METROPOLITAN COAL

2011 ANNUAL REVIEW




Peabody ENERGY

METROPOLITAN COAL

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2011 ANNUAL REVIEW

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EXECUTIVE SUMMARY

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).

Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) 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.au).

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

The Metropolitan Coal Environmental Management Structure is shown on Figure ES-2.

This Annual Review has been prepared to review the environmental performance of the Project during the review period (i.e. from 1 August 2010 to 31 July 2011).

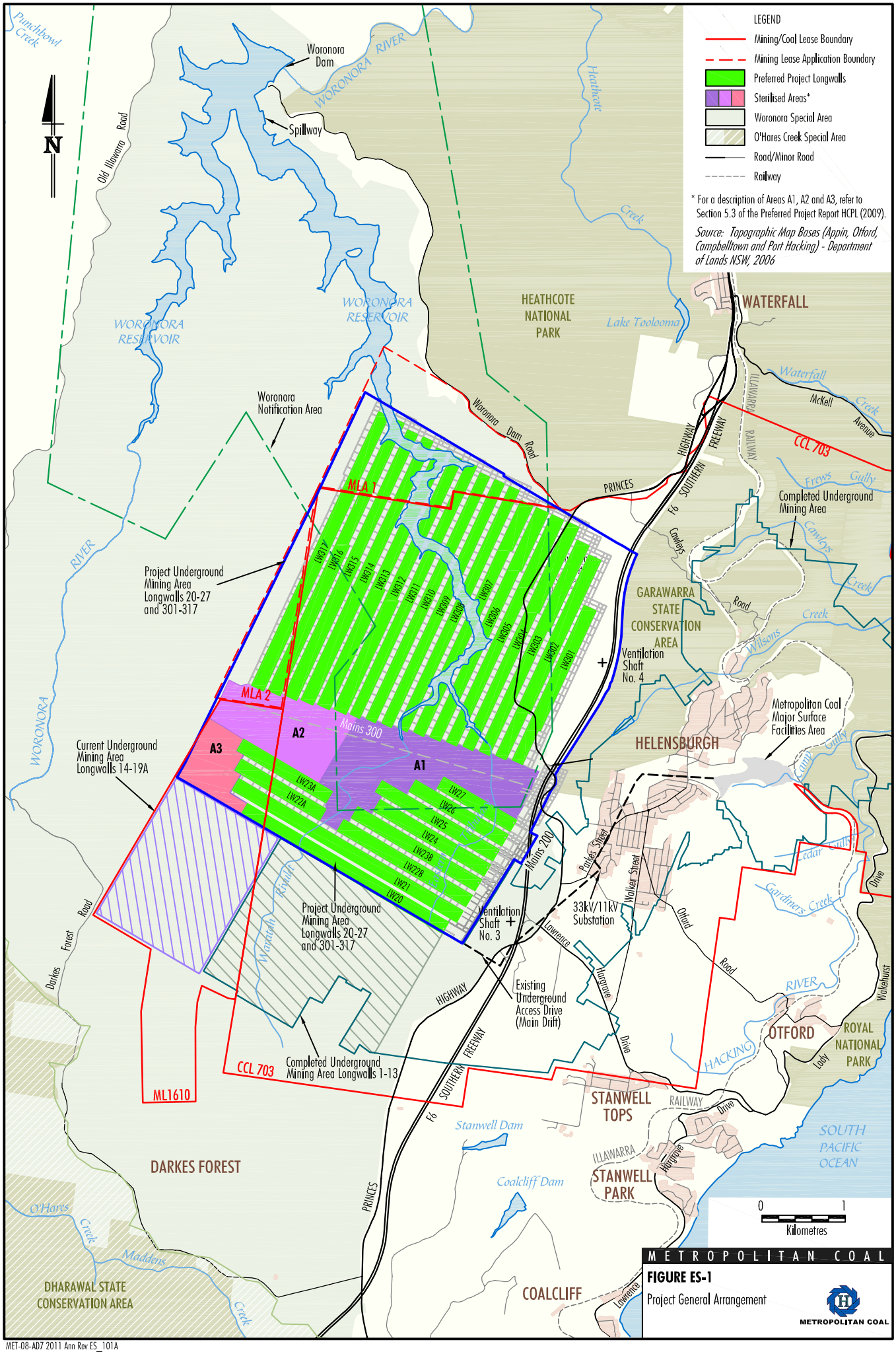
The environmental performance of the Project has been assessed by comparison to the performance indicators and performance measures/criteria identified in the individual management plans and monitoring programs (Figure ES-2).

During the review period, there was one exceedance of a performance indicator *viz., 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.* The performance indicator exceedance triggered an assessment against the relevant performance measure, *negligible reduction to the quality of water resources reaching the Woronora Reservoir*, which was not exceeded.

No Project-related exceedances of performance measures or criteria occurred during the review period.

The Annual Review includes:

- A description of the works that were carried out in the review period, and the works proposed to be carried out in the next review period.
- A comprehensive review of the monitoring results and complaints records of the Project during the review period.
- Identification of non-compliances during the review period and description of what actions were and/or will be taken to ensure compliance.
- Identification of trends in the monitoring data over the life of the Project.
- Identification of any discrepancies between the predicted and actual impacts of the Project, and analysis of the potential cause of any significant discrepancies.
- A description of what measures will be implemented over the next review period to improve the environmental performance of the Project.



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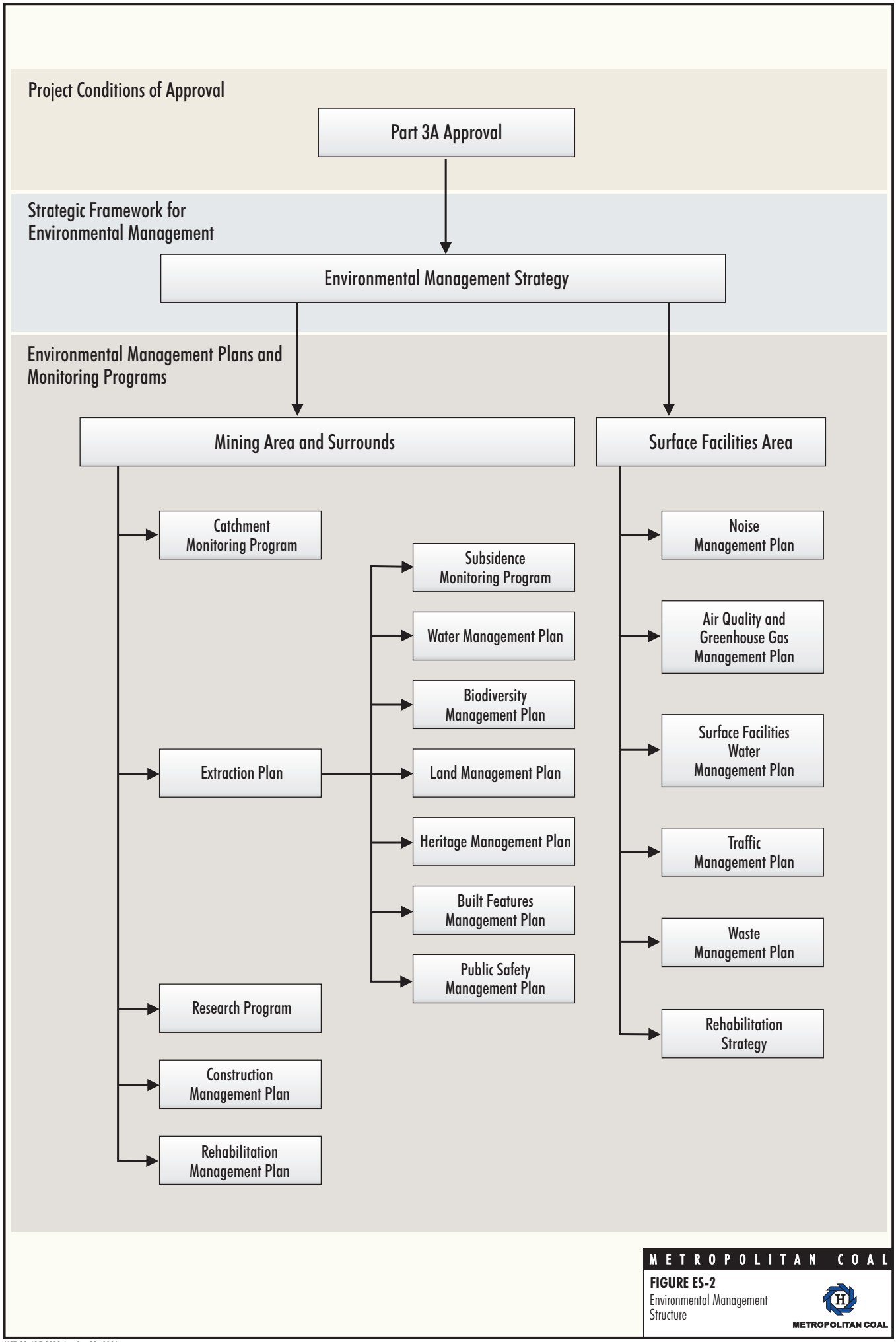

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FIGURE ES-2
Environmental Management Structure

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

Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com.au).

The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The approved underground mining Project layout is shown on Figure 2.

In June 2010, Metropolitan Coal submitted the *Metropolitan Mine Replacement Drift Construction Modification Environmental Assessment* (Metropolitan Coal, 2010a) to the NSW Minister for Planning under Section 75W of the EP&A Act to modify the Project to allow for the additional construction of a replacement underground drift, including construction of a new drift portal at the mine's Major Surface Facilities Area. The modification was approved by the Director-General of the NSW Department of Planning & Infrastructure (DP&I) in September 2010. The extent of the mine's Major Surface Facilities Area is shown on Figure 3.

The Metropolitan Coal Environmental Management Structure is shown on Figure 4. It includes the *Metropolitan Coal Environmental Management Strategy* (Metropolitan Coal, 2011a), developed to provide the strategic context for environmental management at Metropolitan Coal, and management plans and monitoring programs applicable to the underground mining area or mine's surface facilities area.

Figure 4 illustrates that a number of management plans and monitoring programs are included in the *Metropolitan Coal Longwalls 20-22 Extraction Plan* (Metropolitan Coal, 2010b) to manage the environmental consequences of the Extraction Plan, namely the:

- *Metropolitan Coal Longwalls 20-22 Subsidence Monitoring Program* (Metropolitan Coal, 2011b);
- *Metropolitan Coal Longwalls 20-22 Water Management Plan* (Metropolitan Coal, 2011c);
- *Metropolitan Coal Longwalls 20-22 Biodiversity Management Plan* (Metropolitan Coal, 2011d);
- *Metropolitan Coal Longwalls 20-22 Land Management Plan* (Metropolitan Coal, 2011e);
- *Metropolitan Coal Longwalls 20-22 Heritage Management Plan* (Metropolitan Coal, 2011f);
- *Metropolitan Coal Longwalls 20-22 Built Features Management Plan* (Metropolitan Coal, 2011g); and
- *Metropolitan Coal Longwalls 20-22 Public Safety Management Plan* (Metropolitan Coal, 2010c).

1.1 PURPOSE AND SCOPE

Condition 3, Schedule 7 of the Project Approval requires the preparation of an Annual Review, as follows:

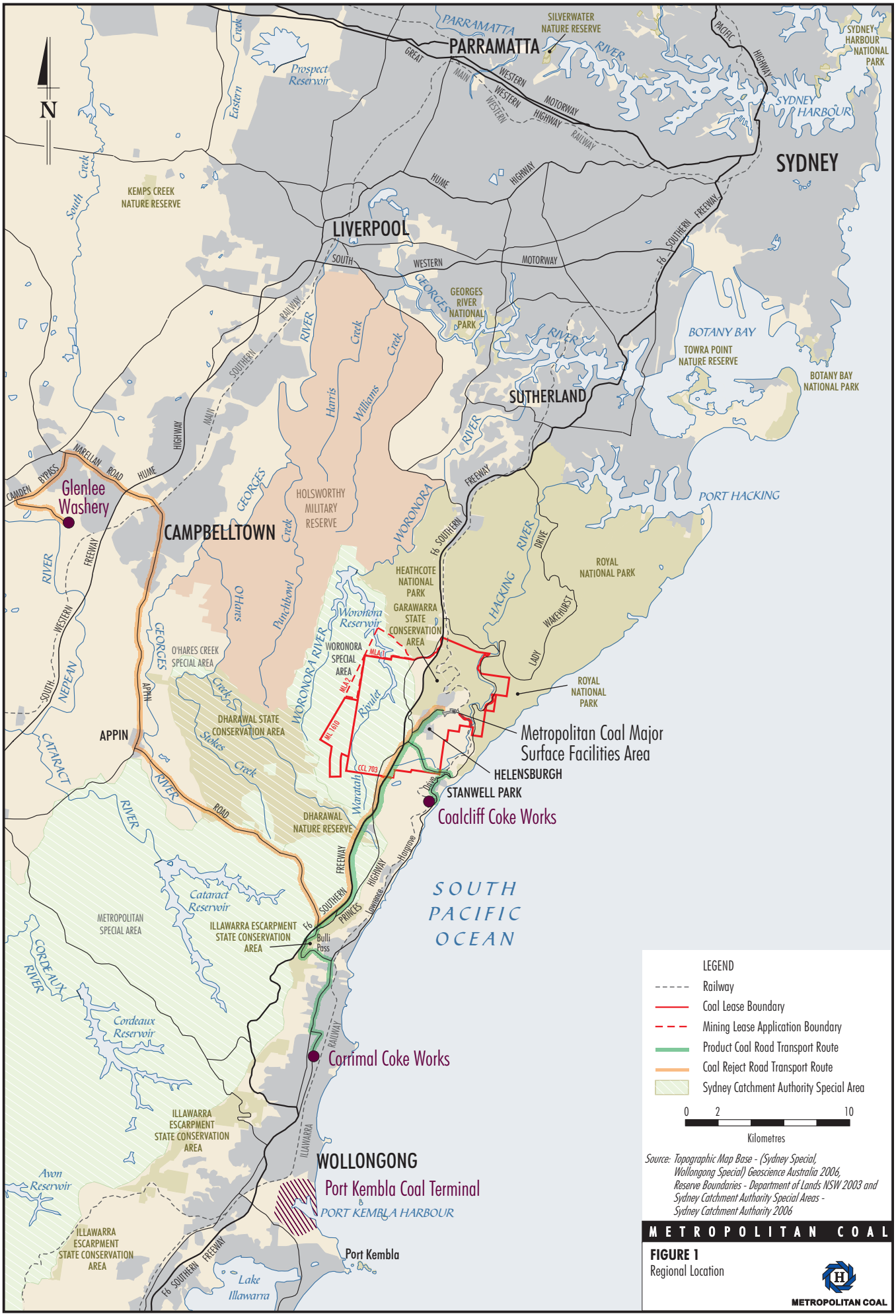
Annual Review

3. By the end of October 2010, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Director-General. This review must:

(a) describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year;

(b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the

- *the relevant statutory requirements, limits or performance measures/criteria;*
- *the monitoring results of previous years; and*
- *the relevant predictions in the EA, PPR, and Extraction Plan;*



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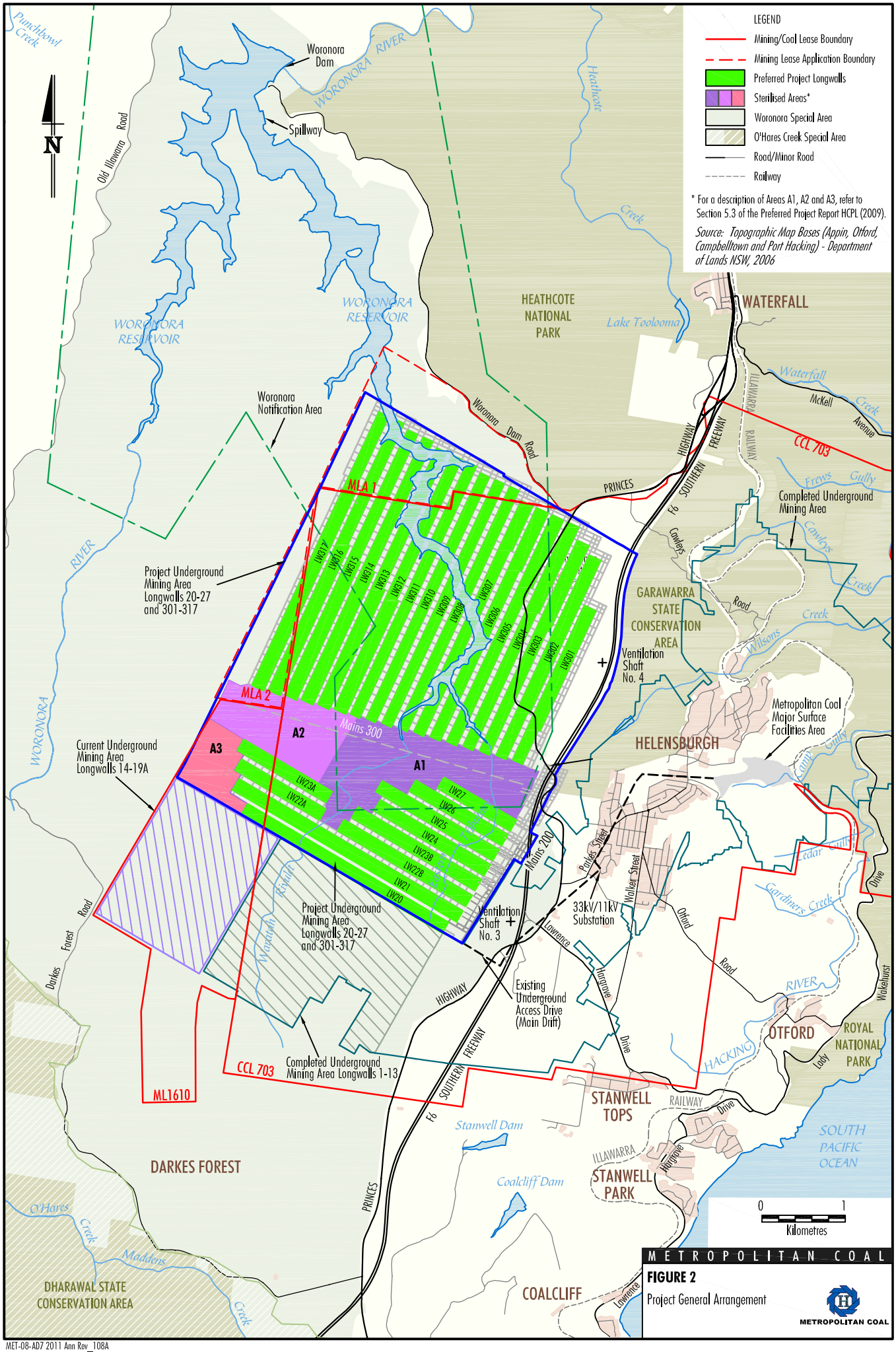

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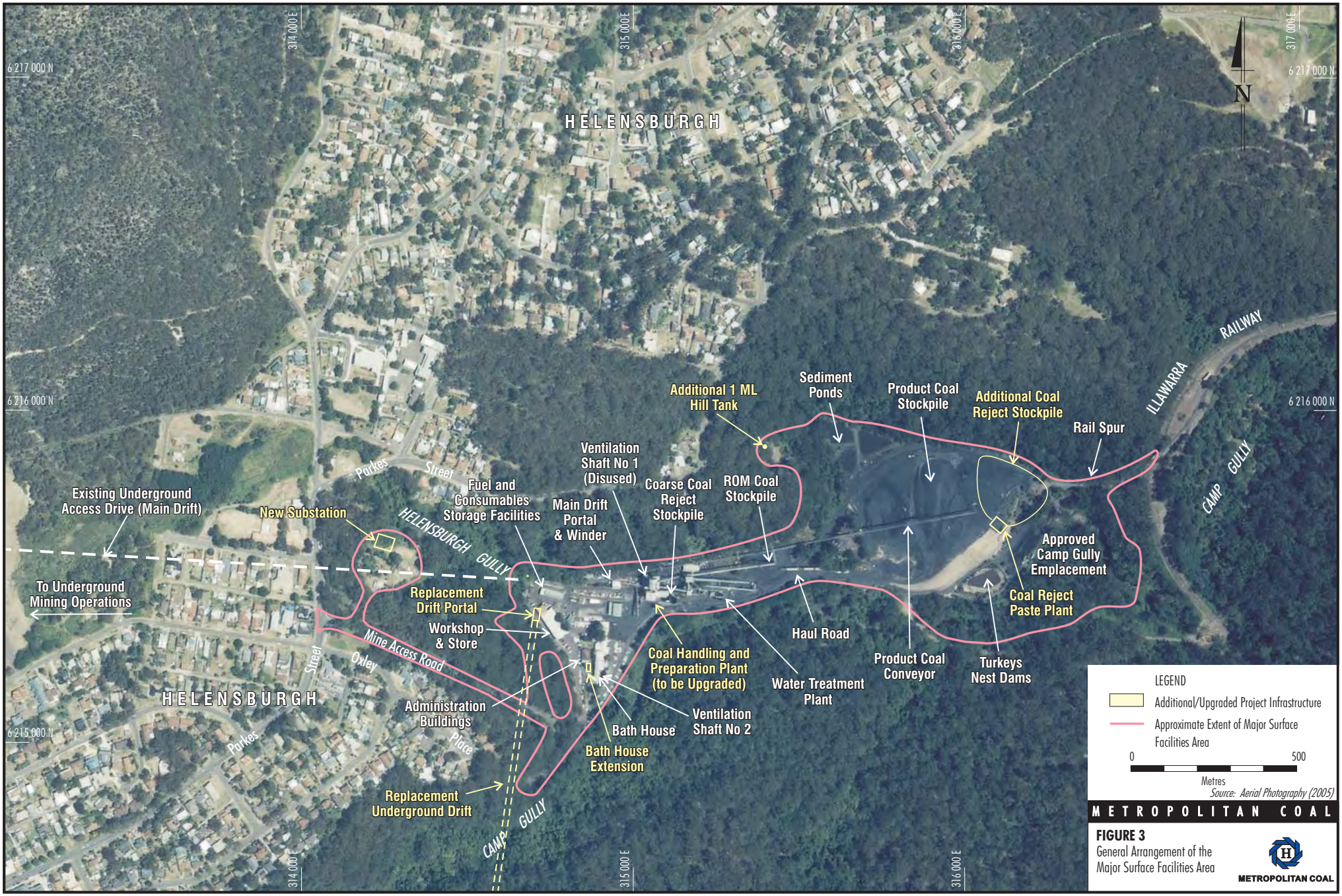

FIGURE 3
General Arrangement of the Major Surface Facilities Area

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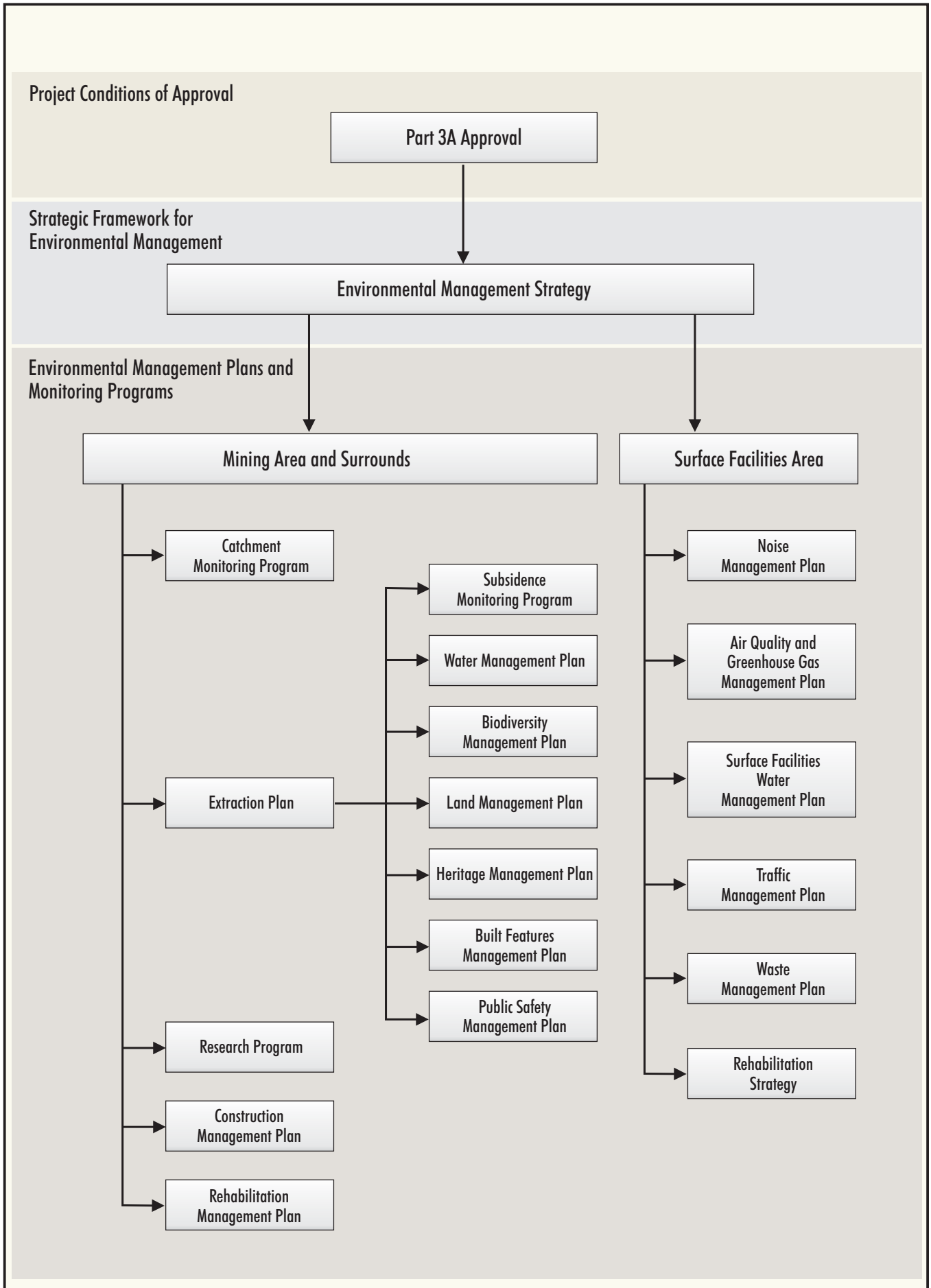

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FIGURE 4
Environmental Management Structure

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(c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;

(d) identify any trends in the monitoring data over the life of the project;

(e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and

(f) describe what measure will be implemented over the next year to improve the environmental performance of the project.

This 2011 Annual Review presents data for the past year (i.e. the review period) from 1 August 2010 to 31 July 2011.

1.2 STRUCTURE OF THE ANNUAL REVIEW

The remainder of this Annual Review is structured as follows:

- Section 2 summarises the works that were carried out in the review period.
- Section 3 describes the environmental performance of mining activities in the underground mining area and surrounds.
- Section 4 describes the environmental performance of mining activities at the surface facilities area.
- Section 5 details the environmental performance of mining activities against other Project Approval requirements.
- Section 6 provides a review of the complaints records for the review period.
- Section 7 outlines the works that will be carried out in the next review period (i.e. 1 August 2011 to 31 July 2012).
- Section 8 lists the references cited.

Sections 3 and 4 include a comprehensive review of monitoring results, identification of any non-compliance, identification of trends in the monitoring data and the identification of any discrepancies between predicted and actual impacts.

2 WORKS DURING THE REVIEW PERIOD

The layout of Longwalls 20-22 is shown on Figure 5. A summary of the longwall dimensions is provided in Table 1 and a provisional production schedule is provided in Table 2.

In accordance with Condition 5, Schedule 3 of the Project Approval, Metropolitan Coal has carried out first workings in the mining area consistent with the approved mine plan. Metropolitan Coal has also carried out secondary extraction in accordance with the approved mine plan.

Metropolitan Coal commenced the secondary extraction of Longwall 20 in May 2010 (at chainage 2,800 metres [m]). Longwall 20 advanced 2,782 m as at 31 July 2011 (Figure 5).

Table 1
Longwall Dimensions

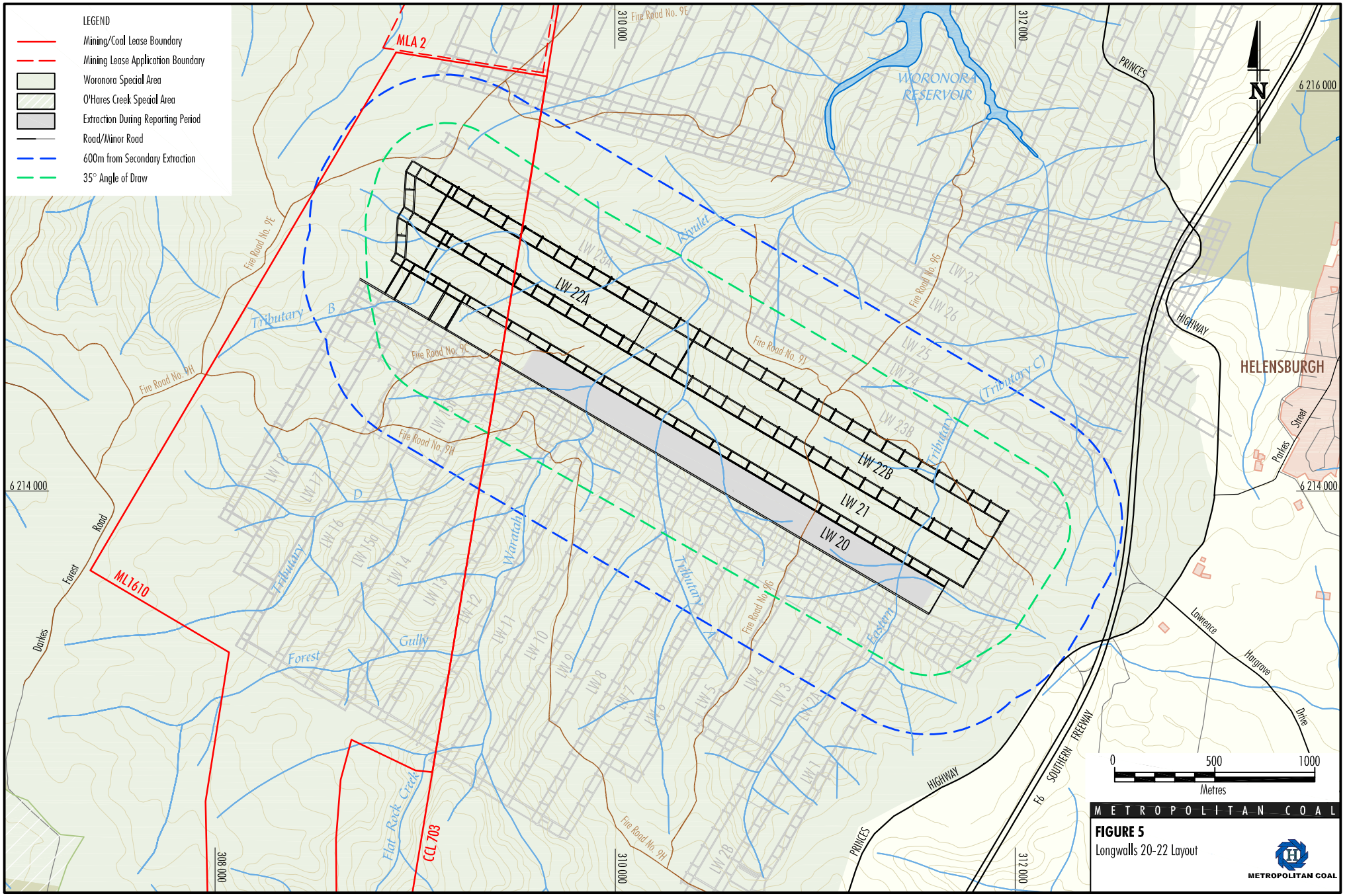
Longwall	Total Void Width (m)	Width of Pillar Preceding Longwall Tailgate (m)	Longwall Length (m)
Longwall 20	163	-*	2,802
Longwall 21	163	40	3,087
Longwall 22A	163	55	1,176
Longwall 22B	163	55	1,782

* The distance between Longwall 20 and Longwalls 1 to 18 is approximately 290 m and the barrier includes several development headings.

Table 2
Provisional Extraction Schedule

Longwall	Start	Finish
Longwall 20	May 2010	September 2011
Longwall 21	October 2011	December 2012
Longwall 22A	January 2013	July 2013
Longwall 22B	July 2013	May 2014

Condition 6, Schedule 2 of the Project Approval requires that Metropolitan Coal not extract more than 3.2 million tonnes (Mt) of run-of-mine (ROM) coal from the mining area in a calendar year. During the 2010 calendar year approximately 1.80 Mt of ROM coal was extracted. From 1 January 2011 to 31 July 2011 a total of 1.28 Mt of ROM coal was extracted from the mining area.



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3 REVIEW OF ENVIRONMENTAL PERFORMANCE – UNDERGROUND MINING AREA AND SURROUNDS

3.1 CATCHMENT MONITORING PROGRAM

3.1.1 Background

A comprehensive *Metropolitan Coal Catchment Monitoring Program* (Metropolitan Coal, 2011h) has been prepared in accordance with Condition 2, Schedule 3 of the Project Approval. The Catchment Monitoring Program includes detailed baseline data of existing surface water and groundwater resources, a program for the ongoing development and use of appropriate surface water and groundwater models, a program to monitor and assess impacts on surface water and groundwater resources, and a program to validate and calibrate the surface water and groundwater models.

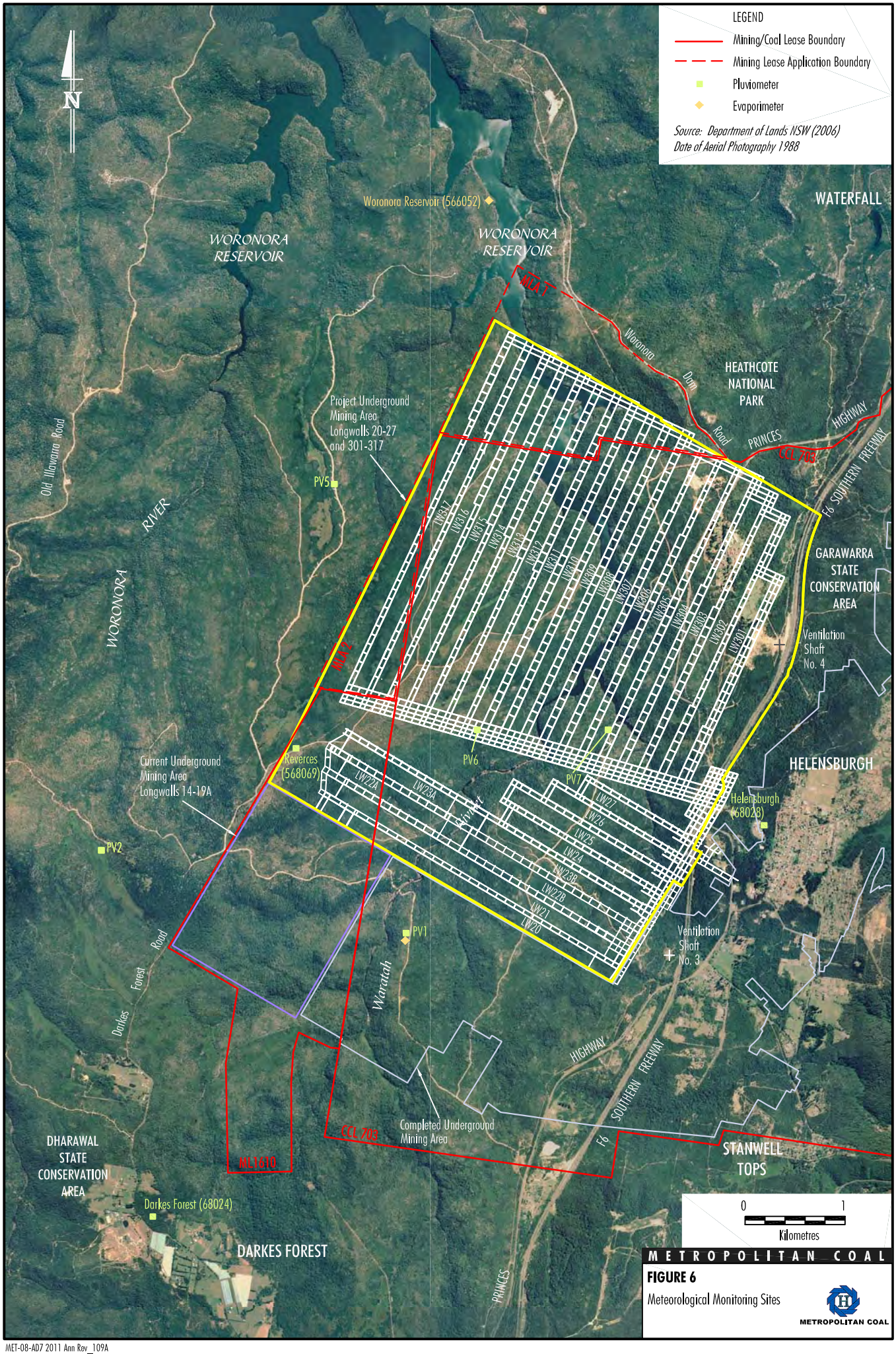
3.1.2 Baseline Data of Existing Surface Water and Groundwater Resources

Figures 6 to 10 show the meteorological monitoring sites, surface water quantity monitoring sites (i.e. gauging stations and pool water levels), surface water quality monitoring sites, groundwater level monitoring sites and groundwater quality monitoring sites, at which baseline data is available or will be obtained for the Metropolitan Coal underground mining area.

As a component of the Catchment Monitoring Program, Metropolitan Coal has established a number of new surface water and groundwater monitoring sites to supplement existing baseline data. The status of the new monitoring sites is summarised in Table 3.

Table 3
Status of New Monitoring Sites

Monitoring Component	New Monitoring Site	Status
Pluviometer	• Site PV5 - Honeysuckle Creek catchment	• Installed
	• Site PV6 - Waratah Rivulet catchment	• Installed
	• Site PV7 - Eastern Tributary catchment	• Installed
Pan evaporation equipment	• At Site PV1 - Waratah Rivulet catchment	• Installed
Gauging station	• Eastern Tributary gauging station	• Proposed to be constructed following approval of the Metropolitan Coal Construction Management Plan
	• Honeysuckle Creek gauging station (control)	• Proposed to be constructed following approval of the Metropolitan Coal Construction Management Plan
Pool water levels	Pools ETF and ETJ on the Eastern Tributary	• Pool ETF unsuitable for installation of pool water level meter; meter installed in Pool ETG • Diver stands to be installed at Pool ETG and Pool ETJ
	• Pools ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI, ETAQ and ETAU on the Eastern Tributary	• Installed (awaiting survey data)
	• Pools WPR2, WRP3 and WRP4 on Woronora River (control)	• Installed (awaiting survey data)
Swamp water levels	• Swamps 16 & 17	• Installed (awaiting survey data commenced August 2010)
	• Swamp 20	• Installed (commenced August 2010)
	• Swamp 25	• Installed (commenced August 2010)
	• Control Swamp 101	• Installed (commenced August 2010)
	• Control Swamp Woronora River 1 (WRSWAMP1)	• Installed (commenced August 2010)



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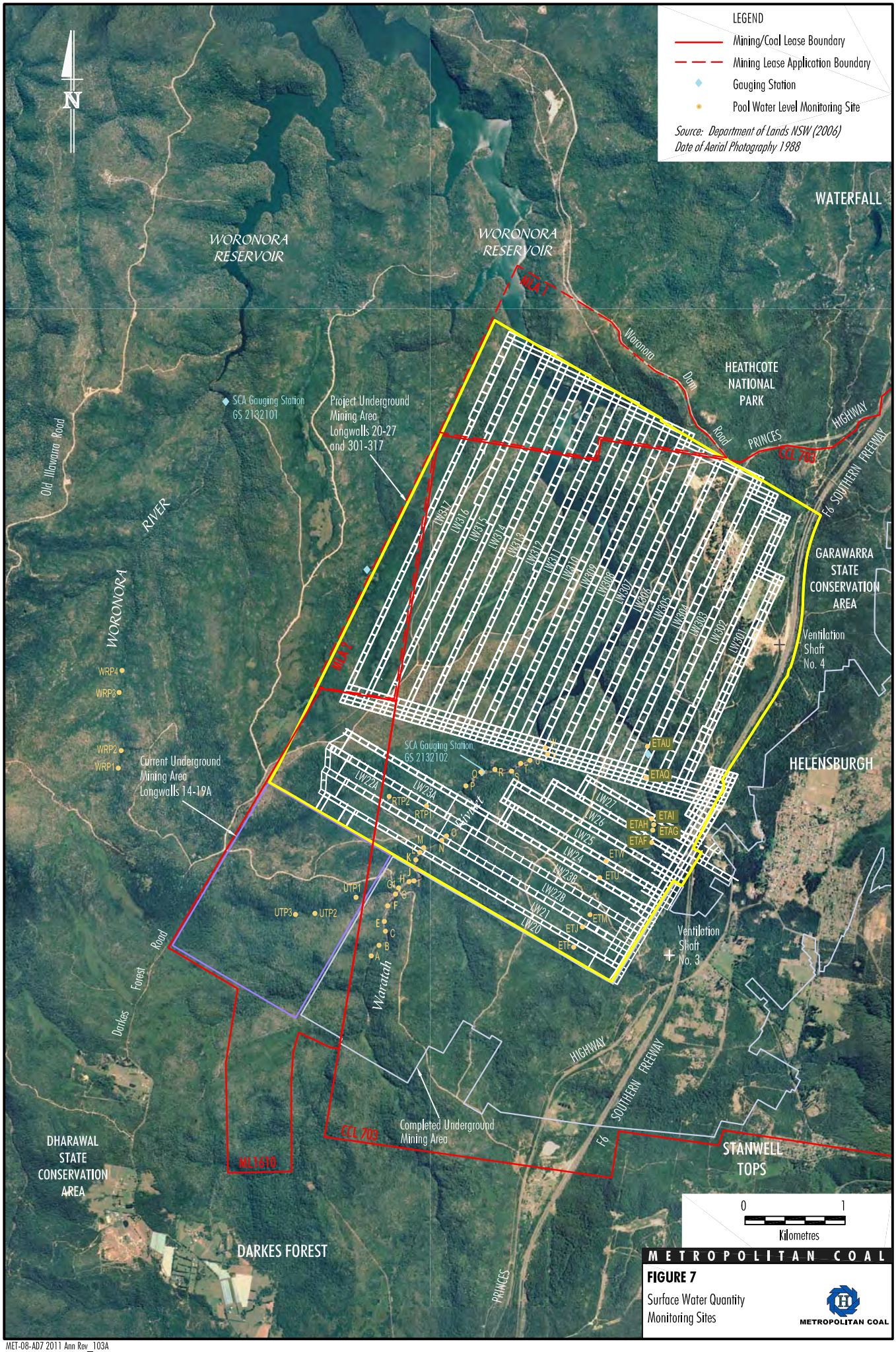

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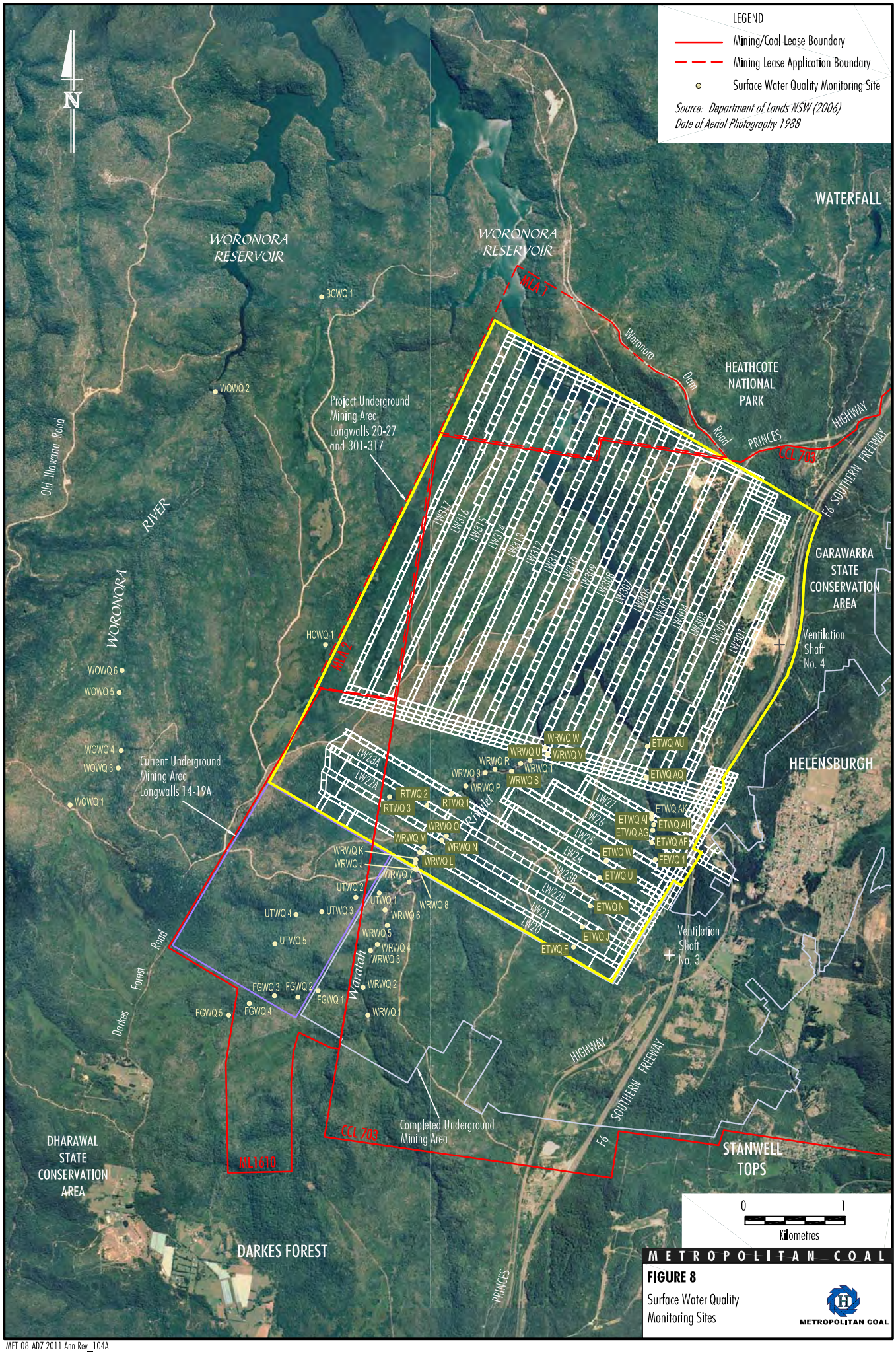

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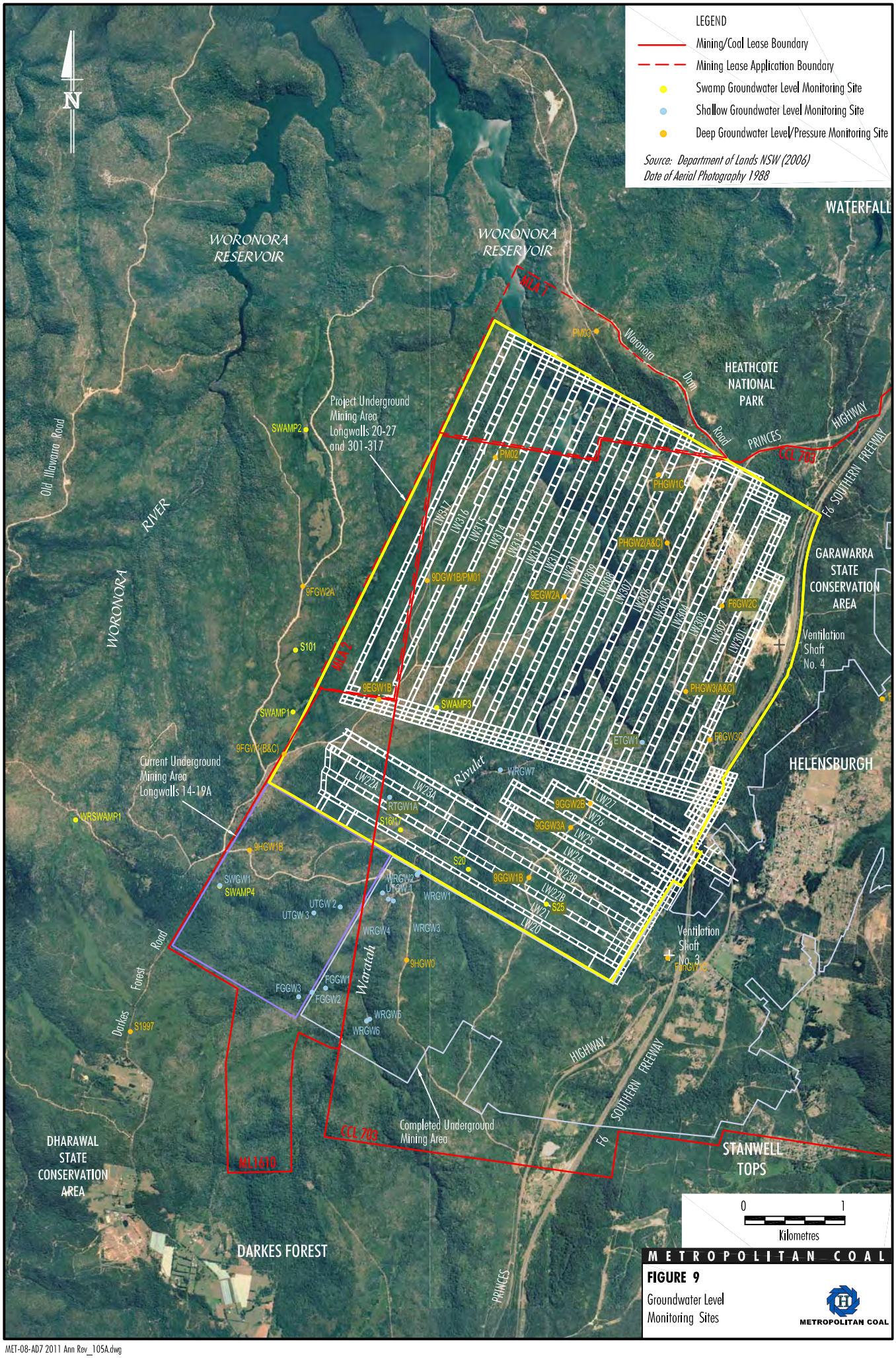

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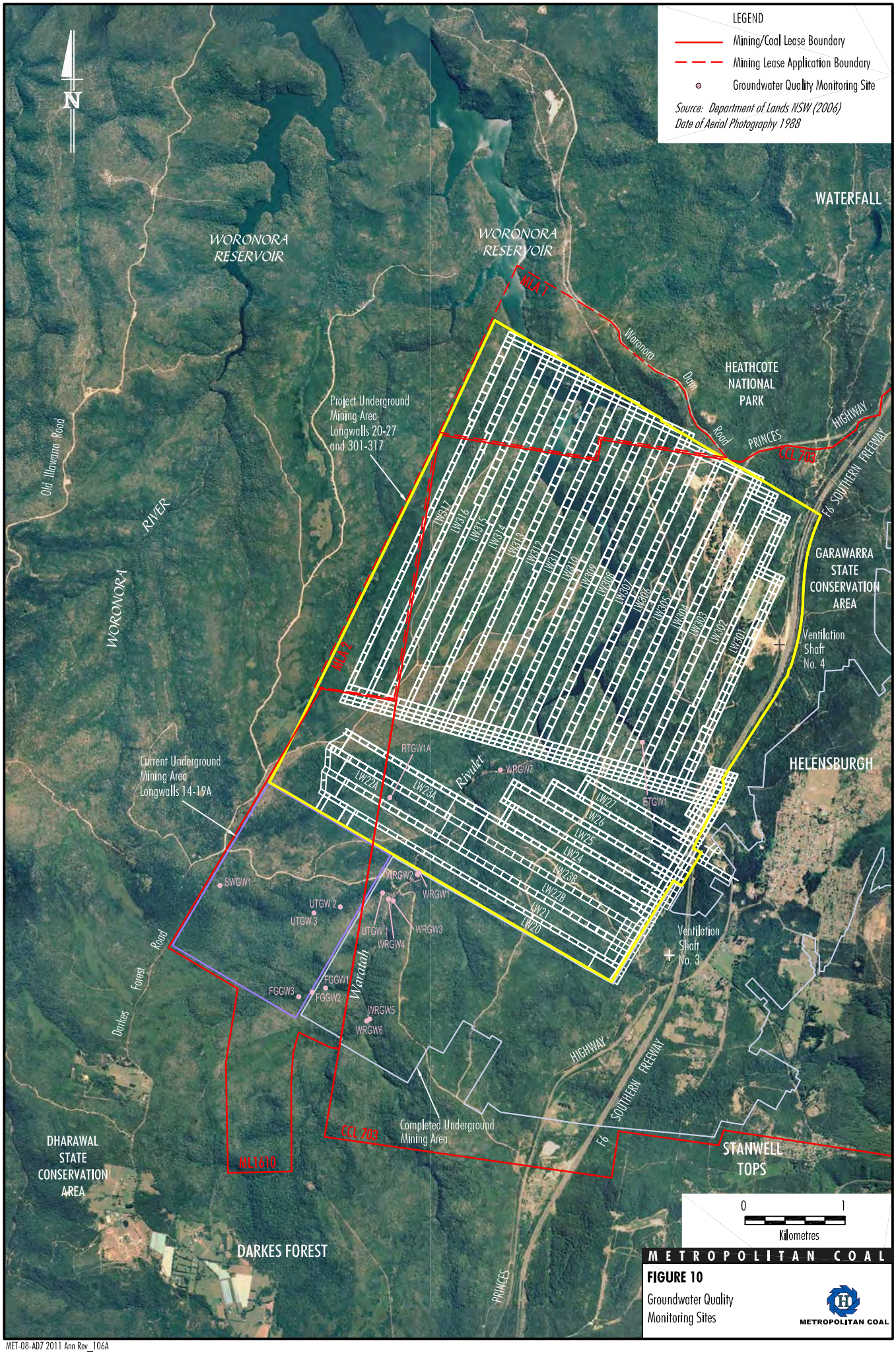

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FIGURE 10

Groundwater Quality Monitoring Sites

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Table 3 9 (Continued)
Status of New Monitoring Sites

Monitoring Component	New Monitoring Site	Status
Shallow groundwater bores	• Site WRGW7	• Installed (commenced August 2010)
	• Site WRGW8	• Installed (commenced August 2010)
	• Site ETGW1	• Installed (commenced September 2010)
	• Site ETGW2	• Installed (commenced September 2010)
Deep groundwater bores	• Site PM03	• Installed February 2011
	• Site 9EGW2	• To be installed by the end of Longwall 21
	• Site 9FGW2	• To be installed by the end of Longwall 21
	• Site PHGW2	• To be installed by the end of Longwall 21
	• Site F6GW1	• To be installed by the end of Longwall 21
Groundwater quality	• Site WRGW7	• Installed (commenced September 2010)
	• Site WRGW8	• Installed (commenced September 2010)
	• Site ETGW1	• Installed (commenced September 2010)
	• Site ETGW2	• Installed (commenced September 2010)

3.1.3 Surface Water Model Development, Calibration and Verification

Numerical catchment runoff models have been developed using the nationally recognised Australian Water Balance Model (AWBM) (Boughton, 2004) and calibrated for the Waratah Rivulet gauging station (GS2132102) and the O'Hares Creek gauging station at Wedderburn (GS213200). The models are progressively updated using the latest monitoring data, and ongoing (periodic) calibration and verification checks are conducted as described below.

Metropolitan Coal has used rating curve and manual gauging information provided by the Sydney Catchment Authority (SCA) for the Waratah Rivulet and Woronora River gauging stations to undertake a critical review of the rating relationships used to generate flow data from the recorded stage (water level) data. Metropolitan Coal has provided feedback to the SCA on the outcomes of the review and proposed amendments to the rating curves. The review recommended the existing low flow ratings for the SCA gauging stations be amended to provide the best match possible to the existing gauging results, and that historical flow data be regenerated using the revised rating relationships for use in subsequent hydrological analyses.

The calibration and verification program will also involve data checking and correction or removal of erroneous data, however, this will be undertaken following updating of the rating curve by the SCA. The model has been verified by testing the model sensitivity for changes of parameter values and by testing the uniqueness of the model calibration – and its goodness of fit to different components and periods of the flow record.

An AWBM has been fitted to monitored flows at GS2132102 (Waratah Rivulet). Model parameters are presented in Table 4.

Table 4
AWBM Parameters

Surface Store	1	2	3
Surface Store Capacities (C) (mm)	5	130	880
Partial Areas (A)	0.1	0.56	0.34
Baseflow Index (BFI)	0.3		
Baseflow Recession Constant (K_{base})	0.979		
Surface Flow Recession Constant (K_{surf})	0.68		
Evaporation Factor (EvF)	0.85		

The period of available recorded flow data is from 21 February 2007 to 4 May 2010. The monitored flow over this period has averaged 294.6 millimetres (mm)/year while the modelled flow averages 356.6 mm/year.

In order to assess the sensitivity of model predictions to changes in key model parameters, model parameters were varied by ± 10% and modelled average flow re-calculated. Table 5 summarises the results.

Table 5
Sensitivity Analysis Results

Model Parameter	Change	Predicted Average Flow (mm/year)	Change in Predicted Flow
-	Base Case	356.6	-
C values	-10%	374.3	5.0%
C values	+10%	339.0	-5.0%
BFI	-10%	356.4	-0.06%
BFI	+10%	356.8	0.06%
K_{base}*	-10%	355.4	-0.34%
EvF	-10%	415.5	16.5%
EvF	+10%	300.6	15.7%

* Note K_{base} cannot be increased by 10% as the constant cannot be greater than 1.

Table 5 indicates that the model is relatively sensitive to the adopted evaporation factor and moderately sensitive to the capacity of the conceptual storage volumes used to simulate catchment storage effects.

The model sensitivity to a baseflow "leakage" (or system loss) was also assessed by subtracting a constant 0.025 mm/day from the baseflow store (equivalent to a flow loss of 0.5 megalitres [ML]/day). Chart 1 shows a comparison of hydrographs of recorded flows, modelled flows and modelled flows with the constant baseflow loss.

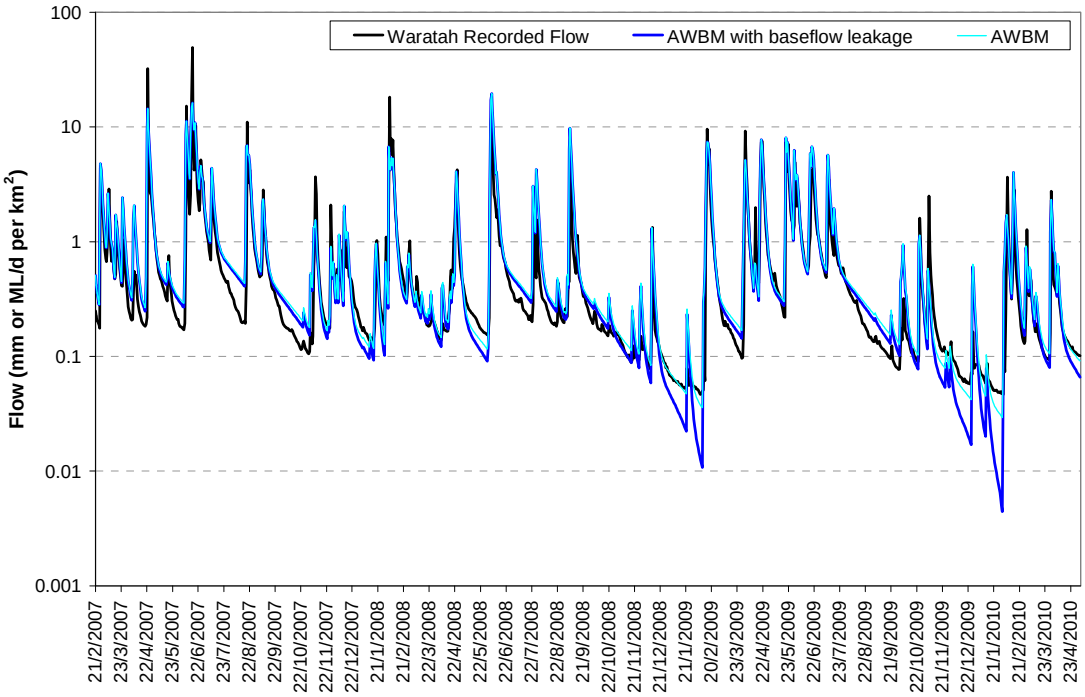


Chart 1 AWBM Model Sensitivity

Chart 1 indicates that the model predictions with a loss of 0.025 mm/day or 0.5 ML/day are inconsistent with the monitored flows. If a loss of this order of magnitude were occurring, it would be expected that it would have been discernible during periods of low flow.

The data from the period following model calibration has been used to verify the reasonableness and robustness of model performance. When checked against streamflow data and concurrent climate data the data indicates that the models provide close predictions of post calibration flow data which verify the current models.

Table 6 shows the calibrated values of these parameters for the SCA owned gauging station on Waratah Rivulet and the Office of Environment and Heritage (OEH) gauging station on O'Hares Creek at Wedderburn.

Table 6
Calibrated AWBM Parameters

Gauging Station	AWBM Parameters							
	C1 (mm)	C2 (mm)	C3 (mm)	A1	A2	A3	BFI	K
GS2132102 Waratah Rivulet	5	130	880	0.10	0.56	0.34	0.30	0.979
GS213200 O'Hares Creek at Wedderburn	4	150	400	0.164	0.633	0.203	0.21	0.97

Chart 2 shows flow hydrographs of data recorded at the Waratah Rivulet gauging station and AWBM generated flows that have been derived from catchment rainfall and regional evaporation data.

Chart 3 shows the same data converted to modelled and observed flow duration curves. Charts 2 and 3 indicate that the catchment model is a good fit to the observed data.

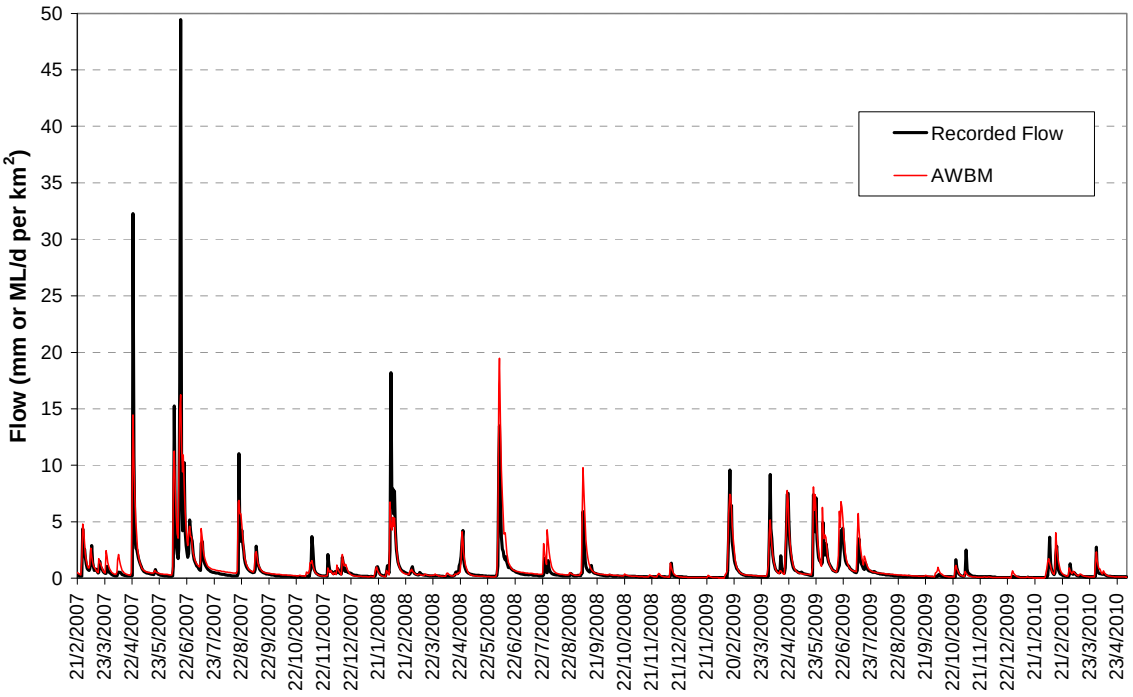


Chart 2 Recorded and Modelled Streamflow Hydrographs – GS2132102 Waratah Rivulet

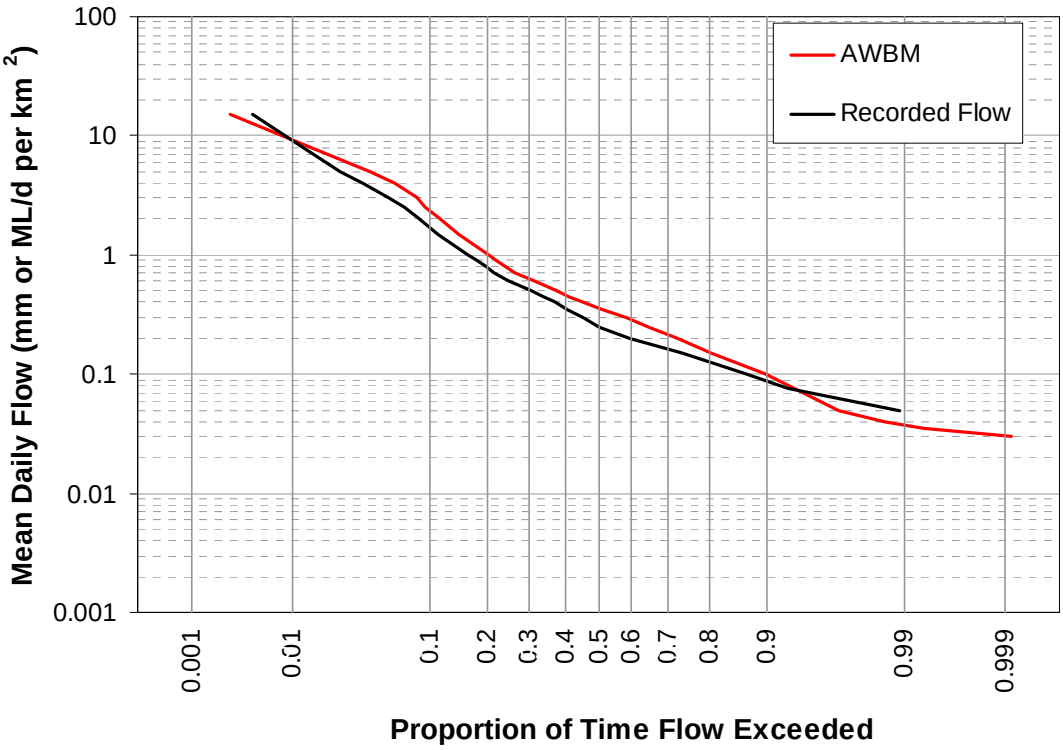


Chart 3 Recorded and Modelled Flow Duration Curves - GS2132102 Waratah Rivulet

Chart 4 presents a comparison of modelled and monitored flows for the post calibration period (i.e. after 14 May 2008). The continued closeness of fit for the post calibration period provides a verification of the original calibration.

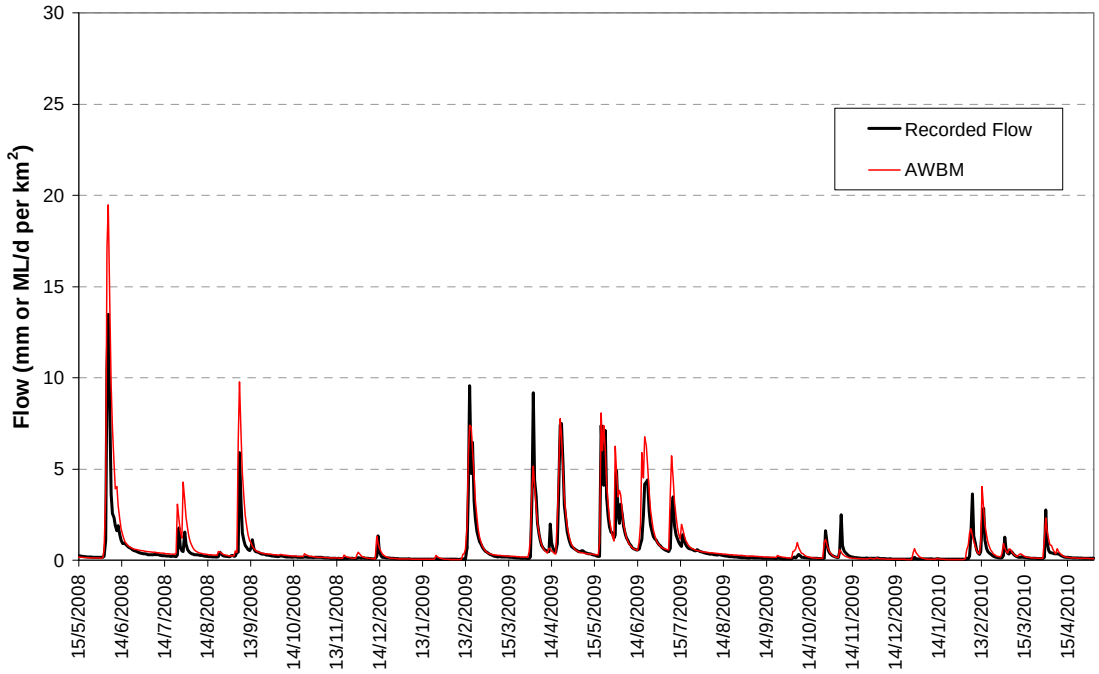


Chart 4 Recorded and Modelled Streamflow Hydrographs – Waratah Rivulet for the Post Calibration Review Period

Whilst additional data has also been recorded at the SCA gauging station on Woronora River (GS 2132101), the data is considered insufficient to enable the development and calibration of a catchment model, due to numerous data gaps.

3.1.4 Groundwater Model Development, Calibration and Verification

A three-dimensional numerical model of groundwater flow has been developed for the mine and its surroundings. During the review period, the model has been used to make impact predictions for future Longwalls 23-27 (Merrick and Alkhatib, 2011).

A review of the groundwater model was undertaken during the review period by Dr Noel Merrick with the following outcomes. The model outputs were compared with the vertical head profiles measured at three deep holes drilled since the model was originally calibrated, and at one of the two holes available for model calibration at the time of the Project Environmental Assessment (EA).

The key findings of the performance review of the groundwater model included:

- The vertical hydraulic gradient profiles at sites 9FGW1B, 9GGW1B and 9GGW2B simulated by the two alternative model variants (termed “high-inflow” and “low-inflow” models) bracket the observed responses. At sites 9GGW1B and 9GGW2B the high-inflow head profile is closer to the measured profile. At site 9FGW1B the measured data are more closely aligned with heads calculated using the low-inflow model.
- The measured head profile at site PM02 is parallel to the simulated profiles but has a consistent offset of about 20 m to the left of the high-inflow profile.
- The review indicates that the results are consistent with the predictions of environmental impacts that were presented in the EA (Helensburgh Coal Pty Ltd, 2008) and the Preferred Project Report (PPR) (HCPL, 2009).

The groundwater models will continue to be refined as new data become available.

3.1.5 Assessment of Environmental Performance

The monitoring and assessment of Project impacts on surface water and groundwater resources described in the Catchment Monitoring Program is consistent with the programs described for the Metropolitan Coal Longwalls 20-22 Water Management Plan in Section 3.3 of this Annual Review.

3.1.6 Management and Mitigation Measures

Metropolitan Coal has maintained a register of water monitoring sites that includes the location, the date the site was established, photographs and relevant comments. The monitoring register has been made publicly available on the Peabody website and will be updated as required.

A Construction Management Plan (refer to Section 3.10 of this Annual Review) has been submitted to DP&I for approval and includes the proposed construction of gauging stations on Honeysuckle Creek and the Eastern Tributary in preparation for Longwalls 23-27.

3.1.7 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Catchment Monitoring Program within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

Metropolitan Coal has proposed to install and commission gauging stations on Honeysuckle Creek and the Eastern Tributary.

Metropolitan Coal replaced existing pool water level monitoring equipment to improve the accuracy of the water level data and improve durability during high flow events. This is discussed further in Section 3.3.

The surface water catchment model has been re-calibrated as data sets from the above instrumentation become available. An expert peer review will be conducted of the surface water catchment model re-calibration.

Metropolitan Coal will continue to monitor and assess data quality from the deep piezometer bores, particularly those piezometers exhibiting relatively long equilibration times in low permeability strata.

3.2 SUBSIDENCE MONITORING PROGRAM

3.2.1 Background

The Metropolitan Coal Longwalls 20-22 Subsidence Monitoring Program has been prepared to validate subsidence predictions and analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan in accordance with Condition 6, Schedule 3 of the Project Approval.

The objectives of the monitoring program are:

- To monitor the subsidence parameters and subsidence impacts about Longwalls 20-22 extraction.
- To provide subsidence parameter and subsidence impact data required as part of the management of environmental consequences as detailed in the Longwalls 20-22 Extraction Plan. These include the:
  - Water Management Plan;
  - Biodiversity Management Plan;
  - Land Management Plan;
  - Heritage Management Plan;
  - Built Features Management Plan; and
  - Public Safety Management Plan.
- To validate subsidence predictions.
- To provide subsidence data to improve the predictive methods and provide a better understanding of the underlying factors contributing to ground movement.

3.2.2 Monitoring

The Subsidence Monitoring Program includes subsidence parameter monitoring (i.e. the actual movement of the ground surface) and subsidence impact monitoring (e.g. surface cracking). The results of subsidence parameter monitoring are described below. The results of subsidence impact monitoring are described in Sections 3.3 to 3.8.

In accordance with the conditions of approval and the Subsidence Monitoring Program, this Annual Review provides a comparison between the predicted and observed subsidence movements for several monitoring lines above or near the extracted Longwall 20 that were surveyed to the end of July 2011.

Subsidence monitoring data from the following monitoring lines and points was assessed (Figure 11):

- Line 9C;
- Line 9C West;
- Longitudinal Line;
- Waratah Rivulet Cross Lines 14, 15 and 16; and
- Ridge to Ridge Monitoring Points.

Additional survey lines, including Princes Highway Line, Freeway Line, Transmission Line, Line 9J, Line 9G and D Line are to be surveyed within three months of the completion of Longwall 20 and will be included in the next Annual Review. This Annual Review also describes the observed impacts on the stream beds and cliffs and overhangs within the Project Underground Mining Area resulting from the extraction of Longwall 20. Descriptions of subsidence related impacts on other natural features within the Project Underground Mining Area are described in other sections of this Annual Review, and the observations provided in this section should be read in conjunction with all other relevant sections.

D Line

Subsidence monitoring over completed Longwalls 1-18 includes a main subsidence line (D Line) established perpendicular to the longwall panels (Figure 11). D Line will continue to be monitored as part of the Subsidence Monitoring Program to provide general information regarding the movement of the landscape over time (over Longwalls 1-18), in addition to general information regarding ground movement in response to Longwalls 20-22.

D Line will be monitored within three months of the completion of each longwall panel (i.e. Longwalls 20-22).

Line 9G

Line 9G is located along Fire Road 9G, extending from D Line to beyond the Longwalls 20-22 35 degree (°) angle of draw (Figure 11). The purpose of Line 9G is to measure the subsidence parameters (subsidence, tilt, strain) associated with the extraction of each longwall and the cumulative subsidence parameters associated with overall extraction.

Line 9G will be monitored within three months of the completion of each longwall panel (i.e. Longwalls 20-22).

Line 9C and Line 9C West

Line 9C and Line 9C West are located along and adjacent to Fire Road 9C (Figure 11).

The purpose of Line 9C and Line 9C West is to:

- supplement the measurement of subsidence parameters from Line 9G to compare the subsidence behaviour in the eastern and western sections of the longwall panels;
- provide a detailed data set for ridge top movement adjacent to the Waratah Rivulet to compare with previous extraction approximately parallel to the Waratah Rivulet (D Line);
- provide a baseline from which ridge to ridge valley closure movements can be measured;
- provide detailed subsidence movements in both longitudinal and lateral directions extending from a ridge top to the base of a valley to measure ‘down slope’ movement; and
- monitor subsidence in the area of Swamps 16 and 17.

Line 9C and Line 9C West have been surveyed monthly while subsidence has been above 20 mm/month (i.e. in June and July 2010).

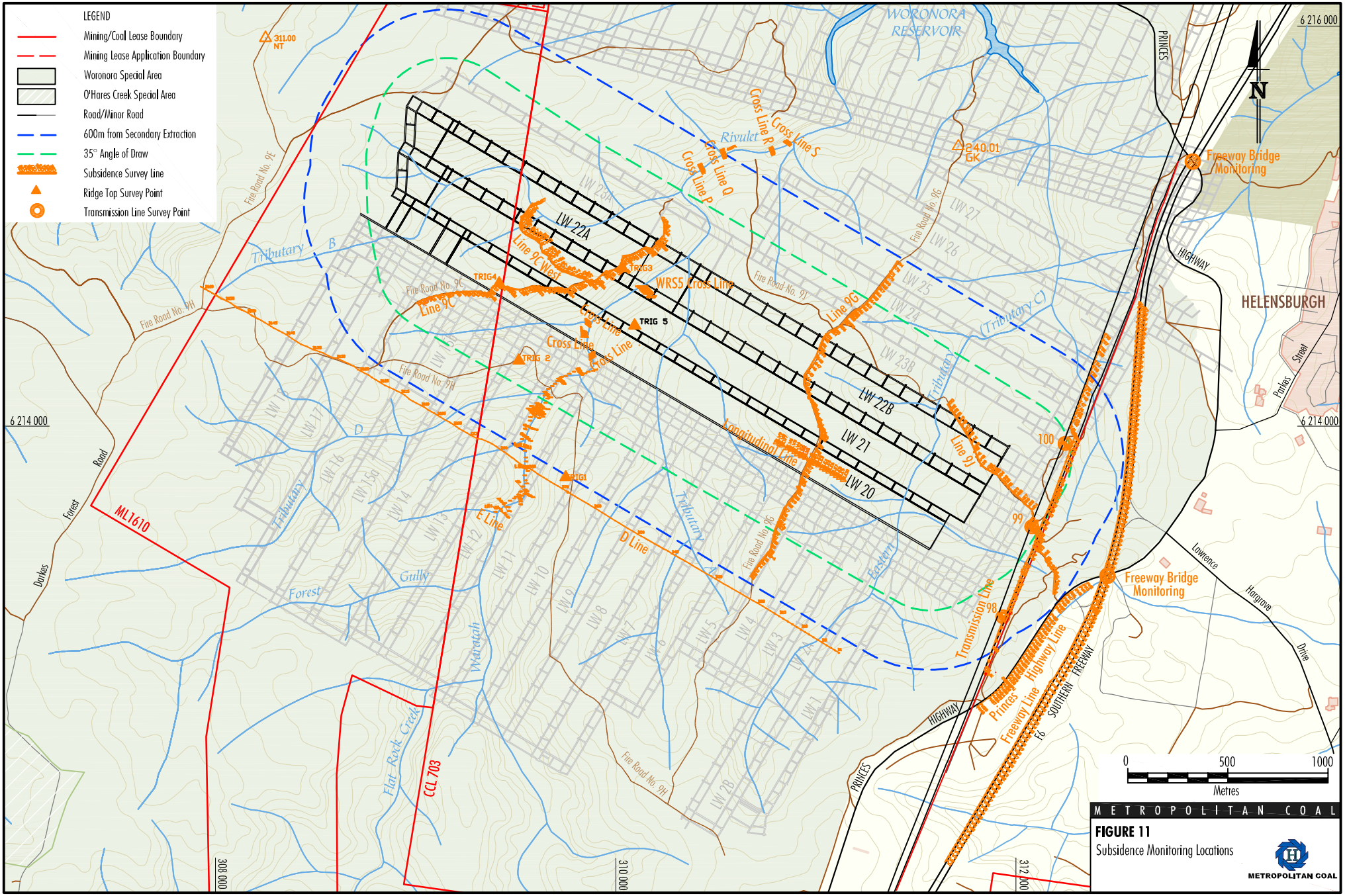
Line 9C and Line 9C West were monitored once Longwall 20 passed beyond the subsidence line by at least 600 m, yet prior to the commencement of Longwall 21.

Longitudinal Line

The Longitudinal Line is situated perpendicular to Fire Road 9G (Figure 11).

The purpose of the Longitudinal Line is to:

- supplement the subsidence measurement from Line 9G to compare the subsidence behaviour in longitudinal and transverse directions; and
- provide an indication of the likely subsidence behaviour ahead of longwall extraction to better understand the likely behaviour ahead of the finish lines, in particular in relation to infrastructure.



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In accordance with the Built Features Management Plan – Roads and Traffic Authority (RTA), the Longitudinal Line has been monitored monthly while Longwall 20 has been within 1,000 m of the Longitudinal Line and until Longwall 20 passed the Longitudinal Line by 200 m.

The Longitudinal Line will also be monitored within three months of the completion of each longwall panel (i.e. Longwalls 20-22).

Line 9J

Line 9J is located along Fire Road 9J, extending from the Princes Highway to a point 200 m west of the Longwall 21 finish line (Figure 11).

The purpose of Line 9J is to:

- complete the subsidence profile from the F6 Southern Freeway bridge to a point over the goaf where subsidence would be expected to have reached a maximum. In other words, to measure the ground response in the area of greatest strain to provide a high level of confidence in the management of the F6 Southern Freeway bridge; and
- obtain subsidence information across the finish line of the longwall panels to calibrate the subsidence prediction methods.

In accordance with the Built Features Management Plan – RTA, Line 9J will be monitored once when Longwall 20 is approximately 200 m from the finish line. Line 9J will also be monitored within three months of the completion of each longwall panel.

Transmission Line

The Transmission Line is located along the easement containing the TransGrid and Integral Energy high tension transmission lines and generally the fibre optic cables (Figure 11).

The purpose of the Transmission Line is to:

- provide monitoring of ground movements about the transmission lines, towers, and fibre optic cables;
- to supplement the subsidence data about the F6 Southern Freeway; and
- obtain subsidence information ahead of the longwall panels to calibrate the subsidence prediction methods.

In accordance with the Built Features Management Plan – RTA, the Transmission Line will be monitored when Longwall 20 is approximately 200 m from the finish line. The Transmission Line will also be monitored within three months of the completion of each longwall panel.

Each of the four legs of the TransGrid transmission towers 98, 99 and 100 (Figure 11) will also be surveyed in accordance with the Built Features Management Plan – TransGrid.

Princes Highway Line

The Princes Highway Line is located along the verge of the Princes Highway extending from the F6 Southern Freeway bridge to the point where the high tension transmission lines intersect the Princes Highway (Figure 11).

The purpose of Princes Highway Line is to:

- provide monitoring of ground movements about the Princes Highway;
- supplement the subsidence data about the F6 Southern Freeway; and
- obtain subsidence information ahead of the longwall panels to calibrate the subsidence prediction methods.

The Princes Highway Line will be monitored within three months of the completion of each longwall panel.

Freeway Line

The Freeway Line is located along the verge of the F6 Southern Freeway extending from 200 m south of Kelly's Creek to a point 600 m from the edge of Longwall 22 extraction (Figure 11).

The purpose of the Freeway Line is to:

- provide monitoring of ground movements about the F6 Southern Freeway; and
- obtain subsidence information ahead of the longwall panels to calibrate the subsidence prediction methods.

The Freeway Line will be monitored within three months of the completion of each longwall panel.

Waratah Rivulet Cross Lines

A number of cross lines will be monitored for subsidence movement, as described below:

- the existing E Line which runs across the Waratah Rivulet at the WRS3 rock bar in a direction perpendicular to the river;
- 13 existing cross lines across the Waratah Rivulet downstream of the WRS3 rock bar;
- an additional three cross lines above Longwalls 20–22 (Lines 14, 15, and 16), including a cross line across the WRS5 rock bar (WRS5 Line); and
- additional cross lines at Pools P, Q, R and S.

The cross lines will be monitored within three months of the completion of each longwall panel.

Lines 14, 15 and 16 were surveyed monthly until the longwall passed the Waratah Rivulet and subsidence was less than 20 mm/month. Lines 14, 15 and 16 will also be surveyed within 1 month of the completion of each longwall panel.

Ridge to Ridge

Five monitoring points have been established at ridge top locations on either side of the Waratah Rivulet (Figure 11). The locations were selected on the basis that a direct line of sight exists between the monitoring points. The purpose of the ridge to ridge survey points is to measure total valley closure and compare predicted values with measured values.

The ridge to ridge monitoring points were surveyed monthly until the longwall passed the Waratah Rivulet and subsidence reduced to less than 20 mm/month.

The ridge to ridge monitoring points will also be surveyed within 1 month of the completion of each longwall panel.

3.2.3 Assessment of Environmental Performance

A review of the subsidence survey results and comparison between the predicted and observed subsidence movements associated with Longwall 20 extraction over the review period was conducted by Mine Subsidence Engineering Consultants (MSEC). The subsidence assessment includes the following monitoring lines:

- Line 9C;
- Line 9C West;
- Longitudinal Line;
- Waratah Rivulet Cross Lines 14, 15 and 16; and
- Ridge to Ridge Monitoring Points.

The assessment found that subsidence impacts were less than that predicted within the accuracy expected from re-survey. As shown in Tables 7 to 10, observed impacts on natural features were similar to or less than predicted.

Additional survey lines, including Princes Highway Line, Freeway Line, Transmission Line, Line 9J, Line 9G and D Line will be surveyed within three months of the completion of Longwall 20 and will be included in the next Annual Review.

Line 9C

A summary of the observed and predicted subsidence movements along the monitoring Line 9C for the latest survey is presented in Table 7.

Table 7
Summary of Predicted and Observed Subsidence Movements for Line 9C Resulting from Longwall 20 Extraction

Monitoring Summary			
Initial Survey Date		29 March 2010 (Longwall 18 Chainage 85 m)	
Latest Survey Date		29 March 2011	
Longwall Chainage at Latest Survey Date		995 m	
Face Distance from Line 9C at Latest Survey Date		1305 m past Line 9C on maingate side, 1050 m from the nearest Line 9C Peg	
Subsidence parameter	**Observed Value**	**Predicted Final Value**	**Comments**
Maximum incremental subsidence due to the extraction of Longwall 20 (mm)	83	155	Maximum observed incremental subsidence at Peg C25
Maximum total subsidence after the extraction of Longwall 20 (mm)	83	155	Maximum observed incremental subsidence at Peg C25
Maximum incremental tilt due to the extraction of Longwall 20 (mm/m)	0.5	1.4	Maximum observed incremental tilt between Pegs C58 and C59
Maximum incremental tensile strain due to the extraction of Longwall 20 (mm/m)	1.0	0.2*	Maximum observed incremental tensile strain between Pegs C39 and C40
Maximum incremental compressive strain due to the extraction of Longwall 20 (mm/m)	0.9	0.2*	Maximum observed incremental compressive strain between Pegs C40 and C41

Note: * denotes that the maximum predicted tensile and compressive strains are based on conventional movements.

The profiles of the observed subsidence, tilt and strain along Line 9C are shown on Figure 1 of Appendix 1. The profiles of the predicted incremental subsidence and tilt due to the full extraction of Longwall 20 are also shown in this figure.

The base survey for Line 9C was undertaken on 29 March 2010 when Longwall 18 still had 85 m of extraction remaining. Hence the survey results along this Line 9C include a small component from the extraction of Longwall 18 which is predicted to be 20 mm as shown in Appendix 1.

The maximum observed incremental subsidence due to the extraction of Longwall 20 was 83 mm at Peg C25, which is located above Longwall 20. The maximum observed incremental tilt was 0.5 mm/m between Pegs C58 and C59, however, as can be seen on Figure 1 of Appendix 1, this small value is considered to be affected by more by survey tolerance than by effects of mining.

The maximum incremental tensile and compressive strains of 0.5 mm/m and 1.0 mm/m occur in survey bays C58-C59 and C39-C40. The maximum tensile and compressive strains ignore the high strains at the location of the bumped peg C40, which has been labelled in Figure 1 of Appendix 1. However these values are considered to be affected more by survey tolerance than by effects of mining.

It can be seen in Figure 1 of Appendix 1 that the maximum observed subsidence (83 mm) is less than the maximum predicted subsidence (155 mm). The observed subsidence profile is, however, greater than the predicted subsidence profile away from the centre of the panel as small vertical movements, with negligible tilts and strains, have occurred to the north of Longwall 20. These small vertical movements extend several hundred metres to the north of Longwall 20 and may be the result of redistribution of *in-situ* stresses due to the extraction of Longwall 20. Such movements were not observed along the D Line monitoring line during the extraction of Longwalls 1 to 18. The movements are within the level of accuracy of predictions as discussed in the EA, specifically "*where subsidence is predicted at points beyond the goaf edge, which are likely to experience low values of subsidence, the predictions should generally be accurate to within 50 mm of subsidence*".

Line 9C West

A summary of the observed and predicted subsidence movements along the monitoring Line 9C West for the latest survey is presented in Table 8.

Table 8
Summary of Predicted and Observed Subsidence Movements for Line 9C West Resulting from Longwall 20 Extraction

Monitoring Summary			
Initial Survey Date		29 March 2010 (Longwall 18 Chainage 85 m)	
Latest Survey Date		29 March 2011	
Longwall Chainage at Survey Date		995 m	
Face Distance from Line 9C West at Latest Survey Date		Line 9C West does not pass above Longwall 20, 1175 m from the nearest Line 9C Peg	
Subsidence parameter	**Observed Value**	**Predicted Final Value**	**Comments**
Maximum incremental subsidence due to the extraction of Longwall 20 (mm)	27	10	Maximum observed incremental subsidence at Peg 9CW8
Maximum total subsidence after to the extraction of Longwall 20 (mm)	27	10	Maximum observed incremental subsidence at Peg 9CW8
Maximum incremental tilt due to the extraction of Longwall 20 (mm/m)	0.3	<0.1	Maximum observed incremental tilt between Pegs 9CW22 and 9CW23
Maximum incremental tensile strain due to the extraction of Longwall 20 (mm/m)	0.2	<0.1*	Maximum observed incremental tensile strain between Pegs 9CW14 and 9CW14
Maximum incremental compressive strain due to the extraction of Longwall 20 (mm/m)	0.3	<0.1*	Maximum observed incremental compressive strain between Pegs 9CW23 and 9CW24

Note: * denotes that the maximum predicted tensile and compressive strains are based on conventional movements.

The profiles of the observed subsidence, tilt and strain along Line 9C West are shown in Figure 2 of Appendix 1. The base survey for Line 9C West was undertaken on 29 March 2010 when Longwall 18 still had 85 m of extraction remaining. The profiles of the predicted incremental subsidence and tilt due to the full extraction of Longwall 20 are also shown on Figure 2 of Appendix 2.

Predictions for Line 9C West were not previously prepared, therefore a new prediction line was prepared for Line 9C West.

Line 9C West is located approximately 100 m to the north of Longwall 20 at its nearest point. As a result, predicted and observed values of subsidence, tilt and strain are very small at this stage. Nevertheless, the subsidence profile indicates that small vertical movements (of the order of 20 mm), with negligible tilts and strains have occurred in this area and are within expected limits of accuracy of predictions as discussed above for Line 9C.

Longitudinal Line

A summary of the observed and predicted subsidence movements along the Longitudinal Line for the latest survey is presented in Table 9.

Table 9
Summary of Predicted and Observed Subsidence Movements for Longitudinal Line Resulting from Longwall 20 Extraction

Monitoring Summary			
Initial Survey Date		4 May 2010	
Latest Survey Date		28 July 2011	
Longwall Chainage at Latest Survey Date		30 m	
Face Distance from Longitudinal Line at Latest Survey Date		521 m to Mark GLE10	
Subsidence parameter	**Observed Value**	**Predicted Final Value**	**Comments**
Maximum incremental subsidence due to the extraction of Longwall 20 (mm)	127	138	Maximum observed incremental subsidence at Peg GLE6
Maximum total subsidence after to the extraction of Longwall 20 (mm)	127	138	Maximum observed incremental subsidence at Peg GLE6
Maximum incremental tilt due to the extraction of Longwall 20 (mm/m)	0.3	0.1	Maximum observed incremental tilt between Pegs GLE4 and GLE5
Maximum incremental tensile strain due to the extraction of Longwall 20 (mm/m)	0.3	<0.1*	Maximum observed incremental tensile strain between Pegs GLE6 and GLE7
Maximum incremental compressive strain due to the extraction of Longwall 20 (mm/m)	0.3	<0.1*	Maximum observed incremental compressive strain between Pegs GLW6 and GLW5

Note: * denotes that the maximum predicted tensile and compressive strains are based on conventional movements.

The profiles of the observed incremental subsidence, tilt and strain along Longitudinal Line are shown Figure 3 of Appendix 1. The observed incremental movements are the additional movements since the base survey that was measured on 4 May 2010 prior to the commencement of Longwall 20. The profile of the predicted incremental subsidence due to the full extraction of Longwall 20 is also shown on Figure 3 of Appendix 1.

The maximum observed incremental subsidence due to the extraction of Longwall 20 was 127 mm at Peg GLE6. The maximum observed incremental tilt was 0.3 mm/m between Pegs GLE4 and GLE5. The maximum incremental tensile and compressive strains of 0.3 mm/m occur in survey bays GLE6-GLE7 and CGLW6-GLW5.

It can be seen on Figure 3 of Appendix 1 that the maximum observed subsidence is less than the maximum predicted subsidence.

Waratah Rivulet Cross Lines 14, 15 and 16

A summary of the observed and predicted subsidence movements along Waratah Rivulet Cross Lines 14, 15 and 16 for the latest survey is presented in Table 10.

Table 10
Summary of Predicted and Observed Subsidence Movements for Waratah Rivulet Cross Lines 14, 15 and 16 Resulting from Longwall 20 Extraction

Monitoring Summary					
Initial Survey Date			17 June 2011		
Latest Survey Date			29 May 2010		
Longwall Chainage at Latest Survey Date			459 m		
Face Distance from Monitoring Line at Latest Survey Date			1476 m to Line 14 1557 m to Line 15 1566 m to Line 16		
Subsidence parameter	**Line**	**Observed Value**	**Predicted Final Value**		
			Subsidence	**Upsidence**	**Net Vertical Movement**
Maximum incremental net vertical movement due to the extraction of Longwall 20 (mm)	14	52	160	74	86
	15	85	203	177	25
	16	83	157	176	-19

Subsidence parameter	**Line**	**Observed Value**	**Predicted Final Value**	**Comments**
Maximum incremental closure due to the extraction of Longwall 20 (mm)	14	3	233	Monitoring line length of 22 m to 27 m represents a small portion of the total valley profile used for closure predictions
	15	5	253	
	16	3	254	
Maximum incremental upsidence due to the extraction of Longwall 20 (mm)	14	0	74	Monitoring line length of 22 m to 27 m represents a small portion of the total valley profile used for upsidence predictions
	15	0	177	
	16	0	176	

The profiles of the observed net vertical movement, strain, upsidence and closure along Waratah Rivulet Cross Lines 14, 15 and 16 are shown on Figures 4, 5 and 6 of Appendix 1. The observed incremental movements are the additional movements since the base survey that was measured on the 17th June 2010 when the Longwall 20 extraction face was at chainage 2,689 m, and was approximately 630 m from the nearest cross line.

The maximum observed net vertical movement of 52 mm at Line 14 was less than the predicted net vertical movement of 86 mm. The maximum observed net vertical movement of 85 mm and 83 mm at Line 15 and Line 16 respectively, are greater than the predicted net vertical movement. The predicted net vertical movement include predicted upsidence which is recognised as providing a conservative prediction of subsidence movements. As described in the EA, if the observed upsidence is much less than the predicted upsidence values, then the predicted net vertical movement may be greater than is currently predicted. The predicted value of net vertical movement may not eventuate and small amounts of subsidence may be observed instead of uplift. Given the low levels of observed strain for Waratah Rivulet Cross Lines 14, 15 and 16 and the zero observed upsidence for these short lines, it is possible that only negligible overall valley upsidence has developed, in which case it is considered appropriate to use the predicted subsidence rather than net vertical movement for comparison with the observed results. The observed net vertical movements are less than the predicted subsidence.

There was negligible measured upsidence and closure at each of the monitoring lines which are approximately 25 m in length and represent a small portion of the overall valley profile. The lines represent the full width of the rockbars present over Longwall 20 and indicate generally low levels of strain. The maximum compressive strain of 2.2 mm/m occurred along Line 15 between Pegs 15002 and 15003.

Ridge to Ridge

The Ridge to Ridge monitoring points were set up to monitor the overall movement of the tops of the ridges adjacent to the Waratah Rivulet Valley. The incremental horizontal movement of the Ridge to Ridge are shown on Drawing No. MSEC 471-102 in Appendix 1. The horizontal movement vectors show a general movement towards the Longwall 20 goaf and the base of the Waratah Rivulet Valley.

The measured closures of the Ridge to Ridge monitoring points are plotted on Figures 4, 5 and 6 of Appendix 1 for the Ridge to Ridge monitoring points across the Waratah Rivulet (i.e. Trig 1-Trig 2, Trig 2-Trig 5, Trig 4-Trig 5, and Trig 3-Trig 5). The greatest observed closures of 67 mm and 79 mm were measured between marks Trig 4-Trig 5 and Trig 2-Trig 5 respectively, both of which cross Longwall 20.

Incremental Vectors

A plot of the observed incremental horizontal movement vectors for the monitoring lines discussed in this Annual Review, based on the latest 3D survey results, is shown on Drawing No. MSEC471-102 in Appendix 1.

The vectors show a general movement towards the extracted goaf of Longwall 20. The vectors towards the western end of the Line 9C show more movement towards the previously extracted longwalls and towards the steep slope on the south eastern side of the monitoring line.

The vector movements of the Waratah Rivulet Cross Lines 14, 15 and 16 do not indicate significant closure movement towards the centre of the stream. Some closure movement can be seen in the Line 15 vectors at the location of the highest compressive strain of 2.2 mm/m.

Horizontal Movements

A plot of observed incremental horizontal movement versus distance from nearest goaf edge for the monitoring lines discussed in this Annual Review is provided in Figure 7 of Appendix 1. It can be seen from Figure 7 that the horizontal movements are consistent with the horizontal movements for the D Line, which was monitored for the previously extracted Longwalls 1 to 18, and fit within the horizontal movement data set for the southern coalfield.

Plots of Incremental Relative Longitudinal peg movement and Incremental Relative Lateral peg movement are presented in Figure 8 and Figure 9 of Appendix 1, respectively. The plot includes survey pegs with spacing of 20m ±10m, which includes Line 9C, Line 9C West, and the Longitudinal Line. The relative lateral and longitudinal horizontal movements for the monitored lines fit within the data set for the southern coalfield.

Impacts on Natural Features

The observed impacts to the stream beds, cliffs and overhangs are presented below. Impacts to other natural features are presented in other sections of the Annual Review. The major streams, cliffs and overhangs located above or adjacent to Longwall 20 are shown on Figure 17 and are listed below:

- Tributary B, Waratah Rivulet, Tributary A, Eastern Tributary.
- Cliff/Overhang COH1 and COH2.

Comparison between Predicted and Observed Impacts on Natural Features

A comparison between the observed and the predicted impacts on the stream bed and cliffs and overhangs above or adjacent to Longwall 20 is summarised in Table 11.

Table 11
Summary of Predicted and Observed Impacts Resulting from Longwall 20

Feature	Predicted Impacts	Observed Impacts
Tributary B, Waratah Rivulet, Tributary A, Eastern Tributary	Cracking in the bedrock along the valleys and fracturing and dilation of the underlying strata. Diversion of a portion of surface flow into underlying bedrock.	Some minor widening of existing cracks but no new cracks observed.
Cliff/Overhang COH1 and COH2	Potential cliff instabilities to less than 3% of the lengths of the cliffs.	No instabilities observed.
Rock Ledges	Isolated rockfalls.	No rockfalls observed.

3.2.4 Management and Mitigation Measures

At this stage the implementation of the Subsidence Monitoring Program and associated management processes are considered to be adequate.

3.2.5 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Subsidence Monitoring Program within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

Metropolitan Coal will continue to meet with the RTA Technical Committee on a regular basis over the next review period, the frequency of which will largely be driven by the location of the longwall.

3.3 WATER MANAGEMENT PLAN

3.3.1 Background

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

3.3.2 Monitoring

Stream Features

Visual and photographic surveys of the Waratah Rivulet (from Flat Rock Crossing to the full supply level) and Eastern Tributary (from within the 35° angle of draw of Longwalls 20-22 to the full supply level) are conducted monthly until subsidence is less than 20 mm/month, and thereafter within three months of the completion of each longwall.

Visual inspections of Tributary A (within the 35° angle of draw of Longwalls 20-22) and Tributary B (within the 35° angle of draw of Longwalls 20-22) are conducted within three months of the completion of each longwall.

The visual and photographic surveys record the nature and extent of:

- the location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.);
- the nature of iron staining (e.g. whether isolated or across the entire streambed);
- the extent of iron staining (e.g. length of stream affected);

- description of gas release (e.g. isolated bubbles or continuous stream and type of gas [methane or carbon dioxide using an OdaLog gas detector]);
- the nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc.;
- water discoloration or opacity if present;
- natural underflow if evident (i.e. evidence of surface flows either entering or existing the sub-surface domain via surface cracks in the streambed);
- rock bar characteristics such as extent of cracking, seepage, underflow;
- whether any actions are required (e.g. implementation of management measures, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Global positioning system (GPS) coordinates are recorded where appropriate (e.g. of particular observations and associated photographs).

The monthly visual and photographic surveys, conducted until subsidence is less than 20 mm/month, record the above parameters by exception (i.e. where they differ to the baseline visual and photographic record). The visual and photographic surveys conducted within three months of the completion of each longwall provide a detailed photographic record similar to that provided in the Water Management Plan.

A gas release from Pool H on the Waratah Rivulet was identified on 5 January 2011. The gas release is not an exceedance of Metropolitan Coal's performance measures which allow for 'minimal' gas release downstream of Pool P. There is no limit to gas release upstream of Pool P.

In accordance with the Longwalls 20-22 Water Management Plan, the following actions were undertaken once the gas release was identified:

- monitoring conducted weekly to determine the extent of the gas releases,
- gas concentration monitoring (using OdaLog meter); and
- identification of any observable environmental effects (e.g. impacts to riparian vegetation or fish).

Gas releases were observed periodically until May 2011, however there were no observable environmental effects of these releases. There were no further indications of gas release from this time until the end of the review period.

Additionally, regular visual inspections of the Waratah Rivulet between Pool A to Pool I are also conducted as part of the ongoing measurement and recording of pool levels for Metropolitan Coal's stream pool/rock bar remediation program.

Surface Water Flow

Surface water flow monitoring has included continuous flow monitoring at the SCA-owned gauging stations on the Waratah Rivulet (GS2132102) and Woronora Reservoir (GS2132102) and at the OEH gauging station on O'Hares Creek at Wedderburn (GS213200).

Chart 5 shows concurrent streamflow data from the SCA-owned gauging stations on Waratah Rivulet and Woronora River and the OEH-owned gauging station on O'Hares Creek at Wedderburn. Streamflow is expressed on a per unit catchment area basis (in mm) to allow direct comparison of flow magnitudes without having to adjust for contributing catchment area. Flows are plotted on a logarithmic scale to emphasise the lower flow range.

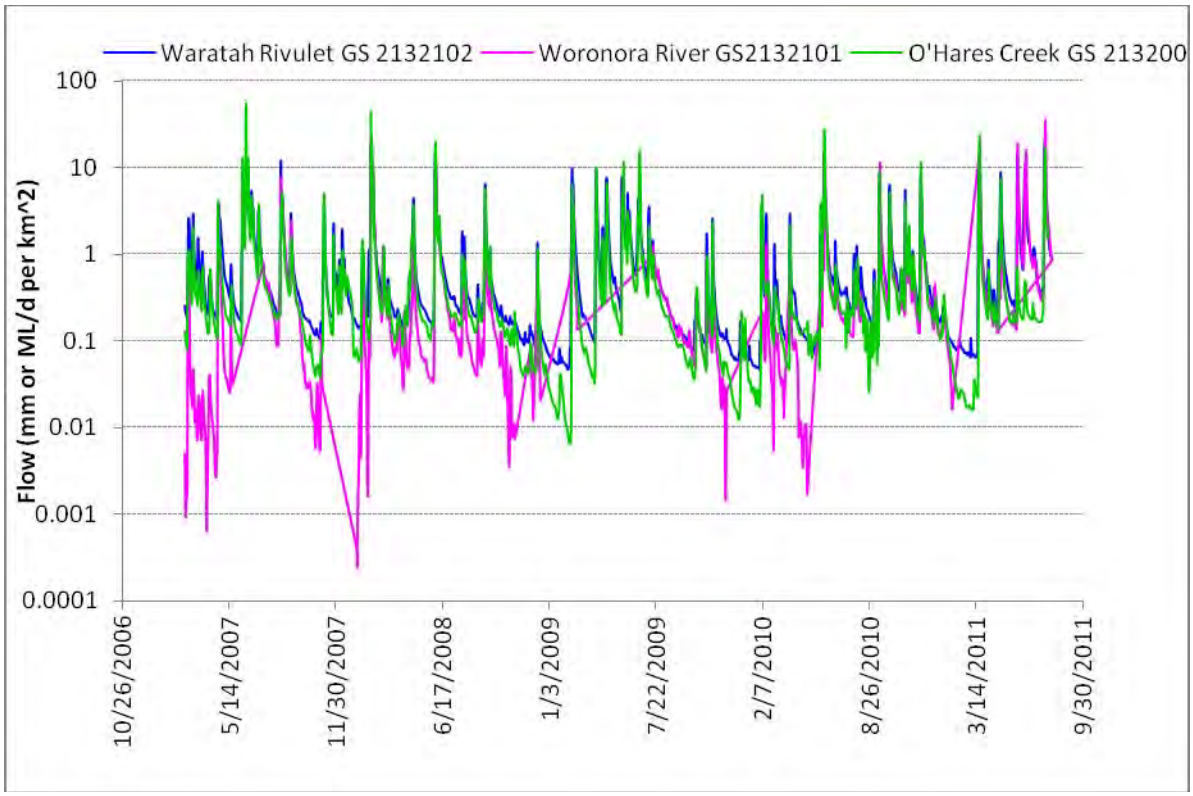


Chart 5 Recorded Streamflow Hydrographs – Waratah Rivulet, Woronora River and O'Hares Creek at Wedderburn

Of the three streams, Waratah Rivulet yielded the highest flow per unit catchment area in medium and low flows, with strong low flow persistence. O'Hares Creek (at Wedderburn) yielded similar flows, with slightly greater high flows, but notably steeper flow recession and lower magnitude low flows. The Woronora River recorded the lowest flows per unit catchment, with the steepest flow recessions. The results of surface water flow monitoring at Waratah Rivulet are analysed in Section 3.3.3.1.

Pool Water Levels

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

The results of pool water level monitoring results are discussed in Section 3.11 in relation to the initiation of stream remediation.

Woronora Reservoir Leakage

Metropolitan Coal will investigate the development of a suitable performance indicator to assess potential leakage from the Woronora Reservoir for future longwalls in consultation with the SCA, with a view to trialling the performance indicator during the mining of Longwalls 26 and 27.

Stream Water Quality

Surface water quality sampling has been conducted monthly at a number of sites on Waratah Rivulet, Tributary B, Tributary D, Eastern Tributary, Far Eastern Tributary, Honeysuckle Creek, Bee Creek and the Woronora River (Figure 8).

Water quality parameters sampled include electrical conductivity (EC), pH, redox potential (Eh), dissolved oxygen (DO), turbidity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO_4), bicarbonate (HCO_3), total nitrogen (Ntot), total phosphorus (Ptot), nitrate (NO_3), barium (Ba), strontium (Sr), manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co) and aluminium (Al). Samples collected for cation, anion and metal analysis have been field filtered.

Unfiltered water quality samples will also be collected at a number of sites on the Waratah Rivulet, Eastern Tributary and Woronora River (Figure 8) and analysed for total iron.

The raw data graphically presented in Appendix 2 demonstrates that the overall water quality of most indicator parameters has not been noticeably affected by mining.

Consistent with the Water Management Plan, the key parameters of interest are pH, EC, dissolved Al, dissolved Fe and dissolved Mn. The results of key water quality parameters are graphically presented for a selection of sites in Charts 6 to 10: Woronora River (sites WOWQ 1, WOWQ 2 and WOWQ 4), Waratah Rivulet (sites WRWQ 1, WRWQ 8 and WRWQ 9) and Eastern Tributary (sites ETWQ F and ETWQ AU). Summary statistics from all locations are presented in Table 12.

The figures show representative samples from the Woronora River (WOWQ 1, WOWQ 2, WOWQ 4), Waratah Rivulet (WRWQ 1, WRWQ 8, WRWQ 9) and Eastern Tributary (ETWQ F, ETWQ AU). Concentrations were relatively consistent between the sites with all watercourses experiencing spikes or pulses throughout the time series. The Waratah Rivulet appeared to have higher Mn concentrations and the Woronora River higher Al concentrations.

Table 12
Surface Water Quality Summary

Location	Eastern Tributary		Waratah Rivulet		Woronora River	
Parameter	**Range**	**Average**	**Range**	**Average**	**Range**	**Average**
pH (field)	4.69 – 7.92	6.5	4.79 – 8.14	6.5	2.42 – 7.35	5.75
Ec (field) (µS/cm)	47 – 310	175	103 – 306	200	0 – 245	175
Mn (mg/L)	0.007 – 0.29	0.058	0.015 – 1	0.1	0.001 – 0.18	0.04
Fe (mg/L)	0.055 – 1	0.3	0.042 – 2.9	0.5	0.012 - 15	0.1
Al (mg/L)	0.011 – 0.2	0.04	0 - 0.1	0.02	0 – 0.42	0.05*
Note: Average does not include WOWQ 1. The average for WOWQ 1 was higher at ~0.2 mg/L						

Woronora and Nepean Reservoir Water Quality

Metropolitan Coal has sourced water quality data for the review period for the Woronora Reservoir, Nepean Reservoir and Cataract Reservoir from the SCA in accordance with a data exchange agreement. The water quality results are analysed in Section 3.3.3.5.

Swamp Groundwater Levels

Upland swamp groundwater monitoring is described in Section 3.4.2.2 of this Annual Review.

Shallow Groundwater Levels

Continuous water level monitoring of shallow groundwater levels has been conducted at sites WRGW1 and WRGW2 along Waratah Rivulet and site RTGW1A on Tributary B (Figure 9). During the current review period, new monitoring sites WRGW7 and WRGW8 were established on the Waratah Rivulet and ETGW1 and ETGW2 commenced on the Eastern Tributary.

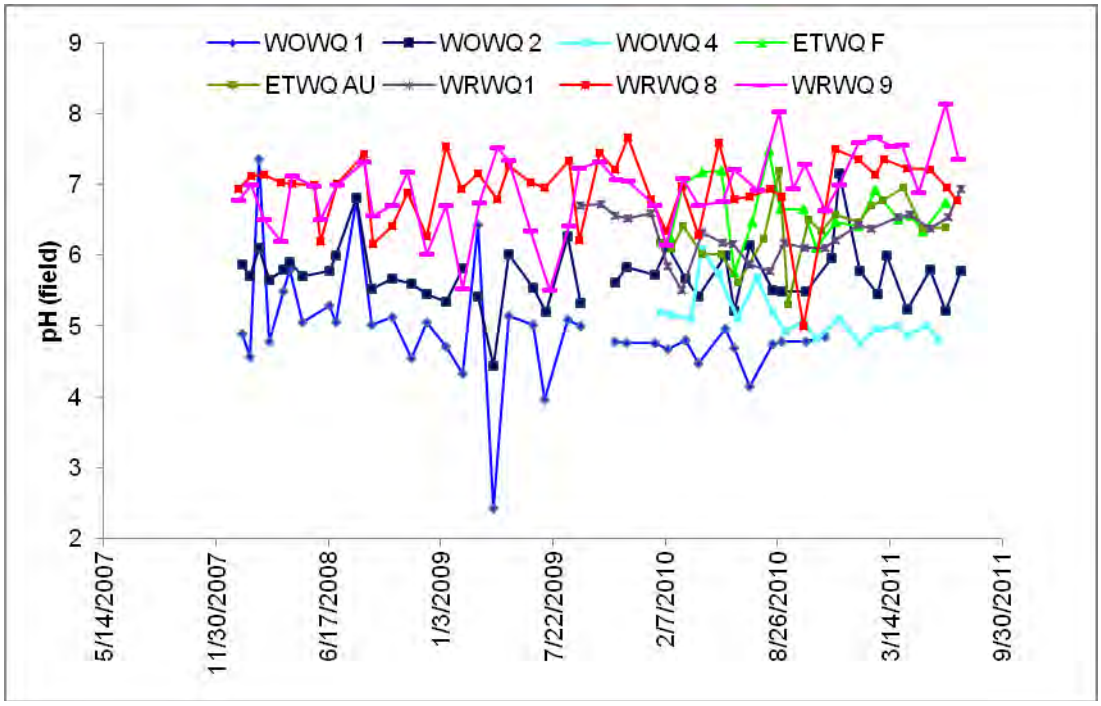


Chart 6 pH

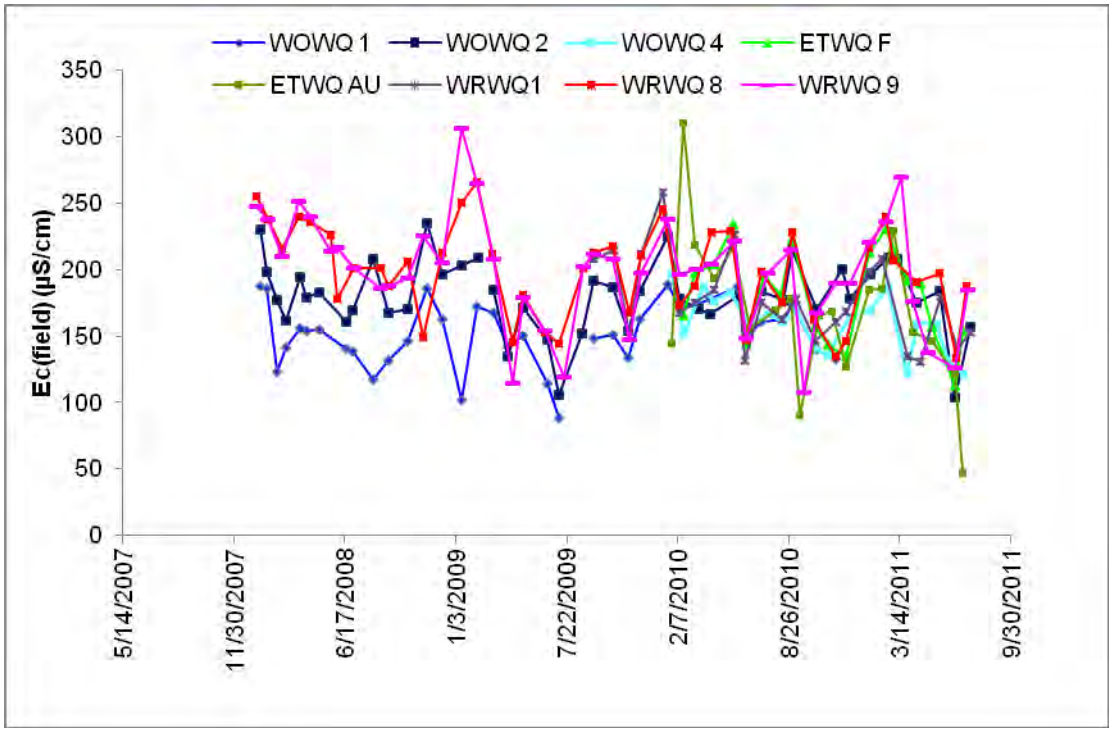


Chart 7 Electrical Conductivity (EC)

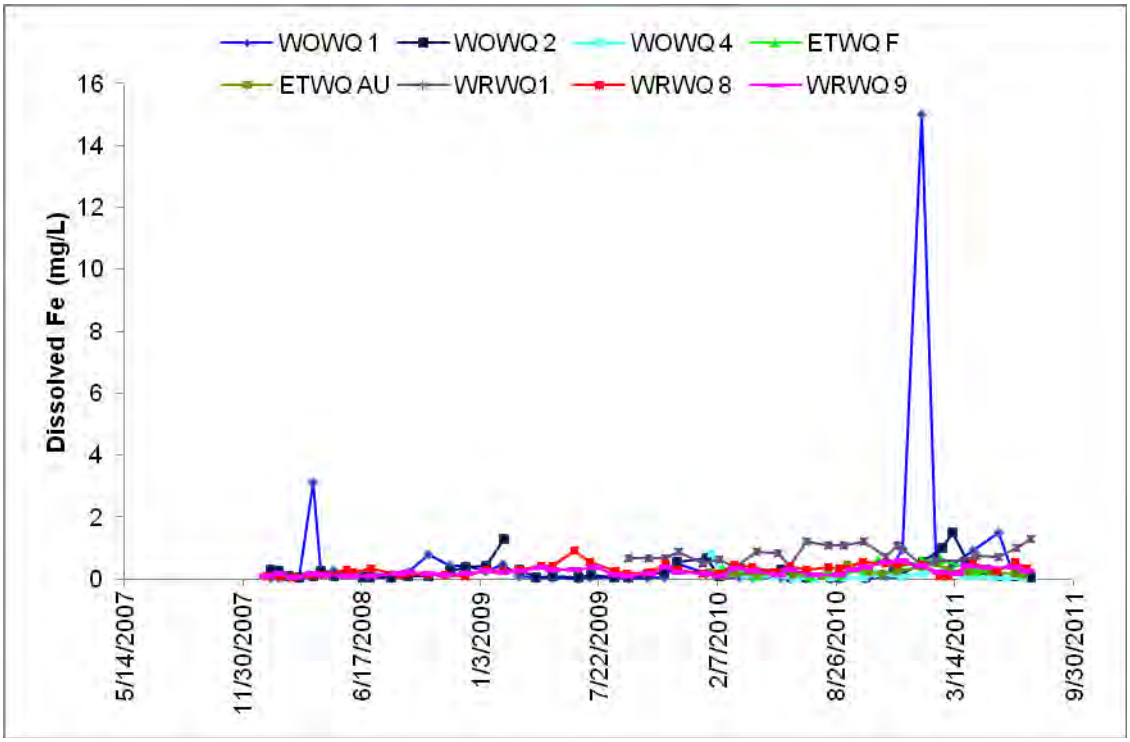


Chart 8 Dissolved Iron (Fe) Concentrations

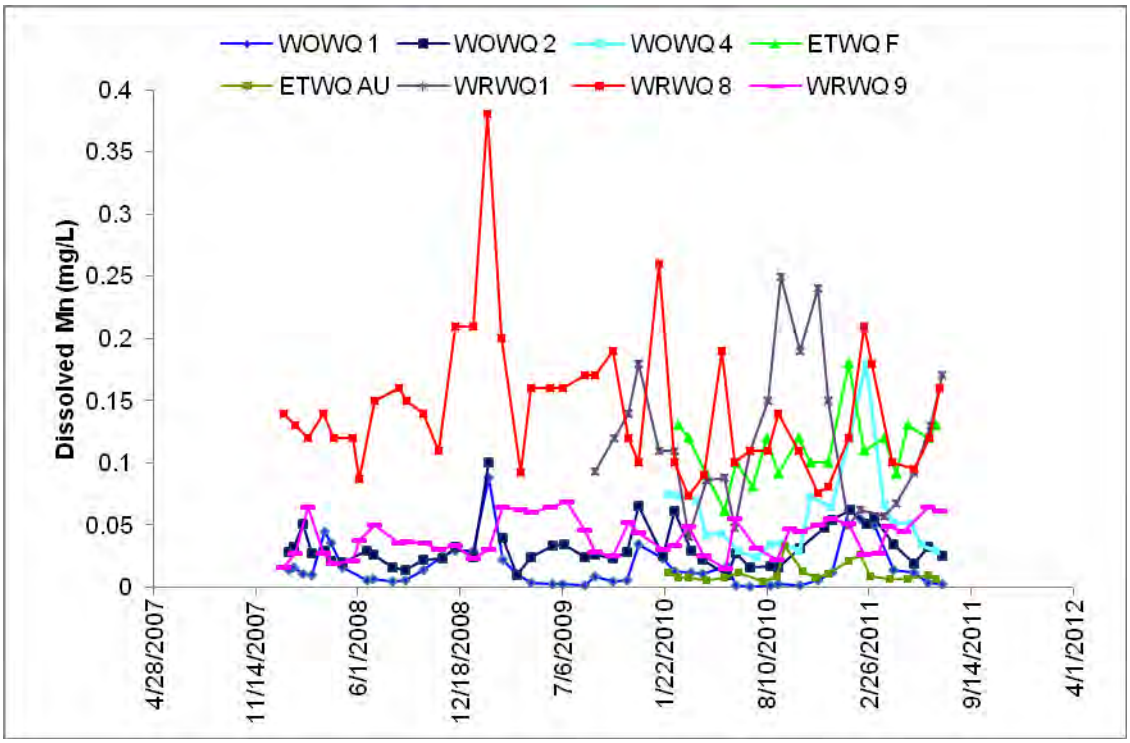


Chart 9 Dissolved Manganese (Mn) Concentrations

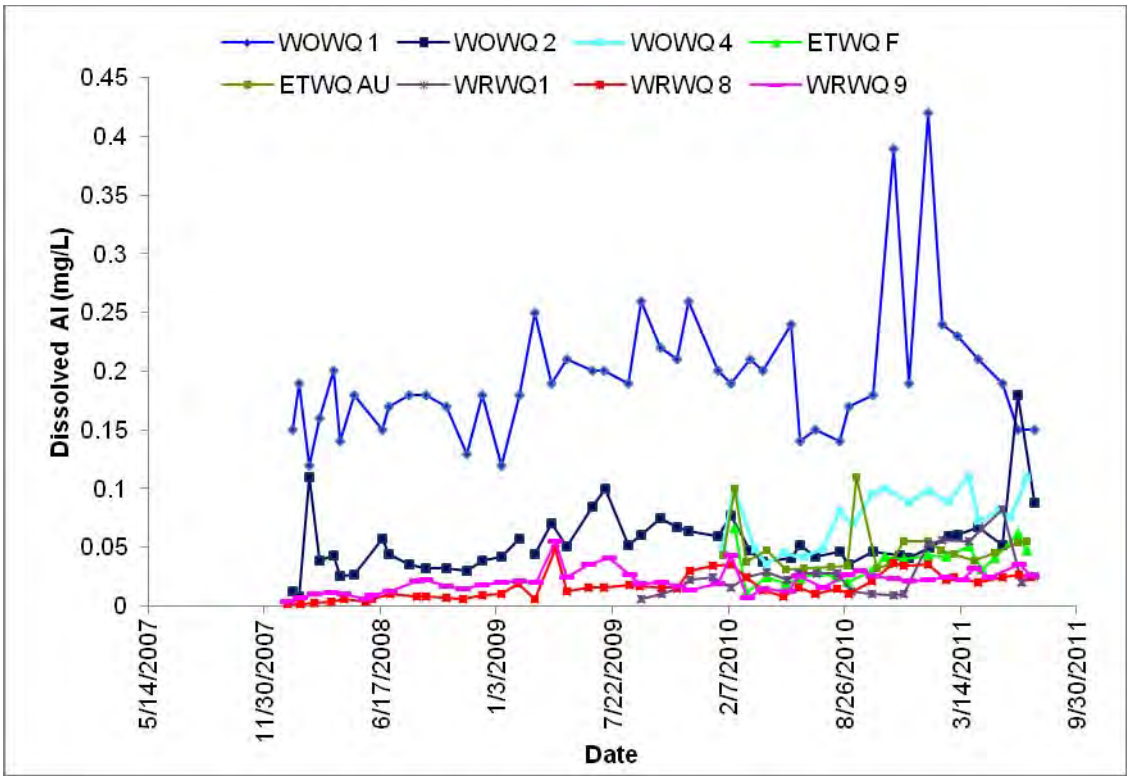


Chart 10 Dissolved Aluminium (Al) Concentrations

Sites WRGW1 and WRGW2 are located on opposite banks of the Waratah Rivulet, to the immediate south of Longwall 20 (Figure 9). The groundwater monitoring results for sites WRGW1 and WRGW2 are shown on Chart 11, and are compared with rainfall events over a period of three years as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 6). Sites WRGW1 and WRGW2 show comparable information over the review period.

All Waratah Rivulet piezometers (i.e. WRGW1 to WRGW8, refer Figure 9) show the same dynamic responses to stream flow interaction and rainfall, with rapid response to rainfall events. Down-gradient site WRGW8 does not exhibit the rapid recession observed at the other sites on the rivulet. Up-gradient sites (WRGW3 to WRGW6) have the greater response amplitude.

During the review period, the water levels at sites WRGW1 and WRGW2 remained stable. There was no sign of irregular behaviour during the mining of Longwall 20 (commencing May 2010).

Deep Groundwater Levels/Pressures

Continuous groundwater level/pressure monitoring has been conducted at site 9EGW1B, site 9FGW1B, site 9GGW1B, site 9GGW2B, site 9HGW0 (Longwall 10 Goaf Hole), site 9HGW1B, site PHGW1, site PM01R, site PM02 and site PM03 (Figure 9).

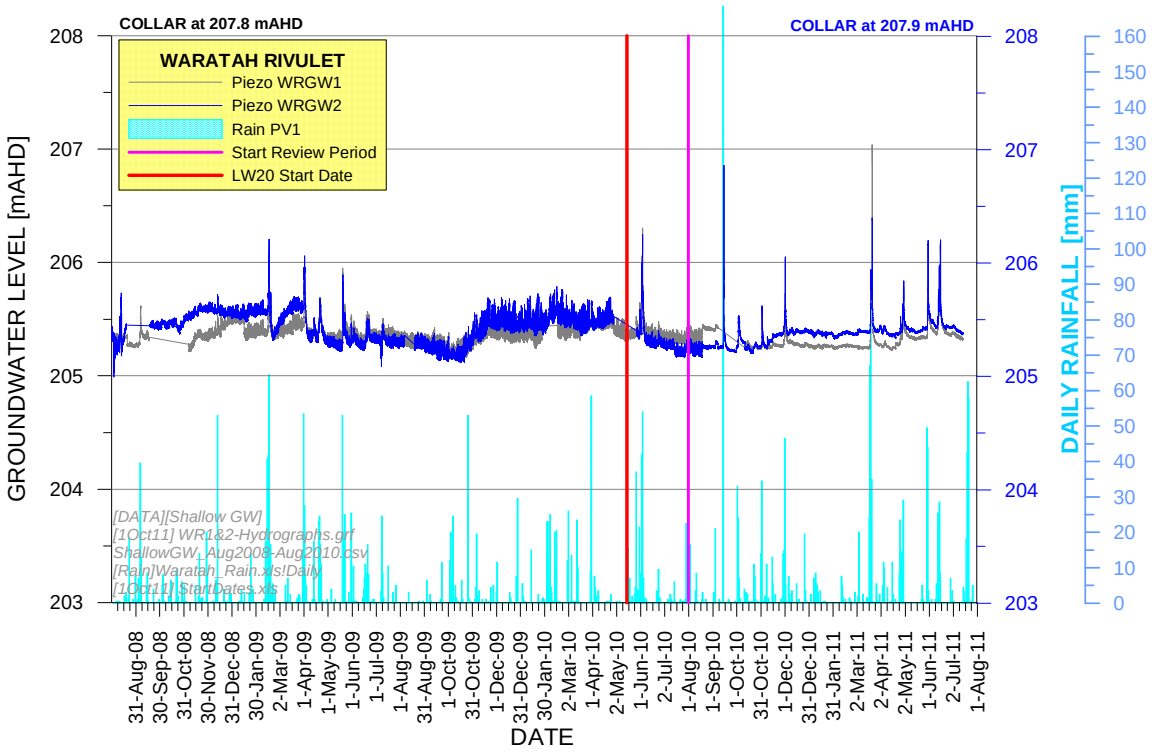


Chart 11 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW1 and WRGW2

The measured vertical hydraulic head profiles for these bores have been examined and selected stable bores compared against the predicted vertical hydraulic head profiles by Dr Noel Merrick, with the following outcomes:

- some installations are providing unreliable data;
- some vibrating wire piezometers have been slow to stabilise since installation, particularly those installed in claystones;
- sites close to current mining show significant depressurisation with depth, consistent with the Project EA;
- sites close to old workings at Helensburgh show substantial depressurisation with depth, consistent with the Project EA; and
- the pressure reductions with depth agree well with model predictions.

The monitoring sites closest to recent mining include site 9FGW1B (900 m north-west of Longwall 20) and site 9GGW1B (above Longwall 22) (Figure 9). Their vertical head profiles are compared with simulated results in Section 3.3.3.3.

The time-series record for site 9FGW1B is shown on Chart 12. This bore has two piezometers that are inconsistent and are regarded as unreliable, and another that is yet to stabilise. In addition, two piezometers have taken some time to stabilise (405 m in Stanwell Park Claystone; 513 m in Bulli Coal seam). The Wombarra Shale piezometer (513 m; not shown here) started responding only in April 2011 about 14 months after installation.

The excavation of Longwall 20 might be responsible for the slow decline in head in the Scarborough Sandstone (piezometer at 455 m). However, it is unclear what effect mining has had on the Bulli Seam piezometer (at 513 m), due to unstable readings when Longwall 20 commenced. At the end of the review period, this piezometer seems to have stabilised with a substantial pressure head of about 220 m.

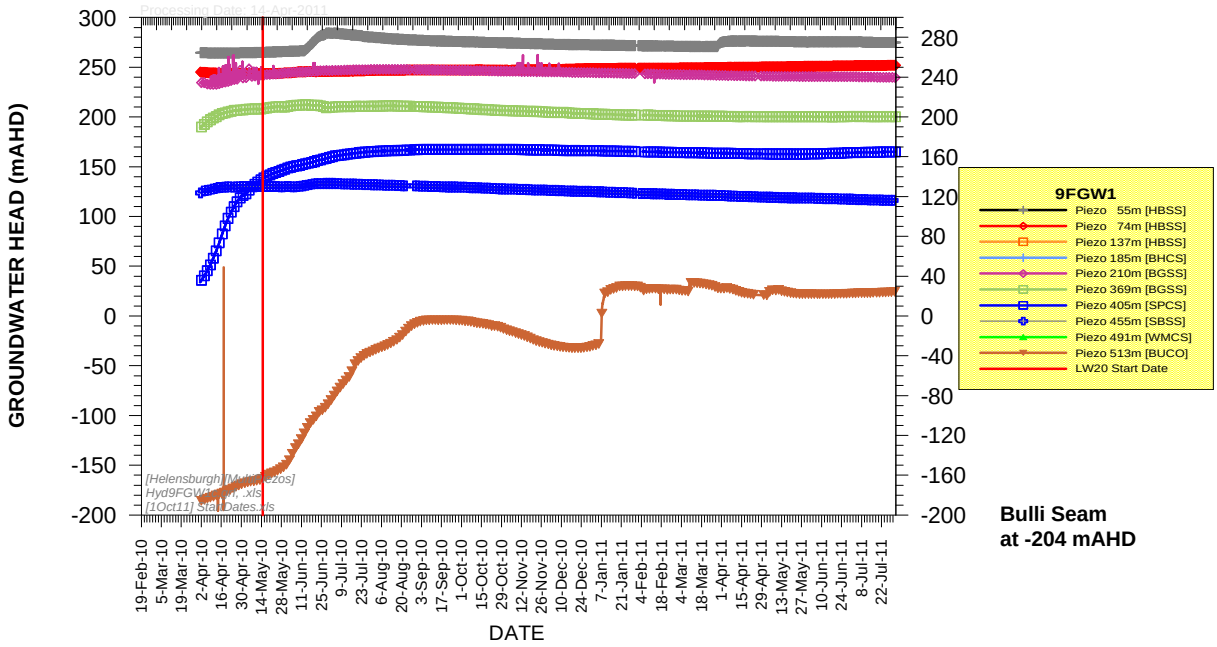


Chart 12 Time Variations in Potentiometric Heads at Site 9FGW1B

The time-series record for site 9GGW1B is shown on Chart 13. Site 9GGW1B (located over Longwall 22 about 300 m from the nearest edge of Longwall 20) shows strong depressurisation below the Bulgo Sandstone, with heads about -20 mAHD in the Scarborough Sandstone and the Coal Cliff Sandstone. The heads in this hole show significant effects from Longwall 20 mining with abrupt events at four times:

1. Longwall face at 1,050 m from bore 9GGW1B at bearing 100 (about 18 October 2010);
2. Longwall face at 450 m from bore 9GGW1B at bearing 060 (about 26 February 2011);
3. Longwall face at 450 m from bore 9GGW1B at bearing 000 (about 5 May 2011); and
4. Longwall face at 800 m from bore 9GGW1B at bearing 330 (about 23 July 2011).

Events 1, 2 and 4 show mirror-image effects centred on the space between the lower Bulgo Sandstone and the Stanwell Park Claystone. This is believed to be the general location of the upper limit of the fractured zone (with connective fractures). The separation between upper piezometer and lower piezometer responses could also be due to an activated shear plane along the top of the Stanwell Park Claystone. Abrupt changes in head correspond to sudden changes in hydraulic conductivity, either lateral or vertical, due to caving, fracturing or shearing, with associated stress redistribution. It is of interest that event 2 occurred when the line joining the longwall face with the bore coincided with the maximum horizontal stress direction (bearing 060). As event 3 occurred only in the upper piezometers, the mechanism might be one of vertical consolidation in the upper formations or closure of bedding planes. The pressure effects reach as far as the lower Hawkesbury Sandstone but there is no response in the upper or middle Hawkesbury Sandstone.

Groundwater Quality

Shallow groundwater quality has been sampled monthly at sites WRGW1 and WRGW2 along the Waratah Rivulet and site RTGW1A adjacent to Tributary B (Figure 10). During the current review period, groundwater quality was monitored also at new monitoring sites WRGW7 and WRGW8 established on the Waratah Rivulet and ETGW1 and ETGW2 on the Eastern Tributary.

Water quality parameters sampled include EC, pH, Eh, Ca, Mg, Na, K, Cl, SO_4, HCO_3, Ba, Sr, Mn, Fe, Zn, Co and Al. The samples collected for the analysis of cations, anions and metals have been field filtered.

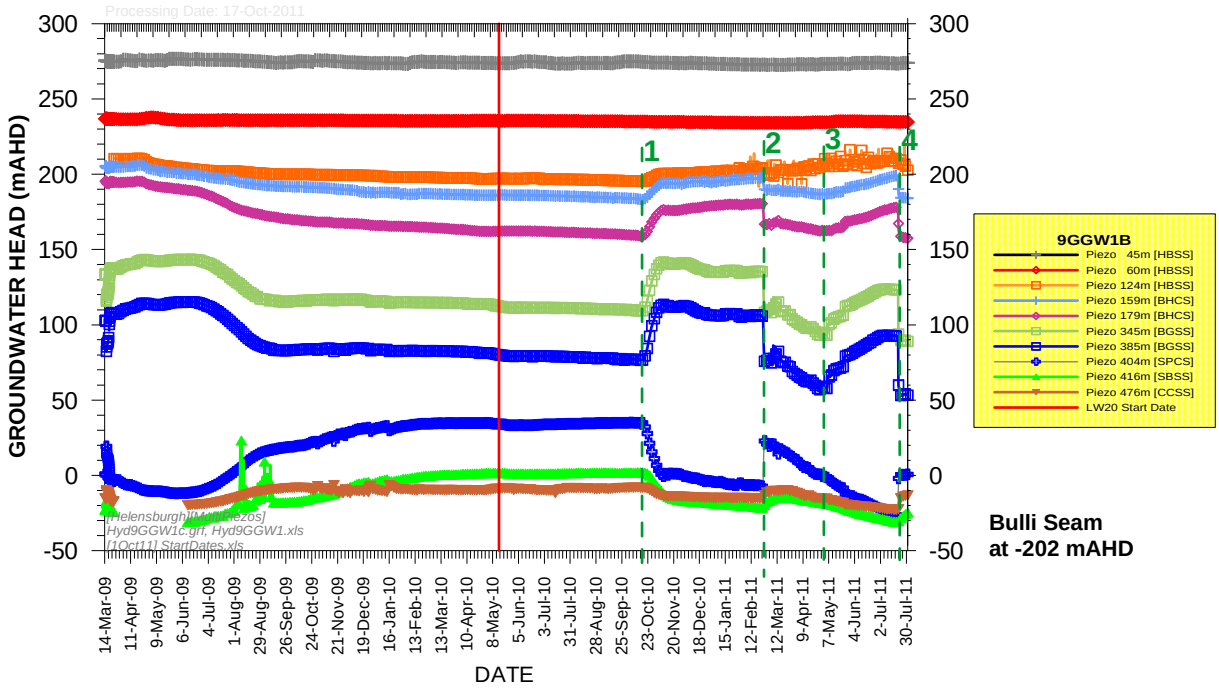


Chart 13 Time Variations in Potentiometric Heads at Site 9GGW1B

Monitoring results for Fe, Mn and pH levels at sites WRGW1 and WRGW2 are provided on Charts 14 to 16. Monitoring results for sites WRGW3 to WRGW8 are also shown on Charts 14 to 16 to show trends over the length of the Waratah Rivulet. Rainfall events over a period of three years, as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 6), provide a context for the substantial fluctuations in parameters; however, there is no obvious relationship with rainfall.

The key observations at the Waratah Rivulet groundwater quality monitoring sites (WRGW1 to WRGW8) are:

- Fe concentrations are usually in the 1 - 10 milligrams/Litre (mg/L) range;
- Peak value Fe concentrations of 14 mg/L occur at WRGW1 and WRGW2;
- Mn concentrations are typically always less than 1 mg/L;
- Groundwater is generally acidic with pH usually between pH 5.5 and 7;
- Fe and Mn concentrations increase with distance downstream to WRGW1 and WRGW2 and then decrease to WRGW7 and WRGW8;
- Aluminium was below the detection limit in all samples; and.
- There is no evidence of irregular behaviour during the mining of Longwall 20 (from May 2010).

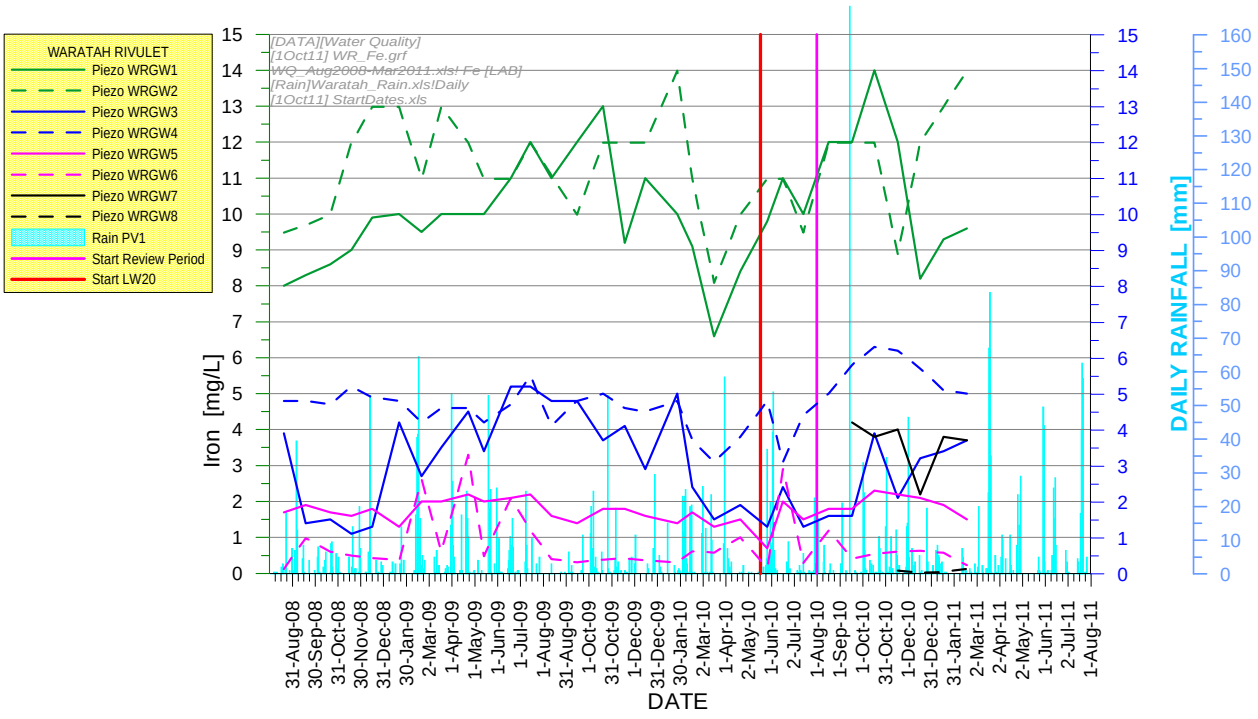


Chart 14 Iron Concentration at Sites WRGW1 to WRGW8

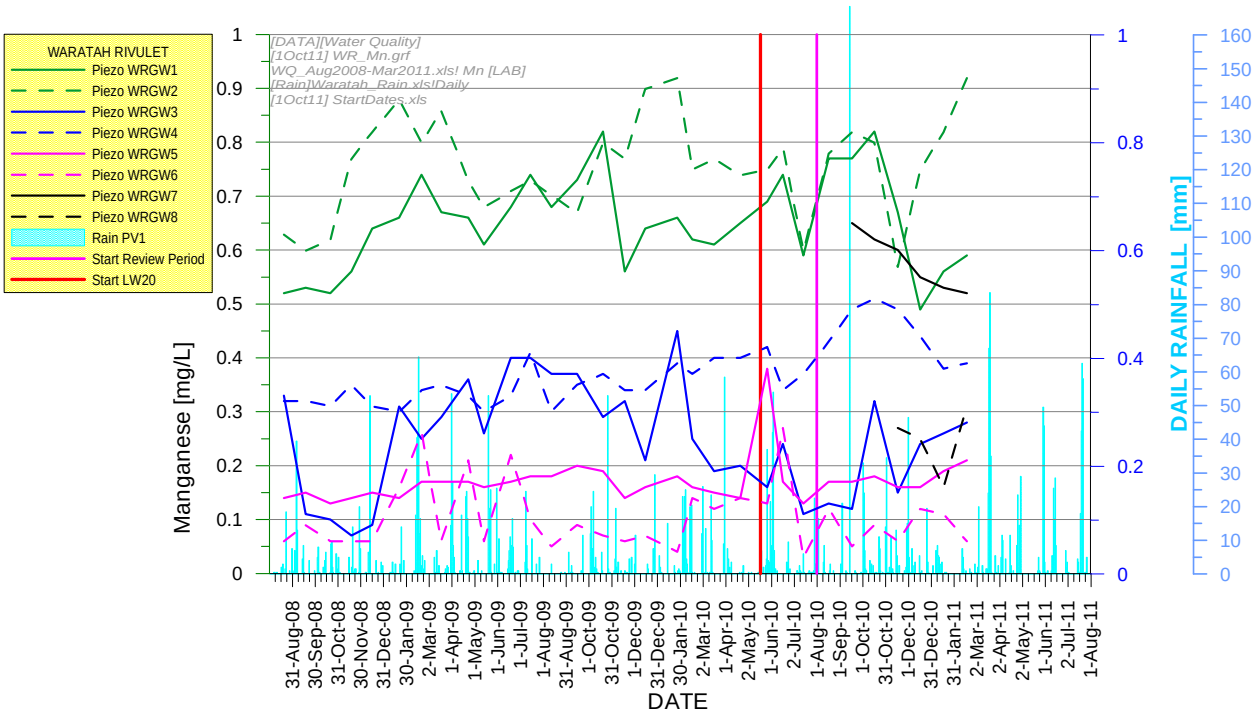


Chart 15 Manganese Concentration at Sites WRGW1 to WRGW8

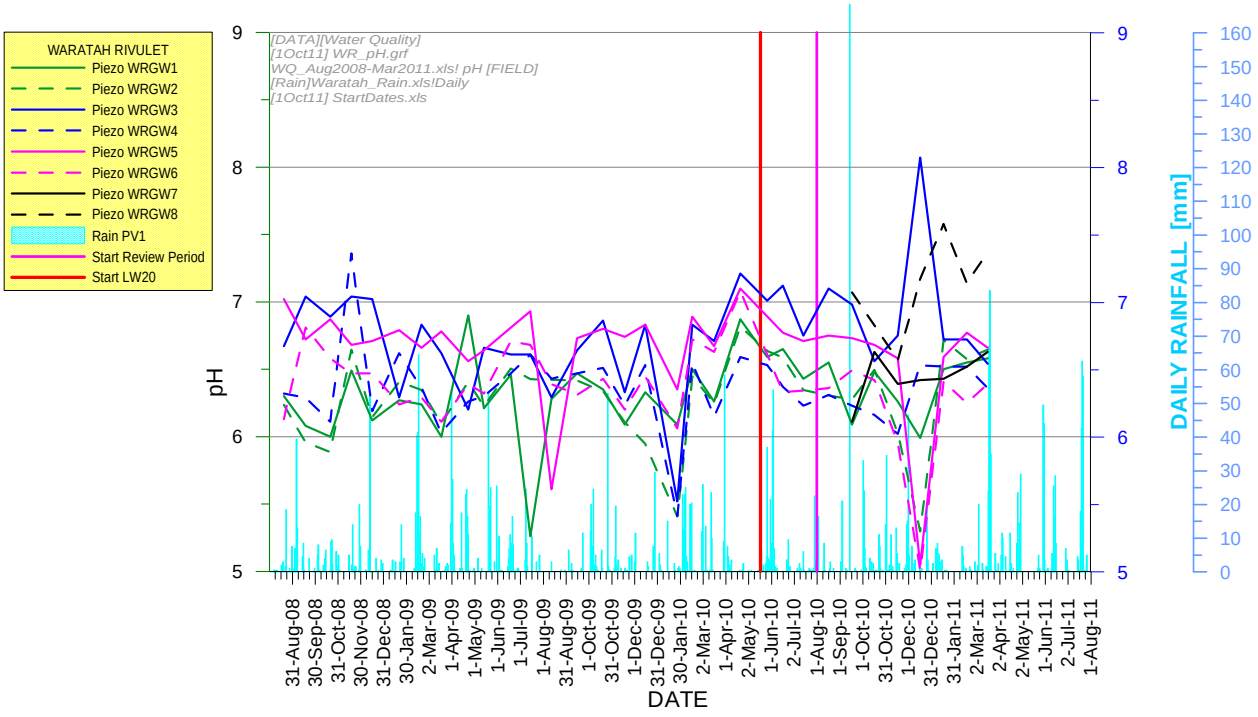


Chart 16 pH Levels at Sites WRGW1 to WRGW8

Site RTGW1A on Tributary B (north of Longwall 20) is sampled monthly for groundwater quality. To provide context for the monitoring results at site RTGW1A, comparison has been made with the up-gradient groundwater quality monitoring site SWGW1 (west of Longwall 18) (Figure 10), positioned in shallow Hawkesbury Sandstone. Groundwater quality at both sites is shown on Charts 17 to 19 for Fe, Mn and pH. Rainfall events over a period of three years, as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 6), provide a context for the substantial fluctuations in parameters; however, there is no obvious relationship with rainfall.

Fe concentrations are generally equal to or below 1 mg/L, with one isolated value of 5.9 mg/L during the review period at site RTGW1A. At the upland swamp, the Fe concentration did not exceed 0.16 mg/L during the review period. Mn concentrations are low at both sites, being always below 0.3 mg/L during the review period. Aluminium was below the detection limit in all samples. The groundwater at the upland swamp (site SWGW1) is acidic, generally around between pH 4 and pH 5, while the groundwater at site RTGW1A is neutral (pH generally around pH 7).

There is no systematic temporal pattern for any analyte, and neither site shows any irregularities due to the mining of Longwall 20 (from May 2010).

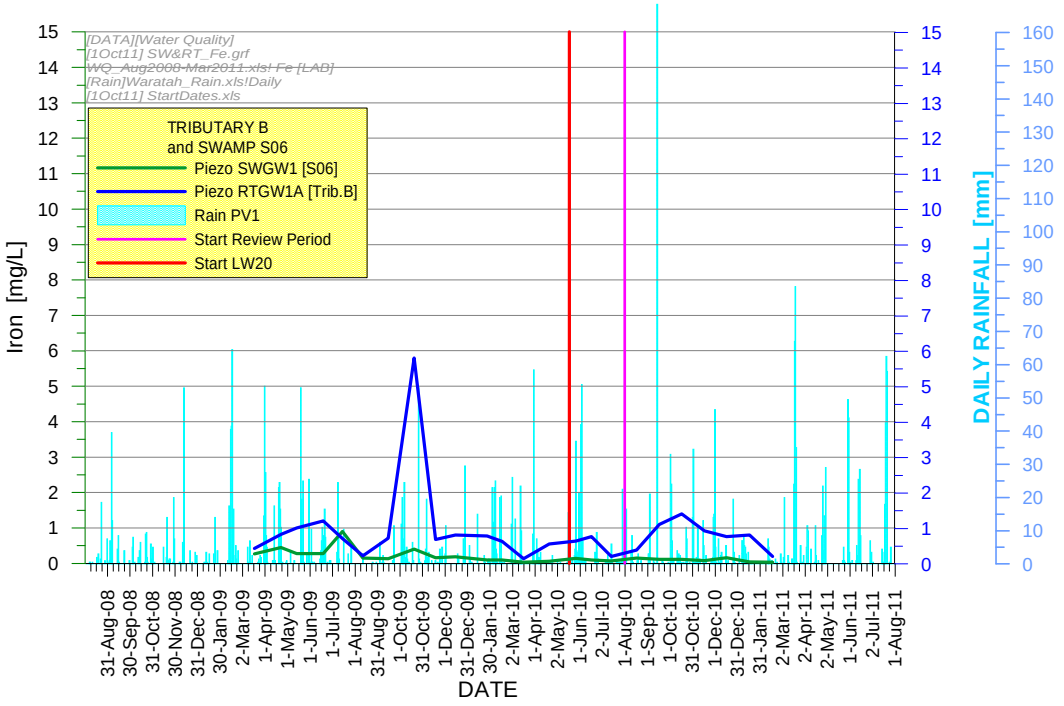


Chart 17 Iron Concentrations at Sites RTGW1A and SWGW1

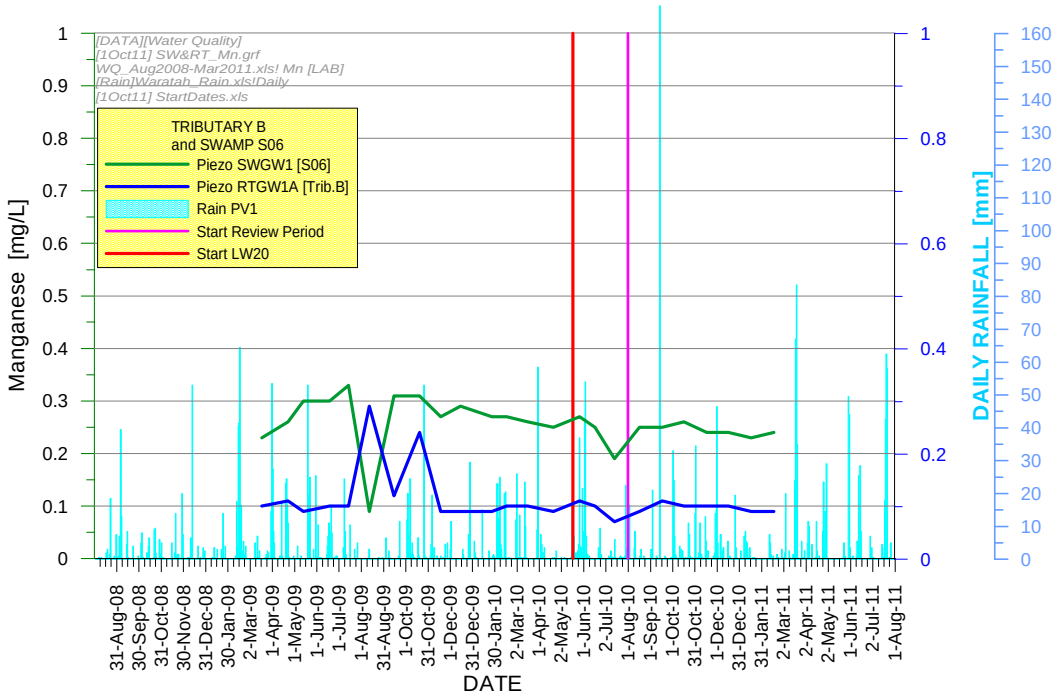


Chart 18 Manganese Concentrations at Sites RTGW1A and SWGW1

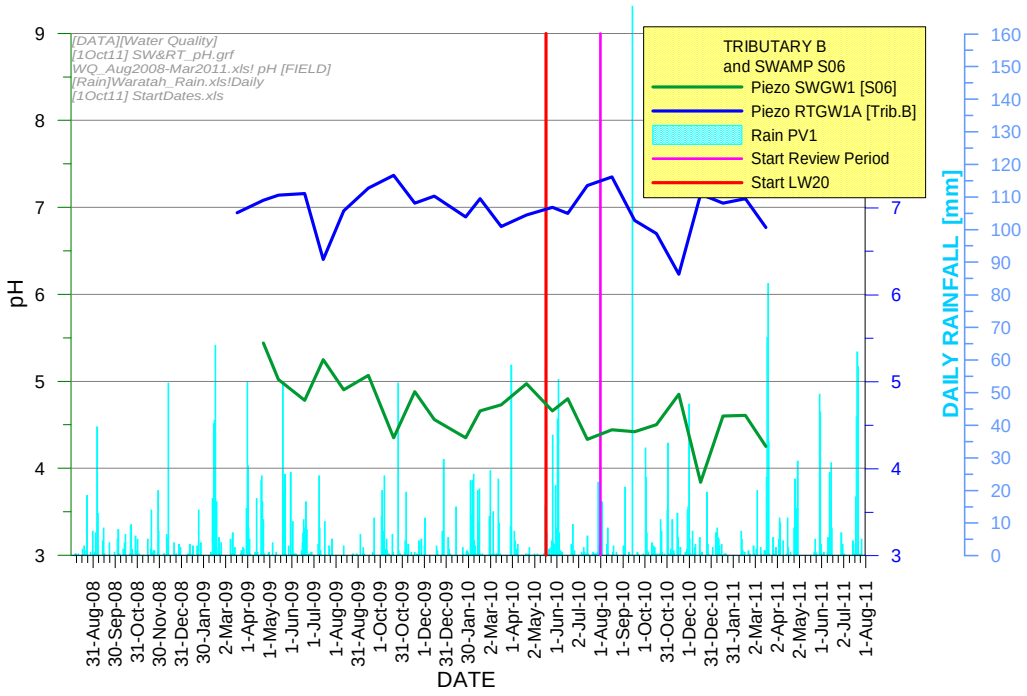


Chart 19 pH Levels at Sites RTGW1A and SWGW1

Groundwater quality at the two Eastern Tributary sites (ETGW1, ETGW2) is shown on Charts 20 to 22 for Fe, Mn and pH. Rainfall events over a period of three years, as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 6), provide a context for the substantial fluctuations in parameters; however, there is no obvious relationship with rainfall.

Fe concentrations are high, ranging from 13 to 15 mg/L. Mn concentrations are low at both sites, in the range 0.5 to 0.6 mg/L. Aluminium was below the detection limit in all samples. The groundwater is generally acidic, between pH 5.5 and pH 6. There is no systematic temporal pattern for any analyte, and neither site shows any irregularities due to the mining of Longwall 20 (from May 2010).

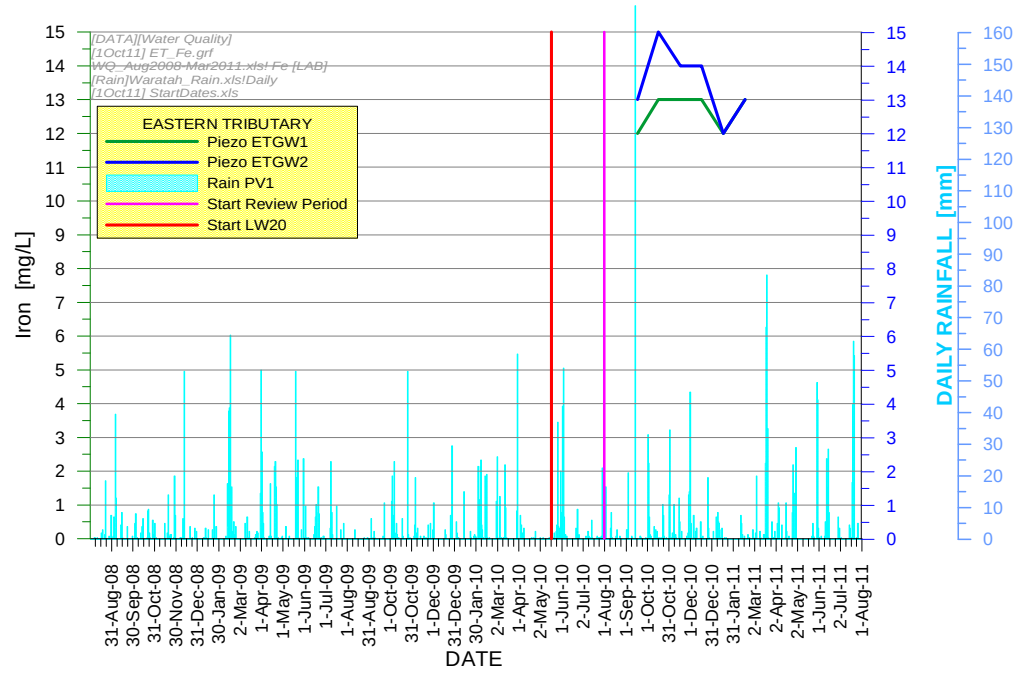


Chart 20 Iron Concentrations at Sites ETGW1 and ETGW2

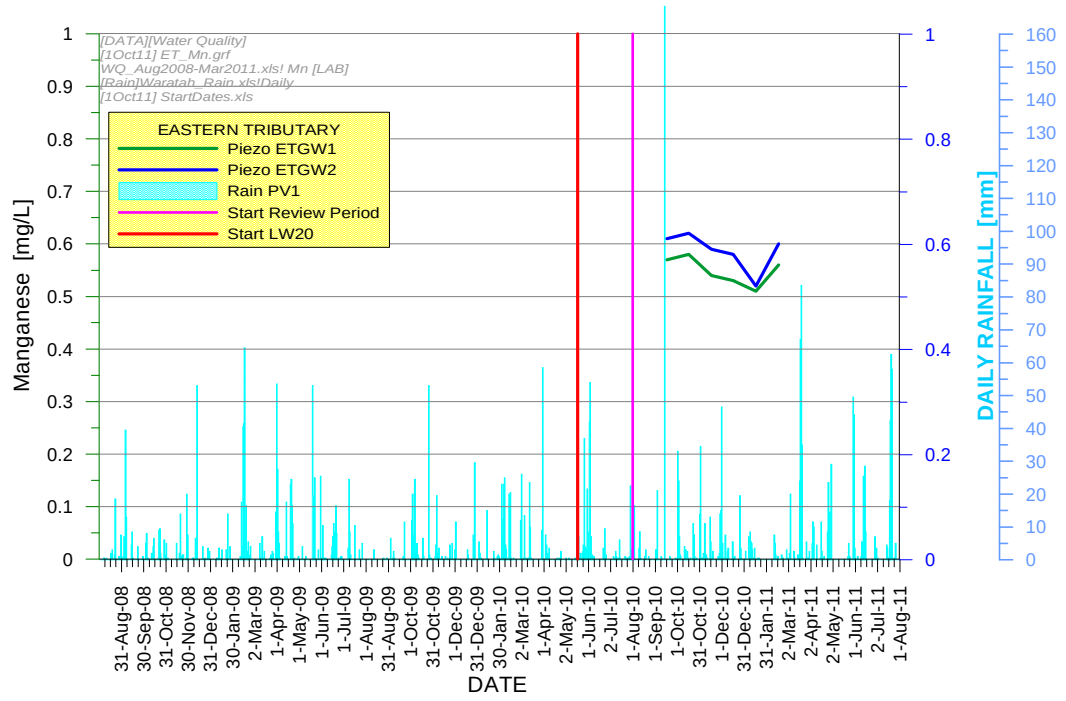


Chart 21 Manganese Concentrations at Sites ETGW1 and ETGW2

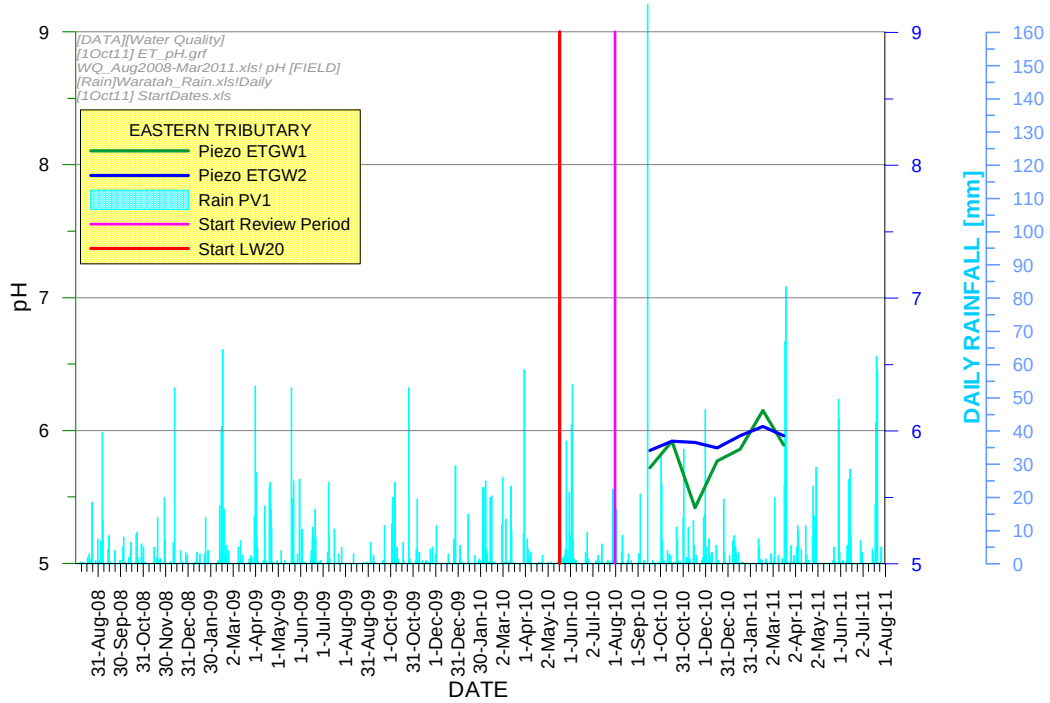


Chart 22 pH Levels at Sites ETGW1 and ETGW2

Inspections of Mine Workings

Metropolitan Coal has developed an In-rush Hazard Management Plan required by the NSW *Coal Mines Health and Safety Regulation, 2006* to manage the potential risk of water in-rush. In addition to shift inspections conducted by statutory officials that report on any abnormal conditions at the working face and in outbye areas, Metropolitan Coal conducts statutory weekly inspections of development workings to identify water accumulations. Monthly inspections of the bleeder roadway (behind the longwall) have been conducted for signs of water make or water build-up however these inspections are no longer possible due to gas content.

A weekly audit of the statutory inspections is conducted by the shift undermanager. In the event the statutory inspection identifies the potential for in-rush, an investigation is conducted by the Senior Mine Supervisor on that shift and reported to the Mine Manager.

The mine inspections did not identify any abnormal water flows from the goaf, geological structure, or strata generally.

Mine Water Make

In accordance with the Water Management Plan, Metropolitan Coal has also monitored the mine water balance. The inferred water make (i.e. groundwater that has seeped into the mine through the strata) has been calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal).

Monitoring of the mine water balance comprises:

- Metered water reticulated into the mine (recorded continuously and downloaded monthly).
- Metered water reticulated out of the mine (recorded continuously and downloaded monthly).
- Manual measurement of moisture content into and out of the mine through the mine ventilation system using a digital psychrometer. The frequency of readings is as follows:
  - every hour over a 12 hour period on four occasions during a 12 month period;
  - every day for two weeks on two occasions during a 12 month period; and
  - otherwise once per week.
- Measurement of the *in-situ* moisture content of the coal during routine channel sampling for coal quality. Channel samples are collected every third cut-through in development driveage.
- Measurement of the moisture content of ROM coal conveyed out of the mine at the drift portal using an automated moisture scanner. Prior to commissioning of a data acquisition system, readings are recorded manually on three occasions on a daily basis.

Water Make Calculation Assumptions

The inferred water make (i.e. groundwater that has seeped into the mine through the strata) is calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal).

Given the large fluctuations in daily water usage and the cycle period for water entering the mine, being used by machinery, and draining to sumps for return pumping to the surface, a 20 day average is used to provide a more reliable estimate of water make.

The estimated daily mine water make during the review period is shown in Chart 23. The following assumptions were made in the estimation of water make:

- Where metered data was unavailable, no estimation of daily water make was calculated and the graph shows a gap.
- Where no air moisture measurement for the downcast ventilation was available for a given day, the average of all measured values was used (0.180 ML/day).
- Where no ROM coal moisture content was available for a given day, the average of all measured values was used (7.84%).
- The *in-situ* coal moisture content was assumed to be 1.5%.

The average daily water make during the review period was 0.14 ML/day (Chart 23). Note that the increased water make during the period April 2011 to July 2011 was a result of dewatering of old workings in advance of the 200 Mains Panel.

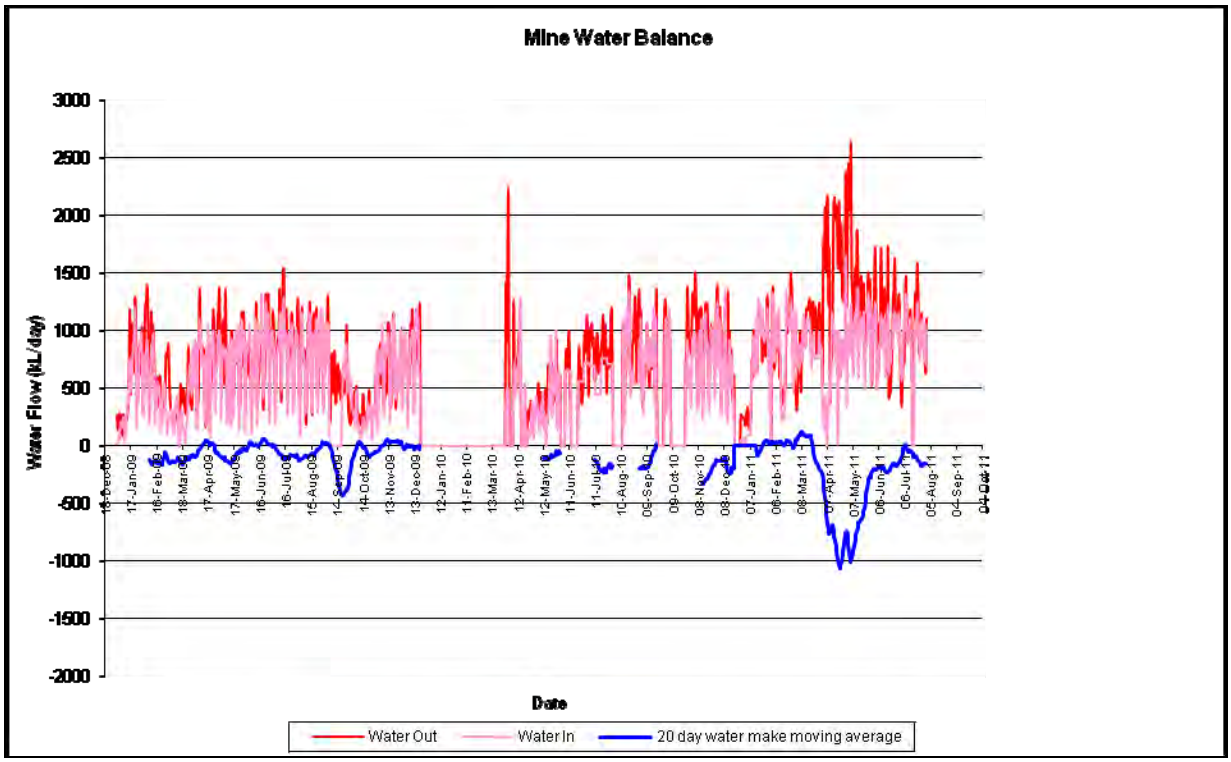


Chart 23 Estimated Daily Mine Water Make

3.3.3 Assessment of Environmental Performance

The performance indicators and subsidence impact performance measures described below have been developed to address the predictions of subsidence impacts and environmental consequences on water resources and water courses included in the EA, PPR and Extraction Plan.

Table 13 provides a summary of the performance of the Project against the water resource and watercourse performance indicators and subsidence impact performance measures.

The results of the assessment are described below.

Table 13
Assessment of Water Resource and Watercourse Performance Indicators and Measures

Subsidence Impact Performance Measure	Performance Indicator(s)	Performance Indicator Exceeded?	Performance Measure Exceeded?
Negligible reduction to the quantity of water resources reaching the Woronora Reservoir.	*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	No
Negligible reduction to the quality of water resources reaching the Woronora Reservoir.	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2.*	Yes	No
No connective cracking between the surface and the mine.	*Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally.*	No	No
	The 20-day average mine water make does not exceed 2 ML/day.	No	No
	Significant departures from the predicted envelope of vertical potentiometric head profiles at Bores 9FGW1B[1] and 9GGW1B do not occur.	No	No
Negligible 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	No
Negligible reduction in the water quality of Woronora Reservoir.	*Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring in the Nepean Reservoir (control site).*	To be assessed following receipt of sufficient data from the SCA with analysis to be included in the 2012 Annual Review	
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).	*Water in Pool P on Waratah Rivulet is observed overflowing the rock bar.*	No	No
	Analysis of pool water level data for Pool P on Waratah Rivulet indicates the pool is overflowing (i.e. the pool water levels are above its cease to flow level).	No	No
	Iron staining to be addressed in future Extraction Plans and revisions to the Water Management Plan.	Not applicable to Longwalls 20-22	
	No gas releases observed at Pool P on the Waratah Rivulet.	No	No
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) of the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.	To be addressed in future Extraction Plans and revisions to the Water Management Plan.	Not applicable to Longwalls 20-22	

[1] The potentiometric head profile of bore 9FGW1 will be used to assess connective cracking once pressures in the bore have equilibrated following bore installation.

3.3.3.1 Quantity of Water Resources Reaching the Woronora Reservoir

Analysis against Performance Indicator

Performance Indicator: *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).*

Consistent with the Water Management Plan, data analysis has been conducted 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), specifically:

- The monitored flow rates on Waratah Rivulet and the control catchments have been integrated over successive 14 day periods for comparison with the corresponding integrated flows (14 day totals) predicted by the AWBM models of the same catchments.
- The ratio of total monitored flow divided by AWBM predicted flow has been calculated at 14 day intervals commencing at the end of the baseline period and advancing from the commencement of Longwall 20.

The performance indicator is considered to have been exceeded if the median of the ratios for the sliding 1 year period in the Waratah Rivulet falls below the 20th percentile of the baseline data, unless the same is also occurring in data for the control sites.

Chart 24 shows a comparison of the monitored and AWBM simulated water flows through Waratah Rivulet (GS2132102) from the commencement of the calibration period to 31 July 2011.

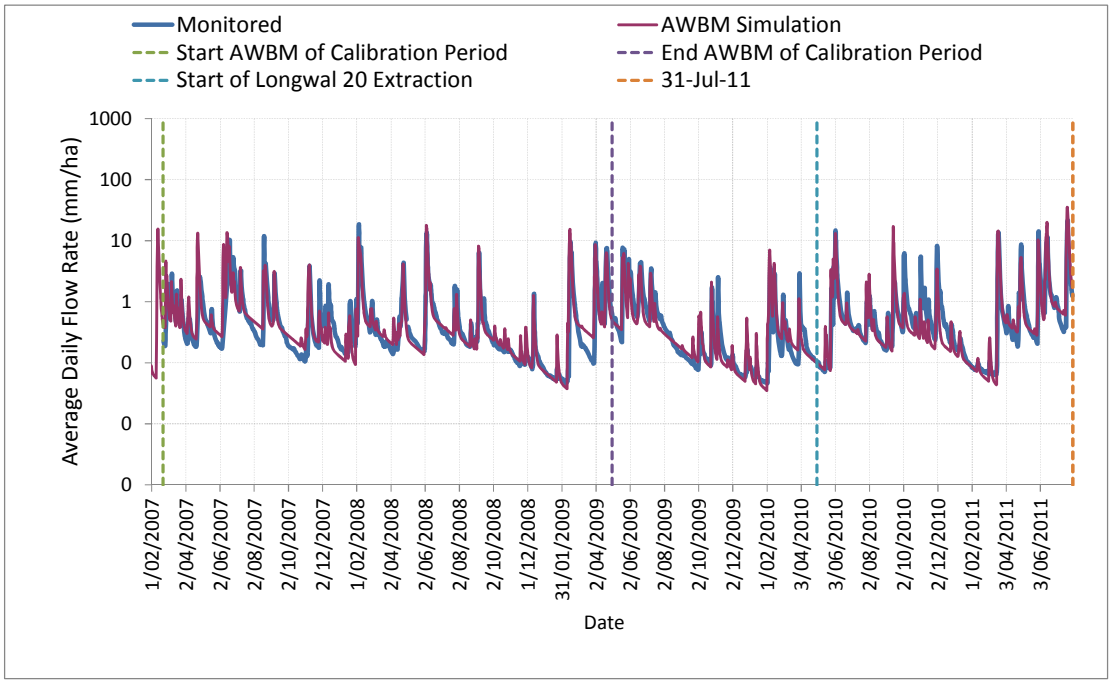


Chart 24 Monitored and AWBM Simulated Average Daily Flow Rates at Waratah Rivulet (GS2132102)

Chart 25 shows a percentile plot for the 77 ratios of 14 day flow sums that occurred in the baseline period. The 20th percentile threshold value required for testing the quantity of water entering Woronora Reservoir past the Waratah Rivulet gauging station (GS2132102) is 0.7.

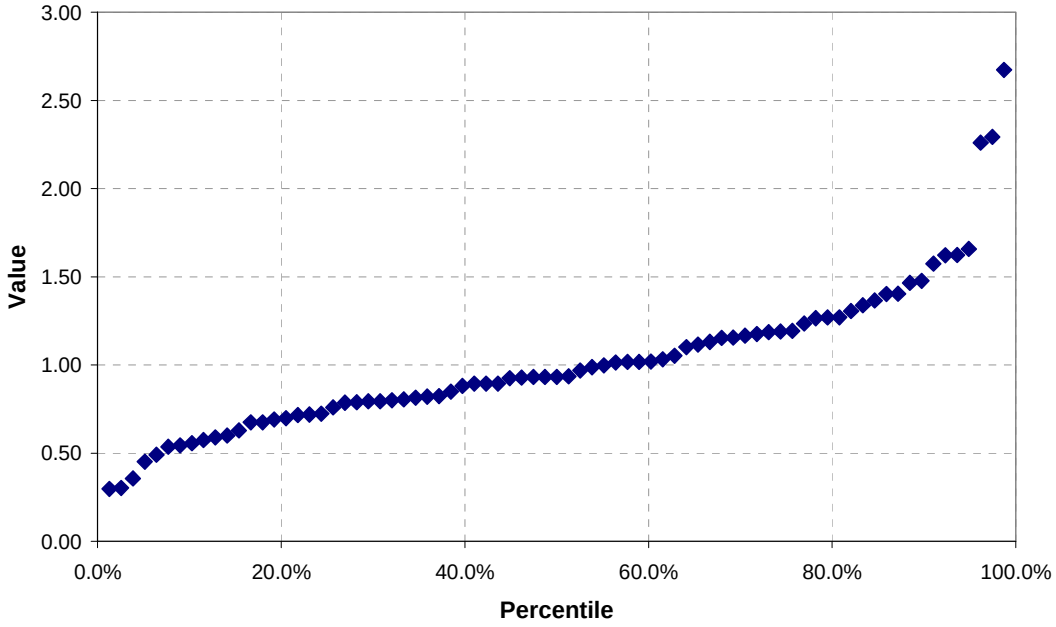


Chart 25 Percentile Values of the 77 Ratios of 14 Day Flow Sums that occurred at Waratah Rivulet (GS2132102) in the Baseline Period

Chart 26 shows a plot of the sliding 12 month mean of the ratio of 14 day sums of monitored flow at GS2132102 and flows simulated via the AWBM. The 12 month sliding mean in Chart 26 does not drop below the 20th percentile value of 0.7. No reduction in the volume of water reaching Woronora Reservoir has occurred in the post-mining period since the scheduled commencement of Longwall 20. The performance indicator was not exceeded during the review period.

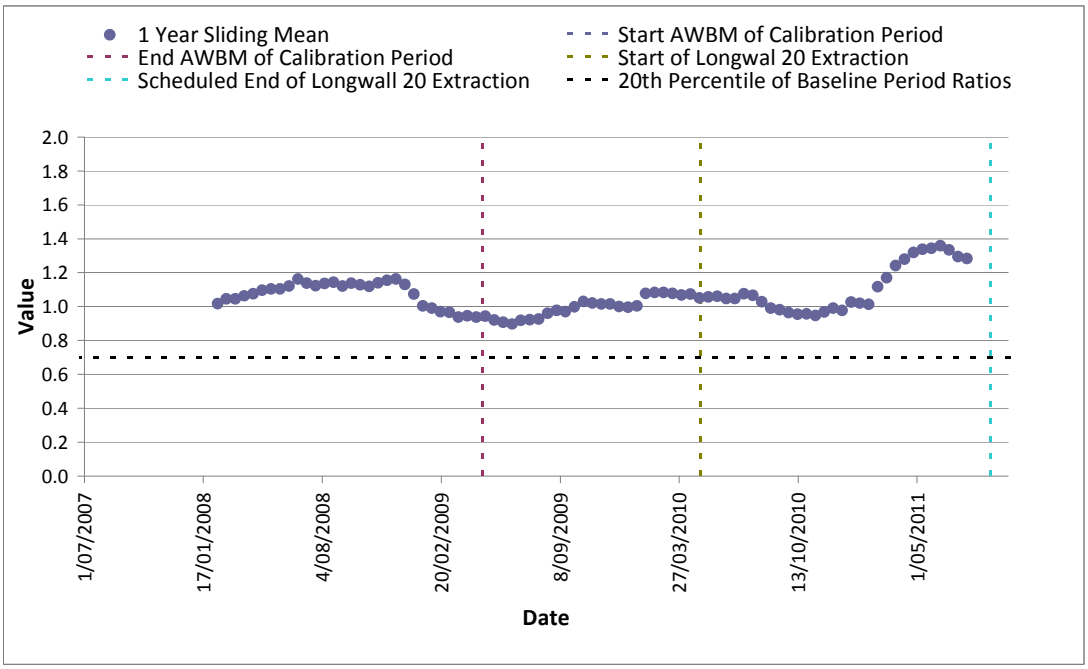


Chart 26 1 year Sliding Mean for the ratios of the 14 Day Sums of Monitored and AWBM Simulated Daily Average Water Flow Rates at Waratah Rivulet (GS2132102)

Analysis against Subsidence Impact Performance Measure

Consistent with the Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure. As described above, the performance indicator was not exceeded during the review period.

Subsidence Impact Performance Measure:

Negligible reduction to the quantity of water resources reaching the Woronora Reservoir

The subsidence impact performance measure will be considered to have been exceeded if analysis of the monitoring and modelling results confirms that the Project has resulted in a greater than negligible reduction in the quantity of water resources reaching the Woronora Reservoir.

3.3.3.2 Quality of Water Resources Reaching the Woronora Reservoir

Water quality sampling is conducted on the Waratah Rivulet (site WRWQ9), Eastern Tributary (ETWQ2) and Woronora River (WOWQ2), near the inflow points to the Woronora Reservoir (Figure 8).

The field filtered water quality data has been analysed for key water quality parameters of relevance to water supply, namely:

- iron;
- manganese; and
- aluminium.

Monitoring of water quality in areas subject to mining indicates that the effects of subsidence on water quality have been most noticeable in iron, manganese, and to a lesser extent, aluminium (Gilbert & Associates, 2008).

Water quality data from sites WRWQ9 and ETWQ2 collected following the commencement of Longwall 20 has been analysed against monitoring data collected at both sites prior to the commencement of Longwall 20 and against water quality data collected from site WOWQ2 on the Woronora River. Data analysis has been conducted to assess whether the performance indicator below has been exceeded.

Analysis against Performance Indicator

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.*

Consistent with the Water Management Plan, this performance indicator will be considered to have been exceeded if data analysis indicates a statistically significant change in the quality of water post-mining of Longwall 20. Specifically if:

- any water quality parameters[1] exceed the baseline mean plus two standard deviations for two consecutive months; or
- the sliding 12 month mean for any water quality parameter exceeds the baseline mean plus one standard deviation; and
- there was not a similar increase in the same measure at the control site.

[1] Log transformations (i.e. base 10 logs of the water quality concentrations) have been used to calculate the arithmetic means and standard deviations. Metal concentrations in water quality are measured as a positive value and therefore have a positively skewed distribution. Log transformations can be used to standardise the variance of a sample (Bland, 2000).

The baseline mean plus one standard deviation and baseline mean plus two standard deviations for each water quality parameter has been calculated from the baseline data and is presented in Table 14.

Table 14
Statistical Analysis of Water Quality Data

Site	Dissolved Aluminium (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)
Waratah Rivulet (WRWQ9)			
Baseline mean plus one standard deviation	0.030	0.284	0.054
Baseline mean plus two standard deviations	0.055	0.544	0.082
Eastern Tributary (ETWQ2)			
Baseline mean plus one standard deviation	0.082	0.545	0.081
Baseline mean plus two standard deviations	0.157	0.898	0.118
Woronora River (WOWQ2)			
Baseline mean plus one standard deviation	0.097	0.326	0.043
Baseline mean plus two standard deviations	0.252	0.754	0.065

Plots showing the concentrations of dissolved Al, Fe and Mn recorded at sampling sites WRWQ9 and ETWQ2 after the commencement of Longwall 20 in relation to the baseline mean plus 2 standard deviations are shown on Charts 27 to 32. Charts 27 to 32 show that none of the dissolved Al, Fe or Mn concentrations recorded at WRWQ9 and ETWQ2 have remained above the baseline mean plus 2 standard deviations level for 2 or more consecutive months.

Charts 33 to 35 show the concentrations of dissolved Al, Fe and Mn recorded at control site WOWQ2 after the commencement of Longwall 20 in comparison to the baseline mean plus 2 standard deviations. It is noted that the Fe concentrations recorded consecutively in February (1.0 mg/L) and March (1.5 mg/L) were significantly above the baseline mean plus 2 standard deviations level (Chart 34). As WOWQ2 is a control site these recordings do not represent an exceedance of the performance indicator.

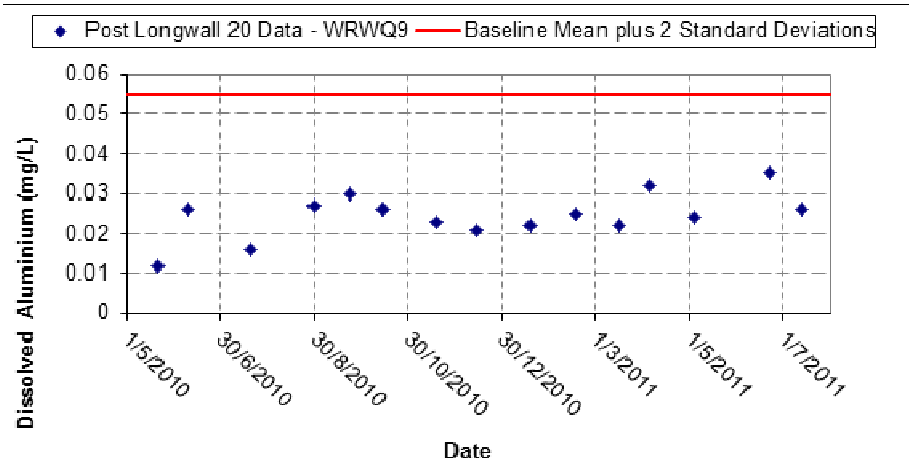


Chart 27 Comparison of Dissolved Aluminium Concentrations Post Longwall 20 with Baseline Data – Waratah Rivulet (WRWQ9)

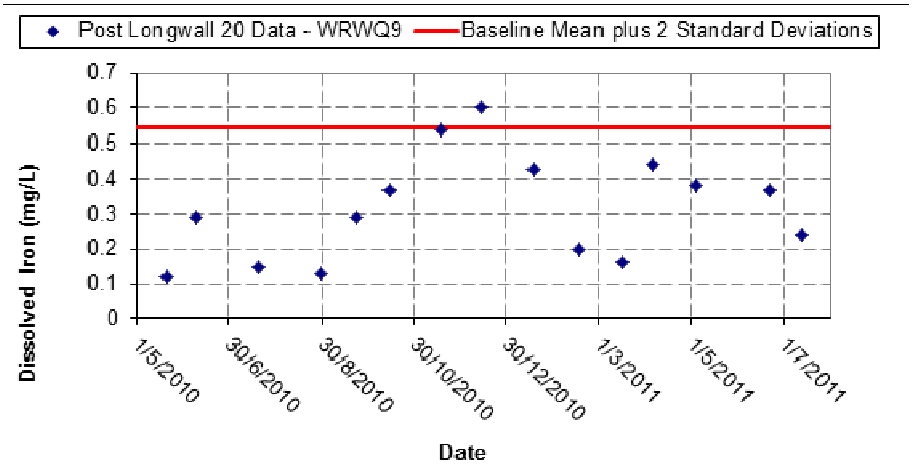


Chart 28 **Comparison of Dissolved Iron Concentrations Post Longwall 20 with Baseline Data – Waratah Rivulet (WRWQ9)**

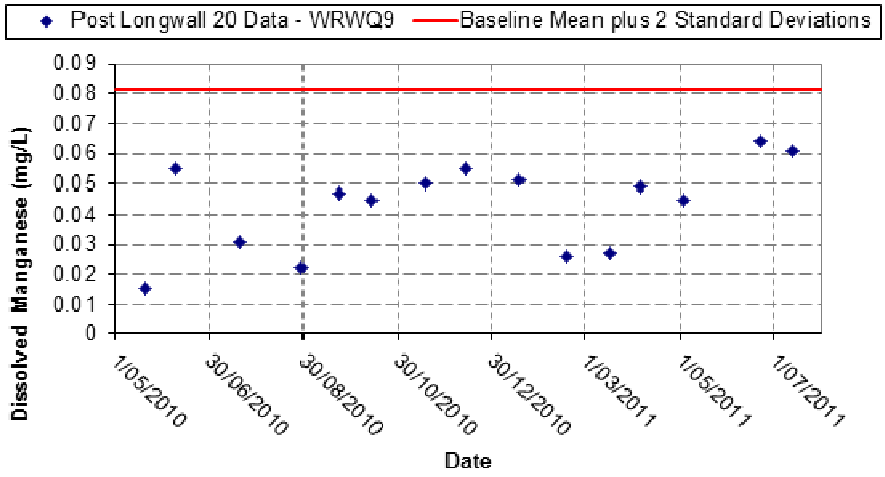


Chart 29 **Comparison of Dissolved Manganese Concentrations Post Longwall 20 with Baseline Data – Waratah Rivulet (WRWQ9)**

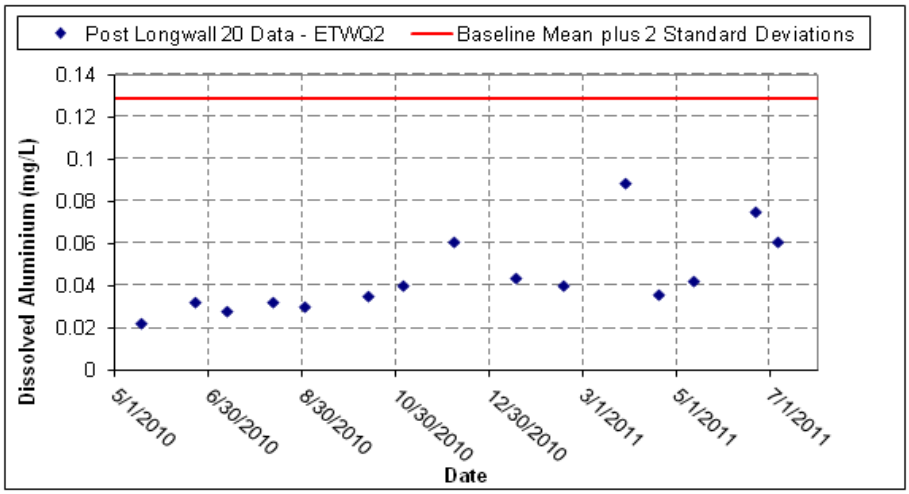


Chart 30 **Comparison of Dissolved Aluminium Concentrations Post Longwall 20 with Baseline Data – Eastern Tributary (ETWQ2)**

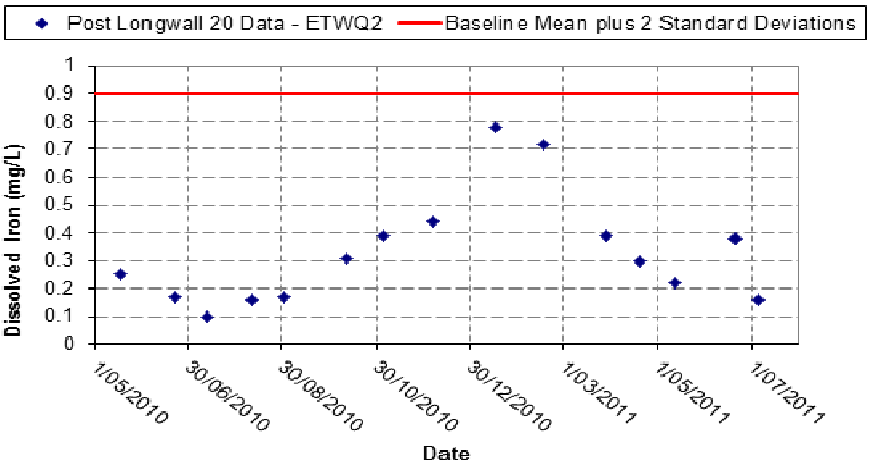


Chart 31 **Comparison of Dissolved Iron Concentrations Post Longwall 20 with Baseline Data – Eastern Tributary (ETWQ2)**

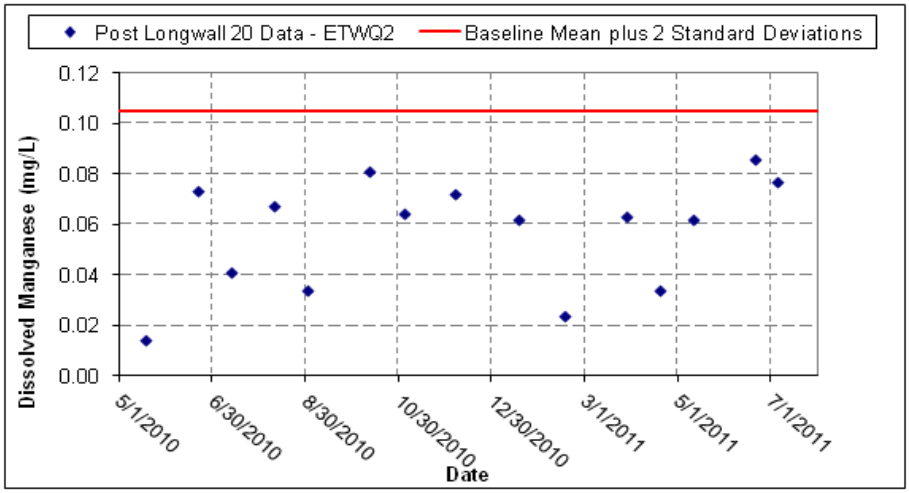


Chart 32 **Comparison of Dissolved Manganese Concentrations Post Longwall 20 with Baseline Data – Eastern Tributary (ETWQ2)**

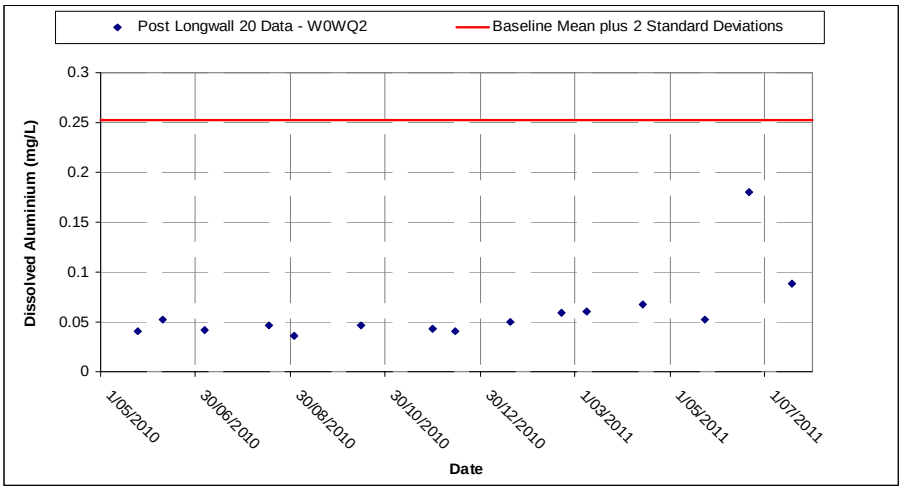


Chart 33 **Comparison of Dissolved Aluminium Concentrations Post Longwall 20 with Baseline Data – Woronora River (WOWQ2)**

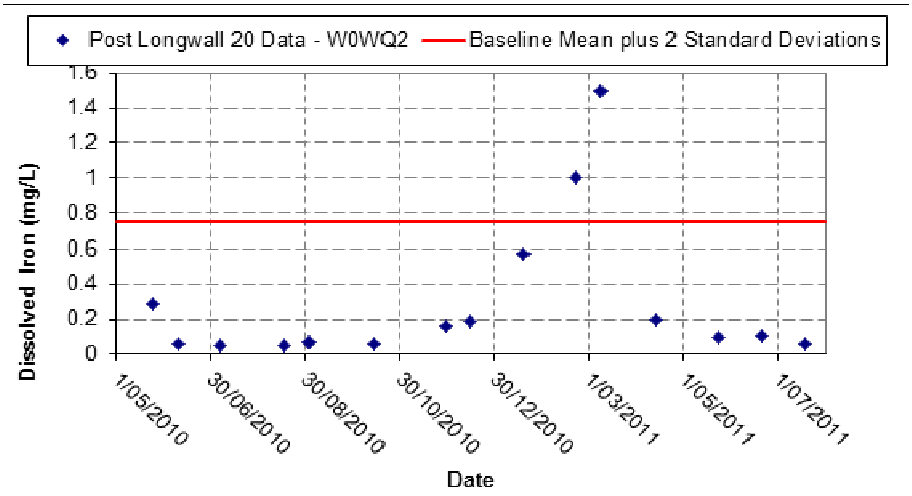


Chart 34 Comparison of Dissolved Iron Concentrations Post Longwall 20 with Baseline Data – Woronora River (WOWQ2)

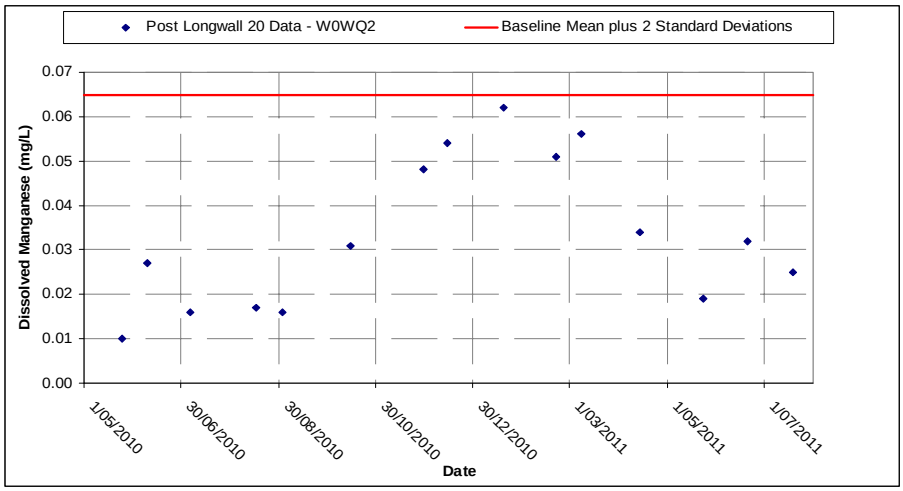


Chart 35 Comparison of Dissolved Manganese Concentrations Post Longwall 20 with Baseline Data – Woronora River (WOWQ2)

Plots showing the 12 month sliding means of the dissolved Al, Fe and Mn concentrations recorded at sampling sites WRWQ9 and ETWQ2 after the commencement of Longwall 20 are shown on Charts 36 to 41. For comparison, plots showing the 12 month sliding means for the same water quality parameters at control site WOWQ2 are shown on Charts 42 to 44.[2] Each plot shows the baseline mean plus 1 standard deviation value.

The 12 month sliding means for dissolved Al, Fe and Mn at sampling site ETWQ2 remained below the baseline mean plus one standard deviation during the review period.

[2] The sliding means in Charts 36 to 44 for dates prior to 1 May 2011 are calculated from a combination of measurements collected before and after the scheduled commencement of Longwall 20.

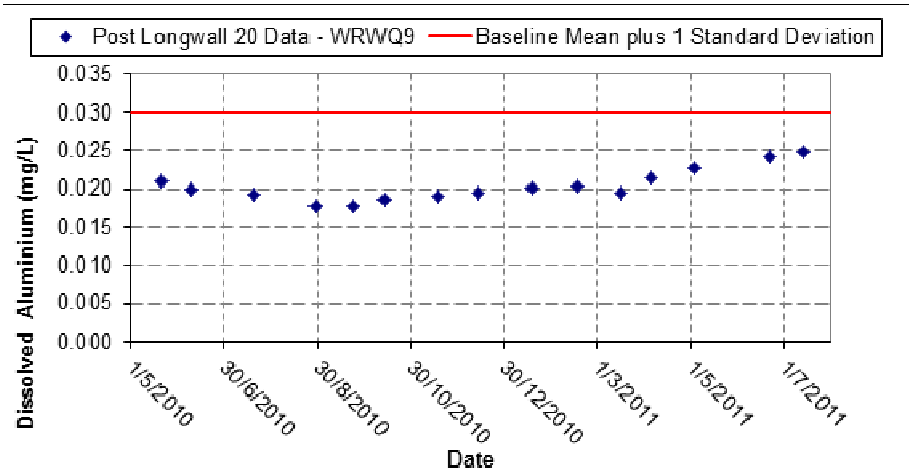


Chart 36 **12 Month Sliding Geometric Mean of Dissolved Aluminium Concentrations at WRWQ9 on Waratah Rivulet**

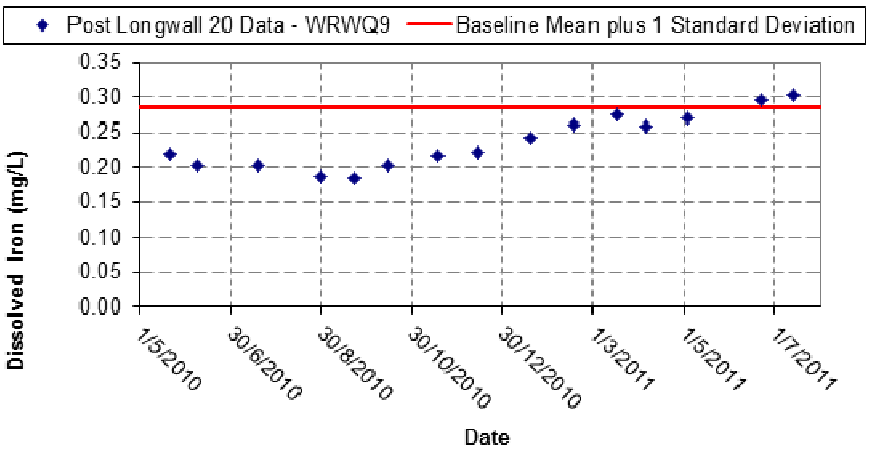


Chart 37 **12 Month Sliding Geometric Mean of Dissolved Iron Concentrations at WRWQ9 on Waratah Rivulet**

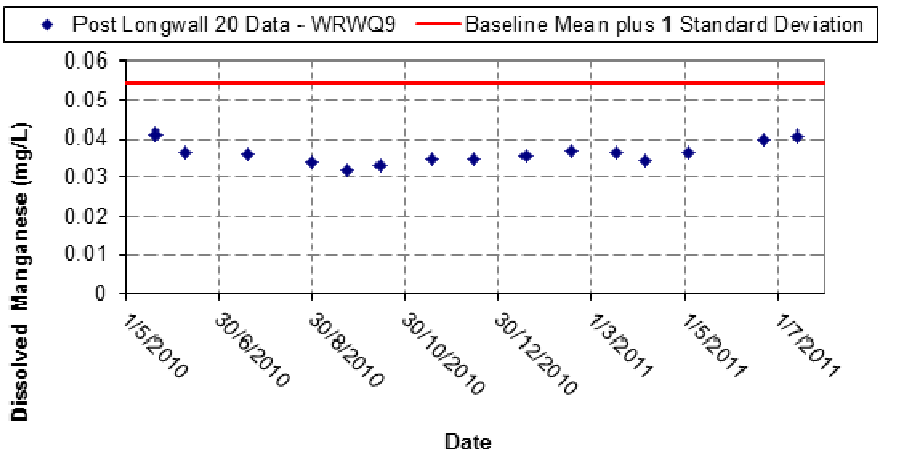


Chart 38 **12 Month Sliding Geometric Mean of Dissolved Manganese Concentrations at WRWQ9 on Waratah Rivulet**

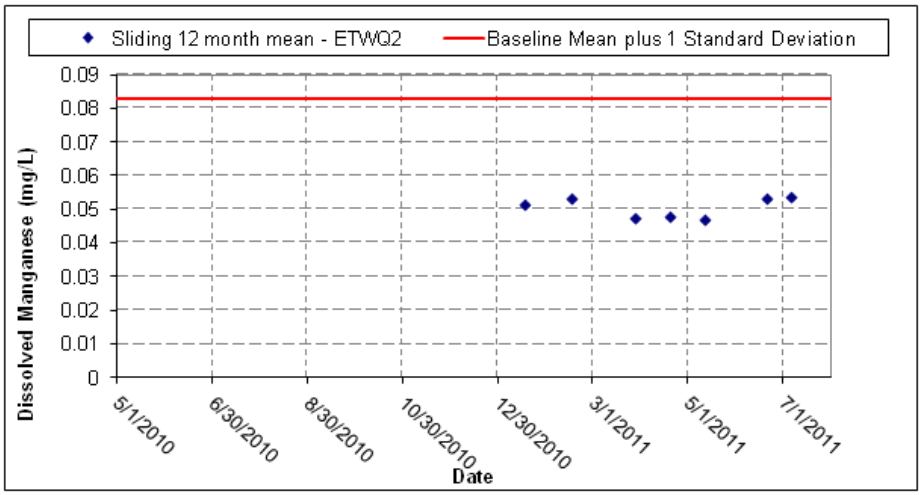


Chart 39 **12 Month Sliding Geometric Mean of Dissolved Aluminium Concentrations at ETWQ2 on Eastern Tributary**

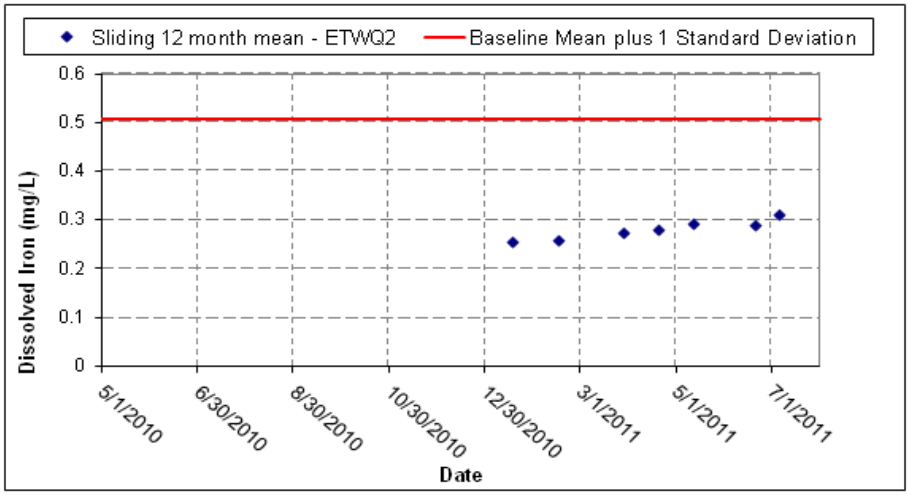


Chart 40 **12 Month Sliding Geometric Mean of Dissolved Iron Concentrations at ETWQ2 on Eastern Tributary**

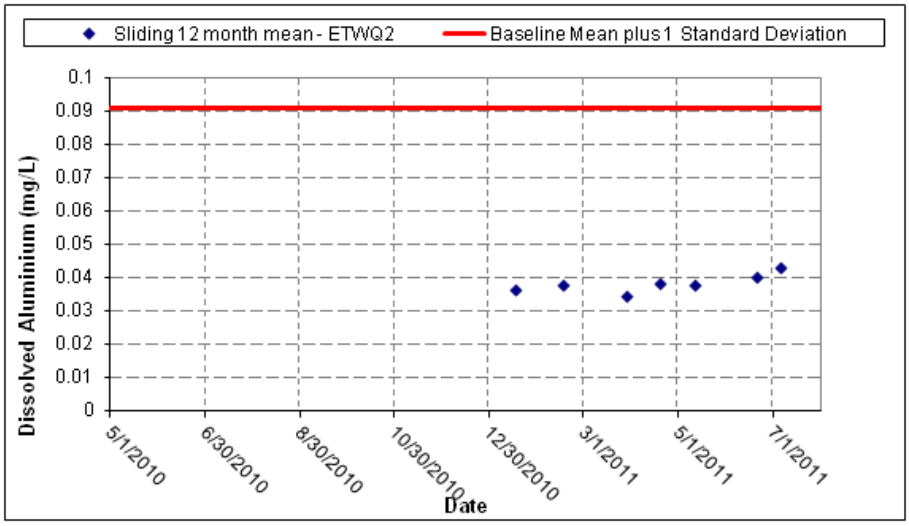


Chart 41 **12 Month Sliding Geometric Mean of Dissolved Manganese Concentrations at ETWQ2 on Eastern Tributary**

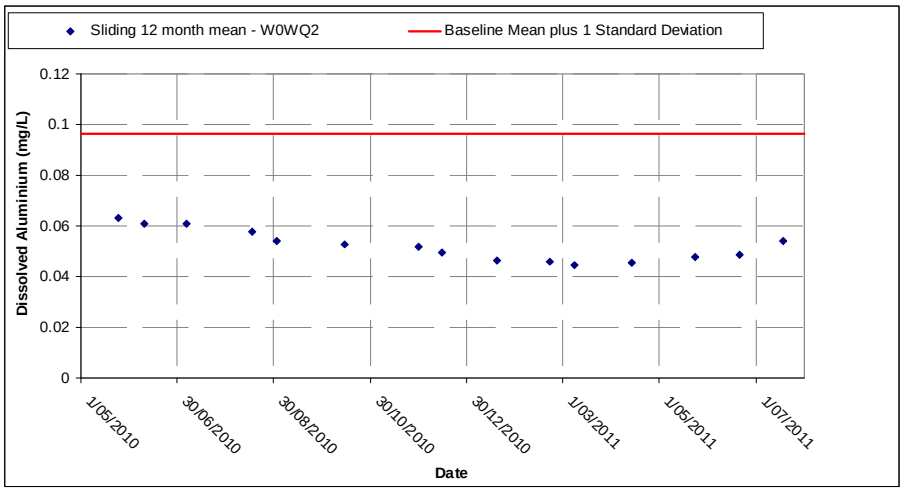


Chart 42 **12 Month Sliding Geometric Mean of Dissolved Aluminium Concentrations at WOWQ2 on Woronora River**

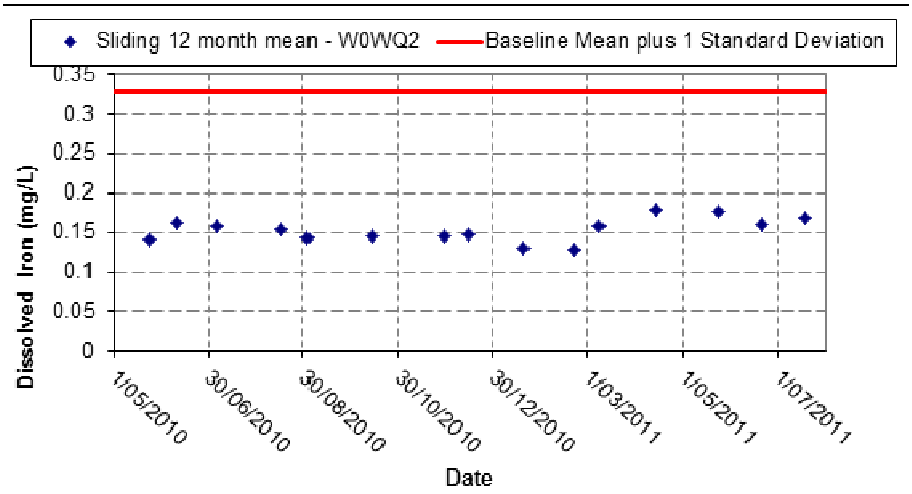


Chart 43 **12 Month Sliding Geometric Mean of Dissolved Iron Concentrations at WOWQ2 on Woronora River**

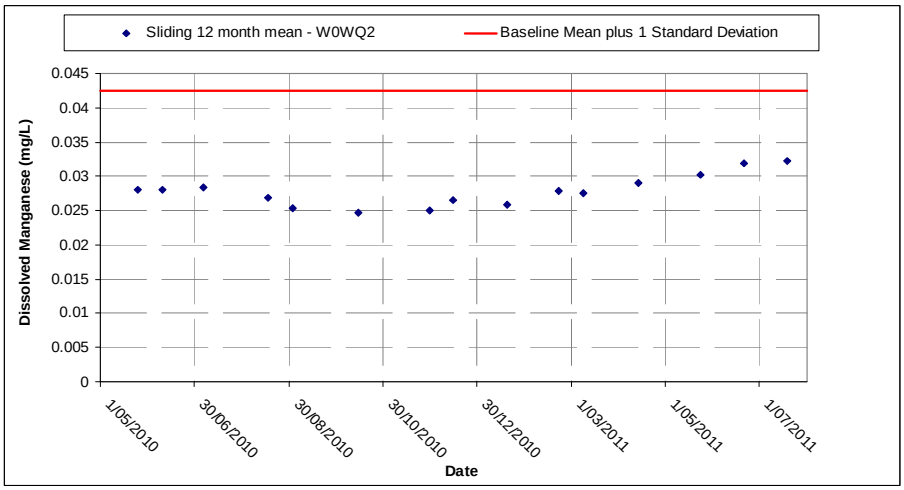


Chart 44 **12 Month Sliding Geometric Mean of Dissolved Manganese Concentrations at WOWQ2 on Woronora River**

At sampling site WRWQ9, the 12 month sliding means for dissolved Al and Mn remained below the baseline mean plus one standard deviation during the review period. The 12 month sliding mean of dissolved Fe concentration was calculated to be 0.29 mg/L for June 2011 and 0.30 mg/L for July 2011, both above the baseline mean plus one standard deviation (0.28 mg/L). These results would indicate that the performance indicator has been exceeded unless there was a similar increase in the same measure at the control site WOWQ2.

Chart 43 shows the 12 month sliding mean for dissolved Fe concentrations at control site WOWQ2. There was not a similar increase in the 12 month sliding mean for dissolved Fe at the control site WOWQ2, with the June and July 2011 sliding means remaining below the baseline mean plus one standard deviation level for that site. Nonetheless, it should be noted that there was a significant increase in the dissolved Fe concentration samples at the control site WOWQ2 in February (1.0 mg/L) and March (1.5 mg/L), with those samples being significantly higher than the baseline mean plus two standard deviations (0.7 mg/L) (Chart 34).

On the basis that the sliding 12 month mean for dissolved Fe at WRWQ9 exceeded the baseline mean plus one standard deviation in June and July 2011, and that there was not a similar increase in the same measure at the control site, the performance indicator was exceeded.

Analysis against Subsidence Impact Performance Measure

Consistent with the Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure.

Subsidence Impact Performance Measure:

Negligible reduction to the quality of water resources reaching the Woronora Reservoir.

As the performance indicator was exceeded during the review period, an assessment against the subsidence impact performance measure was conducted.

The performance measure was assessed by considering if the change in water quality is not negligible (i.e. *small and unimportant, so as to be not worth considering*). The performance measure is considered to have been exceeded if analysis of the monitoring results confirms that the Project has resulted in a greater than negligible reduction in the quality of water resources reaching the Woronora Reservoir.

The assessment of whether the performance measure has been exceeded (i.e. whether the Project has resulted in a greater than negligible reduction in the quality of water resources reaching the Woronora Reservoir) included the following considerations:

- Whether the Fe concentrations which resulted in the exceedance are high relative to historical Fe concentrations observed in other sites on Waratah Rivulet.
- Whether the Fe concentrations are high relative to historical Fe concentrations measured in other watercourses contributing to inflows to Woronora Reservoir.
- Whether the Fe concentrations exceed the SCA's bulk water supply agreement value for Fe (less than 1 mg/L).

The assessment of these considerations of significance is provided below.

Historically recorded iron concentrations at upstream sites on Waratah Rivulet

Site WRWQ9 is located on Waratah Rivulet downstream of the current longwall operations near the inflow to Woronora Reservoir. There are a number of other monitoring sites on Waratah Rivulet, including WRWQ1, WRWQ2, WRWQ3, WRWQ4, WRWQ5, WRWQ6, WRWQ7 and WRWQ8 (Figure 8). Site WRWQ1 is the most upstream site with sites WRWQ2, WRWQ3, WRWQ4, WRWQ5, WRWQ6, WRWQ7, WRWQ8 and WRWQ9 being located progressively further downstream. Of these sites, WRWQ9 is the only site located downstream of Longwalls 20-22 (Figure 8). A statistical summary of pre-longwall 20 iron concentrations recorded at the upstream sites is provided in Table 15 below.

Table 15
Summary of Pre-Longwall 20 Recorded Iron Concentrations at Upstream Sites on Waratah Rivulet

Statistic	WRWQ1	WRWQ2	WRWQ3	WRWQ4	WRWQ5	WRWQ6	WRWQ7	WRWQ8
Number of Observations	49	43	49	49	47	48	50	50
Maximum (mg/L)	1.30	1.40	1.00	0.82	2.9	0.50	1.60	0.92
Minimum (mg/L)	0.17	0.04	0.03	0.02	0.06	0.01	0.10	0.02
Mean (mg/L)	0.65	0.45	0.29	0.38	0.31	0.21	0.56	0.26
Standard Deviation (mg/L)	0.30	0.23	0.22	0.21	0.40	0.14	0.37	0.17
Mean + 2 Standard Deviations (mg/L)	1.26	0.91	0.73	0.80	1.12	0.49	1.30	0.60
Median (50%ile) (mg/L)	0.61	0.42	0.26	0.36	0.26	0.18	0.46	0.22
80 percentile (mg/L)	0.92	0.58	0.37	0.58	0.39	0.35	0.72	0.38
90 percentile (mg/L)	1.1	0.7	0.53	0.67	0.44	0.4	1.2	0.44

It is apparent that Fe concentrations at upstream sampling sites have been significantly higher than those which triggered the exceedance at WRWQ9. Significantly, Fe concentrations at sampling sites upstream of Longwalls 20-22 have been substantially higher than those which triggered the exceedance at WRWQ9 over the post-Longwall 20 period. A comparative plot of Fe concentrations at sites on Waratah Rivulet (WRWQ1 to WRWQ9) is shown in Chart 45 below.

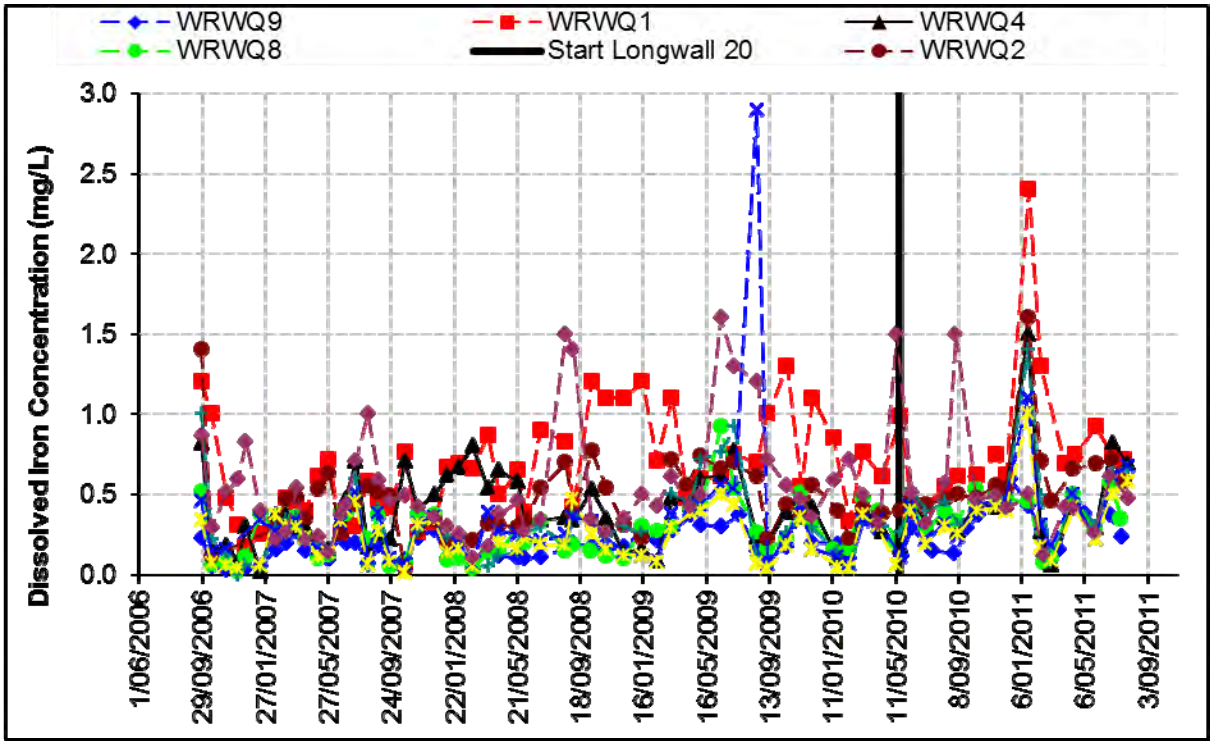


Chart 45 Comparison of Monitored Iron Concentrations along Waratah Rivulet

The plot indicates a trend of generally higher Fe concentrations upstream decreasing progressively downstream. It is also apparent that elevated concentrations of Fe occurred at the upstream sites (WRWQ1 to WRWQ4) in January 2011. These concentrations were substantially higher than the concentrations which resulted in the 12 month sliding mean exceedance at WRWQ9. The most upstream site (WRWQ1) is upstream of subsidence associated with the mining of Longwall 20 and indicates Fe is high in the upper reaches of the Waratah Rivulet.

Historically recorded iron concentrations in Woronora River

The Fe concentrations in Waratah Rivulet (WRWQ9) and Woronora River (WOWQ2) over the pre and post-Longwall 20 mine period are shown on Chart 46 below.

It is apparent that the ranges of Fe concentrations have been generally similar in Waratah Rivulet and Woronora River, with the exception of one higher value recorded on Woronora River in February 2009. It is concluded that the elevated levels in Waratah Rivulet are in absolute terms similar, and not significantly different, to those recorded at WOWQ2 on Woronora River.

Comparison of observed iron concentrations at WRWQ9 against the SCA's Bulk Water Supply Agreement Value

It is understood that the SCA's Bulk Water Supply Agreement provides for an Fe concentration below 1 mg/L. The maximum value during the review period was 0.6 mg/L (December 2010), which is below the Bulk Water Supply Agreement level.

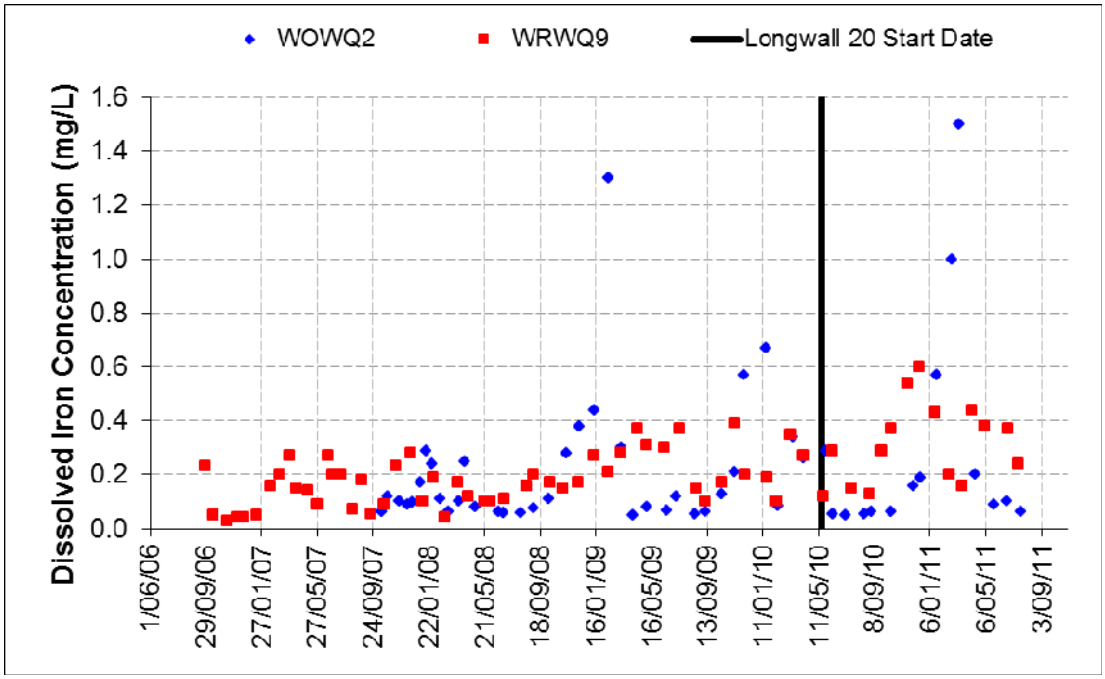


Chart 46 Comparison of WRWQ9 (Waratah Rivulet downstream) and WOWQ2 (Woronora River downstream)

In summary, an analysis of the monitoring results shows that:

- There is little evidence to conclude that the exceedance at WRWQ9 would have resulted in a greater than negligible reduction in the quality of the water resources reaching the Woronora Reservoir.
- Significantly higher concentrations of Fe were observed upstream on Waratah Rivulet (particularly at site WRWQ1) during the same period and that higher concentrations had also been recorded at all upstream sites at other times.
- Equivalent and higher Fe concentrations have been observed in Woronora River at WOWQ2 during the exceedance period and on prior occasions.
- It is understood that the Bulk Water Supply Agreement value applicable to supply from Woronora Reservoir for Fe is 1 mg/L and that the highest recorded observation at WRWQ9 is not considered significant in relation to that limit.

On the basis of the assessment above, it is concluded that the performance measure requiring *negligible reduction to the quality of water resources reaching the Woronora Reservoir* was not exceeded. During the next review period, the analysis against the performance measure will be peer reviewed by a specialist approved by the DP&I and the results will be reported to DP&I, SCA and OEH.

3.3.3.3 Connective Cracking between the Surface and the Mine

Analysis against Performance Indicator 1

Performance Indicator 1: *Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally.*

The performance indicator is considered to have been exceeded if visual inspections identify abnormal water flow from the goaf, geological structure, or the strata generally.

The mine inspections did not identify any abnormal water flows from the goaf, geological structure, or strata.

This performance indicator was not exceeded during the review period.

Analysis against Performance Indicator 2

Performance Indicator 2: *The 20-day average mine water make does not exceed 2 ML/day.*

The performance indicator is considered to have been exceeded if data analysis indicates the 20 day average mine water make exceeds 2 ML/day.

The 20 day average daily mine water make was 0.14 ML/day and the maximum 20 day average water make was 0.18 ML/day.

This performance indicator was not exceeded during the review period.

Analysis against Performance Indicator 3

Performance Indicator 3: *Significant departures from the predicted envelope of vertical potentiometric head profiles at Bores 9FGW1B and 9GGW1B do not occur.*

The performance indicator is considered to have been exceeded if the measured potentiometric head profile is inconsistent in shape or lies significantly to the left of the predicted high-inflow model curve.

Site 9FGW1B is located approximately 600 m west of Longwall 21 and site 9GGW1B is located over Longwall 22. The vertical head profiles measured at the end of the review period (31 July 2011) are presented in Charts 47 and 48 and compared with simulated profiles at the end of Longwall 20.

Three of the piezometers at site 9FGW1B are responding slowly and are increasing towards true equilibrium values (Chart 47). The tardy piezometers are installed in the lower Hawkesbury Sandstone, the Bald Hill Claystone and the Wombarra Shale. Piezometers in the Stanwell Park Claystone and Bulli Coal seam have now stabilised (see Chart 12, Section 3.3.2). When allowance is made for the piezometers that have not reached their final head values, the agreement between measured and simulated head profiles is very good. The measured data are more closely aligned with heads calculated using the low-inflow model.

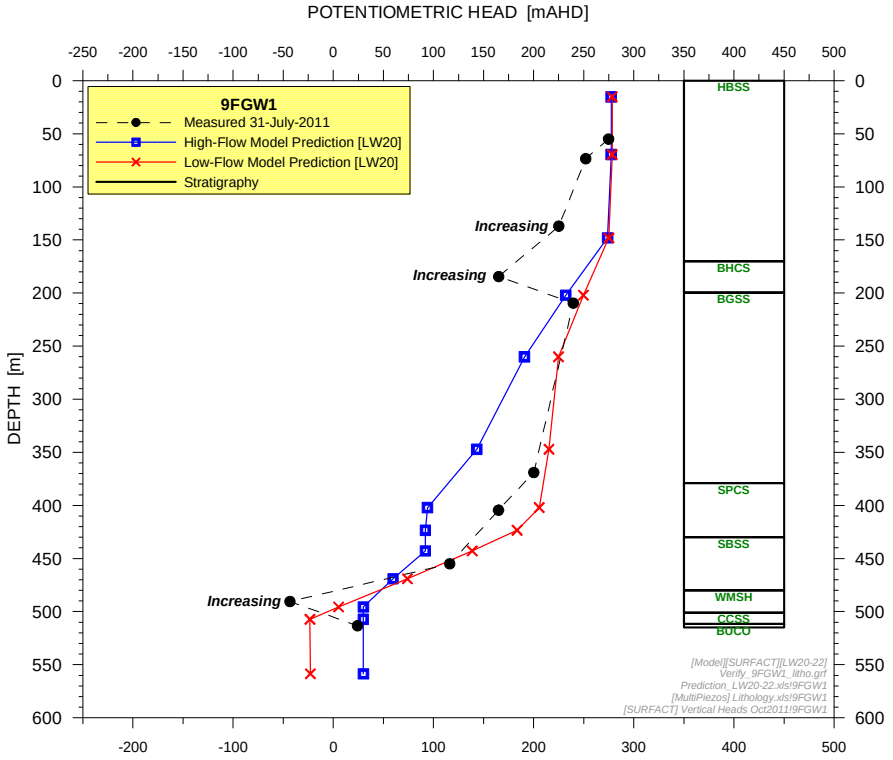


Chart 47 Measured and Simulated Potentiometric Head Profiles at Indicator Site 9FGW1B

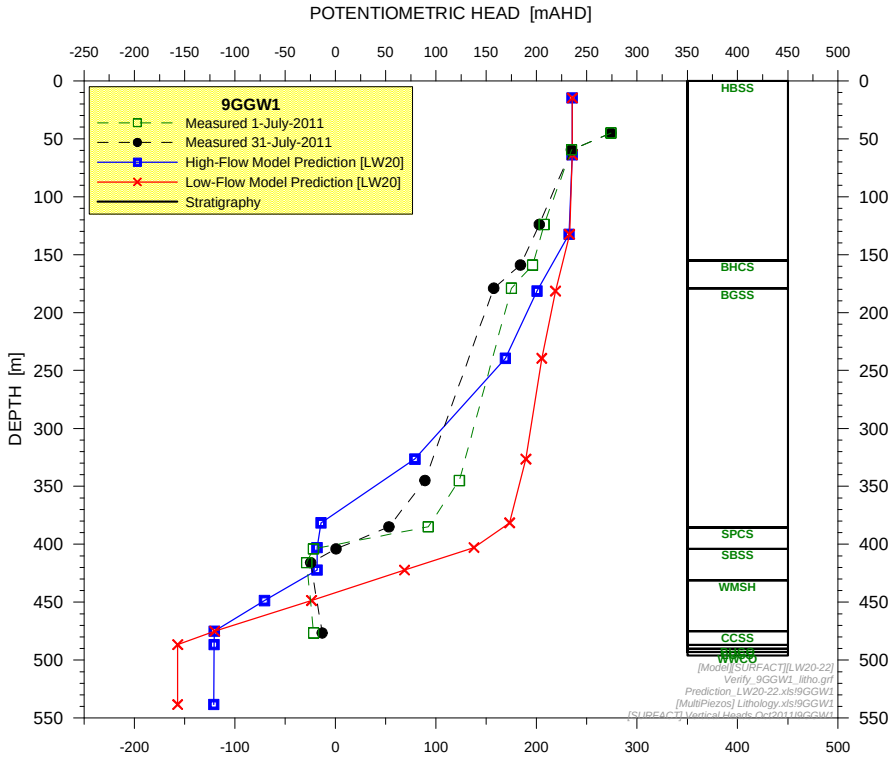


Chart 48 Measured and Simulated Potentiometric Head Profiles at Indicator Site 9GGW1B

As shown in Section 3.3.2 (Chart 13), site 9GGW1B has undergone sudden jumps in head in the lowermost eight piezometers due to the passage of the Longwall 20 face with associated stress re-distribution. The maximum head variation is about 40 m. Chart 48 shows instantaneous measured heads at 1 July and 31 July 2011, either side of one of the jumps in head. The measured profiles agree well with the simulated profiles except at the higher elevations in the Hawkesbury Sandstone. The higher elevations in the Hawkesbury Sandstone are not considered significant but they indicate that the model requires re-calibration in the upper layers. The measured data are more closely aligned with heads calculated using the high-inflow model.

Analysis against Subsidence Impact Performance Measure

Consistent with the Water Management Plan, if data analysis indicates a performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure. The performance indicators were not exceeded during the review period.

Subsidence Impact Performance Measure:

No connective cracking between the surface and the mine.

The performance indicator was not exceeded during the review period.

3.3.3.4 Leakage from the Woronora Reservoir

Analysis against Performance Indicator

Performance Indicator: *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).*

The performance indicator is considered to have been exceeded if the 7-day average potentiometric head at the uppermost piezometer is less than the reservoir water level for one week.

The 7-day average groundwater levels in the uppermost piezometers in the Hawkesbury Sandstone at sites 9GGW2B and PM02 are presented in Chart 49. A comparison of PM02 and 9GGW2B with the maximum possible Woronora Reservoir water level shows a clearance of 15 m to 25 m at 9GGW2B and more than 65 m at PM02.

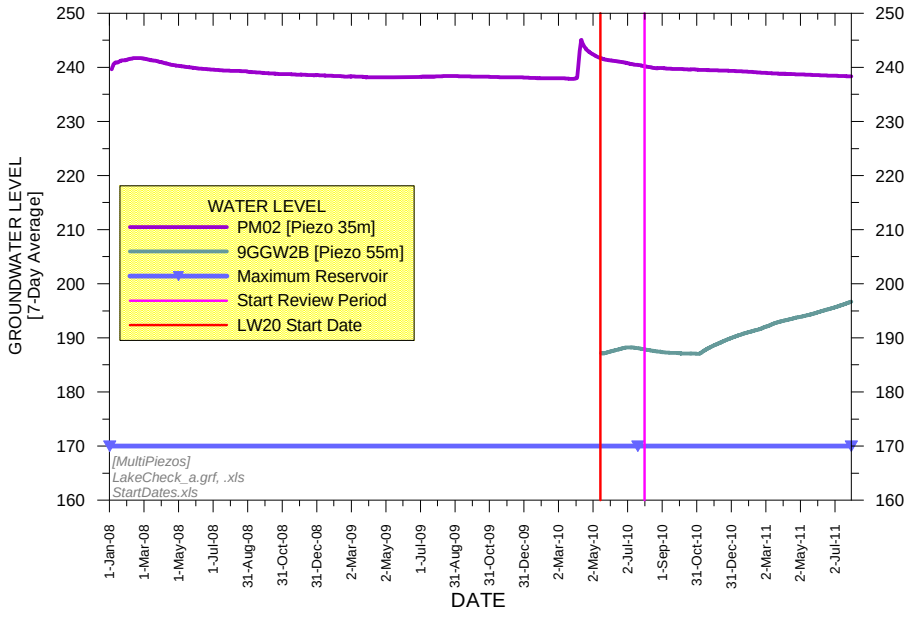


Chart 49 7-day Average Groundwater Levels at Sites 9GGW2B and PM02

This performance indicator was not exceeded during the review period.

Analysis against Subsidence Impact Performance Measure

Consistent with the Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure. The performance indicator was not exceeded during the review period.

Subsidence Impact Performance Measure: *Negligible leakage from the Woronora Reservoir.*

3.3.3.5 Woronora Reservoir Water Quality

Metropolitan Coal sources surface water quality data for the Woronora Reservoir (site DW01, measurements taken from 0 to 9 m below the water surface level) and Nepean Reservoir from the SCA in accordance with a data exchange agreement.

Consistent with the monitoring of water reaching the Woronora Reservoir (Section 3.3.3.2), the water quality data will be analysed for key water quality parameters of relevance to water supply and effects of subsidence, namely:

- iron;
- manganese; and
- aluminium.

Water quality data from site DW01 collected following the commencement of Longwall 20 is analysed against monitoring data collected at site DW01 prior to the commencement of Longwall 20 and against water quality data collected from the Nepean Reservoir.

Data from the Cataract Reservoir will also be sourced from the SCA and considered in the analysis of reservoir water quality.

Analysis against Performance Indicator

Performance Indicator: *Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations, that are not also occurring in the Nepean Reservoir (control site).*

The performance indicator is considered to have been exceeded if data analysis indicates a statistically significant change in the quality of water post-mining, specifically if:

- any water quality parameter's exceed the baseline mean plus two standard deviations for two consecutive months; or
- the sliding 12 month mean for any water quality parameter exceeds the baseline mean plus one standard deviation; and
- there was not a similar increase in the same measure at the control site.

Charts 50 to 52 show the water quality results for total iron, aluminium and manganese at sites DCA1 (Lake Cataract), DNE1 (Nepean Reservoir) and DW01 (Woronora Reservoir).

The comparative water quality data between Woronora Reservoir, Nepean Reservoir and Lake Cataract is limited to a period of about 12 months from August 2010 to September 2011 and is insufficient to establish an adequate baseline for use in assessing any changes associated with the period after commencement of Longwall 20. The data show that total iron and total manganese have been higher in Lake Cataract than in Woronora Reservoir whilst the opposite is true for total aluminium. There is no visual evidence of a trend in either Woronora Reservoir or Lake Cataract in any of these parameters over the period of available data.

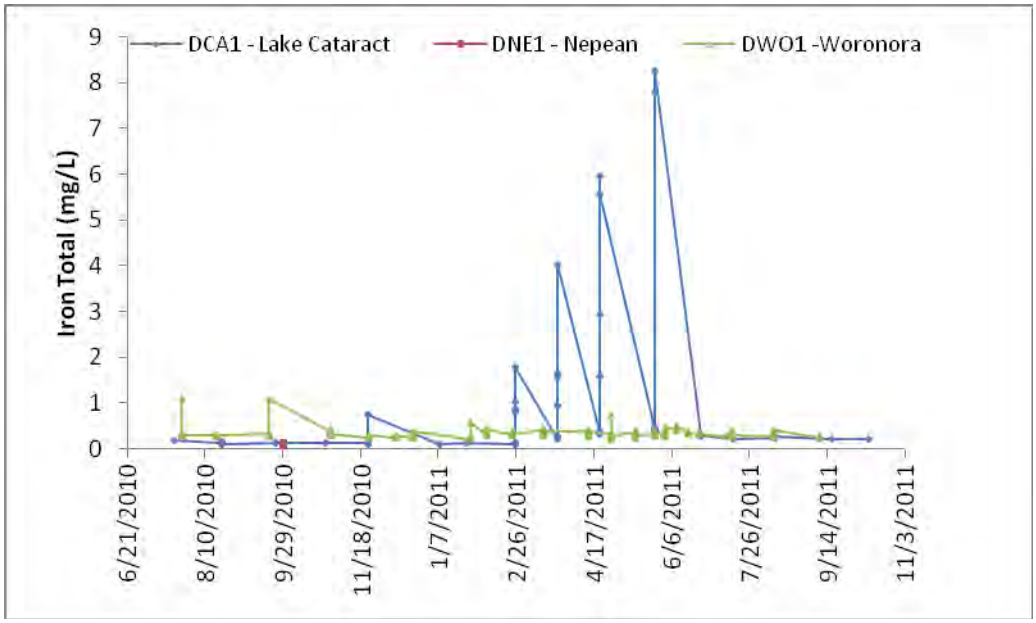


Chart 50 Lake Cataract, Nepean Reservoir and Woronora Reservoir Iron Concentrations

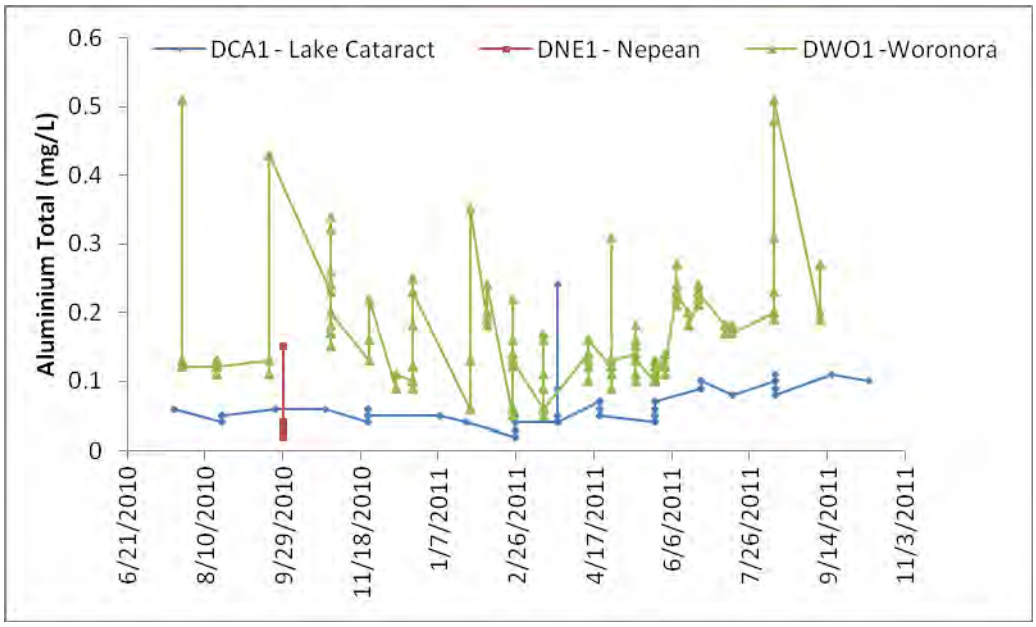


Chart 51 Lake Cataract, Nepean Reservoir and Woronora Reservoir Aluminium Concentrations

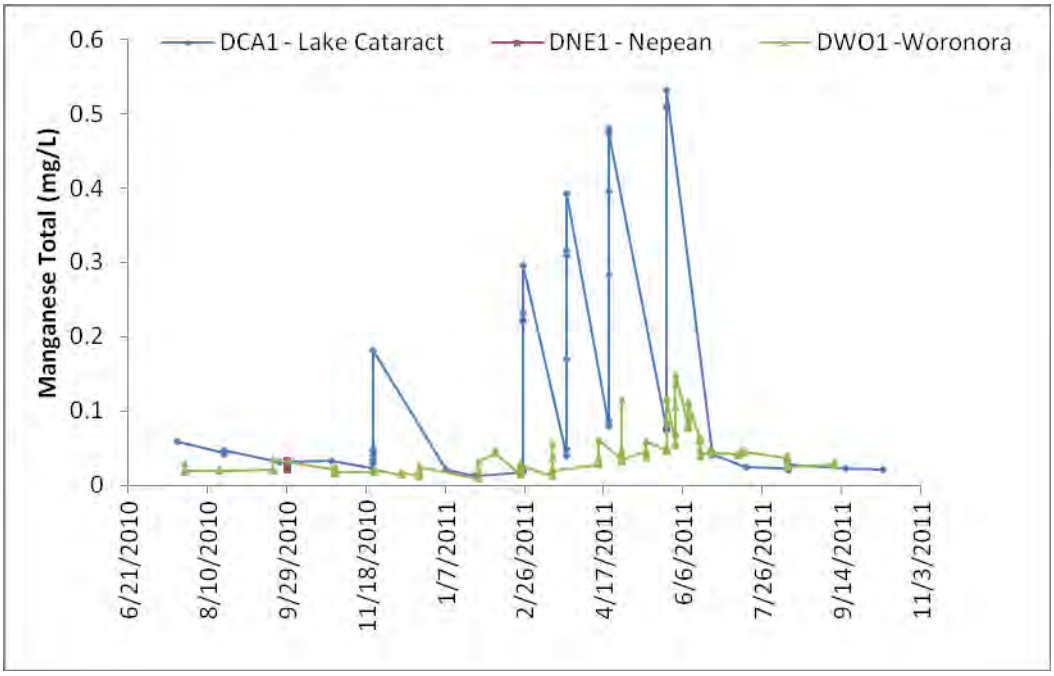


Chart 52 Lake Cataract, Nepean Reservoir and Woronora Reservoir Manganese Concentrations

Metropolitan Coal was unable to access sufficient data from the SCA under the data exchange agreement to conduct an assessment of this performance indicator. To assess this performance indicator, the baseline mean plus one standard deviation level is required to be compared against the post-Longwall 20 commencement data. However, the data provided by the SCA does not cover the period required to calculate the baseline mean plus one standard deviation.

An assessment against this performance indicator will be undertaken once Metropolitan Coal has received sufficient data from the SCA to conduct the assessment. An assessment against this performance indicator will be undertaken in the next review period in conjunction with the peer review of the assessment against the performance measure relating to the quality of water resources reaching the Woronora Reservoir discussed in Section 3.3.3.2. This analysis will be included in the 2012 Annual Review.

Analysis against Subsidence Impact Performance Measure

Consistent with the Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure. As described above, analysis of the Woronora River water quality performance indicator will be included in the 2012 Annual Review.

Subsidence Impact Performance Measure:

Negligible reduction in the water quality of Woronora Reservoir.

3.3.3.6 Waratah Rivulet Downstream of Maingate 23

Table 1 of the Project Approval requires the Project to result in:

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).

Pools P, Q, R, S, T, U, V and W on the Waratah Rivulet, situated downstream of maingate 23, are located approximately 390 m, 600 m, 740 m, 980 m, 1,080 m, 1,350 m and 1,460 m downstream from the maingate of Longwall 22, respectively.

The methods used to assess the performance of the Project against the subsidence impact performance measure are described below.

No Diversion of Flows or Change in the Natural Drainage Behaviour of Pools

Pool P terminates by flowing through and below its rock bar.

Pool P (Figure 7) will be visually inspected on a weekly basis when mining is within 400 m of the pool to observe whether any changes to the natural drainage behaviour of the pool has occurred. Observations will include:

- evidence of new cracking within the stream bed or rock bar;
- whether the pond continues to flow through and below its rock bar; and
- whether surface flow is evident along the length of Pool P prior to flowing through/below its rock bar.

The water depth in Pools P, Q, R and S on the Waratah Rivulet (Figure 7) and at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River is continuously monitored using a water depth sensor and logger.

Assessment against Performance Indicators

Visual inspections of Pool P will be conducted on a weekly basis when mining is within 400 m of the pool and assessed against the following performance indicator:

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.

The performance indicator will be considered to have been exceeded if the natural drainage behaviour is altered such that either: mining induced cracking is evident in the stream bed or rock bar of Pool P; or water ceases to be ponded upstream of the rock bar; or surface flow ceases along the length of Pool P. If visual observation indicates a potential impact to the natural drainage behaviour of Pool P on the Waratah Rivulet, then pools downstream, and the control pools on the Woronora River (i.e. Pools WRP1, WRP2, WRP3 and WRP4) will be inspected and an assessment will be made against the subsidence impact performance measure.

Water level data for Pool P will be downloaded monthly and assessed against the following performance indicator:

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).

The performance indicator will be considered to have been exceeded if the water depth in Pool P (when mining is within 400 m of Pool P) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of Pool P). If data analysis indicates the water depth in Pool P (when mining is within 400 m of Pool P) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of Pool P), pools downstream on Waratah Rivulet and the control pools on Woronora River will be analysed and an assessment will be made against the performance measure.

Although mining has not been within 400 m of Pool P during the review period, Chart 53 shows the pool water levels since the commencement of Longwall 20.

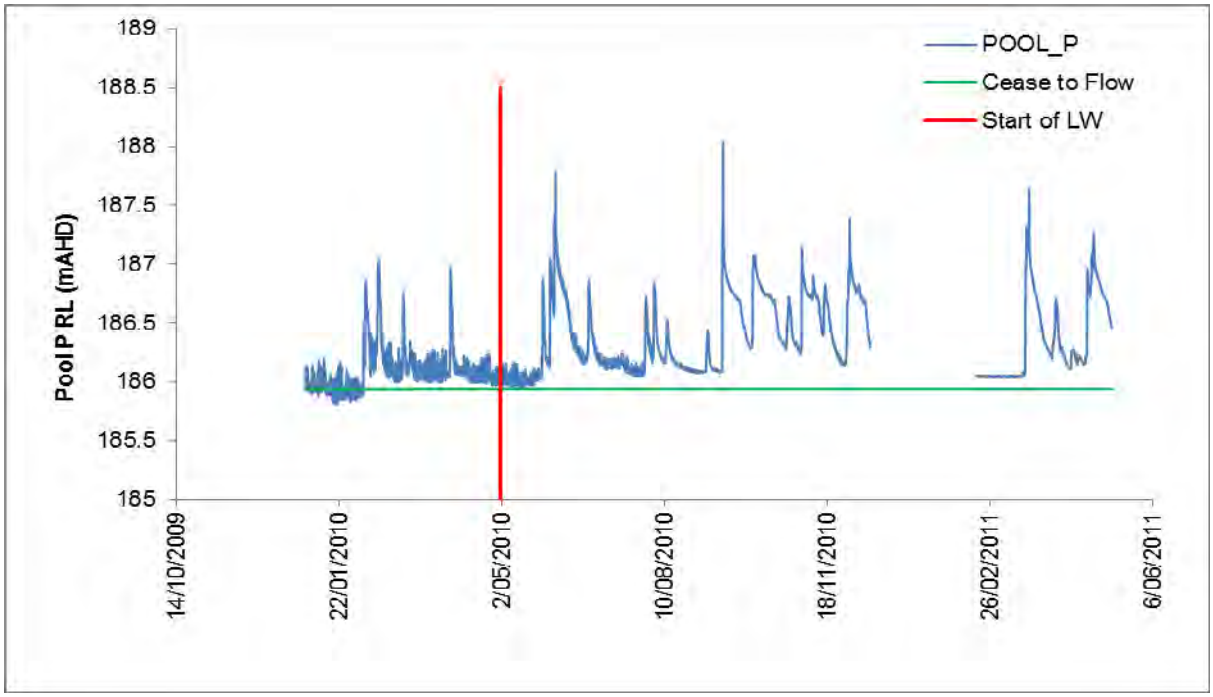


Chart 53 Pool P Water Level

The earlier monitoring data for Pool P showed evidence of daily temperature fluctuations which are superimposed on the recorded water level data. These oscillations were also measured at other pool water level data at Metropolitan Coal during the same period. The data loggers were upgraded which substantially reduced temperature effects. The later monitored data, including the period after the commencement of LW20, indicates that water levels in Pool P have remained above its case to flow level since the commencement of mining of LW20 and therefore meet the performance indicator.

Water level data for Pools Q, R and S will also be downloaded monthly and assessed against the following performance indicator:

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.

The performance indicator will be considered to have been exceeded if the water depth in Pools Q, R or S has been below that required to maintain water over the downstream rock bar. If data analysis indicates water depths in Pools Q, R or S have been below that required to maintain water over the downstream rock bar, pools downstream on the Waratah Rivulet and the control pools on Woronora River will be analysed and an assessment will be made against the subsidence impact performance measure.

Mining has not been within 400 m of Pool P during the review period and thus assessment against the above performance indicators will be undertaken in future Annual Reviews.

Assessment against Performance Measure

The performance measure, *negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools ….)*, will be considered to have been exceeded if analysis of water depth data indicates that changes in the drainage behaviour are statistically different from:

- pre-mining conditions (i.e. when mining is greater than 400 m from the pool); and
- the behaviour of downstream unaffected pools.

As a result of the Project and the change in drainage behaviour cannot be explained by climatic conditions.

Mining has not been within 400 m of Pool P during the review period and thus assessment against the above performance measure will be undertaken, as necessary, in future Annual Reviews.

Minimal Gas Releases

Visual and photographic surveys of the Waratah Rivulet downstream of maingate 23 to the Woronora Reservoir full supply level are conducted monthly until subsidence of Waratah Rivulet is less than 20 mm/month, and thereafter within three months of the completion of each longwall.

Assessment against Performance Indicator

Consistent with the Water Management Plan, the visual surveys will be used to assess whether the following performance indicator has been exceeded:

No gas releases observed at Pool P on the Waratah Rivulet.

Pool P will be monitored for gas releases on a monthly basis when subsidence is greater than 20 mm/month. The performance indicator will be considered to have been exceeded if gas releases are observed at Pool P on the Waratah Rivulet.

Subsidence at Pool P has not been greater than 20 mm/month during the review period. Opportunistic visual inspections of Pool P have not observed any gas releases.

If the visual surveys indicate the performance indicator has been exceeded, an assessment will be made against the subsidence impact performance measure.

Assessment against Performance Measure

The performance measure, *minimal gas releases*, will be assessed by considering if the gas releases observed have resulted in greater than minimal gas releases.

The performance measure is exceeded if analysis of the monitoring results confirms that the Project has resulted in greater than minimal gas releases on the Waratah Rivulet downstream of maingate 23. As described above, the performance indicator was not exceeded during the review period.

3.3.4 Management and Mitigation Measures

Waratah Rivulet Stream Remediation

In accordance with Condition 1, Schedule 6 of the Project Approval, Metropolitan Coal is required to achieve the rehabilitation objective, *restore surface flow and pool holding capacity as soon as reasonably practicable* for Waratah Rivulet, between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir.

Stream remediation activities have commenced at Pools A and F on the Waratah Rivulet in accordance with approvals obtained from the SCA under Part 5 of the EP&A Act. The rock bars at Pools A and F are considered to largely control the pools located upstream of these rock bars. As a result, Metropolitan Coal anticipates that the restoration of surface flow and pool holding capacity at Pools A and F will restore the surface flow and pool holding capacity of pools between Flat Rock Swamp and Pool F. Metropolitan Coal will assess whether stream remediation is required at any additional pools/rock bars between Flat Rock Swamp and Pool F once stream remediation activities at Pools A and F have been completed. Stream remediation activities are described further in Section 3.11.

In addition, monitoring of Pool G1 on the Waratah Rivulet has indicated that although the pool continues to retain water, the water level in the pool temporarily fell below its cease to flow level (i.e. stopped overflowing). This is consistent with the predictions of the EA and that authorised by the Project Approval. As described in the Rehabilitation Management Plan, stream remediation activities will commence at Pools G and G1 following completion of remediation activities at Pool F.

Stream remediation will be initiated at Pools H, I, J, K, L, M, M1, N and O on the Waratah Rivulet if the water level in a pool falls below its cease to flow level (i.e. stops overflowing), except if as a result of climatic conditions. The control pools on Woronora River will be inspected for a similar response.

Analysis of pool water levels is provided in Section 3.11.

Monitoring of Subsidence at Waratah Rivulet Gauging Station

A subsidence survey line has been installed at the Waratah Rivulet gauging station to monitor conventional and non-conventional subsidence magnitudes at this location. If monitoring identifies subsidence effects at this location, Metropolitan Coal will consult with the SCA and conduct a review of the hydrological performance of the gauging station including analysis of the rating curve and separately an analysis of the recession model. No subsidence effects were recorded at this location during the review period.

3.3.5 Further Initiatives

The Construction Management Plan includes the proposed construction of two new gauging stations, one on the Eastern Tributary and another on Honeysuckle Creek (Figure 7). Construction would commence following the approval of the Construction Management Plan.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Water Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

Metropolitan Coal will continue to monitor and assess data quality from the deep piezometer bores, particularly those piezometers exhibiting relatively long equilibration times in low permeability strata.

Metropolitan Coal will arrange for a peer review of the assessment against the performance measure, *negligible reduction to the quality of water resources reaching the Woronora Reservoir*, as discussed in Section 3.3.3.2. Furthermore, as part of this peer review and once Metropolitan Coal has received sufficient data from the SCA under the data exchange agreement, an assessment will be made against the performance indicator, *changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations, that are not also occurring in the Nepean Reservoir (control site)*.

3.4 BIODIVERSITY MANAGEMENT PLAN

3.4.1 Background

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

3.4.2 Monitoring

3.4.2.1 Upland Swamp Vegetation Monitoring

Eight upland swamps, *viz*. Swamps 16, 17, 18, 20, 23, 24, 25 and 26 have been mapped above or immediately adjacent to Longwalls 20-22 (Figure 12). A swamp substrate characterisation study has also been conducted to contribute to Metropolitan Coal's understanding of the ecological, hydrological and geomorphic processes of swamps over Longwalls 20-22.

With the exception of in-valley Swamp 20, which supports tea tree thicket, all swamps over Longwalls 20-22 are small valley-side swamps and comprise restioid heath, with intergrades with banksia thicket. Transitions between restioid heath and banksia thicket are thought to be driven by fire frequency.

Three swamps (Swamps 16, 17 and 23), although showing seepage are more akin to sandstone heath woodland with low tree densities. The vegetation contains species found in upland swamps, mixed with a range of non-swamp species.

Swamps 101, 111a and 125 have been selected as control sites for the restioid heath/banksia thicket valley-side swamps (Figure 12) and Swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp have been selected as control sites for the tea tree thicket vegetation of Swamp 20 (Figure 13).

The upland swamp vegetation monitoring program includes visual monitoring, transect/quadrat monitoring and monitoring of indicator species, as described below.

Visual Inspections

Baseline visual inspections of the swamps overlying and immediately adjacent to Longwalls 20-22 and at the control swamps have been conducted in spring 2010 and autumn 2011 at the same time as the vegetation surveys.

Visual inspections will also be conducted monthly for the period of time that Longwall 20 is within 400 m of a swamp to record evidence of potential subsidence impacts.

Traverses covering the majority of the extent of the swamp are conducted to record:

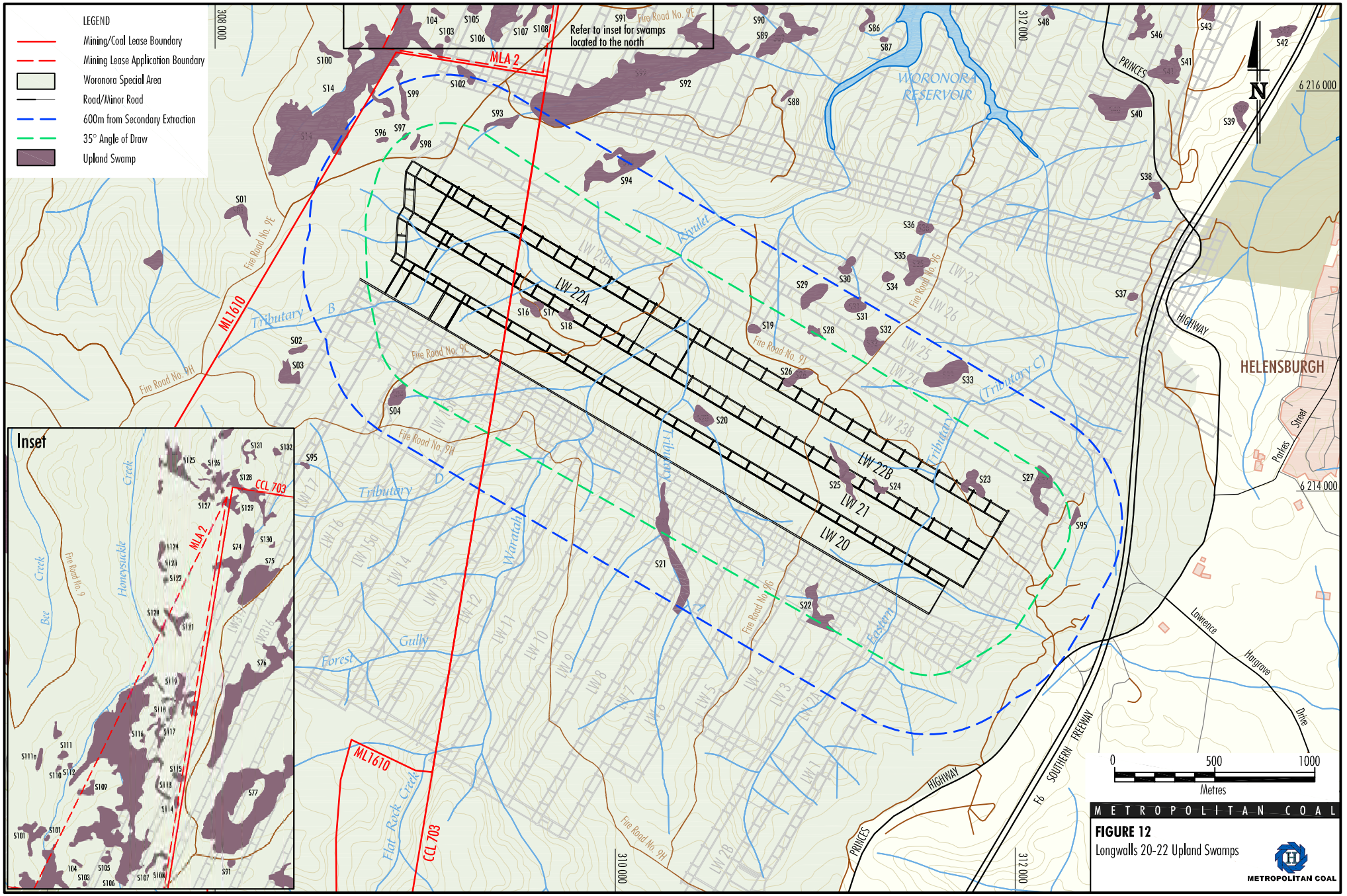
- cracking of exposed bedrock areas and/or swamp sediments;
- areas of increased erosion, particularly along any existing drainage line;
- any changes in water colour;
- changes in vegetation condition, including areas of senescing vegetation that appear unusual; and
- the amount of seepage at the time of inspection, relative to recent rainfall events.

Photographs of any cracking, erosion, water colour changes and vegetation senescence are taken, concurrently with a description of the magnitude and extent of the observations, and appropriate GPS readings. Seepage is documented by photographs of flow over exposed surfaces.

Traverses covering the majority of the extent of each swamp were conducted in spring 2010 and autumn 2011, and the following provides a summary of the visual observations:

<u>Spring 2010</u>

- No cracking of exposed bedrock areas or swamp sediments was observed in either longwall or control swamps, other than what has been reported previously in baseline surveys in Swamps 17 and 23, and the rock displacement in Swamp 24 (Eco Logical Australia, 2010).
- No areas of increased erosion were observed other than minor erosion and surface wash recorded in the downstream section of the drainage line through Swamp 20 (adjacent to the end of Transect 1) and along walking trail 9J adjacent to Swamp 23 following the heavy rainfall events in early spring.
- No changes in water colour observed in either longwall or control swamps; no new areas of water ponding.
- General vegetation condition of both longwall and control swamps was found to be in good condition with no areas of unusual vegetation senescence observed.
- Minor dieback of individuals such as *Banksia ericifolia* subsp. *ericifolia, Petrophile pulchella* and *Xanthorrhoea resinosa* were observed in both longwall and control swamps (for example within Swamp 25, Swamp 101, and Swamp 125).



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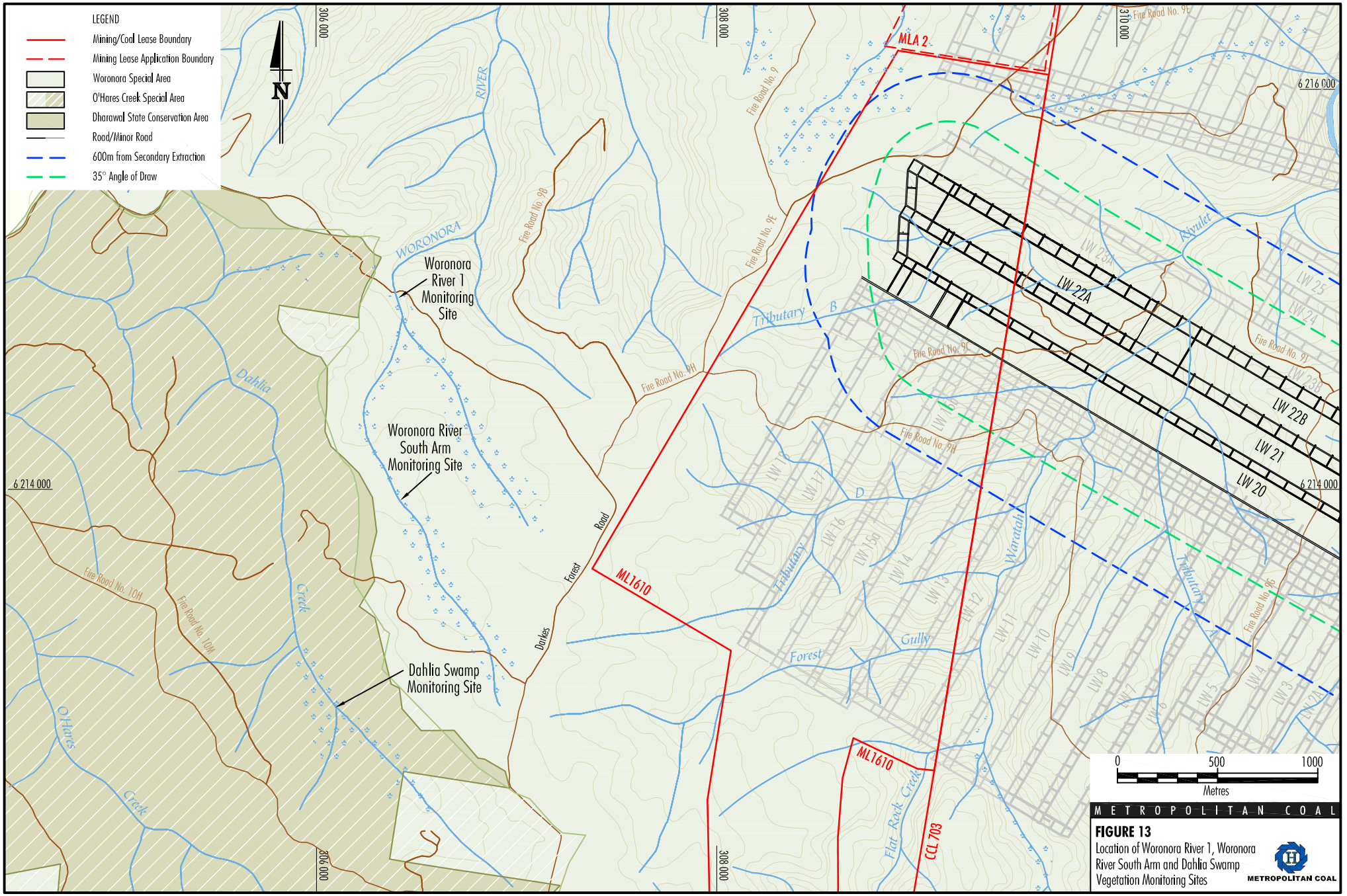

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- Seepage areas were commonly observed across terminal steps and other rocky areas throughout both longwall and control sites.

Autumn 2011

- No cracking of exposed bedrock areas or swamp sediments was observed in either longwall or control swamps, other than what has been reported previously in Swamps 17 and 23, and the rock displacement in Swamp 24 by the baseline surveys (Eco Logical Australia, 2010).
- No areas of increased erosion other than minor erosion and surface wash recorded in the downstream section of the drainage line through Swamp 20 (adjacent to the end of Transect 1), in the north of Swamp 24 (within the drainage line below Swamp 25) and along walking trail 9J adjacent to Swamp 23. Some minor bank scour was also observed within the drainage channel which runs through control Swamp 125.
- No changes in water colour observed in either longwall or control swamps; no new areas of water ponding.
- General vegetation condition of both longwall and control swamps was found to be in good condition. The only exception to the generally good condition of swamp vegetation was small patches of senescent mid layer vegetation which was observed in areas adjacent to exposed bedrock in the lower portions of some of the restioid heath swamps (Swamps 17, 18, 23). Senescent vegetation within these patches was limited to proteaceous shrubs species including *Banksia ericifolia* subsp. *ericifolia*, *Petrophile pulchella* and *Hakea teretifolia*, with the lower stratum not impacted and no over storey layer present within these areas.

  While the cause of this senescence is unknown, it is thought to be caused by the frequent or continued inundation of the shallow sediments in these areas. The shallow nature of the soils adjoining areas of exposed bedrock means that they are more frequently inundated than those areas of the swamps with deeper sediments. The wet conditions in early summer 2010 and autumn 2011 are thought to have caused the frequent/continued inundation of shallower swamp sediments creating anaerobic conditions depriving roots of necessary oxygen. While this pattern was not recorded in control swamps, it has been observed in swamps outside the Longwall 20-22 mining area which have not been undermined. As a result, these small patches of senescent shrubs are thought to be a natural phenomenon and not related to the mining of Longwalls 20-22.
- Minor dieback of scattered individuals such as *Banksia ericifolia* subsp. *ericifolia, Petrophile pulchella* and *Xanthorrhoea resinosa* were observed in both longwall and control swamps (for example within Swamp 25, Swamp 101, and Swamp 125).
- Small patches of senescent vegetation recorded during the baseline surveys (i.e. at the end of Transect 3 in Swamp 25 [longwalls] and between Transects 1 and 2 in Swamp 125 [control] [Eco Logical Australia 2010]) were found to have diminished in area.
- Seepage areas were commonly observed across terminal steps and other rocky areas throughout both longwall and control sites.

Transect/Quadrat Monitoring

Transect and quadrat monitoring has been conducted in spring 2010 and autumn 2011 of:

- restioid heath vegetation – Swamps 18, 24 and 25 overlying Longwalls 20-22, and in control Swamps 101, 111a and 125 (Figure 12); and
- tea tree thicket vegetation – Swamp 20 overlying Longwalls 20-22, and in control Swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp (Figures 12 and 13).

Swamps 16 and 17 (restioid heath/sandstone heath woodland) were also added to the vegetation monitoring program in autumn 2010 (Figure 12).

Each swamp has been monitored with three transects, with the exception of the control swamps for Swamp 20 where only a single transect has been established owing to the much larger size of the control swamps.

For the restioid heath swamps, assessments have been made on 1 square metre (m^2) quadrats centred on the transect line every 5 m starting from 0 m. For the tea tree thicket swamps, assessments have been made on 1 m^2 quadrats located upslope of the transect line with one quadrat edge located on the line as a means of avoiding the impacts of vegetation trampling as a result of access into these thickly vegetated swamps. As for restioid heath swamps, assessments are made every 5 m starting from 0 m.

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat.

Permanent photo points have been established along each transect.

The results of the transect/quadrat monitoring surveys for spring 2010 and autumn 2011 are provided below.

Vegetation Structure, Cover Abundance and Condition

Spring 2010

- A general increasing trend in height and percent cover was recorded in both longwall and control sites during the spring 2010 survey in both the mid and/or lower stratum; for example at Swamp 18, Swamp 25 and Swamp 101 where species including *Banksia ericifolia* subsp. *ericifolia, Hakea teretifolia*, *Leptospermum squarrosum, Actinotus minor*, *Schoenus brevifolius* and *Ptilothrix deusta* were recorded with increased covers. At some sites, the lower stratum showed marked increases in cover and are probably attributed to spring growth conditions.
- This general trend was observed in autumn 2010 (baseline survey).
- Fluctuating cover values were recorded at both longwall and control sites.
- No weeds were recorded within any of the sites.

Autumn 2011

- No general trend in height or percent cover was detectable, with the majority of sites, including both longwall and control sites, recording equal or similar values for vegetation height and percent cover in spring 2010 and autumn 2011. The relative stability of the vegetation percent cover was more widespread in the upper and mid storey vegetation layers with the lower stratum showing more variability.
- Exceptions to the relatively stable vegetation height and percent cover included Swamps 111a and 125 where a general increase in vegetation height was recorded. Additionally, vegetation height and cover generally showed an overall increase at Woronora River 1.
- Fluctuating cover values were recorded at both longwall and control sites.
- No weeds were recorded within any of the sites.
- The changes in species composition, cover and condition reflect normal population variation and cycles in response to seasonal variations and plant growth.

Species Richness

A summary of species richness within swamp quadrats recorded since spring 2009 is provided in Table 16 and Chart 54**.**

Table 16
Species Richness in Upland Swamps Spring 2009, Autumn 2010, Spring 2010 and Autumn 2011

Site	Spring 2009	Autumn 2010	Spring 2010	Autumn 2011
Swamp 16 RH	-	64	68[2]	67
Swamp 17 RH	-	66	64[2]	63
Swamp 18 RH	59*	55	44	59
Swamp 24 RH	57*	62	56	63
Swamp 25 RH	54*	57	61	53
Swamp 101 RH	66	51	59[2]	56
Swamp 111a RH	59*	62	65	59
Swamp 125 RH	62	64	64	58
Swamp 20 TTT	45	39	40	39
Woronora River 1 TTT	24	23	19	20
Woronora River South Arm TTT	29	30	29	26
Dahlia Swamp TTT	24	25	24	22

** Incorrectly reported in Eco Logical Australia (2010), although analysis performed with the correct data.*
Note: RH: restioid heath
TTT: tea tree thicket

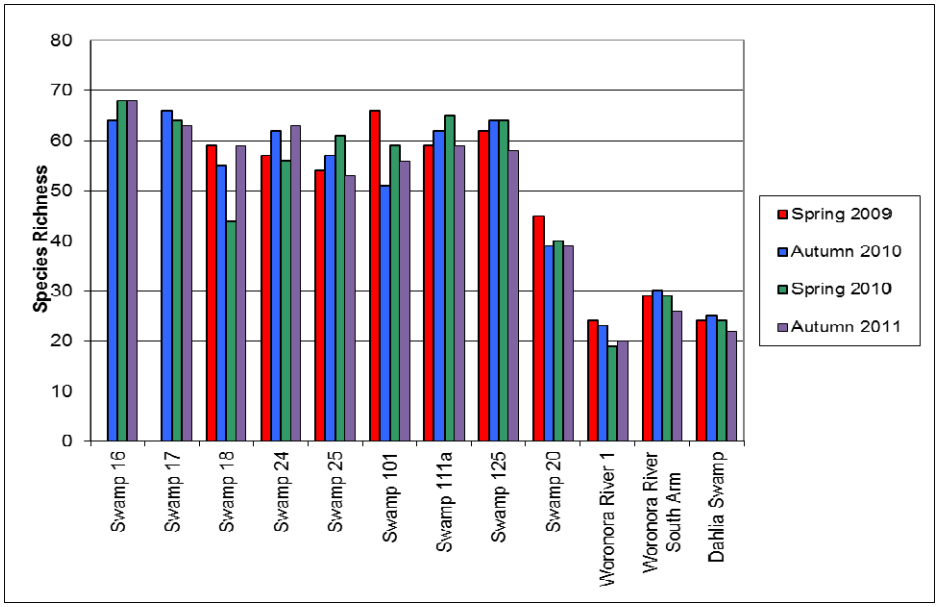


Chart 54 Species Richness in Upland Swamp Sites, Spring 2009, Autumn 2010, Spring 2010 and Autumn 2011

The drier valley side swamps supporting restioid-heath vegetation are more floristically diverse with 44 – 67 (mean = 60) species recorded. The wetter tea tree thickets swamps are less diverse with 19 – 45 species recorded. Of the tea tree thickets, Swamp 20 is the most diverse (mean = 41) compared to the remaining tea tree thicket swamps (Woronora 1, Woronora River south arm and Dahlia Swamp) where a mean average of 25 species were recorded. This difference in floristic diversity is more likely attributed to its position in the landscape (in-valley compared to headwater), and position adjacent to woodland vegetation where species are shared.

Fluctuations in species richness were similar between longwall sites and control sites over the survey period, with no consistent patterns between seasons or across sites for the restioid heath sites.

Of the six longwall sites, three sites recorded an increased species richness from any previous seasons (Swamps 16, 18 and 24) while at the remaining three sites species richness was below or equal to that recorded in previous seasons. Of the six control sites, species richness was within the previously recorded range at three sites (Swamps 101, 111a, Woronora River 1), while declines in species richness were recorded at the remaining sites.

Indicator Species

Population monitoring of indicator species has been conducted in spring 2010 and autumn 2011.

Twenty tagged individuals of *Epacris obtusifolia*, *Sprengelia incarnata* and *Pultenaea aristata* have been monitored in each of the following valley side swamps, commencing spring 2009:

- *Epacris obtusifolia* – Swamps 18, 24 and 25 above Longwalls 20-22 and at control sites 101, 111a and 125.
- *Sprengelia incarnata* – Swamp 24 above Longwalls 20-22 and at control sites 101 and 125.
- *Pultenaea aristata* – Swamps 18, 24 and 25 above Longwalls 20-22 and at control sites 101 and 111a.

  Note, survey of *Pultenaea aristata* in Swamp 24 commenced in autumn 2010.

Twenty tagged individuals of *Banksia robor, Callistemon citrinus* and *Leptospermum juniperinum* have also been monitored in Swamp 20 and at the associated control sites (Woronora River 1, Woronora River South Arm and Dahlia Swamp).

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

The following provides a summary of the results of population monitoring for spring 2010 and autumn 2011:

<u>Spring 2010</u>

- Within valley side swamps the condition of all tagged plants was generally found between Condition 5 (healthy) and Condition 4 (minor dieback) for *Pultenaea aristata* and *Epacris obtusifolia*. Several individuals recorded Condition 3 (some dead branches) within the various swamps but these were scattered individuals and did not reflect any unusual areas of vegetation senescence.
- Within the tea tree thicket swamps, the condition of all tagged plants was generally recorded between Condition 5 (healthy) and Condition 4 (minor dieback). Several individuals recorded Condition 3 (some dead branches) but these were scattered individuals and did not reflect any unusual areas of senescent vegetation.
- *Sprengelia incarnata* consistently recorded Condition 4 (minor dieback) due to individuals usually presenting with leaf dieback on the lower stems. This species is typically found with this habit throughout all sites and probably reflects the normal growth form of this species.
- Two dead individuals were recorded during spring 2010: Tag K26 *Sprengelia incarnata* in control Swamp 101, and Tag A64 *Banksia robur* in control swamp Dahlia Swamp.

No dead individuals were found within the swamps overlying or adjacent to Longwalls 20-22.

Autumn 2011

- Within both the side valley swamps and tea tree thicket swamps the condition of tagged indicator species has progressively declined over the four seasons of surveys. This can be seen by the increase in the number of plants with some level of dieback (Conditions 1 to 4) and a subsequent decrease in the number of tagged plants in a healthy condition (Condition 5).
- This decrease in condition ratings has occurred at both longwall and control sites and has occurred in all seasons, most noticeably during autumn 2010 prior to the commencement of mining of Longwalls 20-22. The declines are considered to represent natural declines in response to climatic conditions, ageing plants and natural disturbances including storm events. The observed declines are not considered to be related to mining of Longwalls 20-22.
- Within the valley side swamps, *Sprengelia incarnata* has undergone the largest decrease in overall condition at both longwall and control sites, followed to a lesser degree by *Pultenaea aristata* with *Epacris obtusifolia* having the most tagged plants scoring a healthy condition rating (Condition 5). The decline in condition for *Sprengelia incarnata* is often due to individuals presenting with leaf dieback on the lower stems. As noted above, this species is typically found with this habit throughout all sites and probably reflects the normal growth form of this species.

Seven dead individuals of the tagged valley side swamp indicator species were recorded during autumn 2011 (including the single individual Tag K26 *Sprengelia incarnata* in control Swamp 101 recorded as dead in spring 2010):

- Tag J6 Pultenaea aristata in Swamp 18;
- Tags K52 and K58 Sprengelia incarnata in Swamp 24;
- Tags J86, J97 and J98 Pultenaea aristata in Swamp 24; and
- Tag K26 Sprengelia incarnata in control Swamp 101.

Senescing or dead individuals of the three indicator species were not confined to longwall sites. For example, a senescing individual (condition rating 1) of *Pultenaea aristata* (J28) was recorded at Swamp 101 during autumn 2011. Dead individuals of indicator species were also observed during the autumn 2011 surveys conducted within other non-undermined swamps (Longwalls 23-27 program).

Of the three monitored species within tea tree thickets, *Banksia robur* at both longwall and control sites has undergone the largest decrease in overall condition, followed to a lesser degree by *Callistemon citrinus* and *Leptospermum juniperinum.* The decline in condition for tea tree thicket indicator species was generally associated with some level of leaf herbivory (commonly *Banksia robur*), leaf discolouration (commonly *Callistemon citrinus*) or some loss of leaves (commonly *Leptospermum juniperinum*).

No further dead individuals were recorded in autumn 2011 (Tag A64 *Banksia robur* in control swamp Dahlia Swamp was recorded as dead in spring 2010), although Tag A58 was not relocated due to an error in the GPS information for this species. Further searches will be conducted in spring 2011 to relocate this plant or a replacement plant will be tagged.

Reproductive rating

The flowering status of tagged indicator species, as recorded in the reproductive scale, shows that for the majority of surveys very little flowering has been detected. The infrequent flowering has been recorded at both longwall and control sites and across all seasons, with the exception of baseline data collected in spring 2009 where *Epacris obtusifolia* was commonly recorded flowering in control swamps and less frequently in longwall swamps.

The infrequent recording of flowering plants of indicator species is thought to be related to the timing of surveys not coinciding with peak flowering periods. As flowering was infrequent across all seasons (including baseline surveys) and at both control and longwall swamps, the infrequent flowering of swamp indicator species does not appear to have been caused by mining of Longwalls 20-22.

Analysis of Monitoring Results

Transect/Quadrat monitoring

Analysis of Species Richness

Upland swamp sites were split into two groups for analysis on the basis of their floristic differences: valley side swamps (restioid heath) and tea tree thicket swamps.

For the valley side swamp sites, species richness data were analysed for each season using analysis of variance (ANOVA). No significant differences between longwall and control sites were recorded for any season (spring 2009 (p=0.086), autumn 2010 (p=0.672) spring 2010 (p=0.501) and autumn 2011 (p=0.341)). The results are presented in Chart 55**.**

As there is only one tea tree thicket longwall site, the data has not been analysed using ANOVA. Instead, a graphical representation of the data is presented in Chart 56. Swamp 20 is floristically more diverse than the tea tree thicket control swamps most likely attributable to the adjacent eucalypt woodland vegetation communities where species are shared. Despite there being differences in species richness between the longwall and control sites, the differences are similar across all survey seasons.

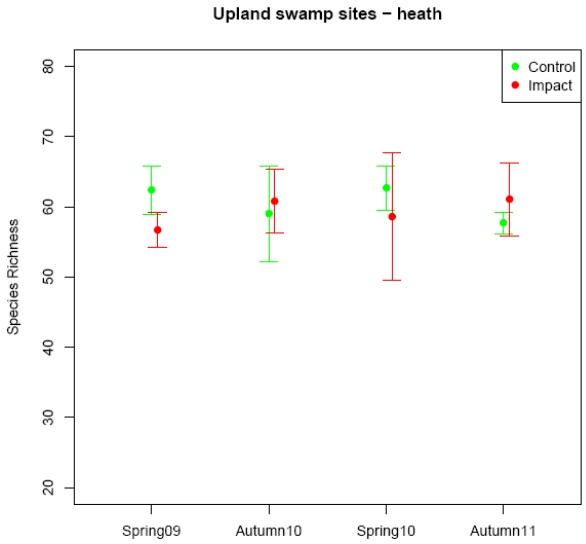


Chart 55 Analysis of Species Richness in Valley Side Swamps – Spring 2009 to Autumn 2011

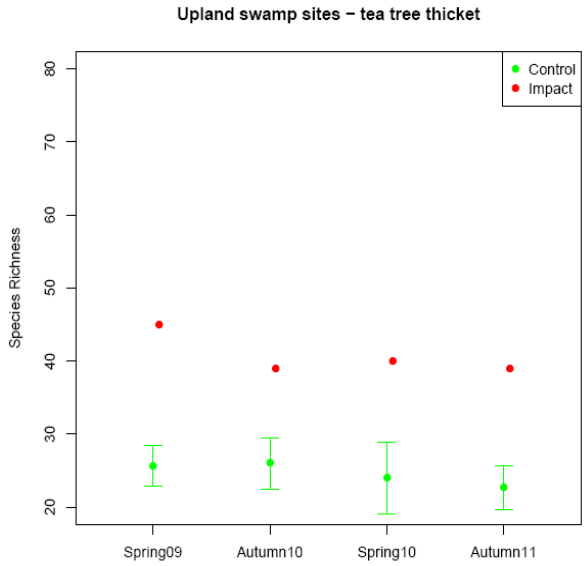


Chart 56 Analysis of Species Richness in Tea Tree Thickets – Spring 2009 to Autumn 2011

Analysis of species lists – valley side swamps vegetation cover abundance and condition

Analysis of similarities (ANOSIM) was used to examine the differences in vegetation cover/abundance overtime between the longwall and control sites for each season, and the results are presented in Table 17**.** Significant differences were observed in spring 2009, autumn 2010 and spring 2010, however, the magnitude of the difference reduced over time as evidenced by the R statistic. For the period autumn 2010 (pre-mining) to spring 2010 (post-mining), the R statistic was similar indicating that the two treatments have become more similar and that there has not been any significant changes in the vegetation cover/abundance between the longwall and control swamps during spring 2010. No significant differences were observed between longwall and control sites in the autumn 2011 measurement further indicating that vegetation cover/abundance at longwall and control sites are becoming more similar.

Table 17
Analysis of Similarities (ANOSIM) for vegetation cover/abundance in valley side swamps (spring 2009, autumn 2010, spring 2010 and autumn 2011)

Season	R statistic	p-value
Spring 2009	0.203	0.012
Autumn 2010	0.104	0.085
Spring 2010	0.162	0.036
Autumn 2011	0.017	0.347

ANOSIM was also used to examine the differences in vegetation condition over time between the longwall and control sites for each season, and the results are presented in Table 18**.**

Significant differences were also observed in spring 2009, autumn 2010 and spring 2010, however, as for vegetation cover/abundance, the magnitude of the difference reduced over time as evidenced by the R statistic. For the period autumn 2010 to spring 2010, the R statistic was similar indicating that the two treatments have become more similar and that there has not been any significant change in the vegetation condition between the longwall and control swamps during spring 2010. No significant differences were observed between longwall and control sites in the autumn 2011 measurement further indicating that vegetation condition at longwall and control sites are becoming more similar.

Table 18
Analysis of Similarities (ANOSIM) for Vegetation Condition (Spring 2009, Autumn 2010, Spring 2010 and Autumn 2011)

Season	R statistic	p-value
Spring 2009	0.211	0.010
Autumn 2010	0.171	0.033
Spring 2010	0.212	0.012
Autumn 2011	0.080	0.143

Indicator Species

Analysis of the proportion of plants surviving

For the spring 2010 survey two individuals were found to have died as follows:

- Tag K26 Sprengelia incarnata in control Swamp 101.
- Tag A64 Banksia robur in control swamp Dahlia Swamp.

No tagged individuals were found to have died within the Longwall 20-22 swamp monitoring sites during spring 2010.

For the autumn 2011 survey six dead individuals of the tagged side valley swamp indicator species were recorded:

- Tag J6 Pultenaea aristata in longwall Swamp 18;
- Tags K52 and K58 Sprengelia incarnata in longwall Swamp 24; and
- Tags J86, J97 and J98 Pultenaea aristata in longwall Swamp 24.

Due to the low occurrence of plant deaths no statistical analysis (e.g. ANOVA) was undertaken for this assessment.

Analysis of differences in health ratings and reproductive ratings

Charts 57 to 59 present the analysis for the selected indicator species in the valley side swamps sites. Charts 60 to 62 present the analysis for the selected indicator species in the tea tree thicket swamp sites.

Data for the reproductive status and condition demonstrated little variation for the six plants considered.

In general vegetation condition has been similar for each species at both longwall and control sites, indicated by overlapping confidence intervals (Charts 57 to 62). Exceptions to this include *Epacris obtusifolia*, *Pultenaea aristata*, *Banksia robur*, *Callistemon citrinus* and *Leptospermum juniperinum* in autumn 2011 and *Callistemon citrinus* and *Leptospermum juniperinum* in spring 2010.

Instances where the confidence intervals for vegetation condition do not overlap may indicate significant differences (although further analysis would be required to confirm this). However these potential differences are unlikely to indicate changes relating to mining as mean vegetation condition was higher (healthier) at impact (longwall) sites than control sites for *Banksia robur*, *Callistemon citrinus* and *Leptospermum juniperinum* and only *Epacris obtusifolia* and *Pultenaea aristata* were lower at impact (longwall) sites than control sites.

As for vegetation condition, reproductive status was generally similar for each species in each season, as indicated by overlapping confidence intervals (Charts 57 to 62). Where confidence intervals did not overlap, reproductive status was higher at impact (longwall sites) for all species and season except *Epacris obtusifolia* and *Pultenaea aristata* in autumn 2011.

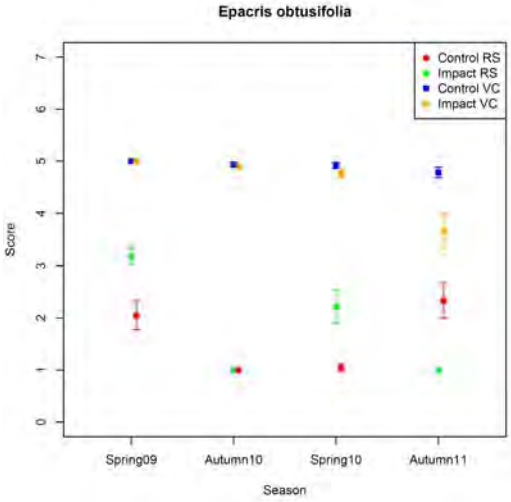


Chart 57 **Indicator Species Monitoring – *Epacris obtusifolia* (RS = reproductive status, VC = vegetation condition)**

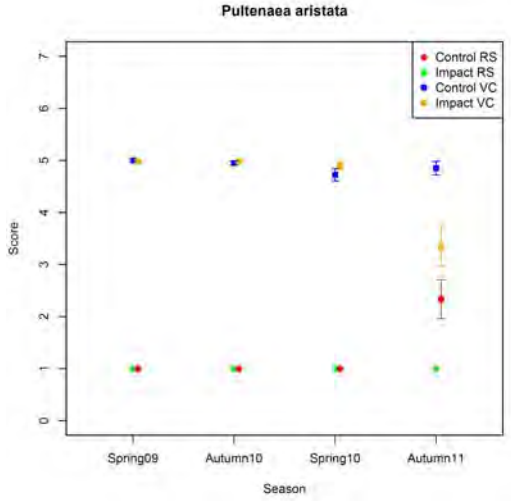


Chart 58 **Indicator Species Monitoring – *Pultenaea aristata* (RS = reproductive status, VC = vegetation condition)**

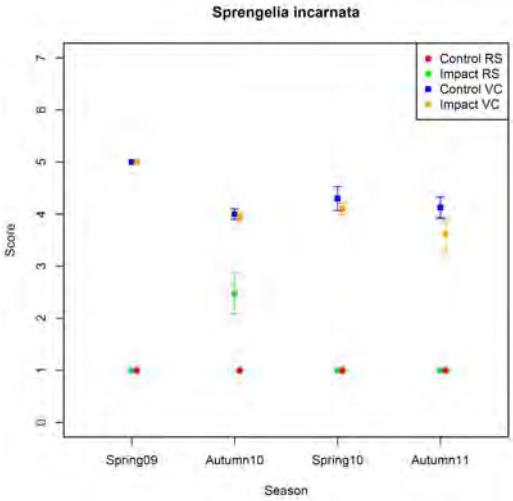


Chart 59 **Indicator Species Monitoring – *Sprengelia incarnata* (RS = reproductive status, VC = vegetation condition)**

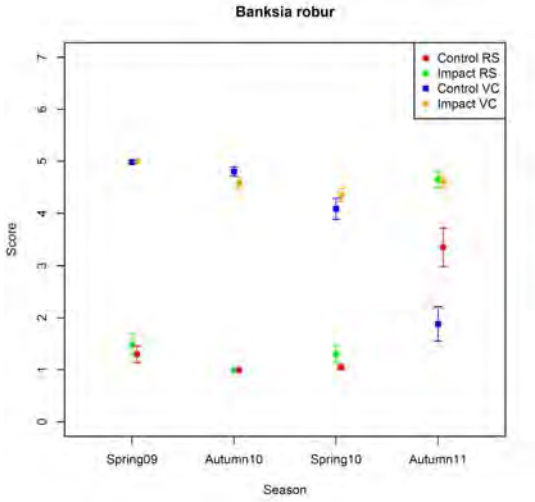


Chart 60 **Indicator Species Monitoring – *Banksia robur* (RS = reproductive status, VC = vegetation condition)**

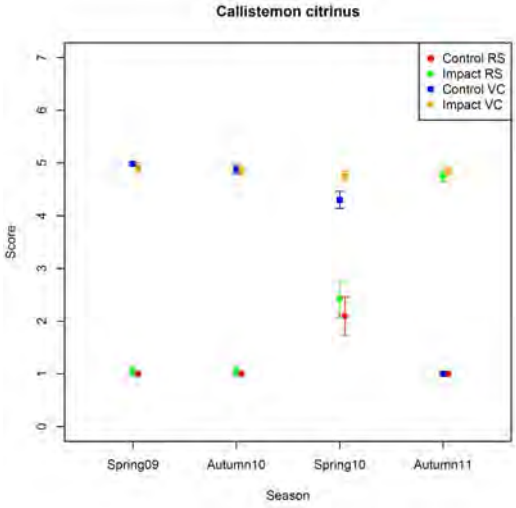


Chart 61 **Indicator Species Monitoring – *Callistemon citrinus* (RS = reproductive status, VC = vegetation condition)**

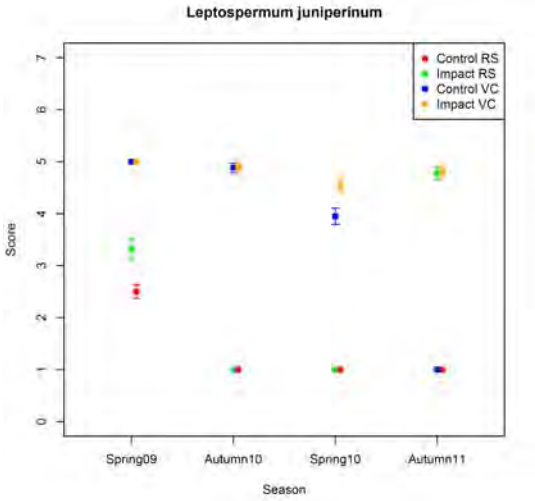


Chart 62 **Indicator Species Monitoring – *Leptospermum trinervium* (RS = reproductive status, VC = vegetation condition)**

Analysis of indicator species data indicates that the upland swamp performance indicator, *the vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps*, has not been exceeded.

3.4.2.2 Upland Swamp Groundwater Monitoring

Groundwater monitoring of upland swamps has involved the use, where practicable, of paired (shallow and deep) piezometers. Where a shallow piezometer has not been practicable to install due to the depth of the swamp sediments, deeper piezometers have been installed. Monitoring commenced in August 2010 at piezometers installed in the following upland swamps (Figures 9, 12 and 13):

- Valley side Swamps 16/17 overlying Longwalls 20-22 (sandstone piezometer to a depth of 10 m).
- Valley side Swamp 25 overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- Valley side Swamp 101 (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- In-valley Swamp 20 overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 3 and 10 m).
- Headwater Swamp Woronora River 1 (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 3 and 10 m).

Longer-term groundwater level data for upland swamps has been acquired with single piezometers at sites SWAMP1, SWAMP2 and SWAMP3, and paired piezometers at site SWAMP4 and SWGW1 (Figure 9).

Chart 63 shows that the perched groundwater levels at SWAMP1, SWAMP2 and SWAMP3 have a highly dynamic behaviour that is characterised by an immediate response to rainfall events, followed by fairly rapid recessions as water is lost by evaporation and evapotranspiration. The monitored sites are far from current mining, and there is no evidence of any change in behaviour due to mining.

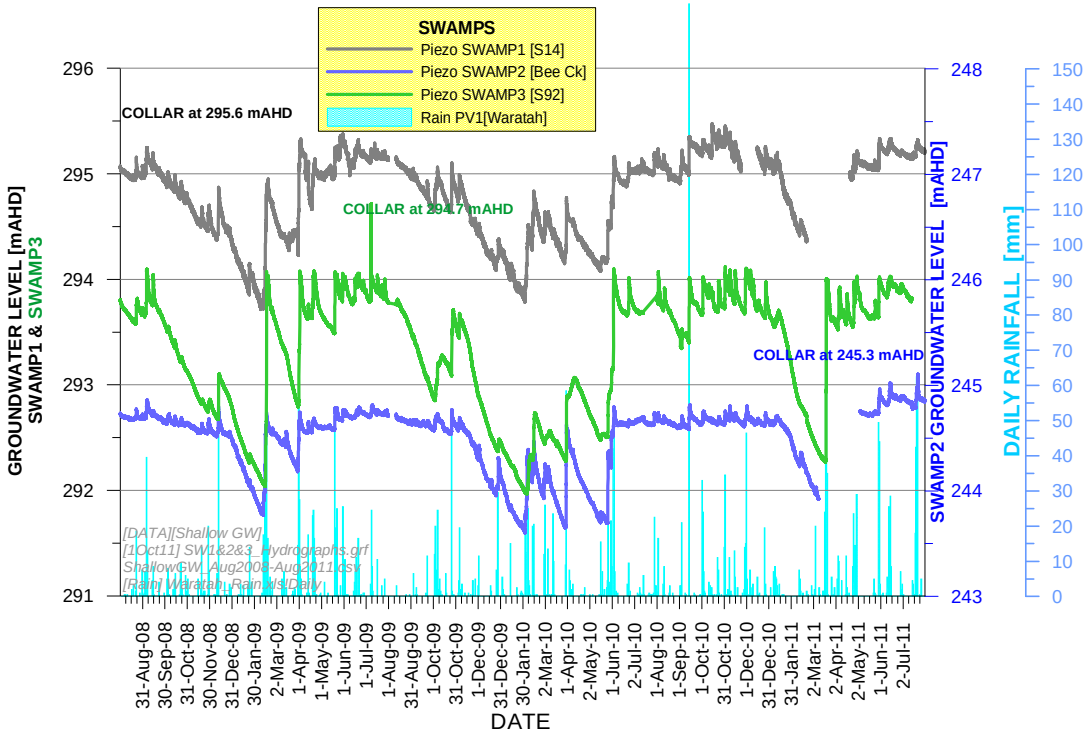


Chart 63 Perched Groundwater Hydrographs in SWAMP 1, SWAMP 2 AND SWAMP3

The groundwater levels in the paired piezometers at SWAMP4 and SWGW1 and their correlations to rainfall are shown on Chart 64. The groundwater levels at SWAMP4 are perched and hydraulically isolated from a deeper perched water table (or the regional water table) in the underlying sandstone aquifer (measured by site SWGW1).

SWAMP4 is considered to be characteristic of headwater upland swamps in that they typically obtain most of their moisture from direct rainfall infiltration. The water tables at SWAMP 4 are greater than 3 m apart. There is a strong correlation between swamp and sandstone water level fluctuations which suggests either direct leakage from the swamp to the underlying sandstone, and/or direct rain recharge to adjacent sandstone with lateral groundwater flow to the sandstone beneath the swamp.

The residual mass curves are indicators of rainfall trends, and they show a pronounced dry period in February 2011 during the review period. This coincides with low groundwater levels in the piezometers featured in Chart 63 and Chart 64. In general, as the residual mass trends agree well with observed groundwater level trends, rainfall is the primary driving force.

The hydrographs at the two control swamps (SWAMP 101 and WRSWAMP1 [Figure 9]) are displayed in Chart 65 and Chart 66. Both sites show a pronounced drop in groundwater levels in February 2011, associated with a rainfall deficit. At SWAMP 101, the water tables are always separated, usually by 0.5 m, and groundwater flow direction is downwards. At site WRSWAMP1, the water level in the swamp (piezometer at 1 m depth) is always lower than the potentiometric level in the deeper sandstone piezometers. This suggests that the swamp is being recharged by groundwater from below and possibly from the sides. The swamp piezometer and the 4 m sandstone piezometer show good connectivity across the swamp/sandstone interface, with separation from the the groundwater head at the 10 m sandstone piezometer.

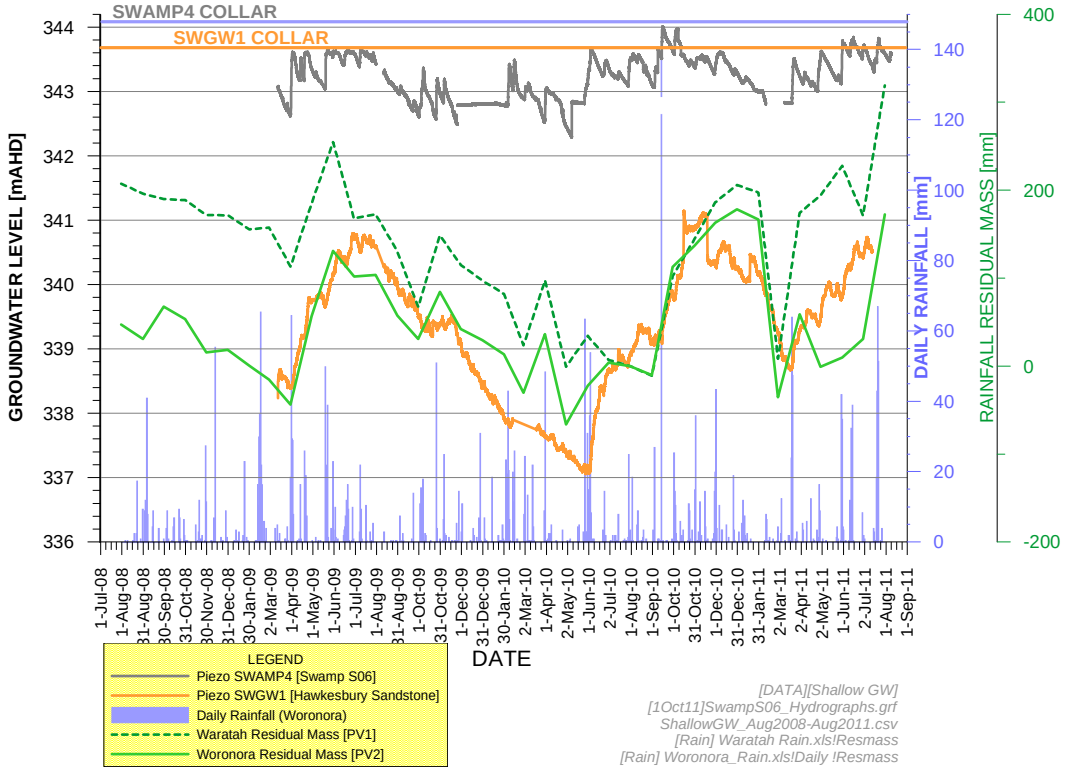


Chart 64 Separation of Water Tables at SWAMP 4

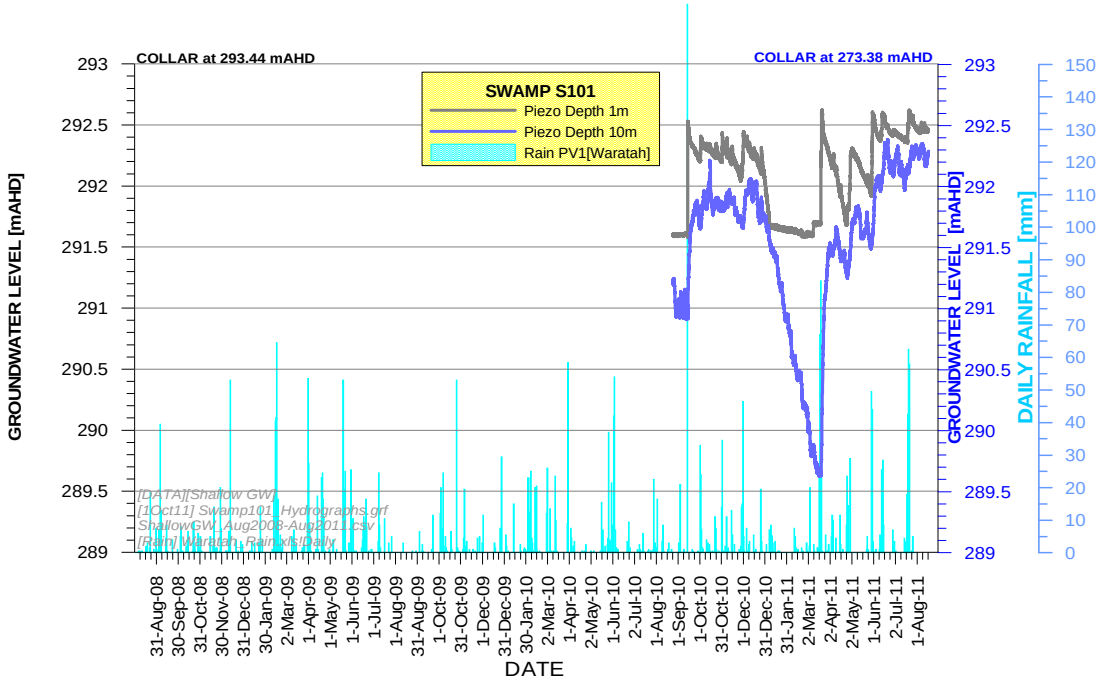


Chart 65 Groundwater Hydrographs at SWAMP 101

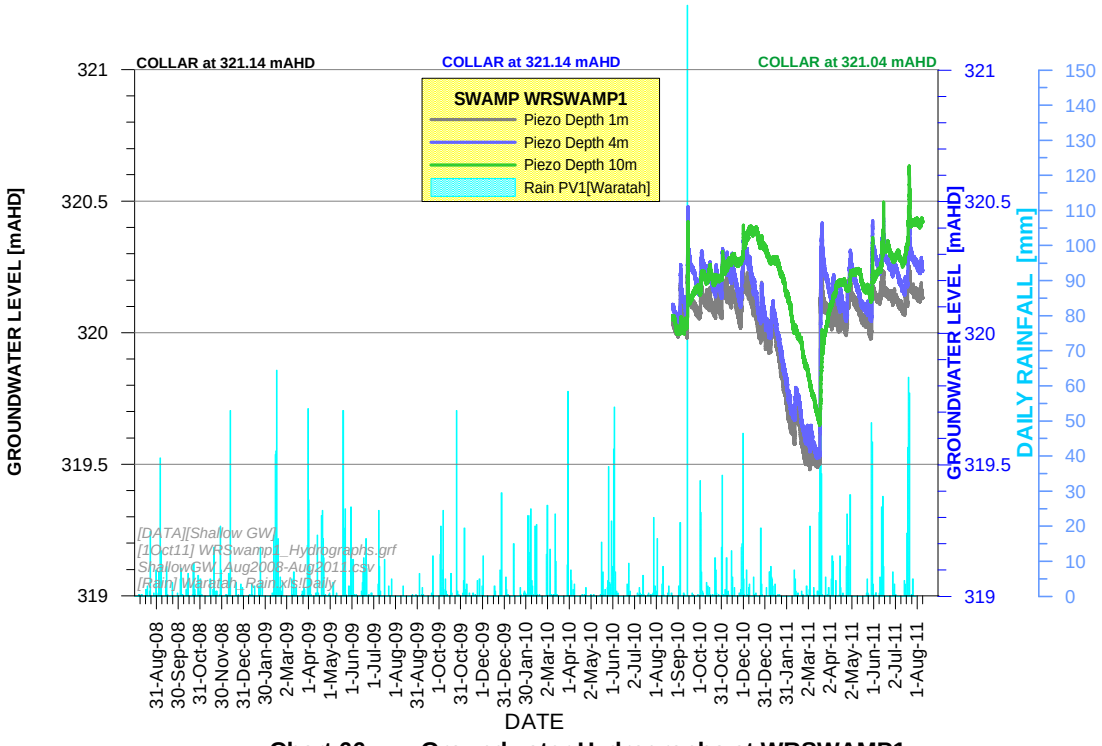


Chart 66 Groundwater Hydrographs at WRSWAMP1

Hydrographic responses for the recently monitored swamps overlying or adjacent to Longwalls 20-22 (Swamp 16/17, Swamp 20 and Swamp 25) are displayed in Charts 67 to 69. All sites show a pronounced drop in groundwater levels in February 2011, associated with a rainfall deficit. At Swamp 20, water appears to be infiltrating downwards to a series of perched water tables monitored by sandstone piezometers at 4 m depth and 10 m depth. Swamp 25 maintains a separation of about 1 m between swamp water levels and the water table level in sandstone at depth 10 m.

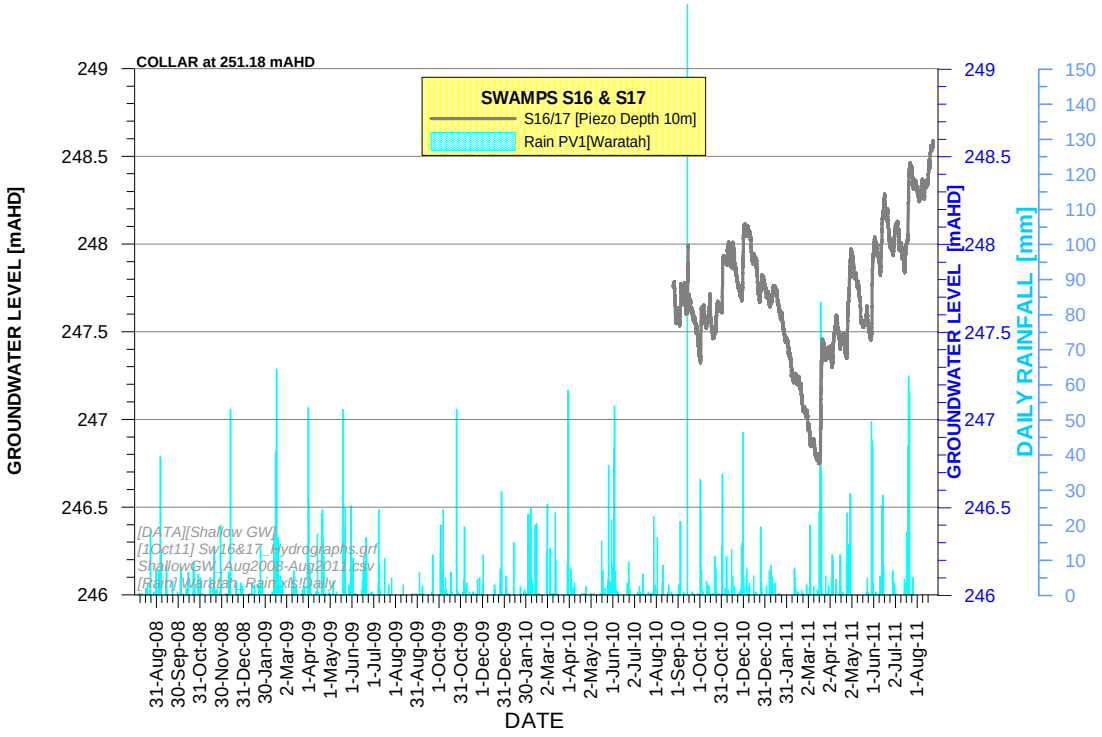


Chart 67 Groundwater Hydrographs at Swamp 16/17

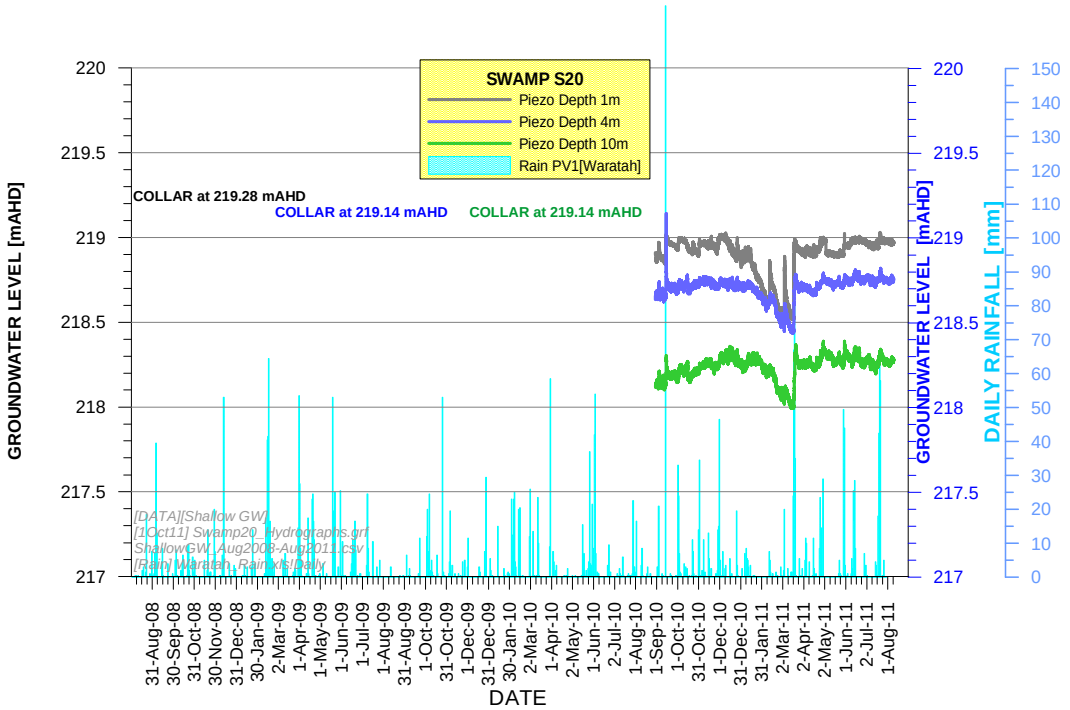


Chart 68 Groundwater Hydrographs Swamp 20

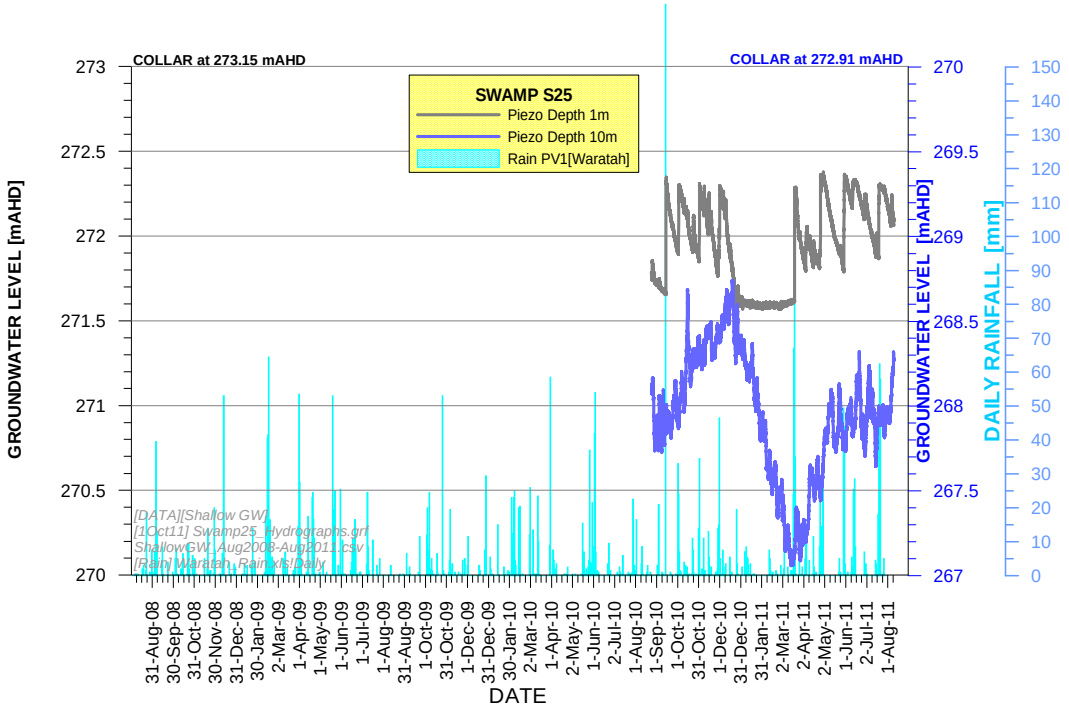


Chart 69 Groundwater Hydrographs at Swamp 25

Longwall 20 extraction passed Swamp 16/17 in August 2010, about the time monitoring commenced, and passed Swamp 20 in January 2011. Although water levels started dropping at Swamp 20 (Chart 68) at this time, the responses at the control swamps confirm that the water level declines are due to a rainfall deficit and are not due to mining.

Longwall 20 came closest to Swamp 25 in May 2011. As water levels fluctuated with rainfall around a stable mean, there is no evidence for any mining impact to groundwater levels within Swamp 25.

3.4.2.3 Riparian Vegetation Monitoring

The riparian vegetation monitoring program includes visual, quadrat, transect and indicator species monitoring of riparian vegetation on the Waratah Rivulet and Eastern Tributary, as described below.

Visual Inspections

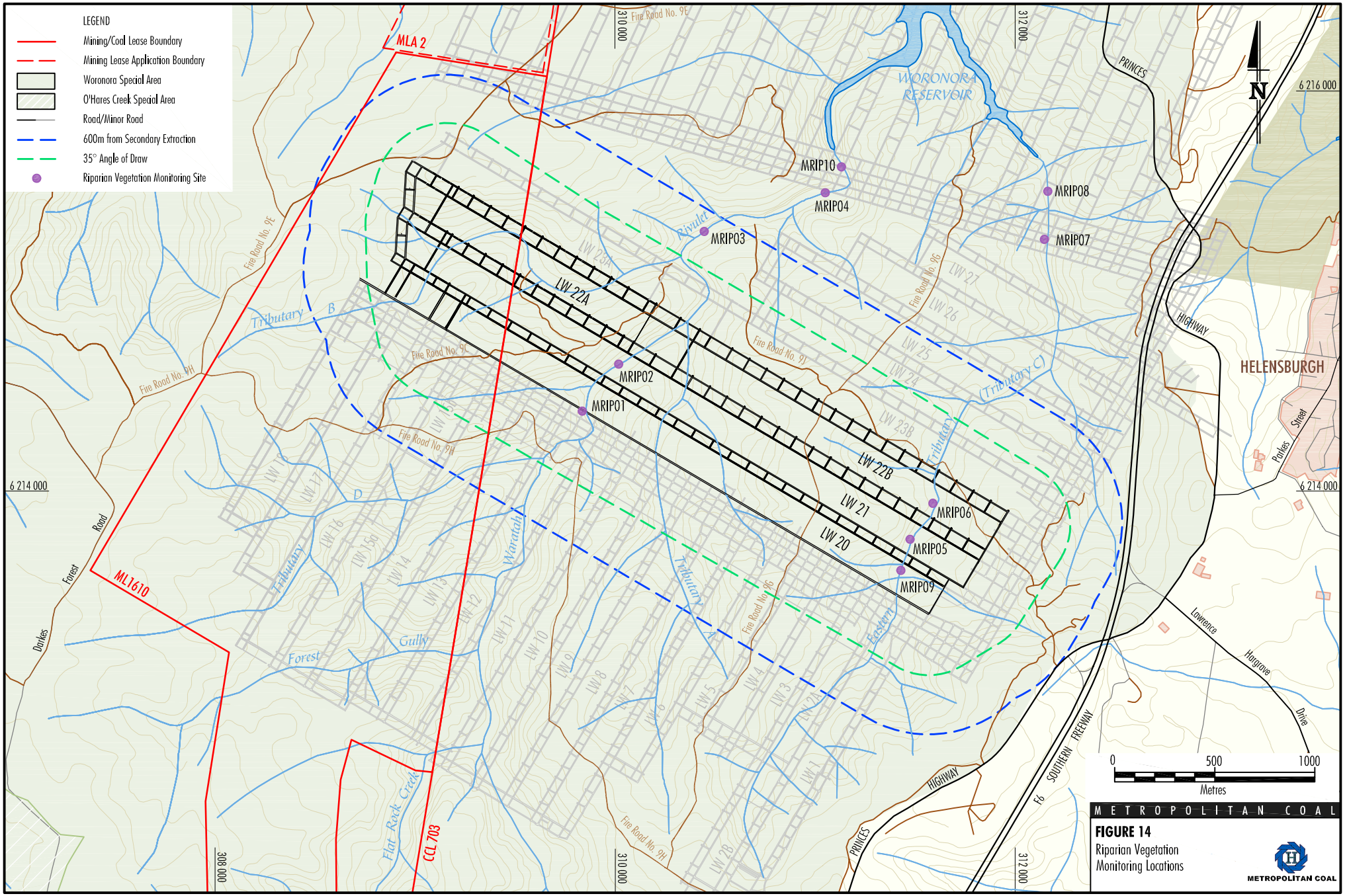
Visual inspections of riparian areas have been conducted in spring 2010 and autumn 2011 in locations adjacent to riparian vegetation monitoring sites (sites MRIP01 to MRIP10, Figure 14), and areas traversed whilst accessing the monitoring sites, to record:

- areas of new water ponding;
- any cracking or rock displacement; and
- changes in vegetation condition, including areas of senescing vegetation that appear unusual.

Photographs of any new water ponding, cracking/rock displacement and vegetation senescence are taken, concurrently with a description of the magnitude and extent of the observations, and appropriate GPS readings.

Visual inspections of riparian vegetation will be conducted bi-annually in autumn and spring at the time of the vegetation surveys.

The following provides a summary of the results of visual inspections for spring 2010 and autumn 2011.



METROPOLITAN COAL

FIGURE 14

Riparian Vegetation Monitoring Locations

METROPOLITAN COAL

MET-08-AD7 2011 Ann Rev_113A

Spring 2010

- No cracking of streamside rocky areas or rock displacement observed within either longwall or control sites.
- No cracking of non-sandy streamside sediments observed within either longwall or control sites.
- No new areas of water ponding observed within either longwall or control sites.
- Flood impacted and senescing vegetation was recorded at all sites, with MRIP06 particularly severely impacted. Most sites were found to have flood-swept vegetation, with plants being buried by sediment and other plant material, woody debris, and have varying degrees of mechanical damage to bark and branches. Woody debris and litter dams were common, and in some areas, soils surfaces were stripped of litter, small shrubs and groundcovers and in others sediments were deposited.
- Some creek bank areas also displayed signs of erosion and scouring of sediments (likely associated with flooding), for example, along the Eastern Tributary, downstream of the ford on Fire Road 9J and within sites MRIP04 and MRIP08. For the most part, much of the flood-swept vegetation was found to be living.
- Cracking of streamside rocky areas was observed during the autumn 2011 survey at the downstream end of MRIP01. A short length of cracking was observed on the western bank above the water level at the time of inspection. No dieback of vegetation was observed in areas adjacent to the cracked bedrock. No other cracking of streamside rocky areas or rock displacement was observed during the autumn 2011 survey.
- No cracking of non-sandy streamside sediments observed within either longwall or control sites.
- No new areas of water ponding observed within either longwall or control sites.
- Flood impacted and senescing vegetation was recorded at all sites, including evidence of further flooding since the spring 2009 survey. Most sites were found to have flood-swept vegetation, with plants being buried by sediment and other plant material, woody debris, and have varying degrees of mechanical damage to bark and branches. Woody debris and litter dams were common, and in some areas, soils surfaces were stripped of litter, small shrubs and groundcovers and in others sediments were deposited. In general vegetation appears to be recovering from flood impacts, although those areas where vegetation has been buried by woody debris, litter or sediments do not appear to be recovering.
- Some creek bank areas still display signs of erosion and scouring of sediments, for example, along the Eastern Tributary, downstream of the ford on Fire Road 9J and within sites MRIP04 and MRIP08.

Autumn 2011

Transect/Quadrat Monitoring

Quadrat and transect monitoring has been conducted in spring 2010 and autumn 2011.

A permanent quadrat (20 m x 2 m) has been used to monitor riparian vegetation on the Waratah Rivulet and Eastern Tributary at sites MRIP01, MRIP02, MRIP05 and MRIP06 (overlying Longwalls 20-22) and at sites MRIP03, MRIP04, MRIP07 and MRIP08 (downstream of Longwalls 20-22) (Figure 14).

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat.

A permanent transect (50 m x 2 m, i.e. a 30 m extension of each quadrat) has also been used to monitor riparian vegetation at sites MRIP01 to MRIP08. The data collected along each transect includes the occurrence of weed species (species and location) and a condition/health rating for each plant along the transect.

Permanent photo points have been established for each quadrat and along each transect.

The following provides a summary of the results of quadrat/transect monitoring for spring 2010 and autumn 2011.

Vegetation Structure, Dominant Species and Estimated Cover and Abundance for each Stratum

Spring 2010

Riparian vegetation at all sites was found to be flood impacted, and as a result the vegetation structure and cover abundance values for each stratum were variable compared to the previous surveys. For site MRIP06, no structure, dominant species and cover/abundance values were recorded due to the severe damage to vegetation caused by flooding resulting in flood-swept, fallen and buried vegetation. At other sites, for example MRIP05, cover/abundance values for the ground layer were less than previously recorded most likely as a result of scouring and loss of ground layer vegetation.

Despite the damage to vegetation and the flood-swept appearance, many individuals at the time of survey were still alive, and/or recovering.

One weed species was recorded, Whiskey Grass (*Andropogon virgincus)* at site MRIP01, downstream from Flat Rock Crossing.

Autumn 2011

Riparian vegetation at all sites was also found to be flood impacted from the spring 2010 flood events and further flooding in autumn 2011. As a result the vegetation structure and cover abundance values are variable compared to previous surveys, although were generally similar for that recorded in spring 2010. For some sites flooding has increased cover of the understorey as flattened vegetation covers areas of previously bare ground (e.g. MRIP07), while flood impacts have decreased vegetation cover in other sites removing ground cover vegetation (e.g. MRIP05).

As observed in spring 2010, despite the damage to vegetation from flooding, many individuals at the time of survey were still alive, and/or recovering.

No weeds were recorded within any of the riparian sites during the survey period. It is considered that this is most likely due to scouring of stream side sediments from flooding events.

Species Richness

A summary of species richness within riparian vegetation sites is provided in Table 19 and Chart 70.

Table 19
Number of Species Recorded in Riparian Sites (Spring 2008, Autumn 2009, Spring 2009, Autumn 2010, Spring 2010 and Autumn 2011)

Site	Spring 2008	Autumn 2009	Spring 2009	Autumn 2010	Spring 2010	Autumn 2011
Longwall Sites						
MRIP01	53	58	53	45	59	40
MRIP02	64	56	60	48	49	48
MRIP05	64	66	69	53	46	47
MRIP06	63	75	65	61	49	57
Control Sites						
MRIP03	55	47	54	42	37	37
MRIP04	43	43	50	47	41	38
MRIP07	56	58	64	44	36	40
MRIP08	42	42*	49	33	20	33

** Incorrectly reported in Eco Logical Australia (2010), analysis performed on correct data.*

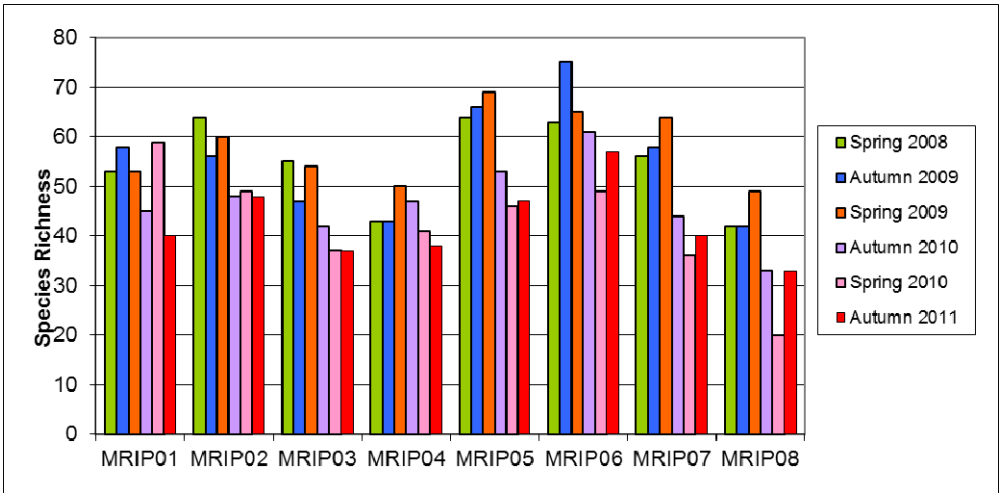


Chart 70 Species Richness in Riparian Monitoring Sites (Spring 2008, Autumn 2009, Spring 2009, Autumn 2010, Spring 2010 and Autumn 2011)

As previously reported (Eco Logical Australia, 2010), site MRIP06 is the most floristically diverse whilst MRIP08 is the least diverse, where the ground layer comprises a combination of boulders and sparse vegetation cover dominated by *Lomandra fluviatilis.*

Riparian vegetation at all sites was found to be flood impacted in spring 2010 and autumn 2011 as a result of floods preceding the spring 2010 survey and further flooding between the spring 2010 and autumn 2011 surveys. With the exception of sites MRIP01 and MRIP02, all sites recorded a reduction in species richness in spring 2010 which is considered to be attributed to the impacts of severe flooding causing burial and/or loss of vegetative cover. For spring 2010, sites MRIP01 and MRIP02 were the least impacted by flood.

In autumn 2011 species richness at riparian sites was similar to that recorded in spring 2010 following the large flooding event. Exceptions to this included site MRIP01, where species richness was largely reduced from spring 2010 and sites MRIP06, MRIP07 and MRIP08, where species richness increased from spring 2010. The increase in species richness at MRIP06, MRIP07 and MRIP08 from spring 2010 to autumn 2011 is likely the result of regeneration following the floods preceding the spring 2010 survey. MRIP06, MRIP07 and MRIP08 were heavily impacted by floods in spring 2010.

The longwall sites are generally more floristically diverse compared to the control sites with a mean average of 57.8 species for longwall sites compared to a mean of 44.7 for control sites. The differences in floristic diversity can be attributed to the nature of the habitats at these sites. All four longwall sites are generally shrubbier, and have little exposed bedrock present. Control sites MRIP03 and MRIP07 are also relatively shrubby, however sites MRIP04 and MRIP08 are characterised by extensive rock and boulders, sediments, and less vegetative cover in comparison.

Cover Abundance and Condition

Spring 2010

Fluctuations in species cover and vegetation condition were recorded across all sites. Some ground cover species recorded cover values less than previous seasons, for example *Sticherus flabellatus* at MRIP02, and the restionaceous species *Eurychorda complanata, Chordifex fastigiatus* (formerly *Saropsis fastigiaus*), and *Lepyrodia scariosa* at sites MRIP01, MRIP02, MRIP05 and MRIP06, most likely due to the impacts of flooding causing loss of cover.

Vegetation was generally found to be in Condition 5 and 4 despite the impacts of flooding. Although flood-swept, the vegetation at the time of survey in most sites was found to be still living, and reflects the robust nature of sandstone vegetation to disturbance.

Autumn 2011

As with spring 2010, fluctuations in species cover and vegetation condition were recorded across all sites. Some ground cover species recorded increased cover values from spring 2010 as these species recolonised and regenerated in bare areas created by previous floods, for example *Gleichenia microphylla* and *Sticherus flabellatus*.

As in the previous season vegetation was generally found to be in Condition 5 and less frequently Condition 4 despite the impacts of flooding. Although flood-swept, the vegetation at the time of survey in most sites was found to be still living, again reflecting the robust nature of sandstone vegetation to disturbance.

Indicator Species Monitoring

Population monitoring of indicator species has been conducted in spring 2010 and autumn 2011.

Twenty tagged individuals of *Prostanthera linearis*, *Schoenus melanostachys* and *Lomatia myricoides* have been monitored at sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 (overlying Longwalls 20-22) and at sites MRIP03, MRIP04, MRIP07, MRIP08[3] and MRIP10 (downstream of Longwalls 20-22) (Figure 14).

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

Monitoring of indicator species is conducted bi-annually in autumn and spring.

A summary of the results is presented below.

Spring 2010 and Autumn 2011

Many of the tagged plants within the riparian sites have been severely flood impacted, with some individuals unable to be relocated in spring 2010 and again in autumn 2011 due to burial under vegetation, sediments and woody debris. Those plants unable to be relocated have been replaced with new individuals.

Condition Scale

The condition of tagged plants of the three indicator species have progressively declined over the four seasons of surveys, with an increase in the number of plants with some level of dieback (Conditions 1 to 4) and a subsequent decrease in the number of tagged plants in a healthy condition (Condition 5). This decrease in condition has occurred at both longwall and control sites and has occurred in all seasons including autumn 2010, prior to the commencement of mining of Longwalls 20-22.

The declines are considered to represent natural declines in response to climatic conditions, ageing plants and natural disturbances including floods. The observed declines are not thought to be related to mining of Longwalls 20-22.

As previously noted, of the three indicator species, *Lomatia myricoides* has been the least impacted by flooding largely in part to its robust habit and deep root zone. This is highlighted by the fact that in all surveys season the vast majority of plants have been observed in Condition 5 including 84% of tagged plants of this species in autumn 2011. Two dead *Lomatia myricoides* plants were observed in autumn 2011.

Prostanthera linearis and Schoenus melanostachys were most impacted by flooding. Many individuals of *Prostanthera linearis* were found flood-swept and uprooted, whilst many *Schoenus melanostachys* were buried under sediment and woody debris.

Prior to the spring 2010 surveys and flooding events, the majority of tagged *Prostanthera linearis* plants were observed in Condition 5 (78% in autumn 2010). Following the floods the number of plants with some level of dieback increased with only 54% of plants observed in Condition 5 (healthy) in spring 2010. The number of plants in condition 5 decreased slightly from spring 2010 to autumn 2011 with 47% of plants in condition 5. In autumn 2011 10 tagged *Prostanthera linearis* were recorded as Condition 1 (5%), eight of which were dead.

[3] Note: Only 10 individuals of *Prostanthera linearis* were available for tagging at site MRIP08.

The general condition of tagged *Schoenus melanostachys* plants declined noticeably in autumn 2010 prior to large flooding events, with 50% of plants in Condition 5 in autumn 2010. The number of plants observed in condition 5 declined slightly in spring 2010 to 46% and declined further to 29% in autumn 2011.

A total of 10 monitored riparian indicator species have died since spring 2009, including eight plants detected during the autumn 2011 surveys:

- Tag G16 *Lomatia myricoides* at longwall site MRIP01 (not located during spring 2010 surveys);
- Tag H7 *Prostanthera linearis* at longwall site MRIP01 (Condition 2 in spring 2010);
- Tag H104 *Prostanthera linearis* at control site MRIP03 (recorded as dead in spring 2010);
- Tag H112 *Prostanthera linearis* at control site MRIP03 (Condition 4 in spring 2010);
- Tag H113 *Prostanthera linearis* at control site MRIP03 (Condition 5 in spring 2010);
- Tag H139 *Prostanthera linearis* at control site MRIP04 (Condition 5 in spring 2010);
- Tag G180 *Lomatia myricoides* at control site MRIP07 (Condition 5 in spring 2010);
- Tag H42 *Prostanthera linearis* at longwall site MRIP09 (Recorded as dead in spring 2010);
- Tag H150 *Prostanthera linearis* at control site MRIP10 (Condition 4 in Spring 2010); and
- Tag H152 *Prostanthera linearis* at control site MRIP10 (Condition 3 in spring 2010).

One of the plants recorded as dead in spring 2010 Tag H140 *Prostanthera linearis* at control site MRIP04 was found to be alive in autumn 2011, having re-sprouted.

Analysis of Monitoring Results

Transect/Quadrat Monitoring

Analysis of Species Richness - Spring 2010 and Autumn 2011

For the riparian vegetation species richness data were analysed for each season using ANOVA. Significant differences between the longwalls and control sites were recorded in spring 2008 (p=0.04), autumn 2009 (p=0.03) spring 2010 (p=0.02) and autumn 2011 (p=0.027) with marginal differences recorded in autumn 2010 (p=0.07). No significant differences were recorded in spring 2009 (p=0.17). Results are presented in Chart 71**.**

The longwall sites are generally floristically richer as recorded over all survey seasons and is most likely attributable to the habitat and shrubbier nature of the longwall sites compared to the control sites. Similar to the spring 2008 and autumn 2009 baseline results, the spring 2010 and autumn 2011 longwall sites were significantly different to the control sites. The monitoring data indicates that changes in species richness at longwall sites are within the range of natural variability as measured at the control sites.

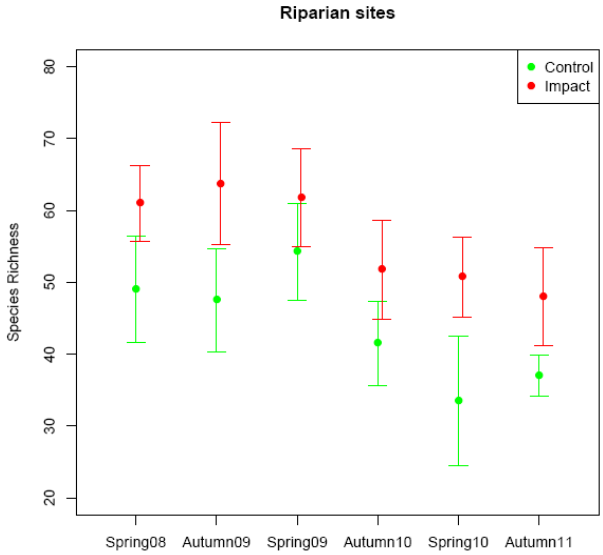


Chart 71 Analysis of Species Richness in Riparian Sites – Spring 2008 to Spring 2010

Analysis of Species Lists - Riparian Vegetation Cover Abundance and Condition

ANOSIM was used to examine the differences in vegetation cover abundance overtime between the longwall and control sites for each season, and the results are presented in Table 20.

Table 20
Analysis of Similarities (ANOSIM) for Vegetation Cover/Abundance in Riparian Sites (spring 2008, autumn 2009, spring 2009, autumn 2010, spring 2010 and autumn 2011)

Season	R statistic	p-value
Spring 2008	0.271	0.092
Autumn 2009	0.203	0.111
Spring 2009	0.417	0.059
Autumn 2010	0.297	0.027
Spring 2010	0.365	0.033
Autumn 2011	0.260	0.038

No significant differences were found between the longwall and control sites during spring 2008, autumn 2009, and spring 2009.

Significant differences were observed in autumn 2010 (baseline) and spring 2010 (post-mining) and autumn 2011 (post-mining). For autumn 2010 the differences are most likely attributable to track establishment through the longwall sites impacting vegetation cover (eg. MRIP01, MRIP05, MRIP06) as reported previously, and the variable impacts of flooding along all riparian sites during spring 2010 and autumn 2011.

ANOSIM was also used to examine the differences in vegetation condition overtime between the longwall and control sites for each season, and the results are presented in Table 21**.**

Table 21
Analysis of Similarities (ANOSIM) for Vegetation Condition in Riparian Sites (spring 2008, autumn 2009, spring 2009, autumn 2010 and spring 2010)

Season	R statistic	p-value
Spring 2008	0.200	0.121
Autumn 2009	0.073	0.286
Spring 2009	0.135	0.188
Autumn 2010	0.406	0.018
Spring 2010	0.583	0.026
Autumn 2011	0.469	0.029

Significant differences were also observed in autumn 2010 and spring 2010 and autumn 2011, consistent with the ANOSIM based on the cover abundance scores.

For autumn 2010 the differences are most likely attributable to track establishment through the longwall sites impacting vegetation condition (eg. MRIP01, MRIP05, MRIP06) as reported previously, and the variable impacts of flooding along all riparian sites during spring 2010 and autumn 2011.

Analysis of the occurrence of weed species

One weed species was recorded in MRIP06 in spring 2009, two species in autumn 2010 (MRIP01 and MRIP03), one species in MRIP01 in spring 2010 and none in autumn 2011. Where weed species were recorded, one to several individuals were found.

Due to the low incidence of weeds species recorded, no statistical analysis (e.g. ANOVA) was undertaken for this assessment. Notwithstanding, analysis of the occurrence of weed species in spring 2010 compared to the baseline data (spring 2008 to autumn 2010) indicates that the riparian vegetation performance indicator has not been exceeded.

Analysis of differences in health ratings

ANOSIM was used to compare the multivariate differences in health ratings (plant condition) along the riparian transects and the results are presented in Chart 72**.** Over the five survey periods, both longwall and control sites show a similar pattern in vegetation condition, with the number of species recording less than Condition 5 increasing in autumn 2010 when most sites were impacted by track establishment and spring 2010 and autumn 2011 where all sites were impacted by severe flooding.

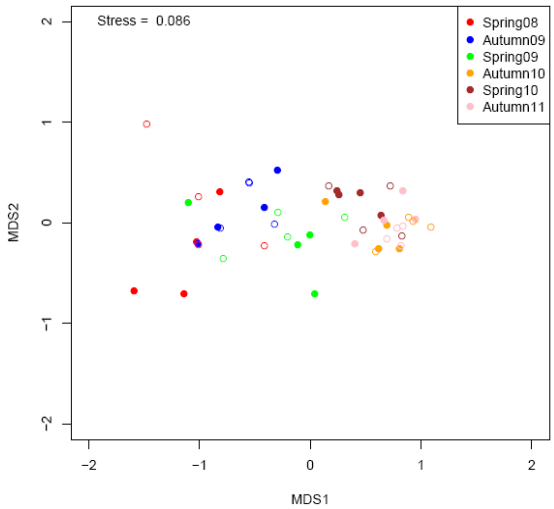


Chart 72 Analysis of Differences in Health Ratings of Plants along Transects – Spring 2008 – Autumn 2011

Indicator Species

Analysis of the proportion of plants surviving

For the spring 2010 survey, three individuals were found to have died, two within control sites and one within longwall site as follows:

- Tag H104 *Prostanthera linearis* in MRIP03.
- Tag H140 *Prostanthera linearis* in MRIP04.
- Tag H42 *Prostanthera linearis* in MRIP09.

A further 12 plants were unable to be found as a direct result of flood impacts to streamside vegetation following the spring 2010 flooding. In Autumn 2011 a further eight individuals were found to have died, seven within control sites and two within longwall sites as outlined above. Additionally, one species previously recorded as dead, Tag H140 *Prostanthera Linearis* at MRIP04, was recorded as alive having resprouted, thus bringing the total number of dead individuals to ten.

Due to the low occurrence of plant deaths no statistical analysis (e.g. ANOVA) was undertaken for this assessment.

Analysis of differences in health ratings and reproductive ratings

Charts 73 to 75 present the analysis for the selected indicator species in the riparian sites. Data for condition and reproductive status demonstrated little variation between control and impact (longwall sites) for *Lomatia myricoides* and *Prostanthera linearis* as indicated by overlapping confidence intervals. A seasonal response in reproductive status is visible for *Prostanthera linearis*. Data for *Schoenus melanostachys* shows vegetation condition and reproductive status to be more variable across all sites with greater confidence intervals and confidence intervals not overlapping between control and impact (longwall) sites.

Instances where the confidence intervals do not overlap may indicate significant differences (although further analysis would be required to confirm this). However, these potential differences are unlikely to indicate changes relating to mining as those seasons in which the confidence intervals do not overlap show vegetation condition was higher (healthier) at impact (longwall) sites than control sites for *Schoenus melanostachys*. Inversely, the reproductive status of plants within control sites was higher than at impact (longwall) sites in those seasons where confidence intervals did not overlap.

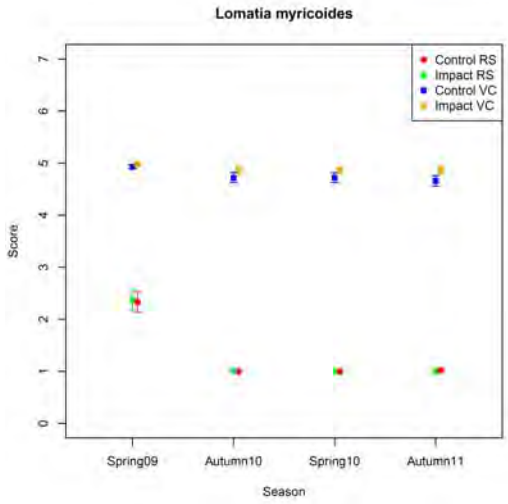


Chart 73 Indicator Species Monitoring – *Lomatia myricoides* (RS = reproductive status, VC = vegetation condition)

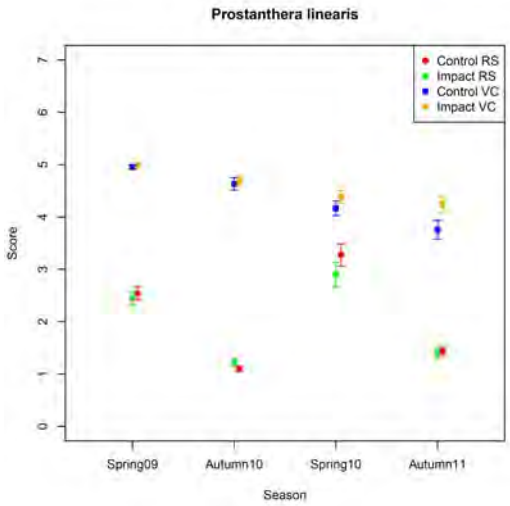


Chart 74 Indicator Species Monitoring – *Prostanthera linearis* (RS = reproductive status, VC = vegetation condition)

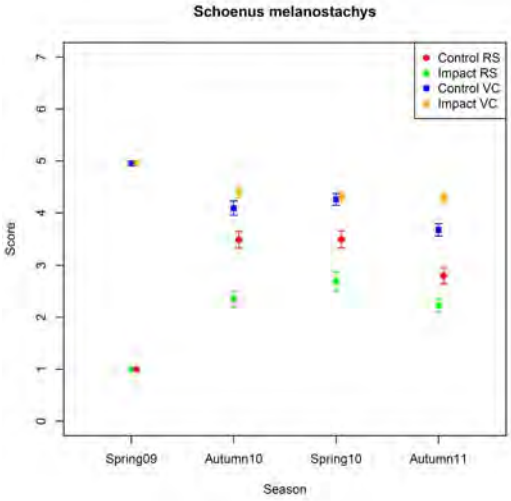


Chart 75 Indicator Species Monitoring – *Schoenus melanostachys* (RS = reproductive status, VC = vegetation condition)

Analysis of riparian vegetation data for spring 2010 indicates that 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'* has not been exceeded.

3.4.2.4 Aquatic Biota and their Habitats

Metropolitan Coal assess subsidence impacts and environmental consequences on aquatic habitats in accordance with the Water Management Plan (Section 3.3 of this Annual Review). Surface water monitoring includes monitoring of surface water flow, pool water levels, surface water quality, iron staining and gas release. Observations of surface cracking, iron staining and gas release are also made during the conduct of the aquatic ecology surveys.

The aquatic ecology monitoring program for Longwalls 20-22 has been designed to:

- monitor subsidence-induced impacts on aquatic ecology (referred to as stream monitoring); and
- monitor the response of aquatic ecosystems to the implementation of stream remediation works (referred to as pool monitoring).

The design of the monitoring programs uses a "Beyond BACI" experimental design and focuses on representative sampling within streams and pools in the Longwalls 20-22 mining area and in suitable control streams and pools not subject to mine subsidence.

Stream Monitoring

The stream monitoring program includes the monitoring of aquatic habitat characteristics, water quality, aquatic macroinvertebrates and aquatic macrophytes.

Baseline monitoring has been conducted in spring 2008, autumn 2009, spring 2009, autumn 2010, spring 2010 and autumn 2011.

Monitoring has been conducted at two sampling sites (approximately 100 m long) at the following stream sampling locations:

- Locations WT3 on Waratah Rivulet, C1 and C3 on Tributary C (also referred to as Eastern Tributary) and B1 on Tributary B, overlying Longwalls 20-22.
- Locations WT4 and WT5 on Waratah Rivulet and C2 on Tributary C, downstream of Longwalls 20-22.
- Control locations: WR1 on Woronora River; OC on O'Hares Creek; BC on Bee Creek; and WOT on Woronora Tributary.

The approximate locations of the sampling sites are shown on Figure 15.

The methods used to survey aquatic biota and their habitats at each site are:

- Stream characteristics are recorded in accordance with the Australian River Assessment System (AUSRIVAS) protocol (including, visual assessment of stream width and depth, composition of the substratum, riparian conditions, signs of disturbance, water quality and percentage cover of the substratum by algae).
- Water quality sampling is conducted for electrical conductivity, dissolved oxygen, pH, temperature, turbidity, oxygen reduction potential, alkalinity, total phosphorous and total nitrogen to provide information relevant to water quality at the time of sampling.
- Aquatic macroinvertebrate sampling is conducted using the AUSRIVAS protocol, as well as quantitative sampling where three replicate macroinvertebrate samples are collected within each site using timed sweeps.
- The distribution of submerged and emergent (occurring in-stream and in the riparian zone) aquatic macrophytes are estimated along each sampling location by assigning a cover class to each species. The cover classes are: (1) one plant or small patch (i.e. few), (2) not common, growing in a few places (i.e. scattered), and (3) widespread (i.e. common). In addition, an assessment of the in-stream (i.e. submerged and emergent) aquatic vegetation is made within each site by estimating the relative abundance (i.e. percentage cover) of aquatic macrophytes within five haphazardly placed 0.25 m^2 quadrats, using a stratified sampling technique.

Table 22 presents the AUSRIVAS Band results for each site.

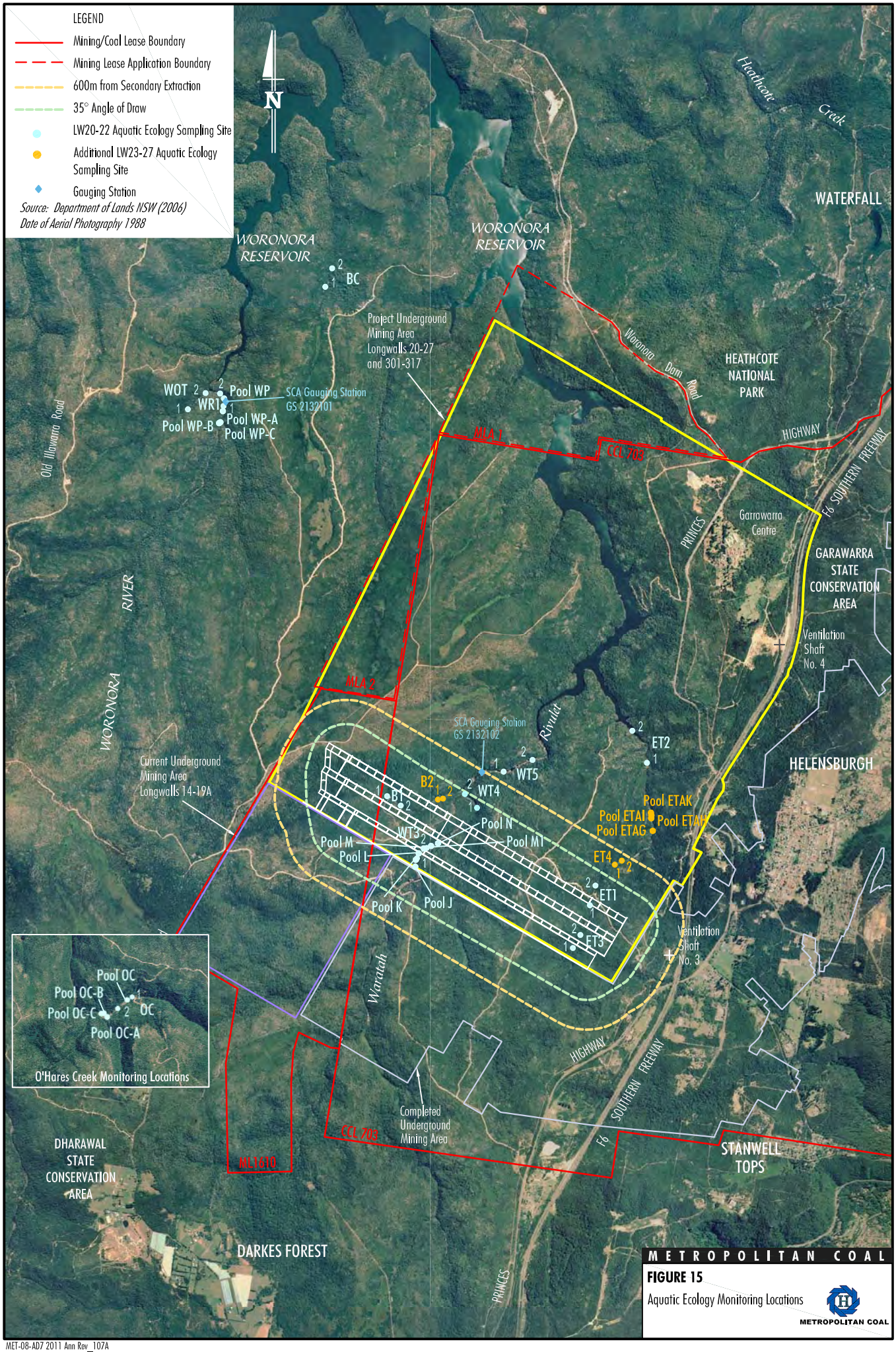


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Table 22
AUSRIVAS Band Results

Stream	Site	AUSRIVAS Band					
		sp-08	aut-09	sp-09	aut-10	sp-10	aut-11
Waratah Rivulet	WT3-1	B	B	B	B	C	C
	WT3-2	B	B	B	B	B	B
	WT4-1	D	C	C	C	C	B
	WT4-2	B	C	C	C	C	C
	WT5-1	B	C	C	C	C	C
	WT5-2	D	C	C	C	C	C
Tributary C *Note: Also referred to as Eastern Tributary (ET)*	ET1-1	D	C	B	B	B	C
	ET1-2	D	C	C	C	B	C
	ET2-1	D	B	B	C	B	C
	ET2-2	D	C	B	B	B	C
	ET3-1	#	#	B	C	C	B
	ET3-2	#	#	D	C	C	C
Tributary B	B1	B	C	C	C	C	C
	B2	C	B	C	B	C	C
Bee Creek	BC1	D	C	C	B	C	C
	BC2	C	B	D	B	C	B
Woronora Tributary	WOT1	C	B	-	B	C	C
	WOT2	C	C	D	C	C	C
Woronora River	WR1	D	B	C	B	C	C
	WR2	C	C	C	B	C	C
O'Hares Creek	OC1-1	B	B	B	A	B	B
	OC1-2	D	B	B	B	B	B

Survey of Sites ET3-1 and ET3-2 commenced in spring 2009 for Longwalls 23-27.

- Insufficient water habitat available to sample.

Charts 76 to 79 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at each sampling location, respectively, using the quantitative sampling data.

The baseline monitoring data provides a benchmark against which aquatic biota and their habitats can be measured during and after the mining of Longwalls 20-22.

Monitoring of the sampling sites will be conducted bi-annually, in autumn and spring.

Pool Monitoring

Baseline monitoring of pools on Waratah Rivulet has been conducted since spring 2008 or spring 2009[4] to assess the response of aquatic ecosystems to the implementation of future stream remediation works, namely:

- Larger pools, J, M1 and N on Waratah Rivulet overlying Longwalls 20-22.
- Smaller pools K, L and M on Waratah Rivulet overlying Longwalls 20-22.
- One larger control pool on Woronora River (Pool WP) and one larger control pool on O'Hares Creek (Pool OC).
- Three smaller control pools on Woronora River (Pool WP-A, WP-B and WP-C) and three smaller control pools on O'Hares Creek (Pool OC-A, OC-B and OC-C).

The approximate locations of the sampling sites are shown on Figure 15.

Sampling is conducted at two random sites within the larger pools and at one site within the smaller pools.

Within each site in each pool, aquatic macroinvertebrates and macrophytes are sampled using the same quantitative techniques described for stream monitoring above. The AUSRIVAS sampling technique is not used for macroinvertebrate sampling in the pool monitoring.

Quantitative estimates of aquatic macrophytes (i.e. emergent, floating attached and/or submerged species of aquatic plants) are collected at one site at each small pool and at two sites at each large pool. In addition, the spatial distribution of floating attached and/or submerged macrophytes (e.g. *Myriophyllum penduculatum* and *Triglochin procerum*) is also mapped in each pool, to provide a visual comparison of their distribution through time.

Charts 80 to 83 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at the larger pools, respectively, using the quantitative sampling data.

Charts 84 to 87 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at the smaller pools, respectively, using the quantitative sampling data.

The baseline monitoring data provides a benchmark against which aquatic biota and their habitats can be measured before and after stream remediation works.

Monitoring of the sampling sites will be conducted bi-annually, in autumn and spring.

[4] Pools monitored since spring 2008: larger pools - Pool N on Waratah Rivulet, Pool WP on Woronora River and Pool OC on O'Hares Creek.

Pools monitored since spring 2009: larger pools - Pools J and M1 on Waratah Rivulet; smaller pools: Pools K, L and M on Waratah Rivulet, Pools WP-A, WP-B, WP-C on Woronora River and Pools OC-A, OC-B, OC-C on O'Hares Creek.

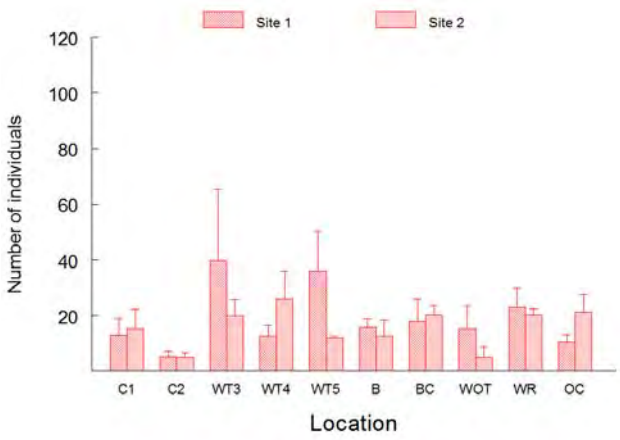

Chart 76a Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2008

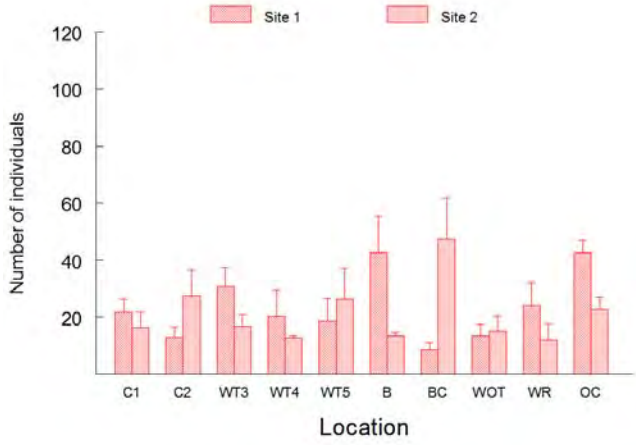

Chart 76b Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2009

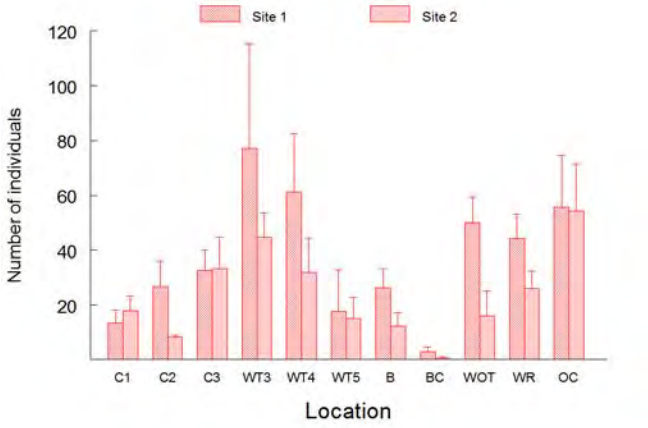

Chart 76c Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2009

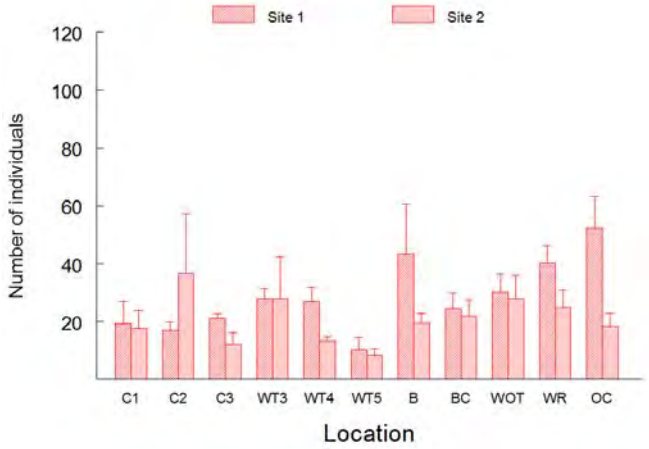

Chart 76d Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2010

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

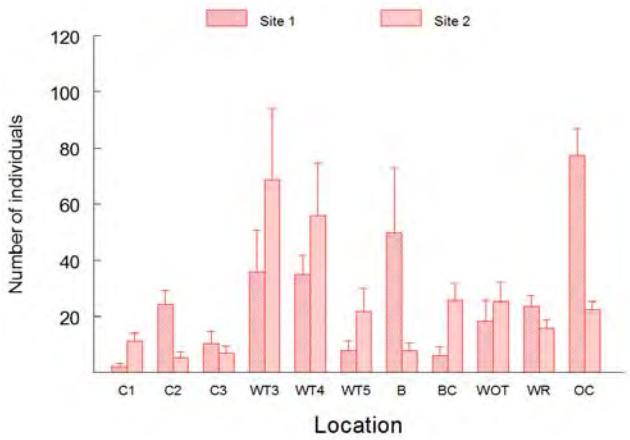

Chart 76e Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2010

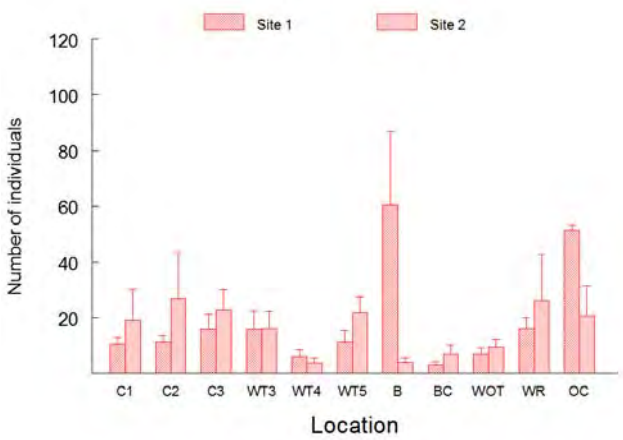

Chart 76f Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2011

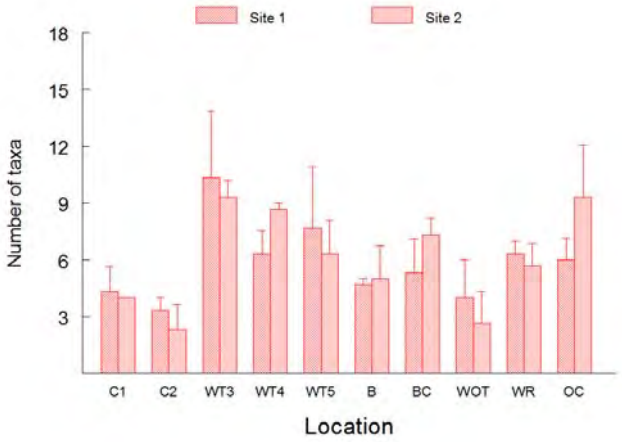

Chart 77a Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2008

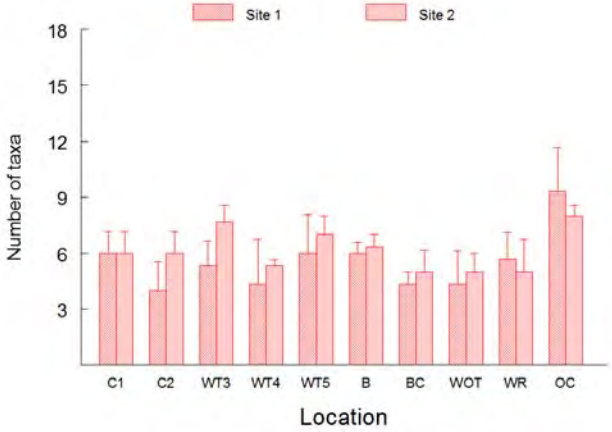

Chart 77b Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2009

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

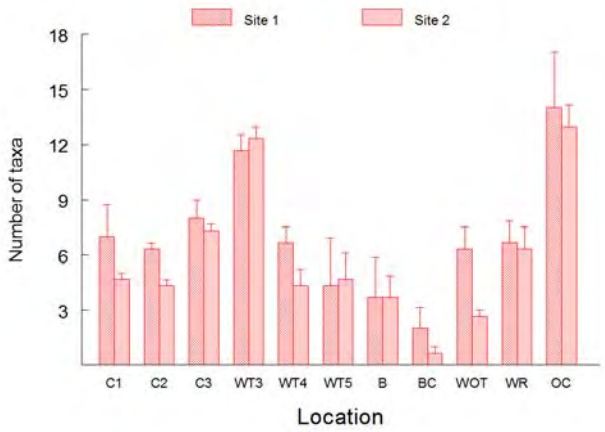

Chart 77c Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2009

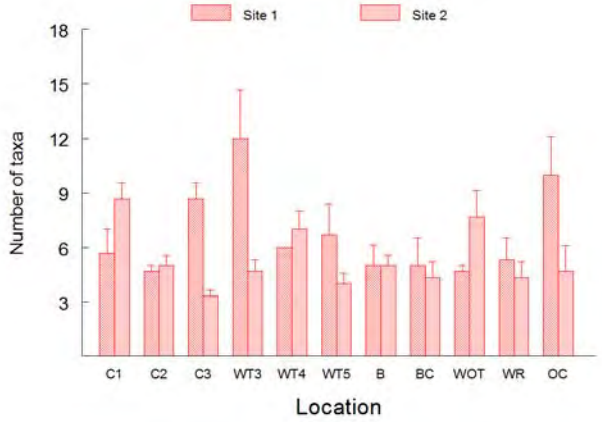

Chart 77d Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2010

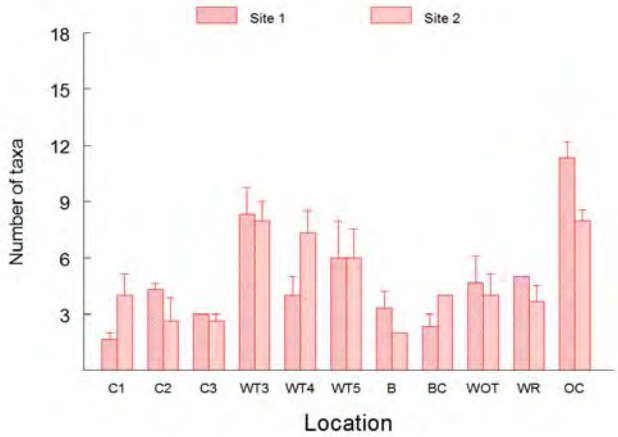

Chart 77e Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2010

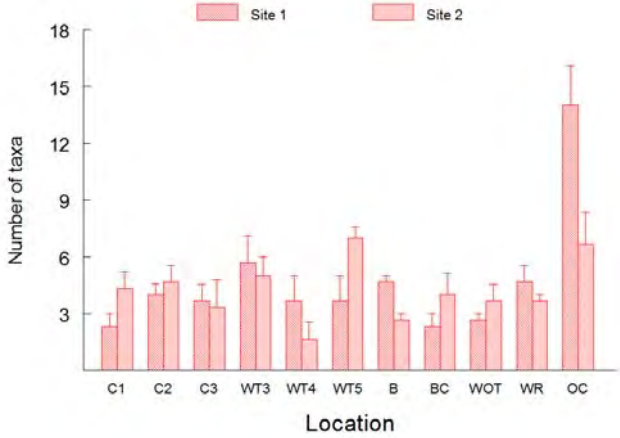

Chart 77f Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2011

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

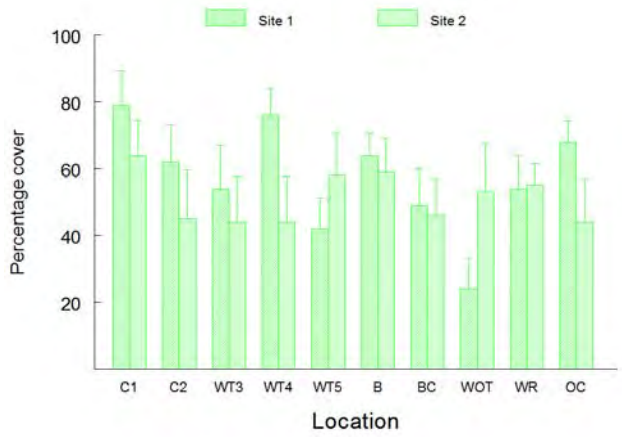

Chart 78a Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Spring 2008

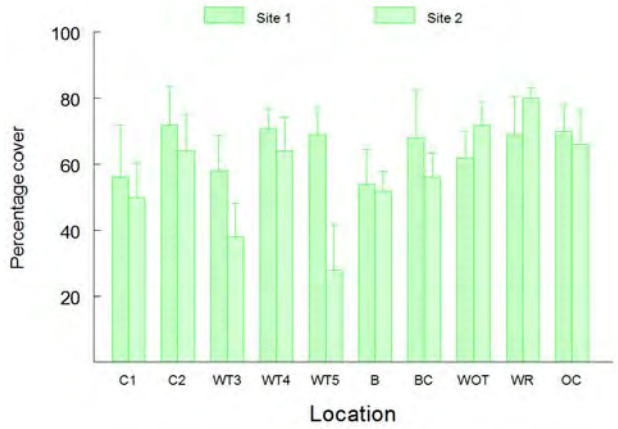

Chart 78b Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2009

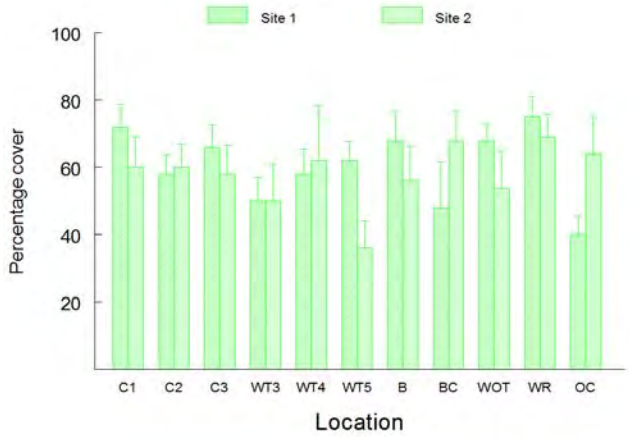

Chart 78c Mean (+SE) Macrophyte Percentage Cover, Steam Monitoring, Spring 2009

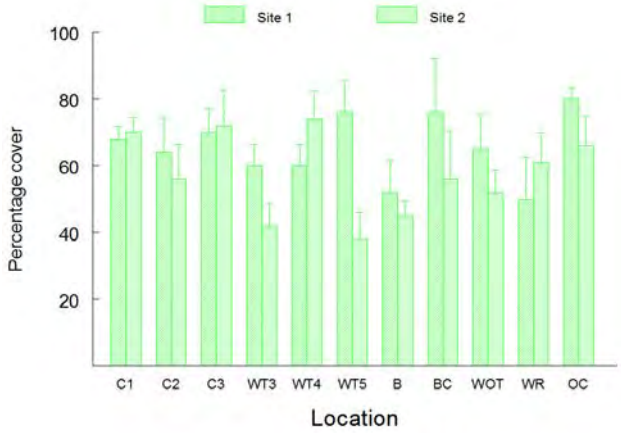

Chart 78d Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2010

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

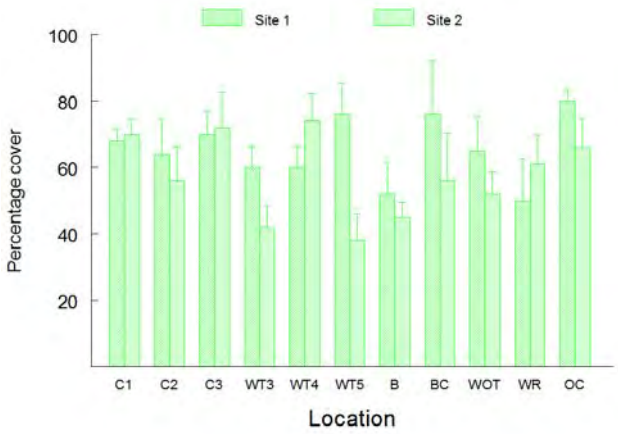

Chart 78e Mean (+SE) Macrophyte Percentage Cover, Steam Monitoring, Spring 2010

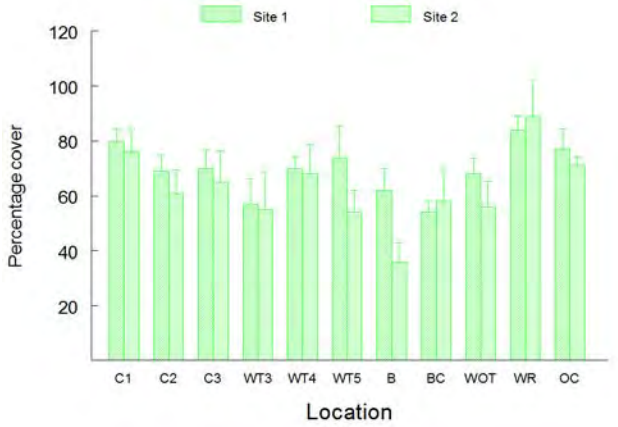

Chart 78f Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2011

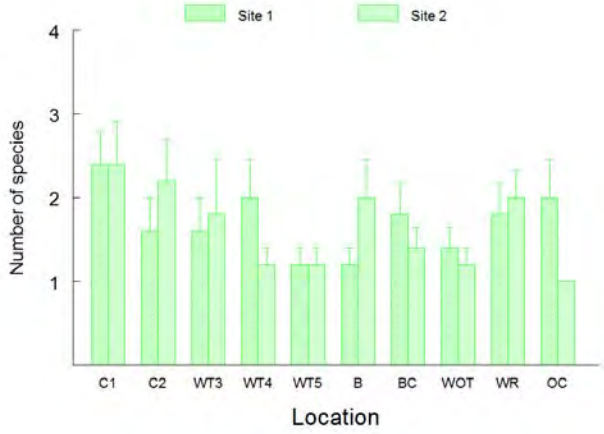

Chart 79a Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2008

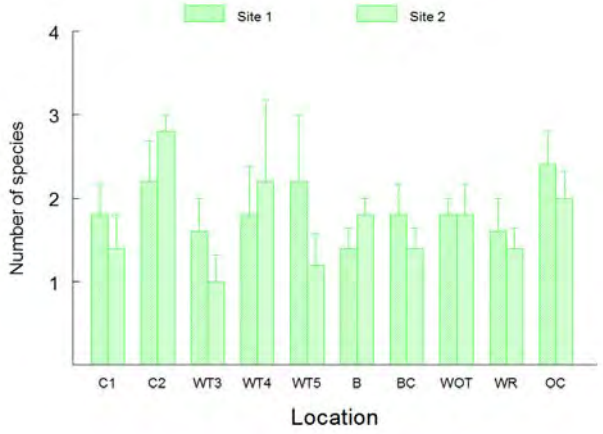

Chart 79b Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2009

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

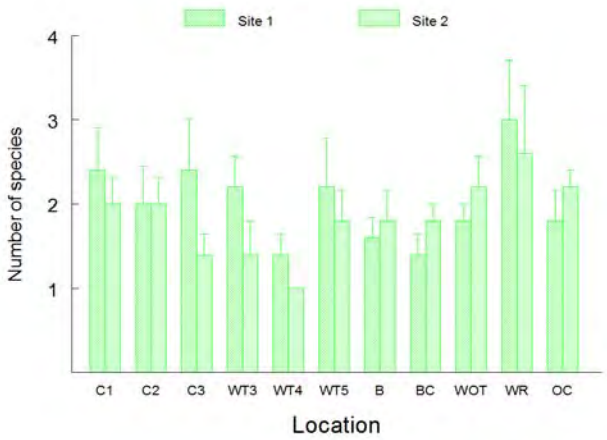

Chart 79c Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2009

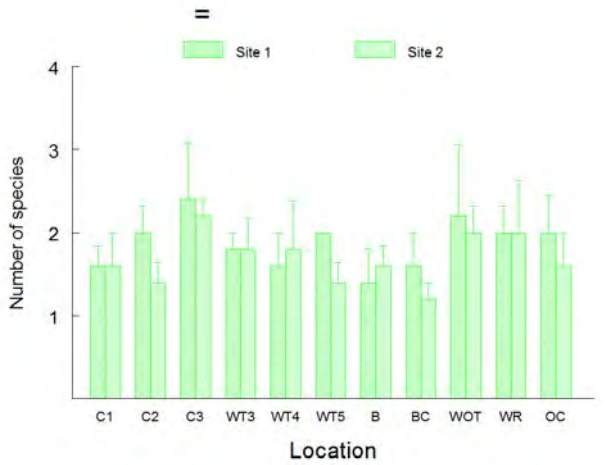

Chart 79d Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2010

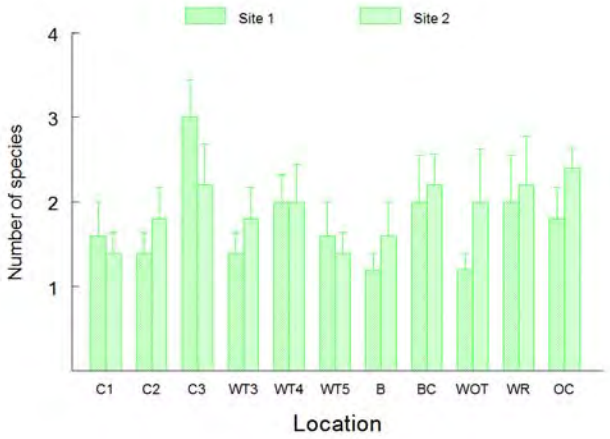

Chart 79e Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2010

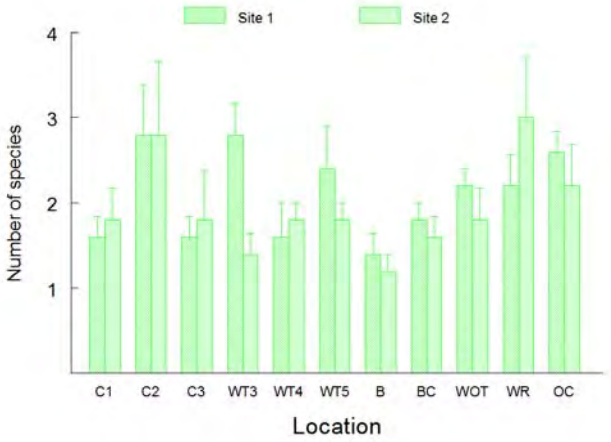

Chart 79f Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2011

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

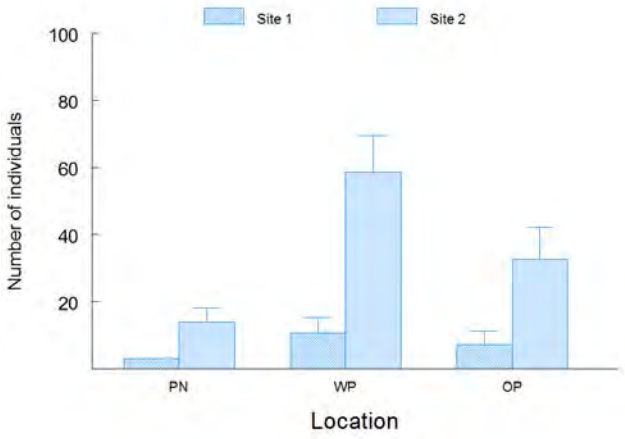

Chart 80a Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2008

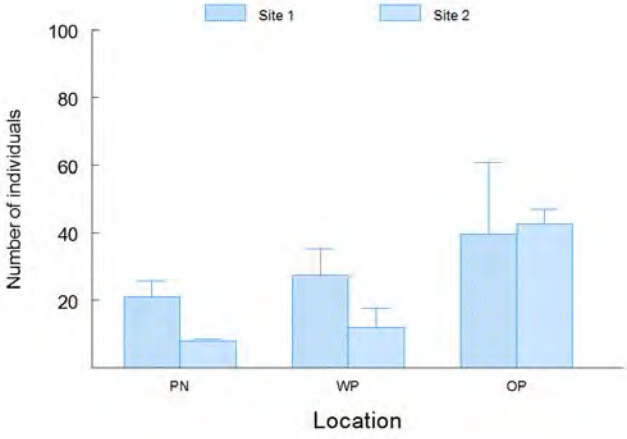

Chart 80b Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2009

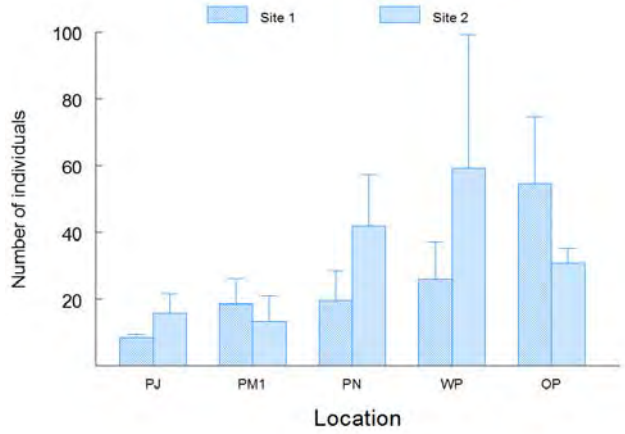

Chart 80c Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2009

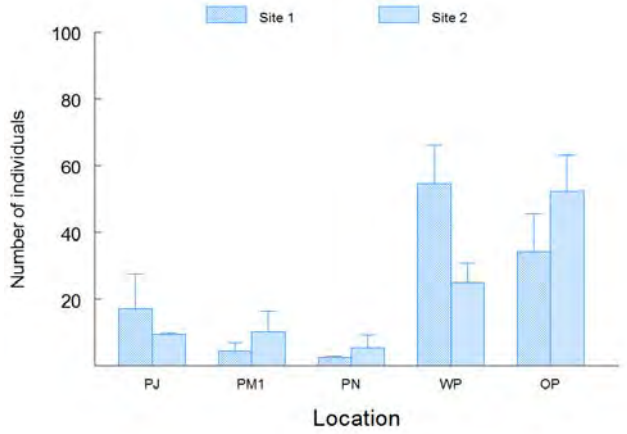

Chart 80d Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2010

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

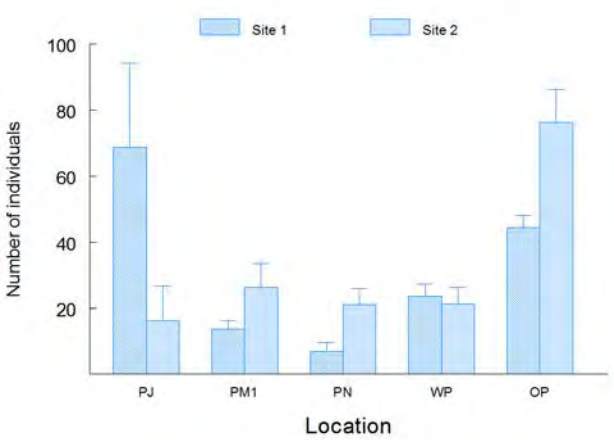

Chart 80e Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2010

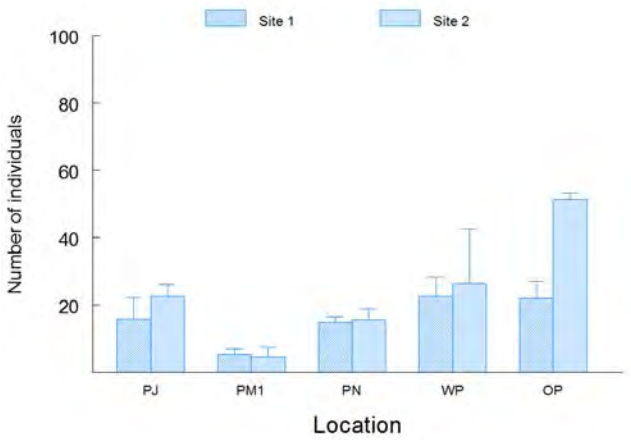

Chart 80f Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2011

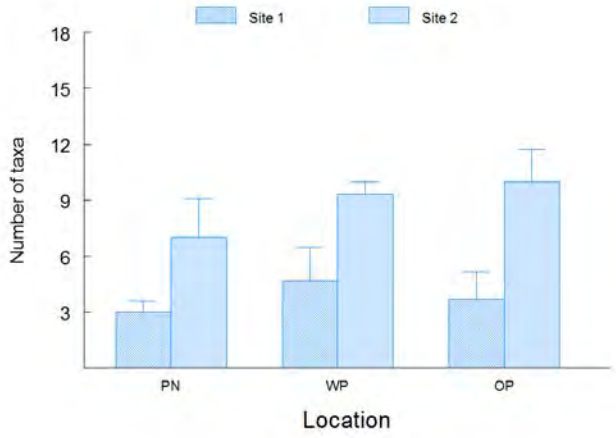

Chart 81a Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2008

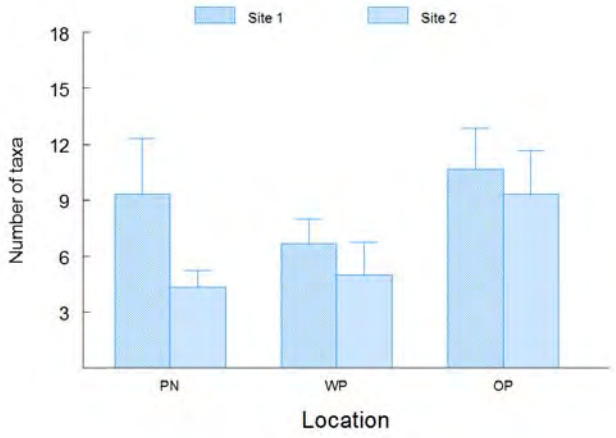

Chart 81b Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2009

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

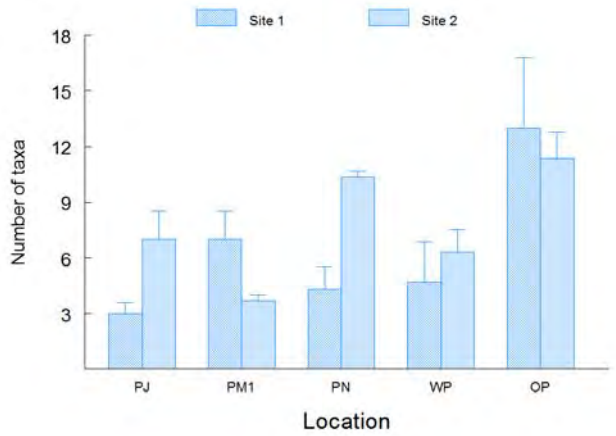

Chart 81c Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2009

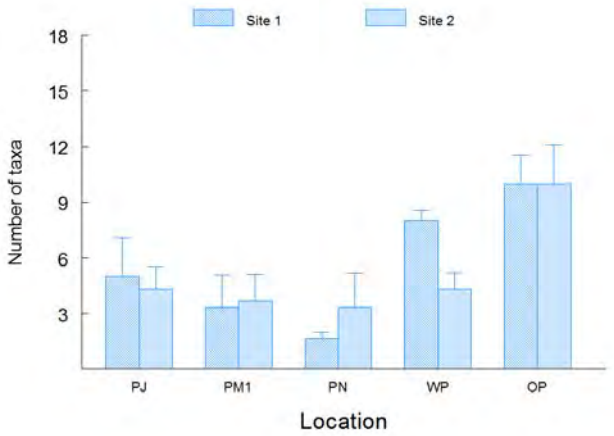

Chart 81d Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2010

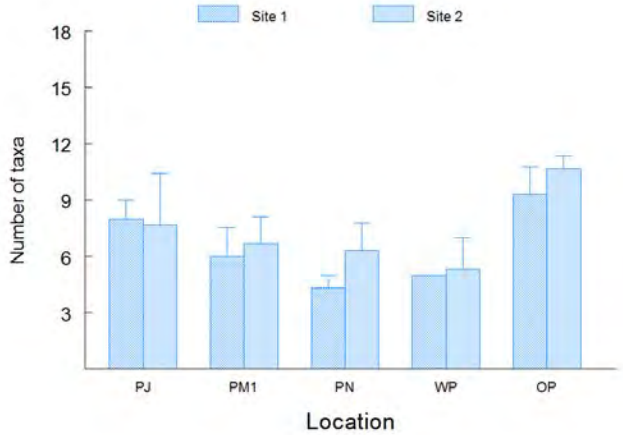

Chart 81e Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2010

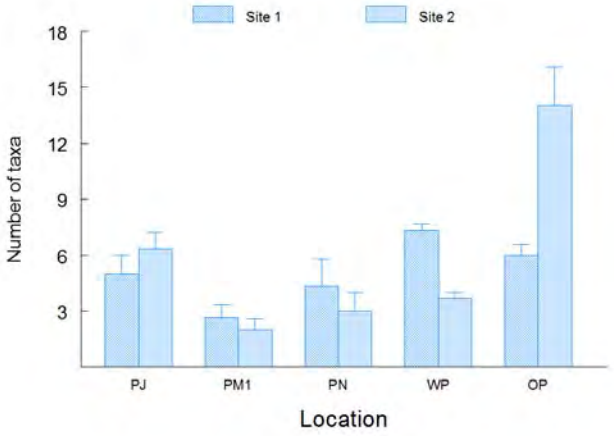

Chart 81f Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2011

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

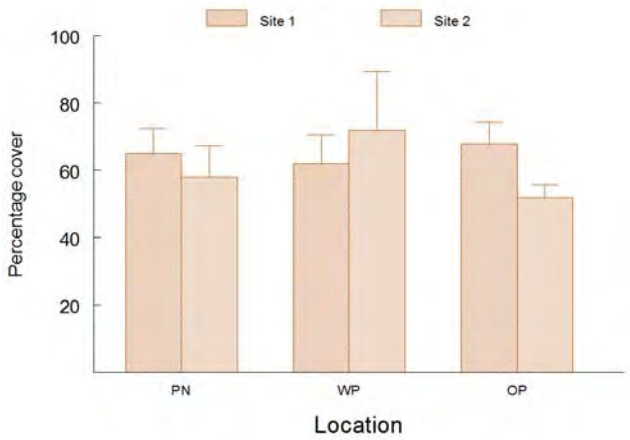

Chart 82a Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2008

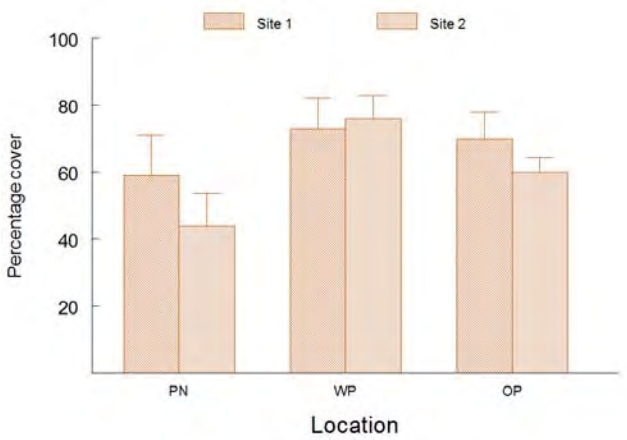

Chart 82b Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2009

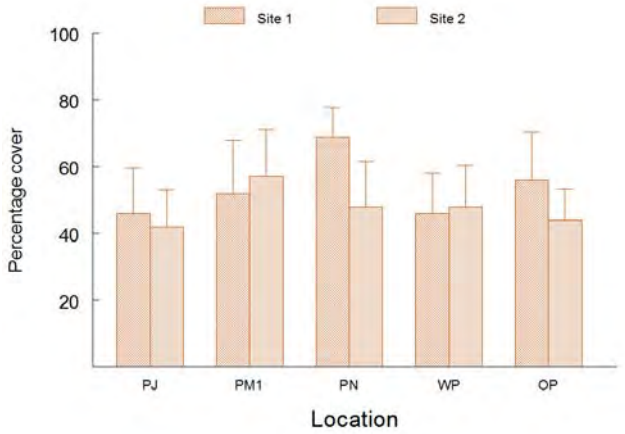

Chart 82c Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2009

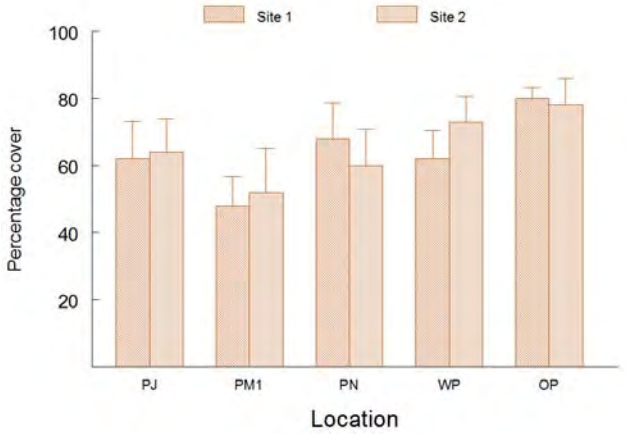

Chart 82d Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2010

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5)

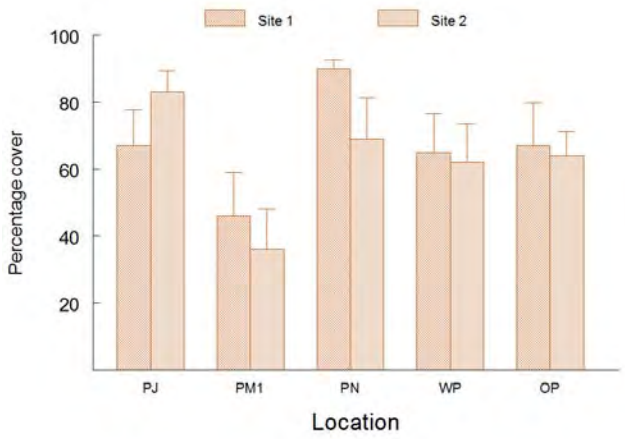

Chart 82e Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2010

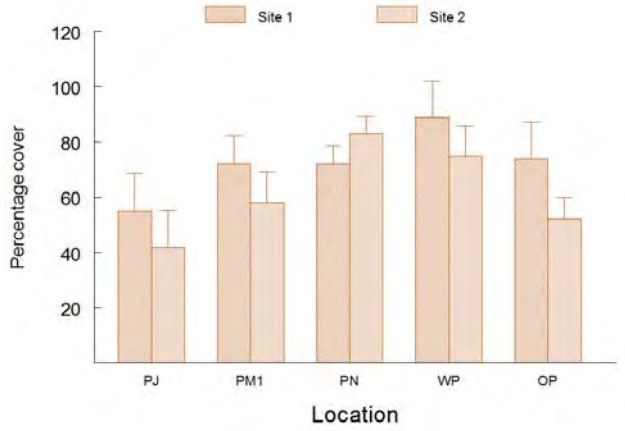

Chart 82f Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2011

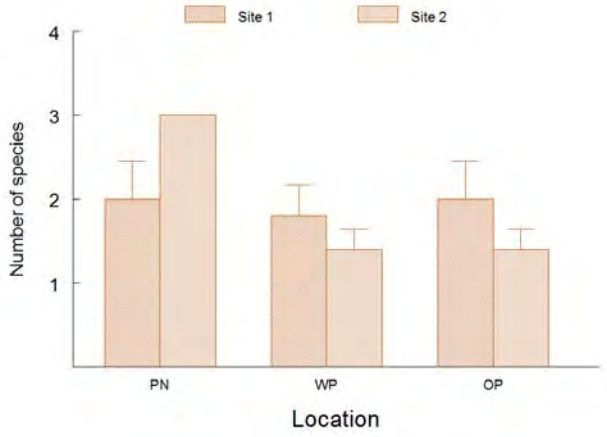

Chart 83a Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2008

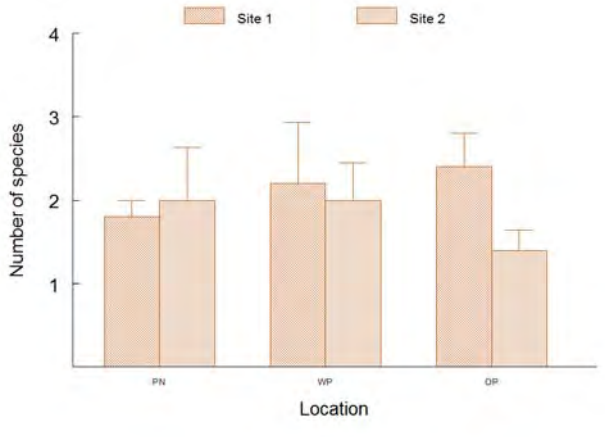

Chart 83b Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2009

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5)

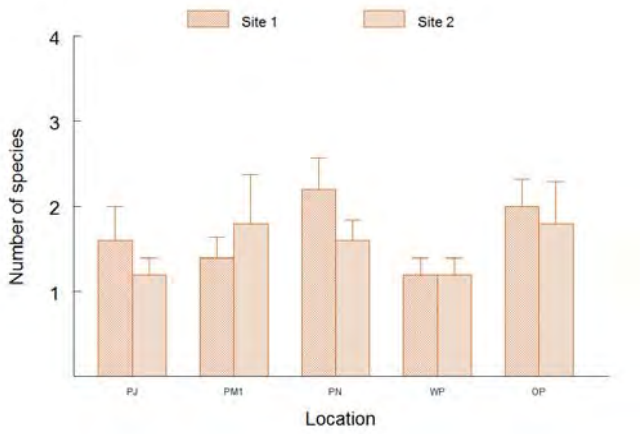

Chart 83c Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2009

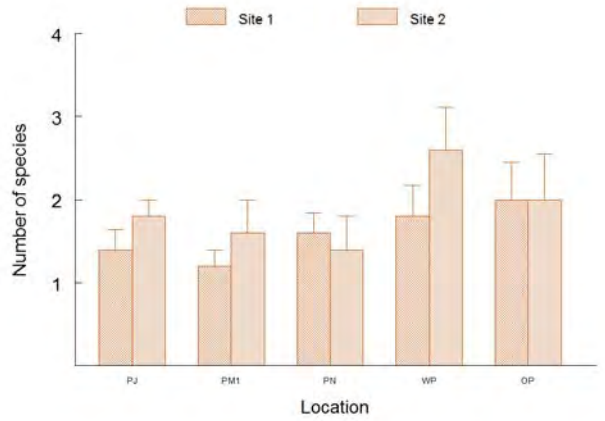

Chart 83d Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2010

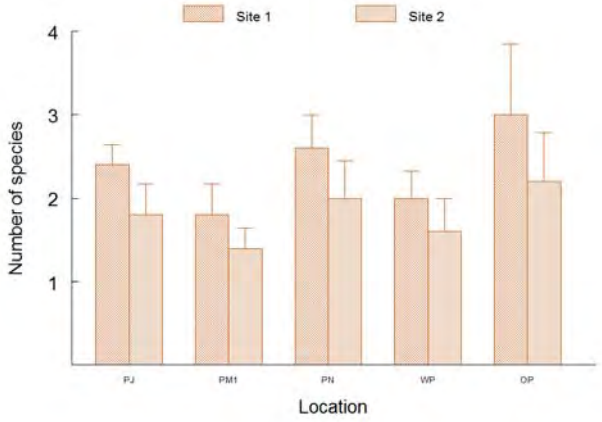

Chart 83e Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2010

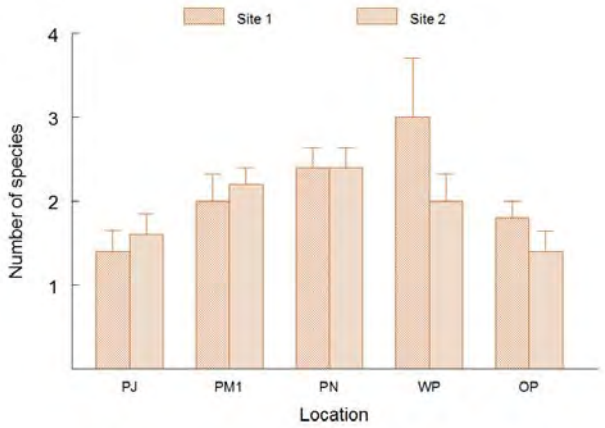

Chart 83f Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2011

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5).

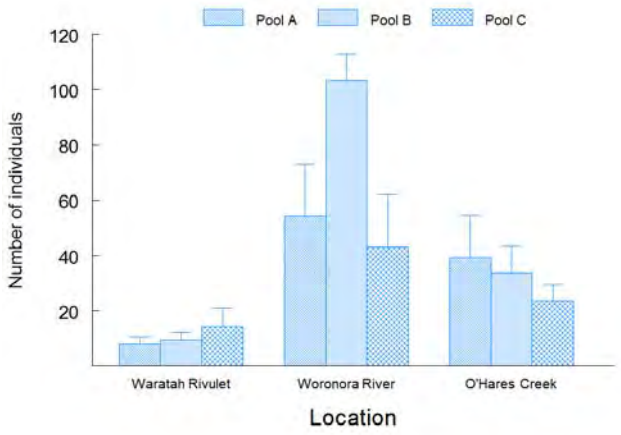

Chart 84a Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Spring 2009

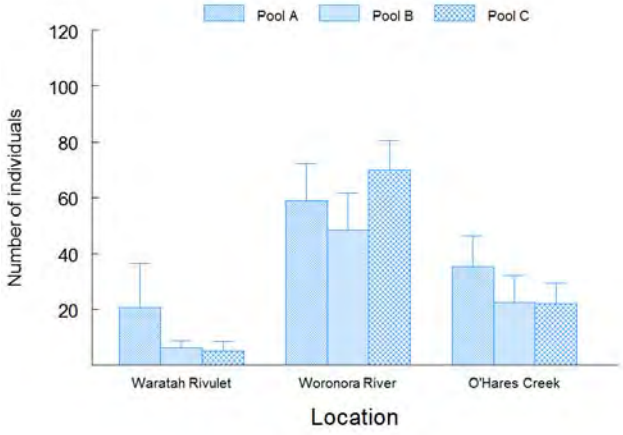

Chart 84b Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Autumn 2010

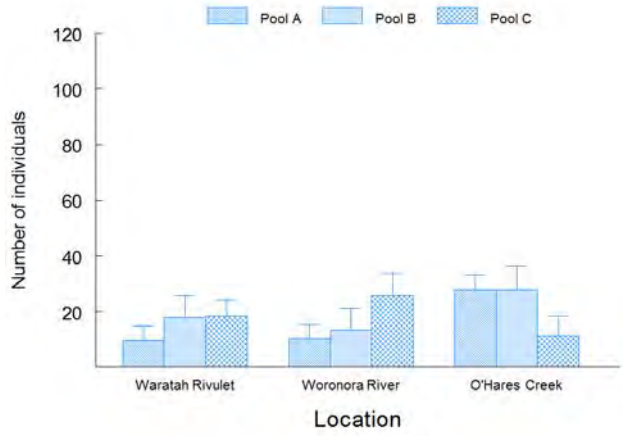

Chart 84c Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Spring 2010

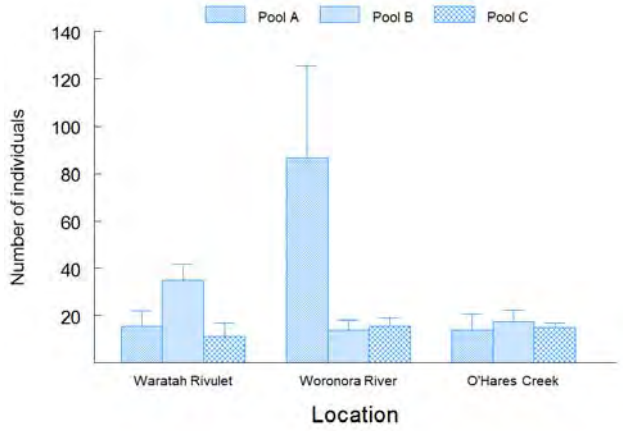

Chart 84d Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 3).

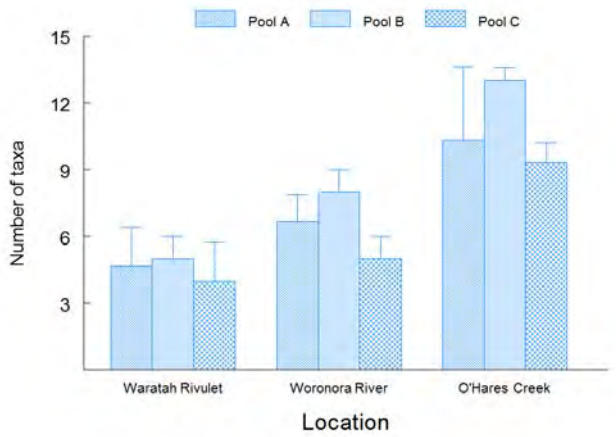

Chart 85a Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Spring 2009

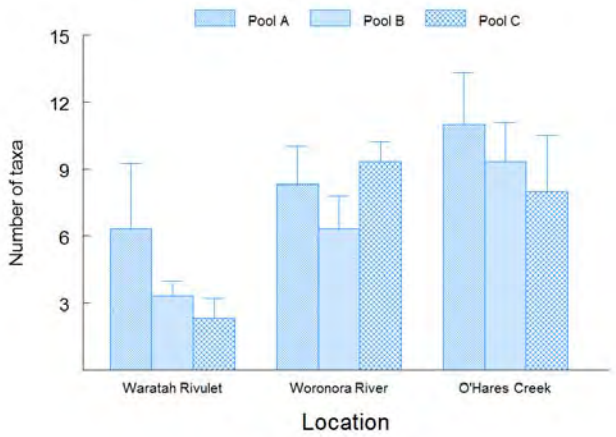

Chart 85b Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Autumn 2010

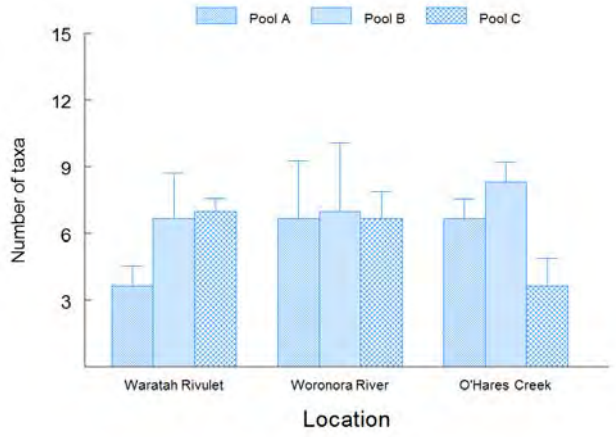

Chart 85c Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Spring 2010

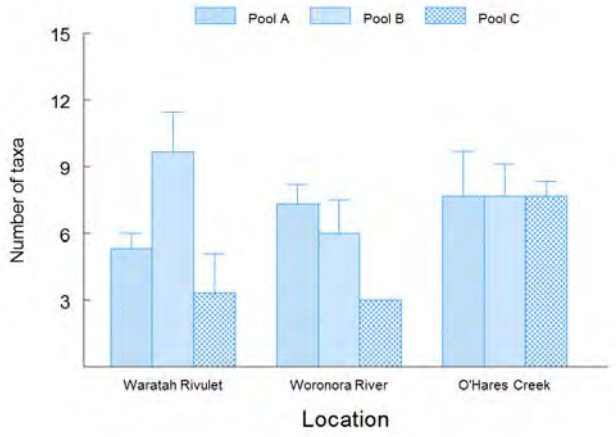

Chart 85d Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 3).

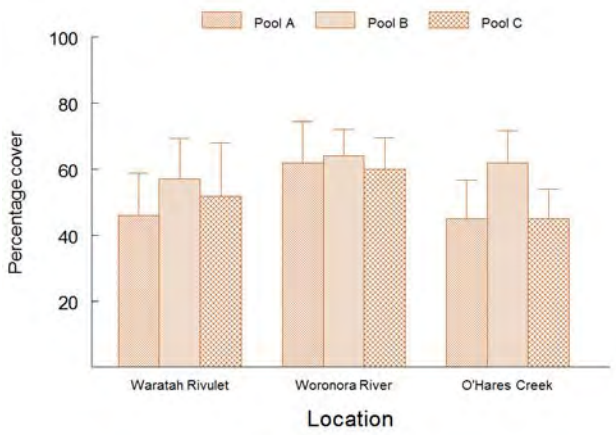

Chart 86a Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Spring 2009

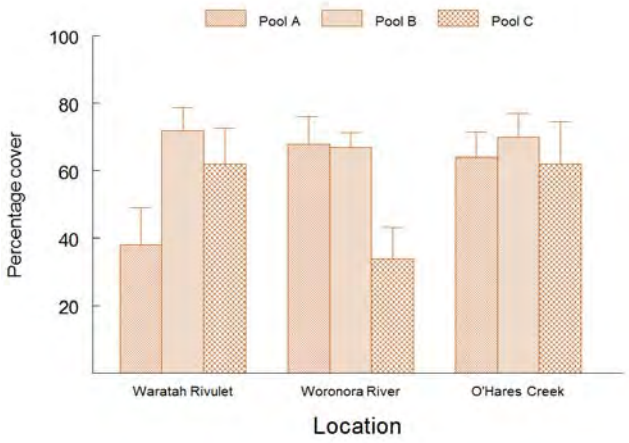

Chart 86b Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Autumn 2010

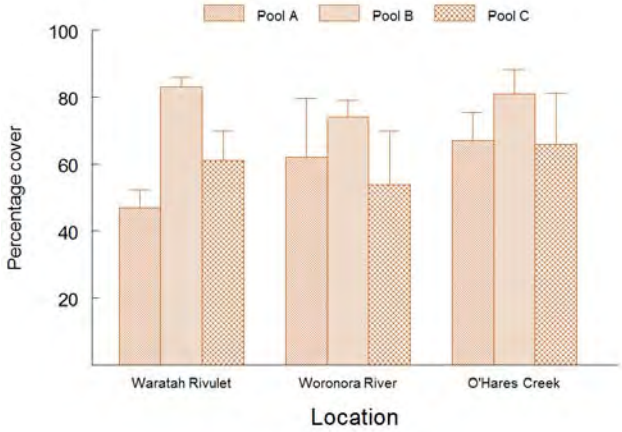

Chart 86c Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Spring 2010

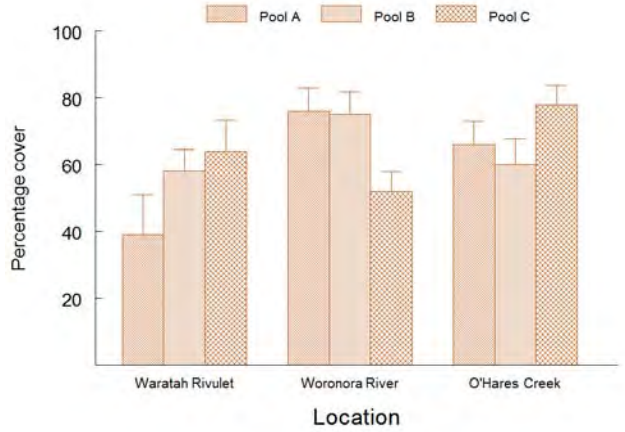

Chart 86d Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 5).

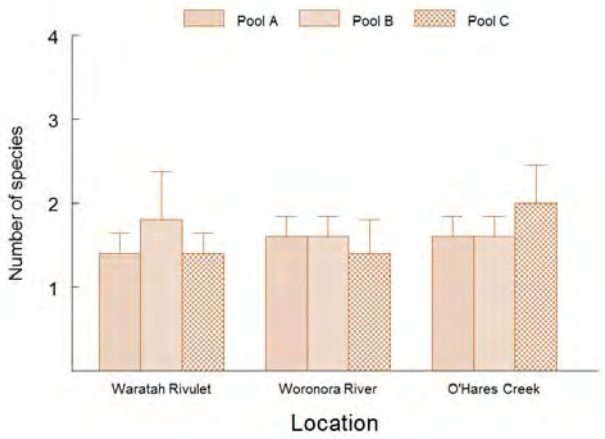

Chart 87a Mean (+SE) Macrophyte Diversity, Smaller Pools, Spring 2009

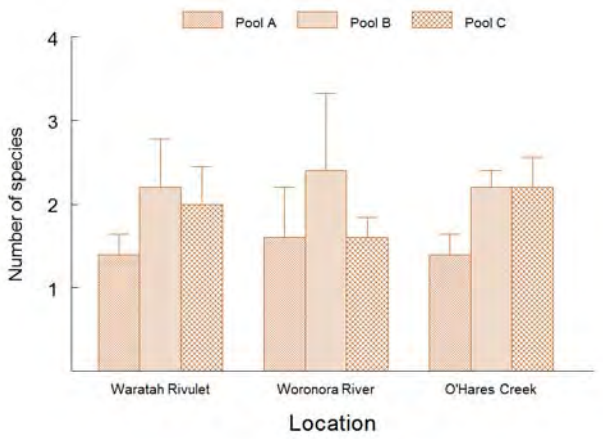

Chart 87b Mean (+SE) Macrophyte Diversity, Smaller Pools, Autumn 2010

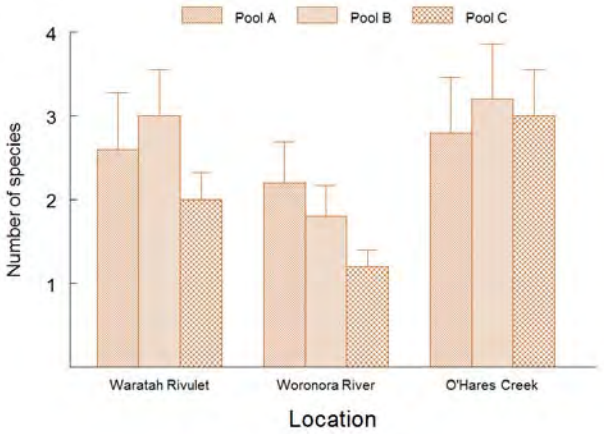

Chart 87c Mean (+SE) Macrophyte Diversity, Smaller Pools, Spring 2010

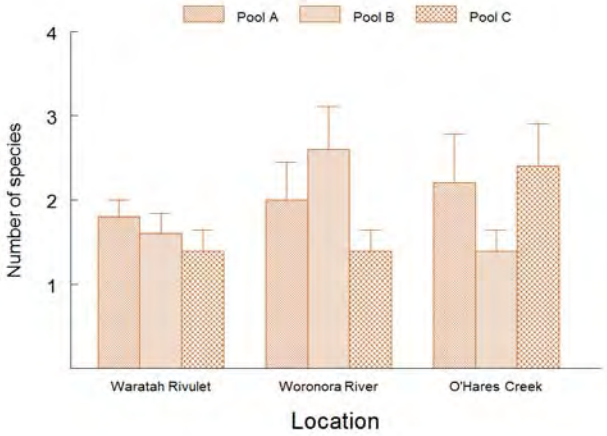

Chart 87d Mean (+SE) Macrophyte Diversity, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 5).

3.4.2.5 Amphibian Surveys

A monitoring program has been developed for Longwalls 20-22 to monitor amphibian species, with a focus on the habitats of the Giant Burrowing Frog (*Heleiporus australiiacus*) and Red-crowned Toadlet (*Pseudophryne australis*) associated with tributaries. Baseline monitoring has been conducted in spring/summer 2010.

Six sites overlying Longwalls 20-22 and six control sites will be surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions. The approximate locations of the sampling sites are shown on Figure 16.

Each site is surveyed once during a standard one hour general area day search (early morning and late afternoon) supplemented by an evening 60 minute search/playback session using hand held spotlights and head lamps.

Species are assigned to the following relative abundance categories for tadpole and adult stages:

- 0 = no sightings;
- 1 = one sighting of adult or tadpole stage;
- UC = uncommon (i.e. 2 to 10 individuals), adult or tadpole stage;
- MC = moderately common (i.e. 11 to 20 individuals), adult or tadpole stage;
- C = common (i.e. 21 to 40 individuals), adult or tadpole stage; and
- A = abundant (>40 individuals), adult or tadpole stage.

The results of the two surveys to date (2009/2010) are presented in Table 23.

The Red-crowned Toadlet was observed at five test sites (sites 2 to 6) in spring/summer 2010 compared with three test sites (sites 2 to 4) in spring/summer 2009 and at three control sites (sites 10 to 12) in spring/summer 2010 compared with two test sites (sites 9 and 10) in spring/summer 2009. The Giant Burrowing Frog was not recorded during the 2010 survey (compared to 1 tadpole at site 10 during the 2009 survey).

Chart 88 shows the number of species recorded at each site in 2009 compared to 2010. A higher number of species was recorded at sites 1, 3, 7, 8, 11 and 12, and a lower number of species was recorded at sites 4, 5, 6, 9 and 10, in 2010 compared with 2009.

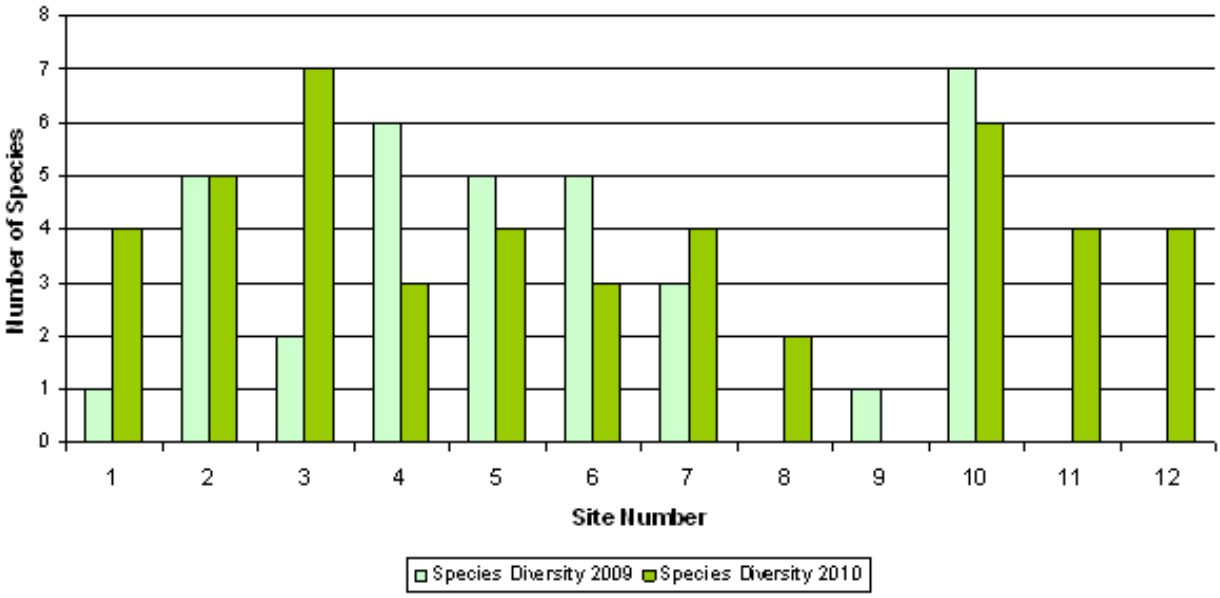

Chart 88 Amphibian Species Diversity, 2009 and 2010

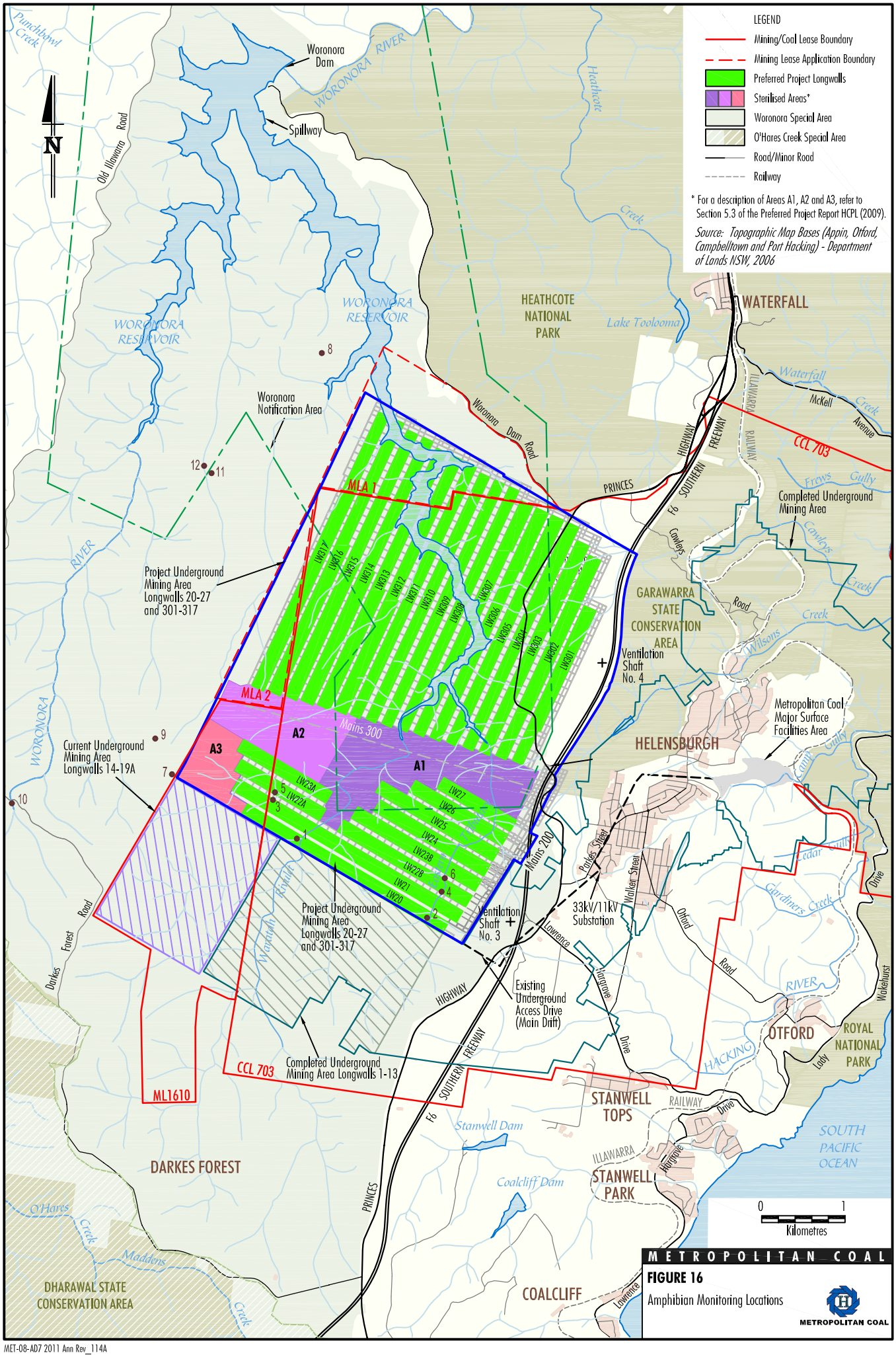

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Table 23
Amphibian Species Diversity and Abundance, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Myobatrachidae																		
Crinia signifera	Common Eastern Froglet	2009	1[1] 0	1 0	1 0	>10 0	2 0	1 0	1 0	0 0	0 0	5 >10	0 0	0 0	>16 0	6 >10	MC MC	U MC
		2010	3 0	4 0	3 c100	2 0	3 0	5 0	4 0	3 0	0 0	4 c200	1 27	2 6	20 c100	14 c233	MC A	MC A
Heleiporus australiiacus	Giant Burrowing Frog[V, v]	2009	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 1	0 0	0 1
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Limnodynastes peronii	Brown-striped Frog	2009	0 0	0 0	0 0	1 0	1 0	1 0	0 0	0 0	0 0	2 0	0 0	0 0	3 0	2 0	UC 0	UC 0
		2010	0 0	0 0	0 53	0 0	0 76	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 129	0 0	0 A	0 0
Limnodynastes tasmaniensis	Spotted Grass Frog	2009	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	1 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Pseudophryne australis	Red-crowned Toadlet[V]	2009	0 0	1 0	2 0	2 0	0 0	0 0	1 0	0 0	1 0	1 0	0 0	0 0	5 0	3 0	UC 0	UC 0
		2010	0 0	1 0	7 0	1 0	6 0	9 0	0 0	0 0	0 0	1 0	1 0	2 0	24 0	4 0	C 0	UC 0
Uperoleia laevigata	Smooth Toadlet	2009	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	1 0	1 0	1 0	1 0
		2010	0 0	2 0	2 10	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	4 10	0 0	UC UC	0 0
Hylidae																		
Litoria citropa	Blue Mountains Tree Frog	2009	0 0	1 0	0 0	1 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	3 0	0 0	UC 0	0 0

Table 23 (Continued)
Amphibian Species Diversity and Abundance at Test Sites, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Hylidae (cont.)																		
Litoria citropa	Blue Mountains Tree Frog	2010	4	0	3	0	2	0	0	0	0	1	0	0	9	1	UC	1
			0	0	4	0	0	0	0	0	0	0	0	0	4	0	UC	0
Litoria dentata	Bleating Tree Frog	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0	3	3	0	0	6	0	UC
			0	0	0	0	0	0	0	0	0	0	15	0	0	15	0	MC
Litoria freycineti	Southern Rocket Frog	2009	0	0	0	0	5	1	0	0	0	2	0	0	6	2	UC	UC
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2010	3	1	2	0	0	0	1	0	0	4	0	1	6	6	UC	UC
			0	8	0	0	0	0	0	c1000	0	38	0	3	8	c1041	UC	A
Litoria latopalmata	Broad-palmed Frog	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	0	c500	0	0	0	c500	0	0	c1000	0	A
LItoria lesueurii	Lesueur's Frog	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2010	0	2	0	2	0	4	0	0	0	0	0	0	8	0	UC	0
			42	0	10	0	0	0	0	0	0	0	0	0	52	0	A	0
Litoria wilcoxii	Stony Creek Frog	2009	0	10	0	0	3	0	0	0	0	4	0	0	13	4	MC	UC
			0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	UC
		2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Litoria peronii	Peron's Tree Frog	2009	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2010	0	0	0	0	0	0	3	0	0	2	0	2	0	7	0	UC
			0	0	0	0	0	0	c1000	0	0	0	0	0	0	c1000	0	A

Table 23 (Continued)
Amphibian Species Diversity and Abundance at Test Sites, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Hylidae (cont.)																		
Litoria phyllochroa	Green Stream Frog	2009	0 0	0 0	0 0	2 0	1 0	>5 0	0 0	0 0	0 0	0 0	0 0	0 0	>8 0	0 0	UC 0	0 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Species Diversity at Each Site		2009	**1**	**5**	**2**	**6**	**5**	**5**	**3**	**0**	**1**	**7**	**0**	**0**				
		2010	**4**	**5**	**7**	**3**	**4**	**3**	**4**	**2**	**0**	**6**	**4**	**4**				
Species Diversity in all Control and all Test sites		2009													**9**	**8**		
		2010													**7**	**7**		
Species Diversity across the survey site		2009													**11**			
		2010													**10**			

[1] First line of data refers to the presence or absence of adults, while the second line of data refers to absence or presence of tadpoles.

[2] Relative Abundance of adult and tadpole stage assessed independently: 0 – no sightings, 1 – One sighting, UC – Uncommon, 2 to 10 individuals, MC – Moderately common, 11 to 20 individuals, C – Common, 21 to 40 individuals, A – Abundant, >40 individuals, c1000 = approximately 1,000 animals estimated.

[V, V] Listed as vulnerable under the NSW TSC Act and EPBC Act. [V] Listed as vulnerable under the TSC Act.

Chart 89 shows the number of sites at which each species was recorded during the 2009 and 2010 surveys.

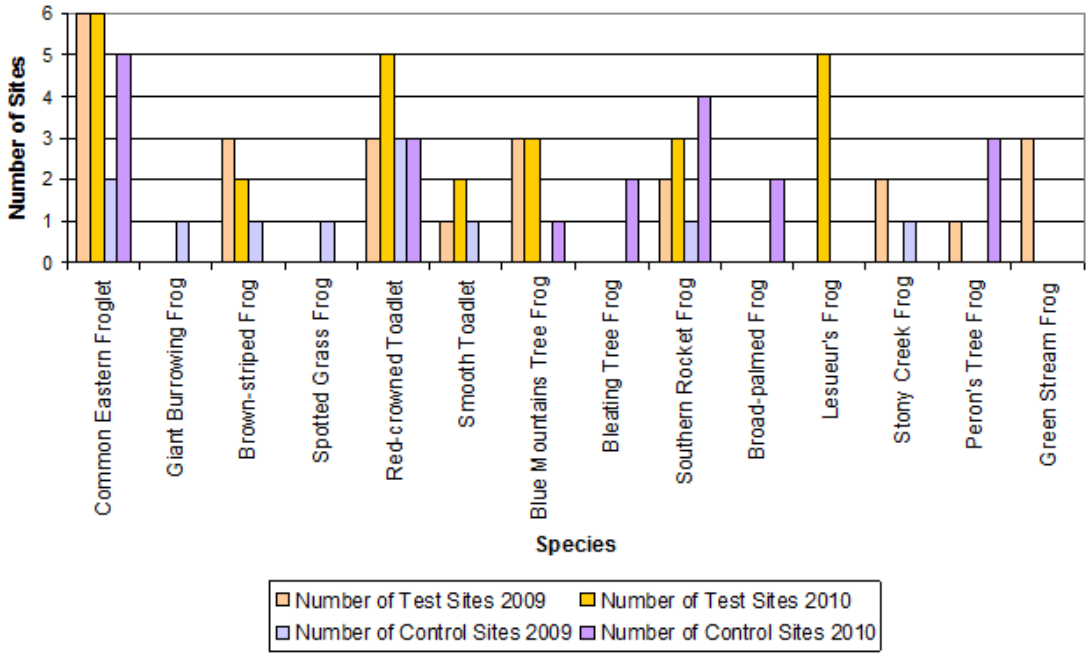

Chart 89 Number of Sites per Species, 2009 and 2010

Table 23 and Charts 88 and 89 indicate:

- The Common Eastern Froglet was located at all test sites in 2009 and 2010. At control sites, this species was recorded at 2 sites in 2009 and 5 in 2010.
- The Giant Burrowing Frog was located once in a control site in 2009 as a single tadpole.
- The Brown-striped Frog was located in 3 test sites in 2009 and 2 test sites in 2010; and located in one control site in 2009.
- The Spotted Grass Frog was located in 1 control site in 2009.
- The Red-crowned Toadlet was located in 3 test sites in 2009, 5 test sites in 2010; and in 3 control sites in both 2009/2010.
- The Smooth Toadlet was located in 1 test site in 2009 and 2 test sites in 2010; and 1 control site in 2009 and no control sites in 2010.
- The Blue Mountains Tree Frog was located in 3 test sites in both 2009/2010; at no control sites in 2009 and 1 control site in 2010.
- The Bleating Tree Frog was located in 2 control sites in 2010.
- The Southern Rocket Frog was located in 2 test sites in 2009 and 3 test sites in 2010; and 1 control site in 2009 and 4 control sites in 2010.
- The Broad-palmed Frog was located in 2 control sites in 2010.
- Lesueur's Frog was located in 5 test sites in 2010.
- The Stony Creek Frog was located in 2 test sites in 2009 and no test sites in 2010; at 1 control site in 2009 and no control sites in 2010.
- Peron's Tree Frog was located in 1 test site in 2009 and no test sites in 2010; at no control sites in 2009 and at 3 control sites in 2010.
- The Green Stream Frog was located in 3 test sites in 2009.

These data reflect an expected variability across sites and years. A portion of the variability is likely associated with survey weather conditions at the time or in the weeks preceding the surveys. The year 2009 was a very dry year, whereas 2010 was a much wetter year and more free surface water and damp micro-habitat areas were present across the survey area than in 2009. In 2010 day time temperatures were generally milder and night time temperatures during evening surveys were lower which may have affected frog calling behaviour. Based on the results of the surveys of longwall and control sites to date, amphibian species diversity and abundance are consistent with expected population variations and cycles in response to seasonal variations.

In summary, the amphibian surveys identified the following:

- Six test sites are located above Longwalls 20-22, however only one site (site 1) had been undermined at the time of the spring/summer 2010 survey.
- Ten amphibian species were located across the survey area including seven in test sites and seven in control sites.
- No amphibians were located at control site 9.
- Species diversity across sites varied from 0-7.
- Three frog species located at control sites were not located in test sites. Three frog species were located in test sites but not at control sites.
- Three frogs not located in the 2009 survey were located in the 2010 survey.
- Breeding events were identified for six species located in test sites and five species located in control sites.
- The amphibian species diversity and abundance data are consistent with expected population variations and cycles in response to seasonal variations.

3.4.3 Assessment of Environmental Performance

The performance indicators and subsidence impact performance measures described below have been developed to address the predictions of subsidence impacts and environmental consequences on biodiversity included in the EA, PPR and Extraction Plan.

The results of the assessment of the performance of the Project against the biodiversity performance indicators and subsidence impact performance measures are described below.

3.4.3.1 Threatened Species, Populations and Ecological Communities

Analysis against Performance Indicator 1

Performance Indicator 1: *The vegetation in upland swamps is not expected to experience changes significantly different to vegetation in control swamps.*

This indicator is considered to have been exceeded if:

- data indicates a declining trend in the condition of swamp vegetation; or
- data analysis indicates statistically significant changes in vegetation between the mined and control swamps.

Detailed analysis of the above performance indicator is provided in Section 3.4.2.1. In summary:

- Visual inspections of upland swamp vegetation indicate that the upland swamp vegetation performance indicator has not been exceeded (i.e. the observations have not identified a declining trend in the condition of vegetation in swamps overlying Longwalls 20-22) during the spring 2010 and autumn 2011 survey periods.
- Analysis of quadrat/transect data indicates that the upland swamp performance indicator '*The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps'* has not been exceeded.

- Analysis of indicator species data indicates that the upland swamp performance indicator '*The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps'* has not been exceeded.

Analysis against Performance Indicator 2

Performance Indicator 2: *Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to seasonal variations in water levels experienced by upland swamps prior to mining or control swamps.*

This indicator is considered to have been exceeded if data analysis indicates statistically significant changes in groundwater levels (i.e. if the seven day moving average data lie outside two standard deviations from the mean established for the preceding six months of data).

Groundwater level bandwidths defined by two standard deviations (2σ) from the mean have been determined for the initial six months of monitoring (August 2010 to February 2011) and for 12 months from August 2010 to July 2011, to assess whether the initial six monthly period is representative of long-term natural bounds. The bandwidths for control swamp 101 (Chart 90) show differences of about ±0.3 m between the two bandwidths, with the longer period having the broader bandwidth. The strong dry episode in February 2011 is responsible for the difference. It is noted that the February 2011 groundwater levels at the 10 m sandstone piezometer lie outside the -2σ limit.

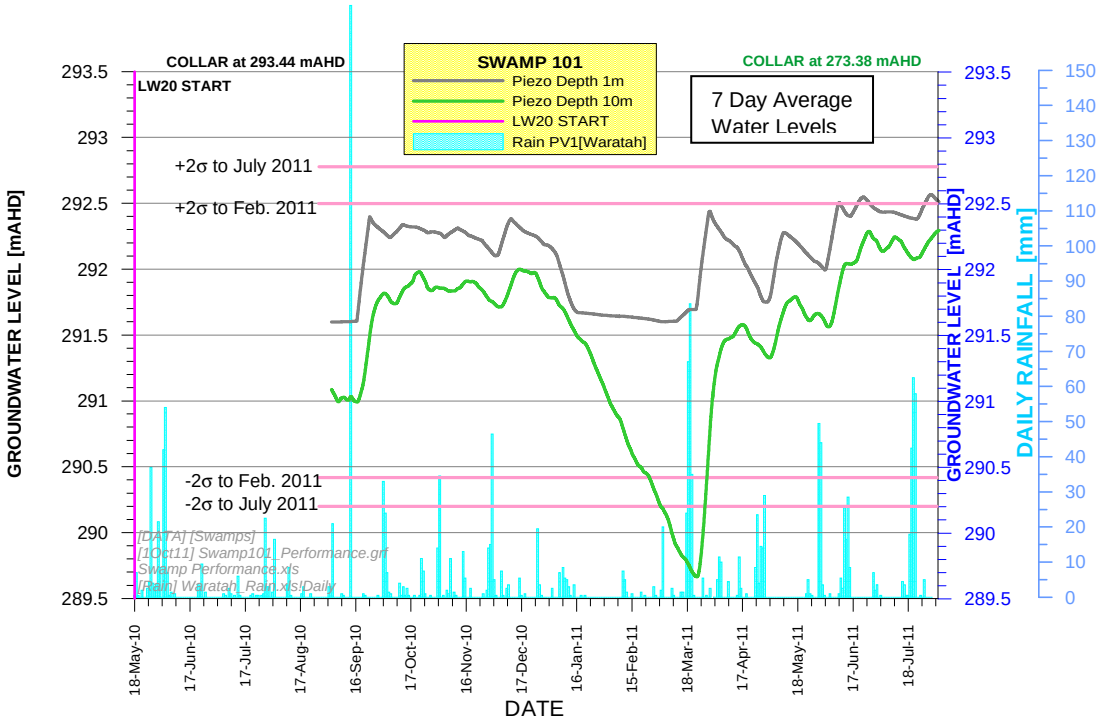

Chart 90 Performance Assessment of Groundwater Hydrographs at Site S101 (Control Swamp 101)

The bandwidths for the Woronora River control swamp (Chart 91) are similar for the shorter and longer time windows. It is noted that the February 2011 groundwater levels at two piezometers lie outside the -2σ limit.

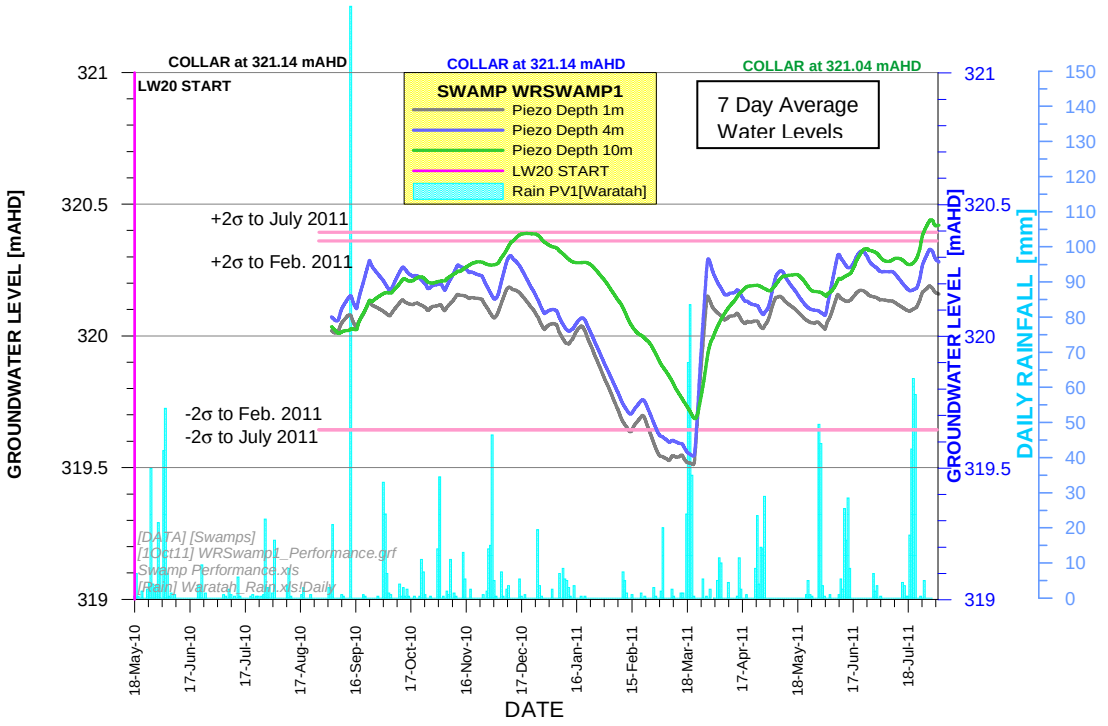

Chart 91 **Performance Assessment of Groundwater Hydrographs at Site WRSWAMP1 (Control Swamp Woronora River 1)**

Performance assessments have been conducted at the swamp sites in the vicinity of mining that occurred during the review period and are illustrated in Charts 92 to 94. In most cases there is a breach of the 2σ lower limit. However, similar responses during the same time period at the control sites confirm that this departure is a natural occurrence due to very dry conditions rather than a possible mining effect. There is one breach of the upper limit (Chart 92) at the end of the review period. This also occurred at control site WRSWAMP1 and is due to a sequence of wet events.

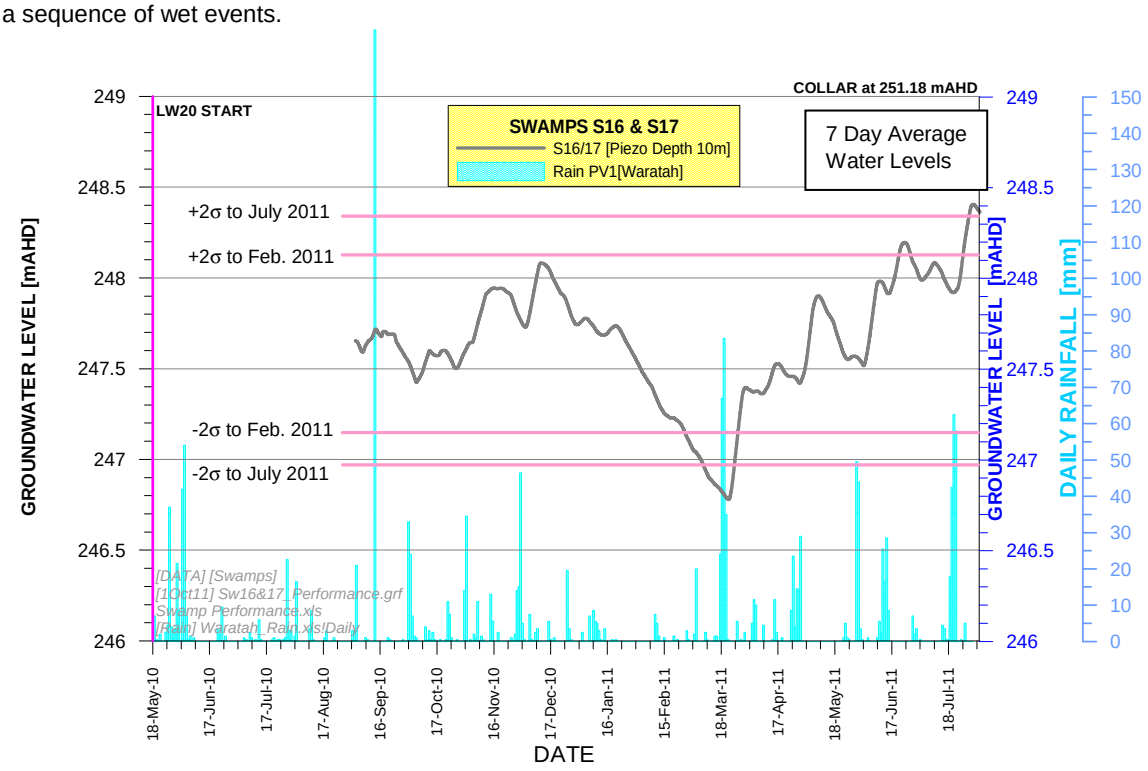

Chart 92 **Performance Assessment of Groundwater Hydrographs at Site S16/17 (Swamps 16 and S17)**

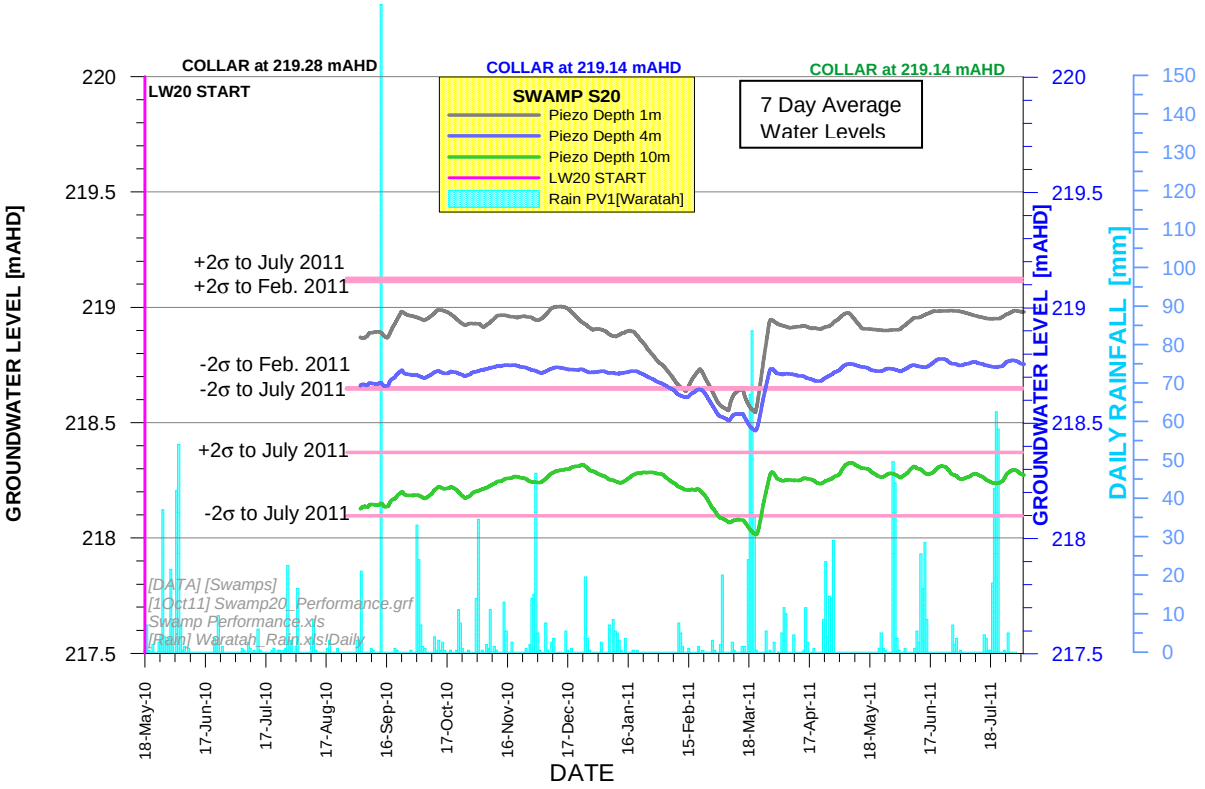

Chart 93 Performance Assessment of Groundwater Hydrographs at Site S20 (Swamp 20)

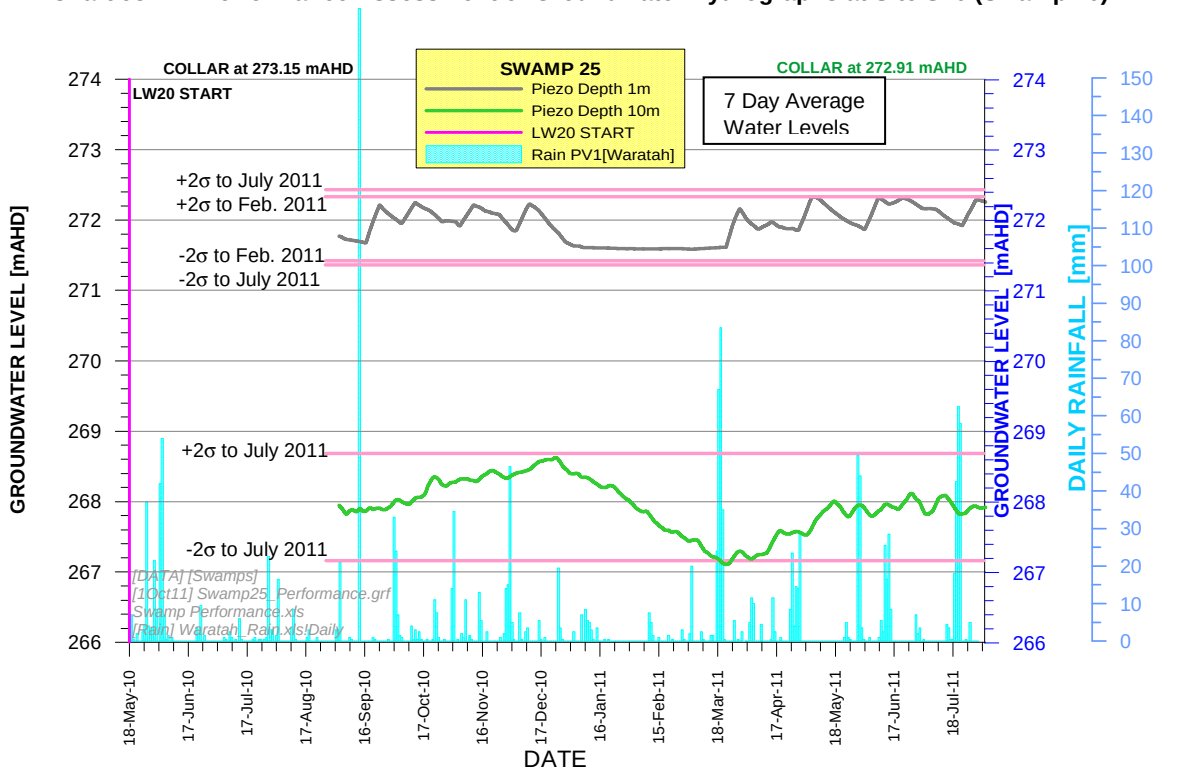

Chart 94 Performance Assessment of Groundwater Hydrographs at Site S25 (Swamp 25)

The current performance indicator is based on comparison of 7-day average groundwater levels with two standard deviations calculated from the preceding six months of data. Given the sensitivity to the length of the time window in the event of pronounced dry or wet periods, it is now considered that the full length of record be considered for establishing the bandwidth limits. The Water Management Plan and Catchment Monitoring Program will be revised to consider the full records of groundwater records when calculating the average and standard deviation.

Analysis against Performance Indicator 3

Performance Indicator 3: *Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at the Metropolitan Colliery.*

This indicator is considered to have been exceeded if:

- visual inspections identify vegetation dieback greater than 50 centimetres from the stream; or
- data analysis indicates the riparian vegetation has not recovered after one year of the completion of stream remediation on Waratah Rivulet.

Detailed analysis of the above performance indicator is provided in Section 3.4.2.3. In summary, despite the impacts of flooding events in spring 2010 and autumn 2011, visual inspections of riparian vegetation indicate that 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*' has not been exceeded.

Additionally, analysis of riparian vegetation data for spring 2010 indicates that 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'* has not been exceeded.

Analysis against Performance Indicator 4

Performance Indicator 4: *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.*

This indicator is considered to have been exceeded if the assessment of subsidence parameters indicates the subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion Endangered Ecological Community (EEC) situated to the east of Longwalls 20-22 are an order of magnitude above those predicted.

As discussed in Section 3.2.3, nil subsidence effects have occurred as a result of Longwall 20 extraction 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.

Analysis against Performance Indicator 5

Performance Indicator 5: *The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence.*

This indicator is considered to have been exceeded if data analysis indicates significant changes in relation to reference places before (i.e. pre-mining) to after (i.e. post-mining) mining of Longwalls 20-22:

- occur in the aquatic macroinvertebrate and macrophyte assemblages in streams at locations WT3, ET1, ET3 and B1 after the completion of Longwall 26; and
- occur in the aquatic macroinvertebrate and macrophyte assemblages at pools J, K, L, M1, M and N after one year of the completion of stream remediation on Waratah Rivulet.

This performance indicator will be assessed and reported on in future Annual Reviews. The baseline monitoring data collected up to the current review period is provided in Section 3.4.2.4.

Analysis against Performance Indicator 6

Performance Indicator 6: *The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites.*

This indicator is considered to have been exceeded if data analysis identifies a significant decline in the amphibian population.

As discussed in Section 3.4.2.5, the amphibian species diversity and abundance data are consistent with expected population variations and cycles in response to seasonal variations. There is no significant difference between test and control sites. Thus, this performance indicator has not been exceeded.

Subsidence Impact Performance Measures included in the Land Management Plan and Water Management Plan

Subsidence impact performance measures of relevance to the Biodiversity Management Plan are also contained in the Land Management Plan and Water Management Plan. In the event the subsidence impacts observed exceed the land subsidence impact performance measure or an applicable water resource/water course subsidence impact performance measure, Metropolitan Coal will conduct a review of potential impacts on flora, fauna, and their habitats in accordance with the Biodiversity Management Plan.

Subsidence impact performance measures of relevance to the Biodiversity Management Plan are outlined in Table 24.

Table 24
Other Subsidence Impact Performance Measures of Relevance to the Biodiversity Management Plan

Water Resources	
Catchment yield to the Woronora Reservoir	*Negligible reduction to the quality or quantity of water resources reaching the Woronora Reservoir* *No connective cracking between the surface and the mine*
Woronora Reservoir	*Negligible leakage from the Woronora Reservoir* *Negligible reduction in the water quality of Woronora Reservoir*
Watercourses	
Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)	*Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases)*
Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	*Negligible environmental consequences over at least 70% of the stream length (that is no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases)*
Land	
Cliffs	*Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining induced rock fall*

None of the subsidence impact performance measures of relevance to the Biodiversity Management Plan have been exceeded during the review period.

Analysis against Subsidence Impact Performance Measure for Threatened Species, Populations and Ecological Communities

If data analysis indicates a biodiversity performance indicator has been exceeded or is likely to be exceeded, Metropolitan Coal will implement suitable management measures and an assessment will be made against biodiversity subsidence impact performance measure.

Subsidence Impact Performance Measure:

Negligible impact on threatened species, populations, or ecological communities

Negligible Impact on Threatened Species - Key Assessment Considerations

In relation to threatened species, a number of threatened flora and fauna species listed under the NSW *Threatened Species Conservation Act, 1995* or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* are known to occur, or have the potential to occur within 600 m of Longwalls 20-22 secondary extraction or in the surrounding area.

The key assessment considerations that will be taken into account to assess whether there has been a greater than negligible impact on threatened species are:

1. What is the nature of the environmental consequence (e.g. the potential for adverse impacts on upland swamps, riparian vegetation, slopes and ridgetops or aquatic habitats)?
2. What are the potential factors that may have contributed to the environmental consequence (e.g. the degree of subsidence effects, ineffective management measures or prevailing climatic conditions)?
3. Which threatened species have the potential to be impacted?
4. What are the potential impacts on the lifecycle of the potential threatened species (e.g. foraging, breeding/reproduction, nesting, shelter and movement/dispersal)?
5. What are the potential impacts on the habitat of the potential threatened species (e.g. area affected)?
6. Has the habitat connectivity of the threatened species been affected (e.g. loss of stream pool habitat connectivity)?
7. What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?

Neither the performance indicators, nor the biodiversity subsidence impact performance measure were exceeded during the review period.

Negligible Impact on Populations - Key Assessment Considerations

No endangered flora or fauna populations listed under the NSW *Threatened Species Conservation Act, 1995* are known to occur within 600 m of Longwalls 20-22 secondary extraction or in the surrounding area.

The key assessment considerations that will be taken into account to assess whether there has been a greater than negligible impact on threatened populations (in the event a threatened population is listed that is applicable to the study area) are:

1. What is the nature of the environmental consequence (e.g. the potential for adverse impacts on upland swamps, riparian vegetation, slopes and ridgetops or aquatic habitats)?
2. What are the potential factors that may have contributed to the environmental consequence (e.g. the degree of subsidence effects, ineffective management measures or prevailing climatic conditions)?
3. Are there any threatened populations have the potential to be impacted?
4. What are the potential impacts on the lifecycle of the threatened population?
5. What are the potential impacts on the habitat of the threatened population (e.g. area affected)?
6. Has the habitat connectivity of the threatened population been affected?
7. What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?

Neither the performance indicators, nor the biodiversity subsidence impact performance measure were exceeded during the review period.

Negligible Impact on Ecological Communities - Key Assessment Considerations

Occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC listed under the NSW *Threatened Species Conservation Act, 1995* are situated some 400 m to the east of Longwalls 20-22, near the 600 m boundary.

The key assessment considerations that will be taken into account to assess whether there has been a greater than negligible impact on threatened ecological communities are:

1. Can any subsidence impacts (e.g. surface cracking, subsidence-induced erosion) be observed within the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated to the east of Longwalls 20-22?
2. If yes, over what area has been affected?
3. What are the potential environmental consequences of the change in subsidence effects?
4. What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?

Neither the performance indicator that relates to the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC, nor the biodiversity subsidence impact performance measure was exceeded during the review period.

3.4.3.2 Swamps 76, 77 and 92

Subsidence Impact Performance Measure:

Swamps 76, 77 and 92 - Set through condition 4

Metropolitan Coal is not permitted to undermine Swamps 76, 77 and 92 without the written approval of the Director-General. Swamps 76, 77 and 92 will not be undermined by Longwalls 20-22.

Swamps 76, 77 and 92 will be subject to assessment in future Extraction Plan(s) and revisions of the Biodiversity Management Plan.

3.4.4 Management and Mitigation Measures

At this stage the implementation of the Biodiversity Management Plan and associated management processes are considered to be adequate.

3.4.5 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review, and if necessary, revise the Biodiversity Management Plan within three months following the submission of this Annual Review to the satisfaction of the Director-General of DP&I.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and revise the Biodiversity Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I. The Biodiversity Management Plan will be revised to amend the upland swamp groundwater performance indicator so that the bandwidth limits of two standard deviations will be calculated from the full length of records rather than the current practice of calculating from the preceding six months of data. The current performance indicator is based on comparison of 7-day average groundwater levels with two standard deviations calculated from the preceding six months of data. Given the sensitivity to the length of the time window in the event of pronounced dry or wet periods, it is now considered that the full length of record be considered for establishing the bandwidth limits.

Baseline collection of aquatic habitat data for Longwalls 23-27 has commenced in accordance with the Water Management Plan. The collection of baseline aquatic ecology data for Longwalls 23-27 commenced in spring 2009.

3.5 LAND MANAGEMENT PLAN

3.5.1 Background

A Metropolitan Coal Longwalls 20-22 Land Management Plan has been prepared to manage the potential environmental consequences of the Extraction Plan on cliffs, overhangs, steep slopes and land in general, in accordance with Condition 6, Schedule 3 of the Project Approval.

3.5.2 Monitoring

Cliffs and Overhangs

Visual inspections are conducted monthly for the period of time that longwall extraction takes place within 400 m of sites COH1, COH2, COH3, COH4 and COH14 (Figure 17) to record evidence of potential subsidence impacts. Specific details that are noted and/or photographed during the inspections include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- the location of the cliff instability (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) relative to the cliff face or overhang;
- the nature and extent of the cliff instability (including an estimate of volume);
- the length of the cliff instability;
- other relevant aspects such as water seepage (which can indicate weaknesses in the rock);
- whether any actions are required (e.g. implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Additional opportunistic observations of subsidence impacts are also conducted during routine works and sampling by Metropolitan Coal and its contractors. Inspections of sites COH1 and COH2 were conducted in July, August, September, and October 2010. No cliff instabilities (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) or areas of water seepage were evident.

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.

Specific details that are noted and/or photographed during the inspections include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to fire trails;
- the location and approximate dimensions of rock falls (e.g. rock ledges that occur along the Waratah Rivulet);
- whether any actions are required (for example – implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction are also documented.

No subsidence impacts (e.g. surface tension cracks or rock falls) have been observed within the Longwalls 20-22 area during the review period.

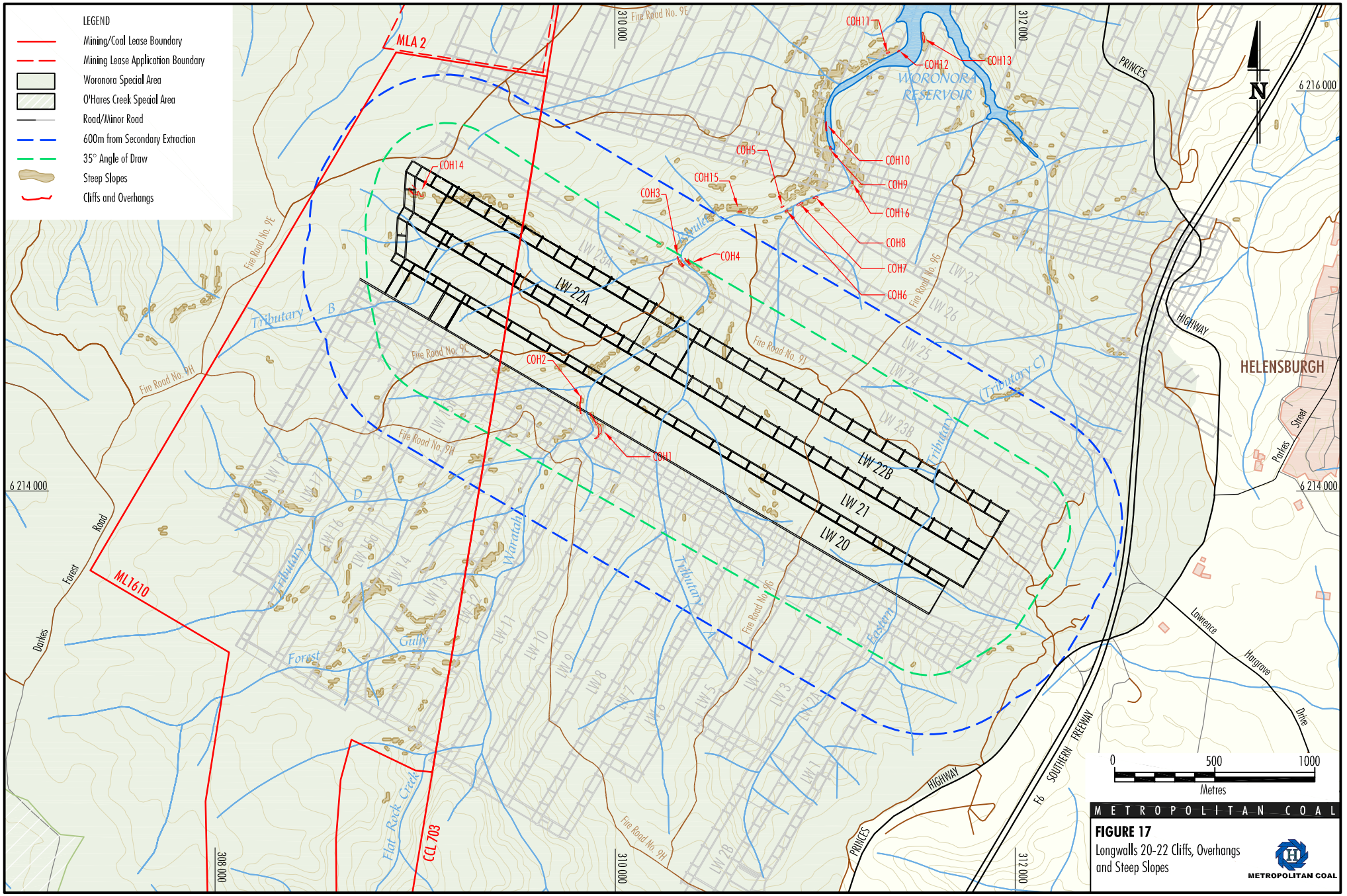

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FIGURE 17

Longwalls 20-22 Cliffs, Overhangs and Steep Slopes

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3.5.3 Assessment of Environmental Performance

The performance indicators and subsidence impact performance measure described below have been developed to address the predictions of subsidence impacts and environmental consequences on land included in the EA, PPR and Extraction Plan.

The results of the assessment are described below.

Analysis against Performance Indicator

Performance Indicator: *Steep slopes and land in general are expected to experience surface tension cracking no greater than 0.1 m wide and 25 m in length.*

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

No surface tension cracks were observed associated with the Longwall 20-22 Extraction.

Analysis against Subsidence Impact Performance Measure

Subsidence Impact Performance Measure:

Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining-induced rock fall.

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

3.5.4 Management and Mitigation Measures

At this stage the implementation of the Land Management Plan and associated management processes are considered to be adequate.

3.5.5 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Land Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

3.6 HERITAGE MANAGEMENT PLAN

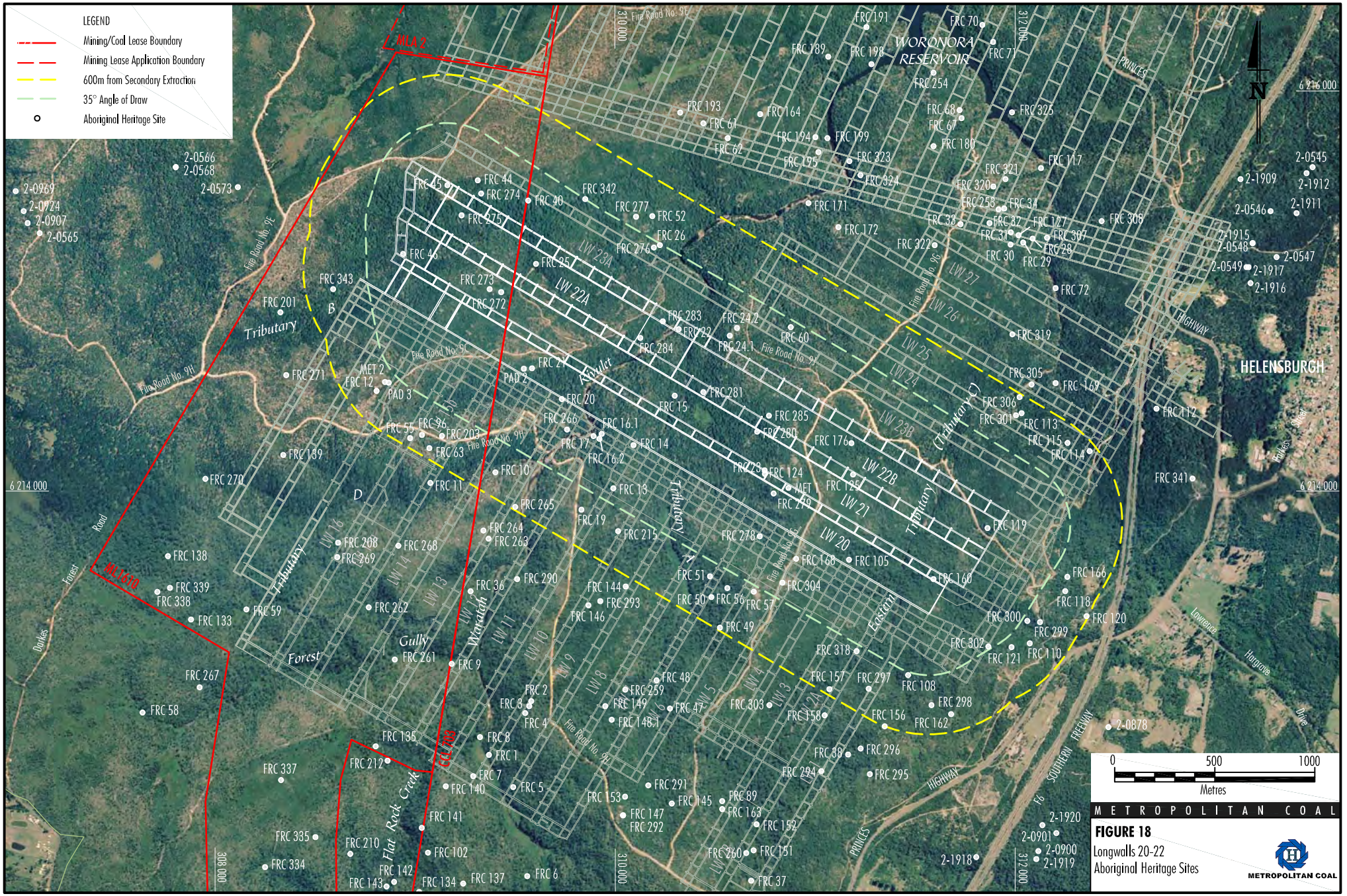
3.6.1 Background

A Metropolitan Coal Longwalls 20-22 Heritage Management Plan has been prepared to manage the potential environmental consequences of the Extraction Plan on Aboriginal heritage sites or values in accordance with Condition 6, Schedule 3 of the Project Approval.

3.6.2 Monitoring

A monitoring program will be implemented to monitor the impacts and consequences of Project related subsidence on Aboriginal heritage sites.

No monitoring was required to be undertaken during the review period. The first round of monitoring (Round 1) will include all Aboriginal heritage sites located within the 35º Angle of Draw for Longwall 20 (Figure 18). Round 1 monitoring will be conducted in the next review period, between three and six months following the completion of Longwall 20.



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The monitoring team will include an archaeologist (with experience in rock art recording and management) and Aboriginal stakeholder representatives. A summary of the information collected during monitoring will be recorded in the Heritage Management Plan – Subsidence Impact Register.

3.6.3 Assessment of Environmental Performance

The subsidence impact performance measure described below has been developed to address the predictions of subsidence impacts and environmental consequences on Aboriginal heritage included in the EA, PPR and Extraction Plan.

The monitoring results will be 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.

The Heritage Management Plan – Subsidence Impact Register will be used to progressively monitor the cumulative number and percentage of Aboriginal heritage sites affected by subsidence impacts.

3.6.4 Management and Mitigation Measures

In the event that any subsidence impact is recorded during monitoring, consideration will be given to implementing appropriate management, remediation and/or mitigation measures in consultation with the OEH and Aboriginal stakeholders.

The development of management and/or remediation measures will be determined in consultation with the OEH and the Aboriginal stakeholders and with regard to the specific circumstances of the subsidence impact (e.g. the location, nature and extent of the impact) and the assessment of consequences. It is acknowledged that whilst measures may reduce the risk of impact and consequence, they may also have the potential to cause substantial damage to Aboriginal heritage sites and their settings.

During field surveys undertaken as part of the Project EA, a tree located near site FRC 279 was identified by the Northern Illawarra Aboriginal Collective as bearing *likely birth-marks*. In accordance with the Heritage Management Plan, prior to secondary extraction of Longwall 20 within 600 m, Metropolitan Coal carried out further investigation of the tree (via site inspection and consultation with Aboriginal stakeholders in October 2010) to determine if the markings were likely to be of Aboriginal origin. These investigations were undertaken by an archaeologist, a suitably qualified arborist and Aboriginal stakeholders.

In summary, the arborist provided an assessment that the markings originated from mechanical means and that the tree was aged approximately 50-100 years. The consultation with Aboriginal stakeholders included details of observations, explanations of technical attributes and discussions of various alternatives to the origins of the marking upon the tree trunk. Although some of the stakeholders maintained that the tree was an Aboriginal birthing tree, the majority were satisfied with the assessment process undertaken by the arborist and acknowledged that the likelihood of the markings being of Aboriginal origin and being indicative of the tree being a birthing tree was low.

Additionally, surveys undertaken as part of the Project EA also identified a number of sites for which the Aboriginal Heritage Information Management System (AHIMS) registered site cards were inconsistent with the current condition of the site. Within 600 m of Longwalls 20-22 secondary extraction, these sites include FRC 57, FRC 63 and FRC 276. Each of these sites was observed during surveys to have been subject to natural deterioration since their initial recording. Site cards for these sites have been revised during the review period to incorporate updated information (in the form of attachments to the original site card). The amended attachments indicate the date the site was visited, who visited the site, recorded location (if different), site condition, any additional photographs, plans, site monitoring forms and any other relevant information.

3.6.5 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Heritage Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

3.7 BUILT FEATURES MANAGEMENT PLAN

3.7.1 Background

A Metropolitan Coal Longwalls 20-22 Built Features Management Plan has been prepared to manage the potential environmental consequences of the Extraction Plan on built features in accordance with Condition 6, Schedule 3 of the Project Approval. Each plan has been developed in consultation with the relevant asset owner.

3.7.2 Monitoring

Site inspections have been conducted prior to the commencement of secondary extraction of Longwall 20 to establish the condition of the infrastructure items.

A monitoring program will be implemented to monitor subsidence impacts on the following infrastructure at the various frequencies described in the Built Features Management Plan:

- Integral Energy infrastructure;
- Nextgen infrastructure;
- TransGrid infrastructure;
- Optus infrastructure;
- Telstra infrastructure;
- Roads and Traffic Authority (RTA) infrastructure;
- RailCorp infrastructure;
- Sydney Water infrastructure; and
- Wollongong City Council.

Subsidence monitoring relevant to each Built Feature Management Plan was conducted in accordance with each Plan. In relation to the Built Features Management Plan – RTA, a Technical Committee was established comprising representatives from the RTA, Metropolitan Coal, the Mine Subsidence Board, and technical specialists to monitor progress on a regular basis. A specific report on Longwall 20 movements and impacts will be prepared at the completion of Longwall 20.

No impact to any built feature was evident over the review period.

3.7.3 Assessment of Environmental Performance

Metropolitan Coal and the infrastructure owners will compare the results of the subsidence impact monitoring against the built features performance indicators and built features subsidence impact performance measure.

Specific performance indicators have been developed for the various infrastructure items and are outlined in the Built Features Management Plan.

Built Features Subsidence Impact Performance Measure

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.*

Neither the performance indicators, nor the built features subsidence impact performance measure was exceeded during the review period.

Heritage Subsidence Impact Performance Measure – Garrawarra Centre Historical or Heritage Significance Items

The Project Approval also requires Metropolitan Coal not to exceed the following heritage 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 3 km from Longwalls 20-22 and at this distance no measurable systematic or non-systematic subsidence movements are anticipated. The subsidence impact performance measure will be assessed as a component of future Extraction Plans.

3.7.4 Management and Mitigation Measures

At this stage the implementation of the Built Features Management Plan and associated management processes are considered to be adequate.

Over the review period, Metropolitan Coal held meetings with infrastructure owners, as well as the RTA Technical Committee which was established to facilitate consultation in regard to the Built Features Management Plan – RTA in relation to the F6 South Freeway and associated bridges.

3.7.5 Further Initiatives

Monitoring of subsidence impacts has occurred in accordance with the Longwalls 20-22 Subsidence Monitoring Program.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Built Features Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

A monthly subsidence status report was developed in relation to the Built Features Management Plan – RTA to be informed of mining progress and the subsidence recorded.

3.8 PUBLIC SAFETY MANAGEMENT PLAN

3.8.1 Background

A Metropolitan Coal Longwalls 20-22 Public Safety Management Plan has been prepared to manage the potential consequences of the Extraction Plan on public safety within the underground mining area in accordance with Condition 6, Schedule 3 of the Project Approval.

3.8.2 Monitoring

Hazards identified in relation to public access to the underground mining area that may arise as a result of the Extraction Plan include:

- damage to fire trails (e.g. cracks);
- dislodgement of rocks onto fire trails or roads;
- dislodgement of rocks from cliffs and overhangs;
- entrapment by fire caused by locked gates;
- vehicle collision with monitoring equipment located near fire trails;
- slips, trips and falls by visitors to the tributaries; and
- snake bite, spider bite or other animal encounter.

Monitoring of cliffs and overhangs, steep slopes and land in general has been conducted for subsidence impacts in accordance with the Land Management Plan, and of infrastructure items in accordance with the Built Features Management Plan. No subsidence impacts were identified during the review 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 review period.

3.8.3 Assessment of Environmental Performance

The monitoring results have been used to assess the Project against the performance indicator and the built features subsidence impact performance measure.

Analysis against Performance Indicator

Performance Indicator: *Public safety will be ensured in the event that any hazard to the general public arising from subsidence effects becomes evident.*

No subsidence impacts were identified during the review period that were considered to pose a risk to public safety.

Analysis against Subsidence Impact Performance Measure

Subsidence Impact Performance Measure:

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

Neither the performance indicator, nor the built features subsidence impact performance measure was exceeded during the review period.

3.8.4 Management and Mitigation Measures

The monitoring information has been used to assess whether any management measures are required in response to subsidence impacts in relation to public safety. No management measures relating to subsidence impacts have been required over the review period in relation to public safety.

The following safety management measures are applicable to persons accessing the Woronora Special Area:

- The *SCA Standard Conditions of Entry,* which outline specific safety controls for authorised personnel accessing the Woronora Special Area.
- The Metropolitan Coal *Catchment Area Induction* and SCA *Catchment Area Induction,* which address the safety of personnel accessing the Woronora Special Area including awareness of SCA Standard Conditions of Entry, suitable Personal Protective Equipment, emergency procedures, other site specific safety protocols outlined in the Environmental Management Plans for catchment works, and the Metropolitan Coal Bushfire Preparedness Plan.
- The Metropolitan Coal *Surface Emergency Management Plan* has been prepared in accordance with the NSW *Coal Mine Health and Safety Act, 2002*, and operates in conjunction with the *First Aid Management Plan* and *Firefighting Capability Management Plan.*

The general public is not permitted to access the Woronora Special Area for any recreational or other purpose.

3.8.5 Further Initiatives

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Public Safety Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

Monitoring of subsidence impacts in relation to public safety will continue in the next review period.

3.9 RESEARCH PROGRAM

3.9.1 Background

In accordance with Condition 9, Schedule 3 of the Project Approval, a Metropolitan Coal Research Program was developed in consultation with the NSW Office of Water, SCA, DECCW and Industry & Investment NSW and submitted to the Director-General of the DP&I during the review period.

The Approval Condition states:

> *The Proponent shall prepare and implement a Research Program for the Project to the satisfaction of the Director General, and allocate $320,000, towards the implementation of the program. This program must:*
>
> *a) be prepared in consultation with DWE, SCA, DECC and DPI*
>
> *b) be submitted to the Director-General for approval by the end of 2010;*
>
> *c) be targeted at genuine research, as opposed to implementing the matters required by this approval; and*
>
> *d) be directed at encouraging research into improving:*
>
> - *the prediction of valley closure and upsidence, and the resultant subsidence impacts;*
> - *the assessment of the environmental consequences of subsidence impacts on natural features;*
> - *the remediation of subsidence impacts on watercourses;*
> - *the understanding of subsidence impacts and their environmental consequences on swamps;*
> - *the conservation of the Eastern Ground Parrot on the Woronora Plateau; or*
> - *the environmental management of underground mining operations in the Southern Coalfield.*

Metropolitan Coal has generally followed the Australian Coal Association Research Program process for the selection of research projects. The selection process included:

- invitation for selected candidates to submit short proposals;
- short listing of projects following an evaluation process;
- invitation to submit full proposals;
- final selection of projects; and
- submission of recommendations to the DP&I for final approval.

The DP&I approved the Metropolitan Coal Research Program on 27 May 2011.

3.9.2 Program Summary

The research program is comprised of three projects that will investigate technical aspects concerning groundwater, subsidence and Eastern Ground Parrot populations on the Woronora Plateau.

The first project is to be undertaken by OEH and will result in the implementation of a targeted regional survey for the Ground Parrot across the Woronora Plateau using bioacoustic monitoring to assess the presence and size of any populations, and establish their relationship to site attributes. The project will establish an experiment using long-term monitoring sites to assess any impact of longwall mining on the species and concurrently assess the status and distribution of the endangered Eastern Bristlebird. This will enable the establishment of a baseline library of digital recordings from swamps across the Woronora Plateau that could be retrospectively analysed for changes in other bird species in the future.

The second project is being conducted by the University of New South Wales, under the supervision of Professor Bruce Hebblewhite. Professor Hebblewhite is undertaking research in the evaluation of fundamental geotechnical mechanisms contributing to valley closure subsidence effects under irregular topographic conditions. Australia has provided world leadership in identifying the now widely accepted phenomenon of valley closure and related valley floor upsidence when mining beneath or in close proximity to valleys and other forms of irregular surface topography. Despite being a widely accepted phenomenon the mechanisms remain unclear. The objective of this project is to carry out a comprehensive program of numerical investigations and calibration studies for a range of different parameters, in order to clearly understand the underlying or driving geotechnical mechanisms which cause this behaviour and hence improve the prediction capabilities.

In the third project Dr Noel Merrick from Heritage Computing will investigate the role played by chain pillars in isolating groundwater pressure reductions above mined longwall panels, and whether they might limit the outwards propagation of pressure reductions and environmental effects. The outcomes of this project will be an improved understanding of the significance of chain pillars with respect to alteration of the groundwater regime, a quantitative appreciation of critical pillar widths in absolute and relative terms and a methodology for transferring geotechnical model outputs to groundwater model inputs (permeability fields).

3.10 CONSTRUCTION MANAGEMENT PLAN

3.10.1 Background

A Metropolitan Coal Construction Management Plan has been prepared for surface construction works (excluding remediation or rehabilitation works) in the Woronora Special Area in accordance with Condition 11, Schedule 3 of the Project Approval. The Construction Management Plan was submitted for approval to the DP&I on 29 April 2011.

3.10.2 Monitoring

The Construction Management Plan includes the proposed construction of two new gauging stations, one on the Eastern Tributary and another on Honeysuckle Creek. Construction would commence following the approval of the Construction Management Plan.

A Construction Management Plan – Performance Indicator Assessment Form will be used to monitor and assess the performance of construction works. The results of the monitoring will be reported in the 2012 Annual Review.

3.10.3 Assessment of Environmental Performance

The performance of the construction activities will be assessed against the performance indicators outlined below.

Performance Indicator 1: *The construction works are/have been conducted as described for the construction site in the Construction Management Plan – Surface Works Assessment Form.*

Performance Indicator 2: *Inspection of the construction works indicates appropriate erosion and sediment controls are/have been installed and are effective.*

Performance Indicator 3: *Inspection of the construction works indicates appropriate fuel and spill management measures are/have been implemented and are effective.*

Performance Indicator 4: *The construction works are/have been conducted in accordance with other management measures described in the Construction Management Plan.*

3.10.4 Management and Mitigation Measures

Management measures will be implemented to minimise potential impacts associated with surface construction works in the Woronora Special Area, including measures relevant to:

- vegetation management;
- Aboriginal heritage management;
- erosion and sediment management;
- fuel and spill management;
- transport management;
- waste management;
- bushfire preparedness and management;
- pest management; and
- site clean up.

The Construction Management Plan – Surface Works Assessment Form will be used to manage the surface construction works.

3.10.5 Further Initiatives

In the next review period, following the approval of the Construction Management Plan, Metropolitan Coal will submit Surface Works Assessment Forms to manage works in the catchment area.

3.11 REHABILITATION MANAGEMENT PLAN

3.11.1 Background

A Metropolitan Coal Rehabilitation Management Plan has been prepared for the underground mining area for areas requiring rehabilitation or remediation measures including surface disturbance areas and stream pool/rock bar remediation in accordance with Condition 4, Schedule 6 of the Project Approval.

3.11.2 Rehabilitation and Remediation Measures

3.11.2.1 Surface Disturbance Areas

A Rehabilitation Management Plan – Surface Disturbance Register will be used to manage the implementation of rehabilitation measures.

No surface disturbance areas were rehabilitated during the review period.

3.11.2.2 Stream Pool/Rock Bar Remediation

Stream remediation activities have commenced at Pools A and F along the Waratah Rivulet in accordance with approvals obtained from the SCA under Part 5 of the EP&A Act.

In the review period, stream remediation activities have been conducted at Pool A and Pool F on the Waratah Rivulet. Stream remediation activities at these pools have included the drilling of holes and the injection of grout (polyurethane resin) into sub-surface fractures. Associated activities have included the mobilisation, placement and operation of equipment and the implementation of a variety of environmental management measures.

In addition, monitoring of Pool G1 on the Waratah Rivulet has indicated that although the pool continues to retain water, the water level in the pool temporarily fell below its cease to flow level (i.e. stopped overflowing). This is consistent with the predictions of the Project Assessment and that authorised by the Project Approval. As described in the Rehabilitation Management Plan, stream remediation activities will commence at Pools G and G1 following completion of remediation activities at Pool F.

3.11.3 Monitoring

3.11.3.1 Surface Disturbance Areas

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

Once a surface disturbance area is no longer being utilised, monitoring is conducted to assess:

- where appropriate, whether equipment/infrastructure items have been removed;
- whether the area is tidy or rubbish removal is required;
- whether erosion and sediment controls are required and if so, the effectiveness of those installed;
- the presence of weeds and the need for the implementation of weed control measures;
- where appropriate, whether vegetation is re-establishing naturally or whether active revegetation is required; and
- if active revegetation is conducted, whether vegetation is establishing.

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

In accordance with the Rehabilitation Management Plan, the Rehabilitation Management Plan – Surface Disturbance Register will be used to monitor the performance of the measures implemented to rehabilitate surface disturbance areas.

3.11.3.2 Stream Pool/Rock Bar Remediation

Monitoring of Pool Water Levels

Water levels in pools on the Waratah Rivulet and Eastern Tributary are monitored in accordance with the Catchment Monitoring Program and Water Management Plan.

Stream remediation will be initiated:

- at pools/rock bars on Waratah Rivulet between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir; or
- at pools/rock bars on the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir

if the water level in a pool falls below its cease to flow level (i.e. stops overflowing), except if as a result of climatic conditions.

An assessment of the monitored pool water levels on Waratah Rivulet between Flat Rock Swamp and the full supply level of the Woronora Reservoir has been conducted, as described below.

Pools A, B, C, E, F, G, G1, H and I on the Waratah Rivulet are situated in the completed mining area (i.e. overlying Longwalls 1 to 13) between Flat Rock Swamp and the tailgate of Longwall 20 (Figure 7).

Pool water level monitoring of Pools A, B, C, E, F, G, G1, H and I are shown on Chart 95.

As a result of previous mining, the water levels in pools upstream of Flat Rock Crossing (i.e. Pools A to G) have been impacted by mine subsidence as described in the Water Management Plan and Rehabilitation Management Plan.

As described in Section 3.11.2, stream remediation activities have commenced at Pools A and F on the Waratah Rivulet. The rock bars at Pools A and F are considered to largely control the pools located upstream of these rock bars. As a result, Metropolitan Coal anticipates that the restoration of surface flow and pool holding capacity at Pools A and F will restore the surface flow and pool holding capacity of pools between Flat Rock Swamp and Pool F. Metropolitan Coal will assess whether stream remediation is required at any additional pools/rock bars between Flat Rock Swamp and Pool F once stream remediation activities at Pools A and F have been completed. Metropolitan Coal will restore surface flow and pool holding capacity at Pools A to G as soon as reasonably practicable.

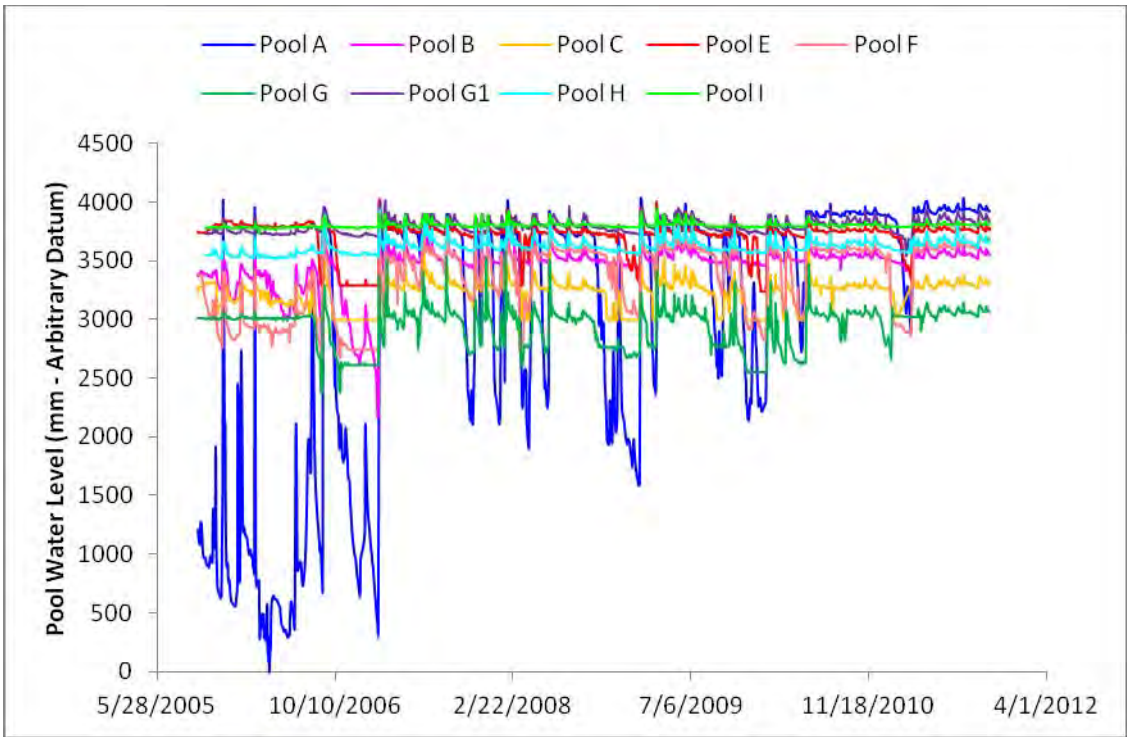


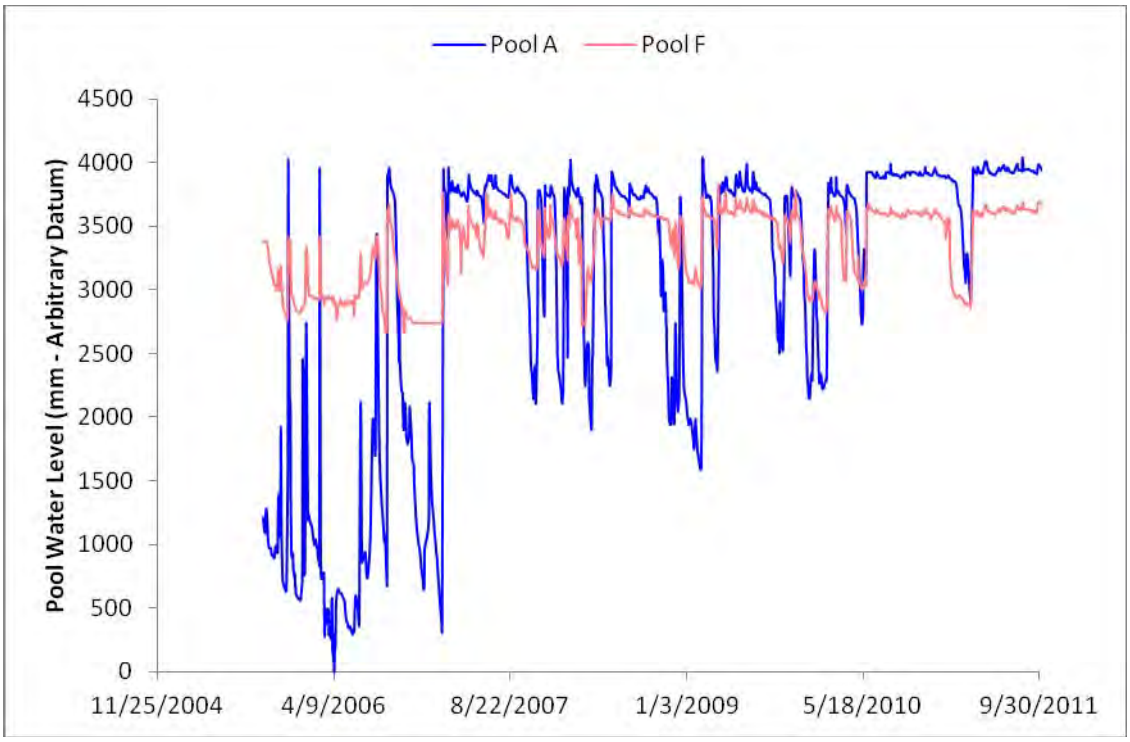
Chart 95 Pool Water Levels in Pools A, B, C, E, F, G, G1, H and I

Pool G1 temporarily fell below its cease to flow level consistent with the predictions of the Project Assessment and that authorised by the Project Approval. As described in the Rehabilitation Management Plan, stream remediation activities will commence at Pools G/G1 following completion of remediation activities at Pool F.

Pool water level monitoring data is available for pools further downstream of Flat Rock Crossing (Pools H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V and W), however cease to flow levels are in the process of being surveyed for all pools except Pools P, R and S. The recorded pool water level response is consistent with natural pool behaviour of pools. The recorded pool water level responses in these downstream pools during low flow periods show the effects of daily temperature fluctuations (refer to Chart 53 for Pool P) but are otherwise consistent with natural pool behaviour and do not exhibit the rapid decline in pool water level observed in pools further upstream which are known to have been affected by subsidence. Pools downstream of Flat Rock Crossing have always been overflowing when observed by Metropolitan Coal personnel during the review period.

Metropolitan Coal is in the process of upgrading the pool water level meter instrumentation in order to remove the effects of daily temperature fluctuations.

Remediation of Pools A and F has been ongoing over the review period. The monitored data show a trend of longer periods of sustained rock bar overflow in both Pools A and F. It is proposed to conduct a formal assessment of recession rates following the completion of remediation works.



Monitoring of Stream Remediation Measures

Stream remediation activities have commenced at Pools A and F on the Waratah Rivulet in accordance with approvals obtained from the SCA under Part 5 of the EP&A Act. An inspection and reporting system has been used to check that suitable environmental controls are in place and working effectively. Water quality monitoring is also conducted prior to the commencement of works and during grouting activities.

During the review period, stream remediation activities have been conducted without any environmental incidents or impacts to the water quality in the Waratah Rivulet.

3.11.4 Assessment of Environmental Performance

3.11.4.1 Surface Disturbance Areas

Analysis against Performance Indicators

Metropolitan Coal will assess the progress of the rehabilitation measures against the following performance indicators:

Redundant equipment/infrastructure items have been removed.

The site is neat and tidy (i.e. it does not contain any rubbish).

No weed management measures are required.

No erosion or sediment control measures are required.

Where appropriate, native vegetation is naturally regenerating or active revegetation is establishing.

No further active revegetation measures are required.

The progress of the rehabilitation will be recorded in the Rehabilitation Management Plan – Surface Disturbance Register and reported in future Annual Reviews.

Analysis against Rehabilitation Objective

When appropriate, an assessment of the site will be made against the rehabilitation objective for other land affected by the Project, *viz*. *Restore ecosystem function, including maintaining or establishing self-sustaining native ecosystems: comprised of local native plant species; with a landform consistent with the surrounding environment*.

The rehabilitation objective will be considered to have been met if:

- the site contains self-sustaining native vegetation (i.e. the vegetation is able to sustain itself, without the implementation of any management measures);
- the vegetation is healthy;
- the native vegetation is comprised of local native plant species, as assessed by a suitably qualified botanist;
- ecosystem function is considered to have been restored (i.e. ecosystem processes [water cycle, nutrient cycle and energy interception] at site scale are functioning well); and
- the landform is consistent with the surrounding environment.

The assessment will be recorded in the Rehabilitation Management Plan – Surface Disturbance Register and the progress of rehabilitation will be reported in Annual Reviews.

3.11.4.2 Stream Pool/Rock Bar Remediation

Analysis against Performance Indicators

Metropolitan Coal will assess the progress of the stream remediation measures against the following performance indicator:

> *Analysis of water level recession rates for a pool indicates a similar pool behaviour to that which existed prior to being impacted by subsidence.*

The water level recession rates performance indicator will be considered to have been met if data analysis indicates there is not a statistically significant change in pool water level recession rates after stream remediation, compared to pool water level recession rates prior to the triggering of stream remediation.

Analysis of water level recession rates will be conducted following completion of stream remediation measures.

Analysis against Rehabilitation Objective

The rehabilitation objective for the Waratah Rivulet between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir and the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir, *viz. Restore surface flow and pool holding capacity as soon as reasonably practicable*, will be assessed using the results of the assessment of the performance indicator and progress reported in Annual Reviews.

3.11.5 Further Initiatives

In the next review period, stream remediation activities will be conducted at Pools A and F on the Waratah Rivulet. Metropolitan Coal will restore surface flow and pool holding capacity at Pools A to F.

Metropolitan Coal will initiate remediation at other pools on the Waratah Rivulet when the appropriate triggers outlined in the Rehabilitation Management Plan are exceeded.

Metropolitan Coal will continue to monitor water levels in pools on the Waratah Rivulet and Eastern Tributary.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Rehabilitation Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4 REVIEW OF ENVIRONMENTAL PERFORMANCE – SURFACE FACILITIES AREA

4.1 NOISE MANAGEMENT PLAN

4.1.1 Background

A Metropolitan Coal Noise Management Plan (NMP) has been prepared for the Major Surface Facilities Area in accordance with Condition 8, Schedule 4 of the Project Approval.

4.1.2 Monitoring

In accordance with the NMP noise monitoring for the Project has consisted of unattended and attended monitoring, as described below.

Real-time Noise Monitoring

Real-time noise monitoring for the Project is undertaken using an unattended statistical noise logger. Real-time noise monitoring is used as an internal Metropolitan Coal noise management tool and not for compliance purposes.

Real-time noise monitoring commenced in December 2010. The real-time noise monitoring site is located at the northern boundary of 16 Oxley Place (Figure 19).

The real-time noise monitor includes the following general specifications:

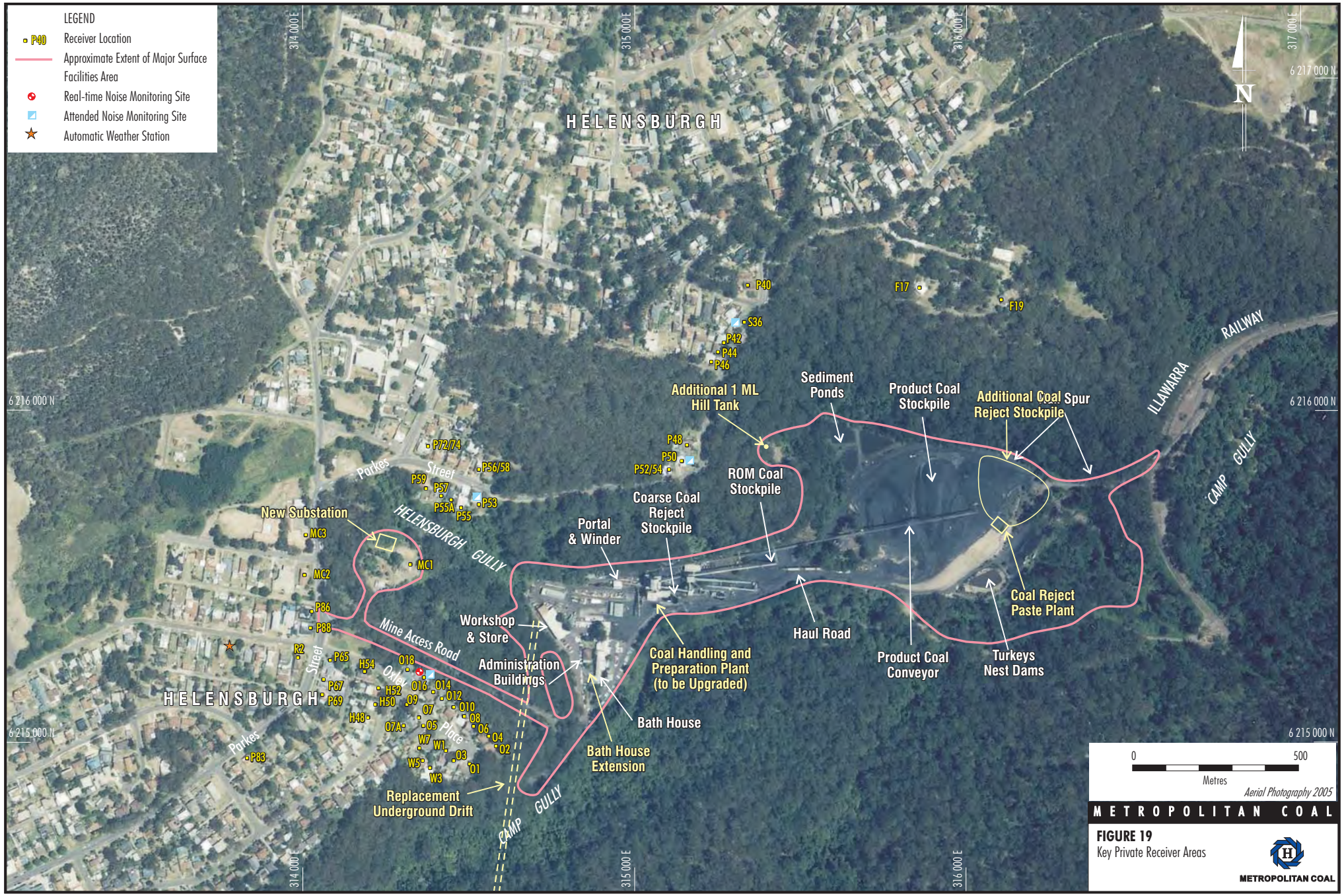
- Records 15 minute statistical noise data.
- Records real-time audio (MP3 or wav) files continuously.
- Produces daily reports, including:
  - 15 minute statistical data ($L_{A10,}$ L_{A90});
  - $L_{Aeq(15\ minute)}$ and $L_{Aeq(period)}$ noise levels;
  - $L_{Aeq(15\ minute)}$ in 1/3 octave; and
  - $L_{Aeq(15\ minute)}$ in the 12.5 to 630 Hertz (Hz) $_{(low\ frequency)}$ range.

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

The continuous recording also includes an audio function which allows the monitor to record audio of the noise signal. This audio information can be downloaded in order to allow the listener to determine whether the noise source is Project related. There are numerous other potential noise sources apart from Project noise, such as insects, frogs, local vehicles, domestic activities (lawn mowers, etc.) and wind and rain, which may influence noise monitoring results.

The real-time monitor was initially set up approximately 20 m east of the rear (eastern) residential boundary of 16 Oxley Place. Following analysis of the results the monitor was moved to be within 5 m of the residential boundary, to provide a more representative measurement of the noise levels at the residential boundary.

The results of the attended surveys conducted at 16 Oxley Place have been compared with those obtained from the real time noise monitor and good correlation was obtained between the attended results and those from the real time noise monitor.



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Attended Noise Monitoring

Continuous real-time monitoring is supplemented by attended noise monitoring, which commenced in September 2010.

Attended noise monitoring is conducted quarterly and additional monitoring may also be conducted in the event of ongoing noise complaints from a particular landholder/locality that requires further investigation.

Results from the attended monitoring program are used to verify data collected from the real-time noise monitor and to track the noise performance of the mine prior to 2014. Post-2014 attended monitoring will be utilised to determine compliance with noise impact criteria.

The NMP requires attended noise measurements and recordings to be conducted quarterly to quantify the intrusive noise emissions from the mine, including processing and transportation operations as well as the overall level of ambient noise. The attended monitoring data has also been used to determine whether there is a consistent relationship between real-time continuous noise levels and long-term attended monitoring data. Consistent with the NMP requirements attended noise monitoring was conducted quarterly for the period from September 2010 until July 2011.

The NMP requires the attended noise monitoring program to be conducted at sites representative of the nearest residences to the Project that are potentially most affected by Project noise emissions and nominates the following as indicated in Figure 19:

- residences to the south-west at 2 to 18 Oxley Place;
- residences to the west north-west at 53 to 59 Parkes Street;
- residences to the north-west at 48, 50, 52/54 Parkes Street; and
- residences further to the north-west at 42, 44 and 46 Parkes Street.

In accordance with the NMP attended noise monitoring was conducted for 15 minute periods during the daytime, evening and night-time periods. The monitoring was carried out on two consecutive days and nights resulting in at least two 15 minute samples for each monitoring location every three months. Daytime monitoring at residences to the south-west at 2 to 18 Oxley Place was conducted in the morning period, to include a representative number of reject and product truck movements on the Mine Access Road.

Consistent with the NMP for the period from September 2010 until July 2011 attended noise monitoring was conducted at:

- 16 Oxley Place;
- 53 Parkes Street;
- 50 Parkes Street; and
- 36 Old Station Road, noting this residence is immediately adjacent to 42 Parkes Street and representative of the nearest residences in this area.

The results of attended noise monitoring are compared against the relevant noise performance indicators and noise criteria.

Attended Monitoring Results

For the four quarterly noise monitoring surveys conducted within the review period, the intrusive $L_{Aeq(15minute)}$ mine-related noise levels were estimated (Tables 25 to 28).

Table 25
Estimated Intrusive LAeq(15minute) Mine-Related Noise Levels - September Quarter 2010

Monitoring Locations	Mine-Related Intrusive LAeq(15minute) (dBA)		
	Day	Evening	Night
16 Oxley Place	51, 52, 52	52, 50, 50	50, 50
53 Parkes Street	52, 57	48, 47	47, 47
50 Parkes Street	48, 49	48, 48	47, 47
36 Old Station Road	44, 44	47, 52	46, 47

Table 26
Estimated Intrusive LAeq(15minute) Mine-Related Noise Levels - December Quarter 2010

Monitoring Locations	Mine-Related Intrusive LAeq(15minute) (dBA)		
	Day	Evening	Night
16 Oxley Place	44, 51, 50, 53	45, 43	45, 43
53 Parkes Street	51, 48	48, 49	47, 47
50 Parkes Street	44, 50	40, 51	42, 48
36 Old Station Road	40, 53	38, 46	37, 46

Table 27
Estimated Intrusive LAeq(15minute) Mine-Related Noise Levels - March Quarter 2011

Monitoring Locations	Mine-Related Intrusive LAeq(15minute) (dBA)		
	Day	Evening	Night
16 Oxley Place	52, 51	50	46, 47
53 Parkes Street	49, 50	49	50, 50
50 Parkes Street	49, 48	47	49
36 Old Station Road	43, 45	45	42

Table 28
Estimated Intrusive LAeq(15minute) Mine-Related Noise Levels - June Quarter 2011

Monitoring Locations	Mine-Related Intrusive LAeq(15minute) (dBA)		
	Day	Evening	Night
16 Oxley Place	51, 52	50, 49	50, 51
53 Parkes Street	49, 50	49	49, 50
50 Parkes Street	48, 49	49, 47	48, 47
36 Old Station Road	45, 50	44, 46	48, 50

Assessment of Monitoring Results

Consistent estimated mine-related noise levels were obtained from the September, March and June surveys, with lower levels on occasion during the December survey as a result of non-operation of the Coal Handling and Processing Plant (CHPP). Furthermore, the attended noise levels recorded at 16 Oxley Place, 53 Parkes Road and 50 Parkes Road were generally constant in noise level as these locations are influenced by continuous noise from the CHPP and conveyors whereas mine-related noise levels at 36 Old Station Road were more varied as a result of mobile plant such as front end loaders and bulldozers associated with the train loading operations.

The attended monitoring results for the four locations when the mine was fully operational are summarised are follows:

- 16 Oxley Place – the typical attended results are 50 dBA to 52 dBA daytime, 49 dBA to 50 dBA evening and 47 dBA to 51 dBA night-time.
- 53 Parkes Road - the typical attended results are 48 dBA to 51 dBA daytime, 48 dBA to 49 dBA evening and 47 dBA to 50 dBA night-time.
- 50 Parkes Road - the typical attended results are 48 dBA to 50 dBA daytime, 47 dBA to 51 dBA evening and 47 dBA to 50 dBA night-time.
- 36 Old Station Road for periods when the mine is fully operational the typical attended results are 40 dBA to 53 dBA daytime, 38 dBA to 52 dBA evening and 37 dBA to 50 dBA night-time.
- Unattended real-time monitor - 16 Oxley Place. The real-time noise monitor has been located at 16 Oxley Place. Higher levels of typically 2 dBA to 3 dBA were recorded by the unattended real-time monitor when compared to the attended location at the rear of the dwelling (approximately 10 m west). The higher levels are considered to result from 'façade reflection' from the acoustically solid rear fence.

Complaints Records

During the review period four complaints relating to operational noise were received by Metropolitan Coal. In response to these complaints, stockpile equipment tonal reversing alarms were replaced with broad spectrum alarms and operational practices relating to the commissioning of continuous miners revised.

In comparison, two operational noise complaints were received in the previous year and four complaints the year before (Section 6).

Given the proximity of the major surface facilities to the nearby private residences (Figure 19) this is considered to be a very low number of noise complaints.

Transport noise complaints are incorporated in traffic complaints (Section 4.4.2).

4.1.3 Assessment of Environmental Performance

Noise performance indicators and impact criteria have been developed in consideration of the predicted impacts of the Project on noise included in the Project EA, as described below.

Assessment against Performance Indicators

Metropolitan Coal has adopted interim noise performance indicators to allow tracking of mine noise improvements and performance, including noise levels at the nearest residential locations at which the Project noise impact criteria will be applicable from the end of 2014.

As described in the Project EA, Metropolitan Coal has, and will be, upgrading and/or extending the existing supporting infrastructure systems at the Major Surface Facilities Area. As noise performance will be linked to the progress of the major surface facilities upgrades, the performance indicators are also linked to the status of the upgrades (Table 29).

None of the relevant noise performance indicators were exceeded during the review period.

Table 29
Noise Performance Indicators

<table>
<tr><th>Status of Major Surface Facilities Upgrades</th><th>Noise Performance Indicator</th><th>Assessment of Noise Performance Indicator</th></tr>
<tr><td rowspan="3">Upgrades Design/ Construction.</td><td>Establishment of a quarterly operational attended noise monitoring program and real-time noise monitoring system at the site by December 2010.</td><td>The performance indicator will be considered to be exceeded if the installation and commissioning of the real-time noise monitor and commencement of quarterly attended noise monitoring is not undertaken prior to 31 December 2010.</td></tr>
<tr><td>Design of the major surface facilities fixed plant upgrades (and any associated mobile plant upgrades) is to be undertaken cognisant of the material noise reductions at the site that will be required.</td><td>The performance indicator will be considered to be exceeded if the formal notification of the design/engineering team is not undertaken.</td></tr>
<tr><td>Undertake noise modelling of the preferred upgrade design prior to construction to determine if sufficient noise reduction is likely to be achieved from the planned fixed and mobile plant upgrades.</td><td>The performance indicator will be considered to be exceeded if the sound power levels audit and noise modelling review (and associated additional design work if necessary) is not undertaken.</td></tr>
<tr><td>Upgrades Commissioned (Pre-end 2014).</td><td>Privately Owned Residences:<table><tr><th>Day $L_{Aeq(15\ minute)}$</th><th>Evening $L_{Aeq(15\ minute)}$</th><th>Night $L_{Aeq(15\ minute)}$</th><th>Night $L_{A1(1\ minute)}$</th></tr><tr><td>53 dB(A)</td><td>48 dB(A)</td><td>48 dB(A)</td><td>53 dB(A)</td></tr></table></td><td>The performance indicator will be considered to be exceeded if the indicator noise levels are not met at the nearest private receivers.</td></tr>
<tr><td>Upgrades Complete (Post-2014).</td><td>Develop real-time noise monitoring performance indicators.</td><td>The performance indicator will be considered to be exceeded if the Noise Management Plan is not updated to include real-time performance indicators prior to 30 June 2014.</td></tr>
</table>

Assessment against Noise Impact Criteria

The Project Approval requires Metropolitan Coal by the end of 2014 to ensure that the noise generated by the Project does not exceed the noise impact assessment criteria in Table 2 of Condition 1, Schedule 4 at any residence on privately-owned land, or on more than 25% of any privately-owned land.

Table 2: Noise Impact Assessment Criteria

Day $L_{Aeq(15\ min)}$	***Evening $L_{Aeq(15\ min)}$***	***Night $L_{Aeq(15\ min)}$***	***Night $L_{A1(l\ min)}$***
50 dB(A)	45 dB(A)	45 dB(A)	50 dB(A)

Notes:

- *To determine compliance with the $L_{Aeq(period)}$ noise limits, noise from the project is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary. Where it can be demonstrated that direct measurement of noise from the project is impractical, alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy) may be accepted. The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*
- *To determine compliance with the $L_{A1(1\ minute)}$ noise limits, noise from the project is to be measured at 1 metre from the dwelling façade. Where it can be demonstrated that direct measurement of noise from the project is impractical, alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy may be accepted.*
- *The noise emission limits identified in the above table apply under meteorological conditions of:*
  - *wind speeds of up to 3 m/s at 10 metres above ground level; or*
  - *temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level, determined in accordance with the NSW Industrial Noise Policy.*

Post 2014, the performance criteria in Table 2 of Condition 1, Schedule 4 will be considered to be exceeded if:

- the recorded noise levels are more than 2 decibels (dB) above the noise criteria specified in the Project Approval; and
- sustained non-compliances are not addressed and rectified.

In addition the Project Approval requires by the end of 2014 that if the noise generated by the Project exceeds the criteria in Table 4 of Condition 1, Schedule 4 at any residence on privately-owned land, Metropolitan Coal will, upon receiving a written request from the landowner, implement reasonable and feasible noise mitigation measures (such as double-glazing, insulation, and/or air conditioning) at the residence in consultation with the landowner. If within 3 months of receiving this request from the landowner, Metropolitan Coal and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General of the DP&I for resolution.

Table 4: Additional Noise Mitigation Criteria

Day $L_{Aeq(15\ min)}$	***Evening $L_{Aeq(15\ min)}$***	***Night $L_{Aeq(15\ min)}$***	***Night $L_{A1(l\ min)}$***
50 dB(A)	45 dB(A)	45 dB(A)	50 dB(A)

Notes: Noise generated by the project is to be measured in accordance with the notes presented below Table 2 of Condition 1

4.1.4 Management and Mitigation Measures

Metropolitan Coal has commenced upgrades to the major surface facilities in the review period and upgrade works will be ongoing over the next few years.

One component of the site upgrades of relevance to major surface facilities noise management is the progressive implementation of additional noise controls.

The following significant noise reduction works were undertaken in the review period at the Major Surface Facilities Area:

- Commissioning of acoustic treatment including double glazed windows to residences abutting the mine in Oxley Place and Parkes Street, Helensburgh.
- Sound insulation cladding designed and installation commenced on the CHPP (Plates 1 to 3).
- Use of a portable noise monitor at sensitive receivers.
- Ordering new drift ventilation fan with superior noise suppression over current fan.
- Ongoing discussions with Pacific National regarding minimisation of night time rolling stock.

While the noise impact assessment criteria described in Section 4.1.3 does not apply until the end of 2014, Metropolitan Coal has commenced addressing aspects of the noise impact criteria in Table 29, including:

- the design of major surface facilities upgrades cognisant of the material noise reductions that will be required, including the notification of the lead upgrade design contractors of the noise impact assessment criteria that need to be achieved;
- ongoing works associated with the noise monitoring program in accordance with the NMP (e.g. selection of permanent monitoring location, confirmation of solar power system requirements and alert systems);
- the potential noise impact of a mobile crusher associated with the paste plant was determined based on noise measurements during commissioning of the equipment. The site specific noise model was used to predict noise levels at the nearest receivers and equipment operational hours determined; and
- a number of options for upgrading of the washery building cladding were evaluated to determine their relative noise mitigation. The options included the provision of internal acoustic absorption within the washery building, combined with alternative cladding options. The site specific noise model was used to predict noise levels at the nearest receivers.

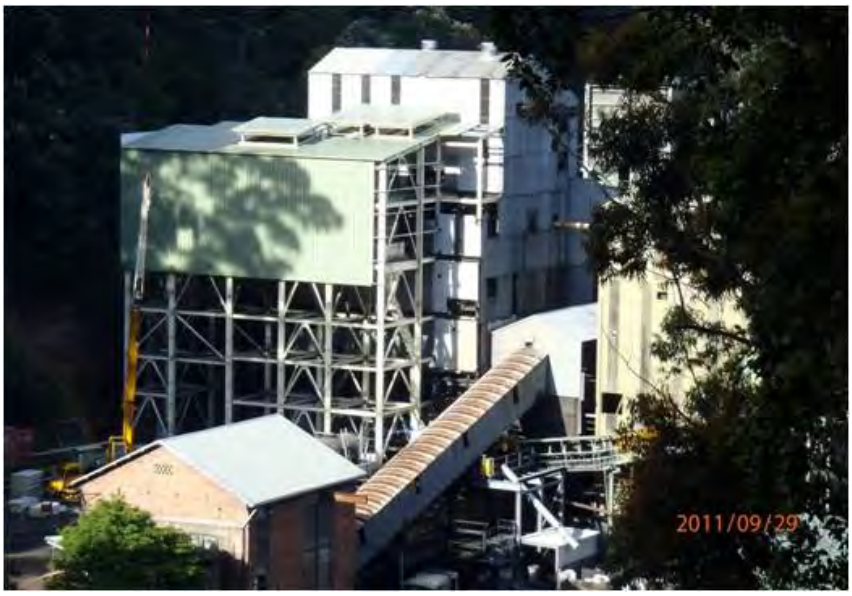

Plate 1 CHPP Installation of Noise Insulation

Plate 2 CHPP Installation of Noise Insulation

Plate 3 Noise Insulation Sheets

Furthermore whilst the '*Additional Noise Mitigation Criteria*' of Table 4 from the Project Approval does not apply until the end of 2014, Metropolitan Coal has taken a proactive approach and commissioned noise mitigation works in the form of double glazing for neighbouring residences in consultation with the landowners. The criteria for eligibility for double glazing was informed by an independent acoustic study.

4.1.5 Further Initiatives

In accordance with the Noise Management Plan, an audit of Metropolitan Coal's on-site sound power levels and noise modelling review has been initiated and will continue in the next review period. The sound power level audit will be used to quantify the noise performance improvements associated with the noise cladding insulation at the CHPP, installation of the coal reject impactor associated with the underground emplacement project and to identify other areas where reasonable and feasible noise attenuation may be able to be implemented.

The Project upgrades of the Major Surface Facilities Area will continue in the next review period and are anticipated to include:

- upgrades of the CHPP;
- ongoing development of the underground emplacement plant and injection trials which will result in reduced trucking of rejects off-site;
- commissioning of the electrical upgrade project resulting in the decommissioning of the temporary diesel generators;
- design finalisation of the material handling systems, incorporating the replacement drift and associated coal conveyors;
- design finalisation of the upgrades to supporting infrastructure such as the workshop, stores, etc.;
- continuation of cladding upgrades for the large coal circuit of the CHPP; and
- installation of a new drift fan utilising noise attenuation technologies.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Noise Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4.2 AIR QUALITY AND GREENHOUSE GAS MANAGEMENT PLAN

4.2.1 Background

The Metropolitan Coal Air Quality and Greenhouse Gas Management Plan prepared for the surface facilities area in accordance with Condition 13, Schedule 4 of the Project Approval was approved by the DP&I on 14 April 2011.

4.2.2 Monitoring

The Metropolitan Coal air quality monitoring network consists of the following components:

- ten dust deposition gauges to monitor monthly dust fall out;
- one High Volume Air Sampler (HVAS) to measure 24 hour average particulate matter less than 10 microns (µm) (PM_{10}) concentrations on a 6-day cycle;
- one Tapered Element Oscillating Microbalance (TEOM) monitor to measure PM_{10} in real-time (installed in December 2010) (Plate 4); and
- one Automatic Weather Station.

The dust deposition and PM_{10} monitoring results are described below.

Plate 4 Metropolitan Coal TEOM

Deposited Dust

Monthly dust deposition rates are measured at ten dust gauges (DG1 to DG10) (Figure 20).

Of the ten dust deposition gauges, five are monitored for compliance with Environment Protection Licence (EPL) 767 (DG1 to DG5). The remaining five dust gauges (DG6 to DG10), as well as the EPL dust gauges are used by Metropolitan Coal to guide operations and monitor the performance of on-site dust controls. It should be noted that DG4 is a control dust gauge that is located at the Helensburgh Golf Course some 2 km from the Major Surface Facilities Area.

Out of a possible 120 samples (10 sites over 12 months) for the reporting year, 115 were collected, resulting in a primary data recovery rate of 96%. Notably, in July 2011 sample holders at 5 of the 10 sites were dropped by the consultant (DG1, 2, 6, 7 and 10) and that there was possible overflow of dust from the sample holders on the remaining 5 sites (DG3, 4, 5, 8 and 9). Due to this issue, these 10 samples have been excluded from calculations. Therefore, the data recovery rate of dust deposition results for the year is 92%.

The annual average dust deposition rates for the dust deposition monitoring results for the review period are presented in Table 30, and the monthly dust deposition monitoring results are shown in Chart 96.

Table 30
Annual Average Dust Deposition Rates

Location	Site ID	Dust Deposition (g/m^2/month)
136 The Crescent [EPA ID 1/H]	DG1	1.0
28 Old Station Road [EPA ID 2]	DG2	1.0
Mine Entrance [EPA ID 3]	DG3	6.8
Helensburgh Golf Course [EPA ID 4]	DG4	1.5
83 Parkes Street [EPA ID 5]	DG5	1.0
55 Parkes Street [EPA ID 6]	DG6	0.8
32 Old Station Road	DG7	1.7
88 Parkes Street	DG8	1.6
Helensburgh Public School	DG9	1.0
Helensburgh Private School	DG10	1.6

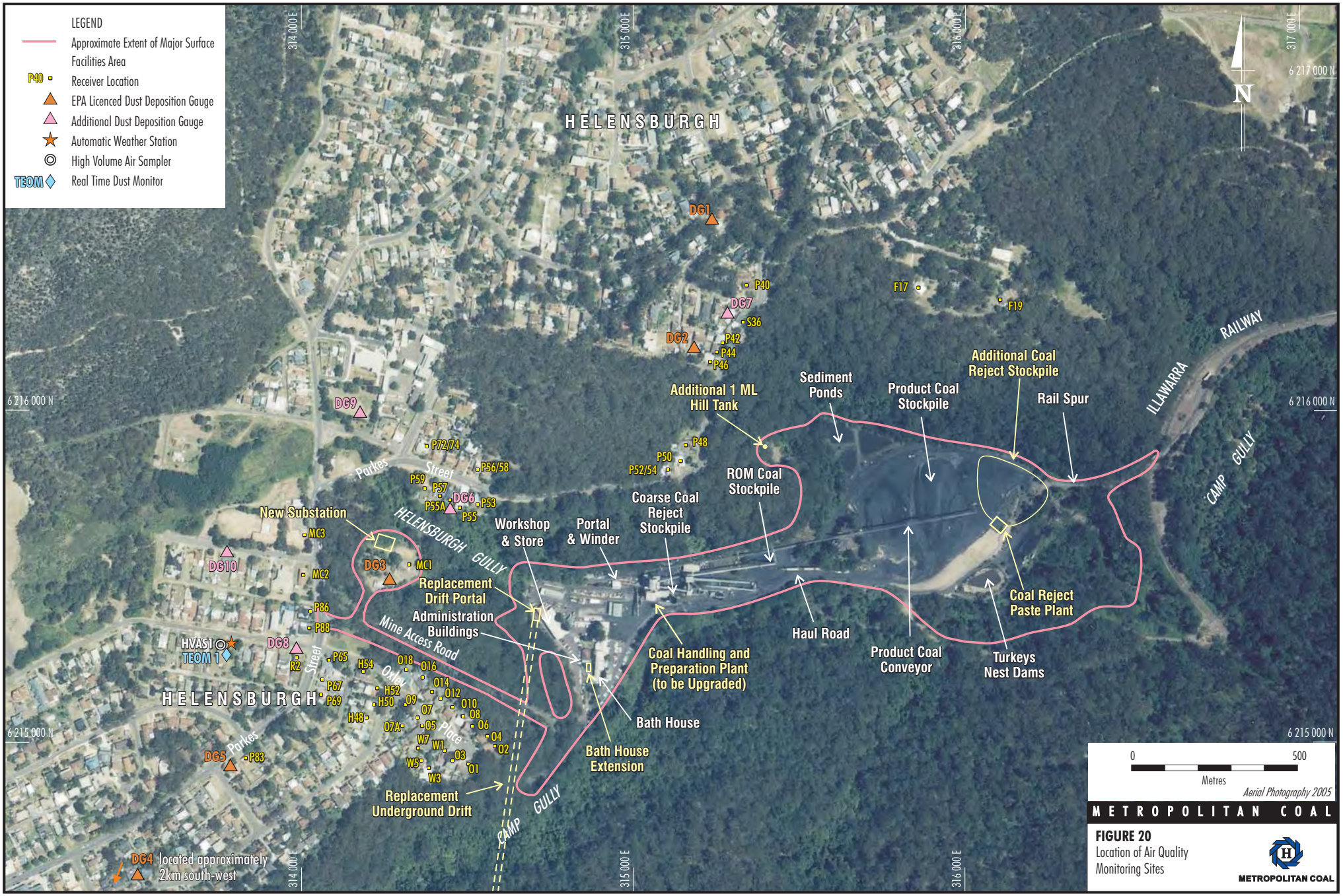

FIGURE 20
Location of Air Quality Monitoring Sites

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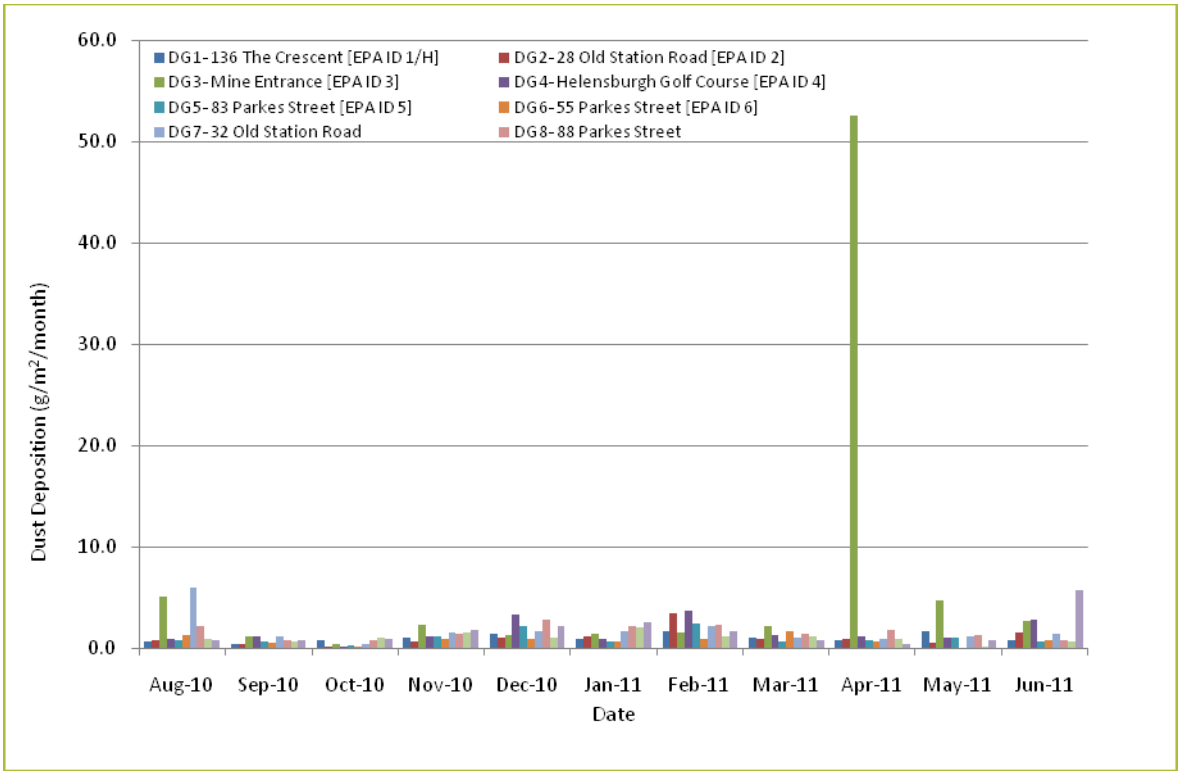


Chart 96 Dust Deposition Monitoring Data

The annual average of dust deposition at the mine entrance (DG3) is higher than the relevant air quality impact assessment criteria (maximum total deposited dust level of 4 g/m^2/month [annual average]). A review of the monthly dust deposition monitoring results in Chart 96 clearly shows that there is an anomaly in the DG3 monitoring results during April 2011. Given the magnitude of the result, which is well in excess of typical dust loading rates expected for an active mine, the recording of 52 g/m^2/month is considered to be an erroneous event, associated with sample contamination. Furthermore, dust gauges DG6, 8, 9 and 10 which are located within the vicinity of DG3 recorded low dust levels during April 2011.

Recalculations excluding these outlying record results in a significant decrease of the annual average deposited dust level at DG3, from 6.8 to 2.2 g/m^2/month. This new value is considered with the other monitoring results in Table 30, the annual averages for deposited dust at all 10 sites are well within the annual average impact assessment criteria of 4 g/m^2/month.

The high reading of 52.5 g/m^2/month has not been used for the calculations proceeding forward. Therefore, the final data recovery rate for dust deposition data for the period August 2010 to June 2011 is 91%.

Annual average dust deposition monitoring results from August 2004 to June 2011 are presented in Chart 97. Higher dust deposition levels were recorded at the majority of the dust gauges during the 2009/2010 review period due to the dust storms and bushfires in NSW during October 2009.

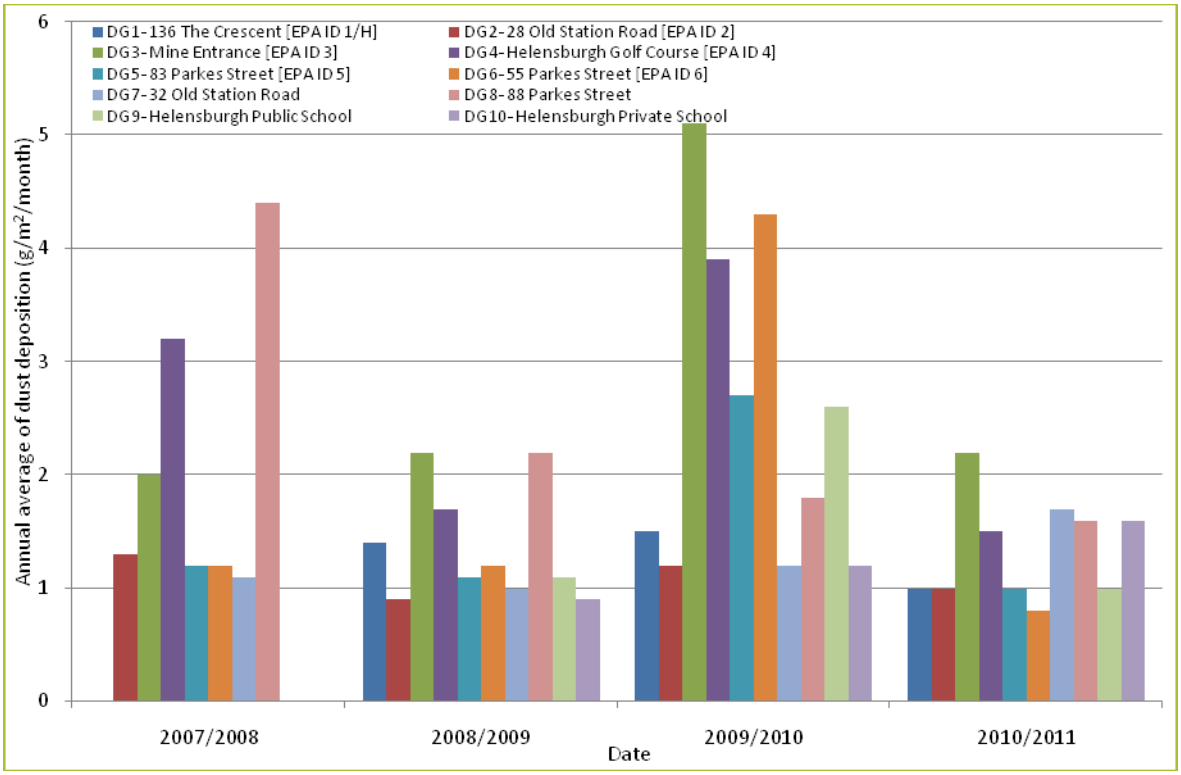


Chart 97 Trends in Annual Average Dust Deposition 2007 to 2011

Particulate Matter

One TEOM and one HVAS are located near the Metropolitan Coal Mine (Figure 20). The TEOM allows for continuous measurement of PM_{10} concentrations, at five-minute intervals, while the HVAS provides an average PM_{10} concentration for a specific 24-hour period, on a six-day cycle. A discussion of PM_{10} monitoring results obtained by both TEOM and HVAS is provided below.

Tapered Element Oscillating Microbalance

Metropolitan Coal installed a TEOM to measure PM_{10} concentrations in real-time and developed associated data review and trigger based systems for on-site dust management in December 2010. The location of the TEOM is in close proximity to the mine as illustrated on Figure 20.

Chart 98 shows a plot of the 24-hour average PM_{10} concentration from 1 December 2011 to 31 July 2011.

The highest 24-hour average PM_{10} concentration during the monitoring period was 71.9 $\mu g/m^3$, recorded on 10 March 2011 (above the PM_{10} 24-hour impact assessment criteria of 50 $\mu g/m^3$). It is considered that this elevated recording was associated with prescribed burning being conducted in the Helensburgh area between 4 and 9 March 2011.

An annual average PM_{10} concentration cannot be calculated as only nine months of monitoring data was available at the time of this analysis. However, the average for this period of recorded data was 10.6 $\mu g/m^3$.

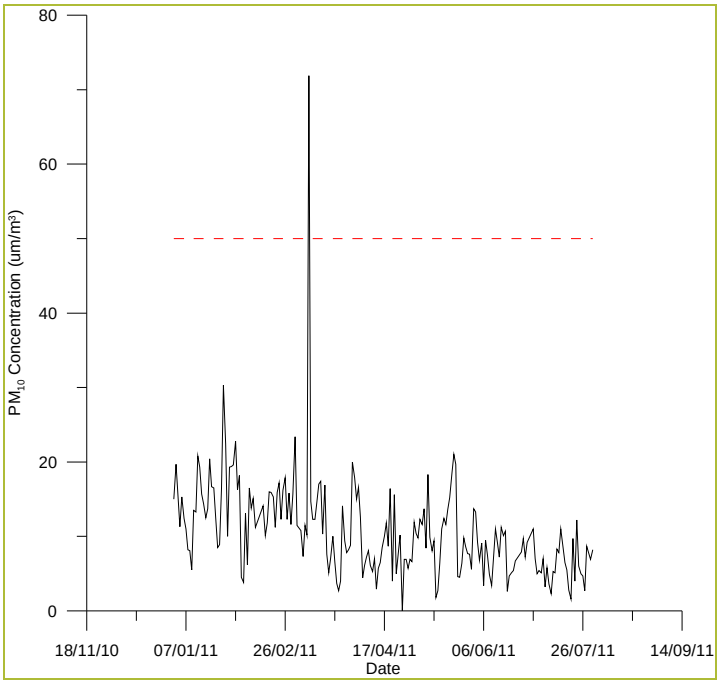


Chart 98 24-Hour Average PM10 Concentration (TEOM) December 2010 to July 2011

High Volume Air Sampler

A HVAS has been installed at the Metropolitan Coal Mine to measure 24-hour PM_{10} concentrations on a six-day cycle. The 24-hour PM_{10} monitoring results recorded at the HVAS during the review period are shown in Chart 99.

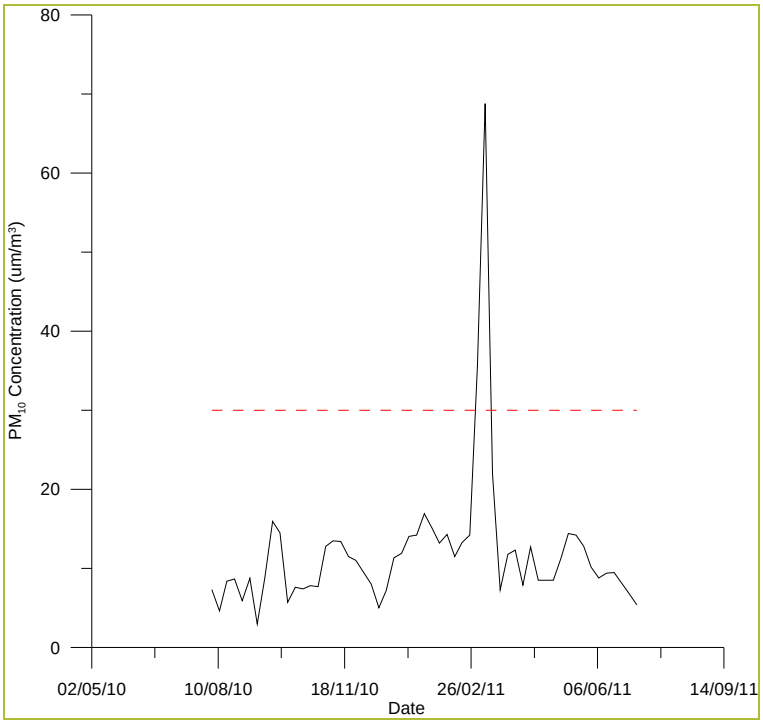


Chart 99 24-Hour Average PM10 Concentration (HVAS) August 2010 to July 2011

The annual average PM_{10} concentration during the review period at the HVAS monitor is 11.8 µg/m^3.

The HVAS data shows one exceedance (68.8 µg/m^3) of the 24-hour average PM_{10} air quality impact assessment criteria (50 µg/m^3) on 9 March 2010, consistent with the timing of the prescribed burning event discussed above. It is likely that the shift in date that the two high results were recorded by the TEOM and the HVAS is simply due to the different times the data was averaged (HVAS are typically run midnight to midnight).

To further investigate the cause of these exceedance events, windroses showing wind data collected on 9 and 10 March 2011 at the automatic meteorological station are presented in Chart 100. The windroses show that winds on 9 March 2011 were predominately from the west and west-north west. Winds on 10 March 2011 were predominantly experienced from the south-east. As the mine is positioned to the east of the TEOM and HVAS monitors (Figure 20), it is unlikely the high PM_{10} readings on 9 and 10 March 2011 were due to mine generated dust.

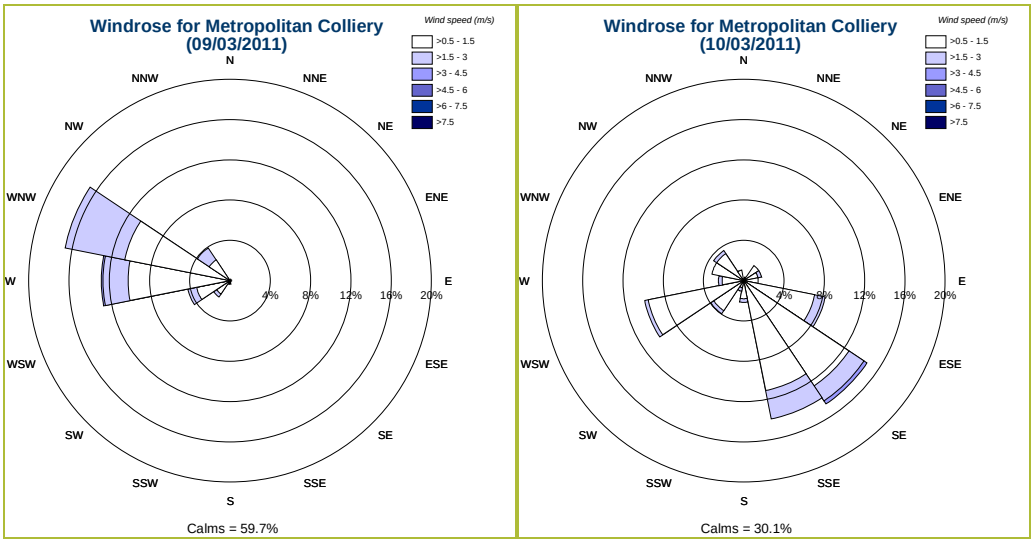


Chart 100 Windroses for 9 and 10 March 2011

Long-term PM_{10} Analysis

Chart 101 shows the 24-hour average PM_{10} concentrations from 2007 to 2011. There are two periods where the data is missing, one from 17 March 2009 to 6 April 2009 and another from 28 August 2009 to 28 January 2010 due to maintenance issues. Chart 101 shows that there are a higher number of elevated measurements (over 50 µg/m^3) in the 2009/2010 period relative to the previous two 12 month periods as well as the 2010/2011 period.

Chart 102 shows the annual average PM_{10} concentrations from 2007 to 2011. The annual average PM_{10} concentrations during 2007/2008 and 2008/209 were stable around 15 µg/m^3, followed by a 10 µg/m^3 increase in 2009/2010. However, in the review period the annual average is at a lower level in comparison to the previous three years.

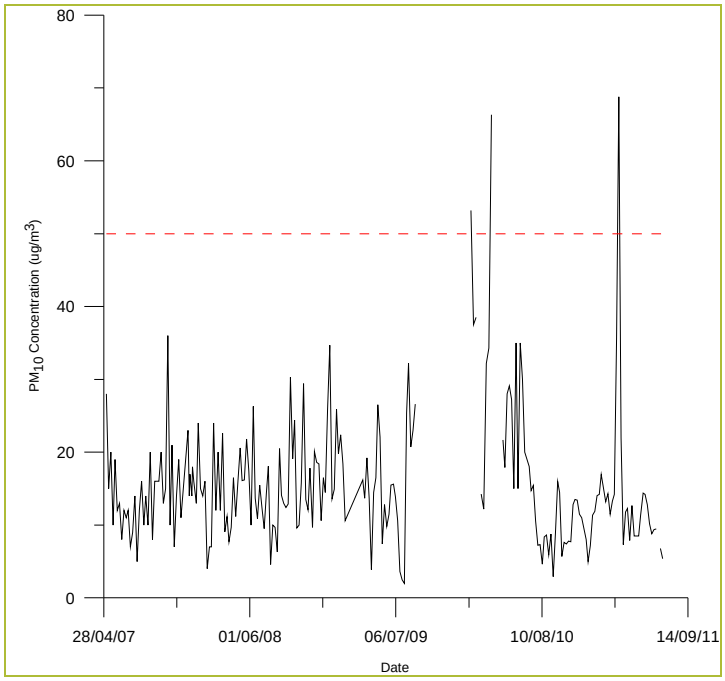


Chart 101 24-Hour Average PM_{10} Concentration (HVAS) 2007 to 2011

Chart 102 Annual Average PM_{10} Concentration (HVAS) 2007 to 2011

Complaints Records

Metropolitan Coal records mine related complaints in a complaint register as described in Section 6.

One dust related complaint was received in the review period. This is an improvement on the number of dust complaints received during the previous review period (two) and historical data, which ranges between two to four dust related complaints per year (Section 6).

4.2.3 Assessment of Environmental Performance

Air quality performance indicators and impact criteria have been developed in consideration of the predicted impacts of the Project on air quality included in the Project EA, as described below.

Assessment against Performance Indicators

Establishment of the Real-Time Monitoring System

Metropolitan Coal installed a TEOM to measure PM_{10} in real-time and associated data review and trigger based systems for Metropolitan Coal on-site dust management in December 2010.

Monitoring Performance Indicators

In accordance with the Air Quality and Greenhouse Gas Management Plan, Metropolitan Coal has assessed the Project against the air quality performance indicators outlined in Table 31.

Table 31
Internal Air Quality Performance Indicators

Pollutant	Averaging Period	Monitoring Point	Performance Indicator[1, 2]
PM_{10}	24 hour	HVAS1	37.5 µg/m^3
	Annual		25 µg/m^3
Deposited Dust	Annual	Metropolitan Coal Dust Gauges excluding DG4	3 g/m^2/month

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

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

HVAS1 = High Volume Air Sampler 1 µg/m^3 = micrograms per cubic metre g/m^2/month = grams per square metre per month

As the abnormal dust deposition level recorded at DG3 in April 2011 has been excluded from the monitoring data, compliance with the deposited dust performance indicator (3 g/m^2/month) was achieved during the review period.

Charts 98 and 99 show one 24-hour PM_{10} measurement above the performance indicator (37.5 µg/m^3) however, this was associated with prescribed burning activities in the local area, and as noted under Table 31, extraordinary events (including prescribed burning) are excluded. As such, there were no exceedances of the PM_{10} 24-hour performance indicator during the review period.

The annual average PM_{10} concentration measured at the HVAS was 11.8 µg/m^3 which is lower than the annual average PM_{10} performance indicator of 25 µg/m^3.

Assessment against Air Quality Impact Criteria

The Project Approval requires Metropolitan Coal to ensure that dust generated by the Project does not cause additional exceedances of the air quality impact assessment criteria listed in Tables 5, 6 and 7 of Condition 11, Schedule 4 at any residence on privately-owned land, or on more than 25% of any privately-owned land.

Table 5: Long term impact assessment criteria for particulate matter

Pollutant	***Averaging period***	***Criterion***
Total suspended particulate (TSP) matter	Annual	90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	30 µg/m^3

Table 6: Short term impact assessment criterion for particulate matter

Pollutant	***Averaging period***	***Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	50 µg/m^3

Table 7: Long term impact assessment criteria for deposited dust

Pollutant	***Averaging period***	***Maximum increase in deposited dust level***	***Maximum total deposited dust level***
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Note: Deposited dust is assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter – Deposited Matter - Gravimetric Method, or its latest version.

Deposited Dust

One unusually high deposited dust measurement was recorded in April 2011 at the dust gauge located at the mine entrance (DG3) which, due to its magnitude, was treated as an anomaly and excluded from the calculations.

Compliance with the dust deposition impact assessment criteria was achieved during the review period.

Particulate Matter

One exceedance of the 24-hour average PM_{10} impact assessment criteria was recorded during the review period, however the analysis described above indicates that mine-related activities were unlikely to be the cause of the exceedance, rather, the high recording was likely due to prescribed burning in the local area. It is therefore considered that compliance with the 24-hour PM_{10} impact assessment criteria was achieved during the review period.

The HVAS recorded annual average PM_{10} value of 11.8 µg/m^3, well below the annual average PM_{10} air quality impact assessment criteria of 30 µg/m^3.

Annual average total suspended particulate (TSP) concentrations can be estimated from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000). Use of this relationship indicates that the annual average TSP concentration for the review period is approximately 30 µg/m^3, well below the relevant performance indicator.

4.2.4 Management and Mitigation Measures

A number of measures have been implemented to manage and mitigate air quality impacts at Metropolitan Coal, including:

- enclosing conveyor systems;
- the operation of automated water sprays on conveyors, transfer points and stockpile areas based on real time meteorological data;
- watering of haulage roads and stockpile areas with a water truck when required;
- progressive sealing of car parks and yard areas;
- the use of chemical dust suppressant on unsealed haulage roads;
- planting of native plants on exposed areas to stabilise soils;

- audit of greenhouse gas data acquisition processes; and
- acquisition of a Dustrak for use as a supplementary real-time monitoring tool for responding to specific dust complaints as required. The portable particulate monitor may also be used periodically to monitor particulate levels upwind and downwind of the site to review the effectiveness of on-site controls.

Metropolitan Coal has also implemented the following measures to minimise dust emissions associated with off-site coal and coal reject haulage:

- underground coal emplacement project minimising coal reject trucking;
- a project implemented to maximise coal yield thereby reducing reject trucking;
- automatic covers have been fitted to coal reject haulage trucks;
- automatic or manual covers have been fitted to coal haulage trucks;
- audits have been performed to ensure haulage truck covers are being used appropriately;
- all haulage vehicles are required to pass through a truck wash before leaving the site;
- the mine entrance road is washed five days per week;
- the mine entrance road is scrubbed using a road sweeper and then washed each Saturday; and
- a sweeper/sucker is operated on Parkes Street by Metropolitan Coal four days per week and one day per week by the Wollongong City Council.

4.2.5 Greenhouse Gas Management

Condition 10, Schedule 4 of the Project Approval requires that Metropolitan Coal implement all reasonable and feasible measures to minimise:

a) energy use on site; and

b) the scope 1, 2 and 3 greenhouse gas emissions produced on site,

to the satisfaction of the Director-General of DP&I.

Scope 1 and Scope 2 greenhouse gas emissions are emissions due to the operation of the Project and consumption of electricity on-site. Scope 3 greenhouse gas emissions are emissions that will result from the off-site transport and burning of the coal produced by the Project, plus emissions associated with the production of diesel that is used on-site.

Table 32 below outlines the key greenhouse gas emission sources at the Project and the respective scope of emissions.

Energy Savings Action Plan

Under the NSW Government's Energy Efficiency Action Strategy, high energy users are required to implement *cost effective* energy saving measures identified in their Energy Savings Action Plans (ESAP).

The ESAP for Metropolitan Coal was formally accepted in January 2008. Annual Reports are required and the ESAP is to be reviewed and updated every four years. The first Annual Report for Metropolitan Coal was released in March 2010 (Metropolitan Coal, 2010d) as a composite report for 2008 and 2009.

Energy savings are seen as an important component of Peabody Energy Australia's commitment to sustainable development. The energy savings measures that have been put into place have resulted in energy savings of more than 1,430 gigajoules (GJ) per annum, more than 890 tonnes of CO_2 and a reduction in the electricity demand of more than 50 kilovolt amps. Table 33 shows energy saving actions that have been completed over the previous five years.

Table 32
Summary of Project CO_2-e Emission Sources

Project Component	Direct Emissions (Scope 1)	Indirect Emissions (Scope 2)	Indirect Emissions (Scope 3)
Consumption of diesel fuel to power on-site equipment.	Emissions from the combustion of diesel during operations.	N/A	Emissions attributable to the extraction of diesel fuel.
Electricity consumption.	N/A	Emissions resulting from generation of the electricity consumed during operations.	Emissions attributable to the extraction of fuel used in electricity generators.
Coal extraction (gas flaring and ventilation).	Emissions resulting from venting or burning methane and venting carbon dioxide (CO_2).	N/A	N/A
Transporting product and reject coal by truck.	N/A	N/A	Emissions from the combustion of diesel from third-party truck operators.
Transporting product coal by train.	N/A	N/A	Emissions from the combustion of diesel from third-party train operators.
Steelmaking.	N/A	N/A	Emissions generated from off-site coke usage for steel and iron production.

Table 33
Completed Energy Savings Actions over Previous Five Years

Description	Annual Savings (gigajoules [GJ])	Annual Greenhouse Gas Savings (tonnes CO_2-e)	Status
Increased conveyor maintenance frequency to reduce friction losses and wear.	Not estimated[1]		Completed
High efficiency motor replacement policy.	Not estimated[1]		Completed
Installation of Current Transformer on hot water system to monitor load on Supervisory Control and Data Acquisition (SCADA) and detect failures.	Not Applicable[2]		Completed
Low impendence transformer purchasing policy.	Not estimated[1]		Completed
Redundant equipment disconnection policy.	> 360	> 100	Completed
Replace existing heat coil ducting with heat pumps.	Abandoned as not technically feasible		
Compressed air receiver installation.	359	98	Completed
Compressed air review and ongoing 10% leakage reduction.	35	10	Completed
Surface lighting optimisation.	35	10	60% complete

[1] Annual savings not estimated as these are measures that will provide minor efficiency gains over an extended period (e.g. gains of approximately 0.5% to 4% on power demand from these components). Minor ongoing efficiency savings will continue as a result of these policies.

[2] This is a monitoring system to evaluate the load on, and efficiency of, the hot water system.

The increasing ROM coal production at the Metropolitan Colliery will increase electricity demand as the throughput of coal handling and processing systems increases. Approved construction activities (e.g. construction of the Replacement Drift) are also likely to increase site electricity demand in the short term.

However, upgrades to the major surface facilities, materials handling systems and ventilation will provide significant opportunities to improve the energy efficiency of the operations (i.e. energy demand per tonne of coal produced).

Metropolitan Coal is also continuing to progressively replace old fluorescent lighting with modern high efficiency lighting.

Reporting on additional actions to improve the energy efficiency of the site will be provided in ESAP Annual Reports and also in the Annual Reviews completed under the Project Approval.

4.2.6 Further Initiatives

Metropolitan Coal will improve ventilation gas monitoring to help refine gas concentration measurements in ventilation air.

Metropolitan Coal's revegetation program will continue during the next review period to stabilise exposed areas and minimise wind-blown dust emissions.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Air Quality and Greenhouse Gas Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4.3 SURFACE FACILITIES WATER MANAGEMENT PLAN

4.3.1 Background

A Metropolitan Coal Surface Facilities Water Management Plan prepared for the surface facilities area and two ventilation shaft sites in accordance with Condition 15, Schedule 4 of the Project Approval was approved by the DP&I on 14 April 2011.

4.3.2 Monitoring

The surface facilities water management system is monitored by Metropolitan Coal, as described below.

Meteorology

Daily total rainfall and rainfall intensity are measured at the Metropolitan Coal meteorological station at Robertson Street in Helensburgh. The rainfall data is used as an input to the surface facilities water balance model.

The total rainfall recorded during the review period was 1,200 mm. The total monthly rainfall data for the review period is shown in Chart 103.

Water Use

Flow meters at key points in the water management system monitor flow rates using an electronic system and manual (weekly) readings. Manual weekly readings have been recorded during the review period while the electronic system is scheduled for additional monitors and improvements.

Metropolitan Coal used approximately 185 ML of potable town water (as recorded by the Sydney Water meter) during the review period, with a monthly average of approximately 15 ML. The amount of town water used over the review period is shown in Chart 103. Metropolitan Coal also sourced approximately 95 ML of water from Camp Gully during the review period.

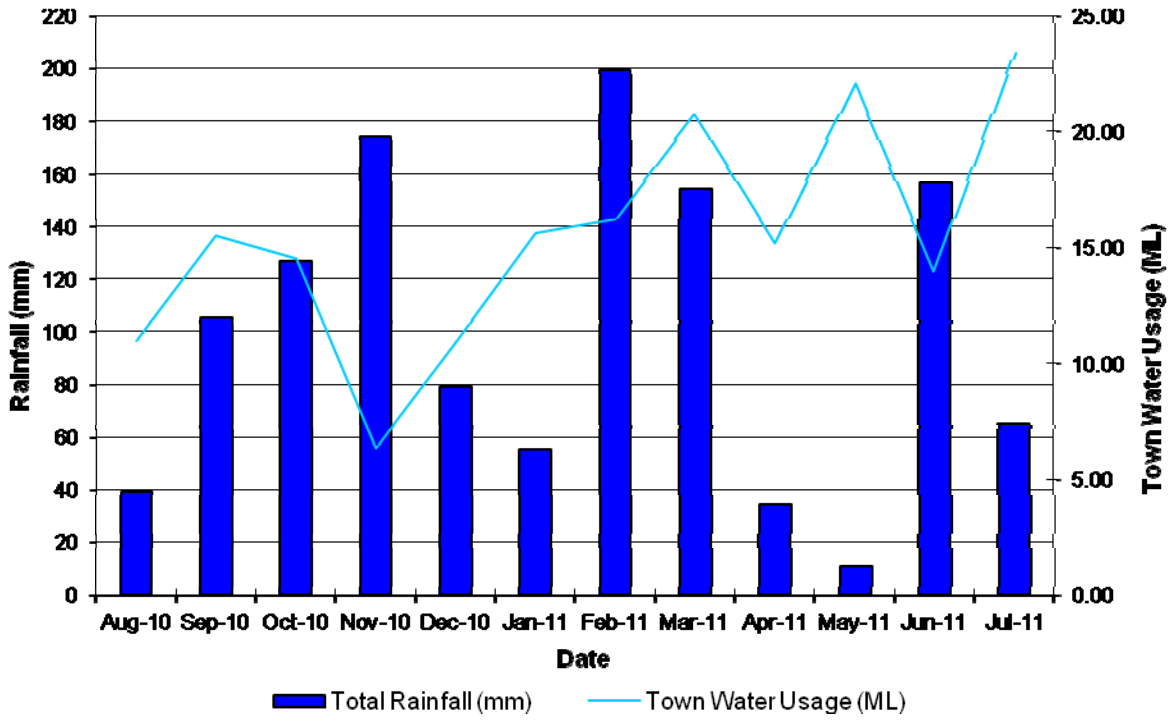


Chart 103 Rainfall and Town Water Use during the Review period

Licensed Discharge

Water discharged from the Water Treatment Plant to Camp Gully is monitored in accordance with EPL No. 767, which requires Metropolitan Coal to continuously monitor the volume (kilolitre/day) of water discharged from the clean water tank in the Water Treatment Plant to Camp Gully.

The total amount of water discharged from the Water Treatment Plant to Camp Gully during the review period was 156 ML.

Water Quality

Surface water quality monitoring is conducted at EPL No. 767 monitoring point 9 (clean water tank of the water treatment plant), if discharge is occurring to Camp Gully. Water quality parameters for EPL No. 767 monitoring point 9 include: pH (pH units), oil and grease (mg/L) and total suspended solids (mg/L).

The levels of pH recorded at EPL No. 767 monitoring point 9 during the review period ranged from 7.6 to 8.6, with an average of 8.4 (Chart 104).

Oil and grease concentrations recorded at EPL No. 767 monitoring point 9 during the review period ranged from less than the detection limit (<5 mg/L from August 2010 and <2 mg/L from September 2011 to July 2011) to 4 mg/L (Chart 105).

Total suspended solids during the review period ranged from <2 mg/L to 19 mg/L, with a monthly average of 8.8 mg/L (Chart 106).

The site water management system continuously monitors total suspended solids and prevents discharges of water that exceeds the criteria. Water that exceeds the criteria is treated further to ensure that only water which meets the acceptable criteria is discharged.

In addition, monthly surface water quality monitoring at four sites on Camp Gully commenced during the review period. More frequent (i.e. event-based) sampling is conducted at the Camp Gully sites during larger rainfall events (i.e. greater than 25 mm/day). Water quality parameters sampled include: pH (pH units), electrical conductivity (microSiemens/cm), oil and grease (mg/L), total suspended solids (mg/L), dissolved oxygen (% Saturation and mg/L) and oxygen reduction potential (milliVolts). An analysis of the monitoring results from these sites will be included in the next Annual Review.

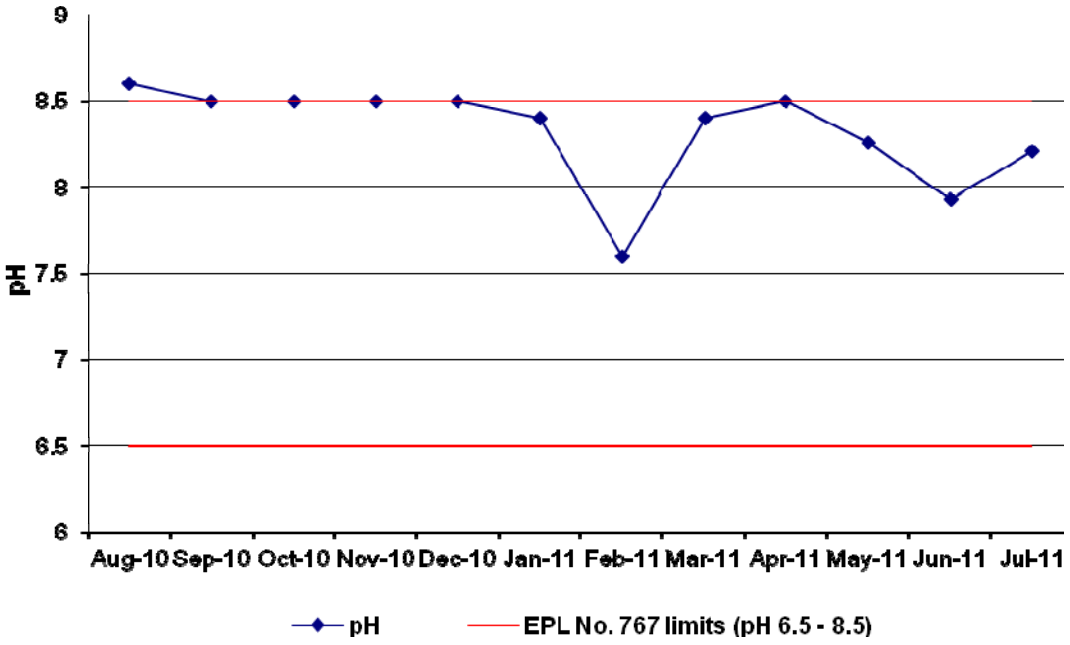


Chart 104 pH recorded at EPL No. 767 Monitoring Point 9

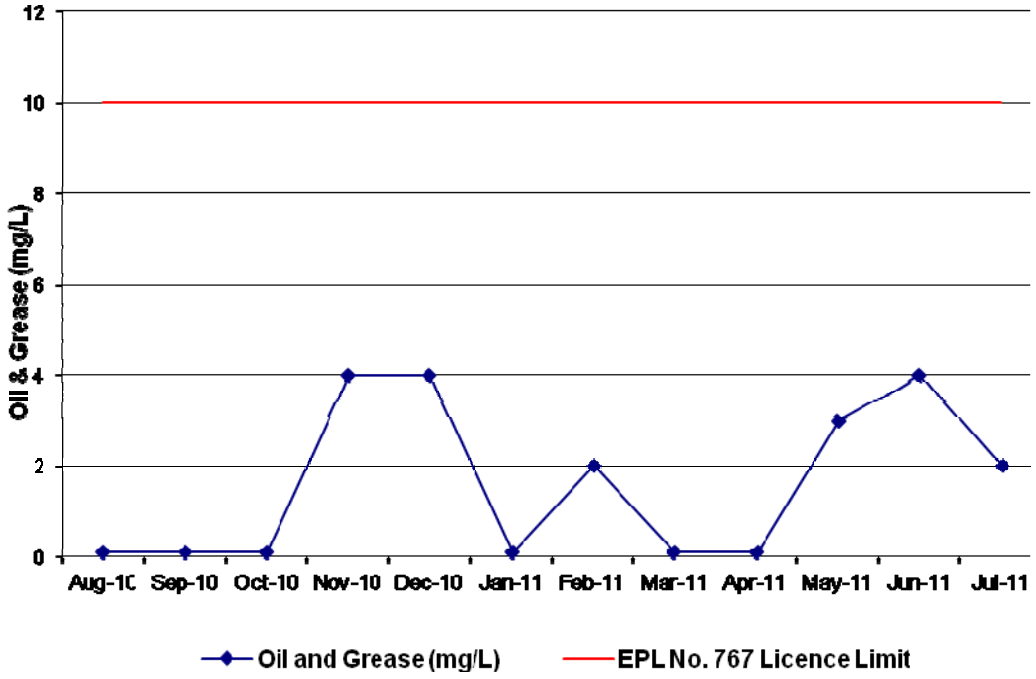


Chart 105 Oil and Grease recorded at EPL No. 767 Monitoring Point 9

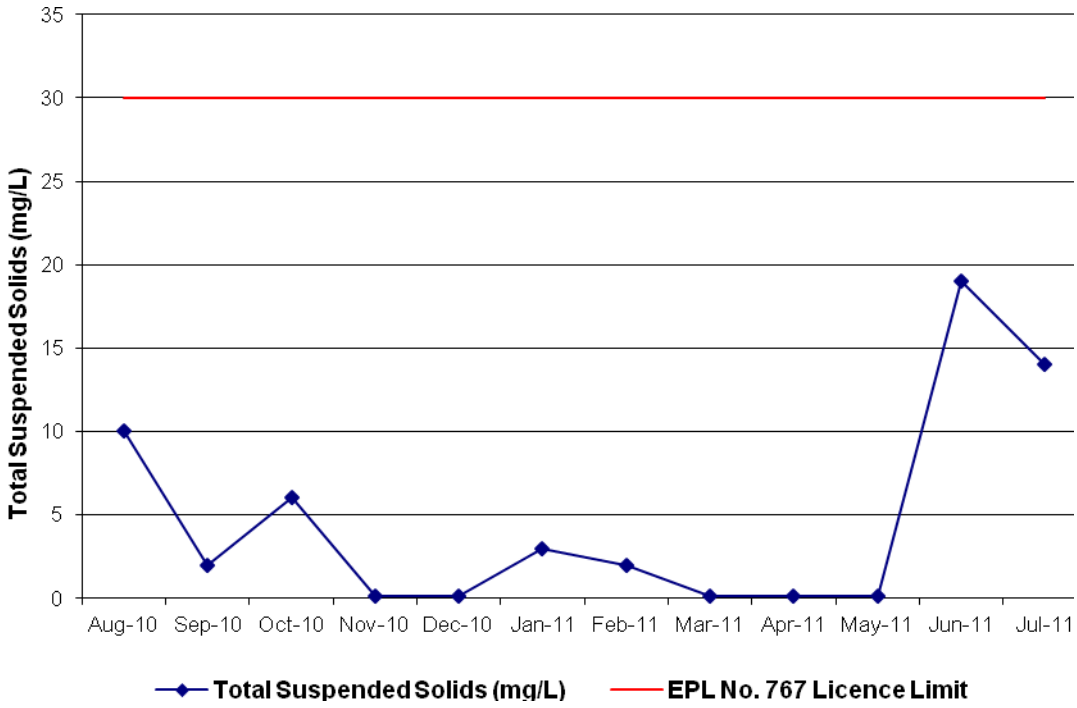


Chart 106 Total Suspended Solids recorded at EPL No. 767 Monitoring Point 9

Mine Water Make

Monitoring of mine water make is conducted in accordance with the Water Management Plan. The monitoring results are described in Section 3.3 of this Annual Review.

Overall System Integrity

The following water management items are visually inspected and reported in accordance with the mine's maintenance system:

- Integrity of all water management system pipelines and pumps for leaks and general serviceability (daily inspection).
- Integrity of all concrete bunded areas (hydrocarbon storages) for integrity and signs of leakage (daily inspection).
- Integrity of main water storages (Turkey's Nests, Sediment Ponds and Taj Mahal) and status of sediment accumulation (daily inspection).
- Signs of discharge of site runoff to Camp Gully or Helensburgh Gully, other than via licensed discharge points (daily inspection).
- Integrity of upslope diversions at site perimeter (weekly inspection).
- Integrity and effectiveness of erosion control measures (weekly inspection).

The Water Treatment Plant is also checked daily by the site's maintenance personnel under the direction of the Environment and Community Manager.

The Environment and Community Manager (or their delegate) also inspects the site weekly.

The daily and weekly inspections identified a number of improvements and required maintenance measures. The improvements and measures are described in Section 4.3.4.

During the review period an environmental incident occurred on 24 November 2010. OEH and DP&I were notified of the incident as soon as practicable. The incident involved water seeping from a borehole which was being drilled to facilitate underground emplacement of coal wash into Helensburgh Creek Culvert and subsequently Camp Creek. The seepage was contained beside the colliery and impacted water was pumped back into the site water management system. The seepage would have included crushed rock, clays, recycled water from the site water treatment plant and a small quantity of drilling fluids.

A spill response procedure was immediately initiated including cessation of drilling operations and the establishment of a containment line and pumping extraction system. This swift implementation of the spill response procedure mitigated the potential environmental harm associated with the incident. Further actions have since been taken to clean up the incident and prevent re-occurrence.

4.3.3 Assessment of Environmental Performance

In accordance with the Surface Facilities Water Management Plan, the performance indicators outlined in Table 34 will be used to assess the performance of the Surface Facilities Water Management Plan.

Table 34
Summary of Surface Facilities Water Management Performance Indicators

Aspect	Objective	Performance Indicator
Water use.	To minimise the use of potable water (i.e. town water) and maximise the use water recycled from underground and water captured on site.	The use of potable water (i.e. megalitres of town water used per tonne of coal produced) does not increase over time, after taking into consideration climatic conditions. Potable water has not been used in circumstances where there is a viable alternative.
Erosion control.	To implement measures to effectively control erosion.	Inspections of the major surface facilities area and ventilation shaft(s) indicate the measures implemented are effectively controlling erosion.
Containment of contaminants.	To implement effective isolation and containment systems to prevent contaminants from impacting on groundwater resources.	Effective containment and/or isolation measures are in place for potential contaminants on site.
Licensed discharge.	To comply with the licensed discharge limits for surface water discharges to Camp Gully.	Surface water discharges comply with the requirements of EPL No. 767.
System integrity.	To regularly check that key components of the water management system are operating effectively.	Inspections of system components indicate no maintenance or additional management measures are required to be implemented.

4.3.3.1 Water Use

Analysis against Performance Indicator

Performance Indicator 1: *The use of potable water (i.e. megalitres of town water used per tonne of coal produced) does not increase over time, after taking into consideration climatic conditions.*

Potable water has not been used in circumstances where there is a viable alternative.

The performance indicator will be considered to have been exceeded if the use of potable water increases over time, after taking into consideration climatic conditions and potable water has been used in circumstances where there is a viable alternative.

The use of potable water used per tonne of coal produced is variable and is seen to generally be highest during periods of low rainfall (Chart 107). The operation's water is sourced from on site harvesting, licensed extraction from Camp Creek and the Sydney Water supply. When on-site harvesting and extraction from Camp Creek is not possible (i.e. during two consecutive months of below average rainfall) additional demands are placed on Sydney Water's supply.

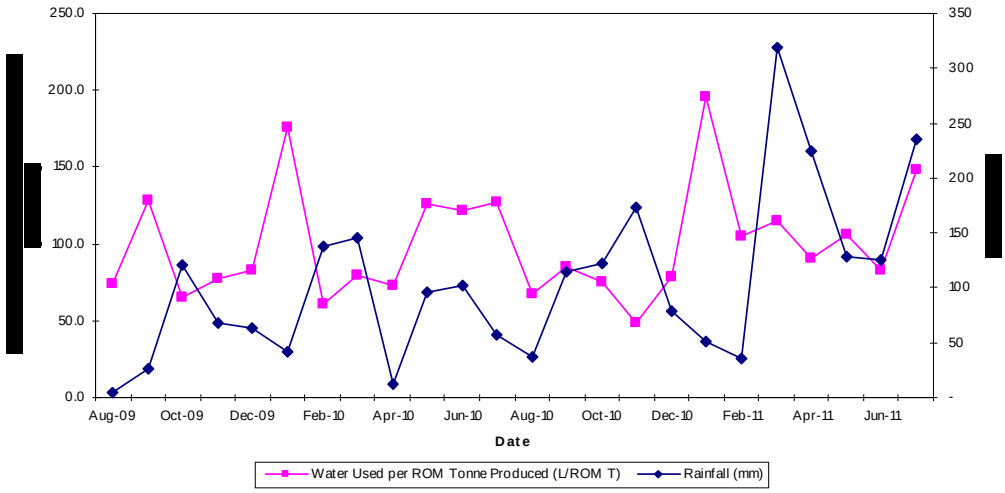


Chart 107 Potable Water Use per ROM Tonne Produced vs Rainfall

An increase in use of potable water used per tonne of coal produced at the start of 2011 can be attributed to commencement of the continuous miner operation in the new drift. Due to the lack of an appropriate recycled water supply the operation of the continuous miner used up to 4 Litres per second or 345,600 Litres per day of potable water.

Ongoing site auditing during the review period has not identified incidences of potable water being used where there is a viable alternative.

The performance indicator regarding the use of potable water over time will be assessed in the next Annual Review, as only 12 months of data has been collected to date which does not allow for consideration of long-term climatic fluctuations.

4.3.3.2 Erosion Control

Analysis against Performance Indicator

Performance Indicator 2: *Inspections of the major surface facilities area and ventilation shaft(s) indicate the measures implemented are effectively controlling erosion.*

The performance indicator will be considered to have been exceeded if inspections of the major surface facilities area and ventilation shaft(s) indicate the measures implemented are not effectively controlling erosion.

Weekly inspections of the major surface facilities area and ventilation shaft(s) indicate that the current erosion control measures implanted during the review period are effective in controlling erosion.

This performance indicator was not exceeded during the review period.

4.3.3.3 Containment of Contaminants

Analysis against Performance Indicator

Performance Indicator 3: *Effective containment and/or isolation measures are in place for potential contaminants on site.*

The performance indicator will be considered to have been exceeded if effective containment and/or isolation measures are not in place for potential contaminants on site.

Effective containment and isolation measures are in place for potential contaminants on site. Effective containment and/or isolation measures in place include the separation of waste materials and storage of liquids within bunded areas. Weekly inspections ensure the ongoing compliance with this standard.
This performance indicator was not exceeded during the review period.

4.3.3.4 Licensed Discharge

Analysis against Performance Indicator

Performance Indicator 4: *Surface water discharges comply with the requirements of EPL No. 767.*

The performance indicator will be considered to have been exceeded if surface water discharges do not comply with the requirements of EPL No. 767.

EPL No. 767 requires that the concentration of oil and grease, pH and total suspended solids discharged from the Water Treatment Plant to Camp Gully do not exceed the levels specified in the EPL. EPL No. 767 states that the monitoring results at EPL No. 767 monitoring point 9 (clean water tank of the water treatment plant) are to be used to determine compliance with the concentration limits in the licence. The recorded monitoring results at EPL No. 767 monitoring point 9 are assessed against the concentration limits specified by EPL No. 767 in Charts 104 to 106 and Table 35.

Table 35
Assessment of Licensed Discharge Compliance

Parameter	EPL No. 767 Concentration Limit	Recorded Values During the Review period[1] (minimum-maximum)
Oil and grease (mg/L)	10	<2 - 4
pH (Ph units)	6.5 – 8.5	7.6 – 8.6
Total suspended solids (mg/L)	30	<2 – 19

[1] August 2010 to July 2011

The pH level recorded in August 2010 was 8.6, which is slightly higher than the EPL limit of 8.5 (Chart 104). The site sources water from the Sydney Water supply, licensed extraction and on-site recycling of mine water. Relatively low precipitation levels in August 2010 reduced the rainfall based pH dilution of recycled mine water. Following receipt of results additional neutral pH water was imported from Camp Creek and Sydney water to bring the discharge tank to within the EPL Licence criterion. Additionally an acid dosing unit has been purchased to enable Metropolitan Colliery to remain compliant by controlling the pH of discharged water.

4.3.3.5 System Integrity

Analysis against Performance Indicator

Performance Indicator 5: *Inspections of system components indicate no maintenance or additional management measures are required to be implemented.*

The performance indicator will be considered to have been exceeded if inspections of system components indicate maintenance or additional management measures are required to be implemented.

Metropolitan Coal site plumbers conduct daily inspections of components of the water management system. In addition the site Environment and Community Coordinator conducts weekly inspections of the water management system.

This performance indicator was not exceeded during the review period.

4.3.4 Management and Mitigation Measures

Metropolitan Coal implemented a number of surface facilities water management measures over the review period including:

- Initiation of a project to increase the number of flow loggers and reconfiguration of the data logging remote network. Additional meters will be added to the system that will include moisture sensors and weightometers.
- Works were completed to convert the Metropolitan Coal truck wash water supply from potable town water to recycled water, with a final potable water rinse.
- The installation and maintenance of erosion and sediment control measures in association with administration office construction works.
- Rehabilitation of areas disturbed by the administration office construction works (i.e. exposed soil) through seeding with grass seed or planted with native species to minimise the potential for erosion.
- Measures to improve the operation of the Turkey's Nest dams including:
  - the installation of a diesel pump for pumping from Turkeys Nest dam 1 into Turkeys Nest dam 2 in order to increase the treatment capacity of the water treatment plant;
  - excavation of the Turkey's Nest dams to remove silt and maintain storage capacity; and
  - adjustment of the Turkey's Nest Dam pump float switches to improve accuracy.
- Improvements to the dirty water drainage system adjacent to the product stockpile to ensure product coal is contained on-site during rainfall events.
- Management measures in response to system integrity issues identified by daily or weekly inspections including:
  - correction and replacement of turbidity sensors in the thickener;
  - repair of paddles in the thickener;
  - replacement of the gearbox in the thickener;
  - servicing of the sand filters in the water treatment plant to improve performance;
  - excavation of sediment ponds to remove silt and maintain storage capacity; and
  - repair of a valve in a water treatment plant sampling chamber.

4.3.5 Further Initiatives

Metropolitan Coal will investigate the potential for improvements to the re-use of site water and site water management over the next review period.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Surface Facilities Water Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4.4 TRAFFIC MANAGEMENT PLAN

4.4.1 Background

A Metropolitan Coal Traffic Management Plan prepared to minimise the traffic impacts of the Project on the residential areas and schools within Helensburgh in accordance with Condition 22, Schedule 4 of the Project Approval was approved by the DP&I on 14 April 2011.

4.4.2 Monitoring

The majority of product coal from Metropolitan Coal is transported by train to the Port Kembla Coal Terminal for transport to domestic and overseas customers, with trains operating up to 24 hours per day, seven days per week (Figure 1). Small volumes of product coal for the domestic market are transported by road to the Corrimal Coke Works and Coalcliff Coke Works (Figure 1), five days per week.

Coal reject material is also transported by road to the Glenlee Washery for disposal (Figure 1), five days per week.

Coal and coal reject deliveries are weighed on receipt at their destination (e.g. Port Kembla, Glenlee Washery) and the delivered tonnages are reported at regular intervals to Metropolitan Coal.
Metropolitan Coal monitors the amount of product coal transported from site by road and by rail. A total of 1,613,265 tonnes (t) of product coal was transported from Metropolitan Coal in the 2010 calendar year. A total of 479,927 t of product coal was transported from site by rail and 51,421 t by road in the period August to December 2010 and 773,441 t by rail and 86,495 t by road in the period January to July 2011.

Metropolitan Coal monitors the amount of coal reject that is transported from the site by road each year. A total of 152,361 t of coal reject was transported from site in the period August to December 2010 and 223,523 t in the period January to July 2011.

In accordance with Condition 21, Schedule 4 of the Project Approval, the results of the monitoring are provided on Metropolitan Coal's website every six months.

Complaints Records

In the review period two complaints relating to transport or transport noise were received (Section 6), which represents a significant improvement compared with the numbers of transport or transport related noise complaints received in previous review periods.

Eight transport related complaints were received in the previous review period, and four complaints the period before (Section 6).

4.4.3 Assessment of Environmental Performance

Analysis against Performance Indicators

In accordance with the Traffic Management Plan, performance indicators will be used to monitor the performance of Project traffic management. If data analysis indicates a performance indicator has been exceeded or is likely to be exceeded, management measures will be implemented and Metropolitan Coal will continue to monitor.

Performance Indicator 1: *When annual road maintenance contribution negotiations are required, the negotiations will commence with the relevant councils and/or DP&I by 31 August.*

The performance indicator will be considered to have been exceeded if the annual contribution negotiations have not commenced by 31 August.

Metropolitan Coal commenced negotiations with Wollongong City Council (WCC), Wollondilly Shire Council (WSC) and Campbelltown City Council (CC) prior to 31 August 2011.

This performance indicator was not exceeded during the review period.

Performance Indicator 2: *Annual road maintenance contributions to relevant councils are made by 30 November.*

The performance indicator will be considered to have been exceeded if the annual contributions to the relevant councils are not made by 30 November each year.

Metropolitan Coal provided contributions to WCC, WSC and CC in December 2010.

The contributions to Councils for road maintenance were made prior to finalisation of the performance indicators and subsequent approval of the Traffic Management Plan by the DP&I.

This performance indicator will be assessed in the next Annual Review.

Performance Indicator 3: *Coal transported off-site by road in a calendar year does not reach 100,000 t prior to 31 October.*

The performance indicator will be considered to have been exceeded if the amount of coal transported off-site by road exceeds 100,000 t prior to 31 October in any one year.

Metropolitan Coal has been granted a modification to Condition 19(b), Schedule 4 of the Project Approval. The aforementioned performance indicator will be reviewed in the next iteration of the Transport Management Plan as triggered by the approval of the Annual Review.

Performance Indicator 4: *Coal and coal reject haulage trucking contractors will be notified of Metropolitan Coal's off-site haulage requirements by 31 October 2010.*

The performance indicator will be considered to be exceeded if the formal notification of the haulage contractors is not undertaken by 31 October 2010.

Metropolitan Coal developed and implemented a Driver's Code of Conduct for truck drivers during the review period. Individual truck drivers signed the code of conduct which stipulated strict procedures to minimise trucking related impacts on the local community.

This performance indicator was not exceeded during the review period.

Analysis against Project Approval Conditions

Condition 6, Schedule 2:

Limits on Approval

6. The Proponent shall not:

…..

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

A total of 1,613,265 t of product coal was transported from Metropolitan Coal in the 2010 calendar year, and some 859,936 t of product coal has been transported from site in the period January to July 2011. This Approval Condition was not exceeded during the review period.

Condition 17, Schedule 21:

Parkes Street Intersection

17. By the end of 2010, the Proponent shall:

(a) undertake a road safety audit of the Parkes Street and Colliery Road intersection, in consultation with the RTA and WCC; and

(b) implement any recommendations of this audit, to the satisfaction of the Director-General.

The Road Safety Audit of the Mine Access Road and Parkes Street intersection (Figure 21) has been undertaken and submitted to the WCC for review. The Road Safety Audit Report has been completed in accordance with *Austroads Road Safety Audit Guidelines, 2002* and *RTA Accident Reduction Guide Part 2 – Road Safety Audits, 2005*.

METROPOLITAN COAL

FIGURE 21
Mine Access Road and Parkes Street Intersection

METROPOLITAN COAL

MET-08-AD7 2011 Ann Rev_117A

The implementation of recommendations of this audit will be conducted once approval is granted by WCC and the RTA for improvement works to commence. This Approval Condition was not exceeded during the review period.

Condition 18, Schedule 21:

Road Maintenance Contributions

18. From the end of 2009, the Proponent shall make a suitable annual contribution to WCC, WSC, and CC for the maintenance of local roads that are used as haulage routes by the project. If there is any dispute over the amount of the contribution, the matter must be referred to the Director-General for resolution.

Metropolitan Coal has made contributions to WCC, WSC and CC in accordance with this condition. This Approval Condition was not exceeded during the review period.

Conditions 19 and 20, Schedule 21:

Road Transport Restrictions

19. The Proponent shall not:

(a) load coal or coal reject onto trucks, or transport it off site by road, outside the hours of 7am and 6pm Monday to Friday;

(b) transport more than 170,000 tonnes of coal off site by road in a calendar year;

(c) transport any coal off site to the Port Kembla Coal Terminal by road;

(d) permit the departure of more than 25 trucks containing product coal for delivery to the Corrimal Cokeworks on any given day; or

(e) permit the departure of more than 30 trucks containing product coal for delivery to the Coalcliff Cokeworks on any given day.

20. During emergencies (such as the disruption of rail services) the Proponent may exceed the restrictions in Condition 19 above with the written approval of the Director-General.

The haulage of coal product and coal reject has been undertaken in accordance with the hours of operation set out in Metropolitan Coal's Project Approval.

As described in Section 4.4.2, a total of 479,927 t of product coal was transported from site by rail and 51,421 t by road, in the period August to December 2010 and 773,441 t by rail and 86,495 t by road in the period January to July 2010.

Metropolitan Coal was granted an amendment to Condition 19, Schedule 4 of the Project Approval on 2 July 2011 regarding the limits on the transport of coal off-site by road. The volume of coal transported by road from the Metropolitan Colliery during the review period was less than 170,000 t.

There were no exceedances of Conditions 19(d) and (e) during the review period, from the time the conditions came into effect.

In accordance with the Project Approval no coal has been transported by road to the Port Kembla Coal Terminal.

Condition 21, Schedule 21:

Monitoring

21. The Proponent shall monitor the amount of coal and coal reject transported from the site by road and rail each year, and report the results of this monitoring on its website every six months.

The results of coal transport monitoring are provided on Metropolitan Coal's website and are updated every six months.

4.4.4 Management and Mitigation Measures

As described above, Metropolitan Coal has contributed to the relevant local Councils for the maintenance of local roads that are used as haulage routes by the Project.

The haulage of coal product and coal reject has been undertaken in accordance with the hours of operation set out in the Metropolitan Coal's Project Approval.

A telephone number for the provision of comments or complaints regarding Metropolitan Coal is prominently displayed at Metropolitan Coal (1800 115 003). This number can be used for members of the community to provide comments regarding product coal and coal reject haulage.

Metropolitan Coal's product coal and coal reject haulage is undertaken by private haulage companies. Metropolitan Coal provided the contract haulage companies with a driver's code of conduct regarding:

- the approved hours of haulage operations;
- speed management and use of air brakes; and
- general community courtesy measures.

Metropolitan Coal instructed the haulage companies to provide these instructions to individual drivers and incorporate these measures in their standard operating procedures. This included a disciplinary procedure for breaches of the standard instructions and operating procedures.

4.4.5 Further Initiatives

As described above Metropolitan Coal conducted a Road Safety Audit of the Mine Access Road and Parkes Street intersection (Figure 21) in consultation with the RTA and WCC. Metropolitan Coal will implement the recommendations of the Road and safety Audit and conduct intersection improvements once was approved by WCC Traffic Committee and the RTA.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Traffic Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4.5 WASTE MANAGEMENT PLAN

4.5.1 Background

A Metropolitan Coal Waste Management Plan has been prepared for the surface facilities area in accordance with Condition 25, Schedule 4 of the Project Approval (approved by the DP&I on 14 April 2011) to:

- identify waste streams and monitor the quantities generated;
- identify waste management measures to minimise waste generation; and
- ensure that waste generated by Metropolitan Coal is appropriately stored, handled and disposed of.

4.5.2 Monitoring

Waste generated at the Project is monitored on a monthly basis through waste disposal receipts provided by Metropolitan Coal's waste contractors.

During the review period, approximately 317 t of waste were recycled and 183 t were disposed of.

Some 375,884 t of coal reject was generated by Metropolitan Coal during the review period.

Visual inspections of on-site waste storage areas have been conducted on a regular basis by Metropolitan Coal to confirm waste materials are being suitably stored.

In accordance with the NSW *Protection of the Environment Operations Act, 1977* and OEH's waste tracking system, Metropolitan Coal has tracked the transportation of waste oil to a licensed recycling facility during the review period. Some 45,700 L of waste oil has been recycled.

4.5.3 Assessment of Environmental Performance

In accordance with the Waste Management Plan, the performance of the mine will be assessed against the performance indicators outlined in Table 36.

Table 36
Waste Management Performance Indicators

Aspect	Performance Indicator
Waste generation	Waste generation has been minimised, as evidenced by: - an increase in the amount or type of waste recycled; - a decrease in the amount of waste generated that is disposed of to licensed landfill facilities; and/or - no practicable opportunities for additional waste minimisation have been identified to those currently being implemented.
Storage of waste	Waste has been separated and stored according to type in appropriate storage facilities (e.g. sealed containers for liquid waste).
Handling and disposal of waste	The transport of particular waste types has been tracked in accordance with DECCW (now OEH) waste tracking requirements. Metropolitan Coal's waste management contracts, where relevant, specify that the waste is to be transported by an appropriately licensed contractor and disposed of at an appropriately licensed facility.

4.5.3.1 Waste Generation

Performance Indicator 1: *Waste generation has been minimised, as evidenced by:*

- *an increase in the amount or type of waste recycled;*
- *a decrease in the amount of waste generated that is disposed of to licensed landfill facilities; and/or*
- *no practicable opportunities for additional waste minimisation have been identified to those currently being implemented.*

The performance indicator will be considered to have been exceeded if waste generation has not been minimised according to any of the above criteria.

The underground emplacement project has resulted in reducing off-site disposal of approximately 12,000 t of coal reject material to date. The emplacement of reject material in unused workings is expected to increase in the future.

Given the expansion projects (i.e. construction activities) currently being undertaken by Metropolitan Coal it has not been possible to decrease the amount of waste generated that is disposed of to licensed landfill facilities.

No further practicable opportunities for waste minimisation have been identified.

Given the reasoning above, it is considered that this performance indicator has not been exceeded during the review period.

4.5.3.2 Storage of Waste

Performance Indicator 2: *Waste has been separated and stored according to type in appropriate storage facilities (e.g. sealed containers for liquid waste).*

The performance indicator will be considered to have been exceeded if waste has not been separated and stored according to type in appropriate storage facilities.

Waste on site is adequately sorted and stored according to waste type prior to collection. Weekly site inspections are conducted by the site Environment and Community Coordinator to ensure waste is separated and stored in accordance with Metropolitan Coal's Waste Management Plan.

This performance indicator has not been exceeded during the review period.

4.5.3.3 Handling and Disposal of Waste

Performance Indicator 3: *The transport of particular waste types has been tracked in accordance with DECCW* (now OEH) *waste tracking requirements.*

The performance indicator will be considered to have been exceeded if transport of particular waste types has not been tracked in accordance with OEH waste tracking requirements.

All transport of waste from the Metropolitan Coal site has been tracked in accordance with OEH waste tracking requirements and therefore this performance indicator has not been exceeded during the review period.

Performance Indicator 4: *Metropolitan Coal's waste management contracts, where relevant, specify that the waste is to be transported by an appropriately licensed contractor and disposed of at an appropriately licensed facility.*

The performance indicator will be considered to have been exceeded if Metropolitan Coal's waste management contracts, where relevant, do not specify that the waste is to be transported by an appropriately licensed contractor and disposed of at an appropriately licensed facility.

Metropolitan Coal's waste management agreements specify waste is to be removed by an appropriately licensed contractor and disposed to an appropriately licensed facility and therefore this performance indicator has not been exceeded during the review period.

4.5.4 Management and Mitigation Measures

Metropolitan Coal aims to implement the waste hierarchy established under the NSW *Waste Avoidance and Resource Recovery Act, 2001* to manage Project waste generation. The waste hierarchy ensures that management measures are considered against the following priorities:

1. Avoidance of unnecessary resource consumption.
2. Resource recovery.
3. Disposal, including management of disposal options in the most environmentally responsible manner.

Metropolitan Coal implemented a number of measures over the review period to minimise waste generation and increase recycling at Metropolitan Coal, including:

- Waste data is collected and recorded according to type in the Metropolitan Coal Waste Register in accordance with the Waste Management Plan.
- Metropolitan Coal consolidated and updated waste management contracts to specify that the waste is to be transported by an appropriately licensed contractor and disposed of at an appropriately licensed facility.
- Metropolitan Coal investigated opportunities to increase the recycling of waste quantities or waste types.
- Metropolitan Coal made significant progress with underground emplacement project and successfully conducted pilot phase underground emplacement of coal reject material.

Waste streams have been kept separate where practicable to improve waste handling and classification, minimise costs associated with disposal and improve environmental outcomes. For example, hazardous waste has not been mixed with non-hazardous waste and where practicable, recyclable waste has been separated out from other waste.

4.5.5 Further Initiatives

Over the next review period the underground emplacement project will move from trial stage toward the detailed design and development of full integration with the CHPP. This integration will result in a significant reduction in coal reject material requiring off-site disposal.

Metropolitan Coal will further identify opportunities for waste minimisation and recycle/reuse at the site. In addition waste minimisation initiatives and waste management practices will continue to be conducted in accordance with Metropolitan Coal's Waste Management Plan.

In accordance with Condition 4, Schedule 7 of the Project Approval, Metropolitan Coal will review and, if necessary, revise the Waste Management Plan within three months of the submission of this Annual Review, to the satisfaction of the Director-General of DP&I.

4.6 REHABILITATION STRATEGY

A Metropolitan Coal Rehabilitation Strategy for the surface facilities area will be prepared in consultation with relevant stakeholders to the satisfaction of the Director-General of the DP&I by the end of October 2011.

The Rehabilitation Strategy will define the conceptual rehabilitation objectives for the surface facilities area and will investigate options for the future use of the area upon the completion of mining in accordance with Condition 2, Schedule 6 of the Project Approval.

5 OTHER APPROVAL CONDITIONS

The Project Approval includes a number of additional conditions that are not specifically addressed in the Metropolitan Coal management plans or monitoring programs. These are discussed below.

Structural Adequacy

Condition 9, Schedule 2 of the Project Approval requires Metropolitan Coal to ensure that new buildings and structures, and any alterations or additions to existing buildings and structure at the surface facilities area, are constructed in accordance with the relevant requirements of the Building Code of Australia and any additional requirements of the Mines Subsidence Board in areas where subsidence effects are likely to occur.

Building construction activities during this review period included commencement of the new Large Coal Plant, installation of a pilot backfill plant, establishment of a portal and commencement of tunnelling for the new mine access. The Large Coal Plant building is an extension of the existing CHPP and has been built in accordance with the Building Code of Australia requirements.

Demolition

In accordance with Condition 10, Schedule 2 of the Project Approval, Metropolitan Coal is required to ensure that all demolition work is carried out in accordance with *Australian Standard AS 2601-2001: The Demolition of Structures*, or its latest version.

Metropolitan Coal has undertaken a number of demolition activities during the review period including partial removal of the existing surface workshop, removal of a yard storage shed, and removal of a 700 t coal storage bin. All activities were carried out as per Australian Standards with demolition applications being approved by Work Cover NSW.

Operation of Plant and Equipment

Metropolitan Coal is required to ensure that all plant and equipment used at the site is maintained in a proper and efficient condition and operated in a proper and efficient manner in accordance with Condition 11, Schedule 2 of the Project Approval.

All plant and equipment in use at Metropolitan Coal is regularly serviced in accordance with the relevant Industry & Investment NSW Mining Design Guidelines to ensure plant and equipment is maintained in proper and efficient condition. All plant and equipment are operated in a proper and efficient manner.

Rail Noise

Condition 4, Schedule 4 of the Project Approval requires Metropolitan Coal to only use locomotives that are approved to operate on the NSW rail network in accordance with noise limits L6.1 to L6.4 in RailCorp's EPL (No. 12208) and Australian Rail Track Corporation's EPL (No. 3142) or a Pollution Control Approval issued under the former *Pollution Control Act, 1970*.

All locomotives that have been used by Metropolitan Coal are approved to operate on the NSW rail network in accordance with the relevant noise limits.

Blasting

The Project Approval (Condition 7, Schedule 4) requires that Metropolitan Coal not undertake blasting operations at the surface facilities area without the written approval of the Director-General of DP&I.

No blasting activities were carried out at the surface facilities area during the review period.

Minor blasting underground is necessary at times when geological structures are encountered that cannot be excavated by the longwall mining machine. Minor blasting is also required underground at times when a section of the longwall roof falls ahead of the hydraulic supports of the longwall mining machine.

Odour

In accordance with Condition 9, Schedule 4 of the Project Approval, Metropolitan Coal has not caused or permitted the emission of offensive odours from the site. No odour complaints were received during the review period.

The Metropolitan Coal sewage system is connected to the town sewage network, and is maintained on a regular basis. Back-up pump systems are incorporated in the Metropolitan Coal sewage system to compensate for any unexpected malfunctions.

Visual

Metropolitan Coal has minimised the visual impacts of the surface facilities area and the ventilation shaft site, particularly the off-site lighting impacts, in accordance with Condition 23, Schedule 4 of the Project Approval.

The Major Surface Facilities Area is located within a narrow valley with heavily vegetated slopes which limit the visibility of the buildings and structures to public areas and private residences in the surrounding area.

Flood lights in the car park are fitted with timers which turn the lights off during periods when the car park is not in use to minimise light nuisance.

A hebel wall has been constructed in consideration of the natural surrounds. The wall is painted to blend in with the surrounding environment and planting of native species in front of the wall to further minimise visual impacts has been undertaken.

The planting program Parkes Street in Helensburgh has been continued to develop a vegetation screen to further minimise the visibility of the Major Surface Facilities Area.

Ventilation Shaft No. 3 has previously been painted a suitable colour to blend in with the surrounding environment and visual vegetation screening has been incorporated to minimise visual impacts. Ventilation Shaft No. 4 is yet to be constructed.

6 ENVIRONMENTAL COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy.

A dedicated telephone number for the provision of comments or complaints is maintained by Metropolitan Coal (1800 115 003) and is displayed on signage at the entrance to the mine and on the Metropolitan Coal website.

Metropolitan Coal records and responds to all complaints and maintains a complaints register on its website.

During the review period a total of seven complaints were received. Four of the issues related to operational noise, with the remaining complaints pertaining to traffic and dust (Chart 108 and 109). A copy of the complaints register is provided in Appendix 3, including actions taken by Metropolitan Coal to address the complaints received.

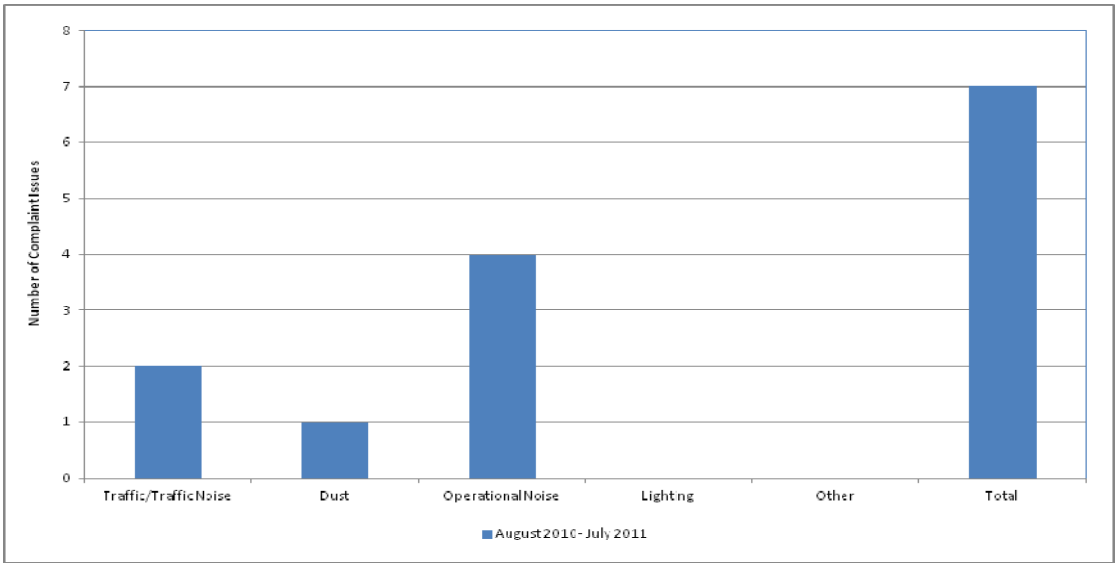


Chart 108 Metropolitan Coal Complaints during the Review Period

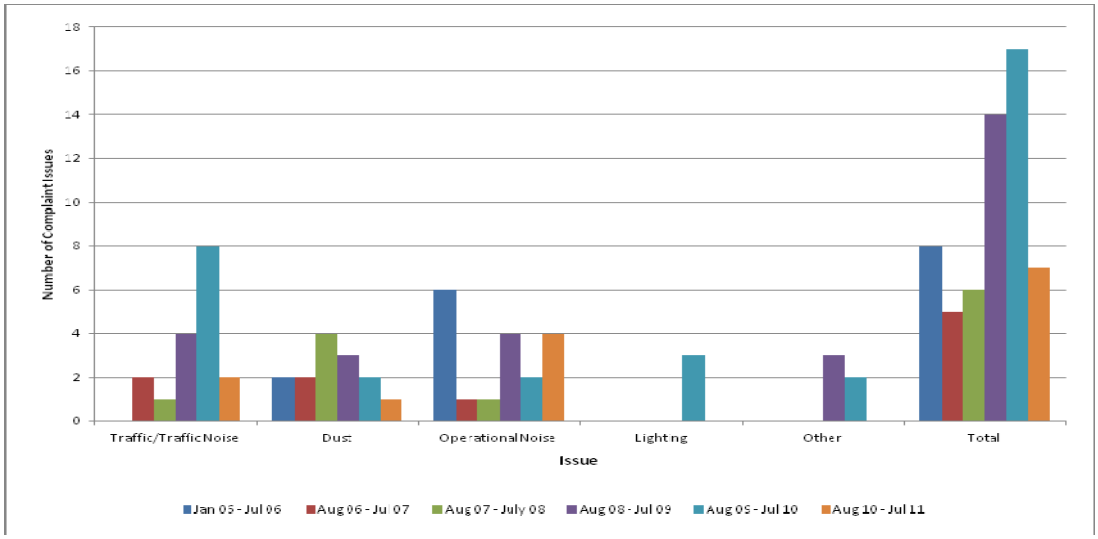


Chart 109 Summary of Metropolitan Coal Complaints Record

7 WORKS PROPOSED IN THE NEXT REVIEW PERIOD

The layout of Longwalls 20-22 is shown on Figure 5. Secondary extraction of Longwall 21 is expected to commence in and continue for the duration of the next review period (1 August 2011 to 31 July 2012). Longwall 21 has a length of 3,087 m.

Metropolitan Coal will commence construction of new electrical infrastructure including substations, switchyard and the floatation building at the mine's Major Surface Facilities Area within the next review period.

8 REFERENCES

Boughton, W.C. (2004) The Australian Water Balance Model. *Environmental Modelling and Software*, Vol 19, pp. 943–956.

Eco Logical Australia (2010) Metropolitan Coal Spring 2010 Longwalls 20-22 Vegetation Report.

Gilbert & Associates (2008) *Metropolitan Coal Project Surface Water Assessment*, Appendix C in Helensburgh Coal Pty Ltd (2008) *Metropolitan Coal Project Environmental Assessment.*

Helensburgh Coal Pty Ltd (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd (2009) *Metropolitan Coal Project Preferred Project Report.*

Merrick, N.P. and Alkhatib, M., (2011) Groundwater Assessment for Metropolitan Colliery Longwalls 23-27. Heritage Computing Report HC2011/3 for Metropolitan Coal, May 2011, 79p.

Metropolitan Coal (2010a) *Metropolitan Coal Replacement Drift Construction Modification Environmental Assessment*.

Metropolitan Coal (2010b) *Metropolitan Coal Longwalls 20-22 Extraction Plan*.

Metropolitan Coal (2010c) *Metropolitan Coal Longwalls 20-22 Public Safety Management Plan.*

Metropolitan Coal (2010d) *Energy Savings Action Plan. First Annual Report*. Prepared for Helensburgh Coal Pty Ltd by Denis Cooke & Associates Pty Ltd.

Metropolitan Coal (2011a) *Metropolitan Coal Environmental Management Strategy.*

Metropolitan Coal (2011b) *Metropolitan Coal Longwalls 20-22 Subsidence Monitoring Program.*

Metropolitan Coal (2011c) *Metropolitan Coal Longwalls 20-22 Water Management Plan.*

Metropolitan Coal (2011d) *Metropolitan Coal Longwalls 20-22 Biodiversity Management Plan.*

Metropolitan Coal (2011e) *Metropolitan Coal Longwalls 20-22 Land Management Plan*.

Metropolitan Coal (2011f) *Metropolitan Coal Longwalls 20-22 Heritage Management Plan*.

Metropolitan Coal (2011g) *Metropolitan Coal Longwalls 20-22 Built Features Management Plan*.

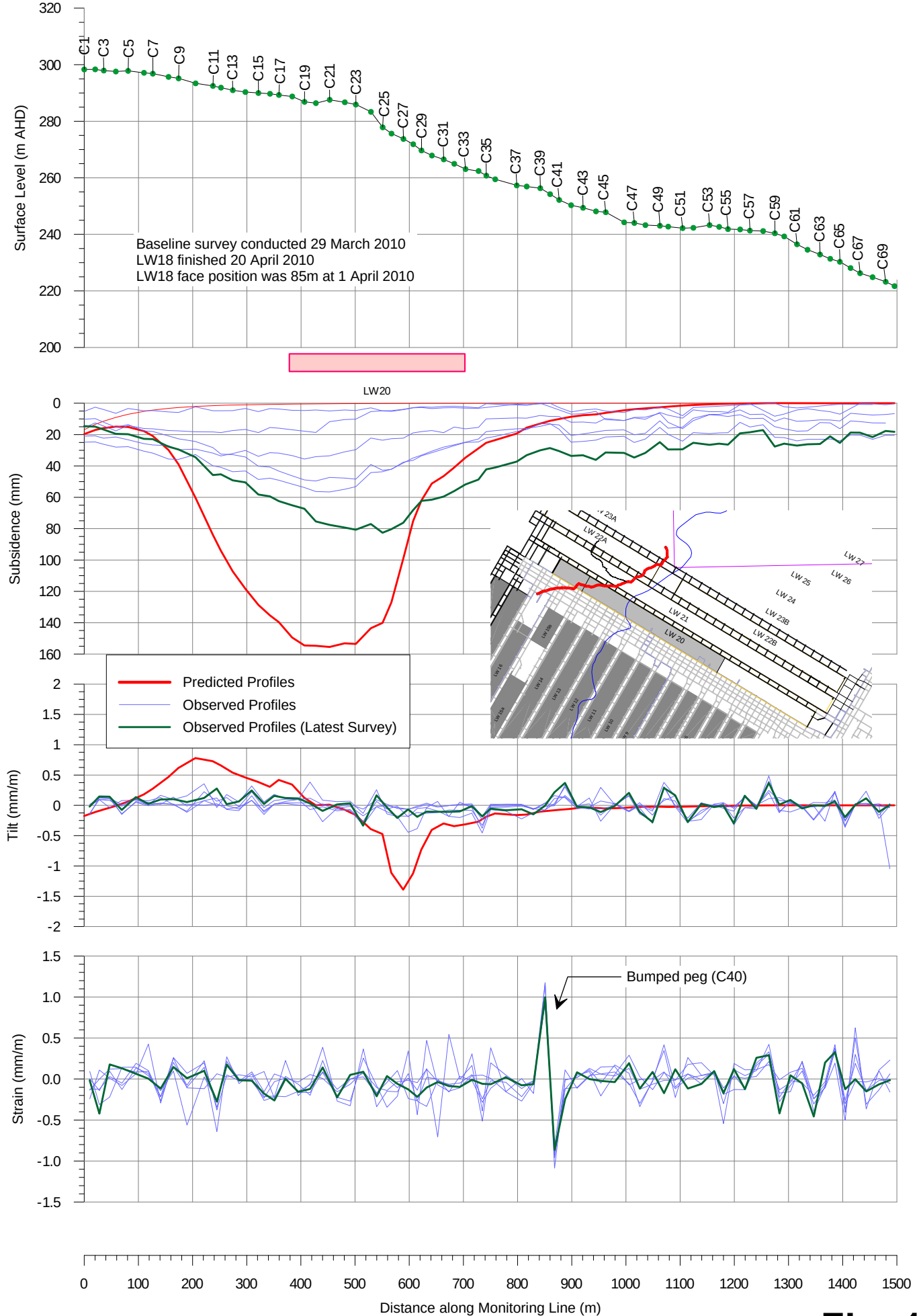
Metropolitan Coal (2011h) *Metropolitan Coal Catchment Monitoring Program*.

New South Wales Minerals Council (2000) *Technical Paper – Particulate Matter and Mining Interim Report*.

APPENDIX 1

SUBSIDENCE MONITORING RESULTS

Profiles of Systematic Subsidence, Tilt and Strain along Monitoring Line 9C Resulting from the Extraction of LW20



msec

Fig. 1

Profiles of Systematic Subsidence, Tilt and Strain along Monitoring Line 9CW Resulting from the Extraction of LW20

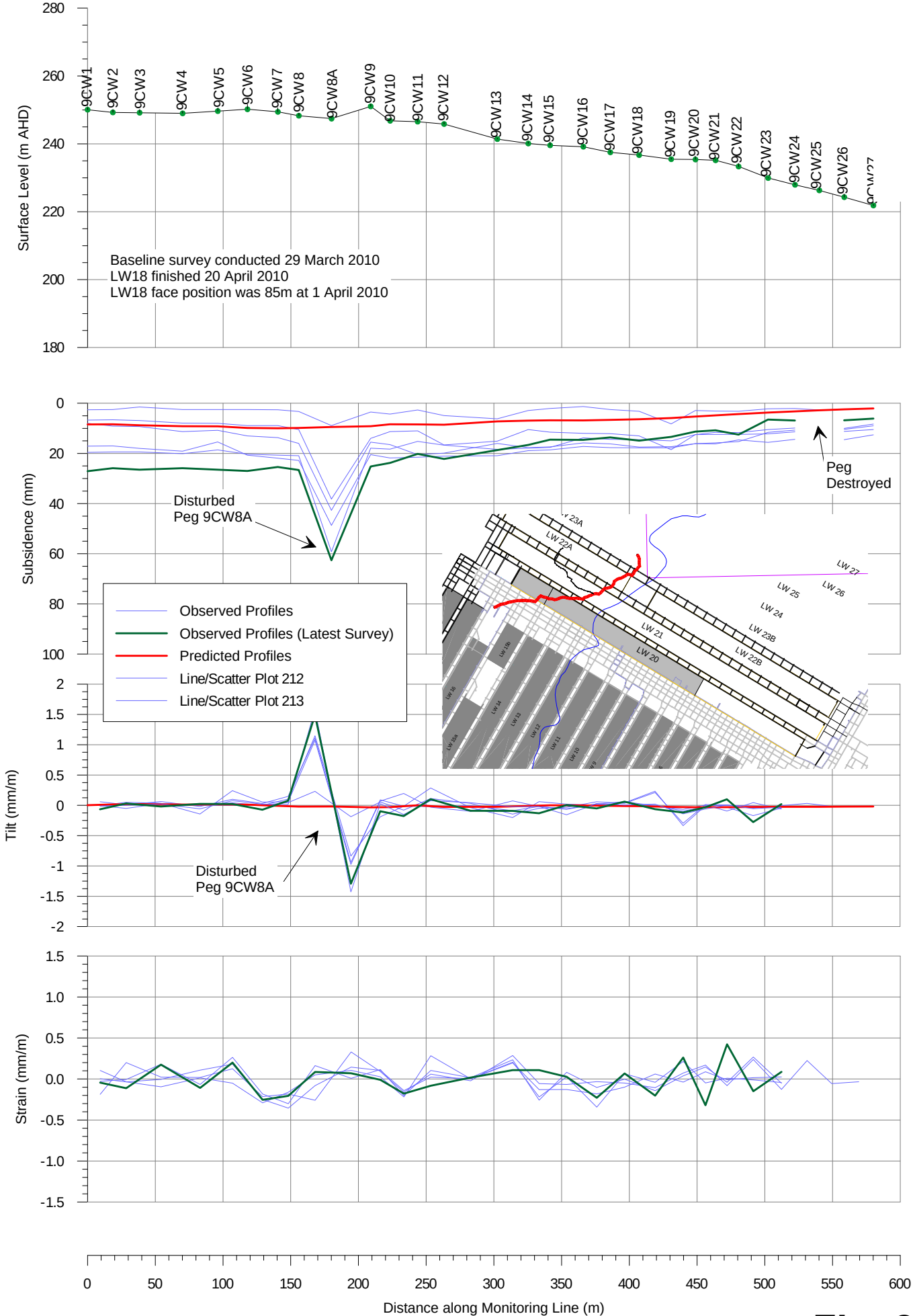


Fig. 2

Profiles of Systematic Subsidence, Tilt and Strain along Monitoring Line GL Resulting from the Extraction of LW20

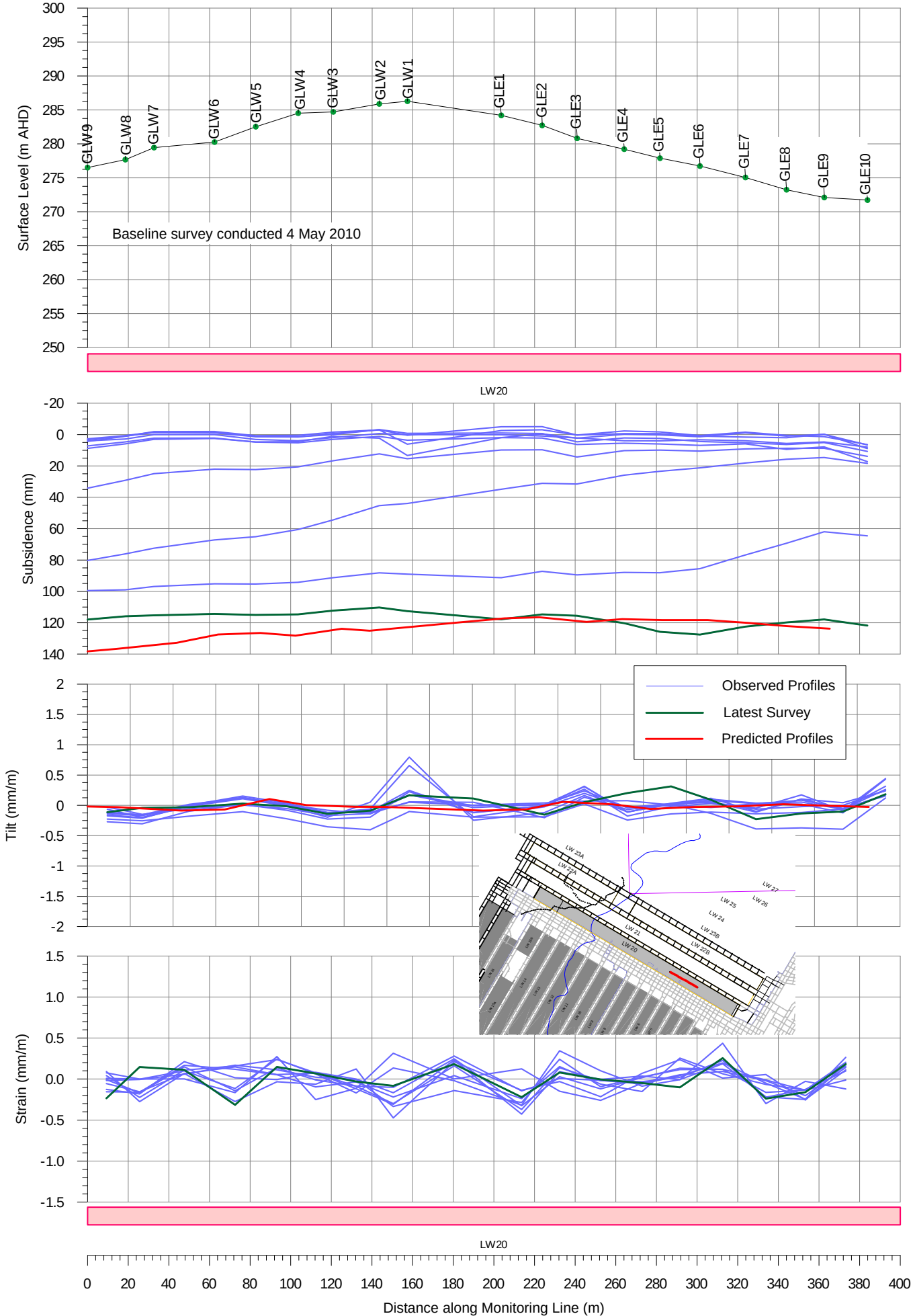


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Fig. 3

Profiles of Net Vertical Movement, Strain, Upsidence and Closure along Monitoring line 1400 Resulting from the Extraction of LW20

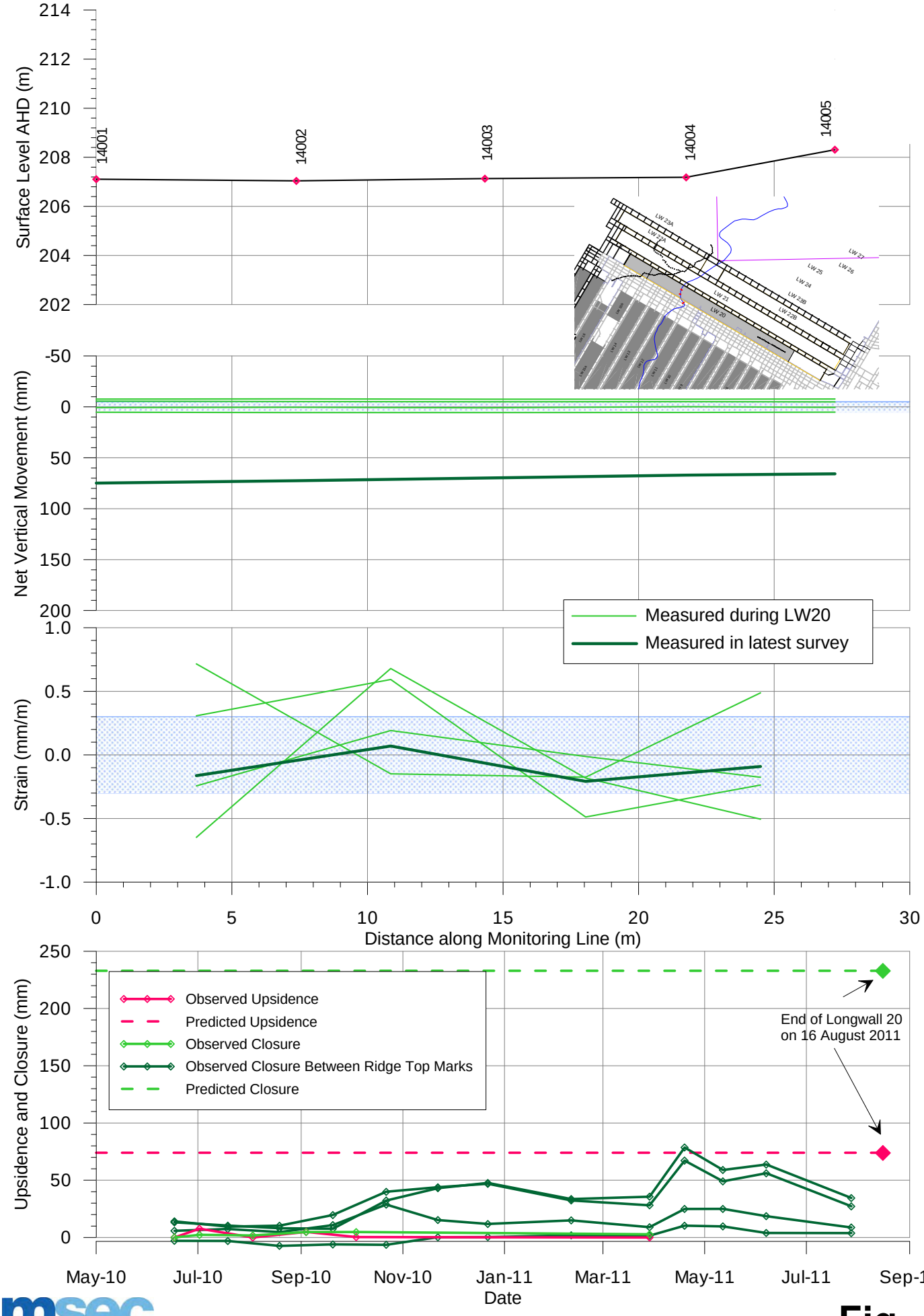

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Fig. 4

Profiles of Net Vertical Movement, Strain, Upsidence and Closure along Monitoring line 1500 Resulting from the Extraction of LW20

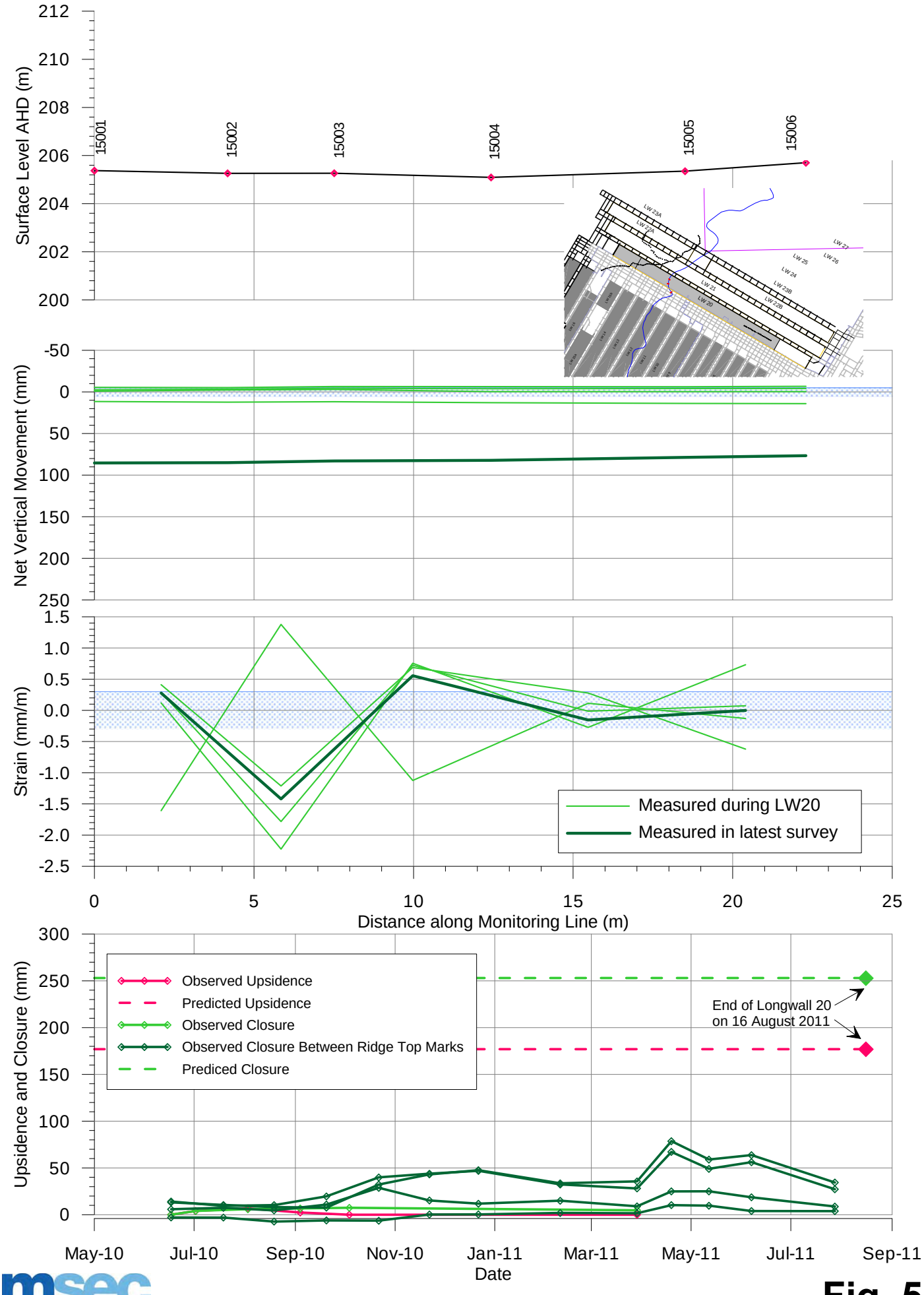

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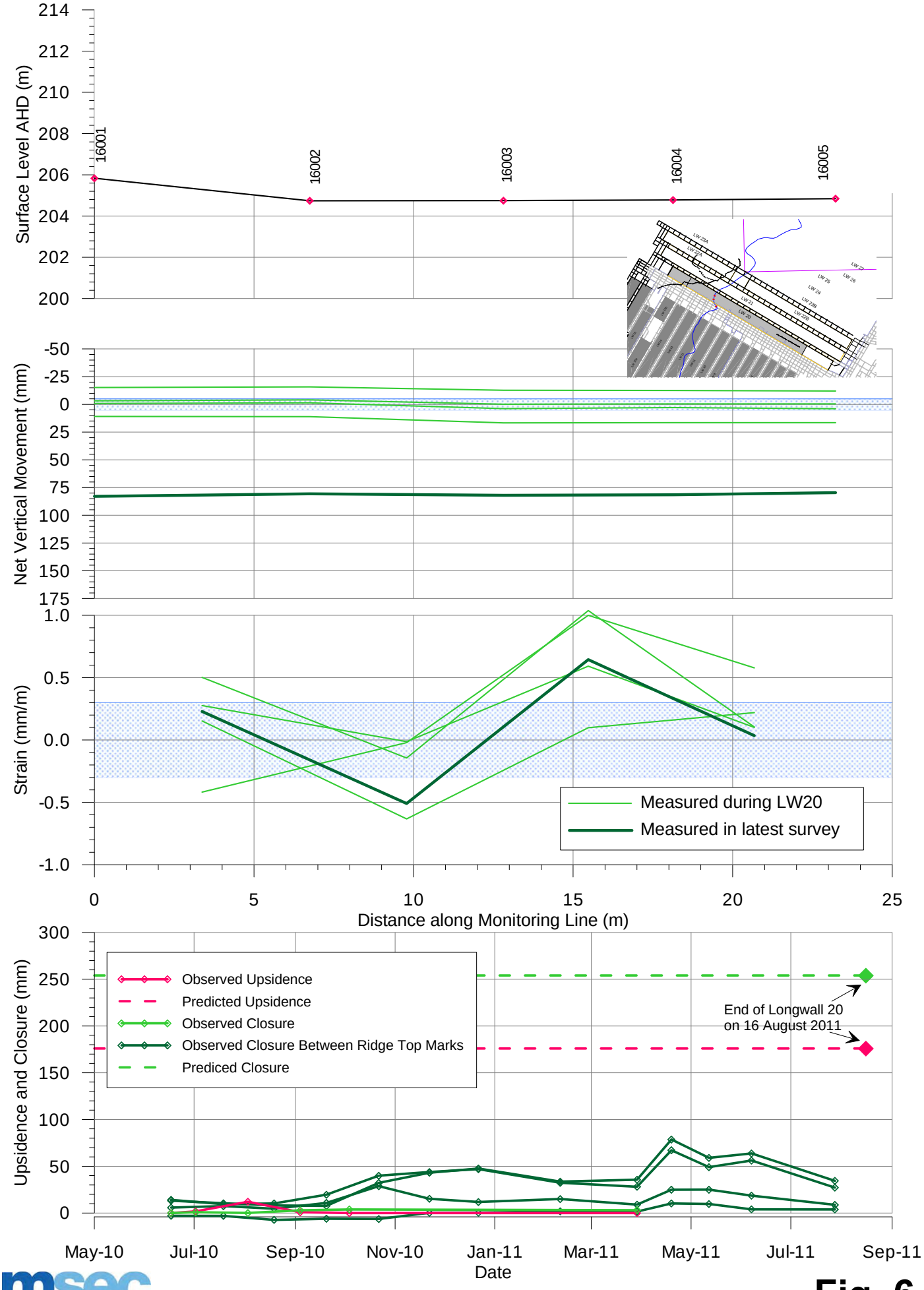
Fig. 5

Profiles of Net Vertical Movement, Strain, Upsidence and Closure along Monitoring line 1600 Resulting from the Extraction of LW20



msec

Fig. 6

Observed Incremental Horizontal Peg Movements for Pegs with Solid Coal between Peg and Mined LW

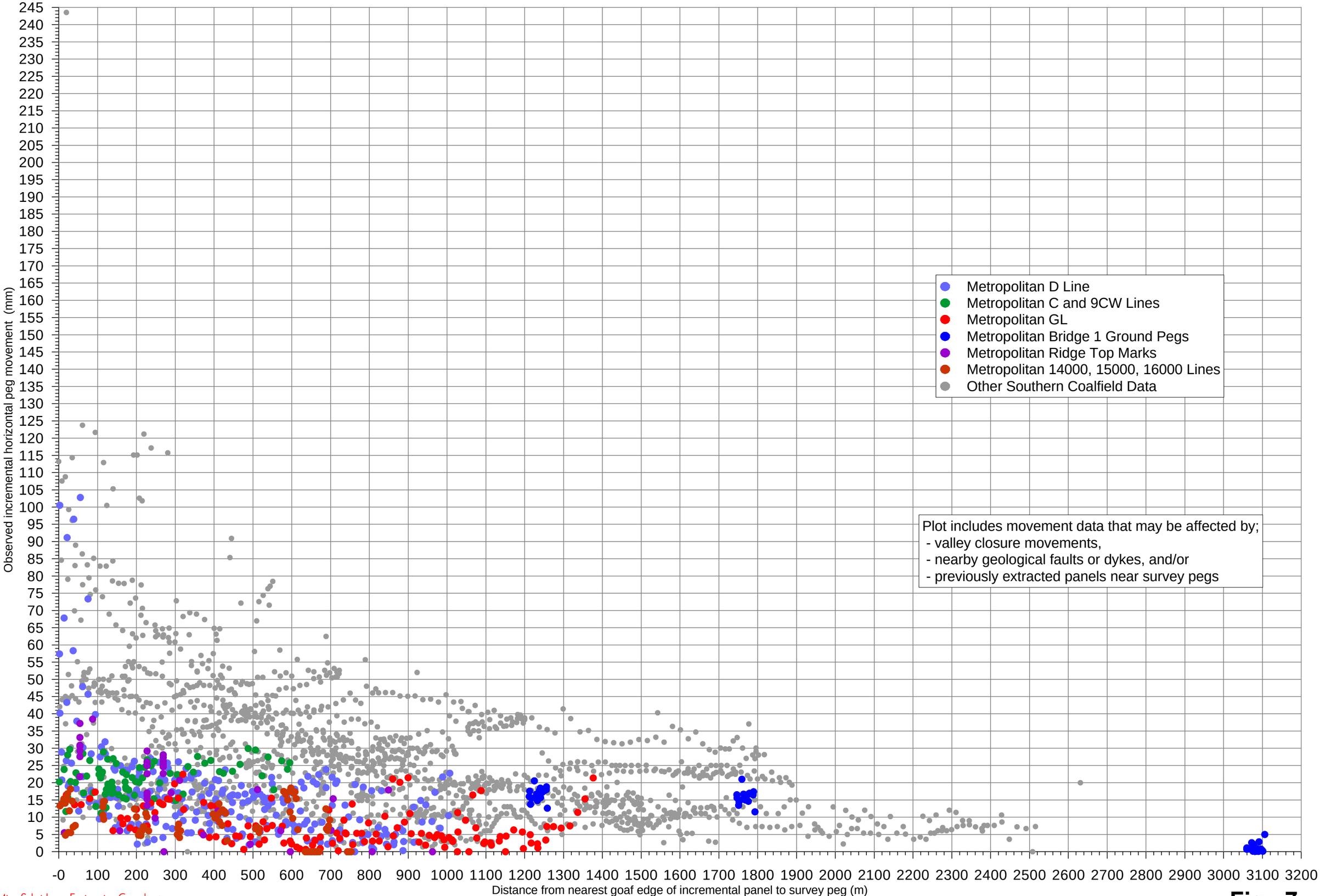


Fig. 7

I:\Projects\Metropolitan\MSEC471 - LW20 Monitoring\SurveyDatabase\Compiled RelLong Mvts 20m-A3-Solid Coal(MSEC378).grf 22-Sep-11

Incremental Observed Relative Longitudinal Peg Movements due to One Longwall (20m peg spacing ± 10m)
Only Pegs with Solid Coal Between Peg and Longwall

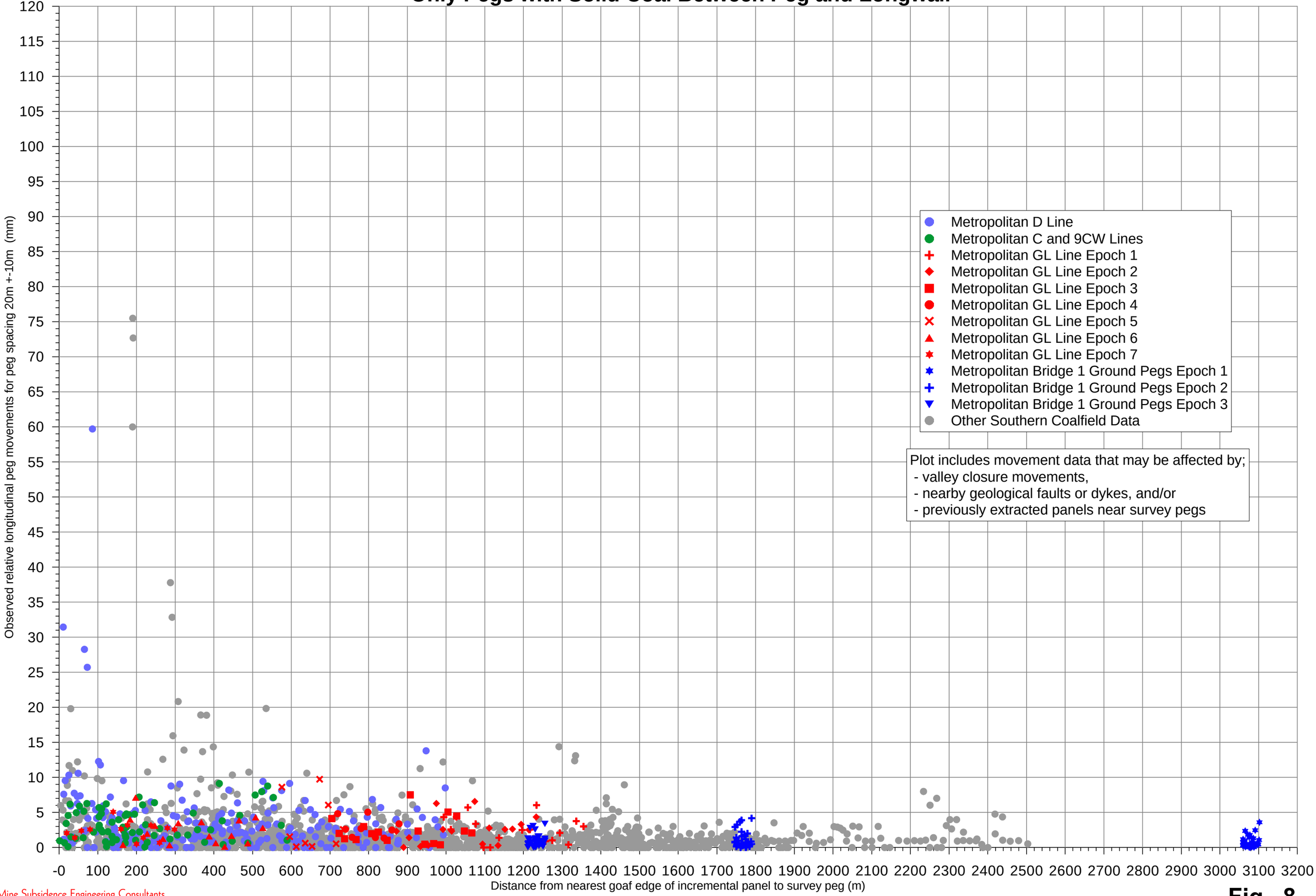


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Fig. 8

Incremental Observed Relative Lateral Peg Movements due to One Longwall (20m peg spacing ± 10m)
Only Pegs with Solid Coal Between Peg and Longwall

Observed relative lateral peg movements for peg spacing 20m ±10m (mm)

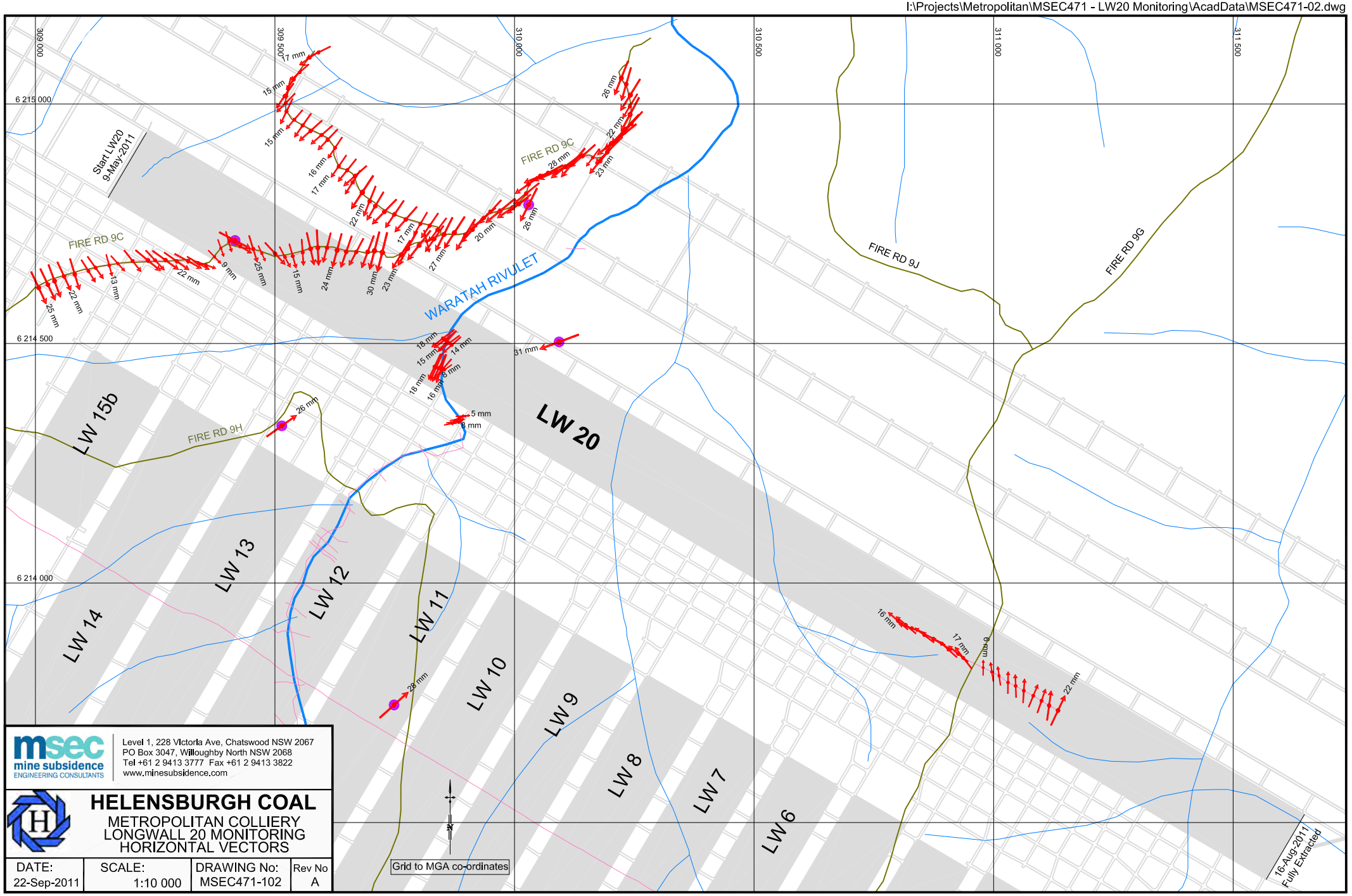
Distance from nearest goaf edge of incremental panel to survey peg (m)

- Metropolitan D Line
- Metropolitan C and 9CW Lines
- Metropolitan GL Line Epoch 1
- Metropolitan GL Line Epoch 2
- Metropolitan GL Line Epoch 3
- Metropolitan GL Line Epoch 4
- Metropolitan GL Line Epoch 5
- Metropolitan GL Line Epoch 6
- Metropolitan GL Line Epoch 7
- Metropolitan Bridge 1 Ground Pegs Epoch 1
- Metropolitan Bridge 1 Ground Pegs Epoch 2
- Metropolitan Bridge 1 Ground Pegs Epoch 3
- Other Southern Coalfield Data

Plot includes movement data that may be affected by;
- valley closure movements,
- nearby geological faults or dykes, and/or
- previously extracted panels near survey pegs

Fig. 9

I:\Projects\Metropolitan\MSEC471 - LW20 Monitoring\AcadData\MSEC471-02.dwg



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METROPOLITAN COLLIERY
LONGWALL 20 MONITORING
HORIZONTAL VECTORS

DATE:	SCALE:	DRAWING No:	Rev No
22-Sep-2011	1:10 000	MSEC471-102	A

APPENDIX 2

SURFACE WATER QUALITY GRAPHS

AVAILABLE ON REQUEST

APPENDIX 3

METROPOLITAN COAL COMPLAINTS RECORD

Metropolitan Coal Complaints Register
August to December 2010

Complaint Number	Person Receiving Complaint	Quarter	Date Received	Time Received	Method of Contact	Nature of Complaint	Action Taken by Licensee	Follow Up Contact
2010_10	Ryan Pascoe	4	10/13/2010	3:39pm	DECCW Referred	The complainant asserted that a truck leaving Metropolitan Coal had not covered its load.	A full investigation was conducted and a report was provided to DECCW. Cover use will be monitored to ensure that all covers are being operated appropriately.	Randomised monitoring has indicated full compliance with regards to covering loads. Cover use will continue to be monitored periodically.
2010_11	Ryan Pascoe	4	10/23/2010	10:15am	Telephone	After a severe downpour the complainant asserted that their outdoor furniture had been covered in coal dust.	An investigation was conducted and samples of the dust have been collected for analysis. Analysis of the dust sample has indicated that less than 10% of the sample was coal dust.	A meeting took place with the complainant and Metropolitan's dust results for the month were discussed.
2010_12	Adam Hatfield	4	12/27/2010	4:05pm	Email	Complaint concerning noise from cobble loading.	Discussed issue with Sada Operations and where feasible cobble will be loaded during daylight hours.	This information was provided to the complainant and they were satisfied with the response.

Metropolitan Coal Complaints Register (Continued)
January to July 2011

Complaint Number	Person Receiving Complaint	Quarter	Date Received	Time Received	Method of Contact	Nature of Complaint	Action Taken by Licensee	Follow Up Contact
2011_1	Jason Fuller (Control Room)	1	1/9/2011	2.45pm	Telephone	Concerns with respect to noise and perception that noise impacts are worsening.	On inspection it was observed that a contractor was commissioning their continuous miner using the power tram. The power tram is relatively noisy and this practice has been discontinued during times which could be disruptive to the community.	Complainant commented that once the power tram was turned off the noise level was more acceptable.
2011_2	Ryan Pascoe (Environment & Community Manager)	1	2/26/2011	3.30am	Telephone	Noise impacting upon sleep - reversing alarm for a machine operating on the stockpile.	The issue was investigated, the responsible equipment was identified and a broad spectrum reversing alarm was installed as per site policy.	Conveyed to resident that the offending equipment was identified and that corrective actions were implemented.
2011_3	Andrew Smith (Control Room)	1	4/22/2011	10.58am	Telephone	Trucks operating on Good Friday.	Complaint referred to Environment & Community Manager to follow up.	Environment & Community Manager called complainant to explain that approval allows trucking Monday to Friday and that truck numbers were reduced to the minimum amount necessary. Additionally, not trucking was not possible given the reject stocks would overflow if there was no trucking across the extended long-weekend. It was also decided not to truck on ANZAC Day.
2011_4	Phillip Matias (Control Room)	2	4/27/2011	3.42pm	Telephone	Noise occurring at 10.30pm and several other times disrupting sleep.	Control Room referred complaint to Environment & Community Manager to investigate.	Environment & Community Manager and Environment & Community Coordinator visited complainant on 5 May 2011 to seek further details of noise issue, which is predominantly intermittent clanging noise at night attributed to the loading of the train from the bulldozers. Advised that issue would be further investigated and advice sought from a Noise Consultant regarding appropriate mitigation measures.