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16 July 2012

Steve Barry
Acting- Director Environmental Sustainability
Department of Industry and Investment- Mineral Resources
PO Box 344
Hunter Regional Mail Centre NSW 2310

Dear Mr Barry,

END OF PANEL REPORT- STAGE 2 LONGWALL A5

Austar Coal Mine Pty Ltd (Austar) completed extraction of Longwall A5 on 26 March 2012. Austar submits this End of Panel report for Longwall A5 in accordance with Condition 18 of Subsidence Management Plan (SMP) Approval for Longwall A4-A5 (File No.08/2956, approved on 24 December 2009).

This report encompasses the monitoring undertaken during the extraction of Longwall A5. There has been no abnormal behavior that has required particular review. The report consists of the analysis from:

- Appendix 1: Surface subsidence monitoring program;
- Appendix 2: Public safety monitoring and management plan;
- Appendix 3: Vibration monitoring plan
- Appendix 4: Groundwater monitoring as per the Site Water Management Plan (SWMP)
- Appendix 5: Surface water monitoring per the SWMP
- Appendix 6: Ecological monitoring per the Stage 2 Ecological Monitoring Program

In summary, surface subsidence was of the order of 1150mm and at its maximum over the chain pillar as predicted. No perceptible impacts to the environment or increase in public safety risk have occurred. Ground and groundwater behaviour indicated by the monitoring is as predicted by the assessment reports.

Please contact myself on (02) 4993 7293 if you require further information regarding any of the data or interpretations summarised in this report.

Yours faithfully,

Adrian Moodie
Technical Services Manager
Austar Coal Mine

Appendix 1: Surface Subsidence Monitoring

1.1 Monitoring Results Summary

Subsidence monitoring has been undertaken in accordance with Subsidence Monitoring Programme. Summary results are displayed below and compared against maximum predicted and upper bound subsidence from MSEC Report MSEC275 which supported the original SMP application and Report MSEC391 which supported a modification to the Longwall A5 geometry (shortened length, increased void width and chain pillar width). Included in **Table 1 and 2** are the Maximum Predicted and Upper Bound subsidence parameters. Whereby the Maximum Predicted case was determined using the calibrated Incremental Profile Method and the Upper Bound case was determined by scaling up the predicted systematic subsidence parameters such that the maximum subsidence of 65% of effective extracted seam thickness is achieved above the longwalls.

Table 1: Actual vs Maximum Predicted Subsidence Parameters

LW	Maximum Predicted Cumulative Subsidence (mm)	Actual Cumulative Subsidence	Maximum Predicted Cumulative Tilt (mm/m)	Actual Cumulative Tilt (mm/m)	Maximum Predicted Cumulative Tensile Strain (mm/m)	Actual Cumulative Tensile Strain (mm/m)	Maximum Predicted Cumulative Compressive Strain (mm/m)	Actual Cumulative Compressive Strain (mm/m)
After A3	295	157	1.5	0.7	0.2	0.2	0.4	0.4
After A4	1130	850	5.1	5.4	0.7	<1.0	1.7	<1.0
After A5	1380	1150	5.6	7.0	1.0	2.2	2.0	3.4

Table 2: Actual vs Upper Bound Subsidence Parameters

LW	Upper Bound Cumulative Subsidence (mm)	Actual Cumulative Subsidence	Upper Bound Cumulative Tilt (mm/m)	Actual Cumulative Tilt (mm/m)	Upper Bound Cumulative Tensile Strain (mm/m)	Actual Cumulative Tensile Strain (mm/m)	Upper Bound Cumulative Compressive Strain (mm/m)	Actual Cumulative Compressive Strain (mm/m)
After A3	630	157	2.9	0.7	0.4	0.2	0.8	0.4
After A4	2335	850	9.4	5.4	1.1	<1.0	3.1	<1.0
After A5	2955	1150	10.9	7.0	1.2	2.2	3.7	3.4

Further detailed analysis of the individual monitoring lines can be found in the attached report '*MSEC565 Longwall A5 End of Panel Subsidence Monitoring Review Report'* as attached.

1.2 Analysis of Monitoring Results

See attached report *MSEC565 Longwall A5 End of Panel Subsidence Monitoring Review Report*.

1.2.1 Comparison to Impact Assessment Criteria

Chapter 5 of the subsidence prediction report (MSEC275) details the anticipated impacts on natural features and surface infrastructure. The following table summarises these impacts and makes comment as to the level of impact created by A3 to A5 subsidence as compared to maximum predicted subsidence parameters.

Table 3- Impact Assessment Criteria Post Longwall A5 Mining

Item	Subsidence Impact Assessment	Actual Observation/Occurrence	Action
Cracking of alluvial creek beds	Strains 0.7 to 1.5mm/m with minor cracking possible around perimeters of the longwalls. Cracks only shallow and would infill with material.	Strains <1.0mm/m. No observed cracking.	Nil
Drainage lines	Potential for shallow cracking around tensile zones of perimeter of longwalls	None observed.	Nil
Steep slopes (south-eastern side A3 and above A4)	Tilts 3.4mm/m, Strains ≤1.0mm/m after A5. Potential for minor cracking and unlikely to cause any slippage event after full subsidence.	Tilt <2.0mm/m, Tensile Strain 1.5mm/m potentially as a result of downward slope movement near top of hill. In ground water tank reported to be damaged in vicinity.	Temporary water supply established. Continue to monitor.
Nash Lane	After A5 1000mm, Tilt 3.7mm/m, Strains 0.3-1.0mm/m. No impact on serviceability due to A5 subsidence	Nearby <0.5mm/m strain, Tilt ~3.0mm/m No impact. Road serviceable. No observed cracking.	Nil
Services	Unlikely to create any significant impact even under full subsidence.	No impact observed.	Nil
Rural building structures	All Category A Tilt and Category 0 to 1 for Strain after A5 (Max Predicted)	Tilt Category B in vicinity of structure A04 and all Strains less than Category 2. Whilst no tilt related impacts reported around structure A04, an in ground concrete water tank nearby (Austar owned) has been reported to be damaged and leaking.	Temporary water supply established. Continue to monitor for impacts of tilt and strain in vicinity of structures A04
Other structures	Minimal impact	In ground concrete water tank (Austar owned) has been reported to be damaged and leaking.	Temporary water supply established.

1.2.2 Comparison to Previous Panels

Monitoring of subsidence parameters and impacts for the mining of two Top Coal Caving panels in Stage 1 confirmed Maximum Predicted Subsidence to be an accurate prediction of actual subsidence. The same observation has been recorded for extraction of A3, A4 and A5 in the Stage 2 mining area. Minimal physical impacts were observed in Stage 1 which is the same for the extraction to date in Stage 2. In summary parameters and impacts for A3 to A5 combined are in line with previous mining and impact assessments.

1.2.3 Comparisons to Predictions in SMP

See sections 1.2 and 1.2.1 above.

1.3 Trends in Monitoring Results

Monitoring data is revealing trends that match predicted profiles, with subsidence parameters around maximum predicted and subsidence being controlled by compression of the strata surrounding the chain pillars. The final survey conducted for A5 was approximately at the completion of mining. A survey completed at the time of compilation of this report showed very minimal additional subsidence since the completion of A5 mining. However the trends in the monitoring data and overall levels of subsidence still indicate that final subsidence parameters due to A5 will be less than maximum predicted with only a minor excedence in tilt (~2mm/m, or 0.2%) and strain (~0.5mm/m tensile) observed. The area of increased tilt on the western side of Longwall A3 is believed to be associated with stronger strata locally reducing subsidence as it cantilevers from the adjacent solid strata further over the extracted void than predicted. The one location of increased strain (not attributable to disturbed markers) appears potentially associated with downward slope movement near the top of a hill creating some increased tensile strain. This coincides with the reported cracking of an in ground concrete water tank located on the Austar owned property in the vicinity of this measurement.

1.4 Subsidence Management Actions

The only action required to be undertaken to date has been the established of a temporary water supply on the Austar owned property where the in ground concrete water tanks were noted as leaking.

On the same Austar owned property it has been reported for one farm dam, which has two overflow weirs, that dam overflow water used to drain from one particular weir, and now favours the other weir. There has been no action required with this dam to date.

No other impact to structure or natural features has been observed or reported. Subsidence monitoring should continue per the Subsidence Monitoring Strategy with particular attention to final tilts and strains in the vicinity of the hill located over the A3 to A4 chain pillar where slightly increased tilts and strains have been recorded.

Appendix 2: Public Safety Monitoring and Management Plan

2.0 Summary

During routine subsidence monitoring and on occasions the area was being accessed for other purposes the following items were inspected for as per the Public Safety Management Plan:

- Surface cracking;
- Surface humps;
- Step changes in landform;
- Serviceability of access tracks;
- Slope or boulder instability;
- Other sign of subsidence.

Of all the inspection occasions no evidence of any of the above could be observed (Also refer to **Table 3**). Correspondence with the landholders in the area surrounding longwalls A3 to A5 also confirmed that no safety issues manifested and no physical signs of subsidence were observed other than some minor plasterboard cracking around an archway and damage to an in ground water tank.

Appendix 3: Vibration Monitoring

3.1 Monitoring Results Summary

Vibration monitoring has been undertaken in accordance with the Vibration Monitoring Plan for Longwall Panels A3, A4, and A5.

Monitoring was undertaken at locations V5, V6 and JB during extraction of LWA5 (refer to **Figure 3.1**).

Monitors were set to monitor vibration continuously, and also to record a waveform when vibration exceeded 1mm/sec in any axis. Results of vibration monitoring greater than 1mm/sec are shown in **Figures 3.2 and 3.3**. Periods which recorded vibration less than 1mm/sec are not shown on the graphs.

Guideline values for annoyance (*Assessing Vibration: a technical guideline, DECC February 2006*), and for minimal risk of cosmetic damage (*BS7385:1993*) are included with the graphed results.

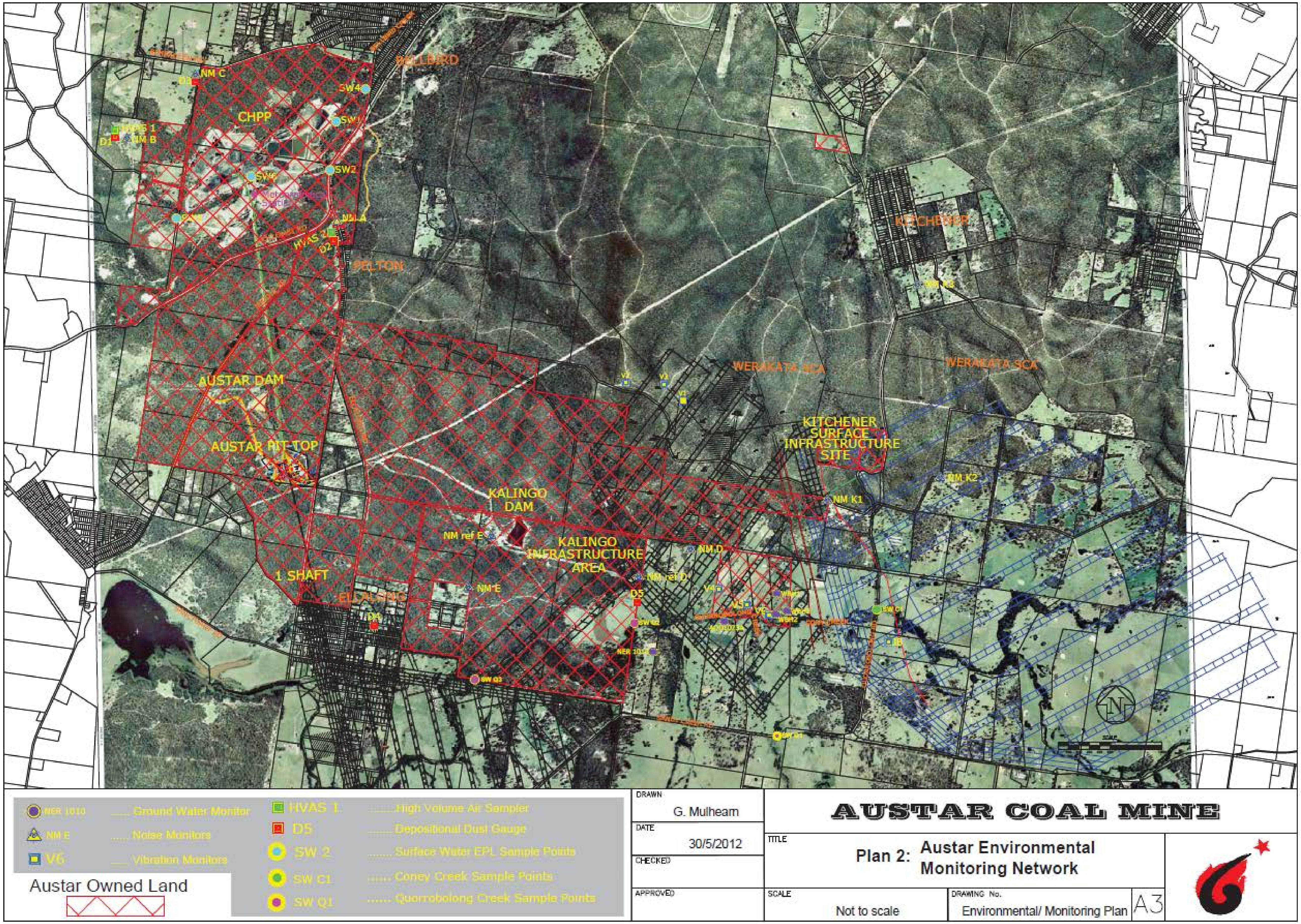

Figure 3.1 Austar Environmental Monitoring Network

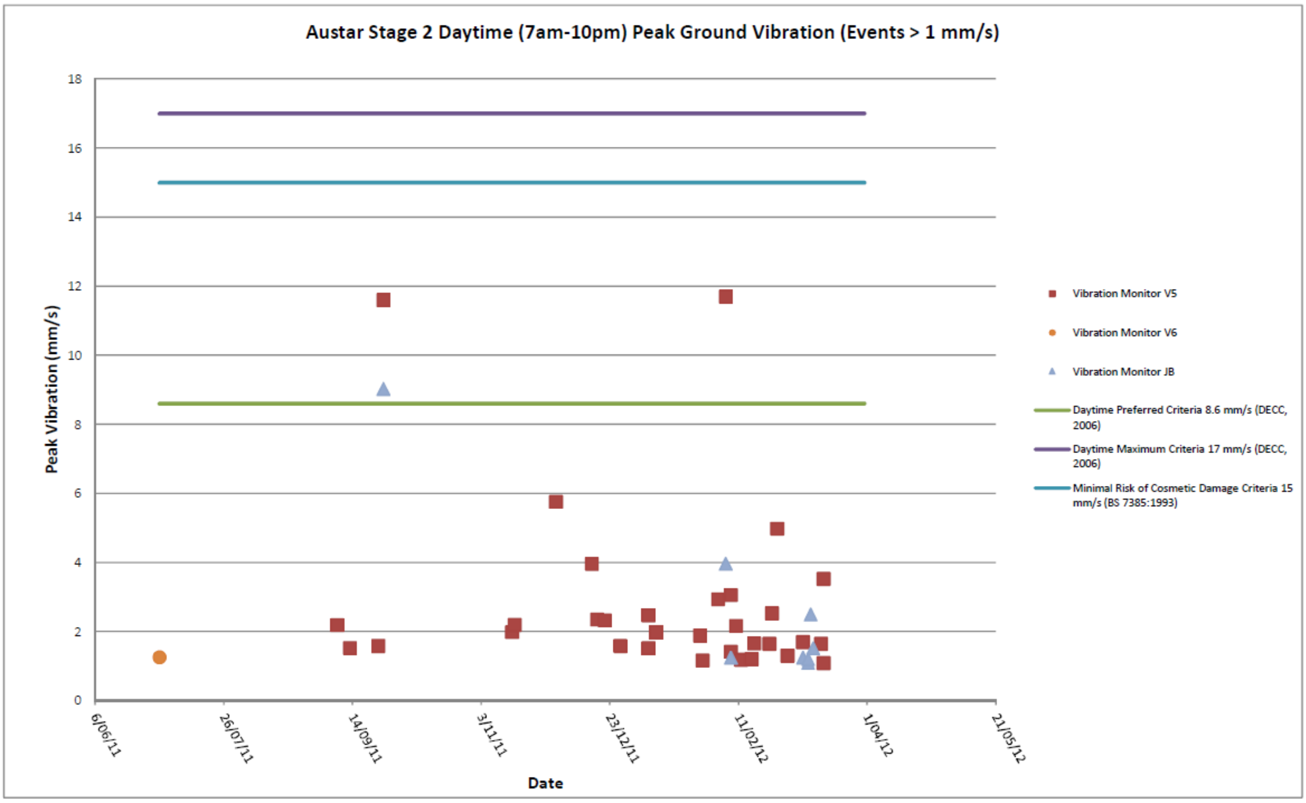

Figure 3.2 Vibration Monitoring Results – Daytime

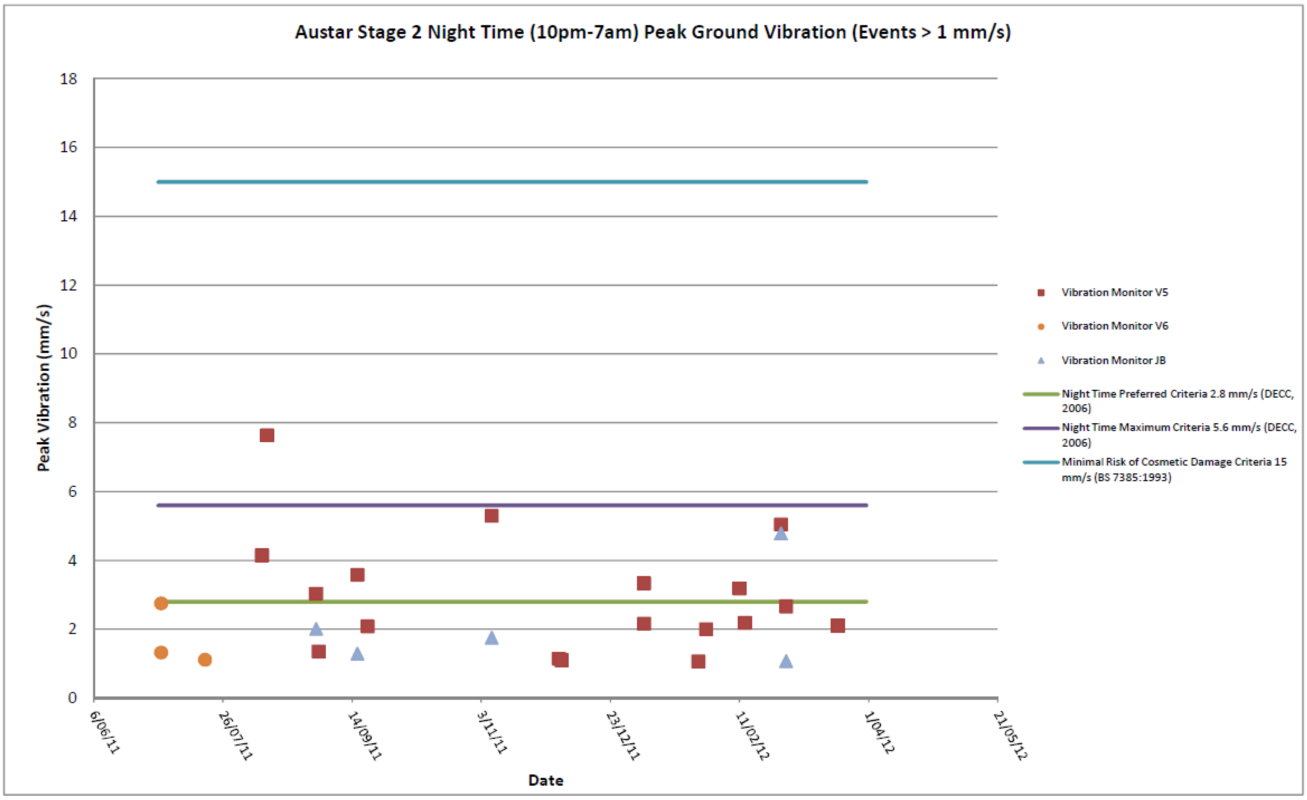

Figure 3.3 Vibration Monitoring Results – Night

3.2 Analysis of Monitoring Results

Results indicate that vibration from extraction of Longwall A5 has been event based in nature, typically generated by strata failures from material overlying the mining area. The majority of vibration events are less than 4 mm/sec, with only 3 events greater than 6 mm/sec over the period of extraction of A5. There were no events greater than 12 mm/sec.

Over the period of monitoring (July 2011 to March 2012), 1 event exceeded the maximum criteria for human response to vibration during the night period. A single exceedance of the maximum criteria over the extraction of Longwall A5 is not considered to be significant. It is important to note that the vibration criteria are non-mandatory (*DECC 2006*) so are used as a monitoring tool to assess possible annoyance. Also, due to the vibration being strata generated, the timing of vibration events cannot be controlled, as would be the case in say pile driving, so operational controls are not feasible in this case.

No events exceeded the guideline value where a minimal risk of cosmetic damage to building structures may occur (15mm/sec).

3.3 Trends in Monitoring Results

There was no vibration measured at >1mm/sec between completion of Longwall A4 and commencement of Longwall A5, and vibration ceased after completion of extraction of Longwall A5, with the exception of a small event on 28 April 2012 at 1.38 mm/sec. This indicates that vibration is coincidental with operational longwall extraction, ceasing after longwall extraction ceases.

Results are similar in magnitude to those from the previous Longwall A4 extraction, with fewer events above 6mm/sec.

The trend of clustering of events observed during extraction of LWA4 seems not to have continued during extraction of LWA5. The hypothesis for the clustering trend of vibration events for LWA4 was thought to be linked to releases of tensile stress in the overlying strata within the caving or fracture zone, observable as vibration, followed by periods of building tension where fewer events were recorded. This hypothesis will again be monitored during LWA5a.

3.4 Management Actions

No management actions relating to vibration have been necessary. Vibration monitoring should continue.

Appendix 4: Ground Water Monitoring

4.1 Monitoring Results Summary

Groundwater monitoring continued in established alluvial monitoring well AQD1073a, and in the sandstone water bearing zone in the Branxton formation in monitoring well NER1010 during longwall extraction of A5. Alluvial groundwater monitoring wells WBH1, WBH2 and WBH3 were established in August 2011.

The location of groundwater monitoring wells is shown in **Figure 3.1**. Water level monitoring results are presented with rainfall data in **Figure 4.1** for 2011 and **Figure 4.2** for 2012.

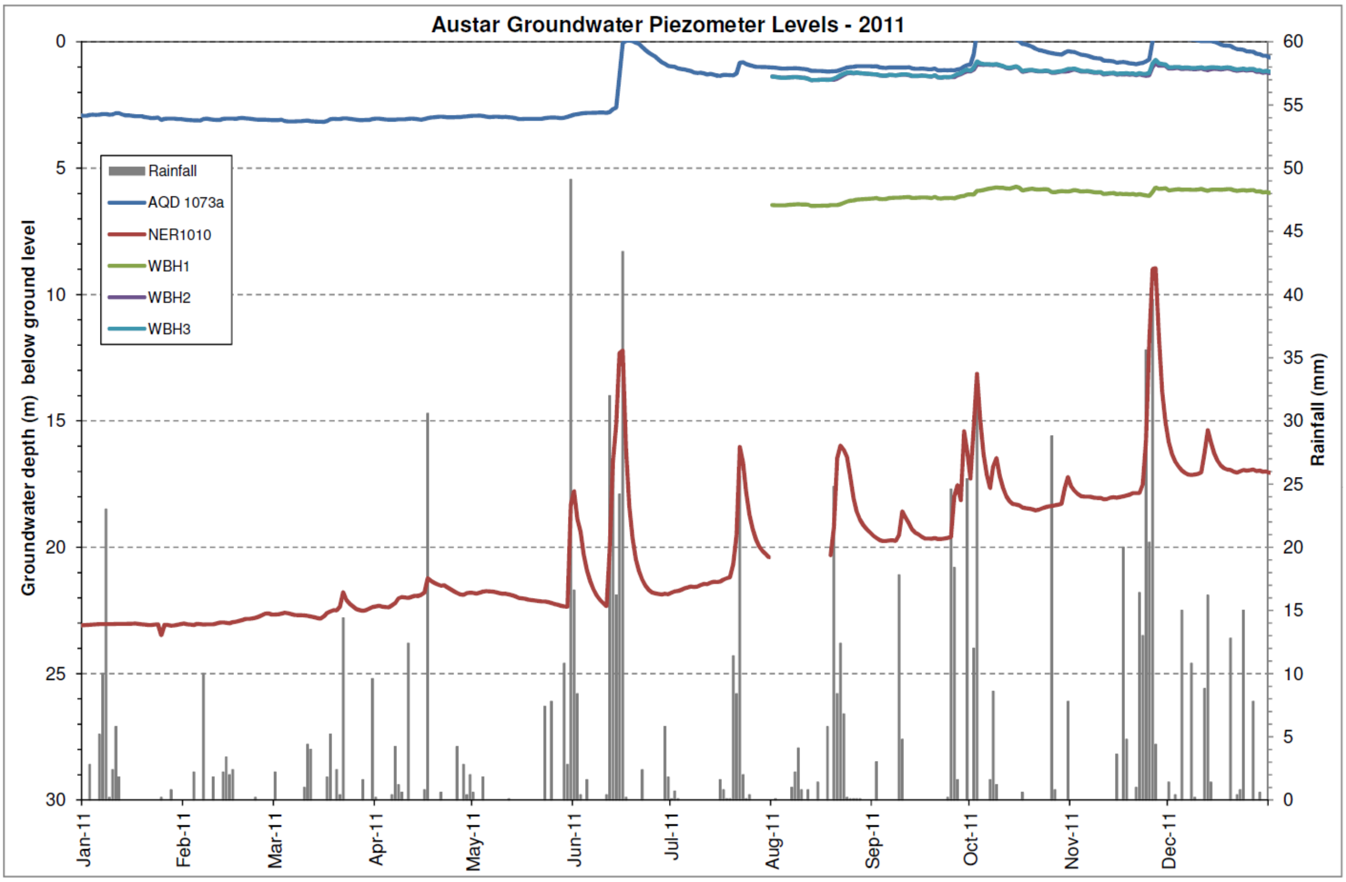

Figure 4.1 – Groundwater monitoring results 2011

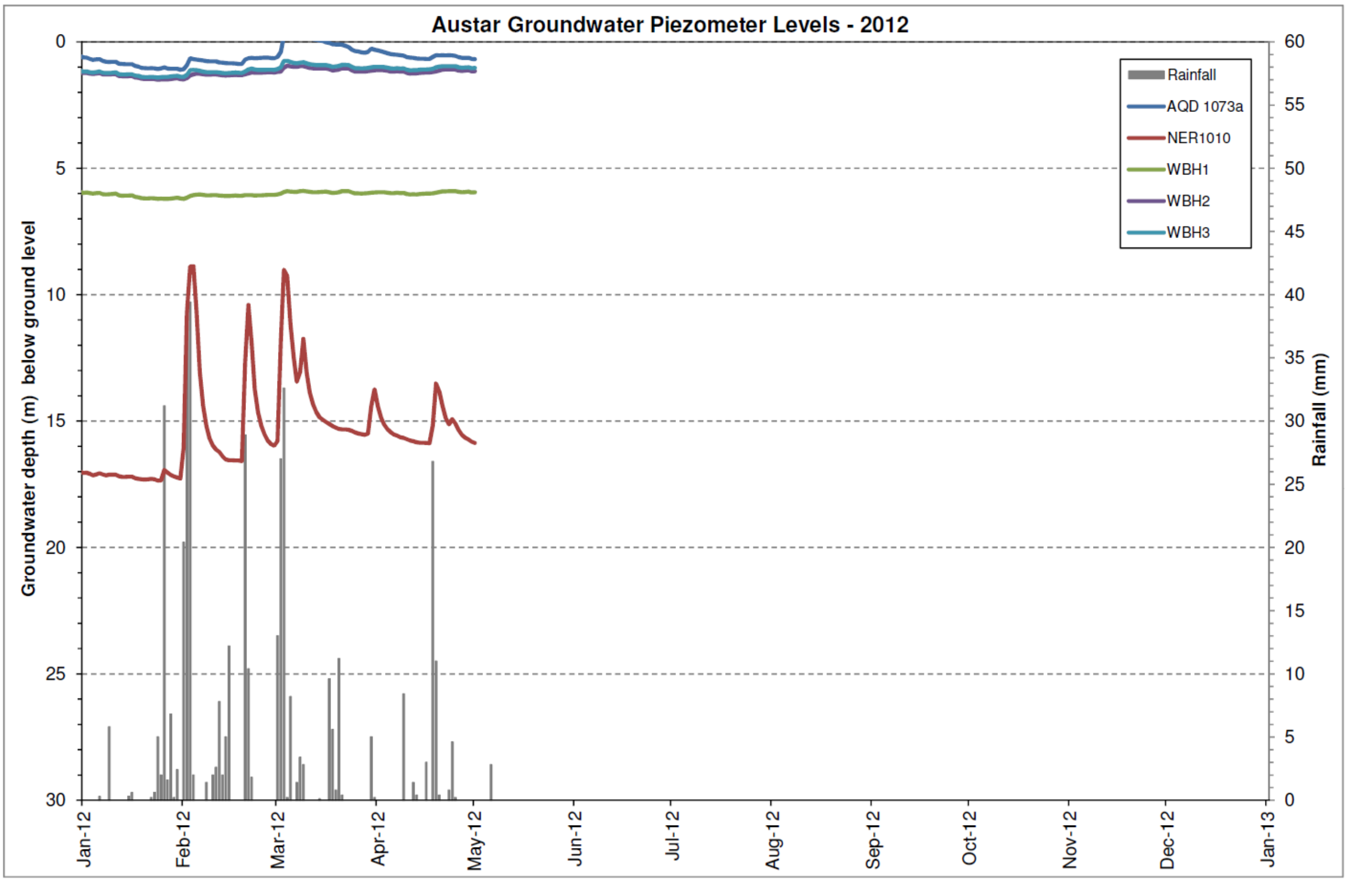

Figure 4.2 – Groundwater monitoring results 2012

4.2 Analysis of Monitoring Results

There are no criteria for groundwater monitoring results in the Site Water Management Plan. Trends are discussed below.

4.3 Trends in Monitoring Results

There has been an overall water level rise observed in the alluvial aquifer at AQD1073a throughout 2011-2012, which was generally from approximately 3metres below ground level (m bgl) to 1-0m bgl. 2011 was a wetter than average year and there was consistent rainfall during the mining of LWA5 (July 2011 to March 2012). Every month during the extraction period had higher than average rainfall, with the exception of January 2012. Groundwater intercepted the surface on four occasions during the period.

From the time of establishment of WBH1, WBH2 and WBH3 in August 2011, through to May 2012, water levels in all three bores remained relatively constant. WBH1 has remained around 6m bgl, while WBH2 and WBH3 remain around 2-1m bgl. WBH2 and WBH3 particularly reflect the pattern of water level fluctuations of AQD1073a.

The water level in the Branxton formation in NER1010 showed a general gradual increase in water level during 2011-2012 from approximately 23m bgl to 16m gbl. Heavy rainfall events caused groundwater levels to briefly spike before falling to meet the general increasing trend line.

4.4 Management Actions

No management actions relating to groundwater level have been necessary. Groundwater monitoring should continue.

Appendix 5: Surface Water Monitoring

5.1 Monitoring Results Summary

Surface water monitoring was conducted in Quorrobolong Creek (locations SWQ1, SWQ2, and SWQ3) and Coney Creek (SW C1) in accordance with the Site Water Management Plan. Monitoring in these water courses is undertaken upstream and downstream of the Stage 2 longwall mining area. The confluence of these creeks resides above the Stage 2 mining area. Longwall A5 was extracted beneath Quorrobolong and Coney Creeks between July 2011 and February 2012. Monitoring locations are presented in **Figure 3.1.**

Water samples are analysed for pH, electrical conductivity (EC), total suspended solids (TSS) and iron (Fe). Results of monitoring are presented in **Figures 5.1 to 5.8**.

Where the creek was dry at the time of sampling, no sample results appear in the relevant graph.

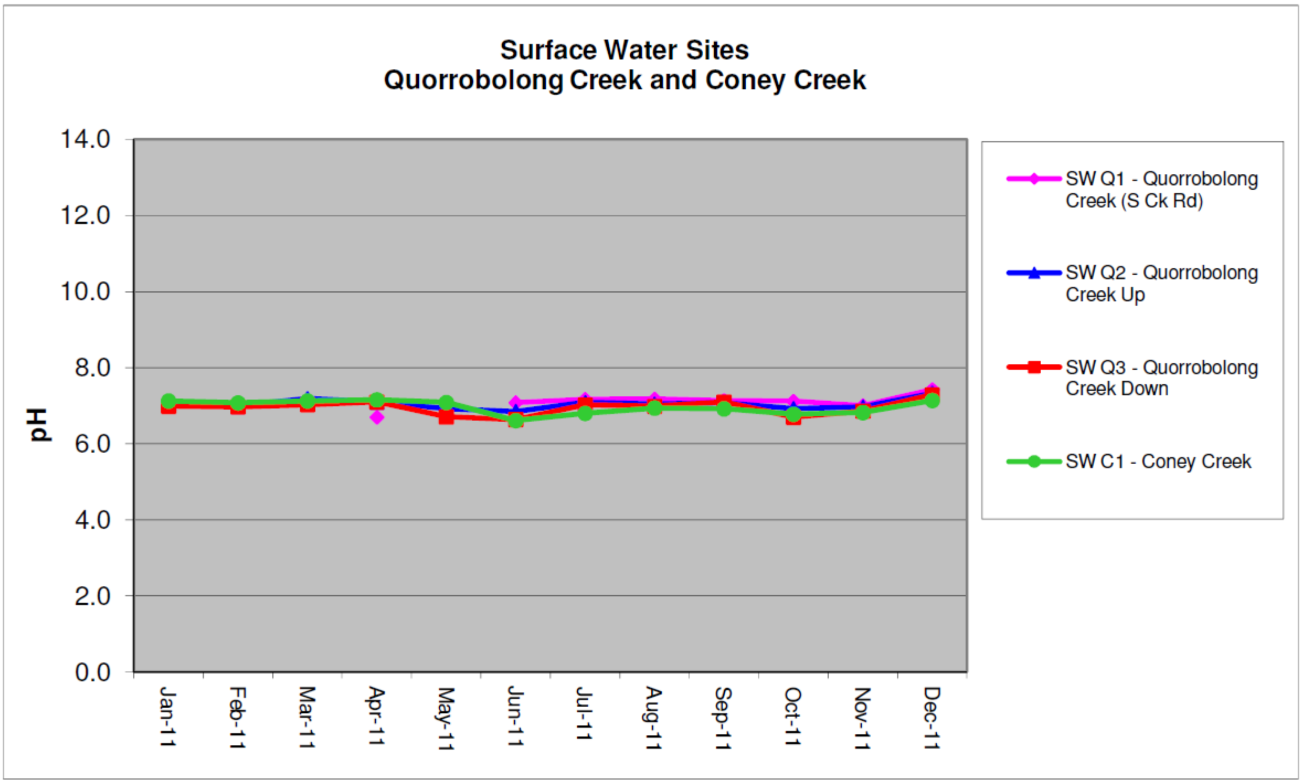

Figure 5.1 – 2011 Surface water results – pH

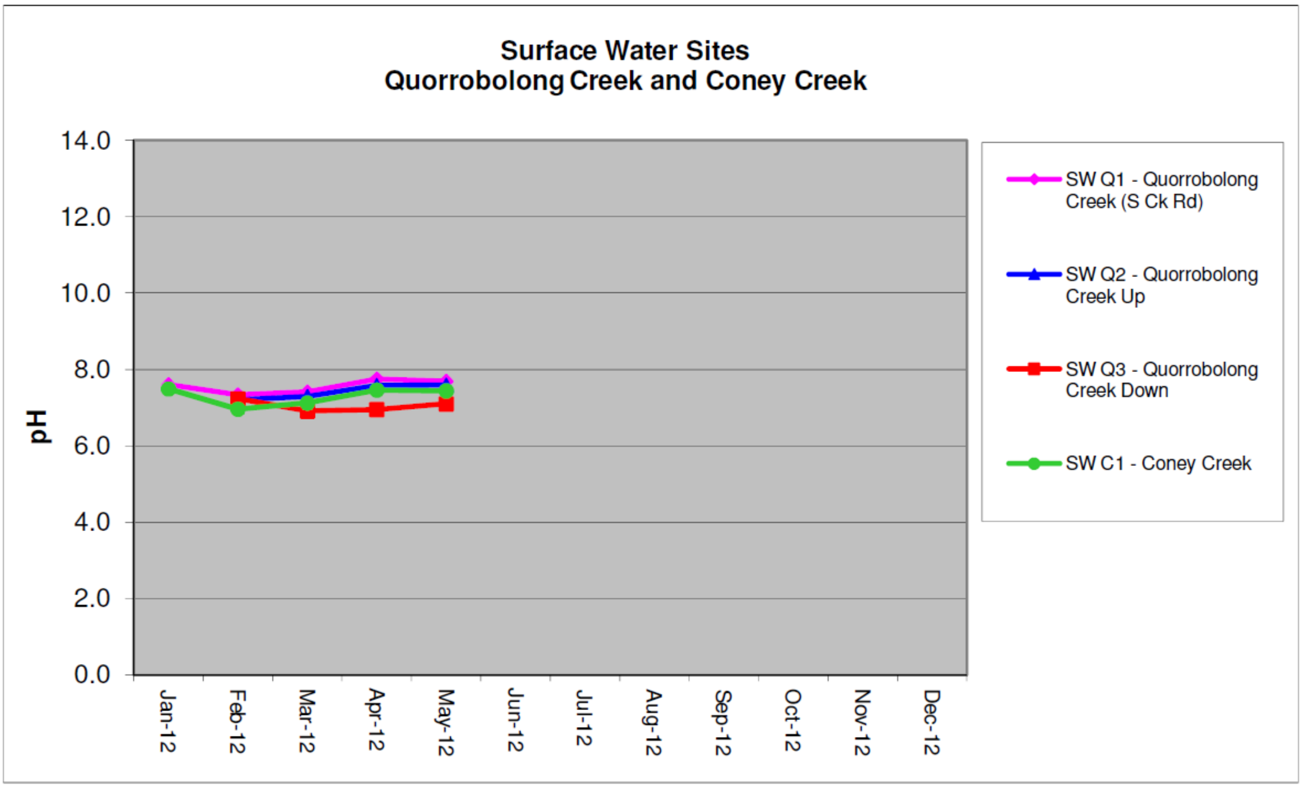

Figure 5.2 – 2012 Surface water results – pH

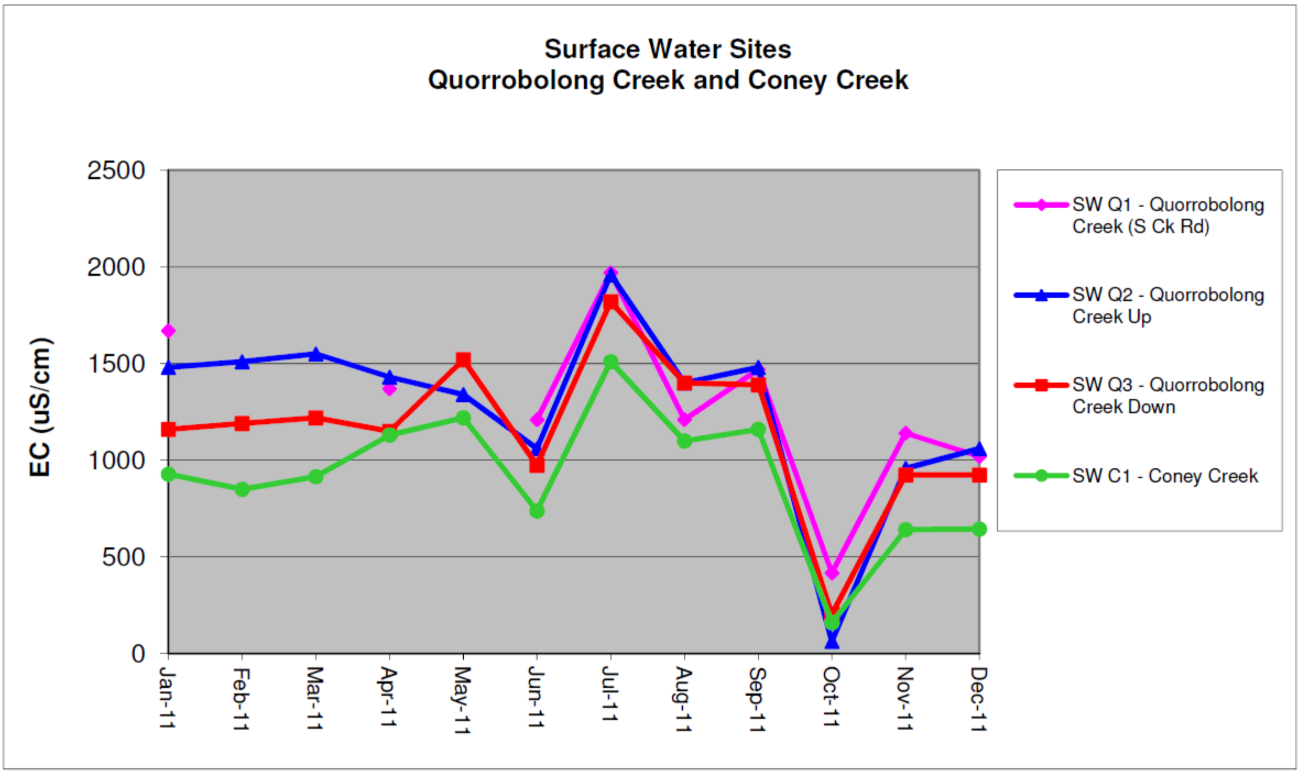

Figure 5.3 – 2011 Surface water results - EC

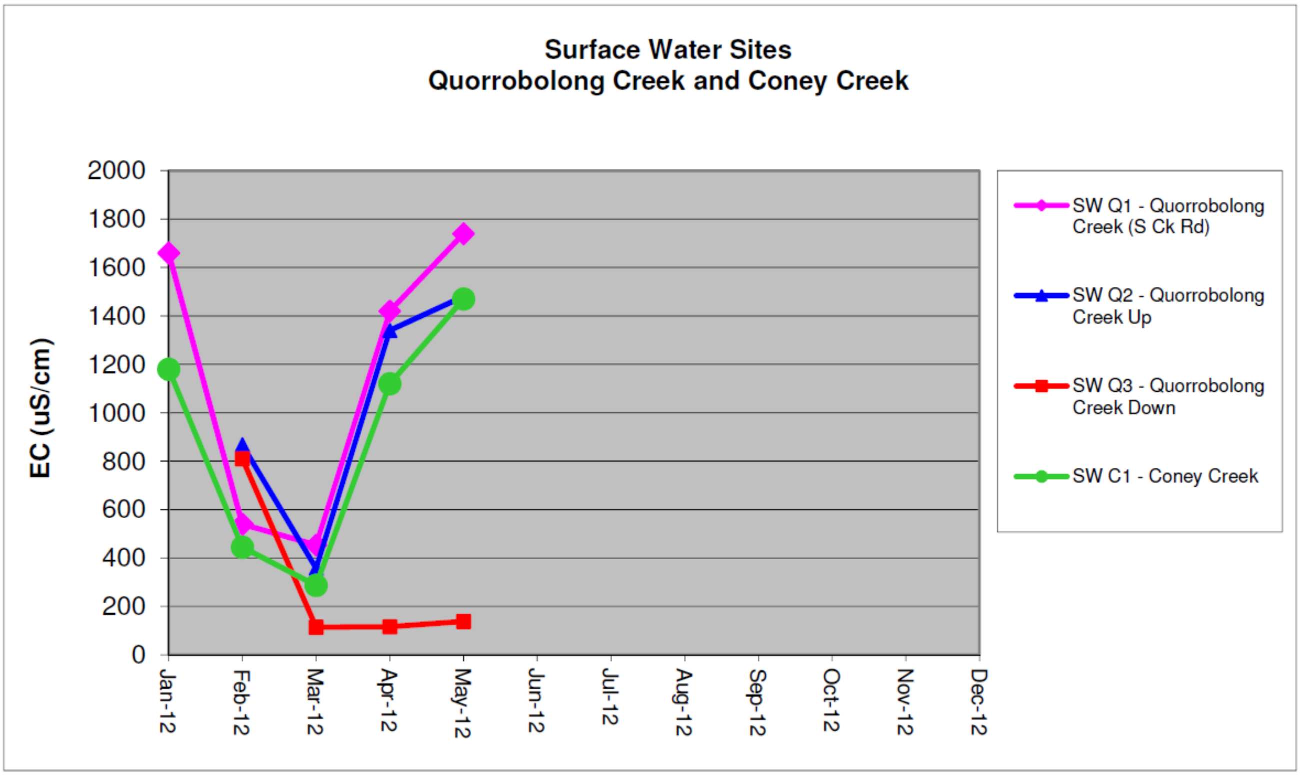

Figure 5.4 – 2012 Surface water results - EC

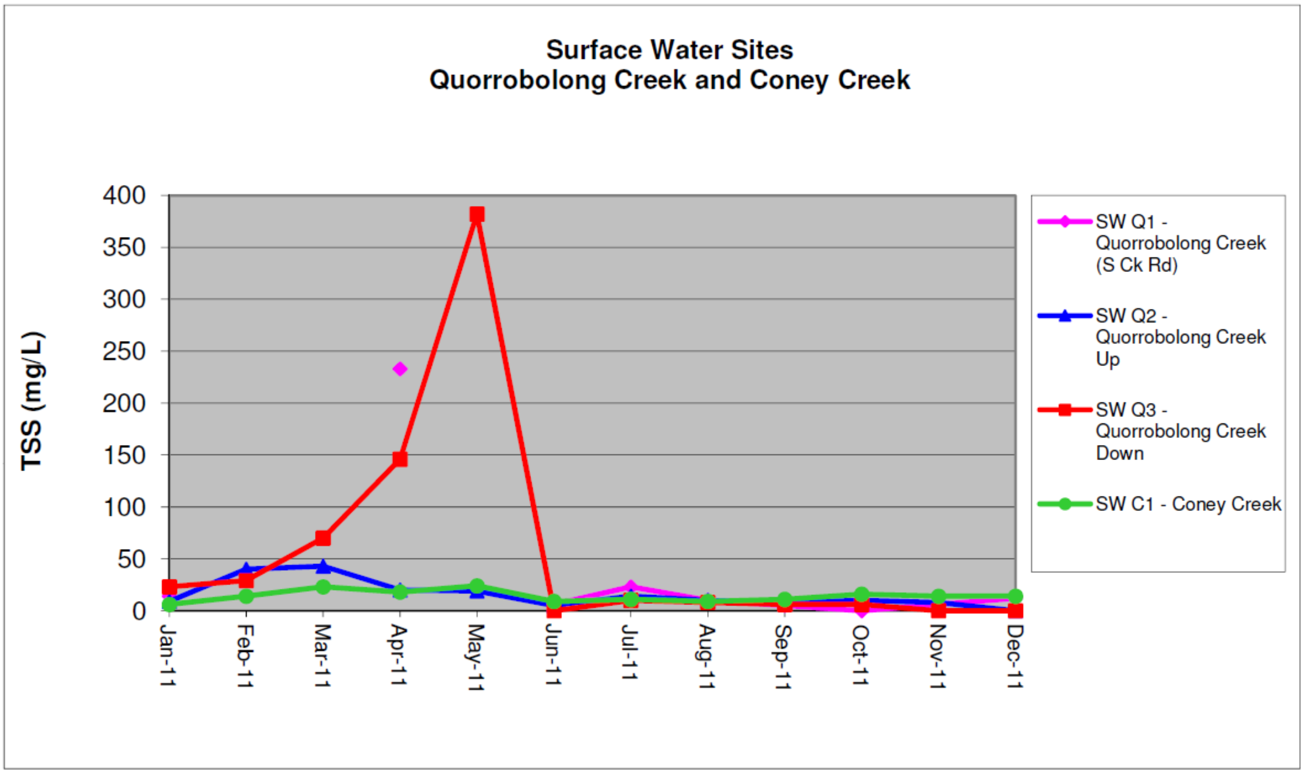

Figure 5.5 – 2011 Surface water results - TSS

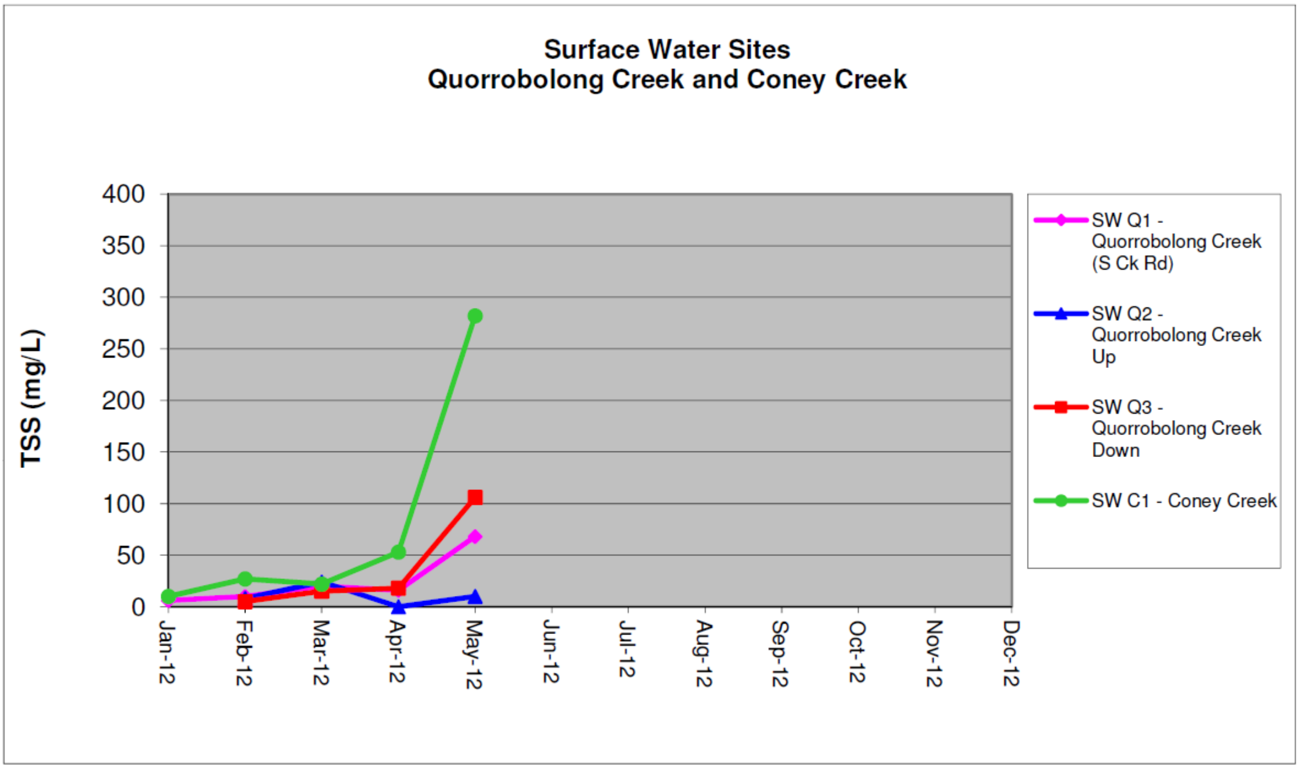

Figure 5.6 – 2012 Surface water results - TSS

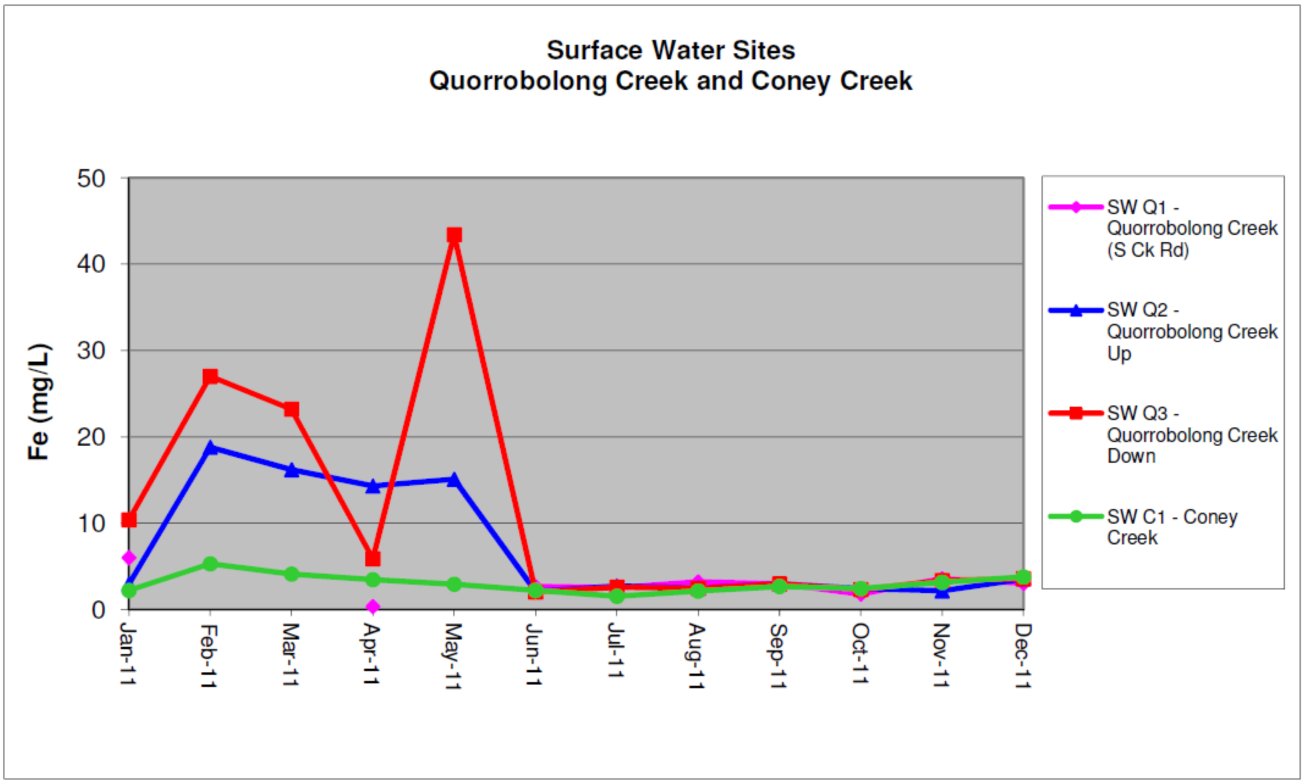

Figure 5.7 – 2011 Surface water results - Fe

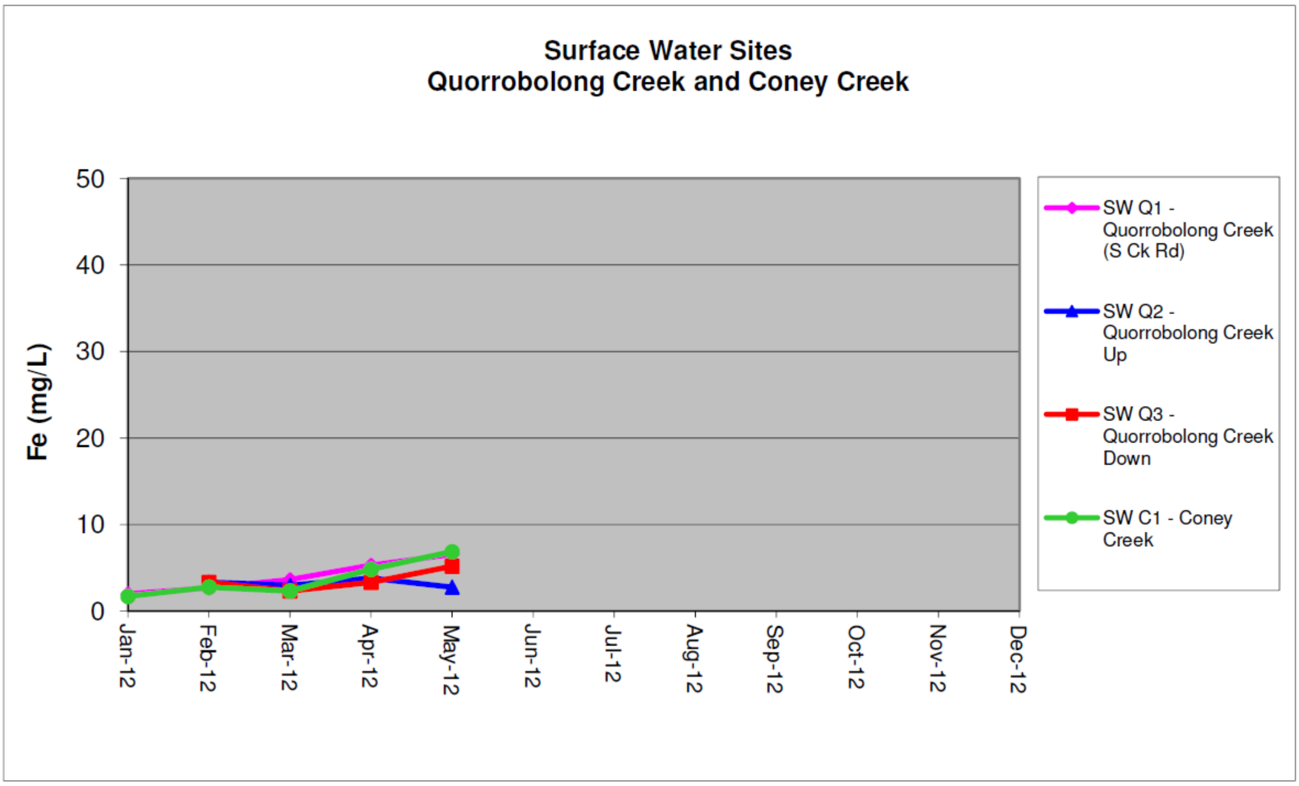

Figure 5.8 – 2012 Surface water results - Fe

5.2 Analysis of Monitoring Results

There are no criteria or predictions for surface water results. pH remained stable and similar at all sampling locations throughout mining of LWA5 (July 2011-March 2012). EC was variable, however similar at all sampling locations throughout mining of LWA5. TSS and Fe were consistently low during the mining period.

The results from Coney Creek and Quorrobolong Creek both upstream and downstream of the longwall LWA5 extraction area have been similar. There appears to be no effect from longwall extraction in LWA5.

5.3. Trends in Monitoring Results

pH has remained relatively steady during 2011-2012. EC was variable in results but similar between sites, with the exception of SWQ3 which remained lower than other sites during April and May 2012. TSS at sites SWQ1 and SWQ3 spiked in the second quarter of 2011, the reason for this is unknown but not related to underground mining activities. TSS results for all locations also increased in May 2012. Fe results were variable during the first half of 2011 and then dropped and stabilised from June 2011 to present.

5.4 Management Actions

No management actions relating to surface water have been necessary. The monitoring program should continue.

Appendix 6: Ecological Monitoring

6.1 Monitoring Results Summary

An ecological monitoring program has been implemented both prior to and during Stage 2 longwall mining. Six ecological monitoring sites are monitored on a bi-annual basis in the season of spring and autumn, with a baseline monitoring survey undertaken in 2008, and ongoing monitoring being undertaken during mining of Longwall A3, A4, A5 and A5a.

The monitoring program incorporates three key survey methods:

- permanent vegetation sampling quadrats;
- ecological condition assessment and
- photographic monitoring.

Over four years of monitoring, three permanent quadrats have been set up for semi-quantitative vegetation sampling. These are sites 1, 2 and 3. Vegetation quadrat sampling, ecological condition assessment and photo monitoring were carried out at each of these sites. Three permanent sites (4, 5 and 6) were set up for condition assessment and photo monitoring only. Monitoring locations are presented in **Figure 6.1**.

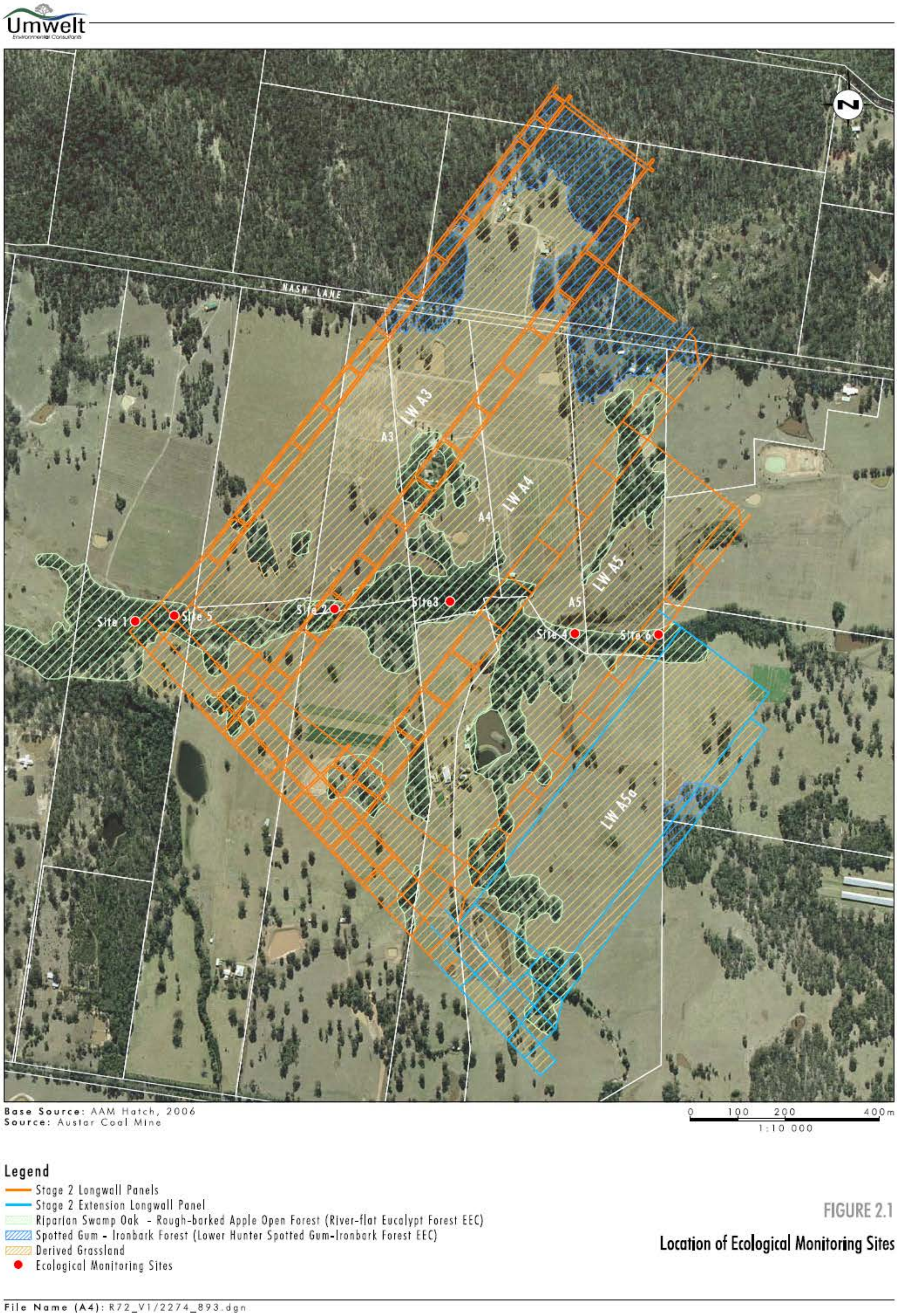

Figure 6.1 – Ecological Monitoring Locations

6.2 Analysis of Monitoring Results

Ecological monitoring has revealed the following:

- There is no evidence to date that any of the fluctuations in species numbers observed (native and introduced) could be associated with underground mining operations.
- No obvious increase in erosion or bank instability has been recorded at any of the sites monitored, or elsewhere in the Study Area.
- No obvious increase in dieback has been recorded at any of the sites monitored (although baseline levels of mild dieback have persisted).
- The photo monitoring indicates there have been no obvious visual changes to the vegetation since the baseline photos were taken.
- High threat weed species observed at all sites were blackberry (*Rubus fruticosus* sp. agg.) and wandering Jew (*Tradescantia fluminensis*).
- Longwall mining under site 4 and site 6 (panel A5) occurred in September–November 2011, therefore the 2012 monitoring surveys would detect any impacts resulting from mining under these sites. It is possible that site 6 could also be affected by panel A5a. The 2011 surveys did not reveal any evidence of impacts on riparian vegetation at these sites as a result of subsidence.
- There is no evidence of any impacts on ecological features as a result of longwall mining.

6.3 Trends in Monitoring Results

None identified with monitoring undertaken to date.

6.4 Management Actions

Autumn monitoring for 2012 had occurred at the date of this report. There was no evidence of any impacts on ecological features as a result of longwall mining.

Biannual monitoring will continue to be undertaken in autumn and in spring. Two monitoring events per year will sample seasonal variation in vegetation, enabling patterns of change to be more accurately attributed to cause.

Biannual monitoring will be conducted for a period of five years after the commencement of mining. The need for and frequency of subsequent monitoring surveys will be reviewed after five years based on the results obtained up to that time.

Despite the fact there are no discernable impacts on the ecological values of the Study Area that could be associated with the underground mining, there are existing threats that require appropriate management. In particular, weed management for Austar owned properties is currently being addressed by a bush regeneration project within Austar owned properties on Quorrobolong Creek, to help conserve and enhance the ecological values of the riparian vegetation which comprises the River-flat Eucalypt Forest EEC. The bush regeneration project commenced in March 2012 in partnership with Conservation Volunteers Australia, and has involved the removal by hand of weed species (particularly wandering Jew) within the Quorrobolong Creek channel and planting of native species to improve creek bank stability. The program has also included cutting / spraying of weed species further outside the channel.

Austar Coal Mine:

Stage 2 – Longwall A5

Longwall A5 End of Panel Subsidence Monitoring Review Report

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	PD	-	5 Jun 12
A	Final Issue	PD	JB	6 Jul 12

Report produced to:- Support the End of Panel Report for Longwall A5 which will be issued to the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS).

Associated reports:- MSEC275 (Revision C) – The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Extraction of Proposed Austar Longwalls A3 to A5 in Support of a SMP Application (February 2007).

Letter dated 13th October 2008 - Austar Stage 2 - Proposed Modification to the Commencing End of Longwall A4.

MSEC391 (Revision B) - The Effects of the Proposed Modifications to Longwalls A4 and A5 in Stage 2 at Austar Mine on the Subsidence Predictions and Impact Assessments (February 2009).

Background reports available at *www.minesubsidence.com*:-

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

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Figures

Figures are prefixed by the letter of the appendix in which they are presented.

Figure No.	*Description*	*Appendix*
Fig. A.01	Observed and Predicted Total Subsidence, Tilt and Strain Along Monitoring Line A3 due to Longwalls A3, A4 and A5	App. A
Fig. A.02	Observed and Predicted Total Subsidence, Tilt and Strain Along Monitoring Line A3X due to Longwalls A3, A4 and A5	App. A
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Drawings

Drawings referred to in this report are included in Appendix B at the end of this report.

Drawing No.	*Description*	*Revision*
MSEC565-01	General Layout	A
MSEC565-02	Surface Level Contours	A
MSEC565-03	Depth of Cover Contours	A
MSEC565-04	Seam Thickness Contours	A
MSEC565-05	Predicted Total Subsidence after Longwall A5	A

1.1. Background

Austar Coal Mine Pty Limited (Austar) has completed the extraction of Longwall A5 in Stage 2 at Austar Coal Mine, which is located in the Newcastle Coalfield in New South Wales. The layout of the longwalls in Stage 2 is shown in Drawing No. MSEC565-01, in Appendix B. The extraction of Longwall A5 commenced on the 11th July 2011 and was completed on the 26th March 2011.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Austar to prepare subsidence predictions and impact assessments for the Stage 2 Longwalls A3 to A5. Report No. MSEC275 (Revision C) was issued in February 2007, which supported the SMP Application for these longwalls.

Austar then proposed to modify Longwall A4 by moving the install road and thereby lengthening the commencing (north - eastern) end by 20 metres. MSEC issued a letter report on the 13th October 2008 in support of the proposed modification.

Austar also proposed to modify Longwalls A4 and A5 by increasing the longwall void widths from 227 metres to 237 metres, increasing the chain pillar width between these longwalls from 45 metres to 60 metres, and slightly shortening the overall length of Longwall A5. Report No. MSEC391 (Revision B) was issued on the 13th February 2009 in support of these modifications.

Industry and Investment NSW (now known as DTIRIS) approved the modified Subsidence Management Planfor Longwall A4 and A5 on the 24th December 2009. The Department of Planning approved the modification of DA 29/95 on the 28th May 2009.

In accordance with Condition 18 of the Subsidence Management Plan Approval for Longwalls A4 and A5, this report provides comparisons between the observed and predicted subsidence movements for the monitoring lines in Stage 2 resulting from the extraction of Longwall A5.

1.2. Mining Geometry

The layout of the longwalls in Stage 2 is shown in Drawing No. MSEC565-01, in Appendix B. The overall length of Longwall A5 is 960 metres and the overall void width, including first workings, is 237 metres. The width of the solid chain pillar between Longwalls A4 and A5 is 60 metres.

The depth of cover to the Greta Seam, directly above Longwall A5, varies between a minimum of 510 metres, near middle of the longwall tailgate, and a maximum of 535 metres, towards the finishing end of the longwall.

The thickness of the Greta Seam, within the extent of Longwall A5, varies between a minimum of 5.3 metres, towards the finishing (south-western) end of the longwall, and a maximum of 6.5 metres, at the commencing (north-eastern) end of the longwall.

The Longwall Top Coal Caving (LTCC) equipment extracted the bottom 3.1 metres of the seam and recovered approximately 70% of the remaining top coal from chainage 960m (start) to chainage 305m. The remainder of the longwall (chainage 305m to the finishing end) extracted an average seam thickness of 3.3 metres with no top coal extracted.

2.0 COMPARISONS BETWEEN THE OBSERVED AND PREDICTED SUBSIDENCE MOVEMENTS

2.1. Introduction

The mine subsidence movements resulting from the extraction of Austar Longwall A5 were monitored using the following:-

- Line A3,
- Line A3X, and
- Line A4.

The locations of these monitoring lines are shown in Drawing No. MSEC565-01, in Appendix B. The proposed Line A5 was not installed due to landowner access issues however Longwall A5 was monitored by the A3X cross line.

The following sections provide comparisons between the observed and predicted subsidence movements at these monitoring lines. The predicted movements are based on those provided in Report No. MSEC391 (Rev. B), which included all the modifications to Longwall A5.

The predicted total conventional subsidence contours, resulting from the extraction of Longwalls A3, A4 and A5, have been reproduced in Drawing No. MSEC565-05, in Appendix B. The predicted subsidence contours are based on extracting 3.0 metres of coal and achieving an 85 % recovery of the top coal.

2.2. Line A3

Line A3 is a longitudinal monitoring line which follows the centreline of Longwall A3. The location of this monitoring line is shown in Drawing No. MSEC565-01, in Appendix B. The monitoring line was measured three times during and after the extraction of Longwall A5. The latest survey was carried out on the 20th March 2012, when the longwall was at chainage 7m.

The observed profiles of total subsidence, tilt and strain along Line A3, resulting from the extraction of Longwalls A3, A4 and A5, are shown in Fig. A.01, in Appendix A. The predicted profiles of subsidence and tilt along this monitoring line, after the completion of Longwall A5, are also shown in this figure for comparison.

A summary of the maximum observed and maximum predicted total subsidence parameters along Line A3, resulting from the extraction of Longwalls A3, A4 and A5, are provided in Table 2.1.

Table 2.1 Maximum Observed and Predicted Total Subsidence Parameters along Line A3 Resulting from the Extraction of Longwalls A3, A4 and A5

Type	Maximum Total Subsidence (mm)	Maximum Total Tilt (mm/m)	Maximum Total Tensile Strain (mm/m)	Maximum Total Comp. Strain (mm/m)
Observed	478	1.6	1.5	3.4
Predicted	900	3.2	*- Refer to discussions below -*	

The maximum observed total subsidence along Line A3 was 478 mm, which was around half of the maximum predicted subsidence of 900 mm. Caution should be taken when comparing the magnitudes of observed and predicted subsidence for longitudinal monitoring lines, such as Line A3, as they are sensitive to lateral shifts (i.e. transverse to longwall) between the observed and predicted profiles, especially in the location of maximum transverse tilt.

This is illustrated in Fig. A.02, for the cross-line Line A3X, which shows that the difference between the magnitudes of observed and predicted subsidence along Line A3 appears to be the result of less subsidence developing above the tailgate of Longwall A3 than was predicted. The magnitude of observed subsidence is more comparable with that predicted closer to the location of maximum subsidence.

The maximum observed total tilt of 1.6 mm/m is also less than the maximum predicted of 3.2 mm/m. The maximum observed tilt was very small and represents a change in grade around 0.2 %.

The maximum observed total tensile and compressive strains along Line A3 were 1.5 mm/m and 3.4 mm/m, respectively. The maximum predicted conventional tensile and compressive strains in Stage 2, based on applying a factor of 15 to the maximum predicted conventional curvatures anywhere above the longwalls, were 1 mm/m and 2 mm/m, respectively.

The observed total compressive strains exceeded the maximum predicted conventional strain in two locations, between Marks A325 to A326 and between Marks A333 and A334. These compressive strains were very localised, however, they were not associated with any bumps or irregularities in the observed subsidence profiles. As these high compressive strains were measured in the first survey, prior to Longwall A3 mining directly beneath them, it appears that they are the result of disturbed ground marks. The maximum observed tensile strain of 1.5 mm/m slightly exceeded the maximum predicted conventional strain by 0.5 mm/m between marks A343 and A344. These survey marks are located near the top of a hill and the elevated tensile strain could be associated with down slope movements.

Elsewhere, the observed strains along Line A3 were in the order of those predicted based on conventional ground movements.

2.3. Line A3X

Line A3X is a cross-line above Longwalls A3, A4 and A5. The location of this monitoring line is shown in Drawing No. MSEC565-01, in Appendix B. The monitoring line was measured four times during and after the extraction of Longwall A5. The latest survey was carried out on the 22nd March 2012, when the longwall was at chainage 0m (i.e. after completion of the longwall).

The observed profiles of total subsidence, tilt and strain along Line A3X, resulting from the extraction of Longwalls A3, A4 and A5, are shown in Fig. A.02, in Appendix A. The predicted profiles of subsidence and tilt along this monitoring line, at the completion of Longwall A5, are also shown in this figure for comparison.

A summary of the maximum observed and maximum predicted total subsidence parameters along Line A3X, resulting from the extraction of Longwalls A3, A4 and A5, are provided in Table 2.2.

Table 2.2 Maximum Observed and Predicted Total Subsidence Parameters along Line A3X Resulting from the Extraction of Longwalls A3, A4 and A5

Type	Maximum Total Subsidence (mm)	Maximum Total Tilt (mm/m)	Maximum Total Tensile Strain (mm/m)	Maximum Total Comp. Strain (mm/m)
Observed	1150	7.0	2.2	1.0
Predicted	1350	4.9	*- Refer to discussions below -*	

The maximum observed total subsidence along Line A3X was 1150 mm, which represents approximately 85 % of the maximum predicted subsidence of 1350 mm. It can be seen from Fig. A.02, that the observed subsidence profile reasonably matches the predicted subsidence profile. The observed subsidence is less than that predicted above the tailgate of Longwall A3, which may indicate that the overburden has cantilevered further over the longwall void than was anticipated.

The maximum observed total tilt was 7.0 mm/m, which was greater than the maximum predicted tilt of 4.9 mm/m. It can be seen from Fig. A.02 that, whilst the maximum observed tilt exceeds the maximum predicted, the observed tilt profile reasonably matches the predicted tilt profile. The maximum observed tilt occurs in the area over the tailgate of Longwall A3 and is associated with the reduced subsidence which may be the result of stronger strata cantilevering and reducing the subsidence over the tailgate of Longwall A3 and resulting in greater than expected tilt. As the exceedance in the A3 tailgate area is small (i.e. around 2 mm/m, or 0.2 %), it is considered that this has no significant affect on the impact assessments that were provided in Reports Nos. MSEC275, MSEC391 and the SMP Application.

The maximum observed total tensile and compressive strains along Line A3X were 2.2 mm/m and 1.0 mm/m, respectively. The maximum predicted conventional tensile and compressive strains in Stage 2, based on applying a factor of 15 to the maximum predicted conventional curvatures anywhere above the longwalls, were 1 mm/m and 2 mm/m, respectively.

The observed total tensile strains exceeded the maximum predicted conventional strain in two locations, between Marks AX01 and AX02 and between Marks AX39 and AX40. These elevated tensile strains occur outside the extents of Longwalls A3 and A5, towards the bottom of the natural ground slopes.

As the high tensile strain between Marks AX01 and AX02 was measured in the second survey, prior to Longwall A3 mining directly beneath it, it appears that it is the result of a disturbed ground mark. Similarly, as the high tensile strain between Marks AX39 and AX40 was measured the first time it was surveyed, prior to Longwall A4 mining directly beneath it, it also appears that it is the result of a disturbed ground mark.

Elsewhere, the observed strains along Line A3X were in the order of those predicted based on conventional ground movements.

2.4. Line A4

Line A4 is a longitudinal monitoring line which follows the centreline of Longwall A4. The location of this monitoring line is shown in Drawing No. MSEC565-01, in Appendix B. The monitoring line was measured three times during and after the extraction of Longwall A5. The latest survey was carried out on the 16th March 2012, when the longwall chainage was at 22m.

The observed profiles of total subsidence, tilt and strain along Line A4, resulting from the extraction of Longwalls A4 and A5, are shown in Fig. A.03, in Appendix A. The predicted profiles of subsidence and tilt along this monitoring line, at the completion of Longwall A5, are also shown in this figure for comparison.

A summary of the maximum observed and maximum predicted total subsidence parameters along Line A4, resulting from the extraction of Longwalls A4 and A5, are provided in Table 2.3.

Table 2.3 Maximum Observed and Predicted Total Subsidence Parameters along Line A4 Resulting from the Extraction of Longwall A4 and A5

Type	Maximum Total Subsidence (mm)	Maximum Total Tilt (mm/m)	Maximum Total Tensile Strain (mm/m)	Maximum Total Comp. Strain (mm/m)
Observed	1145	3.8	1.8	1.4
Predicted	1285	4.7	*- Refer to discussions below -*	

The maximum observed total subsidence along Line A4 was 1145 mm, which represents approximately 90 % of the maximum predicted subsidence of 1285 mm. Also, the maximum observed total tilt of 3.8 mm/m is similar to but less than the maximum predicted tilt of 4.7 mm/m.

It can be seen from Fig. A.03, that the observed profiles of subsidence and tilt reasonably match the predicted profiles of subsidence and tilt. The observed subsidence is less than predicted at the longwall finishing end (but noting the break in the monitoring line). Some small long term residual subsidence will continue to develop at the longwall finishing end, however, it is not expected the maximum observed subsidence would exceed that predicted.

The maximum observed total tensile and compressive strains along Line A4 were 1.8 mm/m and 1.4 mm/m, respectively. The maximum predicted conventional tensile and compressive strains in Stage 2, based on applying a factor of 15 to the maximum predicted conventional curvatures anywhere above the longwalls, were 1 mm/m and 2 mm/m, respectively.

The observed total tensile strains exceeded the maximum predicted conventional strain in two locations, between Marks A408 to A409 and between Marks A447 and A448. As the high tensile strain between Marks A408 to A409 was measured in the first survey, prior to Longwall A4 mining directly beneath it, it appears that the strain is the result of a disturbed ground mark. Similarly, as the high tensile strain between Marks A447 and A448 is located adjacent to other disturbed survey marks, it is possible that it is also the result of a disturbed ground mark.

Elsewhere, the observed strains along Line A4 were in the order of those predicted based on conventional ground movements.

2.5. Summary

The ground movements measured along Lines A3, A3X and A4 indicate that the observed subsidence and tilt, resulting from the extraction of Longwalls A3, A4 and A5, were reasonably similar to those predicted. The maximum observed tilt along Line A3X was greater than the maximum predicted over a portion of Longwall A3, however, this exceedance was small.

The ground strains were typically in the order of those predicted based on conventional ground movements. The ground strains exceeded the maximum predicted conventional strains in some locations. One of these locations along monitoring Line A3 may be a result of downslope movements, while the remaining cases occurred prior to the longwall extraction faces mining directly beneath them. It appears, therefore, that the remainder of these localised grounds strains were the result of disturbed survey marks.

It has been considered, therefore, that the Incremental Profile Method has provided adequate predictions of the mine subsidence movements for Austar Stage 2 Longwalls A3, A4 and A5. It has also been considered that it is not necessary to undertake any further calibration of the prediction model, based on the monitoring data, or to update the impact assessments which have been provided in Reports Nos. MSEC275, MSEC391 and the SMP Application.

APPENDIX A. FIGURES

Observed and Predicted Total Subsidence, Tilt and Strain Along Monitoring Line A3 due to Longwalls A3, A4 and A5

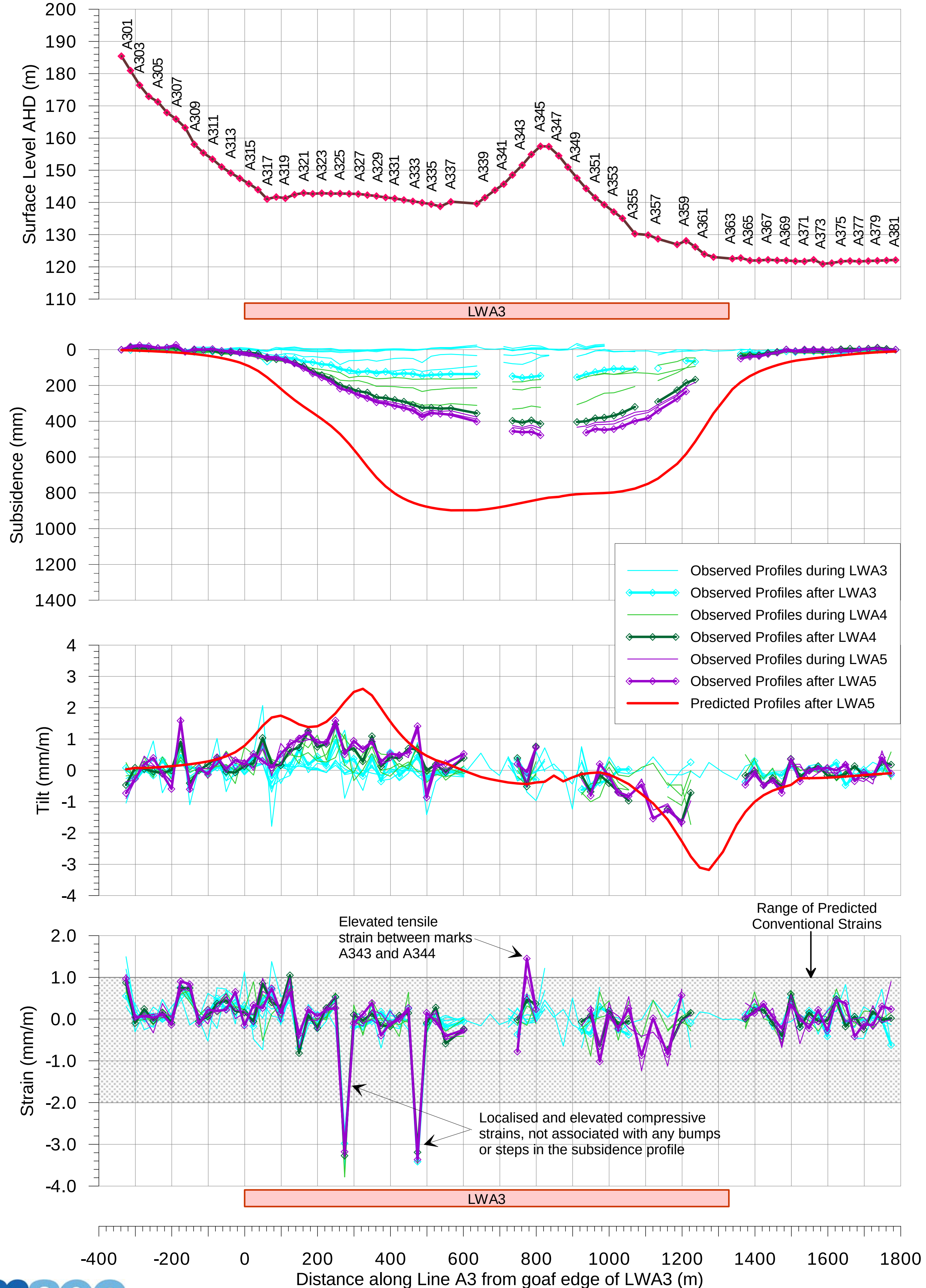

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Fig. A.01

Observed and Predicted Total Subsidence, Tilt and Strain Along Monitoring Line A3X due to Longwalls A3, A4 and A5

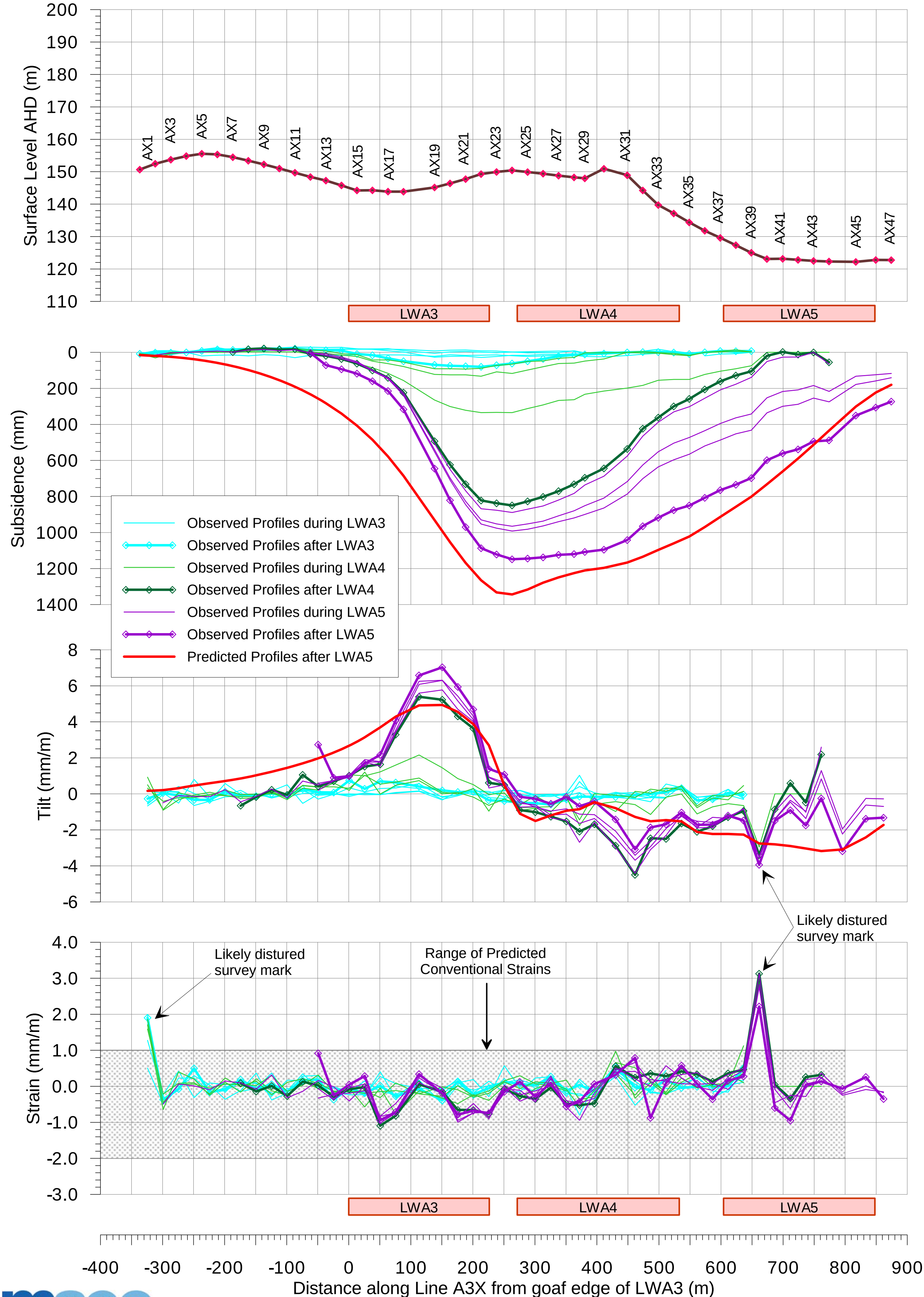

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Fig. A.02

Observed and Predicted Total Subsidence, Tilt and Strain Along Monitoring Line A4 due to Longwalls A4 and A5

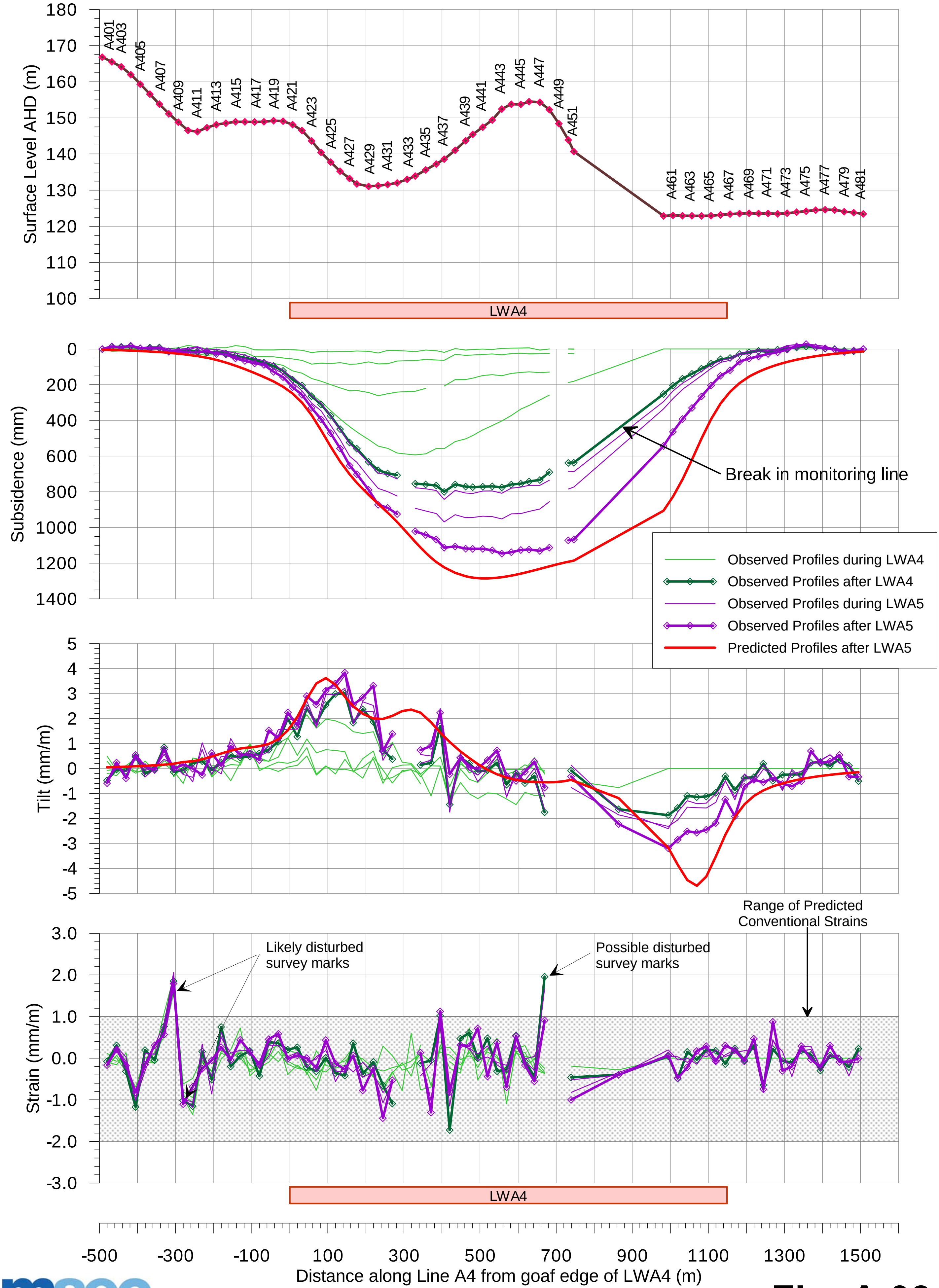

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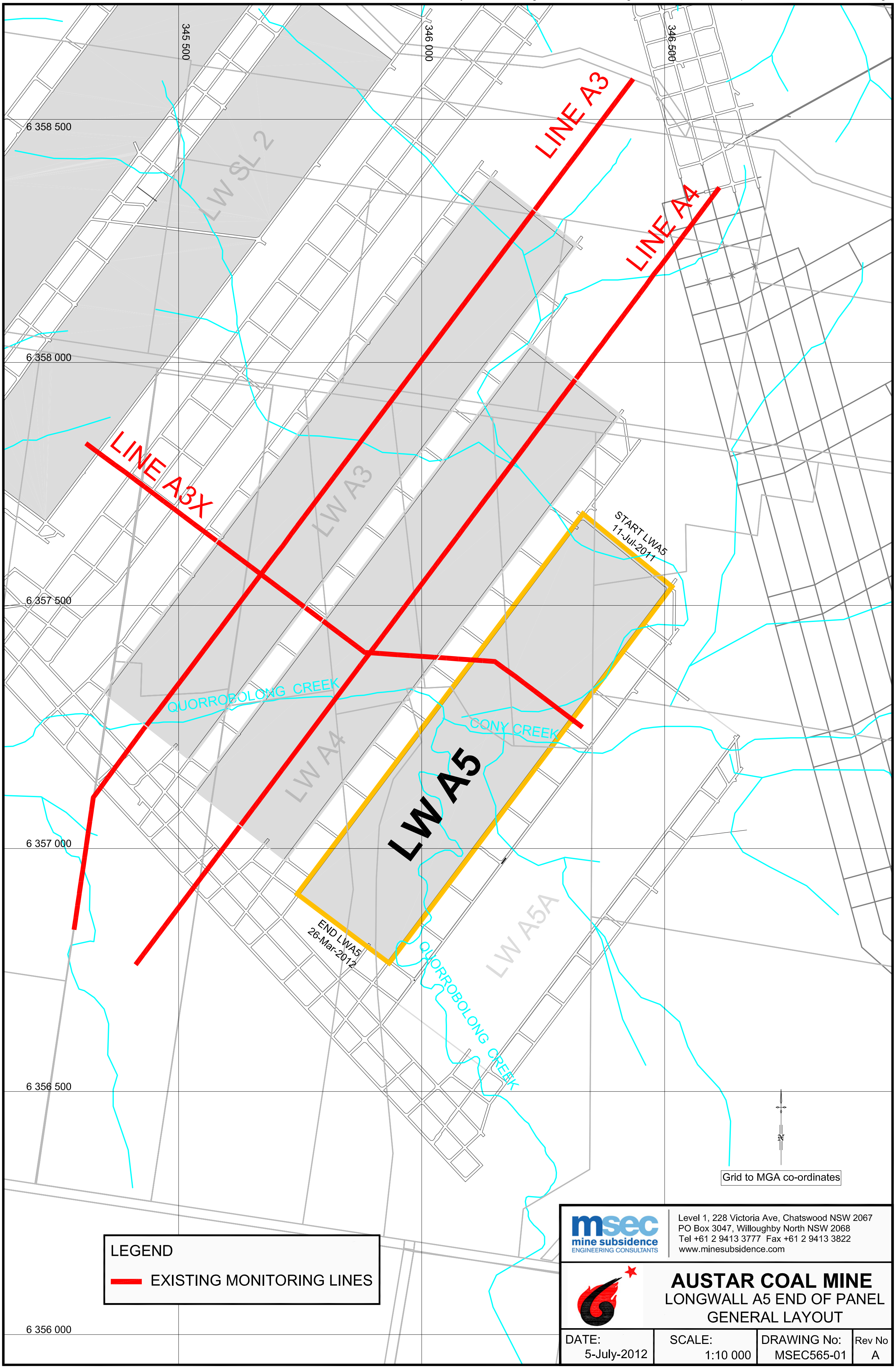
Fig. A.03

APPENDIX B. DRAWINGS



LEGEND

EXISTING MONITORING LINES

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AUSTAR COAL MINE
LONGWALL A5 END OF PANEL
GENERAL LAYOUT

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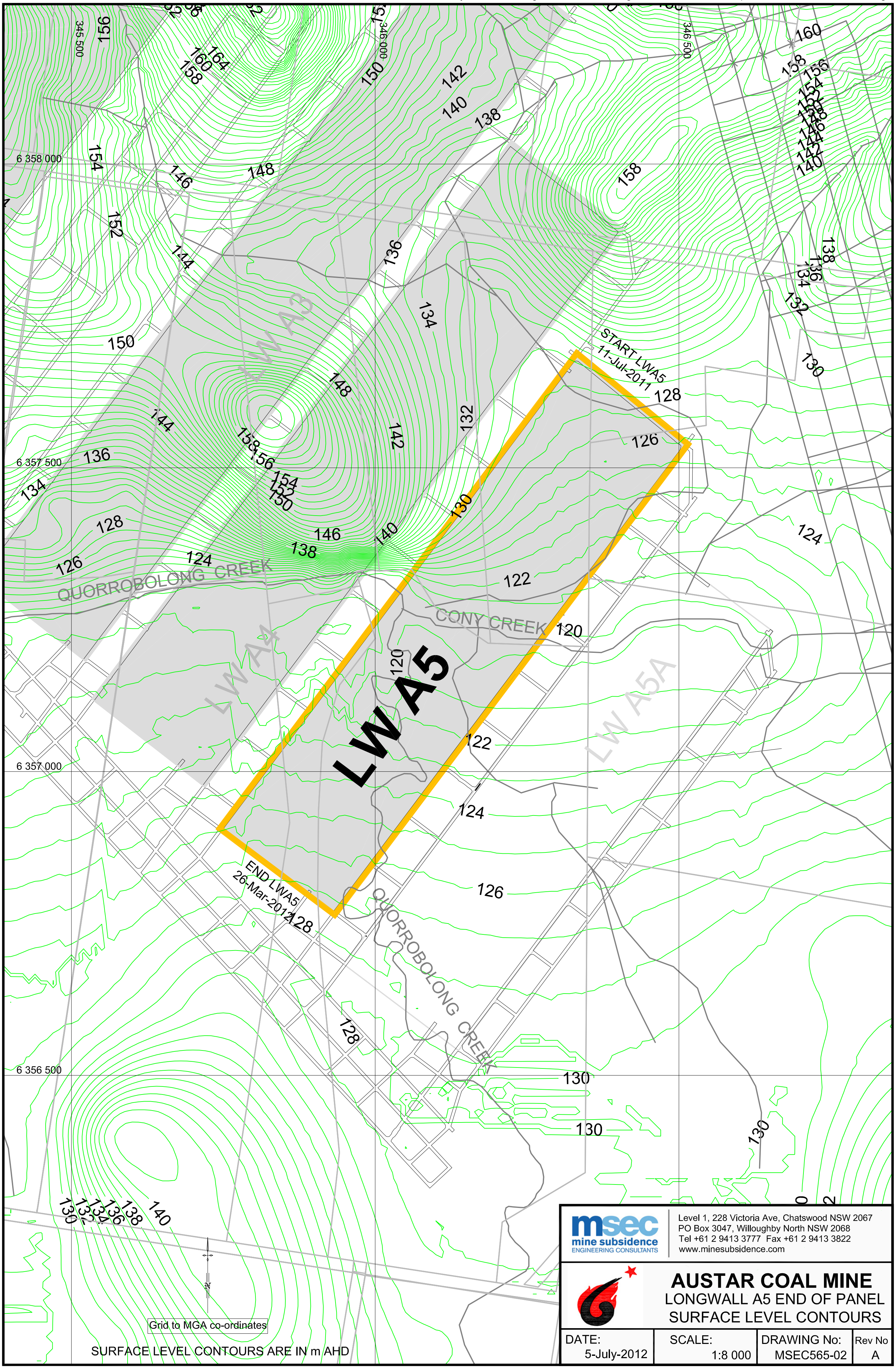

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LONGWALL A5 END OF PANEL SURFACE LEVEL CONTOURS

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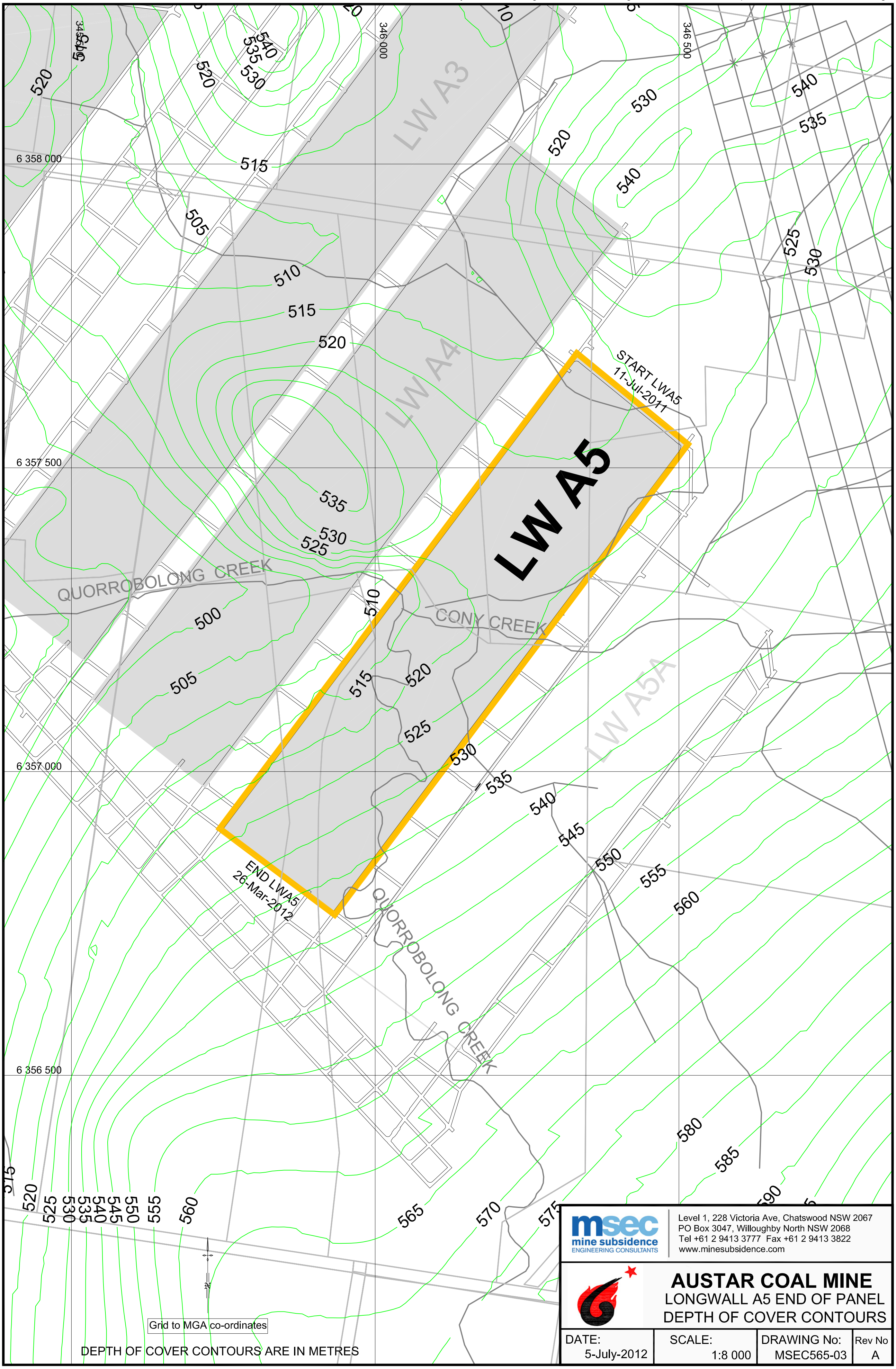

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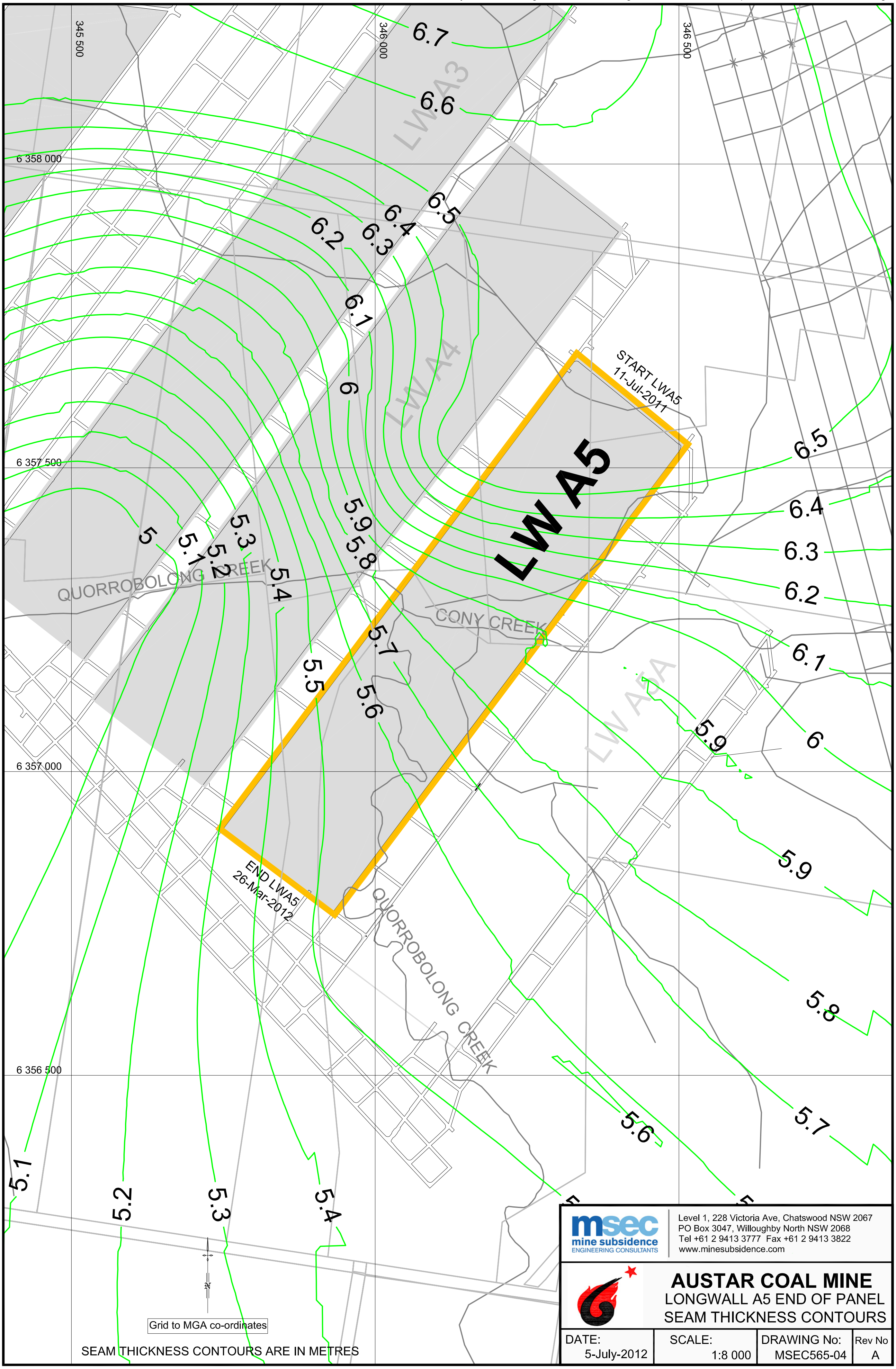

SEAM THICKNESS CONTOURS ARE IN METRES

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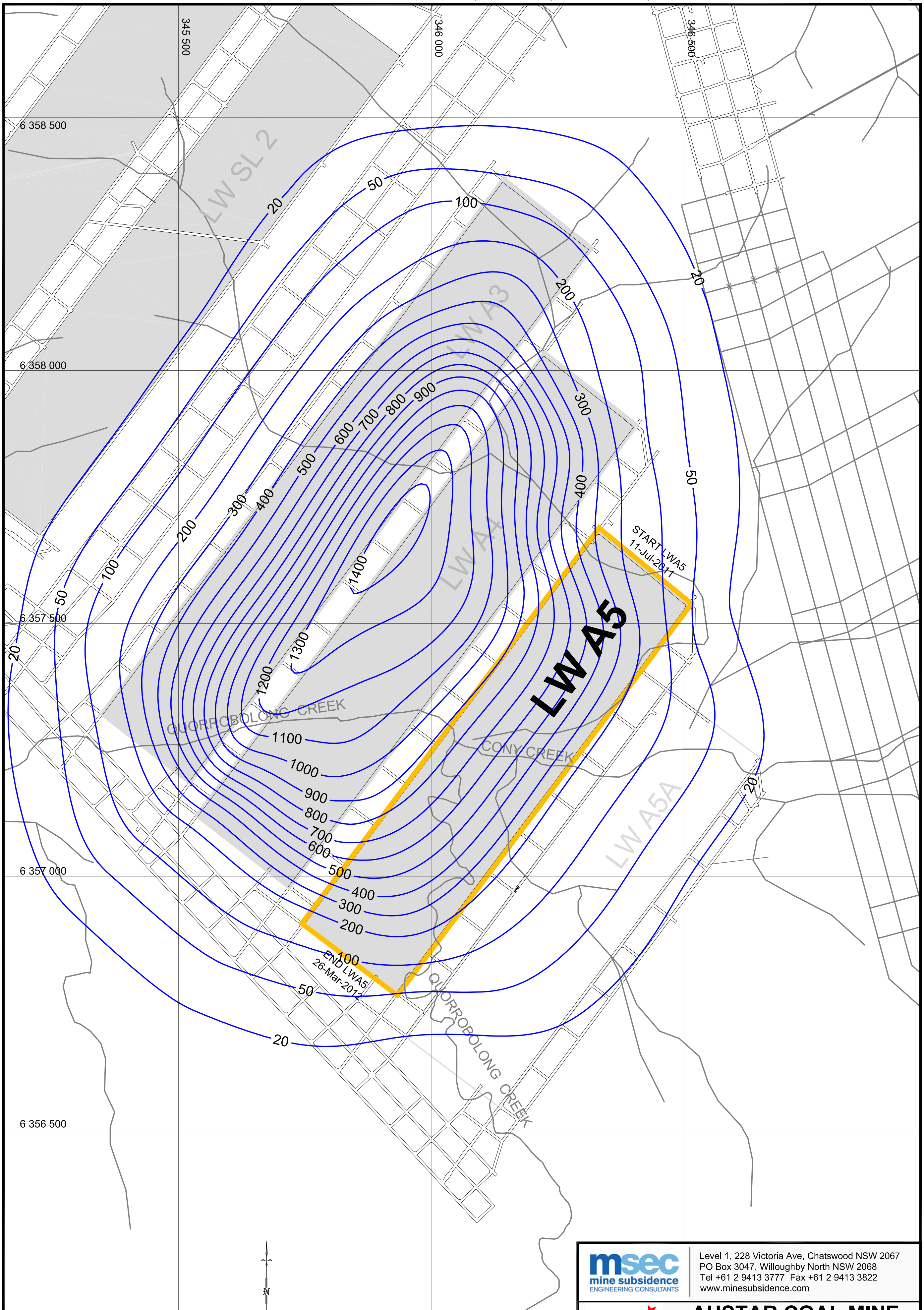

PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)

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AUSTAR COAL MINE
LONGWALL A5 END OF PANEL
PREDICTED TOTAL SUBSIDENCE CONTOURS AFTER LONGWALL A5

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