Strata Control Technology

WOLLONGONG COAL LIMITED

Wongawilli Colliery: Nebo N4 End of Panel Subsidence Report

WCW04693

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TITLE Wongawilli Colliery: Nebo N4 End of Panel Subsidence Report

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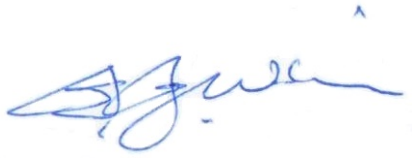

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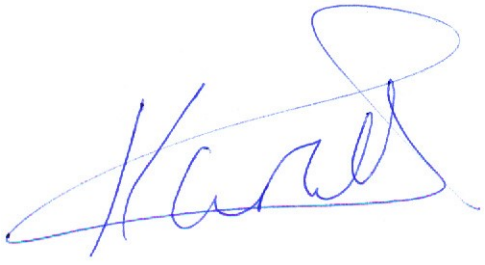

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SUMMARY

Wollongong Coal Limited (WCL) recently completed mining the Nebo N4 Panel at Wongawilli Colliery near Wollongong in NSW. WCL is required to prepare subsidence report to satisfy mining approval Condition 18 of SMP Approval 09/5341 and Condition 7 of Extraction Plan requirements of Schedule 3 of Project Approval 09_0161. WCL commissioned SCT Operations Pty Ltd (SCT) to analyse the subsidence monitoring conducted and to prepare a report suitable to meet these end of panel and annual reporting requirements for subsidence. This report presents the results of our review and analysis including comparison of results with subsidence predictions (MSEC 2010) made in the Extraction Plan (EP)/ Subsidence Management Plan (SMP) (Niche 2012).

Our review and analysis indicates that subsidence movements were not measured in the area where maximum subsidence was expected because the subsidence line follows the alignment of the road and does not cross the area between extracted panels where greatest subsidence is expected. The subsidence that was observed on subsidence monitoring line NM1 is consistent with the predictions made in the EP/SMP and Part 3A Application for the location where the measurements were made (within survey tolerance) but greater subsidence is expected to have occurred over the pillar between N4 and a previously extracted panel.

Despite not measuring the maximum subsidence, overburden behaviour similar to that which occurred above Longwall N2 is expected to have occurred above N4 Panel. The Cordeaux Crinanite is a significant dolerite sill intruded within the overburden sequence over the approved panel geometries in the Nebo area. Subsidence monitoring above the nearby Longwall N2 (SCT2014) confirmed that the bridging capacity of the Cordeaux Crinanite limited the magnitude of maximum subsidence and associated parameters to levels that are imperceptible for all practical purposes.

The maximum subsidence parameters observed in the vicinity of the N4 Panel along NM1 monitoring line, a monitoring line located alongside the panel, are:

- vertical subsidence approximately 40mm
- horizontal movement less than 40mm
- tilt less than 0.9mm/m
- strains of 0.6mm/m in compression and 0.4mm/m in tension.

Subsidence line NM2 is remote from the extracted panel and no subsidence would be expected at the location of this line. None was measured.

There is considered to be no significant potential for impacts to man-made features such as power lines, access roads and heritage sites, or any natural features including watercourses, cliffs and steep slopes in the vicinity of N4 Panel. The subsidence impacts and consequences from the mining of N4 Panel are expected to be compliant with the subsidence impact performance measures in Project Approval 09_0161 for subsidence related categories.

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1. INTRODUCTION

Wollongong Coal Limited (WCL) recently completed mining Nebo N4 Panel at Wongawilli Colliery southwest of Wollongong in NSW. This panel was initially approved to be mined using the longwall method but the panel was subsequently mined by secondary pillar extraction using a continuous miner and breaker line supports. WCL commissioned SCT Operations Pty Ltd (SCT) to analyse the subsidence monitoring conducted on the single subsidence line located adjacent to this panel and to prepare a report suitable to meet the end of panel or annual reporting requirements for subsidence. This report presents the results of our analysis and review of the subsidence monitoring data for N4 Panel in accordance with Condition 18 of SMP Approval 09/5341 and Extraction Plan requirements of Condition 7 in Schedule 3 of Project Approval 09_0161.

The report includes a comparison of results with subsidence predictions (MSEC 2010) made in the Extraction Plan (EP)/ Subsidence Management Plan (SMP) (Niche 2012) based on the Part 3A Application for the Nebo Area Project (09_0161).

Our assessment is based on the survey data supplied by WCL for two monitoring lines (NM1 and NM2) and a site visit to inspect the surface above N4 Panel conducted on 11 October 2017.

The report is structured to provide the conclusions of the review and analysis, a site description, a summary of the results and comparison with predicted subsidence behaviour.

2. CONCLUSIONS

Our review and analysis indicates that subsidence movements measured on monitoring line NM1 were not measured in the area where maximum subsidence was expected. The subsidence line follows the alignment of the road to minimise clearing of natural vegetation and does not cross the area between extracted panels where subsidence is expected to be greatest. The subsidence that was observed on subsidence monitoring line NM1 is consistent with the predictions made in the EP/SMP and Part 3A Application for the location where the measurements were made (within survey tolerance). Greater subsidence is expected to have occurred over the pillar between N4 and a previously extracted panel in an area where subsidence movements were not able to be measured.

Recent subsidence monitoring above the nearby Longwall N2 (SCT2014) confirmed the bridging capacity of the Cordeaux Crinanite, a dolerite sill intruded within the overburden sequence, across a panel of similar width to N4. This bridging limited the magnitude of the maximum subsidence and associated subsidence parameters to levels that are imperceptible for all practical purposes. Similar overburden behaviour is likely to have occurred above N4 Panel, although this has not been confirmed with direct measurement.

The maximum subsidence parameters observed in the vicinity of the N4 Panel along NM1 monitoring line, a monitoring line located alongside the panel, are:

- vertical subsidence approximately 40mm
- horizontal movement less than 40mm
- tilt less than 0.9mm/m
- strains of 0.6mm/m in compression and 0.4mm/m in tension.

Subsidence line NM2 is remote from the extracted panel and no subsidence would be expected at the location of this line. None was measured.

Based on a site inspection and the low levels of ground movement expected over N4 Panel, there is considered to be no significant potential for perceptible impacts to man-made features such as power lines, access roads and heritage sites or any natural features including watercourses, cliffs and steep slopes in the vicinity of the panel.

On this basis, the subsidence impacts and consequences from the mining of N4 Panel are expected to compliant with the subsidence impact performance measures in Project Approval 09_0161 for water resources, watercourses, land, biodiversity, heritage features, built features and public safety.

N4 Panel was approved for longwall mining with an extraction height of 3.6m. The panel was actually mined using a pillar extraction method with reduced dimensions. Typically, this change of mining method with reductions in the mining area, mining height and percentage of coal extracted would be expected to reduce subsidence effects. However, the changes in mining technique and geometry for N4 Panel are unlikely to have had any significant effect on the subsidence outcomes, as no significant sag subsidence was originally anticipated.

The reduction in predicted sag subsidence is based on the width of the panel and bridging characteristics of the crinanite sill in the overburden strata. In areas where the thickness of the crinanite is greater than 30-40m, the main subsidence component is expected to be elastic compression of the abutment coal and surrounding strata. The level of compression is expected to be similar, regardless of minor variations in mining height or the percentage of extraction at seam level.

3. SITE DESCRIPTION

Figure 1 shows a plan of the mining layout in the Nebo area superimposed onto a 1:25,000 series topographic map. The locations of three subsidence monitoring lines (NM1, NM2 and NM3) are also shown. NM1 I located over the corner of and adjacent to N4 Panel. NM2 is remote from N4 Panel.

The site is located 13km due west of Wollongong in NSW in the upper reaches of the Cordeaux River valley within the Sydney Water Catchment Metropolitan Special Area. The surface above N4 Panel is undeveloped bushland comprising sections of native vegetation and other areas regenerating from previous European habitation.

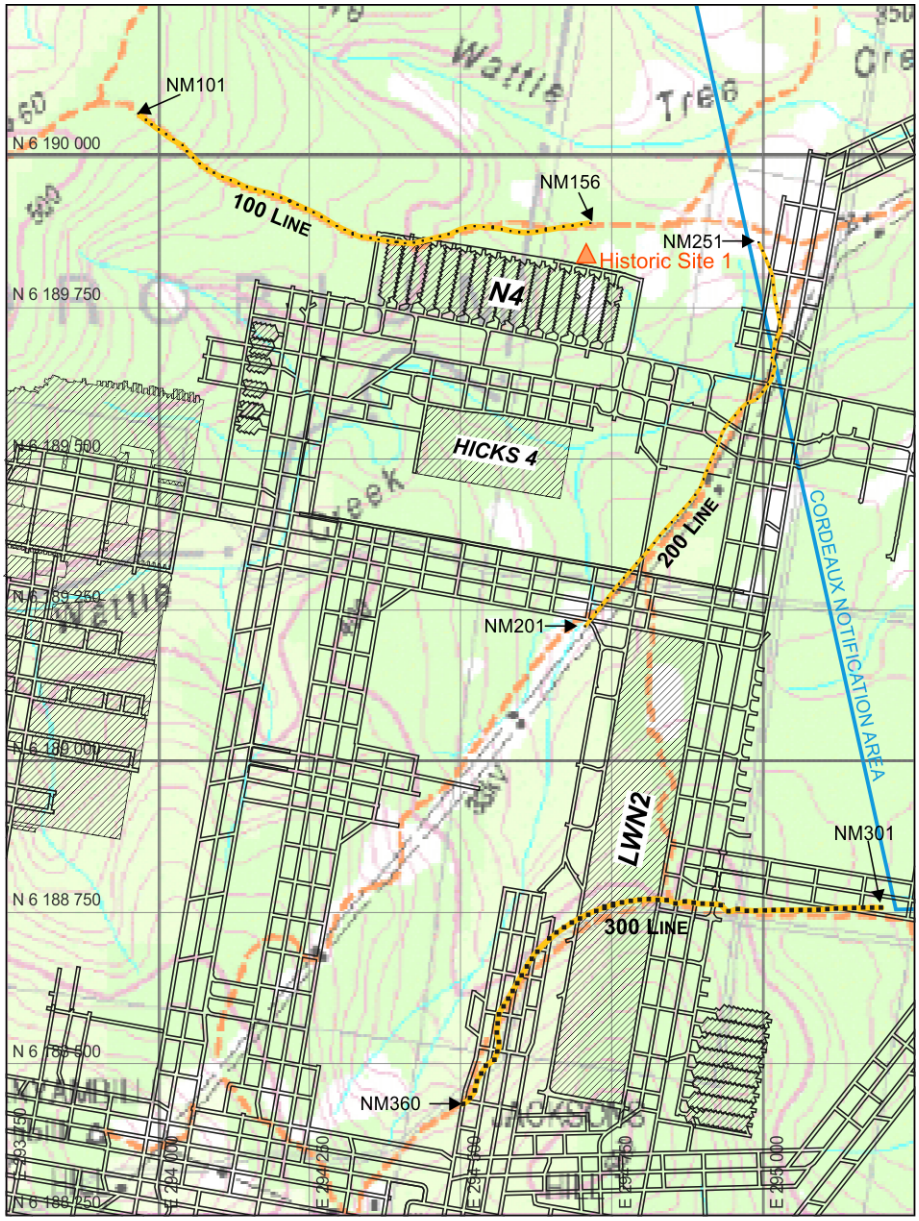

Figure: 1: Site plan showing location of N4 Panel plotted on 1:25,000 series topographic map and subsidence monitoring lines.

N4 Panel is positioned below a topographic ridge between the drainages lines of Little Wattle Tree Creek and Wattle Creek. The slope of the surface above the panel is to the south towards main channel of Wattle Creek. An unnamed first order tributary to Wattle Creek is located above the start line of the panel.

The panel is located outside the Dams Safety Committee Notification Area for the Cordeaux Storage Reservoirs.

The mining layout was originally developed as part of Nebo Colliery but has subsequently been mined by WCL from Wongawilli Colliery.

The extraction of N4 Panel created a goaf area that is around 125m wide and 395m long. This represents a slightly smaller area than approved for Longwall N4. The panel was mined from east to west. The mining height is reported as being 2.8m. The percentage extraction within the panel boundary is reported as 79%.

The depth to the Wongawilli Seam mining horizon ranges from about 120m at the start of the panel in the east to approximately 180m at the western end.

Secondary extraction commenced on 7 August 2016 and was completed on 6 March 2017.

The overburden sequence in the general vicinity has been intruded by a crinanite (dolerite) sill known as the Cordeaux Crinanite as shown in Figure 2.

Based on a number of nearby borehole intersections, this crinanite intrusion outcrops at the surface and ranges in thickness from 60m to 70m in proximity to the N4 Panel extraction area. The base of the crinanite sill is located approximately 50m to 60m above the mining horizon over the panel.

Previous exploratory work (SCT 2010) showed that a 65m thick section of the crinanite is sufficiently massive to be able to bridge across a 120m wide void at an overburden depth to the mining horizon of 116m.

Subsidence behaviour above previous and current panels is expected to have been significantly influenced by the presence of this crinanite sill.

Heritage site (Historic 1) is located to the north of the panel above solid coal.

4. SUBSIDENCE MONITORING RESULTS

In this section, the subsidence monitoring results from the two survey lines are presented and discussed.

4.1 NM1 (100) Line

The locations of the individual pegs on NM1 Line are shown in Figure 1. This line is subparallel to the N4 Panel extraction direction along the edge of a four wheel drive access track known as Fire Road No 6D.

Figure 3 shows photographs of the surface along the NM1 subsidence line.

This line was originally positioned to minimise impacts to the existing environment and to cross the extended part of N5 Panel. The line is only above the corner of N4 Panel for a short section of its length.

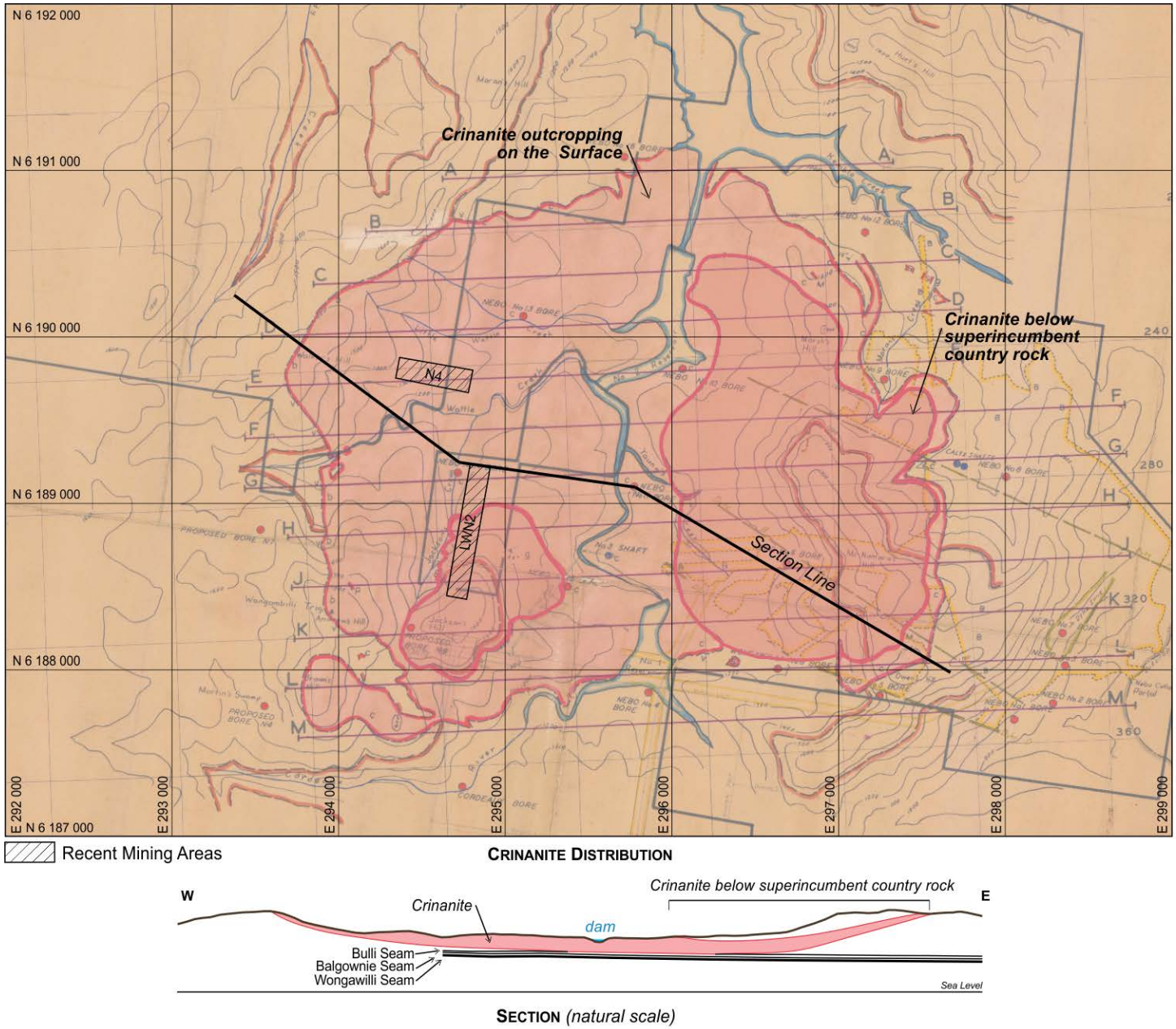

Figure 2: Crinanite distribution based on AIS Coal Geology Plan S3-64 *(accuracy is estimated to be generally better than 50m).*

Looking East - Subsidence Pegs at Ground Level on Left Hand Edge of Road

Looking West - Subsidence Pegs at Ground Level on Right Hand Edge of Road

Figure 3: Photographs of surface along the NM1 subsidence monitoring line

The overburden depth along the line ranges from 140m in the east to 300m in the west. The overburden is approximately 180m where the line crosses the northwest corner of N4 Panel. Monitoring marks (pegs) are installed along the edge of Fire Road No 6D flush with the ground surface at approximately 15m centres.

Surveys were conducted in January 2016, as the baseline, prior to secondary extraction in N4 Panel and recently in early September 2017 after mining was completed.

Figure 4 shows a plot of the subsidence movements measured on the NM1 Line. The components of movement are resolved and plotted as if the line was parallel to the panel. The distances are relative to the goaf edge at the start of the panel in the east. The long panel and cross panel horizontal movements are derived from the three-dimensional survey data and plotted relative to the panel direction.

The subsidence movements measured are of low magnitude. However, these need to be considered in the context of the expected survey tolerances and Trigger Action Response Plans (TARPS) outlined in the Nebo Longwalls 1-6 Subsidence Monitoring Plan.

Vertical subsidence was assumed to be zero at the western end of the line remote from mining. Vertical subsidence reaches a peak of approximately 40mm above the solid coal adjacent to the panel. This level of subsidence is imperceptible for all practical purposes.

Maximum tilt calculated between individual pegs is less than 0.9mm/m and more typically around 0.5mm/m. These levels of tilt are imperceptible for all practical purposes.

The horizontal movements measured on NM1 Line are smaller than the vertical subsidence. Horizontal movement across the panel is less than 40mm. Southward movement is towards the panel.

The maximum horizontal strain calculated between individual pegs is 0.6mm/m and generally around 0.3mm/m. The maximum compressive strain was 0.6mm/m with a maximum of 0.4mm/m in tension. These levels of strain are imperceptible for all practical purposes.

Most of subsidence movements measured are attributable to compression of the strata adjacent to N4 Panel goaf and survey tolerance.

Figure 5 shows photographs typical of the surface above N4 panel.

Surface inspections along the subsidence line and across the panel outline indicate that these low level subsidence effects are imperceptible for all practical purposes. No impacts or consequences were observed.

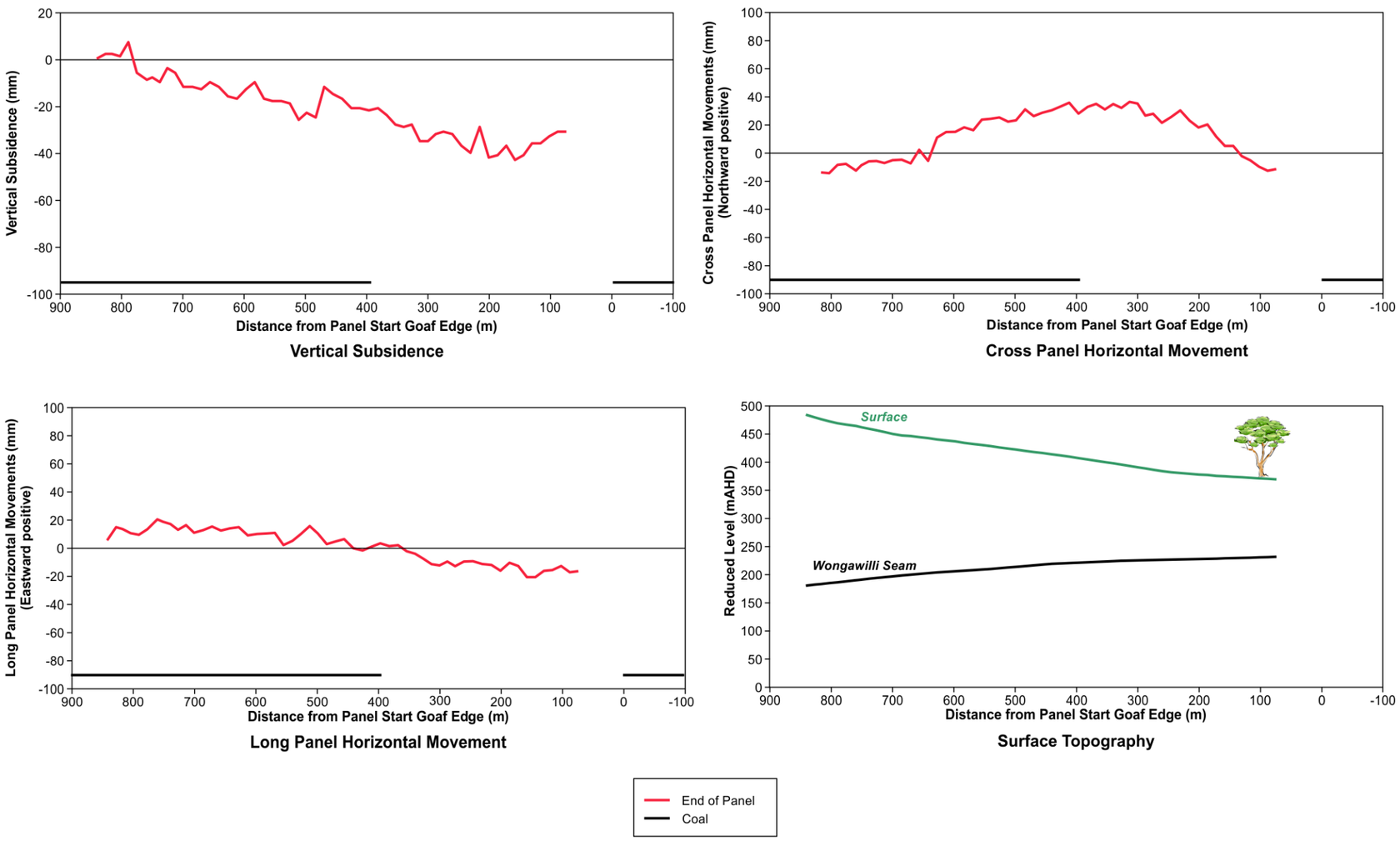

Figure 4: Summary of subsidence monitoring results along NM1 (100) line after mining of N4 Panel.

Surface Above N4 Panel - Looking South

Surface Above N4 Panel - Looking West

Figure 5: Photographs typical of surface above N4 Panel

4.2 NM2 (200) Line

The positions of the pegs on NM2 Line are shown in Figure 1. These pegs are nominally spaced at 15m centres. The line now starts near the finish line of the shortened Longwall N2 and extends approximately 800m to the northeast. The line is installed along the powerline easement and four wheel drive tack (Fire Road No 6E) over the remaining section of Longwall N2 and first workings or solid coal.

The line is located beyond 0.7 times depth from N4 Panel. NM2 Line is considered too remote from N4 Panel to detect any subsidence movements of significance.

The NM2 line was originally established to monitor subsidence effects from the mining of Longwall N2. However, since the cessation of Longwall N2 mining, the line has been refurbished and resurveyed. This was done to rectify damage to a number of pegs sustained from maintenance activities for the surface powerline infrastructure during the mining of this longwall panel. As a result of this refurbishment no meaningful correlation with previous surveys for Longwall N2 is possible.

Surveys of the refurbished 200 Line were conducted in January 2016 to establish a new baseline prior to secondary extraction of N4 Panel. A second survey was conducted again in early September 2017 once mining was finished.

Overburden depth varies along the line from 90m to 120m. The crinanite extends from the surface to a depth of approximately 50m to 70m. The base of the crinanite is typically 40m to 50m above the Wongawilli Seam.

Analysis of the data indicates that the vertical and horizontal subsidence movements measured are generally within survey tolerance of ±20mm for vertical subsidence and ±30mm for horizontal movements. These measurements do not indicate any significant subsidence movements.

5. COMPARISON WITH PREDICTIONS

Mine Subsidence Engineering Consultants (MSEC) provided predictions of the subsidence parameters and likely impacts of mining in the Part 3A Application for Longwalls N1 to N6 (MSEC 2010). These predictions were then used in the EP/SMP Application (Niche 2012) for these panels.

Figure 6 shows the predicted contours of vertical subsidence and locations of prediction lines for the approved Nebo Longwalls N1 – N6 (after MSEC 2010).

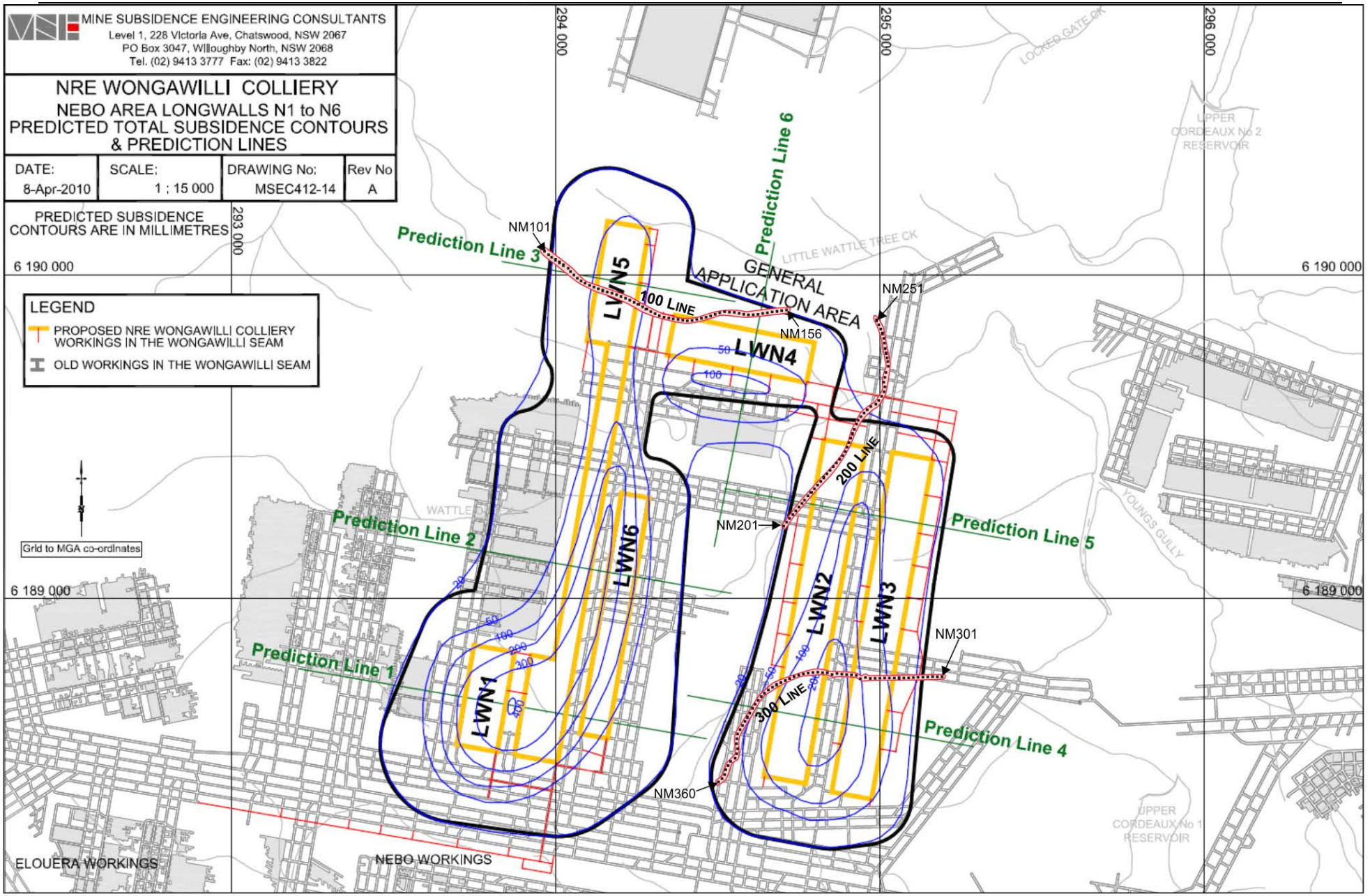

Figure 6: Vertical subsidence predicted in MSEC (2010) with subsidence monitoring lines superimposed.

The subsidence monitoring lines NM1, NM2 and NM3 (100, 200, and 300) have been added to Figure 6. Prediction Line 6 traverses the N4 Panel. Prediction Line 3 is parallel to the N4 Panel.

Direct comparison between the subsidence measurements and predictions is not possible due to the position and extent of the monitoring line relative to the prediction lines.

The subsidence movements measured are of low magnitude and consistent with the expectation of low magnitude outside the goaf. However, these need to be considered in the context of the expected survey tolerances and Trigger Action Response Plans (TARP) outlined in the Nebo Longwalls 1-6 Subsidence Monitoring Plan.

The accuracy expectations in the TARPS for regional points are ±25mm for position and ±35mm for height. The accuracy expectations for individual pegs on subsidence lines are:

- ±50mm for absolute position
- ±30mm for relative position
- ±5mm for level

The surveying accuracy appears from general variability to be within the range of these expectations. A consequence of these survey tolerances is that even if the subsidence lines were located in an area where maximum subsidence movements would be expected, the tolerance of the survey techniques used would be too high to measure the low values of the subsidence parameters predicted.

Maximum vertical subsidence of 105mm was predicted to occur on Prediction Line 6 above the coal pillars between N4 Panel and Hicks 4 Panel. This subsidence is expected to be a result of compression of the strata above and below these pillars with the crinanite bridging across the panels themselves.

The maximum predicted subsidence on Prediction Line 3 adjacent to N4 panel was 55mm midway across the single panel and represents the sag subsidence above a single panel.

The maximum value of vertical subsidence measured on NM1 line was 43mm along the edge of the panel. This measured maximum cannot be readily compared to the maximum predicted for either of the two prediction lines. The available monitoring data does not support a conclusion either way as to whether the maximum subsidence is compliant with predictions or not.

Maximum tilts were predicted along Prediction Lines 3 and 6 to be between 0.2mm/m and 0.8mm/m in a direction across the panel. The maximum value of tilt measured on NM1 line was 0.9mm/m in a direction parallel to the goaf edge. The measured value provides confirmation of the survey tolerance being ±1.0mm/m. The available monitoring data does not support a conclusion either way as to whether the actual tilt has exceeded predictions.

With an estimated survey tolerance for tilt of ±1.0mm/m, it would not be possible for the subsidence monitoring to indicate compliance or otherwise given the low values of tilt predicted even if the subsidence line was optimally located.

Maximum strains were predicted along Prediction Lines 3 and 6 to be <0.1–0.2mm/m in tension and <0.1–0.3m/m in compression in a direction perpendicular to the goaf edge. The maximum values of strain measured on NM1 line were 0.4mm/m in tension and 0.6mm/m in compression, both in a direction parallel to the goaf edge. With an estimated survey tolerance for strain of about ±1.0mm/m, it would not be possible for the subsidence monitoring to indicate compliance or otherwise given the low values of strain predicted even if the subsidence line was optimally located.

Although the subsidence monitoring above N4 Panel does not measure maximum subsidence over the panel, previous subsidence monitoring of NM3 (300) line above Longwall N2 (SCT2014) confirmed the expected bridging capacity of the crinanite. This bridging limited the magnitude of the maximum subsidence to less than 100mm and associated tilt and strain parameters to levels that are imperceptible for all practical purposes.

The subsidence behaviour above N4 Panel is not expected to have been significantly different to that previously monitored over Longwall N2. Although the design of the subsidence monitoring line and survey technique are not able to confirm the actual subsidence behaviour above N4 Panel, the impacts are considered likely to have been insignificant for all practical purposes even.

Heritage site (Historic 1) is located to the north of the panel above solid coal. The subsidence movements at this location are not expected to have affected any of the features located at this site. These include a stone wall and remnants of previous European habitation.

6. REFERENCES

MSEC 2010 "Prediction of subsidence parameters and the assessment of mine impacts on natural features and surface infrastructure resulting from the proposed extraction of Longwalls N1 to N6 in the Nebo area in support of a Part 3A Application" Report to Gujarat NRE FCGL Pty Ltd, Report Number MSEC412, Revision B, dated June 2010.

Niche 2012 "NRE Wongawilli Colliery Nebo Longwalls N1-N6 Extraction Plan – November 2012 – Revision 1" Niche Environment and Heritage Report to Gujarat NRE Wonga Pty Ltd dated 22 November 2012.

SCT 2010 "Implications of Nebo 8/8A results for subsidence and groundwater modelling" SCT Report GUJWO3548A dated 8 April 2010.

SCT 2014 "Wongawilli Colliery – LWN2 End of Panel Subsidence Report" SCT Report WCWO4319 dated 29 August 2014.