

29 August 2018

Austar Coal Mine Pty Limited
Locked Bag 806
Cessnock NSW 2325

For the attention of: Carly McCormack, Environment and Community Superintendent

Dear Carly,

RE: Austar Coal Mine – Modified finishing end of LWB4
Review of subsidence effects, subsidence impacts and environmental consequences

Mine Subsidence Engineering Consultants (MSEC) was previously engaged by Austar Coal Mine Pty Ltd (Austar) to prepare subsidence predictions and impact assessments for Longwalls B4 to B7 (LWB4 to LWB7). Report No. MSEC903 (Rev. A) was issued in June 2017 in support of the Extraction Plan Application for these longwalls. The layout of the longwalls adopted in the Extraction Plan Application and Report No. MSEC903 is referred to as the *Previous Layout* in this letter report.

Austar now proposes to shorten the finishing (i.e. north-eastern) end of Longwall B4 (LWB4) by 279 m from the location indicated in the approved Extraction Plan for LWB4 to LWB7. The layout of the longwalls that includes the proposed modified finishing end of LWB4 is referred to as the *Modified Layout* in this report.

The previous and the modified finishing ends of LWB4 are shown in Drawings Nos. MSEC966-01 and MSEC966-02 in the appendix at the end of this letter report. The completed LWB2 and LWB3 and the future LWB5 to LWB7 and LWB1 are also shown in these drawings.

Condition 2A of the Development Consent (DA29/95, MOD7) states that “*with the approval of the Secretary, longwall panels may be shortened or narrowed, providing that the proposed variations do not result in increased subsidence impacts or environmental consequences*”.

The Consent provides the definition of *subsidence impacts* as “*physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs*” and for “*environmental consequences of subsidence impacts, including: damage to built features; loss of surface flows to the subsurface; loss of standing pools; adverse water quality impacts; development of iron bacterial mats; cliff falls; rock falls; damage to Aboriginal heritage sites; impacts to aquatic ecology; ponding*”.

MSEC has been engaged by Austar to review the changes to the predicted subsidence effects, assessed subsidence impacts and environmental consequences due to the proposed modified finishing end of LWB4. The changes are summarised in this letter report.

Minimum geometry

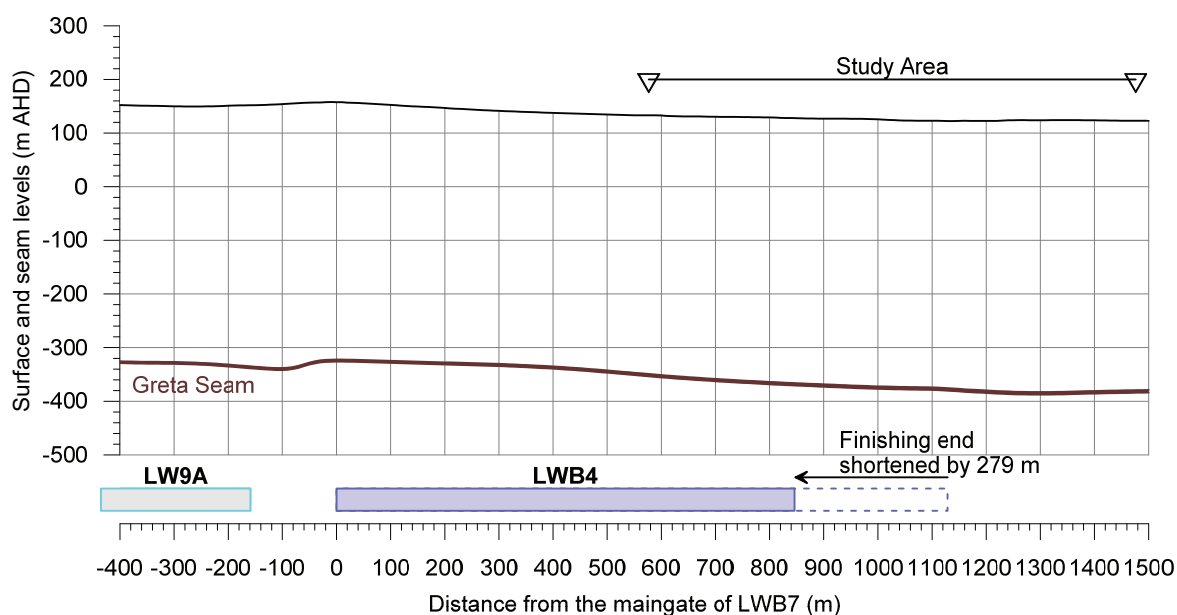
A summary of the dimensions of LWB4 based on the Previous and Modified Layouts is provided in Table 1. The width of the longwall extraction face (i.e. excluding the first workings) is 226 m. The lengths of longwall extraction (i.e. excluding the installation heading) are approximately 9 m less than the overall void lengths provided in the table.

Table 1 Dimensions of LWB4 based on the Previous and Modified Layouts

Longwall	Layout (Report)	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
LWB4	Previous Layout (MSEC903)	1129	237	45
	Modified Layout (MSEC966)	850	237	45

The length of LWB4 is proposed to be shortened by 279 m at the finishing end.

The surface and seam levels along the centreline of LWB4 are illustrated in Figure 1. The longwall commencing end is on the left side and the longwall finishing end is on the right side of this figure.

**Figure 1 Surface and seam levels along the centreline of LWB4**

The depth of cover to the Greta Seam directly above LWB4 varies from 465 m at the commencing end and 505 m at the previous finishing end of LWB4. The seam floor within the proposed mining area dips from the west toward the east, having an average gradient of around 8 %, or 1 in 12. The thickness of the Greta Seam within the extent of LWB4 varies between 3.9 and 4.8 m. The longwall extracts a constant thickness of 3.4 m using conventional longwall mining techniques.

Predicted subsidence effects

The Incremental Profile Method (IPM) was previously used to predict the conventional subsidence effects due to the extraction of LWB1 to LWB7 based on the Previous Layout. These subsidence effects were provided in Report No. MSEC903 which supported the Extraction Plan Application for LWB4 to LWB7. The IPM has now been used to predict the conventional subsidence effects for LWB1 to LWB7 based on the Modified Layout, i.e. based on the proposed modified finishing end of LWB4.

A summary of the maximum predicted incremental subsidence effects due to the extraction of LWB4 only, based on the previous and proposed modified extents of this longwall, is provided in Table 2. The incremental values are the additional movements due to the extraction of LWB4 only.

Table 2 Maximum predicted incremental subsidence effects due to the extraction of LWB4 only

Longwall	Layout	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature (km ⁻¹)	Maximum predicted incremental sagging curvature (km ⁻¹)
LWB4	Approved (MSEC903)	675	3.5	0.03	0.06
	Modified (MSEC966)	675	3.0	0.03	0.06

The maximum predicted incremental vertical subsidence, hogging curvature and sagging curvature do not change due to the modified finishing end of LWB4. The maximum predicted tilt slightly decreases from 3.5 mm/m to 3.0 mm/m due to the modification.

The predicted total subsidence contours due to the extraction of LWB1 to LWB7, including the modified finishing end of LWB4, are shown in Drawing No. MSEC966-06. The predicted total 20 mm subsidence contour, based on the Previous Layout is also shown in this drawing for comparison.

A summary of the maximum predicted total subsidence effects due to the extraction of LWB1 to LWB7, based on the Previous and Modified Layouts, is provided in Table 3. The total values are the accumulated movements due to the extraction of LWB1 to LWB7.

Table 3 Maximum predicted total subsidence effects due to the extraction of LWB1 to LWB7

Longwall	Layout	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km ⁻¹)	Maximum predicted total sagging curvature (km ⁻¹)
LWB1 to LWB7	Approved (MSEC903)	1350	5.5	0.05	0.06
	Modified (MSEC966)	1275	5.0	0.04	0.06

The maximum predicted vertical subsidence, tilt and hogging curvature slightly decrease due to the modified finishing end of LWB4. The proposed modification staggers the finishing end of LWB4 relative to the other longwalls in the series and, therefore, slightly reduces the accumulation of these subsidence effects.

Whilst the maximum predicted total subsidence effects are the same or slightly reduce, the locations of the predicted longitudinal tilts and curvatures at the finishing end of LWB4 move due to the proposed modification. This is illustrated along Prediction Line 1 in Fig. A.01 in the appendix at the end of this letter report. The location of this prediction line is shown in Drawing No. MSEC966-06.

The predicted total profiles along Prediction Line 1 after the extraction of all previous longwalls, up to and including LWB3, are shown as the cyan lines in Fig. A.01. The predicted profiles after the completion of all longwalls in the Bellbird South Mining Area (i.e. LWB1 to LWB7) are shown as the orange lines based on the Previous Layout and the blue lines based on the Modified Layout.

The predicted longitudinal tilts and curvatures move 279 m towards the south-west (i.e. towards the longwall commencing end) due to the proposed modified finishing end of LWB4. The magnitudes of these movements reduce since the finishing end of this longwall is setback from the finishing ends of the other longwalls in the series. Whilst the overall predicted subsidence effects reduce, the natural and built features could experience lower or slightly higher tilts and curvatures, depending on their locations relative to the longwall finishing end.

The maximum predicted strains due to the extraction of LWB4, based on the Modified Layout, are similar to those predicted based on the Previous Layout. However, the locations of the tensile and compressive zones above LWB4 move due to the proposed modified finishing end. The natural and built features could experience lower or slightly higher strains depending on their locations relative to the longwall finishing end.

Study Area

The *Study Area* has been defined as the zone where the subsidence effects, based on the Modified Layout, are different to those predicted based on the Previous Layout. The Study Area has been based on the greater of the:

- 26.5° angle of draw line around the previous and modified finishing ends of LWB4; and
- the limit where the change in the predicted vertical subsidence due to the proposed modified finishing end of LWB4 is greater than 20 mm.

The extent of the Study Area is shown in Drawings Nos. MSEC966-01 and MSEC966-02.

There are natural and built features that are located within the Study Area, as shown in Drawings Nos. MSEC966-03 to MSEC966-05. These features include:

- Drainage Line 1;
- Sandy Creek Road;
- 11 kV powerlines;
- Copper telecommunications cables;
- Houses Refs. A02d, A06a and C02h01;
- Rural structures and farm dams; and
- Archaeological sites.

The reviews of the subsidence effects, subsidence impacts and environmental consequences due to the proposed modified finishing end of LWB4 are provided in the following sections.

Drainage Line 1

The location of Drainage Line 1 is shown in Drawing No. MSEC966-03. This drainage line crosses the previous finishing end of LWB4, but it is located outside the extents of this longwall based on the proposed modified finishing end.

The predicted profiles of total vertical subsidence, tilt and curvature along Drainage Line 1 are shown in Fig. A.02 in the appendix at the end of this letter report. The predicted total profiles after the extraction of all previous longwalls, up to and including LWB3, are shown as the cyan lines in this figure. The predicted profiles after the completion of all longwalls in the Bellbird South Mining Area (i.e. LWB1 to LWB7) are shown as the orange lines based on the Previous Layout and the blue lines based on the Modified Layout.

A summary of the maximum predicted total subsidence effects for Drainage Line 1, based on the Previous and Modified Layouts, is provided in Table 4. The total values are the maximum accumulated movements within the Study Area, due to the extraction of LWB1 to LWB7, as well as the previously extracted longwalls at Ellalong and in Austar Stage 2.

Table 4 Maximum predicted total subsidence effects for Drainage Line 1

Longwall	Layout	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km ⁻¹)	Maximum predicted total sagging curvature (km ⁻¹)
LWB1 to LWB7	Approved (MSEC903)	1250	4.0	0.05	0.06
	Modified (MSEC966)	1200	3.0	0.02	0.06

The maximum predicted vertical subsidence, tilt and hogging curvature for Drainage Line 1 slightly decrease due to the proposed modified finishing end of LWB4. These parameters reduce since the modified finishing end of LWB4 does not directly mine beneath the drainage line. The maximum predicted sagging curvature does not change as it occurs above the previously extracted LWB2.

The predicted tilt and curvature slightly increase near the modified finishing end of LWB4; however, these localised effects are less than the maxima that occur elsewhere along the drainage line. The overall levels of predicted movement along Drainage Line 1 decrease due to the proposed modified finishing end of LWB4.

The maximum predicted total valley related upsidence and closure movements, based on the Modified Layout, are slightly less than the maximum predicted values based on the Previous Layout. These parameters reduce since the drainage line is not directly mined beneath by the shortened extent of LWB4.

The assessed subsidence impacts and environmental consequences for Drainage Line 1, based on the Modified Layout, are the same or slightly less than those based on the Previous Layout. The management strategies and recommendations for the drainage line provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

Sandy Creek Road

The location of Sandy Creek Road is shown in Drawing No. MSEC966-04.

Sandy Creek Road crosses directly above LWB4 based on both the Previous and Modified Layouts. The road is located south of the finishing end of LWB4 at distances of 350 m based on the previous position and 100 m based on the proposed modified position.

The predicted profiles of total vertical subsidence, tilt and curvature along Sandy Creek Road are shown in Fig. A.03 in the appendix at the end of this letter report. The predicted total profiles after the extraction of all previous longwalls, up to and including LWB3, are shown as the cyan lines in this figure. The predicted profiles after the completion of all longwalls in the Bellbird South Mining Area (i.e. LWB1 to LWB7) are shown as the orange lines based on the Previous Layout and the blue lines based on the Modified Layout.

A summary of the maximum predicted total subsidence effects for Sandy Creek Road, based on the Previous and Modified Layouts, is provided in Table 5. The total values are the maximum accumulated movements within the Study Area, due to the extraction of LWB1 to LWB7, as well as the previously extracted longwalls at Ellalong and in Austar Stage 2.

Table 5 Maximum predicted total subsidence effects for Sandy Creek Road

Longwall	Layout	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km ⁻¹)	Maximum predicted total sagging curvature (km ⁻¹)
LWB1 to LWB7	Approved (MSEC903)	1300	4.0	0.03	0.06
	Modified (MSEC966)	1200	2.5	0.03	0.04

The maximum predicted vertical subsidence, tilt and sagging curvature for Sandy Creek Road slightly decrease due to the proposed modified finishing end of LWB4. These parameters reduce due to their closer proximity to the modified finishing end of LWB4. The maximum predicted hogging curvature along the road does not change as it occurs towards the commencing end of LWB5.

The predicted tilt and curvature slightly increase near the modified finishing end of LWB4; however, these localised effects are less than the maxima that occur elsewhere along the road. The overall levels of predicted movement along Sandy Creek Road decrease due to the proposed modified finishing end of LWB4.

The assessed subsidence impacts and environmental consequences for Sandy Creek Road, based on the Modified Layout, are the same or slightly less than those based on the Previous Layout. The management strategies and recommendations for the road provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

11 kV powerlines

The locations of the 11 kV powerlines are shown in Drawing No. MSEC966-04. An 11 kV Powerline (Branch 1) follows the alignment of Sandy Creek Road and another 11 kV powerline (Branch 2) is located to the west of LWB4. Consumer powerlines service the residential properties within the Study Area.

The predicted profiles of vertical subsidence, tilt and curvature along the 11 kV Powerline Branch 1 are similar to those predicted along Sandy Creek Road, as illustrated in Fig. A.03.

Summaries of the maximum predicted total subsidence effects at the 11 kV Powerlines, based on the Previous and Modified Layouts, are provided in Table 6 and Table 7. The total values are the accumulated movements within the Study Area, due to the extraction of LWB1 to LWB7, as well as the previously extracted longwalls at Ellalong and in Austar Stage 2.

Table 6 Maximum predicted total subsidence effects for the 11 kV Powerline Branch 1

Longwall	Layout	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)
LWB1 to LWB7	Approved (MSEC903)	1300	4.0	3.0
	Modified (MSEC966)	1250	4.0	3.5

Table 7 Maximum predicted total subsidence effects for the 11 kV Powerline Branch 2

Longwall	Layout	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)
LWB1 to LWB7	Approved (MSEC903)	1250	4.0	1.5
	Modified (MSEC966)	1250	4.0	3.0

The maximum predicted vertical subsidence and tilts along the alignments of the 11 kV powerlines, based on the Modified Layout, are the same or slightly less than the maximum predicted values based on the Previous Layout. The predicted tilts across the alignments of these powerlines slightly increase; however, these values are less than the maxima that occur along the powerline alignments.

The predicted tilts across the alignments of the 11 kV powerlines slightly increase due to the closer proximity of the powerlines to the modified finishing end of LWB4. However, these tilts are very small (i.e. less than 0.5 %) and are not expected to result in adverse impacts on the powerlines.

The predicted subsidence effects for the consumer powerlines, based on the Modified Layout, are similar to the predictions based on the Previous Layout. The predicted tilts for the consumer powerline that is located immediately adjacent to the modified finishing end of LWB4 slightly increase; however, these values are less than the predicted tilts for other consumer powerlines located elsewhere within the Study Area. No adverse impacts are anticipated due to the low magnitudes of the predicted tilts.

The assessed subsidence impacts and environmental consequences for the 11 kV powerlines and consumer powerlines, based on the Modified Layout, are the same or slightly less than those based on the Previous Layout. The management strategies and recommendations for the powerlines provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

Houses

There are three houses located within the Study Area, being Refs. A02d, A06a and C02h01. The positions of these houses are shown in Drawing No. MSEC966-05. These three houses are located outside the extents of LWB4 based on both the Previous and Modified Layouts.

A summary of the maximum predicted total subsidence effects at the houses within the Study Area, based on the Previous and Modified Layouts, is provided in Table 8. The total values are the accumulated movements due to the extraction of LWB1 to LWB7 as well as the previously extracted longwalls at Ellalong and in Austar Stage 2.

Table 8 Maximum predicted total subsidence effects for the houses

Longwall	Layout	House Ref.	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km ⁻¹)	Maximum predicted total sagging curvature (km ⁻¹)
LWB1 to LWB7	Approved (MSEC903)	A02d	700	5.5	0.04	0.02
		A06a	125	0.5	< 0.01	< 0.01
		C02h01	1200	1.0	0.03	0.03
	Modified (MSEC966)	A02d	125	1.0	0.01	< 0.01
		A06a	70	< 0.5	< 0.01	< 0.01
		C02h01	1200	1.0	0.03	0.03

House A02d is located above the finishing end of LWB3 and House A06a is located outside the extents of the mining area. The predicted subsidence effects for these houses, based on the Modified Layout, are less than those predicted based on the Previous Layout. These houses are located further away from the modified finishing end of LWB4 and, therefore, they are predicted to experience smaller movements due to the extraction of this longwall.

House C02h01 is located above LWB5. The predicted subsidence effects for this house, based on the Modified Layout, are the same as those predicted based on the Previous Layout. The predicted subsidence effects do not change due to its distance from the finishing end of LWB4 based on both layouts.

The assessed subsidence impacts and environmental consequences for the houses, based on the Modified Layout, are the same or less than those based on the Previous Layout. The management strategies and recommendations for the houses provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

Rural structures and farm dams

The locations of the rural structures and farm dams are shown in Drawing No. MSEC966-05.

Rural structures C01r01 to C01r04 and Dam C01d01 are located near the modified finishing end of LWB4. The predicted vertical subsidence and sagging curvatures for these features, based on the Modified Layout, are less than those predicted based on the Previous Layout. These parameters reduce due to their closer proximity to the modified finishing end of LWB4.

The maximum predicted tilt at rural structures C01r01 to C01r04 and Dam C01d01 slightly increase from 1.5 mm/m to 2.5 mm/m due to the proposed modified finishing end of LWB4. The increase in tilt due to the proposed modification of 1 mm/m represents a change in grade of 0.1 % or 1 in 1000. This tilt is also less than that predicted at other rural structures and farm dams located elsewhere within the mining area. It is unlikely that rural structures C01r01 to C01r04 and Dam C01d01 would experience adverse impacts due to the low-levels of predicted tilt based on the Modified Layout.

The maximum predicted hogging curvature for rural structures C01r01 to C01r04 and Dam C01d01 is 0.03 km⁻¹ based on both the Previous and Modified Layouts. The predicted value does not change since predicted hogging curvature transverse to LWB4, based on the Previous Layout, is similar to the predicted longitudinal hogging curvature at the modified longwall finishing end.

Farm Dam B01d03 is located directly above LWB4 at a distance of 300 m from the modified finishing end. At this distance, the predicted subsidence effects for this farm dam do not change due to the modified finishing end of this longwall.

The remaining rural structures and farm dams within the Study Area are located outside the extents of LWB4 and are at a minimum distance of 200 m from the modified finishing end of this longwall. At this distance, the predicted subsidence effects for these rural structures and farm dams do not change due to the proposed modified finishing end of LWB4.

The assessed subsidence impacts and environmental consequences for the rural structures and farm dams, based on the Modified Layout, are the same as those based on the Previous Layout. The management strategies and recommendations for these features provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

Archaeological sites

Artefact scatters are located within the Study Area and above LWB5. These sites are located at a minimum distance of 160 m north-west of the modified finishing end of LWB4, at their closest points. The maximum predicted subsidence effects for the artefact scatters, based on the Modified Layout, are the same or slightly less than those predicted based on the Previous Layout.

The assessed subsidence impacts and environmental consequences for the Archaeological sites, based on the Modified Layout, are the same as those based on the Previous Layout. The management strategies and recommendations for these sites provided in Report No. MSEC903 and the Extraction Plan do not change due to the modified finishing end of LWB4.

Summary

The maximum predicted incremental subsidence effects for LWB4, based on the Modified Layout, are the same or slightly less than those predicted based on the Previous Layout. Similarly, the maximum predicted total subsidence effects due to LWB1 to LWB7 are similar to or slightly reduce due to the proposed modified finishing end of LWB4. The locations of the predicted longitudinal tilts and curvatures at the finishing end of LWB4 move 279 m towards the south-west; however, these values are less than the maxima that occur elsewhere within the mining area.

The maximum predicted subsidence effects for the natural and built features within the Study Area, based on the Modified Layout, are generally the same or less than those predicted based on the Previous Layout. The predicted tilts and hogging curvatures slightly increase where the features are located close to the modified finishing end, including at Sandy Creek Road, four rural structures and one farm dam. However, these changes are very small and are less than the maxima that occur elsewhere within the mining area. The overall levels of the subsidence effects for the natural and built features reduce due to proposed modified finishing end of LWB4.

The assessed subsidence impacts and environmental consequences for the natural and built features either do not change or reduce as a result of the proposed modified finishing end of LWB4. The management strategies and recommendations for the natural and built features are the same as those previously provided in Report No. MSEC903 and the Extraction Plan.

I trust that this letter report provides the necessary information on the changes to the predicted subsidence effects, assessed subsidence impacts and environmental consequences due to the modified finishing end of LWB4. If you have any questions or require further information, please do not hesitate to contact me on (02) 9413-3777.

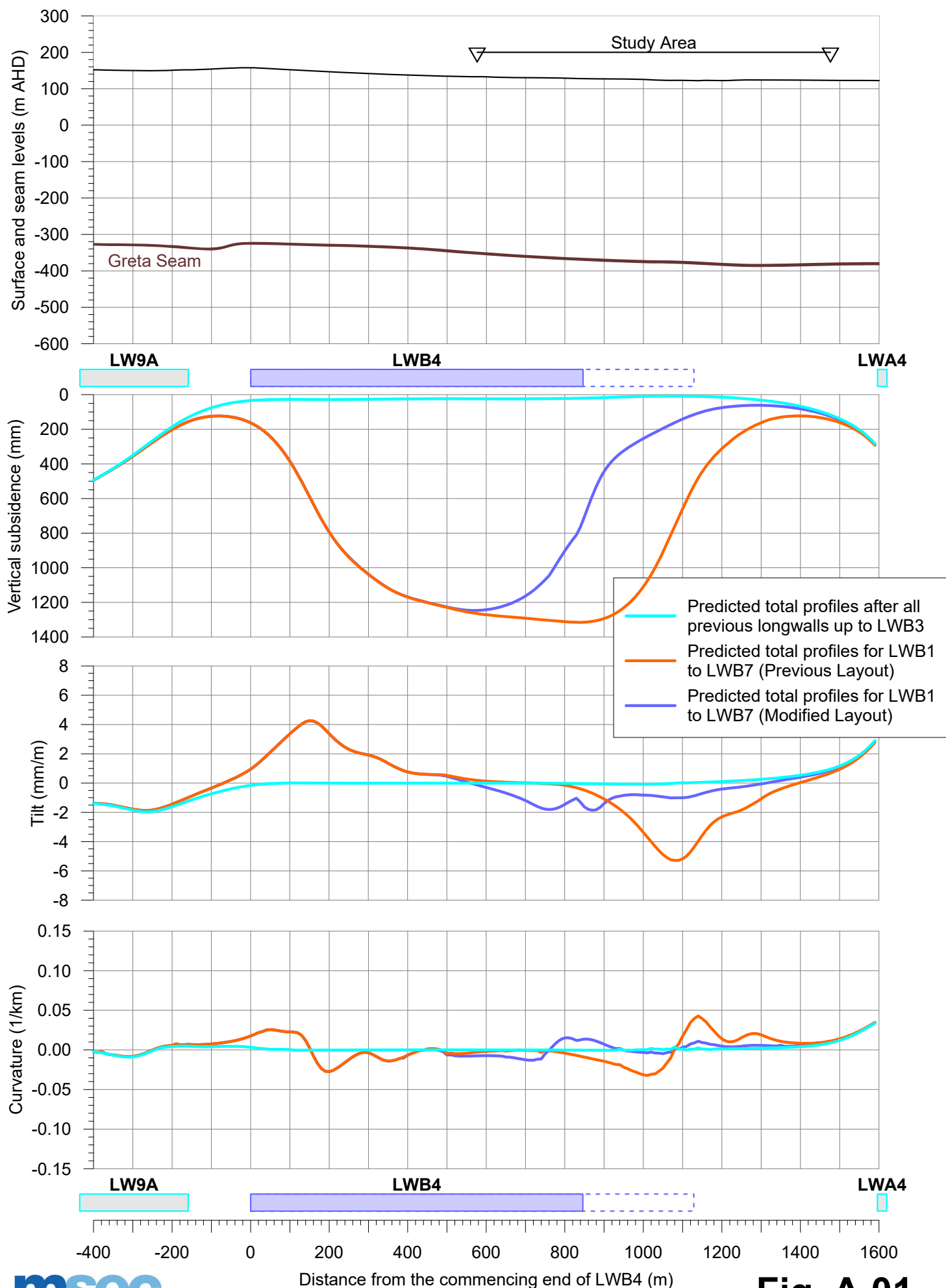
Yours sincerely,



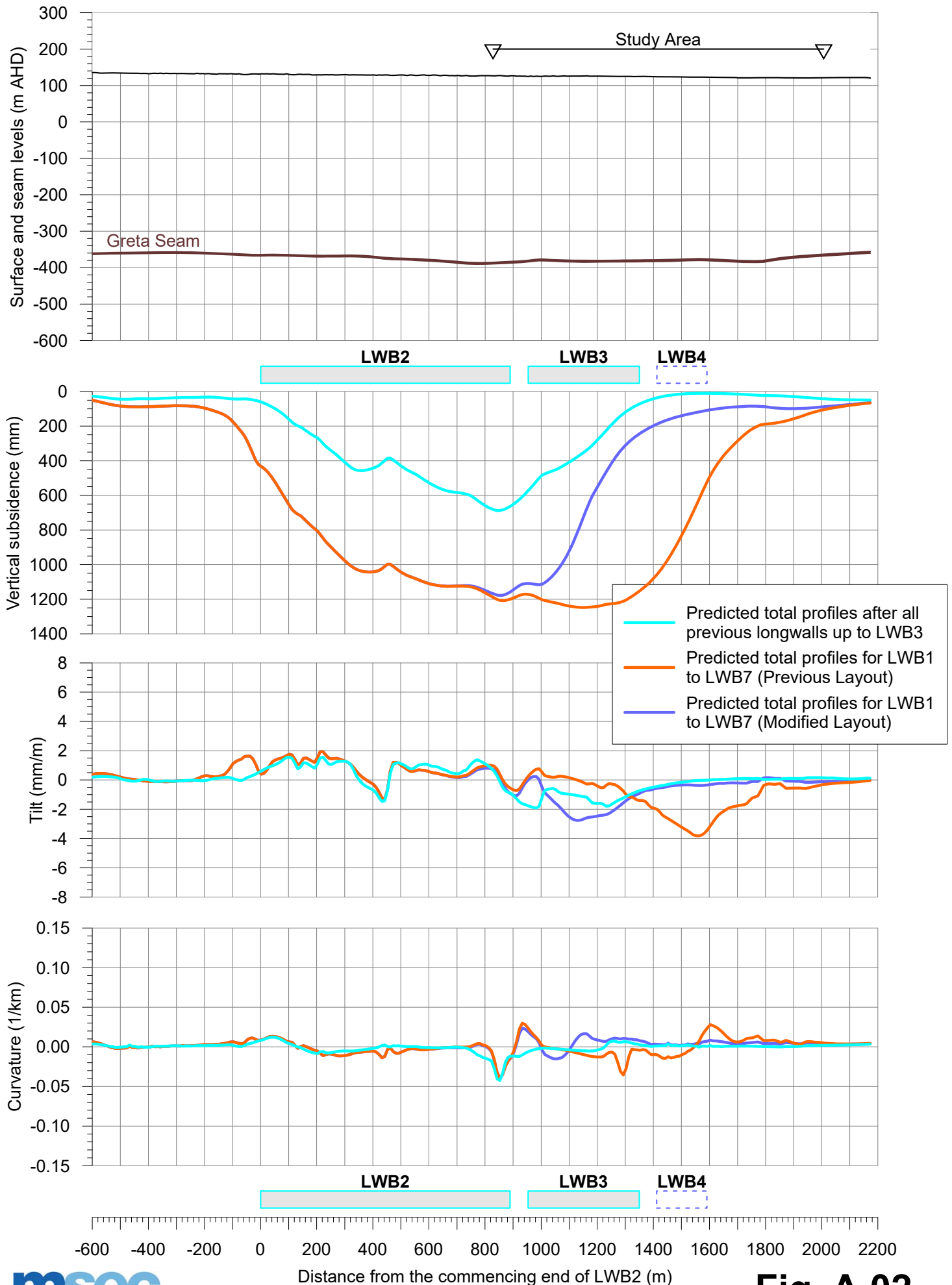
Dr James Barbato
Mine Subsidence Engineering Consultants

Appendix

Predicted profiles of vertical subsidence, tilt and curvature along Prediction Line 1 resulting from the extraction of Longwalls B1 to B7



Predicted profiles of vertical subsidence, tilt and curvature along Drainage Line 1 resulting from the extraction of Longwalls B1 to B7



Predicted profiles of vertical subsidence, tilt and curvature along Sandy Creek Road resulting from the extraction of Longwalls B1 to B7

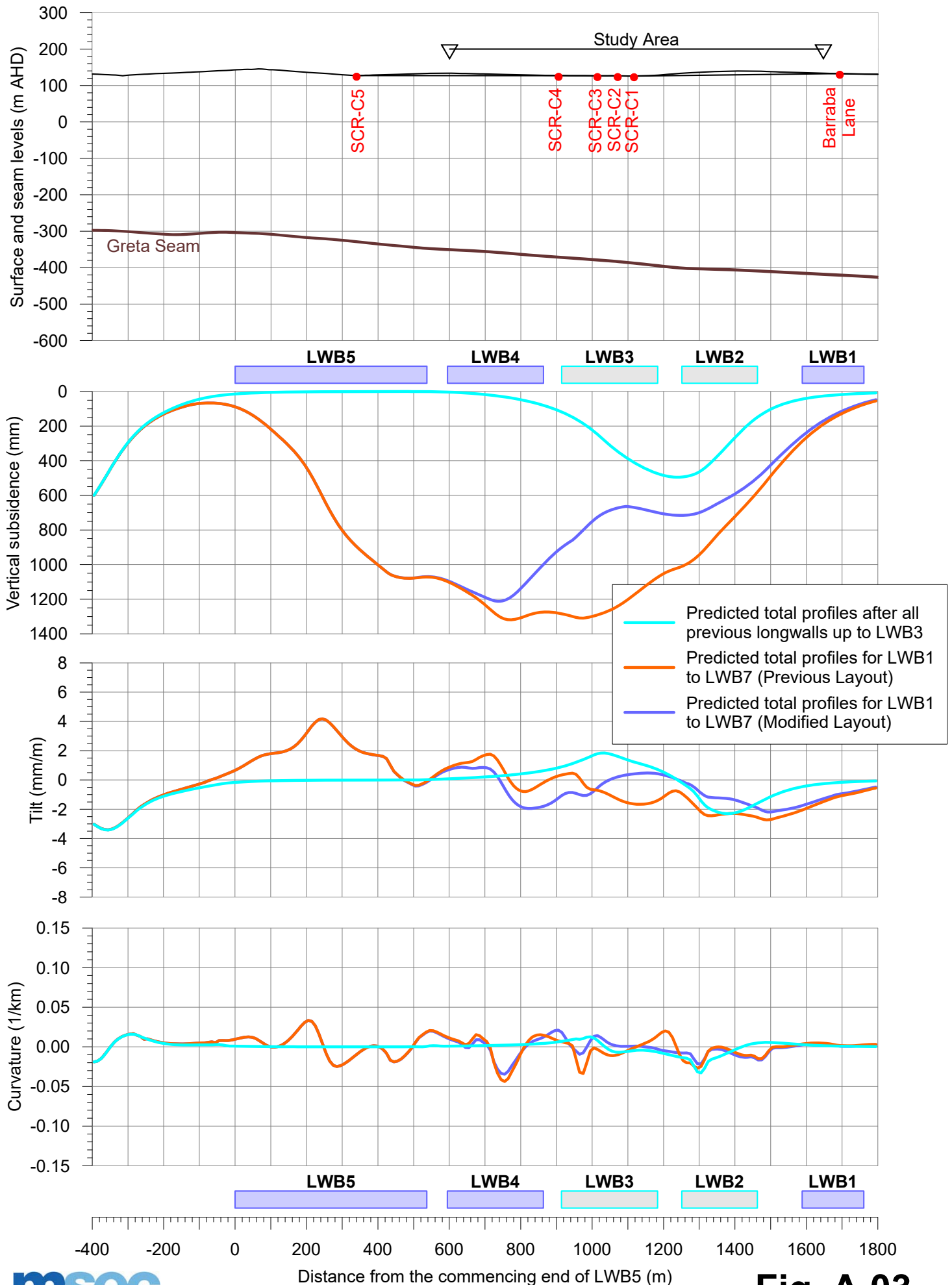
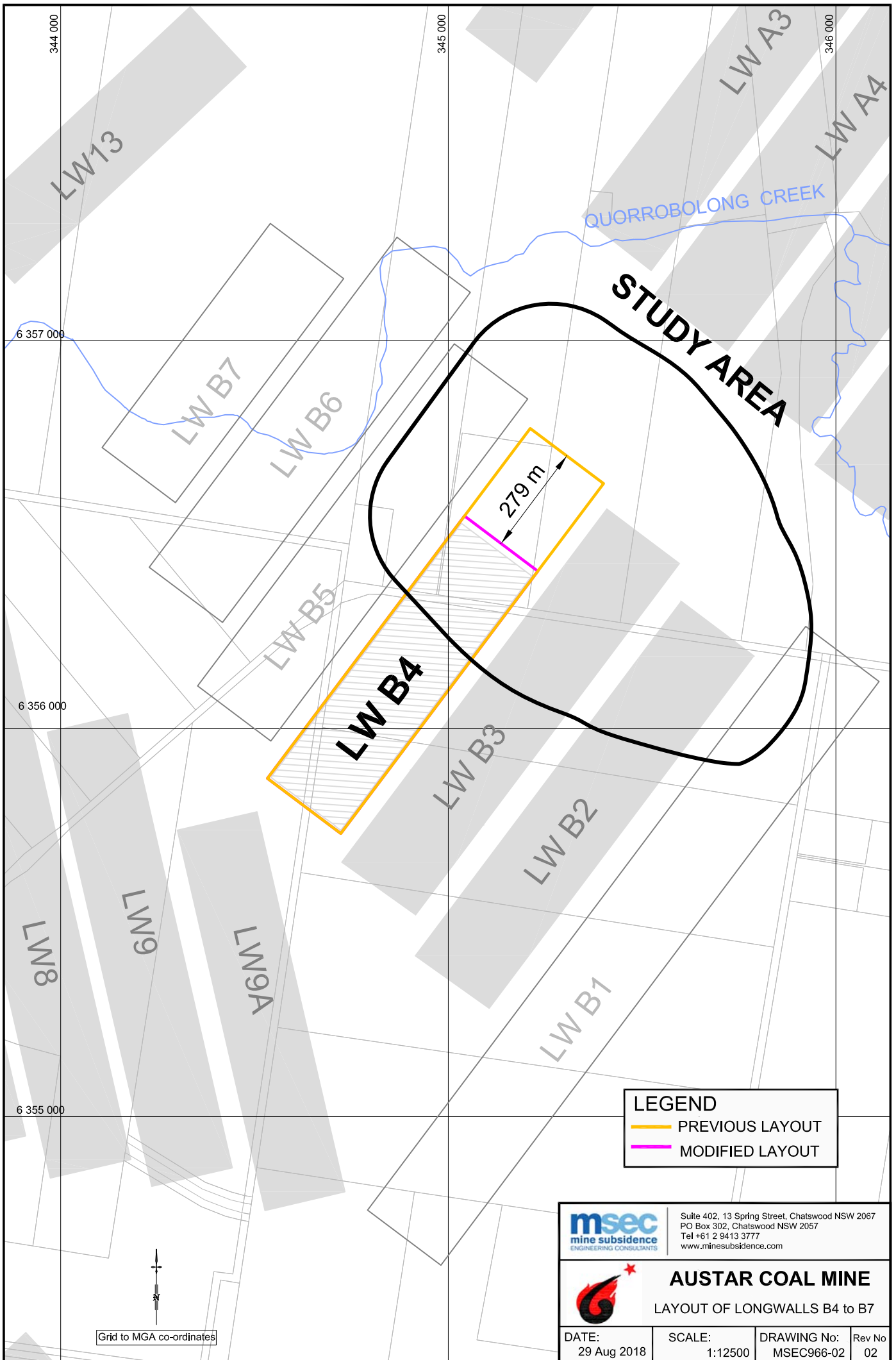
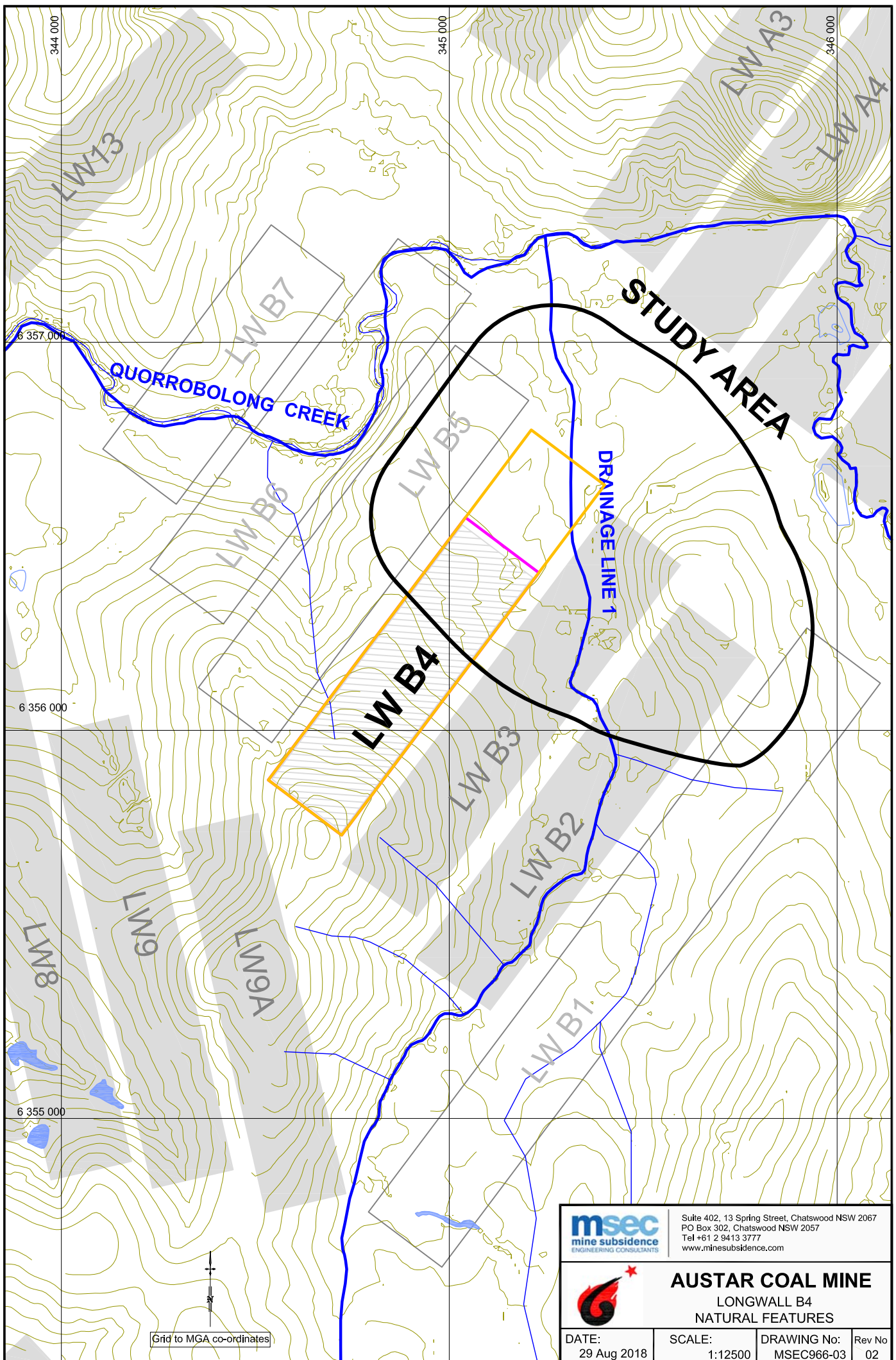


Fig. A.03





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AUSTAR COAL MINE
LONGWALL B4
NATURAL FEATURES

DATE:
29 Aug 2018

SCALE:
1:12500

DRAWING No:
MSEC966-03

Rev No
02

LEGEND

- LOCAL ROADS
- HV POWERLINES
- LV POWERLINES
- TELSTRA CABLES
- BRIDGE
- CULVERT

Grid to MGA co-ordinates



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AUSTAR COAL MINE
LONGWALL B4
SURFACE INFRASTRUCTURE

DATE:
29 Aug 2018

SCALE:
1:12500

DRAWING No:
MSEC966-04

Rev No
02

