mine subsidence ENGINEERING CONSULTANTS

# South32

**Illawarra Coal**

SOUTH32 ILLAWARRA COAL:

## Dendrobium - Area 3B - Longwall 11

End of Panel Subsidence Monitoring Review Report for Dendrobium Longwall 11

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Associated reports:-

WKA77 (January 2001) – Dendrobium Mine Project – Report on the Prediction of Mining Subsidence Parameters and the Assessment of Impacts on Surface Infrastructure – Longwalls 1 to 18 (In support of the EIS).

MSEC311 (October 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 6 to 10 in Area 3A and Future Longwalls in Areas 3B And 3C at Dendrobium Mine (In Support of the SMP Application and the Modification to the Development Consent).

MSEC459 (September 2012) – Dendrobium Area 3B – Longwalls 9 to 18 – Subsidence Predictions and Impact Assessments for Natural Features and Surface Infrastructure in Support of the SMP Application.

MSEC651 (October 2013) – Dendrobium Area 3B – Longwall 10 – The Effects of the Proposed Modified Commencing End on the Subsidence Predictions and Impact Assessments.

MSEC652 (May 2014) – Dendrobium Area 3B – The Effects of the Proposed Modifications to the Commencing End of Longwall 11 and to the Widths of Longwalls 12 to 18 in Area 3B at Dendrobium Mine on the Subsidence Predictions and Impact Assessments.

MSEC821 (July 2015) – The Effects of the Proposed Modifications to the Finishing End of Longwall 11 and to the Commencing End of Longwall 12 in Area 3B at Dendrobium Mine on the 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)

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**Drawings**

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

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## 1.1. Introduction

Illawarra Coal (IC) has completed the extraction of Longwall 11 at Dendrobium Mine, which is located in the Southern Coalfield of New South Wales. The locations of the longwalls in Area 3B at Dendrobium Mine are shown in Drawing No. MSEC821-01, in Appendix A. The extraction of Longwall 11 commenced on the 18th February 2015 and was completed on the 26th January 2016.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by IC to prepare subsidence predictions and impact assessments for Dendrobium Longwalls 9 to 18 in Area 3B at Dendrobium Mine. Report No. MSEC459 (Revision B) was issued in September 2012, which supported the SMP Application for these longwalls. IC shortened the commencing (western) end of Longwall 10 by 60 metres from that indicated in the SMP Application. MSEC prepared Report No. MSEC651 Revision A, in October 2013, in support of this variation to the approved Subsidence Management Plan.

IC then shortened the commencing (western) end of Longwall 11 by 68 metres and shortened the finishing end by 98 metres from the extents indicated in the SMP Application. Reports Nos. MSEC652 (Revision B) and Report No. MSEC785 (Revision A) were issued in support of the applications for these modifications. The modified commencing and finishing ends of Longwall 11 were approved by the DTIRIS on the 19th August 2014 and the 4th September 2015, respectively.

In accordance with Condition 9 End of Panel Reporting, of the Modification to the Development Consent (Schedule 3) for the Area 3B longwalls, this report provides:-

- Comparisons between the observed and predicted subsidence movements at the monitoring lines and points in Dendrobium Area 3B resulting from the extraction of Longwall 11; and
- Comparison between the observed and predicted effects and impacts on the natural and built features within the SMP Area resulting from the extraction of Longwall 11.

Further details on the predicted and observed impacts for natural features, resulting from the extraction of Longwall 11, are provided in the reports by other consultants. The observations provided in this report should be read in conjunction with those and all other relevant reports.

Section 2 of this report describes the locations of the ground monitoring lines and points which were surveyed during the extraction of Longwall 11. This section also provides comparisons between the observed and predicted movements resulting from the extraction of Longwall 11.

Section 3 of this report describes the natural and built features in the vicinity of Longwall 11. This section also provides comparisons between the observed and predicted impacts for these features resulting from the extraction of Longwall 11. Further discussions on the observed and assessed impacts for some natural features are provided in reports by other consultants.

Appendix A includes all drawings associated with this report.

## 1.2. Mining Geometry

The approved overall void length (i.e. including the installation heading) of Longwall 11 was 2,370 metres. The longwall was shortened at the commencing (western) end by 68 metres and at the finishing (eastern) end by 98 metres. The total extracted length of the longwall was 2,204 metres. The overall void width of Longwall 11, including the first workings, is 305 metres. The extent of mining for Longwall 11 is shown in Drawing No. MSEC821-01, in Appendix A.

The depth of cover to the Wongawilli Seam, directly above Longwall 11, varies between a minimum of 330 metres, near the eastern (finishing) end of the longwall, and a maximum of 410 metres, near the western (commencing) end of the longwall.

The extraction height varied along the length of the longwall, depending on the local roof conditions. The predictions provided in this report have been based on a constant extraction height of 4.6 metres, as adopted in Report No. MSEC459, MSEC652 and MSEC785.

## 2.1. Introduction

The mine subsidence movements resulting from the extraction of Dendrobium Longwall 11 were monitored along a number of survey lines and at a number of survey points including the following:-

- Wongawilli Creek Closure Lines;
- Area 3B 3D monitoring points;
- Tributary Cross Lines;
- Donalds Castle Creek Cross Lines; and
- Airborne laser scans of the area.

The locations of these survey lines and survey points are shown in Drawing No. MSEC821-01, in Appendix A. Comparisons between the observed and predicted subsidence movements at these monitoring lines and points are provided in the following sections. The predicted subsidence parameters are based on those presented in Report No. MSEC459 (Rev. B), which supported the SMP Application for Longwalls 9 to 18.

## 2.2. Wongawilli Creek Closure Lines

The closure movements across Wongawilli Creek were measured by IC using 2D survey techniques at the Wong X A-Line, Wong X B-Line and the Wong X C-Line. The locations of these monitoring lines are shown in Drawing No. MSEC821-01. The survey dates for the Wongawilli Creek Closure Lines are provided in Table 2.1.

**Table 2.1 Summary of Survey Dates for the Wongawilli Creek Closure Lines during Longwall 11**

| Mining Phase Commitments | Mining Phase Survey Dates | Post Mining Phase Commitments |
|---|---|---|
| Start and end of Longwall 11 | 2nd February 2015 (End of LW10)<br>4th March 2016 (End of LW11) | Start and end of each of the future longwalls in Area 3B |

The monitoring lines each comprise two survey marks located either side of the creek and, therefore, measure the closure between the valley sides. Survey marks could not be located near the base of the creek, due to the difficult terrain. The upsidence in the base of the creek therefore was not measured.

The predictions of subsidence, upsidence and closure for Wongawilli Creek, resulting from the extraction of Dendrobium Longwalls 6 to 19, were provided in Report No. MSEC459. The observed and predicted total closures along Wongawilli Creek after the completion of Longwall 11 are illustrated in Fig. 2.1.

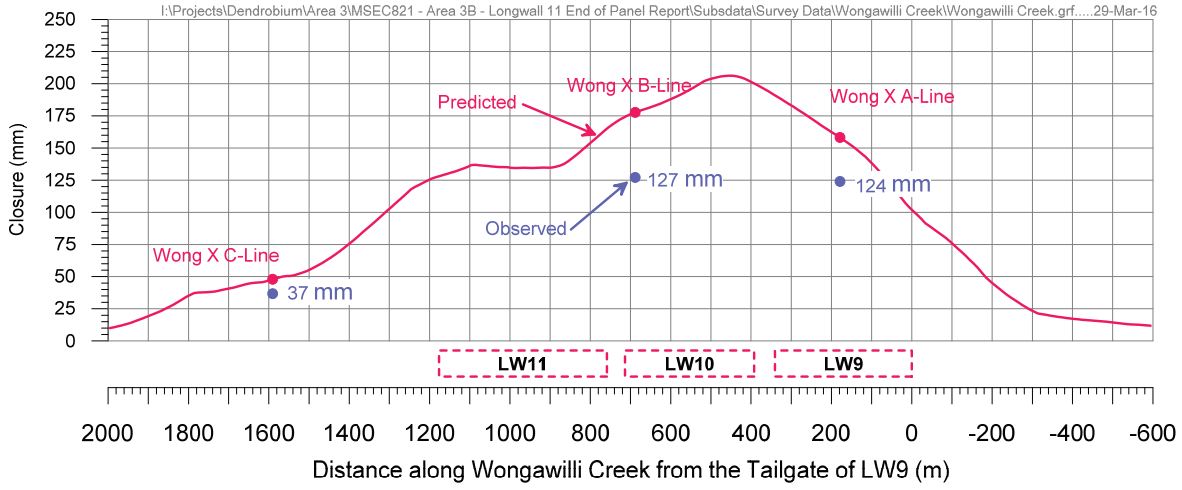


**Fig. 2.1 Observed and Predicted Total Closure along Wongawilli Creek**

A summary of the maximum observed and maximum predicted total closure movements for each of the Wongawilli Creek Closure Lines, due to the extraction of Longwalls 6 to 11, is provided in Table 2.2.

**Table 2.2 Summary of the Maximum Observed and Maximum Predicted Total Closure at the Wongawilli Creek Cross Lines due to the Extraction of Longwalls 6 to 11**

| Location | Observed Total Closure (mm) | Predicted Total Closure (mm) |
|---|---|---|
| Wong X A-Line | 124 | 160 |
| Wong X B-Line | 127 | 180 |
| Wong X C-Line | 37 | 50 |

The accuracies of the measured closure movements are in the order of ±5 mm.

It can be seen from Fig. 2.1 and Table 2.2, that the maximum observed total closures at each of the Wongawilli Creek cross-lines were less than the predictions after the completion of Longwall 11.

## 2.3. Dendrobium Area 3B 3D Monitoring Points

The far-field horizontal movements in the vicinity of Longwall 11 were measured by IC using the Dendrobium Area 3B 3D monitoring points (DA3B 3D). The locations of these monitoring points are shown in Drawing No. MSEC821-01.

The survey dates for the DA3B 3D points are provided in Table 2.3.

**Table 2.3 Summary of Survey Dates for the DA3B 3D Points during Longwall 11**

| Mining Phase Commitments | Mining Phase Survey Dates | Post Mining Phase Commitments |
|---|---|---|
| Start and end of Longwall 11. | 12th March 2015 (End of LW10)<br>4th March 2016 (End of LW11) | Start and end of each of the future longwalls in Area 3B |

The observed incremental horizontal movement vectors for DA3B 3D points, due to the extraction of Longwall 11, are shown in Drawing No. MSEC821-04. The accuracies of the measured absolute Eastings and Northings at the DA3B 3D points are in the order of ±20 mm. The accuracy of the measured absolute levels are in the order of ±30 mm.

The horizontal movements at the marks located outside the extents of Longwall 11 were generally orientated towards the extracted longwall, but slightly angled towards the longwall finishing end. The horizontal movements at the marks located directly above Longwall 11 were generally oriented towards the finishing end.

The greatest horizontal movements occurred directly above Longwall 11 and, to a lesser extent, above the previously extracted Longwall 10. The horizontal movements outside the extents of mining were generally around 50 mm or less.

The maximum observed incremental horizontal movement at the DA3B 3D monitoring points, resulting from the extraction of Longwall 11, was 395 mm at Mark DA3B-23, which is located above the centre of Longwall 11. The maximum predicted total conventional horizontal movement, resulting from the extraction of Longwalls 9 to 18, was 600 mm which was provided in Section 4.4 of Report No. MSEC459.

The comparison between the maximum observed incremental horizontal movements at the DA3B 3D monitoring points with those previously measured in Dendrobium Area 1 (DA1 3D) and Dendrobium Area 2 (DA2 3D), as well as other collieries in the Southern Coalfield, is provided in Fig. 2.2.

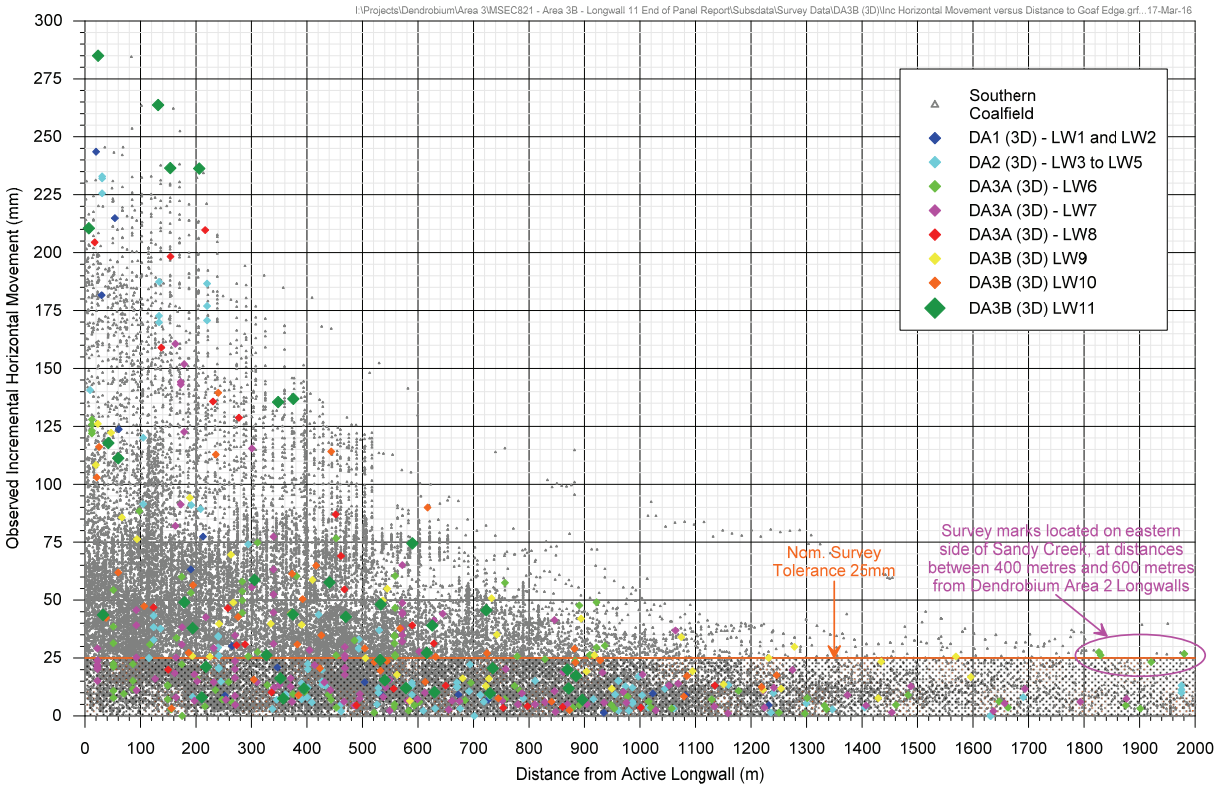


**Fig. 2.2 Observed Incremental Horizontal Movement for DA3B 3D Monitoring Points**

The observed incremental horizontal movements at the DA3B 3D monitoring points, resulting from the extraction of Longwall 11 (i.e. dark green diamonds), were within the range of those measured at similar distances from previously extracted longwalls at Dendrobium Mine (i.e. red, blue, cyan, green, magenta, yellow and orange diamonds) and elsewhere in the Southern Coalfield (i.e. grey diamonds).

## 2.4. Wongawilli Creek Tributary Cross Lines

The mine subsidence movements across drainage lines were measured by IC using 2D survey techniques using the WC21XB Line, WC21XC Line, WC21XD Line, WC21XE Line, WC21XF Line, WC21XG Line and WC21XH Line. The WC21XA Line was not measured during Longwall 11. The locations of the Tributary Cross Lines are shown in Drawing No. MSEC821-01. The survey dates for these monitoring lines are provided in Table 2.4.

**Table 2.4 Summary of Survey Dates for the Wongawilli Creek Tributary Cross Lines during Longwall 11**

| Mining Phase Commitments | Mining Phase Survey Dates | Post Mining Phase Commitments |
|---|---|---|
| First survey 100 m before lines, then monthly surveys. Final survey when mining 400 m past lines | 13th February 2013 (Base Survey)<br>21st October 2015<br>19th November 2015<br>29th December 2015<br>21st January 2016<br>4th March (End LW11) | Future requirements for LW12 |

Summaries of the maximum observed and predicted total subsidence and closure along the Tributary Cross Lines, after the extraction of Longwall 11, are provided in Table 2.5 to Table 2.11. The predicted subsidence values are based on the predicted subsidence contours illustrated in Report No. MSEC459. The predicted closures are based on a combination of the conventional and valley related movements, taking the equivalent valley heights of the valleys within half-depths of cover from the valley bases.

Survey line WC21XG was established on the 28th October 2014 and therefore does not include the effects of Longwall 9. WC21XH was established on the 21st October 2015 and therefore does not include the effects of Longwalls 9 and 10.

**Table 2.5 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XB-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 1,743 | 308 |
| Predicted | 2,125 | 400 |

**Table 2.6 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XC-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 526 | 172 |
| Predicted | 600 | 425 |

**Table 2.7 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XD-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 1,989 | 869 |
| Predicted | 2,500 | 900 |

**Table 2.8 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XE-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 574 | 376 |
| Predicted | 800 | 575 |

**Table 2.9 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XF-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 1,489 | 669 |
| Predicted | 2,300 | 325 |

**Table 2.10 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XG-Line Resulting from the Extraction of Longwalls 10 and 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 922 | 177 |
| Predicted | 1,575 | 325 |

**Table 2.11 Maximum Observed and Predicted Total Subsidence and Closure at the WC21XH-Line Resulting from the Extraction of Longwall 11 Only**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 84 | 81 |
| Predicted | 80 | 100 |

The accuracies of the measured relative levels of the survey marks along the Tributary Cross Lines are in the order of ±5 mm. The accuracies of the measured absolute levels of the survey marks are in the order of ±30 mm. The accuracies of the measured closures are in the order of ±5 mm.

The observed total closure at the WC21XF-Line of 669 mm was greater than the maximum predicted total closure of 325 mm. This monitoring line is orientated along the main axis of Longwall 11 and, therefore, the predicted conventional closure is less than the other monitoring lines which are oblique to the longwalls. The observed total closure for WC21XF-Line is less than that observed and predicted along the WC21XD-Line, which is located in a similar position above Longwall 10, but orientated obliquely to the longwall.

The observed total subsidence and total closure at the remaining Tributary Cross Lines were less than those predicted after the completion of Longwall 11. The observed total closures for these monitoring lines were between 40 % and 97 % of the predicted total closures.

## 2.5. Donalds Castle Creek Cross Lines

The mine subsidence movements across Donalds Castle Creek lines were measured by IC using 2D survey techniques using the DCCXB-Line, DCCXC-Line, DCCXD-Line, DCCXE-Line and DCCXF-Line. DCCXA-Line was not measured during Longwall 11. The locations of the Donalds Castle Creek Cross Lines are shown in Drawing No. MSEC821-01. The survey dates for these monitoring lines are provided in Table 2.12.

**Table 2.12 Summary of Survey Dates for the Donalds Castle Creek Tributary Cross Lines during Longwall 11**

| Mining Phase Commitments | Mining Phase Survey Dates | Post Mining Phase Commitments |
|---|---|---|
| First survey 100 m before lines, then monthly surveys. Final survey when mining 400 m past lines | 13th February 2013 (Initial survey)<br>15th June 2015<br>29th July 2015<br>24th August 2015<br>23rd September 2015<br>21st October 2015<br>19th November 2015<br>4th March 2016 (End LW11) | Future requirements for LW12 |

Summaries of the maximum observed and predicted total subsidence and closure along the Donalds Castle Creek Cross Lines, after the extraction of Longwall 11, are provided in Table 2.13 to Table 2.17. The predicted subsidence values are based on the predicted subsidence contours illustrated in Report No. MSEC459. The predicted closures are based on a combination of the conventional and valley related movements, taking on the equivalent valley heights of the valleys within half-depths of cover from the valley bases. Survey line DCCXF-Line was established on the 8th May 2015 and therefore does not include the effects of Longwalls 9 and 10.

**Table 2.13 Maximum Observed and Predicted Total Subsidence and Closure at the DCCXB-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 791 | -4 (opening) |
| Predicted | 575 | 250 |

**Table 2.14 Maximum Observed and Predicted Total Subsidence and Closure at the DCCXC-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 2,567 | 499 |
| Predicted | 1,950 | 375 |

**Table 2.15 Maximum Observed and Predicted Total Subsidence and Closure at the DCCXD-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 1,299 | 25 |
| Predicted | 600 | 225 |

**Table 2.16 Maximum Observed and Predicted Total Subsidence and Closure at the DCCXE-Line Resulting from the Extraction of Longwalls 9 to 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 2,253 | 468 |
| Predicted | 1,925 | 300 |

**Table 2.17 Maximum Observed and Predicted Total Subsidence and Closure at the DCCXF-Line Resulting from the Extraction of Longwall 11 Only**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 44 | 75 |
| Predicted | 125 | 80 |

The accuracies of the measured relative levels of the survey marks along the Donalds Castle Creek Tributary Cross Lines are in the order of ±5 mm. The accuracies of the measured absolute Levels of the survey marks are in the order of ±30 mm. The accuracies of the measured closures are in the order of ±5 mm.

The total observed subsidence were greater than predicted along the DCCXB-Line, DCCXC-Line, DCCXD-Line and DCCXE-Line. The DCCXB-Line and DCCXD-Line are located above the chain pillars, away from the locations of the maximum vertical subsidence. The DCCXC-Line and DCCXE-Line are located closer to the longwall centrelines and the observed vertical subsidence exceeded those predicted by 32 % and 17 %, respectively. The accuracy of empirical prediction methods are generally in the order of ±15 % to ±25 % for maximum vertical subsidence.

The subsidence prediction model was calibrated based on monitoring data available at the time of the SMP Application, from Longwalls 1 and 2 in Area 1, Longwalls 3 to 5 in Area 2 and Longwall 6 in Area 3A at the mine. The predicted subsidence parameters provided in this report are based on those presented in Report No. MSEC459 and the SMP Application.

The subsidence model was subsequently reviewed, based on the updated monitoring data from Longwalls 7 and 8 in Area 3A and Longwalls 9 and 10 in Area 3B, which was summarised in Report No. MSEC792 (Rev. C). The review found that the subsidence prediction model provides reasonable predictions of vertical subsidence for the longwalls in Areas 1, 2 and 3A at the mine. However, the maximum observed vertical subsidence in Area 3B is around 30 % greater than the maxima predicted for Longwalls 9 and 10 in Area 3B. The higher magnitudes of vertical subsidence is the result of the higher depth of cover and wider longwall widths in Area 3B, resulting pillar compression greater than that predicted by the subsidence model.

The subsidence model was then recalibrated by increasing the predicted vertical subsidence by 30 %. The impact assessments were reviewed, based on the revised predictions of vertical subsidence, and were provided in Report No. MSEC792. It was found that "*Whilst it would be expected that the rates of potential impacts would increase, given the greater predicted subsidence, the nature of these impacts are unlikely to change, i.e. a greater number of fractures with increased widths in the exposed bedrock resulting in a slightly increased potential for surface water flow diversions*" and therefore "*The management strategies for the natural and built features for the future Longwalls 12 to 18, therefore, are the same those provided in Report No. MSEC459 and the SMP Application*".

The total observed closure were greater than predicted along the DCCXC-Line and DCCXE-Line. These exceedances are partly due to under-predicting the vertical subsidence and, therefore, under-predicting the conventional component of closure. The DCCXE-Line is orientated along the main axis of Longwall 11 and the DCCXC-Line is oblique to Longwall 10 and, therefore, the predicted conventional closures are less than for other lines orientated more transverse to the longwalls.

The observed total closures along the DCCXB-Line and DCCXD-Line were less than those predicted. A net opening of 4 mm was measured along the DCCXB-Line. The observed total subsidence along the DCCXF-Line was less than that predicted.

## 2.6. Swamp Cross Lines

The mine subsidence movements across the Swamp Cross Lines were measured by IC using 2D survey techniques using the SW3 Line, SW 4 Line and SW 10 Line. The locations of the Swamp Cross Lines are shown in Drawing No. MSEC821-01. The survey dates for these monitoring lines are provided in Table 2.18.

**Table 2.18 Summary of Survey Dates for the Swamp Cross Lines during Longwall 11**

| Mining Phase Commitments | Mining Phase Survey Dates | Post Mining Phase Commitments |
|---|---|---|
| First survey 100 m before lines<br>Then monthly surveys<br>Final survey when mining 400 m past lines | 9th February 2015 (Initial survey) (All lines)<br>18th February 2015 (Line 3)<br>26th March 2015 (Lines 3 and 4)<br>7th May 2015 (Lines 3 and 4)<br>3rd June 2015 (Line 4)<br>29th June 2015 (Line 4)<br>24th September 20155 (Line 10)<br>21st October 2015 (Line 10)<br>19th November 2015 (Line 10)<br>29th December 2015 (Line 10)<br>21st January 2016 (Line 10)<br>17th February 2016 (End LW11) (All Lines) | Future requirements for LW12 |

Summaries of the maximum observed and predicted total subsidence and closure along the Swamp Cross Lines, resulting from the extraction of Longwall 11, are provided in Table 2.19 to Table 2.21. The predicted subsidence values are based on the predicted subsidence contours illustrated in Report No. MSEC459. The predicted closures are based on a combination of the conventional and valley related movements, taking the equivalent valley heights within half-depths of cover from the valley bases.

**Table 2.19 Maximum Observed and Predicted Total Subsidence and Closure at the SW3-Line Resulting from the Extraction of Longwall 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 26 | 4 |
| Predicted | < 20 | < 50 |

**Table 2.20 Maximum Observed and Predicted Total Subsidence and Closure at the SW 4-Line Resulting from the Extraction of Longwall 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 30 | 4 |
| Predicted | < 20 | < 50 |

**Table 2.21 Maximum Observed and Predicted Total Subsidence and Closure at the SW 10-Line Resulting from the Extraction of Longwall 11**

| Location | Maximum Total Subsidence (mm) | Maximum Total Closure (mm) |
|---|---|---|
| Observed | 18 | 12 |
| Predicted | < 20 | < 50 |

The accuracies of the measured relative levels of the survey marks along the Swamp Cross Lines are in the order of ±5 mm. The accuracies of the measured absolute Levels of the survey marks are in the order of ±30 mm. The accuracies of the measured closures are in the order of ±5 mm.

The observed total subsidence for the Swamp Cross-Lines were between 18 mm and 30 mm. These low level vertical movements are similar to the accuracy of the prediction method outside of the active longwall, i.e. in the order of 20 mm vertical subsidence. The observed total closures for these monitoring lines were less than those predicted.

## 2.7. Airborne Laser Scan/LiDAR

The results from the Airbourne Last Scan / Light Distance and Ranging surveys were not available at the time of this report.

## 3.1. Natural Features

The natural features in the vicinity of Dendrobium Longwall 11 are shown in Drawing No. MSEC821-02, in Appendix A, and include:-

- Wongawilli Creek;
- Donalds Castle Creek;
- Drainage lines;
- Rockbars;
- Rock outcrops;
- Steep slopes;
- Swamps; and
- Archaeological sites.

The MSEC predicted impacts for the natural features, resulting from the extraction of Dendrobium Longwalls 9 to 18, were provided in Report No. MSEC459. More detailed assessments for some natural features were also provided in other consultants reports. Comparisons between the MSEC assessments and the observed impacts for the natural features listed above, resulting from the extraction of Longwall 11, are provided in Table 3.1. The observed impacts are based on those recorded by IC field investigations, which are described in their report which is attached to the *End of Panel* report.

**Table 3.1 Summary of the Assessed and Observed Impacts for the Natural Features Resulting from the Extraction of Longwall 11**

| Natural Feature | MSEC Assessed Impacts | Observed Impacts |
|---|---|---|
| Wongawilli Creek | Very localised additional **ponding** or **flooding** developing in the locations of existing pools, steps or cascades | No reported impacts |
| | Minor **fracturing** of the bedrock within 400 metres of the longwalls | No reported impacts |
| | Unlikely that **surface water flow diversions** would occur | No reported impacts |
| Donalds Castle Creek | Localised additional **ponding** or **flooding** developing in the locations of existing pools, steps or cascades | No reported impacts |
| | Fracturing of the bedrock directly above the longwall, however, the majority of this section of the creek has soil accumulations (i.e. only isolated outcropping of bedrock above the longwall). Also possible for some minor **fracturing** of the bedrock outside and within 400 metres of the longwalls | No reported impacts |
| | **Surface water flow diversions** could occur directly above the longwall | No reported impacts |

| Natural Feature | MSEC Assessed Impacts | Observed Impacts |
|---|---|---|
| Drainage Lines | Localised additional **ponding**, **flooding** or **scouring** along sections of the drainage lines located directly above the longwall | No reported impacts |
| | **Buckling** and **fracturing** of the bedrock along the drainage lines above or within 250 metres of the longwalls | Multiple fractures, uplift and displacement in two locations along Watercourse WC21, in Rockbar 27 and upstream of Pool 30. Refer to the IC landscape report for further details |
| | **Surface water flow diversions** into the dilated strata beneath the drainage lines which are directly mined beneath | Loss of surface water flow along Watercourse WC21 in Pool 30. Refer to the IC landscape report for further details |
| | **Water quality** – Refer to the attached water quality report<br>**Terrestrial ecology** – Refer to the attached terrestrial ecology report<br>**Aquatic ecology** – Refer to the attached aquatic ecology report | |
| Rock Outcrops | Fracturing of bedrock which could result in **rockfalls** along the exposed rockfaces | Localised fracturing |
| Steep Slopes | **Soil slippage** resulting in tension cracks and compression ridges | Some soil / surface cracking observed on or near fire trails or tracks. Refer to the IC landscape report for further details |
| Swamps | **Fracturing** of the underlying strata which could result in the **diversion of surface water** | Groundwater levels lower than baseline and recession rates greater than baseline for Swamps 3 and 5. Soil moisture levels below baseline also reported in Swamp 5. Refer to the IC landscape report for further details |
| Archaeological Sites | Impacts on overhang sites include fracturing of sandstone, rock falls, or water seepage through joints which may affect artwork | No impacts reported. Refer to the attached archaeological report for further details |

It can be seen from Table 3.1, that the observed impacts on the natural features, resulting from the extraction of Longwall 11, are similar to or less than the MSEC assessments. Further assessments of natural features have been provided by other consultants, which are described in the relevant reports attached to the *End of Panel* report.

## 3.2. Built Features

The built features in the vicinity of Longwall 11 are shown in Drawing No. MSEC821-03, in Appendix A, and include:-

- Fire trails and four wheel drive tracks;
- Disused Maldon Dombarton Railway Corridor; and
- Survey control marks.

Cordeaux Dam Wall is located in excess of 5 kilometres north of Longwall 11, at its closest point. The Upper Cordeaux No. 2 Dam Wall is located in excess of 6 kilometres south-east of Longwall 11, at its closest point. It is unlikely that these dam walls would experience any measurable far-field horizontal movements resulting from the extraction of Longwall 11 and, therefore, they have not been included in the following comparisons.

MSEC predicted impacts for the surface infrastructure, resulting from the extraction of Dendrobium Longwalls 9 to 18, and these were provided in Report No. MSEC459. Comparisons between the MSEC assessments and the observed impacts for the surface infrastructure listed above, resulting from the extraction of Longwall 11, are provided in Table 3.2.

**Table 3.2 Summary of the Assessed and Observed Impacts for Surface Infrastructure Resulting from the Extraction of Longwall 11**

| Surface Infrastructure | MSEC Assessed Impacts | Observed Impacts |
|---|---|---|
| Fire Trails and Four Wheel Drive Tracks | Cracking of unsealed road surfaces | Localised surface cracking observed in Access Track 6000, Fire Road 6A and one seismic line. Refer to the IC landscape report for further details |
| Survey Control Marks | Vertical and horizontal movements which could require re-establishment | No reported impacts. Survey Control Marks to be re-established after completion of mining |
| Disused Maldon-Dombarton Railway | Possible fracturing of rock cuttings, spalling, and/or mobilisation of rock joints | No reported impacts |

It can be seen from Table 3.2, that the observed impacts on the surface infrastructure, resulting from the extraction of Longwall 11, are generally similar to or less than the assessed (i.e. predicted) impacts.

# APPENDIX A. DRAWINGS

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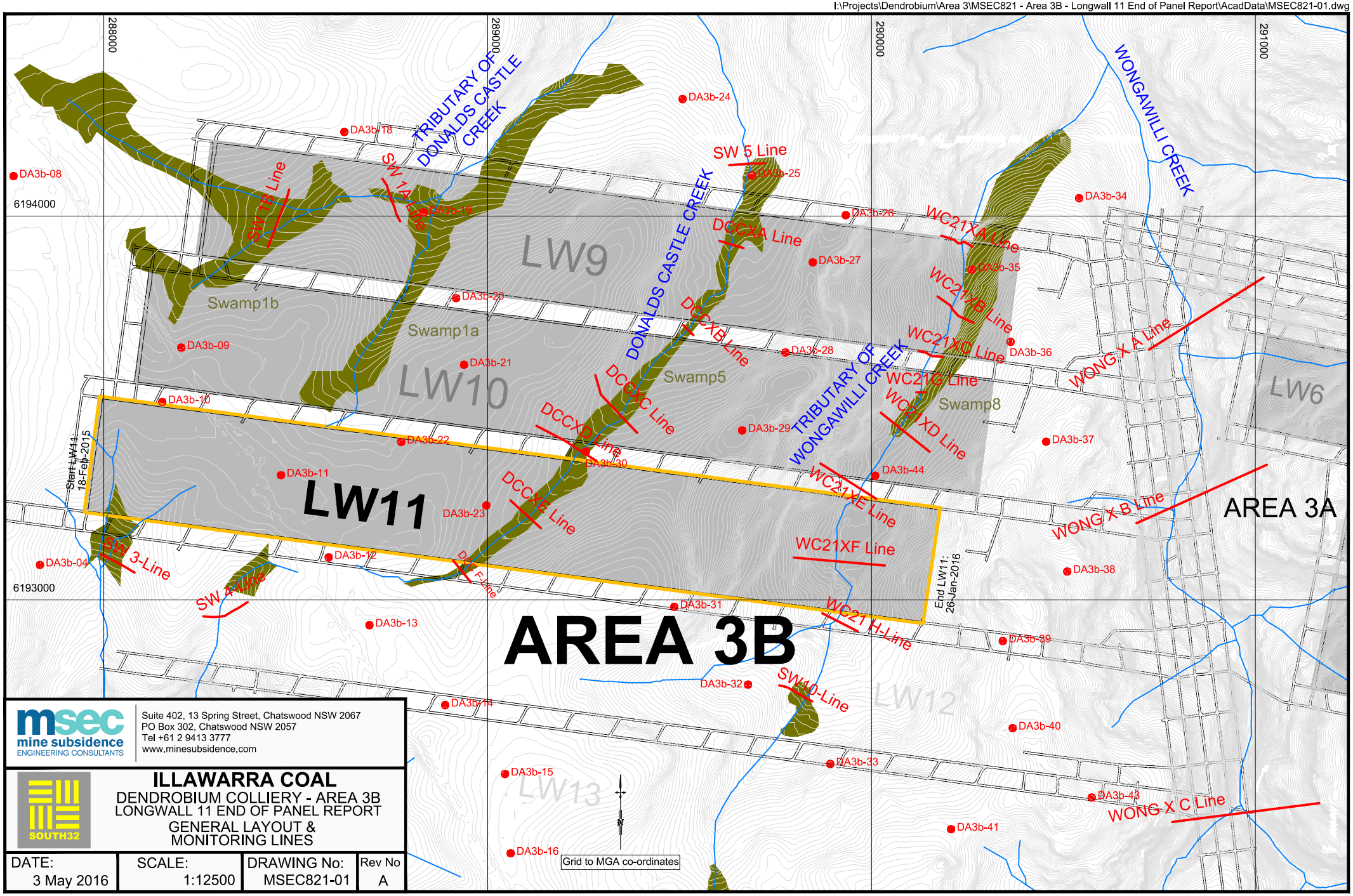



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# ILLAWARRA COAL

## DENDROBIUM COLLIERY - AREA 3B
## LONGWALL 11 END OF PANEL REPORT
## GENERAL LAYOUT & MONITORING LINES

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 3 May 2016 | 1:12500 | MSEC821-01 | A |

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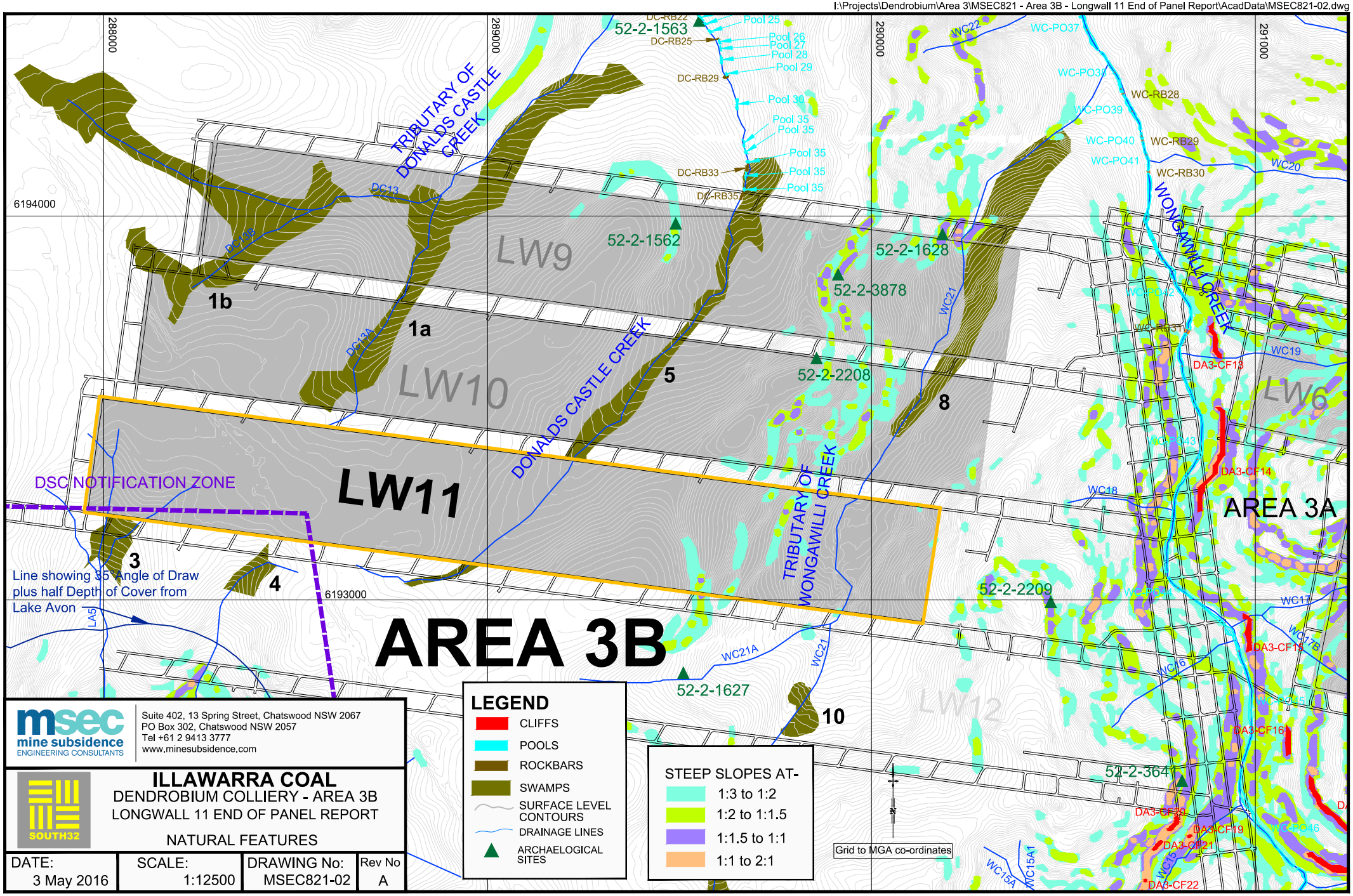



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# ILLAWARRA COAL

## DENDROBIUM COLLIERY - AREA 3B
## LONGWALL 11 END OF PANEL REPORT

NATURAL FEATURES

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
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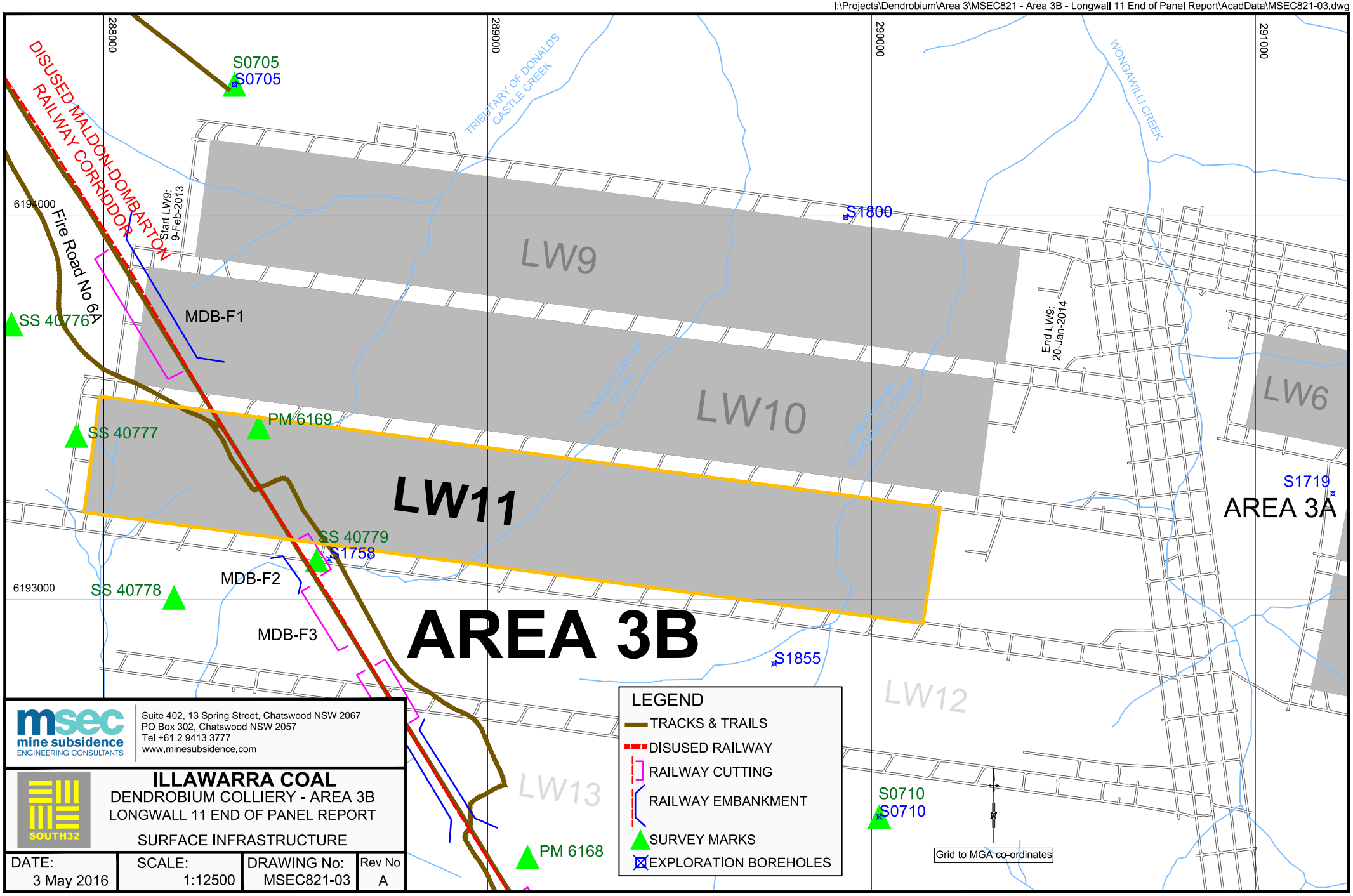



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DENDROBIUM COLLIERY - AREA 3B
LONGWALL 11 END OF PANEL REPORT
SURFACE INFRASTRUCTURE

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
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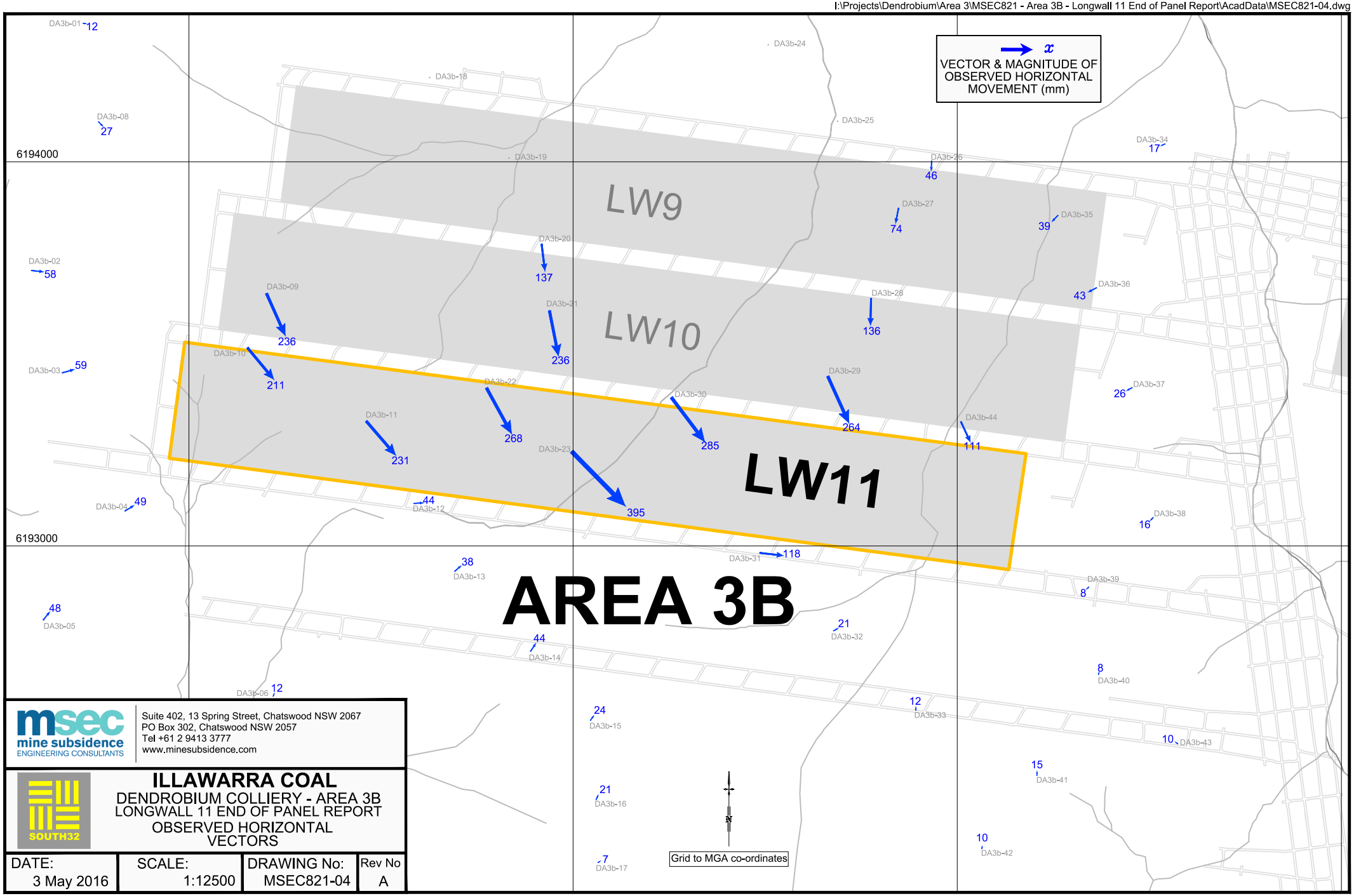



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# ILLAWARRA COAL

## DENDROBIUM COLLIERY - AREA 3B
## LONGWALL 11 END OF PANEL REPORT
## OBSERVED HORIZONTAL VECTORS

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 3 May 2016 | 1:12500 | MSEC821-04 | A |