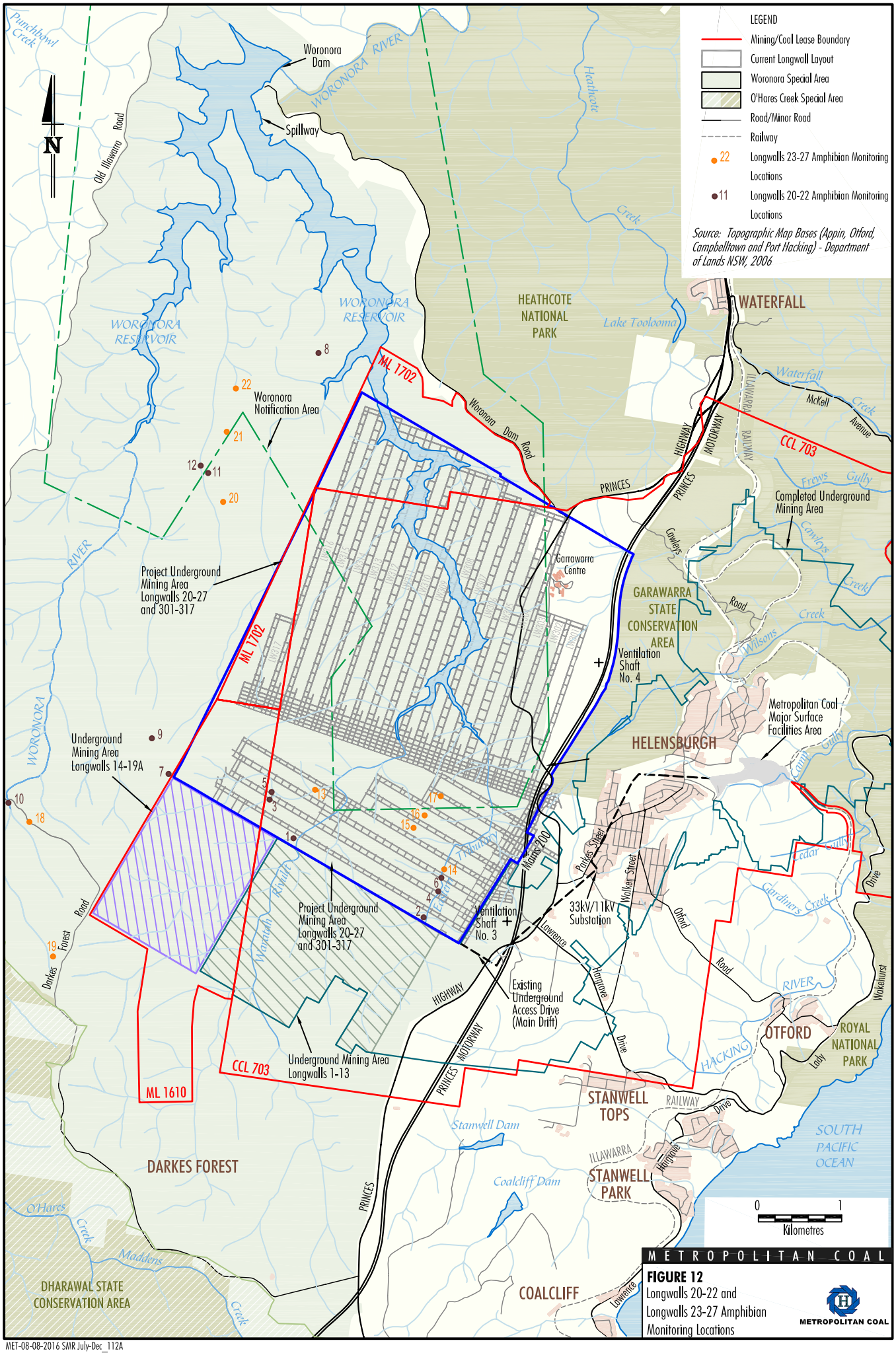
Opportunistic visual inspections for subsidence impacts on steep slopes and land in general are conducted by Metropolitan Coal and its contractors as part of routine works conducted in the catchment.

During the reporting period, surface cracking and minor rock fall was opportunistically observed at a rock ledge located over Longwall 23B (Figure 13). The fallen rock, approximately 50 cm wide and 3 m in length, came from the underside of the sandstone boulder overhang. Most of the fallen rock landed on the sandstone platform underneath, with some smaller pieces falling on the vegetated area below the platform. 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.

4.2 CLIFFS AND OVERHANGS

Visual inspections are conducted monthly for the period of time Longwalls 23-27 extraction is within 400 m of sites COH2, COH3, COH4, COH5, COH6, COH6a, COH7, COH8, COH9, COH10, COH14, COH15 and COH16 (Figure 13) and following the completion of each longwall to record evidence of subsidence impacts.

Previously, a small rock fall was recorded in December 2013 at site COH2 (Figure 13). No additional rock falls at the cliff or overhang sites were recorded during the reporting period.



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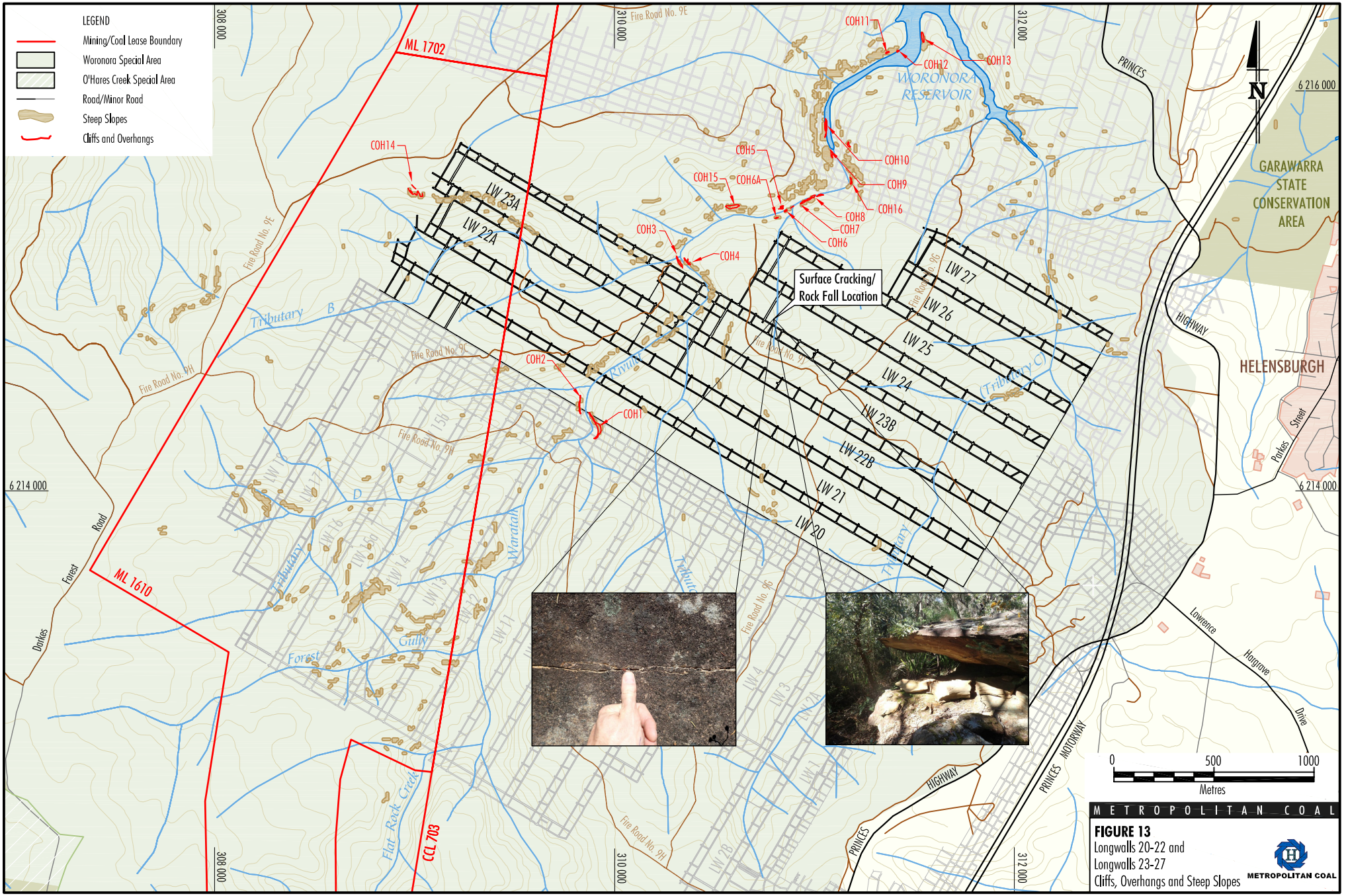

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FIGURE 13
Longwalls 20-22 and
Longwalls 23-27
Cliffs, Overhangs and Steep Slopes

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5 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.

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 14). The Aboriginal heritage sites monitoring program is carried out by an archaeologist (with experience in rock art recording and management) and Aboriginal stakeholder representatives.

Six heritage sites (FRC 15, FRC 176, 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 and Round 2 Aboriginal heritage surveys to have changes due to mining induced subsidence from Longwalls 20-22 and Longwalls 23-27 (as reported in the Metropolitan Coal 2015 Annual Review and Metropolitan Coal Six Monthly Report, 1 January to 30 June 2016).

The third round of monitoring for Longwalls 23-27 (Round 3) was conducted in September 2016 following the completion of Longwall 25 by Niche Environment and Heritage. The Round 3 monitoring report is provided in Appendix K and the results are summarised below.

Aboriginal heritage site FRC 176 (a sandstone overhang with charcoal infill art on the ceiling) was observed to have changes attributable to mine subsidence (i.e. vertical cracking along the northern and southern ends of the shelter) during the Longwalls 23-27 Round 1 survey. No further changes were recorded at site FRC 176 during the Round 2 survey. During the Longwalls 23-27 Round 3 survey, the crack at the northern end of the shelter was observed to have opened 5 mm wider. The art panel was not affected by the cracking at the time of the Longwalls 23-27 Round 1, Round 2 and Round 3 surveys.

Changes due to mining were also recorded by the Longwalls 23-27 Round 3 survey to site FRC 275 (a sandstone overhang with charcoal infill art on the ceiling). The horizontal bedding plane of the shelters joins was observed to have opened, causing vertical hairline cracks along the back wall of the shelter. This cracking has not affected the art panel which is located on the ceiling of the shelter. Site FRC 275 will be observed in future monitoring rounds to assess whether or not there are changes to water flow and seepage at the site.

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.

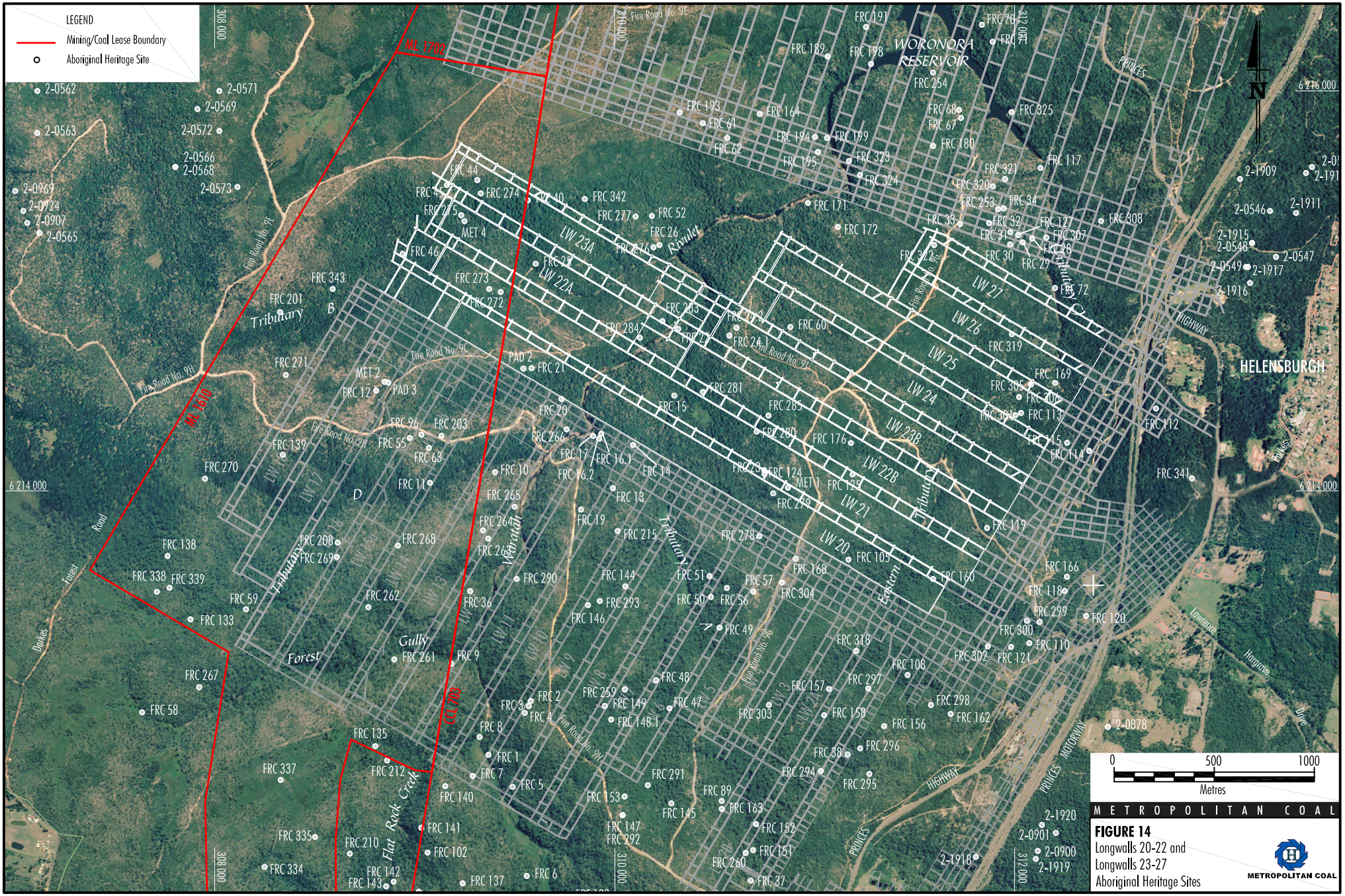

FIGURE 14
Longwalls 20-22 and Longwalls 23-27
Aboriginal Heritage Sites

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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.

6 BUILT FEATURES MANAGEMENT

The Metropolitan Coal Longwalls 20-22 and Longwalls 23-27 Built Features Management Plans were developed 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.

A 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.

During the reporting period, detailed discussions and risk assessments were held with the owners of transmission lines (TransGrid and Endeavour Energy) and the DRE in relation to Longwall 26 and Longwall 27 extraction in the vicinity of electrical assets. The risk assessments reviewed the potential for impacts on public safety in the event of a fault in electricity supply. The Longwalls 23-27 Subsidence Monitoring Program, Longwalls 23-27 Built Features Management Plan – Endeavour Energy and Longwalls 23-27 Built Features Management Plan – TransGrid were updated during the reporting period to include additional subsidence monitoring at transmission towers located at the end of Longwall 26 and Longwall 27. Metropolitan Coal also commenced a trial of real time 3D monitoring on two 330 kilovolt transmission towers located near Longwall 26 and Longwall 27 to inform the suitability and accuracy of the 3D monitoring technology for deployment to other built features.

An extensive structural investigation was completed in 2015 for Bridge 2 in consultation with the Roads and Maritime Services (RMS) to determine the safe and serviceable criteria for the bridge. Real time monitoring provisions and future mining stand-off requirements were also established. A real time high precision fibre optic monitoring system (Fibre Bragg Grating [FBG] Monitoring System) was installed on both bridge structures (RMS reference BN616-southbound and BN617-northbound) at the Old Princes Highway Underpass during 2016 to gather pre-mining data (i.e. prior to the commencement of Longwall 301). The pre-mining data will be used to filter out the effects of vehicles on the bridges, diurnal effects of expansion and contraction, and seasonal effects of earth swelling in summer/winter periods. This monitoring system communicates directly by mobile phone network to inform RMS bridge engineers and Metropolitan Colliery of detected movements.

Structural analysis of the Cawleys Road Bridge, as well as buildings within the Garrawarra Centre Complex, was also completed for the preparation of the Longwalls 301-303 Extraction Plan. In consultation with NSW Health, Longwalls 301-303 shortened the commencing ends of Longwalls 302 and 303 to reduce subsidence impacts to the Garrawarra Centre Complex.

For the preparation of the Longwalls 301-303 Built Features Management Plans (for the Longwalls 301-303 Extraction Plan submitted to the DP&E in November 2016), individual risk assessments were completed with each of the 12 infrastructure owners in the vicinity of Longwalls 301-303. Each Longwalls 301-303 Built Features Management Plan was prepared in consultation with the infrastructure owner.

Reporting of built features monitoring and management for Longwalls 301-303 will be included in future Metropolitan Coal reports.

7 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.

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 safety incidents were reported by visitors, personnel or contractors to Metropolitan Coal in the underground mining area during the reporting period.

8 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 July to 31 December 2016) 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	Assessments against the performance measure conducted for Waratah Rivulet and Eastern Tributary by Hydro Engineering & Consulting (2017) (Appendix A). Continue monitoring	*Negligible reduction to the quality of water resources reaching the Woronora Reservoir*	No. Assessments for the period July to December 2016 to be subject to peer review.
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*	✓	✓	Yes	Assessment against the performance measure conducted by Hydro Engineering & Consulting (2017) (Appendix A). Continue monitoring	*Negligible reduction in the water quality of Woronora Reservoir*	No. Assessment to be subject to peer review.
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

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 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)*	✓	×	Yes (the water level in Pool P previously fell below historically recorded water levels)	Analysis of recession rates and the shape of the water level hydrograph indicate pool water levels were consistent with natural behaviour. There has been a change in the datum levels associated with a change in water level logger housing. 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 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)	×	✓	Yes (Pool P, as above)	As above		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

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)	*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	*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 gas releases observed at Pools Q to W on the Waratah Rivulet	✗	✓	Yes (at Pool U and Pool W)	Assessments against the performance measure conducted by Associate Professor Barry Noller (Appendix D) Continue monitoring		No. Assessments subject to peer review (Appendix E).

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*	×	✓	No	Continue monitoring	*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*	No. Note, however that the diversion of flows/change in natural drainage behaviour exceeded in January 2017. Contingency Plan process already initiated by the exceedance of the iron staining component of the performance indicator (see further below)
	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)	Assessment against the performance measure		As above.
	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	Assessment against the performance measure		Yes. Contingency Plan and Incident Notification initiated
	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 and populations*	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 B) Yes – continuation of performance indicator exceedance for Swamp 28 (Longwalls 23-27 upland swamps) (Appendix B)	Assessments against the performance measure conducted by FloraSearch (threatened flora) and Cenwest Environmental Services (threatened fauna) (Appendices H and I) Continue monitoring	*Negligible impact on threatened species and populations*	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 and between sites MRIP09 and MRIP05 on the Eastern Tributary (Appendix G)	Assessment against the performance measure conducted by FloraSearch (threatened flora) and Cenwest Environmental Services (threatened fauna) (Appendix H) 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 and populations*	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 Location B1 on Tributary B	Assessment against the performance measure to be conducted		Assessments to be conducted
Amphibian Monitoring	*The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites*	✓	✓	No	Continue monitoring		No
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

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?
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 K ARE AVAILABLE ON CD (AS LISTED BELOW):

APPENDIX A	METROPOLITAN COAL ANNUAL SURFACE WATER REVIEW 2016
APPENDIX B	METROPOLITAN COAL 2016 ANNUAL REVIEW GROUNDWATER MONITORING AND ENVIRONMENTAL PERFORMANCE ASSESSMENT
APPENDIX C	MAPPED POOL LOCATIONS ON THE WARATAH RIVULET, EASTERN TRIBUTARY, TRIBUTARY A AND TRIBUTARY B
APPENDIX D	POOLS U AND W GAS RELEASES ASSESSMENT AGAINST SUBSIDENCE IMPACT PERFORMANCE MEASURE
APPENDIX E	PEER REVIEW OF POOLS U AND W GAS RELEASES ASSESSMENT
APPENDIX F	INDEPENDENT PEER REVIEW OF ASSESSMENT AGAINST THE WATER QUALITY PERFORMANCE MEASURE (METROPOLITAN COAL SIX MONTHLY REPORT, 1 JANUARY TO 30 JUNE 2016)
APPENDIX G1	METROPOLITAN COAL LONGWALLS 20-22 AUTUMN 2016 VEGETATION MONITORING REPORT
APPENDIX G2	METROPOLITAN COAL LONGWALLS 23-27 AUTUMN 2016 VEGETATION MONITORING REPORT
APPENDIX H1	METROPOLITAN COAL SWAMP 20 AND RIPARIAN VEGETATION THREATENED FLORA ASSESSMENTS, SEPTEMBER 2016
APPENDIX H2	METROPOLITAN COAL SWAMP 20 AND RIPARIAN VEGETATION THREATENED FAUNA ASSESSMENTS, SEPTEMBER 2016
APPENDIX I1	METROPOLITAN COAL SWAMP 28 THREATENED FLORA ASSESSMENT, NOVEMBER 2016
APPENDIX I2	METROPOLITAN COAL SWAMP 28 THREATENED FAUNA ASSESSMENT, NOVEMBER 2016
APPENDIX J1	METROPOLITAN COAL LONGWALLS 20-22 AUTUMN 2016 AQUATIC ECOLOGY MONITORING REPORT
APPENDIX J2	METROPOLITAN COAL LONGWALLS 23-27 AUTUMN 2016 AQUATIC ECOLOGY MONITORING REPORT
APPENDIX K	LONGWALLS 23-27 ROUND 3 MONITORING OF ABORIGINAL HERITAGE SITES