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3 February 2014

NSW Department of Primary Industries
PO Box 344
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Attn: Paul Langley

Dear Paul

Variation to West Cliff SMP – Finishing end Longwall 36

As per the Georges River Management Plan Illawarra Coal has reviewed the impacts to Georges River from Longwalls 34 – 35 and reported these assessments in End of Panel Reports. Illawarra Coal has also reviewed the approved length of Longwall 36 and in particular the setback from the Georges River (MSEC674). In order to increase the setback from the Georges River, Illawarra Coal seeks approval to reduce the length of Longwall 36 by 128m.

A revised Approved Plan (AS-2753 Rev 0) and Surface Features Plan (AS-2754 Rev 0) are attached. The plans show the approved and proposed development and secondary extraction.

The implications of the proposed modification to Longwall 36 have been assessed by Mine Subsidence Engineering Consultants (MSEC674). The proposed reduction in longwall extraction will reduce the subsidence impacts and consequences. Illawarra Coal proposes to continue the exiting management measures and therefore the Management Plans that have been approved in accordance with the SMP do not require modification to accommodate the mine plan variation.

Pursuant to Condition 6 (Minimise Harm to the Environment) of the SMP Approval for Longwalls 34 - 36 dated 13 May 2009, Illawarra Coal seeks to vary the Approved Plan (Condition 1).

If you have any queries please contact the undersigned.

Yours sincerely

Gary Brassington
Manager Approvals (Mining)

cc: Howard Reid

Att: Plan AS-2753 Rev 0 Approved Plan
Plan AS-2754 Rev 0 Surface Features
MSEC Report 674 – West Cliff Colliery – Longwall 36. The Effects of the Proposed Modified Finishing End of Longwall 36 on Previous Subsidence Predictions and Impact Assessments.

msec
mine subsidence
ENGINEERING CONSULTANTS

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BHP BILLITON ILLAWARRA COAL:

West Cliff Colliery – Longwall 36

The Effects of the Proposed Modified Finishing End of Longwall 36
on Previous Subsidence Predictions and Impact Assessments

 | REPORT NUMBER: MSEC674 | REVISION A

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	JB	-	29th Jan 14
A	Final Issue	JB	DRK	31st Jan 14

Report produced to:- Support the Application to Modify the Finishing End of West Cliff Longwall 36 to be submitted to the Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS).

Previous reports:-

MSEC326 (Revision C – December 2007) - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Extraction of Proposed Longwalls 34 to 36 in Area 5 at West Cliff Colliery (In Support of the SMP Application).

MSEC463 (Revision B – July 2011) - The Effects of the Proposed Modified Commencing End of Longwall 35 at West Cliff Colliery on Previous Subsidence Predictions and Impact Assessments.

MSEC573 (Revision A – July 2012) – The Effects of the Proposed Modified Commencing End of Longwall 36 on Previous Subsidence Predictions and Impact Assessments.

MSEC598 (Revision A – November 2012) – The Effects of the Proposed Modified Finishing End of Longwall 35 on Previous Subsidence Predictions and Impact Assessments.

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)

CONTENTS

Tables

Tables are prefixed by the number of the chapter in which they are presented.

Figures

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

Drawings

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

1.1. Background

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Illawarra Coal (IC) to prepare subsidence predictions and impact assessments for the proposed Longwalls 34 to 36 at West Cliff Colliery. Report No. MSEC326 (Revision C) was issued in December 2007, which supported the SMP Application for these longwalls. The Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS), then known as Industry and Investment NSW, granted IC approval under the SMP approval process for extraction of Longwalls 34 to 36 on the 13th May 2009.

Impacts were observed in the Georges River as a result of the extraction of Longwalls 32 and 33. Fracturing was first observed in Rockbar 36 at the completion of Longwall 32, which is located immediately adjacent to the north-eastern corner of this longwall. Further fracturing was observed in this rockbar as Longwall 33 approached the Georges River. The water level in the pool upstream of Rockbar 36 was observed to drop on the 27th November 2009, when the longwall extraction face was 80 metres from the finishing end. Fracturing was also observed in Rockbar 39, during the extraction of Longwall 33, and then the water level in the pool upstream was observed to drop at the completion of the longwall.

IC then made the decisions to shorten the finishing (i.e. eastern) ends of Longwalls 34 and 35 by 125 metres and 185 metres, respectively, so as to minimise the potential for further impacts on the Georges River. Report Nos. MSEC444 and MSEC598 were issued in February 2010 and November 2012, respectively, in support of these modifications. There was no major fracturing or reduction of pool water levels along the Georges River resulting from the extraction of Longwall 34. Impacts were observed along the Georges River due to the extraction of Longwall 35 and were described in the End of Panel Report as follows:

> "*These impacts included rock fracturing, uplift and gas releases*" and that "*Following observations of pool water level reduction, release from Bennans Creek Dam was increased to return pool water levels to pre-mining conditions. This corrective action intervention was successful.*"

It is noted, that IC also previously shortened the commencing (i.e. western) end of Longwall 36 by 1,020 metres from that indicated in the SMP Approval. Report No. MSEC573 (Revision A) was issued in July 2012, which supported the application for the modification of the commencing end of this longwall.

IC now proposes to shorten the finishing (i.e. eastern) end of Longwall 36 by 125 metres from that indicated in the SMP Approval. The proposed location of the modified finishing end is based on an assessment of the offset distances of the previous longwalls from the Georges River and the impacts observed resulting from that mining. This report provides information that will support a Variation to the Approved Subsidence Management Plan.

The longwall layout adopted in Report No. MSEC326, which supported the SMP Application for Longwalls 34 to 36, is referred to as the *SMP Layout* in this report. The longwall layout adopted in Report No. MSEC598, which includes the previous modifications to the finishing ends of Longwalls 34 and 35 and to the commencing end of Longwall 36, is referred to as the *Approved Layout* in this report. The longwall layout that includes the proposed modified finishing end of Longwalls 36, as well as the previous modifications to the finishing ends of Longwalls 34 and 35 and to the commencing end of Longwall 36, is referred to as the *Modified Layout* in this report.

1.2. Mining Geometry

The Approved and Modified Layouts of the longwalls at West Cliff Colliery are overlaid in Drawing No. MSEC674-01, in Appendix B. A summary of the dimensions of Longwall 36 for both these layouts is provided in Table 1.1.

Table 1.1 Dimensions of Longwall 36 Based on the Approved and Modified Layouts

Layout	Overall Void Length Including Installation Heading (m)	Overall Void Width Including First Workings (m)	Overall Tailgate Chain Pillar Width (m)
Approved Layout	1,795	305	42
Modified Layout	1,670	305	42

It can be seen from the above table, that the length of Longwall 36 is proposed to be shortened by 125 metres, at the finishing (i.e. eastern) end, from the approved length which was adopted in Report No. MSEC598.

The depths of cover contours for the Bulli Seam are shown in Drawing No. MSEC674-02. The minimum depth of cover directly above the finishing end of Longwall 36 is around 465 metres based on the Approved Layout, and is around 480 metres based on the Modified Layout.

The seam thickness at the finishing end of Longwall 36 varies between 2.35 metres and 2.45 metres. IC proposes to extract a minimum height of 2.4 metres where the seam thickness is less than 2.4 metres and will extract the full height where the seam thickness is greater than 2.4 metres.

2.0 THE EFFECTS OF THE PROPOSED MODIFIED FINISHING END OF LONGWALL 36 ON THE MAXIMUM PREDICTED SUBSIDENCE PARAMETERS

2.1. Maximum Predicted Conventional Subsidence Parameters

The Incremental Profile Method was previously used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the SMP Layout, and these predictions were provided in Report No. MSEC326. The Incremental Profile Method was also used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the Approved Layout, which were provided in Report No. MSEC598.

The Incremental Profile Method has now been used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the Modified Layout. The predicted incremental subsidence contours due to the extraction of Longwall 36, based on the Modified Layout, are shown in Drawing No. MSEC674-06. The predicted total subsidence contours resulting from the extraction of Longwalls 29 to 36, based on the Modified Layout, are shown in Drawing No. MSEC674-07. The predicted incremental and total 20 mm subsidence contours, based on the Approved Layout, are also shown in these drawings for comparison.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature due to the extraction of Longwall 36, based on the Approved and Modified Layouts, is provided in Table 2.1. The predicted strains directly above the longwall are discussed in Section 2.2.

Table 2.1 Maximum Predicted Incremental Conventional Subsidence, Tilt and Curvature Resulting from the Extraction of Longwall 36 Based on the Approved and Modified Layouts

Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Approved Layout	775	5.5	0.05	0.11
Modified Layout	775	5.5	0.05	0.11

It can be seen from the above table, that the maximum predicted incremental conventional subsidence parameters, due to the extraction of Longwall 36, do not change as a result of the proposed modification to the longwall finishing end. Similarly, the maximum predicted total conventional subsidence parameters, resulting from the extraction of Longwalls 29 to 36, also do not change as a result of the proposed modification.

Although the predicted maxima do not change, the locations of the predicted maximum longitudinal tilt and curvatures change as a result of the proposed modification to the longwall finishing end. This is illustrated in Fig. A.01, in Appendix A, which shows the profiles of predicted incremental subsidence, tilt and curvature along Prediction Line 1, which has been taken through the centreline of Longwall 36, as shown in Drawing Nos. MSEC674-06 and MSEC674-07.

It can be seen from Fig. A.01, that the predicted longitudinal tilts and curvatures at the finishing end of Longwall 36 have moved around 125 metres west as a result of the proposed modification. It can also be seen, that the magnitudes of the predicted longitudinal tilt and curvatures, based on the Modified Layout, are similar to those predicted based on the Approved Layout.

2.2. Predicted Strains

The prediction of strain is more difficult than the prediction of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values. Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones.

In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the maximum predicted conventional curvatures and the maximum predicted conventional strains. The maximum predicted incremental conventional strains due to the extraction of Longwall 36, based on applying a factor of 15 to the maximum predicted incremental conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive, for both the Approved and Modified Layouts.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strains for low magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of potential strains above Longwall 36 has been determined using monitoring data from the previously extracted longwalls in the Southern Coalfield. The monitoring data was used from West Cliff Colliery, as well as the nearby Appin, Tower and Tahmoor Collieries, where the overburden geology and mining geometry are reasonably similar to the proposed longwalls. The range of strains measured during the extraction of these longwalls should, therefore, provide a reasonable indication of the range of potential strains for the proposed longwall.

The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

The survey database has been analysed to extract the maximum total tensile and compressive strains that have been measured at any time during mining, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls. A number of probability distribution functions were fitted to the empirical data. It was found that a Generalised Pareto Distribution (GPD) provided a reasonable fit to the raw strain data.

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for the previously extracted longwalls from the Southern Coalfield, is provided in Fig. 4.1. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

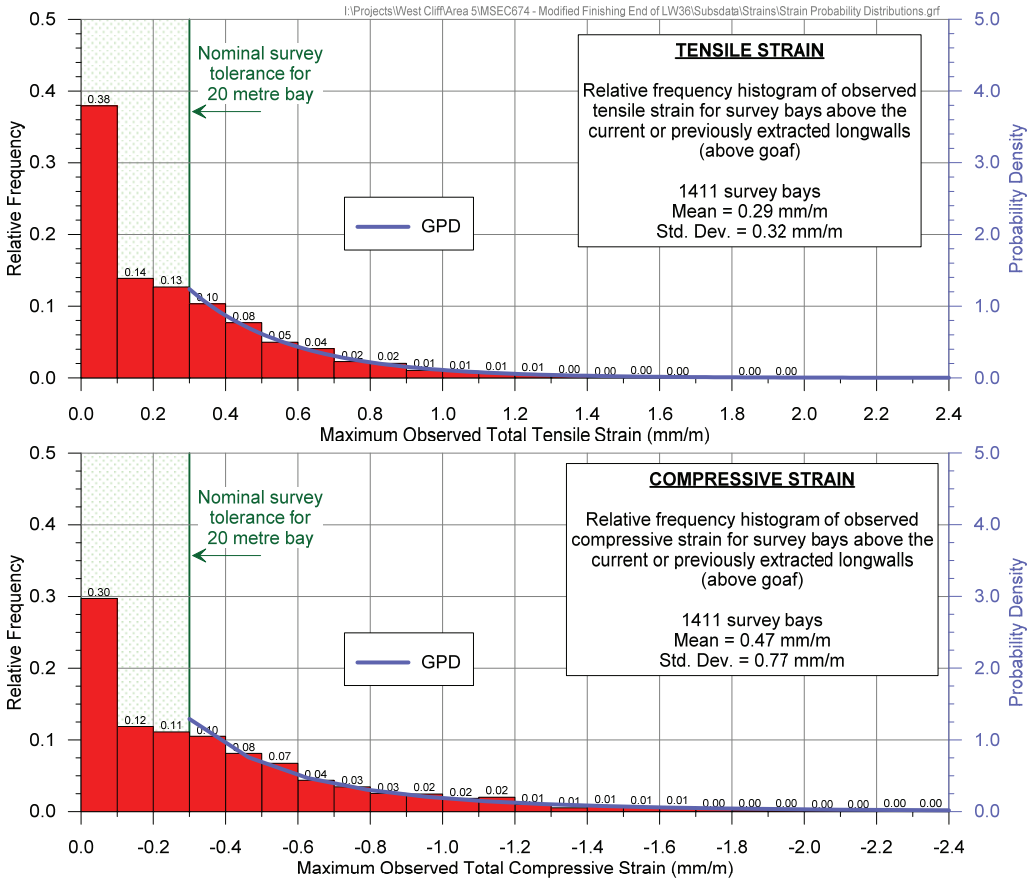


Fig. 2.1 Distributions of the Maximum Observed Total Tensile and Compressive Strains during the Extraction of Previous Longwalls for Survey Bays Located Above Goaf

Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

The 95 % confidence levels for the maximum strains that the individual survey bays experienced at any time during mining were 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence levels for the maximum strains that the individual survey bays experienced at any time during mining were 1.4 mm/m tensile and 3.2 mm/m compressive.

2.3. Maximum Predicted Valley Related Movements

The predicted valley related movements along the watercourses at West Cliff Colliery have been determined using the methods outlined in ACARP Research Project No. C9067, which were published in the handbook entitled "*Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems*", issued in September 2002. Details on the ACARP 2002 Prediction Method are provided in the background report entitled "*General Discussion on Mine Subsidence Ground Movements*" which can be obtained from *www.minesubsidence.com*.

The predicted upsidence and closure movements along the watercourses have been determined from the empirical database based on their lateral and longitudinal distances from the extracted longwalls, the depths of the valleys and the maximum predicted incremental subsidence resulting from the extraction of each longwall. The predicted upsidence and closure movements for the watercourses near the finishing end of Longwall 36 are discussed further in Chapter 3.

For the watercourses which are located directly above Longwall 36, the predicted maximum upsidence and closure movements do not change as a result of the proposed modification to the finishing end of this longwall.

For the watercourses which are located outside the extents of Longwall 36, the predicted maximum upsidence and closure movement, based on the Modified Layout, are similar to or less than the maxima predicted based on the Approved Layout, depending on their relative location to the finishing end of this longwall.

Further discussions on the predicted valley related movements are provided in Chapter 3.

3.0 THE EFFECTS OF THE PROPOSED MODIFIED FINISHING END OF LONGWALL 36 ON THE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE NATURAL AND BUILT FEATURES

3.1. The Study Area

The *Study Area* has been defined as the zone where the predicted mine subsidence parameters, based on the Modified Layout, are different to those predicted based on the Approved Layout. The Study Area has been based on the following:-

- 35 degree angle of draw line from the Longwall 36 finishing ends, based on both the original position (i.e. Approved Layout) and the modified position (i.e. Modified Layout), and
- The limit where the change in the predicted vertical subsidence, resulting from the proposed modification to the longwall finishing end, is greater than 20 mm.

The extent of the Study Area is shown in Drawing No. MSEC674-01. The Study Area is governed by the 35 degree angle of draw line to the north and to the east of Longwall 36, and is governed by the limit where the change in the predicted vertical subsidence is greater than 20 mm to the south-west of the longwall finishing end, above the previously extracted Longwall 34.

There are a number of natural and built features that are located within the Study Area, which are shown in Drawing Nos. MSEC674-03 to MSEC674-05. There are also a number of features which are located outside this area, which could experience valley related or far-field movements, and could be sensitive to such movements, and these features have also been included as part of the assessments.

The natural and built features which have been included in the assessments provided in this report are:-

- The Georges River,
- Drainage lines,
- Cliffs and rock outcrops,
- Steep slopes,
- The Dharawal State Conservation Area,
- Appin Road,
- Optical fibre cable and copper telecommunications cables,
- Houses and rural building structures,
- Farm dams, and
- Archaeological sites.

The predicted vertical subsidence at the natural and built features located within the Study Area, based on the Modified Layout, are similar to or less than those based on the Approved Layout. The predicted conventional tilts, curvatures and strains at these features, based on the Modified Layout, however, could be greater or less than those based on the Approved Layout, depending on their position relative to the longwall finishing end.

The effects of the proposed modification to the finishing end of Longwall 36 on the subsidence predictions and impact assessments for these features are provided in the following sections.

3.2. The Georges River

The location of the Georges River is shown in Drawing No.MSEC674-03. The mapped pools, rockbars, boulderfields, islands and riffles are also indicated in this drawing. It can be seen from this drawing that Longwall 36 was approved to be extracted up to the bank of the Georges River. The modified finishing end of this longwall is now proposed to be setback by 125 metres from the river.

The profiles of predicted incremental and total subsidence, upsidence and closure along the Georges River are shown in Fig. A.02 in Appendix A. The predicted incremental profiles due to the extraction of Longwall 36, based on the Approved and Modified Layouts, are shown as the dashed red and blue lines, respectively. The predicted total profiles resulting from the extraction of Longwalls 29 to 36, based on the Approved and Modified Layouts, are shown as the solid red and the blue lines, respectively.

The predicted profiles of subsidence, upsidence and closure after the completion of Longwall 35 are shown in Fig. A.02 as the solid cyan lines. For comparison, the observed closures at the Georges River monitoring lines, after the completion of Longwall 35, are also shown in this figure. The locations of the Georges River crosslines are shown in Drawing No. MSEC674-01.

It can be seen from Fig. A.02, that the maximum observed total closure movements at the Georges River L-Line and M-Line were greater than the maxima predicted after the completion of Longwall 35. These monitoring lines were located adjacent to the corner and the side of the longwall, where valley related movements are often observed to be greater than those observed off the ends of longwalls. The maximum observed total closure movements at the remaining Georges River crosslines were less than the maxima predicted after the completion of Longwall 35.

A summary of the maximum predicted incremental subsidence, upsidence and closure along the Georges River, due to the extraction of Longwall 36, is provided in Table 3.1. A summary of the maximum predicted total subsidence, upsidence and closure along the river, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.2. The results are provided for both the Approved and Modified Layouts.

Table 3.1 Maximum Predicted Incremental Subsidence, Upsidence and Closure along the Georges River due to the Extraction of Longwall 36

Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Upsidence (mm)	Maximum Predicted Incremental Closure (mm)
Approved Layout	20	80	65
Modified Layout	< 20	45	50

Table 3.2 Maximum Predicted Total Subsidence, Upsidence and Closure along the Georges River Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Approved Layout	60	155	190
Modified Layout	60	145	180

It can be seen from the above tables, that the predicted subsidence, upsidence and closure along the Georges River, based on the Modified Layout, are less than those based on the Approved Layout. This is understandable, as Longwall 36 is proposed to be setback from the river by around 125 metres.

It is concluded, therefore, that the assessed levels of potential impact for the Georges River reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the river are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.3. Drainage Lines

The locations of the drainage lines are shown in Drawing No. MSEC674-03. The drainage lines that are located partially or wholly within the Study Area are Drainage Lines GR104 and GR105, which are all tributaries of the Georges River.

Drainage Line GR105 is located immediately to the east of Longwall 36 based on the Approved Layout. The predicted conventional subsidence and valley related movements for this drainage line, therefore, reduce as a result of the proposed modification.

The lower reaches of Drainage Line GR104 are located directly above the maingate of Longwall 36 based on the Approved Layout. The upper reaches of this drainage line are located north of the maingate of Longwall 36. A summary of the maximum predicted total subsidence, tilts and curvatures for this drainage line, resulting from the extraction of Longwalls 29 to 36, is provided Table 3.3.

Table 3.3 Maximum Predicted Total Subsidence, Tilts and Curvatures for Drainage Line GR104 Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Tilt Across Alignment (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	85	0.5	1.0	0.01	< 0.01
Modified Layout	75	< 0.5	0.5	0.01	< 0.01

It can be seen from the above table, that the predicted conventional subsidence parameters for Drainage Line GR104, based on the Modified Layout, are similar to or less than those based on the Approved Layout. Also, the predicted valley related movements for this drainage line are similar to, but slightly reduce, as a result of the proposed modification.

It is concluded, therefore, that the assessed levels of potential impact for the drainage lines do not change or reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the drainage lines are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.4. Cliffs, Rock Outcrops and Steep Slopes

The locations of the cliffs, rock outcrops and steep slopes are shown in Drawing No. MSEC674-04. These features are located within the valley of the Georges River.

Cliff GR-CF02 is located around 50 metres north of the maingate of Longwall 36 based on the Approved Layout. Rock outcrops are located above the longwall maingate, based on the Approved Layout, and also to the east of the longwall finishing end. The distances to the cliff and to the rock outcrops increase and, therefore, the predicted conventional and valley related movements reduce as a result of the proposed modification.

The steep slopes are located above and to the east of the finishing end of Longwall 36 based on the Approved Layout. The steep slopes are essentially located to the east of the longwall, based on the Modified Layout, with only isolated steep slopes associated with Drainage Line GR104 located above the longwall maingate. The predicted conventional and valley related movements for the steep slopes reduce as a result of the proposed modification.

It is concluded, therefore, that the assessed levels of potential impact for the cliffs, rock outcrops and steep slopes reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for these features are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.5. The Dharawal State Conservation Area

The location of the Dharawal State Conservation Area is shown in Drawing No. MSEC674-05. The Conservation Area is located east of the finishing end of Longwall 36 based on both the Approved and Modified Layout. The distances to the Conservation Area increase and, therefore, the predicted conventional and valley related movements reduce as a result of the proposed modification.

It is concluded, therefore, that the assessed levels of potential impact for the Dharawal State Conservation Area reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the Conservation Area are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.6. Appin Road

The location of Appin Road is shown in Drawing No. MSEC674-05. The road is located to the west of the finishing end of Longwall 36 based on both the Approved and Modified Layouts.

The profiles of predicted incremental and total subsidence, tilt and curvature along Appin Road are shown in Fig. A.03 in Appendix A. The predicted incremental profiles due to the extraction of Longwall 36, based on the Approved and Modified Layouts, are shown as the dashed red and blue lines, respectively. The predicted total profiles resulting from the extraction of Longwalls 29 to 36, based on the Approved and Modified Layouts, are shown as the solid red and the blue lines, respectively.

A summary of the maximum predicted total subsidence, tilt along, tilt across and curvatures for Appin Road, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.4. The results are the maxima within the Study Area for both the Approved and Modified Layouts. The predicted tilts are the maxima along and across the alignment of the road and the predicted curvatures are the maxima in any direction.

Table 3.4 Maximum Predicted Total Subsidence, Tilts and Curvatures for Appin Road Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Tilt Along Alignment (mm/m)	Maximum Predicted Tilt Across Alignment (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	1025	3.5	3.0	0.07	0.11
Modified Layout	900	3.5	4.5	0.07	0.11

It can be seen from the above table, that the maximum predicted cross tilt increases as a result of the proposed modification. The maximum predicted cross-tilt of 4.5 mm/m (i.e. 0.45 %, or 1 in 220), based on the Modified Layout, is still less than 1 % and is unlikely, therefore, to have any adverse impacts on the surface water drainage and the serviceability of the road. The maximum predicted subsidence, tilt along the alignment and curvatures in any direction, based on the Modified Layout, are less than the maxima based on the Approved Layout.

It is concluded, therefore, that the assessed levels of potential impact for Appin Road are similar or reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the road are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.7. Sewerage Pipeline

A sewerage pipeline has recently been constructed adjacent to Appin Road. The location of the pipeline is shown in Drawing No. MSEC674-05. The predicted conventional subsidence movements for the pipeline are the same for Appin Road, which are described in Section 3.6.

The sewerage pipeline is a pressure main and is unlikely, therefore, to be affected to any great extent by changes in gradient due to subsidence or tilt. The potential impacts on the pipeline result from curvature and strain. The predicted curvatures and, hence, the magnitudes of predicted strain along the pipeline, based on the Modified Layout, are similar to those based on the Approved Layout. Also, the pipeline was designed for mine subsidence parameters greater than those predicted within the Study Area, being 1,900 mm subsidence, 10 mm/m tilt, 1.4 mm/m tensile strain and 2.9 mm/m compressive strain.

It is concluded, therefore, that the assessed level of potential impact for the sewerage pipeline do not change as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the pipeline are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.8. Telecommunications Cables

The locations of the telecommunications infrastructure are shown in Drawing No. MSEC674-05. There is a direct buried optical fibre cable located adjacent to Appin Road. The predicted conventional subsidence movements for this cable are the same for Appin Road, which are described in Section 3.6.

The optical fibre cable is not affected by vertical subsidence or tilt. The potential impacts on the cable result from curvature and strain. The predicted curvatures and, hence, the magnitudes of predicted strain along the cable, based on the Modified Layout, are similar to those based on the Approved Layout.

It is concluded, therefore, that the assessed level of potential impact for the optical fibre cable do not change as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the cable are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.9. Houses

There are four houses located within the Study Area, being Structure Refs. A35a, A36a, D03a and D04a. The locations of these structures are shown in Drawing No. MSEC674-05.

A summary of the maximum predicted total subsidence, tilt and curvatures for the houses within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.5. The results are provided for both the Approved and Modified Layouts. The predicted tilts and curvatures are the maxima in any direction.

Table 3.5 Maximum Predicted Total Subsidence, Tilts and Curvatures for the Houses Resulting from the Extraction of Longwalls 29 to 36

Layout	Structure Ref.	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Final Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	A35a	775	1.5	0.07	0.02
	A36a	900	1.5	0.03	0.02
	D03a	825	0.5	0.02	0.06
	D04a	600	6.0	0.06	0.02
Modified Layout	A35a	775	1.5	0.07	0.02
	A36a	850	1.0	0.03	0.02
	D03a	725	3.0	0.01	0.05
	D04a	600	6.0	0.05	0.02

It can be seen from the above table, that the maximum predicted tilt at House Ref. D03a of 3.0 mm/m (i.e. 0.3 %, or 1 in 335), based on the Modified Layout, is greater than the maximum predicted tilt of 0.5 mm/m (i.e. < 0.1 %, or 1 in 2,000) based on the Approved Layout. The predicted tilt at this house is still less than 7 mm/m and, therefore, is not expected to result in any significant serviceability impacts. Any such impacts would be remediated by the Mine Subsidence Board. The predicted tilts at the remaining houses within the Study Area are similar to or reduce as a result of the proposed modification.

The maximum predicted curvatures at the houses within the Study Area, based on the Modified Layout, are similar to or less than the maximum predicted curvatures based on the Approved Layout.

It is concluded, therefore, that the assessed level of potential impact for the houses do not change as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the houses are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.10. Rural Building Structures

There are 45 rural building structures located within the Study Area on Property Refs. A35, A36, A39, D01, D02, D03 and D04. The locations of these structures are shown in Drawing No. MSEC674-05.

A summary of the maximum predicted total subsidence, tilt and curvatures for the rural building structures within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.6. The results are provided for both the Approved and Modified Layouts. The predicted tilts and curvatures are the maxima in any direction.

Table 3.6 Maximum Predicted Total Subsidence, Tilts and Curvatures for the Rural Building Structures Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	1,050	6.0	0.07	0.11
Modified Layout	1,000	6.0	0.07	0.11

It can be seen from the above table, that the maximum predicted conventional subsidence parameters for the rural building structures, based on the Modified Layout, are similar to or less than those based on the Approved Layout. It is likely that the predicted tilts and curvatures at some structures would slightly increase, whilst the predicted tilts and curvatures at other structures would slightly decrease, depending on their locations relative to the longwall finishing end. It is expected, however, that the overall levels of movement for these structures would not change as a result of the proposed modification.

It is concluded, therefore, that the assessed level of potential impact for the rural building structures do not change as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the structures are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.11. Farm Dams

There are seven farm dams located within the Study Area, being Dam Refs. A38d01, A38d02, A39d01, D39d02, D01d01, D02d02 and D10d01. The locations of these farm dams are shown in Drawing No. MSEC674-05.

A summary of the maximum predicted total subsidence, tilt and curvatures for the farm dams within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.7. The results are provided for both the Approved and Modified Layouts. The predicted tilts and curvatures are the maxima in any direction.

Table 3.7 Maximum Predicted Total Subsidence, Tilts and Curvatures for the Farm Dams Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	1,100	6.0	0.07	0.12
Modified Layout	1,100	6.0	0.07	0.12

It can be seen from the above table, that the maximum predicted conventional subsidence parameters for the farm dams, based on the Modified Layout, are similar to those based on the Approved Layout. It is likely that the predicted tilts and curvatures at some dams would slightly increase, whilst the predicted tilts and curvatures at other dams would slightly decrease, depending on their locations relative to the longwall finishing end. It is expected, however, that the overall levels of movement for these farm dams would not change as a result of the proposed modification.

It is concluded, therefore, that the assessed level of potential impact for the farm dams do not change as a result of the proposed modification of the longwall finishing end. The recommended management strategies for the dams are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.12. Archaeological Sites

There is one archaeological site located within the Study Area, being Site 52-2-2242, which is a shelter with art. The site is located immediately to the east of the finishing end of Longwall 36 based on the Approved Layout. The location of this site is shown in Drawing No. MSEC674-05.

The distance of this archaeological site from Longwall 36 increases as a result of the proposed modification. Hence, the predicted conventional and valley related movements, based on the Modified Layout, are less than those based on the Approved Layout.

It is concluded, therefore, that the assessed levels of potential impact for the archaeological site reduce as a result of the proposed modification of the longwall finishing end. The recommended management strategies for these sites are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

3.13. Summary

The maximum predicted incremental conventional subsidence parameters, due to the extraction of Longwall 36, do not change as a result of the proposed modification to the longwall finishing end. Similarly, the maximum predicted total conventional subsidence parameters, resulting from the extraction of Longwalls 29 to 36, also do not change as a result of the proposed modification.

Although the predicted maxima do not change, the locations of the maximum predicted longitudinal tilt and curvatures change as a result of the proposed modification to the longwall finishing end. As shown in Fig. A.01, the predicted longitudinal tilts and curvatures at the finishing end of Longwall 36 moved around 125 metres west as a result of the proposed modification.

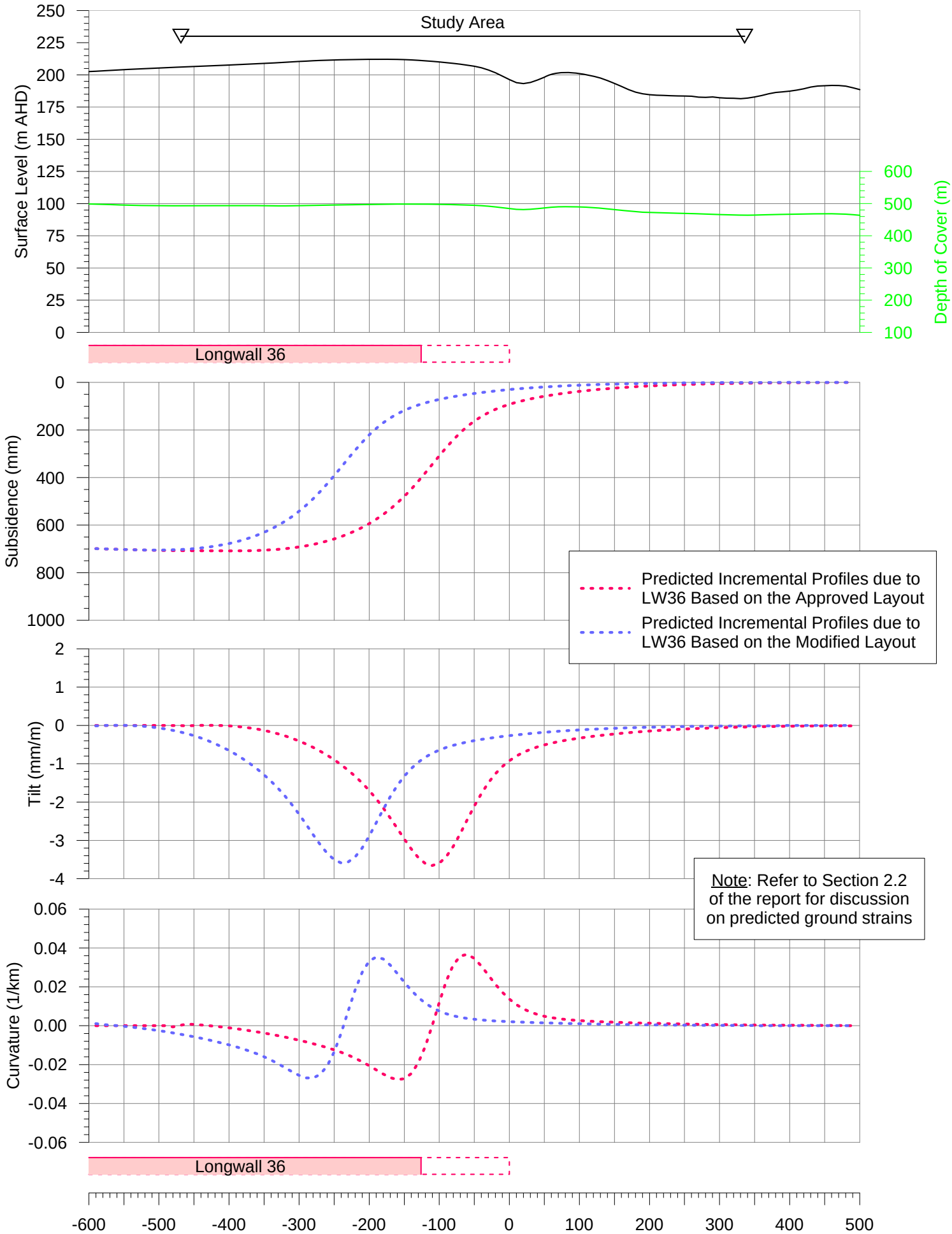
The maximum predicted mine subsidence parameters for the natural and built features, based on the Modified Layout, are generally similar to or less than those predicted based on the Approved Layout. The maximum predicted cross-tilt for Appin Road increases, due to the proposed modification, but is less than 1 % and unlikely therefore to have any adverse impacts on the serviceability of the road. The predicted tilt at House Ref. D03 increases, due to the proposed modification, but is less than 7 mm/m and unlikely therefore to result in any serviceability impacts.

It predicted tilts and curvatures at some rural building structures and farm dams slightly increase, whilst the predicted tilts and curvatures at other rural building structures and farm dams slightly decrease, depending on their locations relative to the longwall finishing end. It is expected, however, that the overall levels of movement for these features do not change as a result of the proposed modification.

It is concluded, therefore, that the assessed levels of potential impact for the natural and built features either do not change or reduce as a result of the proposed modification of the Longwall 36 finishing end. The recommended management strategies for the natural and built features are the same as those previously provided in Report No. MSEC326 and as proposed in the SMP Application.

APPENDIX A. FIGURES

Predicted Profiles of Incremental Subsidence, Tilt and Curvature along Prediction Line 1 Resulting from the Extraction of Longwall 36



msec

Fig. A.01

Predicted Profiles of Subsidence, Upsidence and Closure along the Georges River Resulting from the Extraction of Longwalls 29 to 36

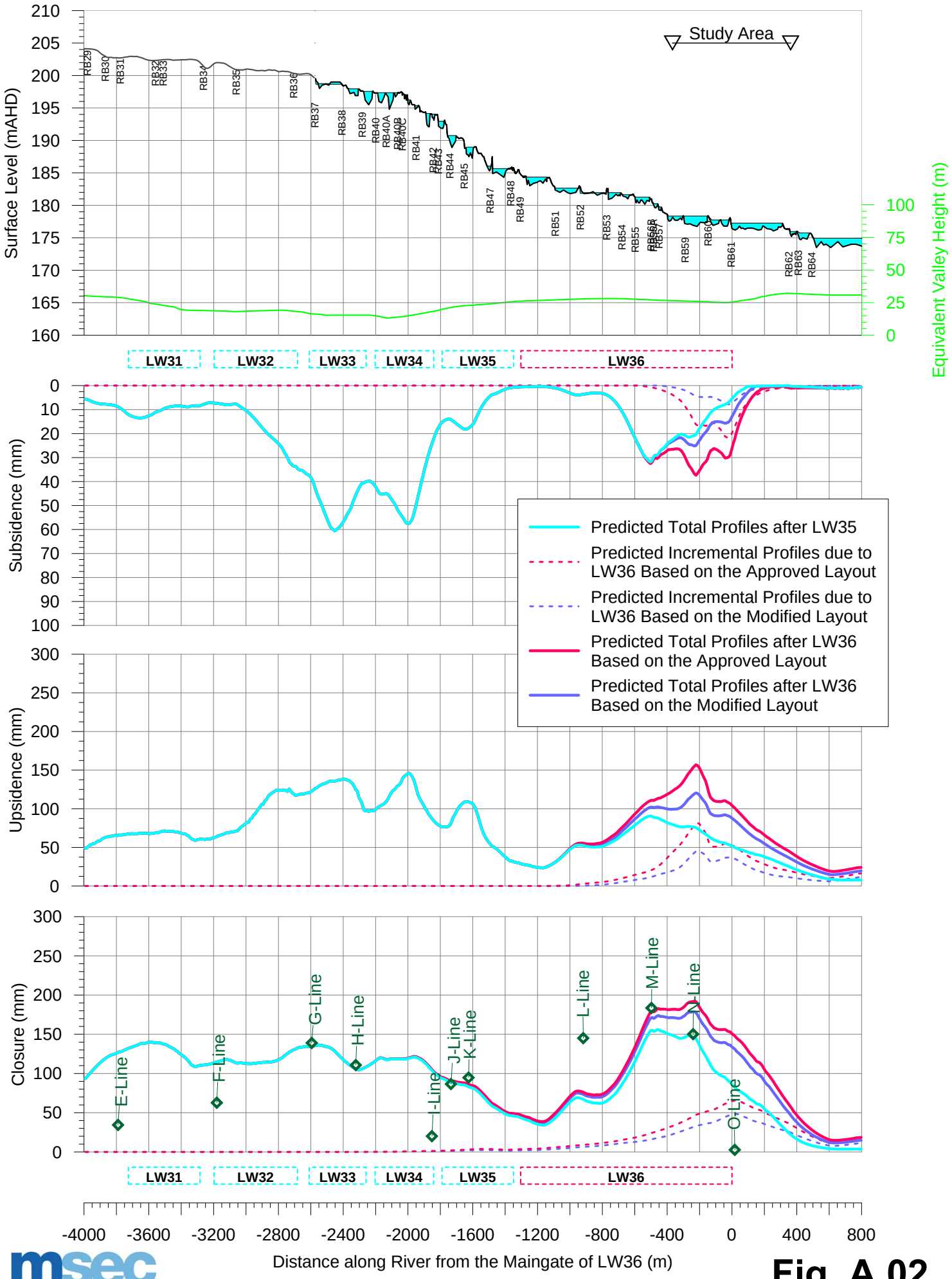


Fig. A.02

APPENDIX B. DRAWINGS

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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END
GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
31-Jan-2014	1:10000	MSEC674-01	A

296 000

297 000

Grid to MGA co-ordinates

FINISHING END OF LONGWALL36 BASED ON APPROVED LAYOUT

FINISHING END OF LONGWALL 36 BASED ON MODIFIED LAYOUT

28-Jan-2014

6 218 000

6 217 000

6 216 000

STUDY AREA

LW 36

LW 35

LW 34

LW 33

LW 32

APPIN ROAD

LEGEND

GEORGES RIVER CROSSLINES

GEORGES RIVER

GEOX 0

GEOX N

GEOX M

GEOX L

GEOX K

GEOX J

GEOX I

GEOX H

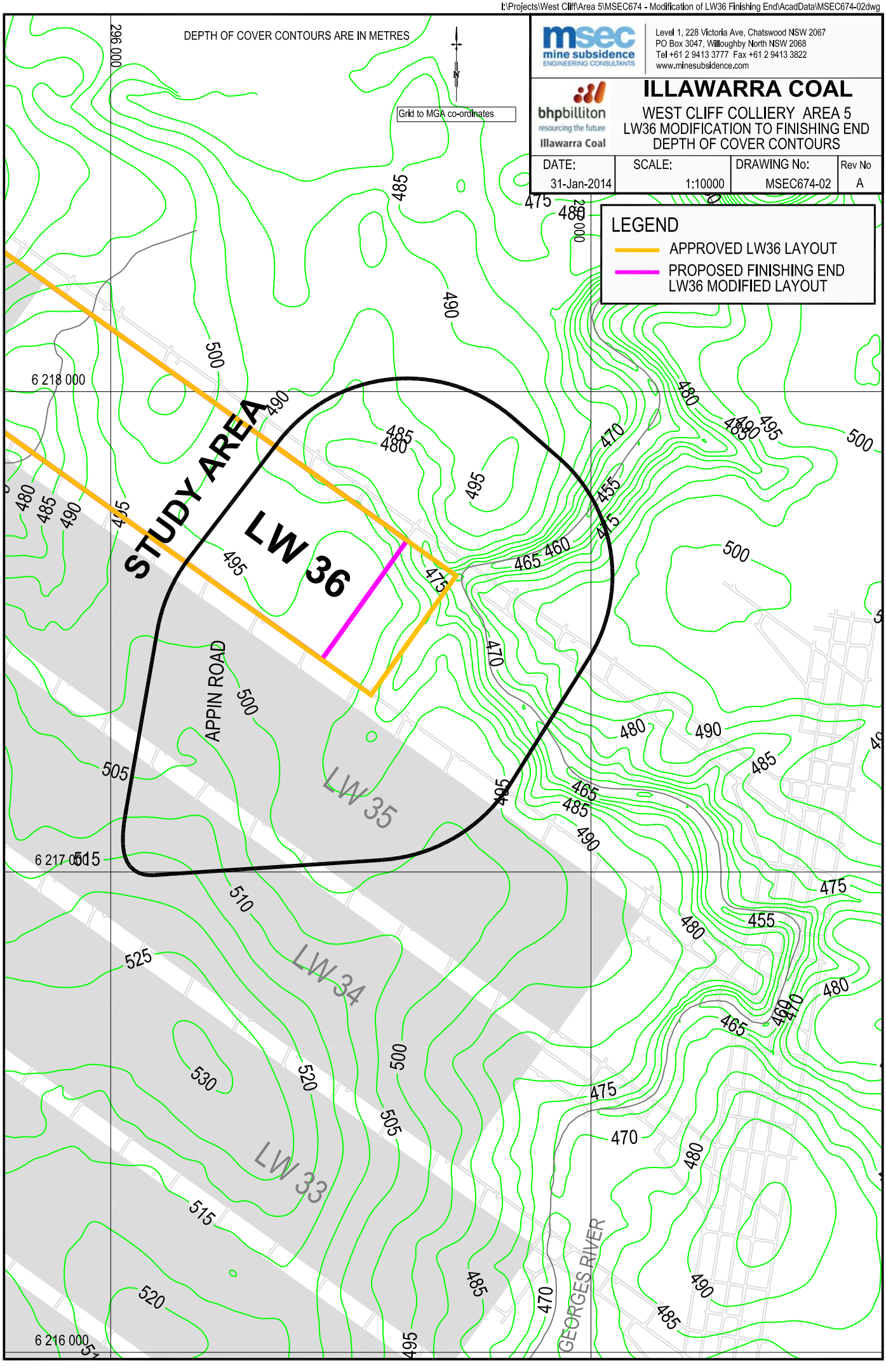
Finish LW35 20-July-2013

Finish LW34 14-Sep-2011

Finish LW33 21 Dec 2009

LYSAGHTS RD

I:\Projects\West Cliff\Area 5\MSEC674 - Modification of LW36 Finishing End\AcadData\MSEC674-02dwg



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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END
DEPTH OF COVER CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END WATERCOURSES

DATE:	SCALE:	DRAWING No:	Rev No
31-Jan-2014	1:10000	MSEC674-03	A

Grid to MGA co-ordinates

296 000

297 000

6 218 000

6 217 000

6 216 000

STUDY AREA

LW 36

LW 35

LW 34

LW 33

MALLATY CK

GEORGES RIVER

GR-PO64
GR-RB64
GR-BF64
GR-PO63
GR-RB63
GR-PO62
GR-RB62
GR-BF62
GR-PO61
GR-RB61
GR-PO60
GR-RB60
GR-PO59
GR-RB59
GR-PO58
GR-RF58
GR-PO57
GR-PO56
GR-RF56
GR-PO55
GR-PO54
GR-RB54
GR-PO53
GR-RB53
GR-PO52
GR-RB52
GR-PO51
GR-RB51
GR-PO50
GR-RB50
GR-BF50
GR-PO49
GR-IS49
GR-RB49
GR-PO48
GR-RB48
GR-PO47
GR-BF46
GR-PO45
GR-RB45
GR-PO44
GR-RB44
GR-PO43
GR-RB43
GR-PO42
GR-PO41a
GR-RB41
GR-PO40e
GR-PO40d
GR-PO40c
GR-PO40b
GR-RB40c
GR-RB40b
GR-PO40a
GR-RB40a
GR-PO40

GR102
GR103
GR104
GR105
GR106
GR107
GR108
GR109
GR110
GR111
GR111A
GR111B
GR112
GR113
GR113A

LEGEND
APPROVED LW36 LAYOUT
PROPOSED FINISHING END LW36 MODIFIED LAYOUT

LEGEND
WATERCOURSE
SURFACE LEVEL CONTOURS
GEORGES RIVER- STREAM FEATURES
POOLS
ROCKBARS
RIFFLES
ISLAND
BOULDERS

I:\Projects\West Cliff\Area 5\MSEC674 - Modification of LW36 Finishing End\AcadData\MSEC674-04dwg

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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END CLIFFS & STEEP SLOPES

DATE:	SCALE:	DRAWING No:	Rev No
31-Jan-2014	1:10000	MSEC674-04	A

296 000

297 000

Grid to MGA co-ordinates

LEGEND
- WATERCOURSE
- CLIFFS
- ROCK OUTCROP
- STEEP SLOPES
- SURFACE LEVEL CONTOURS

LEGEND
- APPROVED LW36 LAYOUT
- PROPOSED FINISHING END LW36 MODIFIED LAYOUT

6 218 000

6 217 000

6 216 000

STUDY AREA

LW 36

LW 35

LW 34

LW 33

LW 32

APPIN ROAD

GR-CF02

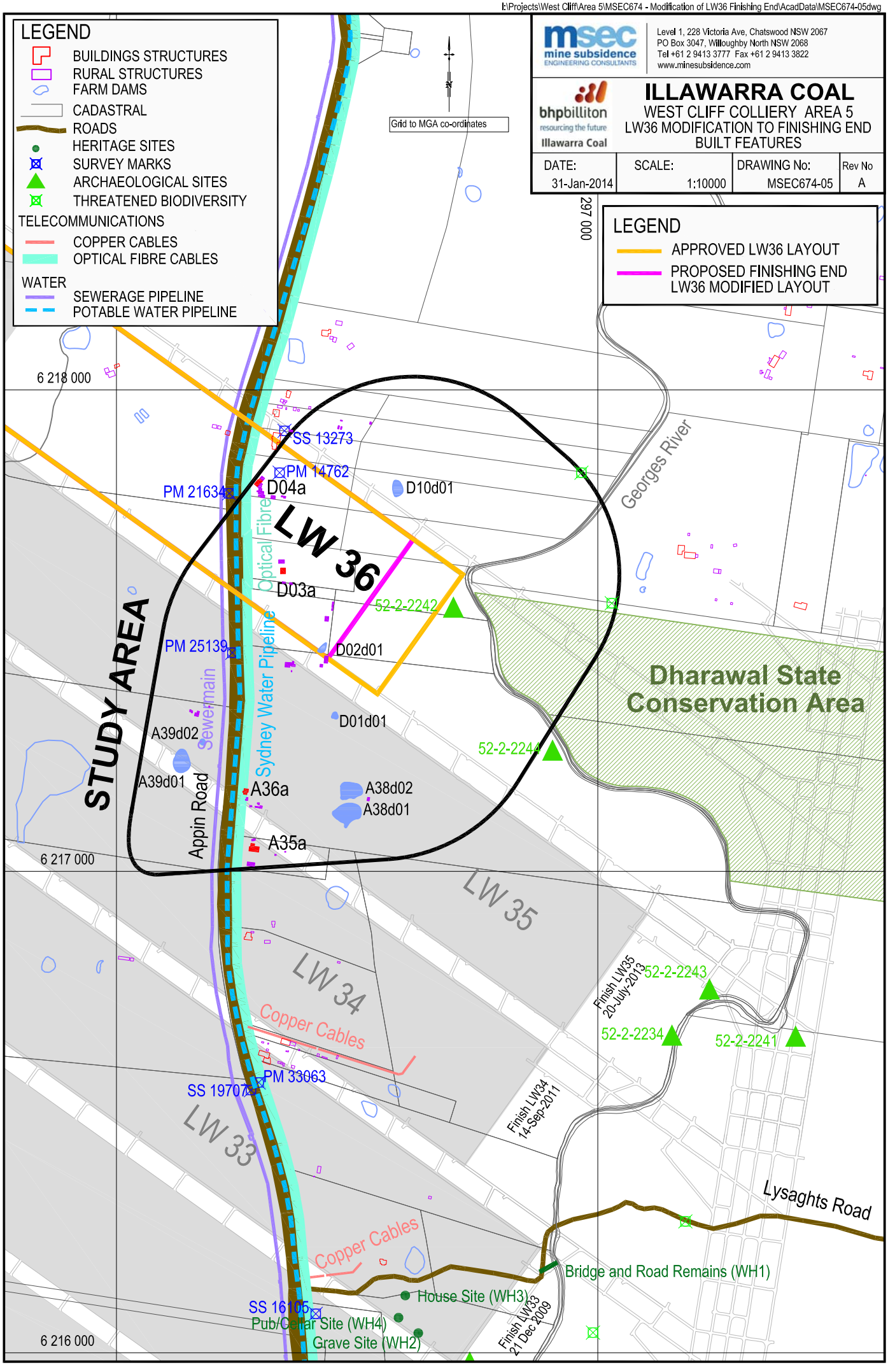
GR-CF01

ROCK OUTCROPS ALONG GEORGES RIVER BETWEEN 5m TO 10m HIGH

ROCK OUTCROPS ALONG GEORGES RIVER BETWEEN 5m TO 10m HIGH

GEORGES RIVER

I:\Projects\West Cliff\Area 5\MSEC674 - Modification of LW36 Finishing End\AcadData\MSEC674-05dwg



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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END
PREDICTED INCREMENTAL SUBSIDENCE CONTOURS DUE TO LW36

DATE:	SCALE:	DRAWING No:	Rev No
31-Jan-2014	1:10000	MSEC674-06	A

PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)

Grid to MGA co-ordinates

296 000

297 000

6 218 000

6 217 000

6 216 000

LEGEND

APPROVED LW36 LAYOUT

PROPOSED FINISHING END LW36 MODIFIED LAYOUT

STUDY AREA

LW 36

LW 35

LW 34

LW 33

LW 32

20

50

100

200

300

400

500

600

700

APPIN ROAD

GEORGES RIVER

PREDICTED 20mm SUBSIDENCE CONTOUR BASED ON THE APPROVED LAYOUT

PREDICTED SUBSIDENCE CONTOURS BASED ON THE MODIFIED LAYOUT

PREDICTION LINE 1

I:\Projects\West Cliff\Area 5\MSEC674 - Modification of LW36 Finishing End\AcadData\MSEC674-07dwg

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WEST CLIFF COLLIERY AREA 5
LW36 MODIFICATION TO FINISHING END
PREDICTED TOTAL SUBSIDENCE CONTOURS DUE TO LW29 TO LW36

DATE:	SCALE:	DRAWING No:	Rev No
31-Jan-2014	1:10000	MSEC674-07	A

PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)

Grid to MGA co-ordinates

296 000

297 000

6 218 000

6 217 000

6 216 000

LEGEND

APPROVED LW36 LAYOUT

PROPOSED FINISHING END LW36 MODIFIED LAYOUT

PREDICTED 20mm SUBSIDENCE CONTOUR BASED ON THE APPROVED LAYOUT

PREDICTED SUBSIDENCE CONTOURS BASED ON THE MODIFIED LAYOUT

PREDICTION LINE 1

STUDY AREA

LW 36

LW 35

LW 34

LW 33

LW 32

GEORGES RIVER

500 600 700 800 900 1000 1100 1200

20 50 100