YANCOAL
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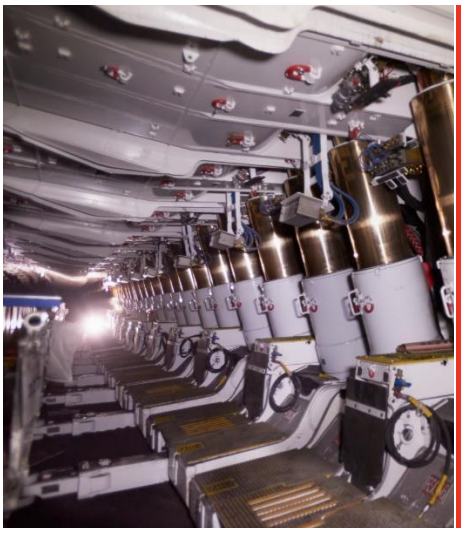
MOOLARBEN COAL



UG4 LONGWALLS 401 TO 408 S1MC280 SUBSIDENCE MONITORING AND MITIGATION PROGRAM

Version	Effective Date *(Month/YYYY)*	Revision Details *(Include the main areas reviewed, trigger / why the change)*	Author *(Name/s)*	Review Team *(Name/s)*
2	Jan 23	S1MC280 SMMP	MCO MSEC SCT	MCO
3	Sep 23	Post-mining review of trigger action response plan	MCO	MCO

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1.0 INTRODUCTION

The Moolarben Coal Complex (MCC) is an open cut and underground coal mining operation located approximately 40 kilometres north of Mudgee in the Western Coalfield of New South Wales (NSW) (**Figure 1**).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben [YM] Pty Ltd and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia Limited.

The UG4 Underground Mine (UG4) is a component of the approved Moolarben Coal Complex (Figure 2). First workings for UG4 North Mains commenced in October 2020 (Figure 3). Secondary extraction in UG4 of the first Longwall LW401 commenced in 2022.

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and continue to be carried out in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified).

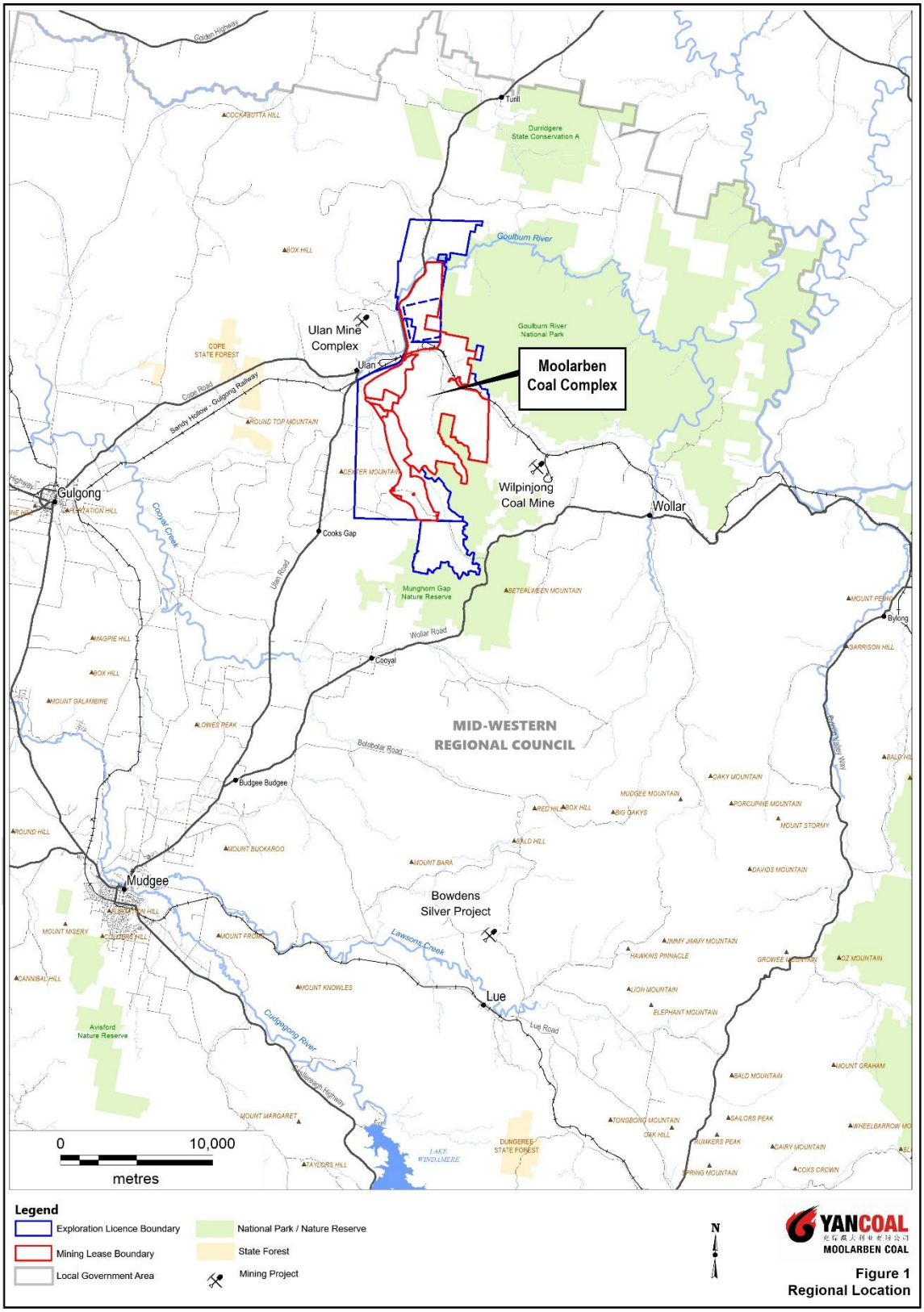
This UG4 Longwalls 401 to 408 S1MC280 Management Plan (LW401-408 S1MC280 MP) forms a part of the Extraction Plan for Longwalls 401 to 408 (herein referred to as Longwalls 401-408) of the approved UG4 Underground Mine. The location of the S1MC280 site relative to the UG4 mine plan is shown in **Figure 4**.

1.1 PURPOSE AND SCOPE

Purpose: This LW401-408 S1MC280 MP outlines the management of potential subsidence impacts of the proposed secondary workings described in the Extraction Plan on the S1MC280 Heritage Site

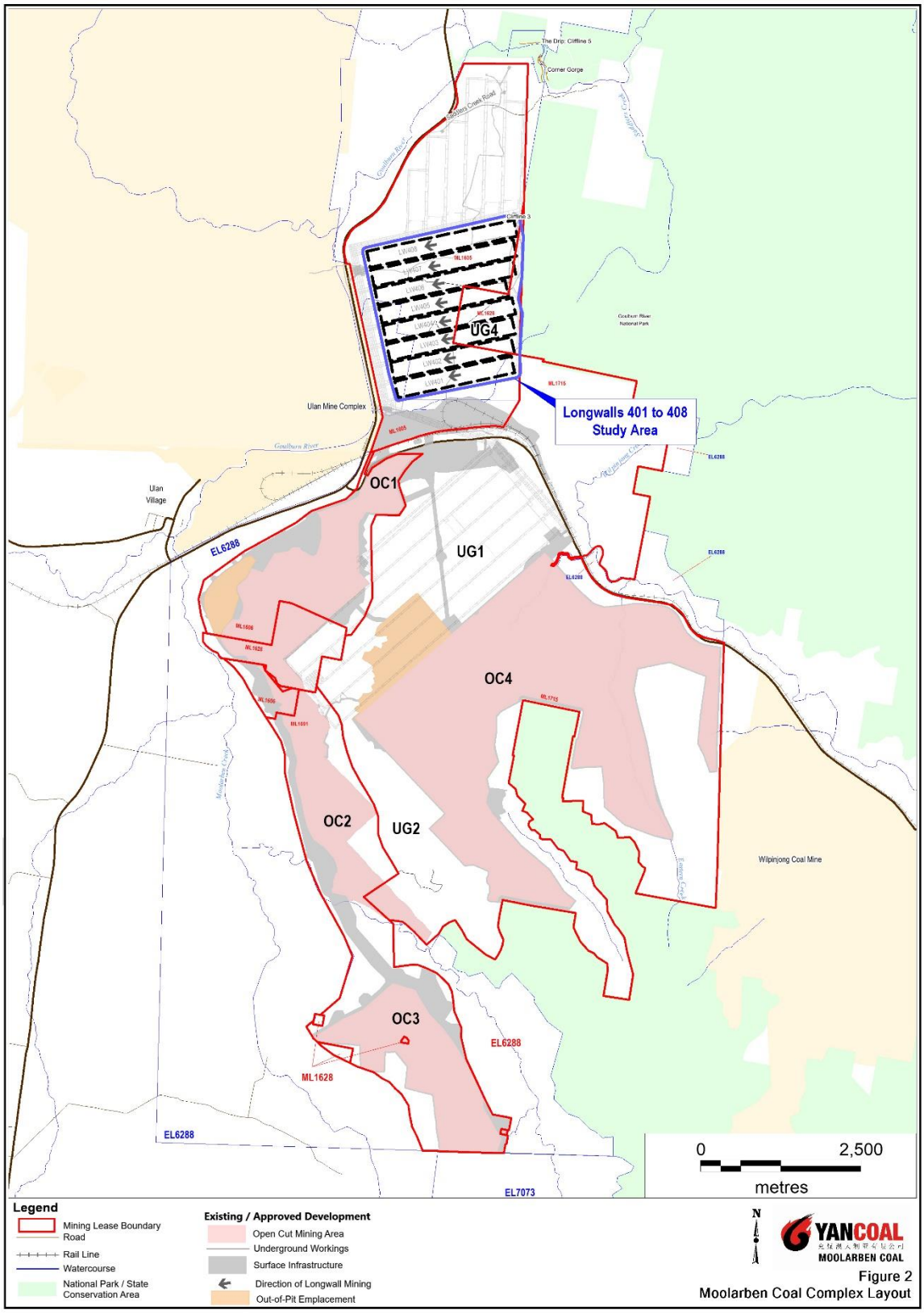
Scope: This LW401-408 S1MC280 Monitoring and Mitigation Program covers the rock shelter with art, artifacts and grinding grooves identified within LW401-408 Heritage Management Plan as S1MC280.

Figure 1: MCO Locality



Document	Version	Effective	Status	Author
MCO_UG4_LW401-408_S1MC280	3	Sep 23	Approved	MCO

Figure 2: Moolarben Coal Complex Layout



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MCO_UG4_LW401-408_S1MC280	3	Sep 23	Approved	MCO

Figure 3: UG4 Longwall 401-408 Layout

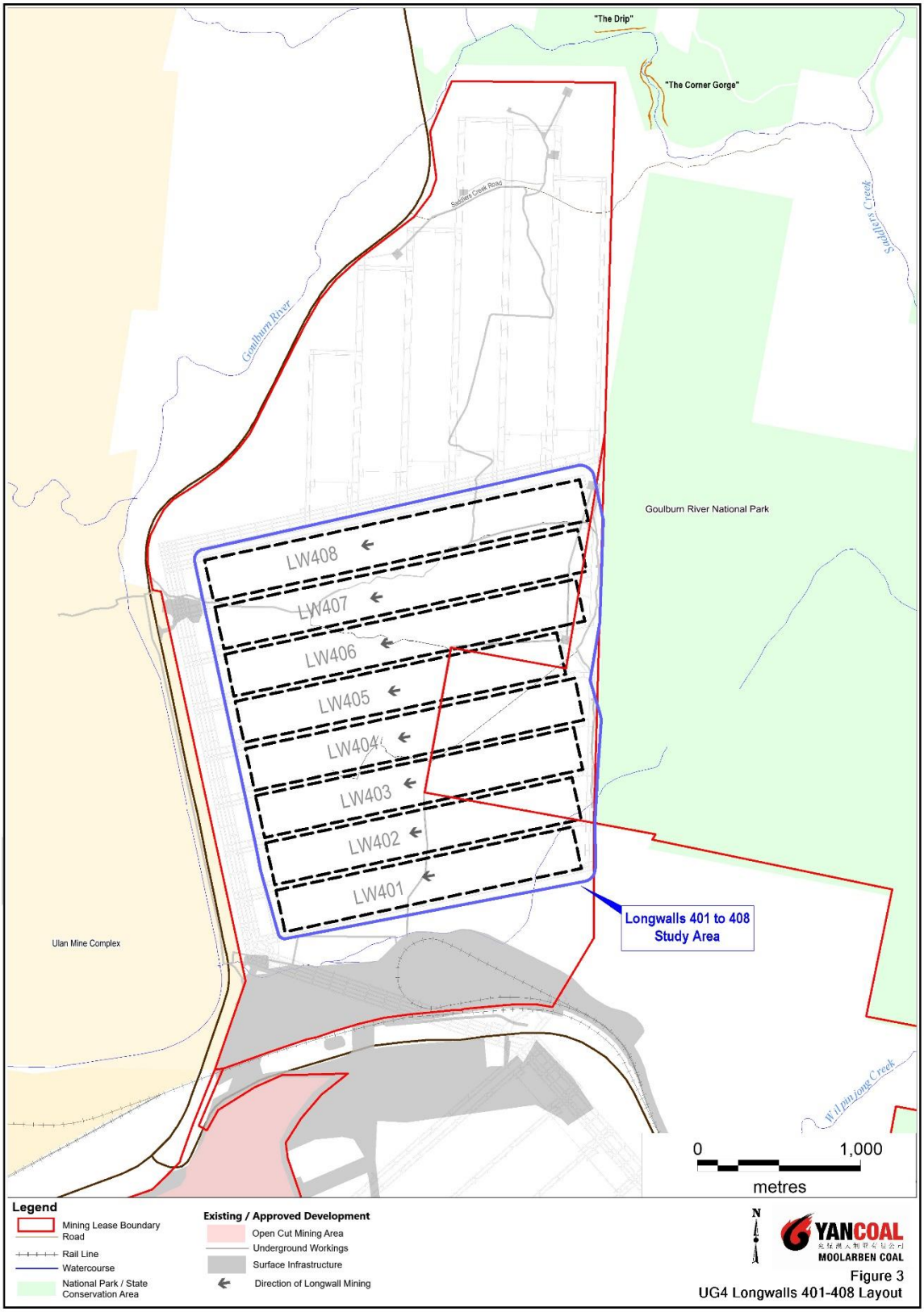
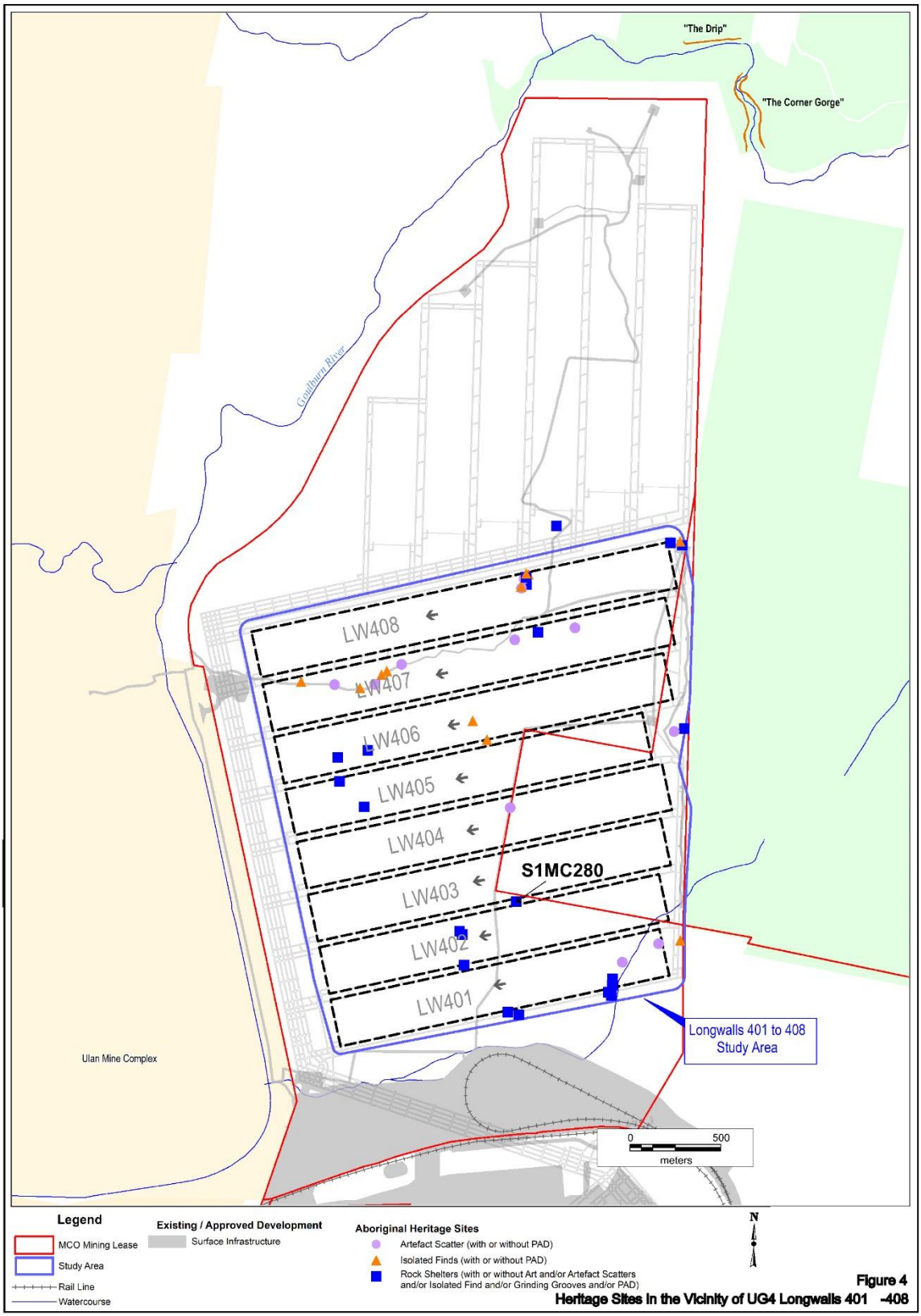


Figure 4: Heritage Sites in the Vicinity of UG4 Longwalls 401-408 including Site S1MC280



1.2 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

In accordance with Condition 77(a), Schedule 3 of Project Approval (05_0117), the suitably qualified and experienced persons that have prepared this Monitoring and Mitigation Program, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and MCO, were endorsed by the Secretary of the Department of Planning and Environment (DPIE).

2.0 S1MC280 BASELINE ASSESSMENT

2.1 BASELINE SUBSIDENCE IMPACTS ASSOCIATED WITH SITE S1MC280

S1MC280 has been assessed as being of high archaeological significance. S1MC280 contains a Shelter with Art, Artefacts and Grinding Grooves and is located centrally above the chain pillar between Longwalls 402 and 403.

By locating S1MC280 above the chain pillar the risk of subsidence impacts to S1MC280 has been reduced from high to moderate in accordance with Condition 73, Schedule 3 of Project Approval (05_0117). Large scale failure of the rock shelter is not expected to occur and the likelihood of tensile cracks coinciding with the location of the grinding grooves and art is considered to be low.

A framework for the management of Aboriginal Heritage sites within the approved Moolarben Coal Complex has been developed as part of the Moolarben Heritage Management Plan (MCO 2020) based on the sites assessed significance, site type and the nature of proposed impacts. This management framework provides a robust system for managing subsidence impacts within LW401-408.

MSEC (2021) reviewed the maximum predicted subsidence parameters for each of the Aboriginal heritage sites located within the LW401-408 Study Area. **Table 1** provides the maximum predicted values of total conventional subsidence, tilt and curvature for site S1MC280, resulting from the extraction of Longwalls 401 to 408 for the Extraction Plan Layout. This is prior to any additional controls being implemented as part of this Monitoring and Mitigation Program.

Table 1: Maximum Predicted Subsidence, Tilt and Curvature for Site S1MC280 due to the Extraction of Longwalls 401-408

Site Type	Maximum Predicted Subsidence[1, 2] (mm)	Maximum Predicted Tilt[3] (mm/m)	Maximum Predicted Hogging Curvature[4] (km^{-1})	Maximum Predicted Sagging Curvature[4] (km^{-1})
Shelter with Art, Artefacts, and Grinding Grooves (S1MC280)	150	4	0.25	<0.01

Source: MSEC (2021).
mm/m = millimetres per metre, km^{-1} = 1/kilometres.
1 Subsidence refers to vertical displacements of the ground.
2 Maximum Predicted Total Conventional Subsidence for Longwalls 401-408 based on the Maximum Subsidence due to the Extraction Plan Layout after Longwall 408.
3 Tilt is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those two points.
4 Curvature is the second derivative of subsidence, the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.

The predicted total vertical subsidence at site S1MC280 is 150 mm and total tilt is 4.0 mm/m (i.e. 0.4%, or 1 in 250). The site is unlikely to be impacted by this magnitude of tilt. The site will experience hogging curvature due to the extraction of Longwalls 402 and 403. The maximum predicted total hogging curvature during or after the extraction of the longwalls is 0.25 km^{-1}, which equates to a radius of curvature of 5 km. The site is located in a net tensile zone. The predicted tensile strain based on 10 times hogging curvature is 2.5 mm/m. Tensile strains of greater than approximately 0.5 mm/m are considered to be sufficient to result in tensile cracking of sandstone. The rock shelter is an isolated site within a small area of steep slopes at a topographical high point. The risk of subsidence impacts to Site

S1MC280 is low to moderate consistent with the approved impacts and includes potential for tensile cracks and instabilities. Large scale failure of the rock shelter is not expected to occur and the likelihood of tensile cracks coinciding with the location of the grinding grooves is considered to be low.

3.0 S1MC280 SITE SPECIFIC MITIGATION PROGRAM

3.1 UG4 LW401-408 EXTRACTION PLAN APPROVAL CONDITIONS

Conditional approval of the UG4 LW401-408 Extraction Plan was received by MCO in July 2022. Condition 1 is outlined in **Table 2** and has been addressed through this Subsidence Mitigation and Monitoring Program.

Table 2: LW401-408 Extraction Plan Approval Condition 1

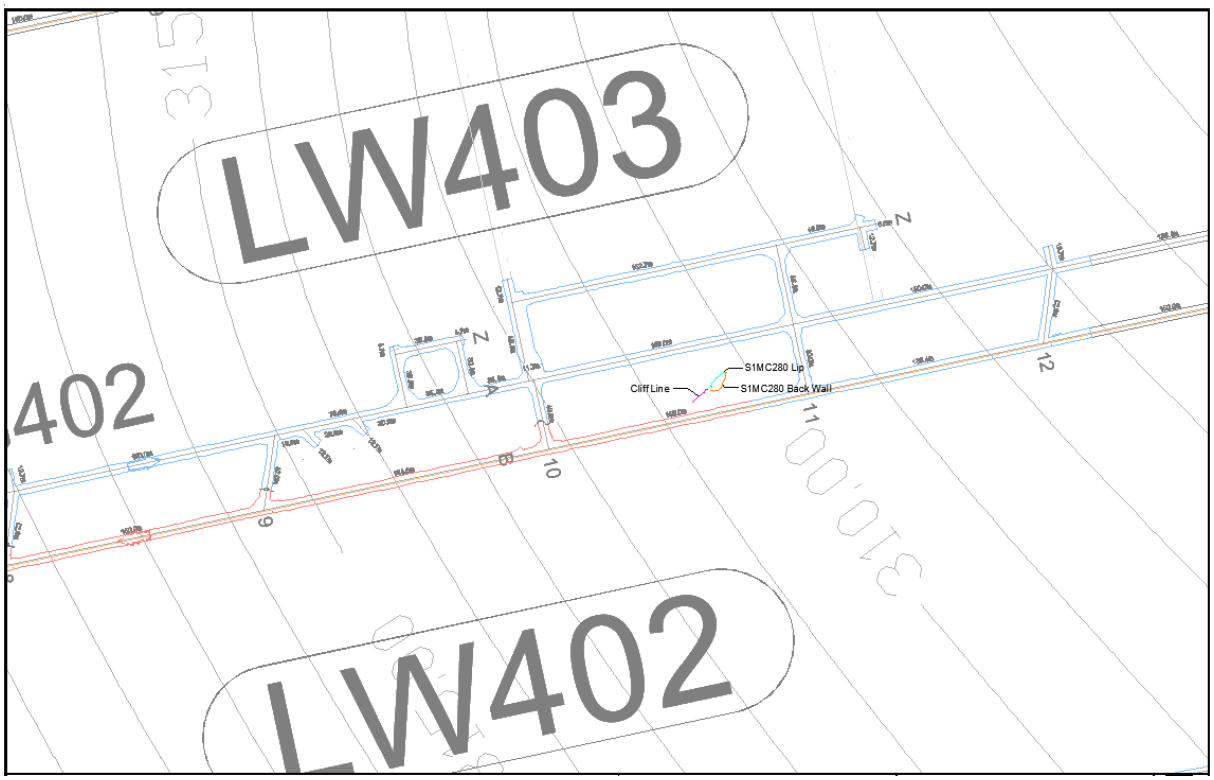
Condition	Details
1	The Proponent must prepare a site-specific subsidence monitoring and mitigation program for Aboriginal heritage site S1MC 280 to the satisfaction of the Secretary prior to the commencement of longwall mining of LW402. The program must include: a) a suitable "early warning" subsidence monitoring site above the LW402/LW403 row of chain pillars, at least several pillars inbye of the site, to monitor the subsidence effects and impacts of both LW402 and LW403 to determine the actual subsidence, tilt and strain figures, by comparison to the predicted values; b) a comprehensive Trigger Action Response Plan for both the "early warning" site listed in (a) above, and for monitoring at the site; c) a comprehensive mitigation plan for the site, to cover all actions to prevent any significant subsidence impact to Site S1MC 280 due to subsidence, tilt or strain, including i. the planned stress-relief slotting design ii. consideration of temporary support of the rock shelter overhang; and iii. design of a LW403 Panel face shortening, to leave some additional coal in the vicinity of the site. For the purposes of this condition, significant subsidence impact means: • overhang collapse; or • cracking of sandstone that coincides with the Aboriginal heritage feature(s) of the site that make it significant; or • rock fall that damages the Aboriginal heritage feature(s) of the site that make it significant that cannot be attributed to natural weathering or deterioration.

3.2 LW403 FACE SHORTENING

Site S1MC280 is located directly above the chain pillar MG402 10-11CT. As part of the Site S1MC280 Mitigation Plan an assessment was undertaken by MSEC to determine the impact of leaving an addition coal pillar in LW403 in the vicinity of Site S1MC280.

An additional 40m solid (45.4m Roadway Centre) pillar has been designed and implemented in MG402 between 10-11CT. This will result in a LW403 face shortening of 40m in the vicinity of Site S1MC280 as shown in **Figure 5**.

Figure 5: TG403 Shortening Pillar



Revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the LW403 Face Shortening have been prepared by MSEC. Table 3 shows that the TG Shortening reduces the Maximum Predicted Subsidence impacts at Site S1MC280.

Table 3: Comparison of Maximum Predicted Subsidence, Tilt, Curvature, and Strain for Site S1MC280 due to the Extraction of LW401-408 with LW403 TG Shortening

Site	Maximum Predicted Subsidence[1, 2] (mm)	Maximum Predicted Tilt[3] (mm/m)	Maximum Predicted Hogging Curvature[4] (km^{-1})	Maximum Predicted Sagging Curvature[4] (km^{-1})	Maximum Predicted Total Conventional Strain (mm/m)
S1MC280 (due to Extraction of LW401-408)	150	4.0	0.25	<0.01	2.5
S1MC280 (due to the Extraction of LW401-408 with LW403 TG Shortening)	100	5.0	0.2	<0.01	1.5

Source: MSEC (2022) LW401 – 408 Assessment of 40m Pillar Widening at S1MC280
mm/m = millimetres per metre, km^{-1} = 1/kilometres.

1 Subsidence refers to vertical displacements of the ground.

2 Maximum Predicted Total Conventional Subsidence for Longwalls 401-408 based on the Maximum Subsidence due to the Extraction Plan Layout after Longwall 408.

3 Tilt is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those two points.

4 Curvature is the second derivative of subsidence, the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.

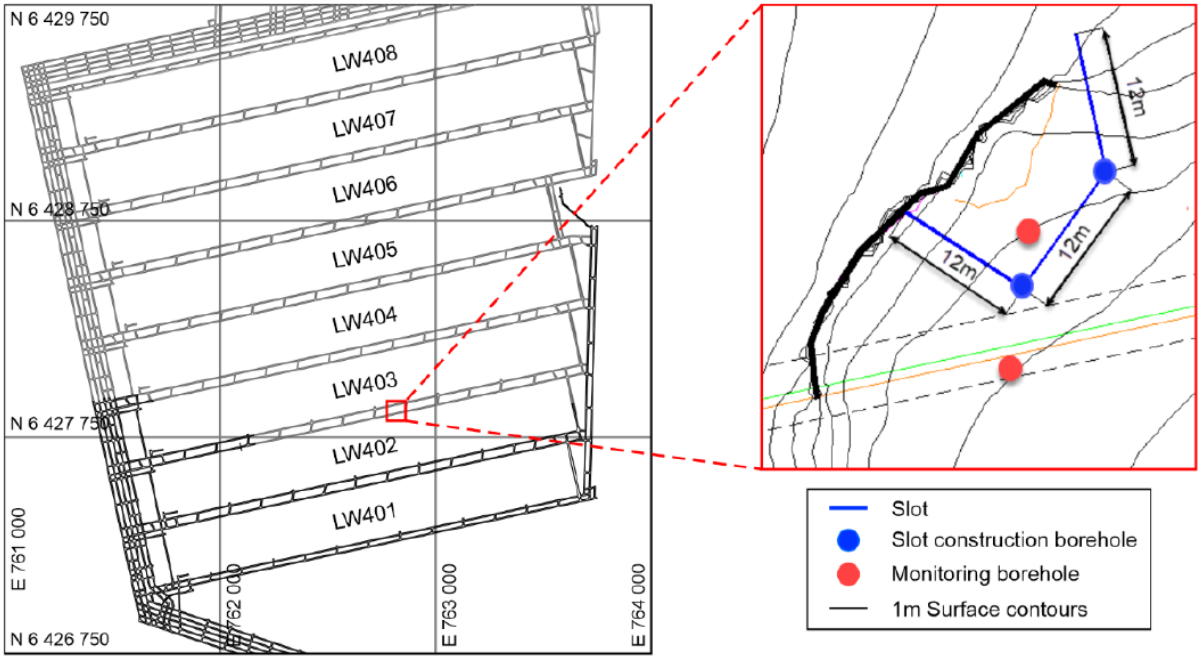
3.3 S1MC280 STRESS RELIEF VERTICAL SLOTS

MCO engaged SCT Operations to assess and design a series of vertical stress relief slots to be implemented at Site S1MC280. These slots and the slot geometry have been designed to isolate the sandstone formation from the differential subsidence related ground movements that are predicted to impact the area during longwall mining.

The proposed slot geometry is shown in **Figure 6**. These slots are designed to comprise of three interconnected sections, each approximately 12m long and 12mm wide. The slot is designed to extend around, and be at least 5m behind, the back of the overhang. The slot is designed to extend to a depth 1 metre below the floor of the overhang. These slots will be cut using a series of vertical drillholes and diamond wire saw cuts from the surface to the base of the drillholes. At completion of longwall mining operations in LW402 and LW403 panels, these vertical slots will be refilled with grout material in staged lifts. These slots will be installed prior to LW402 retreating past MG402 12CT.

The installation of the stress relief vertical slots will require the disturbance and temporary removal of vegetation surrounding S1MC280. Prior to installation of the stress relief vertical slots a Ground Disturbance Permit (GDP) must be completed and approved by MCO's Environment and Community Manager (E&C Manager) or delegate to consider the presence of Aboriginal heritage sites and other potentially sensitive features. This may require some variation to the location of slots and number of boreholes shown in **Figure 6**.

Figure 6: S1MC280 Stress Relief Slot Proposed Geometry



MSEC Subsidence Modelling predicts the S1MC280 site will experience net tensile rather than compressive ground strain above the chain pillar following longwall mining. As a result, it is predicted that these vertical slots will increase in width (open) during mining rather than decrease in width (close) following the completion of longwall mining. Minor transient compressive ground strain may be observed during mining.

Monitoring of the vertical slots and Site S1MC280 is outlined in **Section 4.0.**

3.4 TEMPORARY STANDING SUPPORT OF S1MC280

Consideration of temporary support of the rock shelter overhang has been undertaken by MCO in conjunction with SCT and is not recommended as a preventative mitigation measure.

Experience has shown that mining induced impacts to sandstone rock features such as Site S1MC280 are caused, almost entirely, by differential horizontal movements acting along the line of the sandstone formation. Sandstone formations are tolerant of tilt, vertical subsidence and general horizontal movement perpendicular to the face of the formation. They can also tolerate small compressive movements along the line of the formation.

The vertical slots are designed to provide as much freedom as possible to allow mining-induced movements to be accommodated without generating horizontal stresses or movements within the rock formation. This strategy has been effective at rockbar sites and is entirely consistent with observations of impacts to numerous rock formations of different sizes.

The concept of providing temporary support to the overhang has been considered and trialled at other mine sites with SCT involvement. This strategy aims to support the overhang but unfortunately, in doing so, it also limits freedom for the overhang to move under the influence of mining-induced movements. Through this restriction of movement, there is potential to damage the formation.

A peer review of a draft version of this Subsidence Monitoring and Mitigation Plan which was commissioned by the Department of Planning and Environment and undertaken by Dr Bruce Hebblewhite (report No. 2212/01.1 dated 3rd January 2023) recommended a contingency plan be added to the Subsidence Monitoring and Mitigation Plan to include the installation of temporary standing support under the overhang if triggered by adverse tilt, roof to floor closure or onset of instability detected in the rock mass. This recommendation has been adopted and consequently the installation of standing support as a contingency measure is now included in the Site S1MC280 TARPs outlined in **Section 5.2** and **Attachment 4**.

The installation of temporary support under the overhang is proposed to consist of Acrow Props (or similar) set between the overhang and the floor of the overhang. Installation of the temporary support may require disturbance of the ground underneath the overhang to achieve adequate installation. The use of timber caps may also be required to minimise the impact of the temporary support on the overhang ceiling.

The installation of temporary support under the overhang will be considered by the Technical Committee based on the results of monitoring. If the Technical Committee deem that temporary support may be required, the installation will only occur after consultation with the Registered Aboriginal Parties (RAPs).

The installation of the temporary support under the overhang will be contingent on the work required being assessed as safe to do as part of a formal risk assessment process.

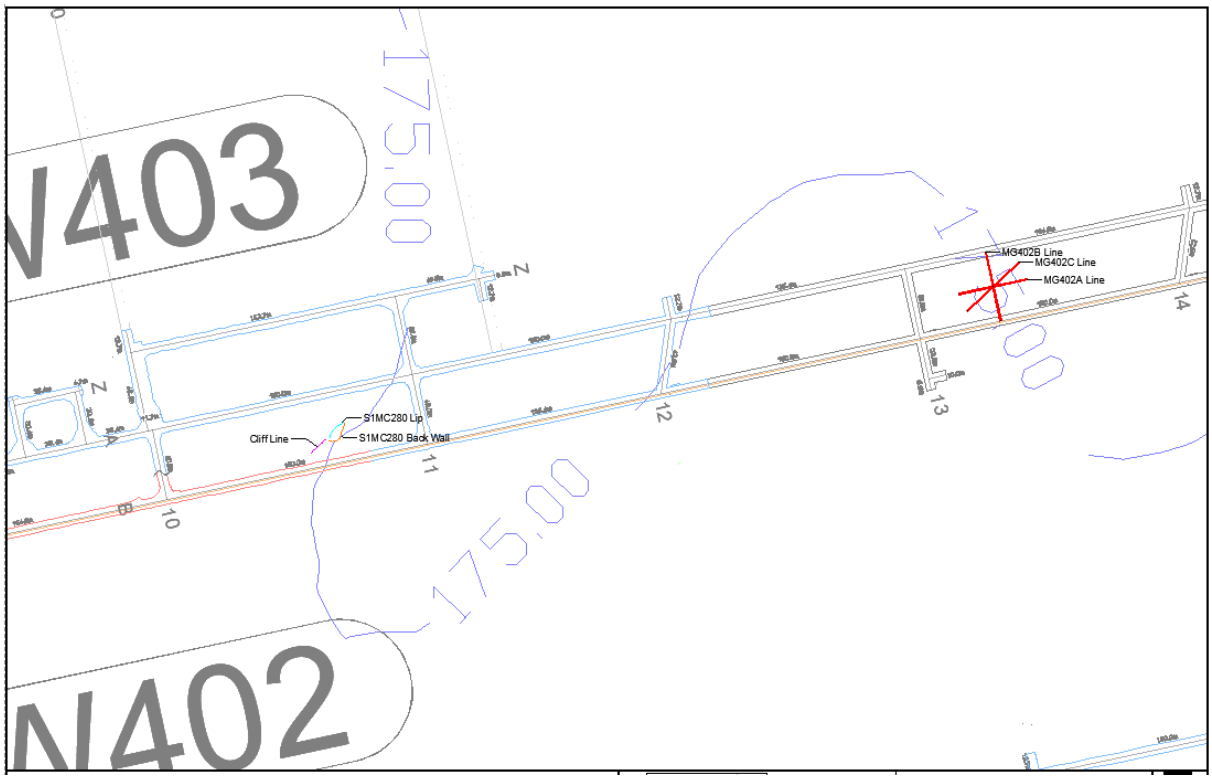
4.0 S1MC280 SITE SPECIFIC MONITORING PROGRAM

4.1 'EARLY WARNING' SUBSIDENCE MONITORING SITE

An 'Early Warning' Subsidence Monitoring Site will be installed above MG402 13-14CT Chain Pillar. The centre of this site is approximately 375m inbye of Site S1MC280 and will provide subsidence monitoring during mining of LW402 and LW403. This Monitoring Site is in addition to the Subsidence Monitoring Lines outlined in the UG4 LW401-408 Subsidence Monitoring Program and consists of 3 ground transect lines. These lines are arranged to have a longitudinal line, a line across the chain pillar, and a line of similar orientation to Site S1MC280.

The monitoring site has a similar depth of cover to Site S1MC280 (175m). The location relative to Site S1MC280 is shown as shown in **Figure 7**.

Figure 7: MG402 13-14CT Subsidence Monitoring Site



The subsidence lines will be composed of survey marks comprised of either stations set in rock or star pickets. Prior to installation of the survey marks, a Ground Disturbance Permit (GDP) must be completed and approved by MCO's Environment and Community Manager (E&C Manager) or delegate to consider the presence of Aboriginal heritage sites and other potentially sensitive features.

Prior to the commencement of LW402, the subsidence lines will be installed and surveyed in three dimensions to establish the baseline to assess the nature of any future ground movements.

The UG Technical Services Manager is responsible for ensuring the implementation of the subsidence parameters monitoring program. The UG Registered Mine Surveyor is responsible for ensuring the surveys of the ground transects are completed as required and the data is verified, processed and maintained.

A detailed layout of the MG402 Early Warning Monitoring Site is shown in **Figure 8**. The subsidence parameters monitoring program for the site is outlined in **Table 4** and **Table 5**.

The longwall retreat rate is nominally in the range of 120m - 130m per week. The monitoring of the survey lines is specified to occur on the first dayshift following nominated longwall chainage positions which are located 50m apart. Consequently, the surveys will be undertaken following nominally 50-60m of longwall retreat through the monitored zone.

Figure 8: MG402 13-14CT Subsidence Monitoring Site Detailed

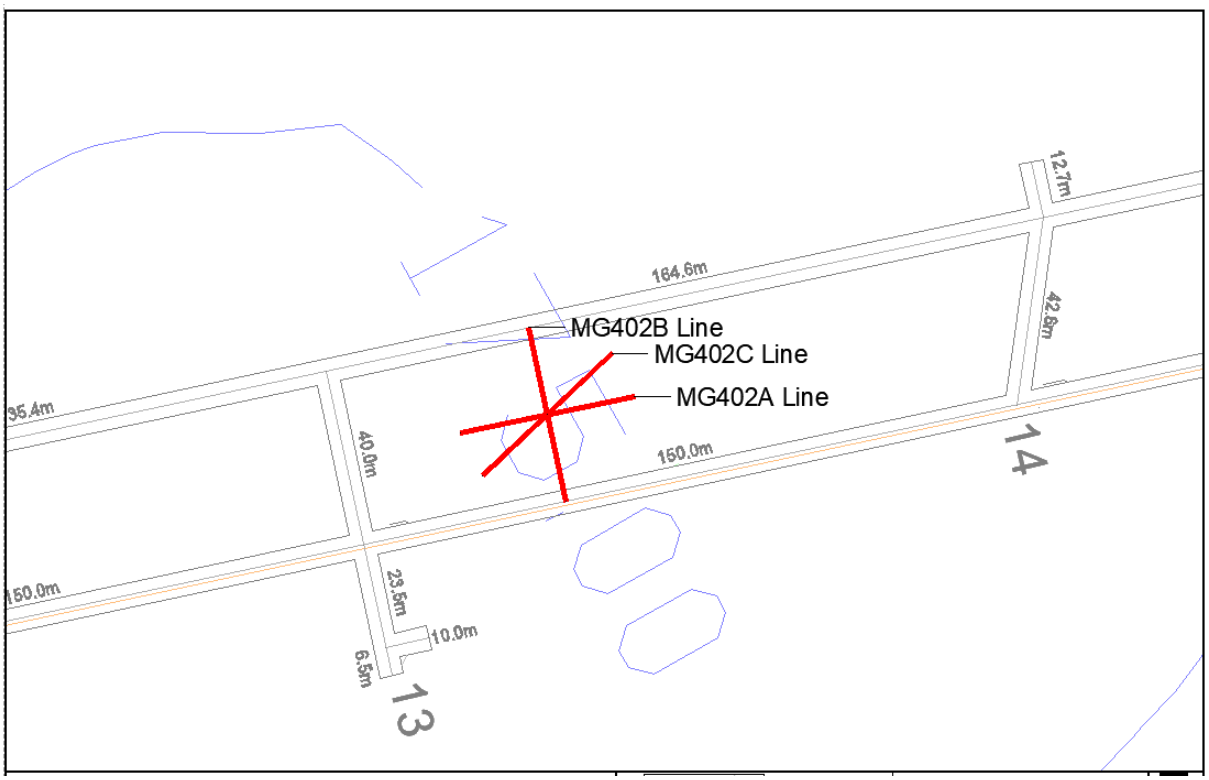


Table 4: MG402 13-14CT Subsidence Monitoring Site Program

Monitoring Component	Description
MG402A Line	Longitudinal monitoring line above MG402 13-14CT Chain Pillar 40m Length. Points to be installed at 5m spacing
MG402B Line	Perpendicular monitoring line above MG402 13-14CT Chain Pillar 40m Length. Points to be installed at 5m spacing
MG402C Line	Monitoring line above MG402 13-14CT Chain Pillar. Orientation parallel to Site S1MC280. 40m Length. Points to be installed at 5m spacing

Table 5 :MG402 13-14CT Subsidence Monitoring Site Program

Monitoring Component	Parameters	Frequency
MG402A Line MG402B Line MG402C Line	3D Monitoring parameters include: • Easting; • Northing; • Vertical Subsidence; • Tilt; • Strain.	• Prior to commencement of Longwall 402 extraction. • When LW Mining in LW402 and LW403 is within 200m Inbye and 200m Outbye of the monitoring site centre point On the Dayshift Immediately Following the LW Face Position 200m Inbye the Centre Point 150m Inbye the Centre Point 100m Inbye the Centre Point 50m Inbye the Centre Point At the Centre Point 50m Outbye the Centre Point 100m Outbye the Centre Point 150m Outbye the Centre Point 195m Outbye the Centre Point (at MG402 12CT)

To enable collation and analysis of all survey data from the Early Warning Monitoring Site longwall mining will hold at MG402 12CT when actively mining in both LW402 and LW403 to ensure that all survey data is processed and reviewed prior to longwall mining continuing towards S1MC280. MG402 12CT is approximately 175m inbye of S1MC280.

The hold point position may vary nominally from MG402 12CT if longwall mining conditions prohibit stopping at MG402 12CT. Varying this hold point will be reviewed and determined by the S1MC280 Steering Committee if required.

This monitoring will be actively reviewed by the Technical Committee outlined in Section 5 and inform the TARP outlined in **Section 5**.

4.2 SITE S1MC280 SITE MONITORING

Monitoring at Site S1MC280 will comprise of several different elements designed to monitor the subsidence experienced at the site.

4.2.1 Visual Inspections

Visual inspections of S1MC280 will be undertaken daily while LW402 and LW403 are mining within 200m inbye and 200m outbye of the site itself.

Photographic records of the site will be taken daily to identify and record any visual signs of damage or potential instability. The records will be actively reviewed by the Technical Committee outlined in Section 5 and inform the TARP outlined in **Section 5**.

4.2.2 Slot Width Monitoring

Slot width monitoring will be employed across the vertical stress relief slots at the surface level. The slot width monitoring will comprise of eight (8) instruments bolted at the surface to either side of the slot. Three will be installed on the back slot, three on the south-western slot and two on the north-eastern slot.

As the slot changes width in response to horizontal subsidence movements, the modules will detect any change, record the change and display the change at the monitoring unit.

The monitoring units will have a resolution of the order of +/-1mm change and will be visually inspected daily while LW402 and LW403 are mining within 200m inbye and 200m outbye of Site S1MC280. This monitoring will be actively reviewed by the Technical Committee outlined in Section 5 and inform the TARP outlined in **Section 5**.

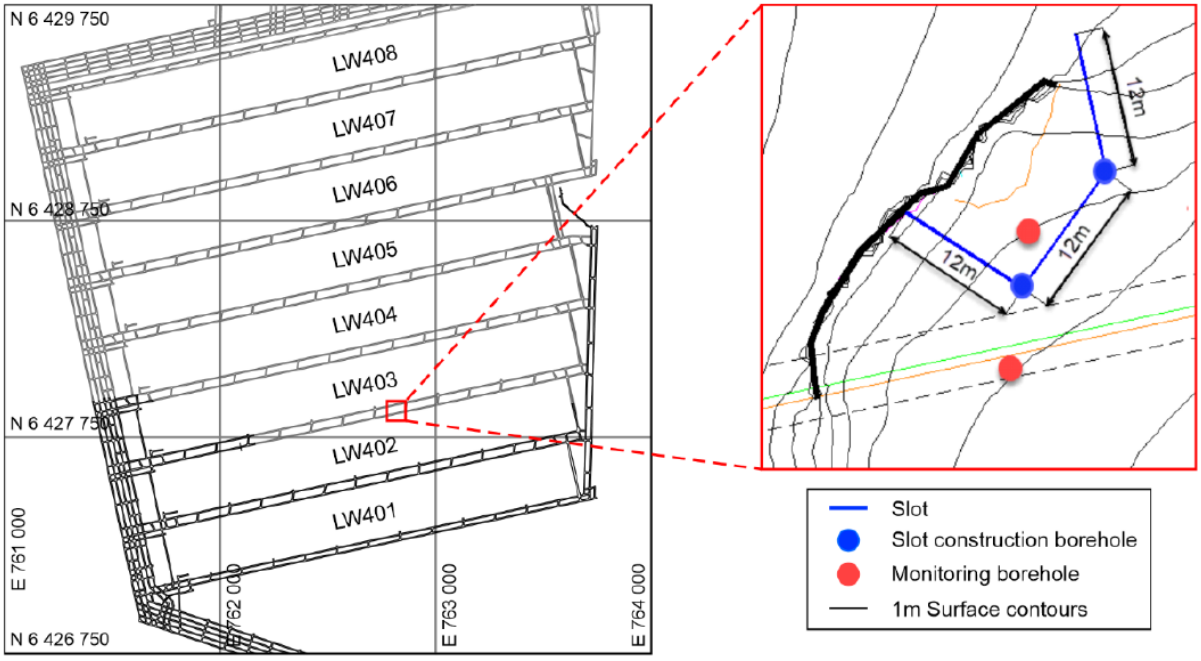
4.2.3 Stress Change Monitoring

An ANZI strain cell will be installed in the borehole to the south of the stress relief slots to measure and monitor changes in stress experienced at Site S1MC280 outside of the stress relief slots. **Figure 9** shows the proposed location of the southern monitoring borehole.

This instrument uses strain gauges bonded to the wall of the borehole which is capable of responding to 0.001 mm of movement in the borehole wall. The strains will be logged on site at regular intervals and regular analysis of the data will be undertaken by SCT Geotechnical Engineers. The stress change data will inform the Technical Committee of changes in rock stress at the site.

A second monitoring borehole will be investigated inside the slots as shown in **Figure 9**. This additional borehole will be dependant on site access and consideration of drilling closer to Site S1MC280 overhang. If drilling this additional borehole is assessed to have too high risk of negative impact on Site S1MC280, this monitoring borehole will not be installed.

Figure 9: S1MC280 Stress Relief Slot Proposed Geometry



4.2.4 Additional Slot Width Monitoring

A two-arm calliper designed to be capable of operation in a 12 mm slot has been constructed to monitor the profile of the slot width at different depths within the slot itself. This system will be used to determine the depth of any shear horizons if one develops during mining operations. The calliper will be employed by the SCT engineer on site during regular inspections and the findings reported back to the Technical Committee.

The instrument will be deployed in a long-term monitoring role by leaving it in one position if a shear zone is identified within the slot. Between manual profile surveys, the calliper would be installed midway along the back slot near the bottom of the slot and logged using a similar system to the crack width monitoring modules.

4.2.5 Borehole Camera Inspections

A borehole camera will be available to deploy in the slot construction boreholes once the slots have been created. Surveys of these holes using the camera will identify the locations of any points where shear movements are causing the slot to close (or open).

The borehole camera will be employed by the SCT engineer on site and the findings reported back to the Technical Committee. It is anticipated that camera surveys would only be conducted intermittently or by exception as required.

4.2.6 Tilt Monitoring

An electronic tilt monitoring system will be installed. The tilt sensor will be located on the top side of the overhang to avoid impacting the front or underside of the S1MC280 site and will be removed upon completion of monitoring requirements. The sensor will be bonded to the rock surface to measure tilt

and temperature change. A data logging system will monitor and record the tilt and temperature at the instrument for review by the S1MC280 Technical Committee.

The recording of Temperature as well as Tilt will allow for the impacts of diurnal temperature changes to be assessed in addition to any changes due to mining.

4.2.7 Overhang Closure Monitoring

Roof to Floor convergence monitoring will be installed underneath the S1MC280 Overhang. This system will comprise of an instrumented pogo stick installed within the overhang at a location where there is firm floor and minimal potential to impact the overhang ceiling. Installation of the convergence monitoring may require disturbance of the ground underneath the overhang to achieve adequate installation.

The monitoring system will utilise the sensors similar to the slot width monitoring system. A data logging system will monitor and record the changes in convergence at the instrument for review by the S1MC280 Technical Committee.

The instrumented pogo stick will be able to be read visually during the daily inspections.

4.2.8 S1MC280 Subsidence Monitoring

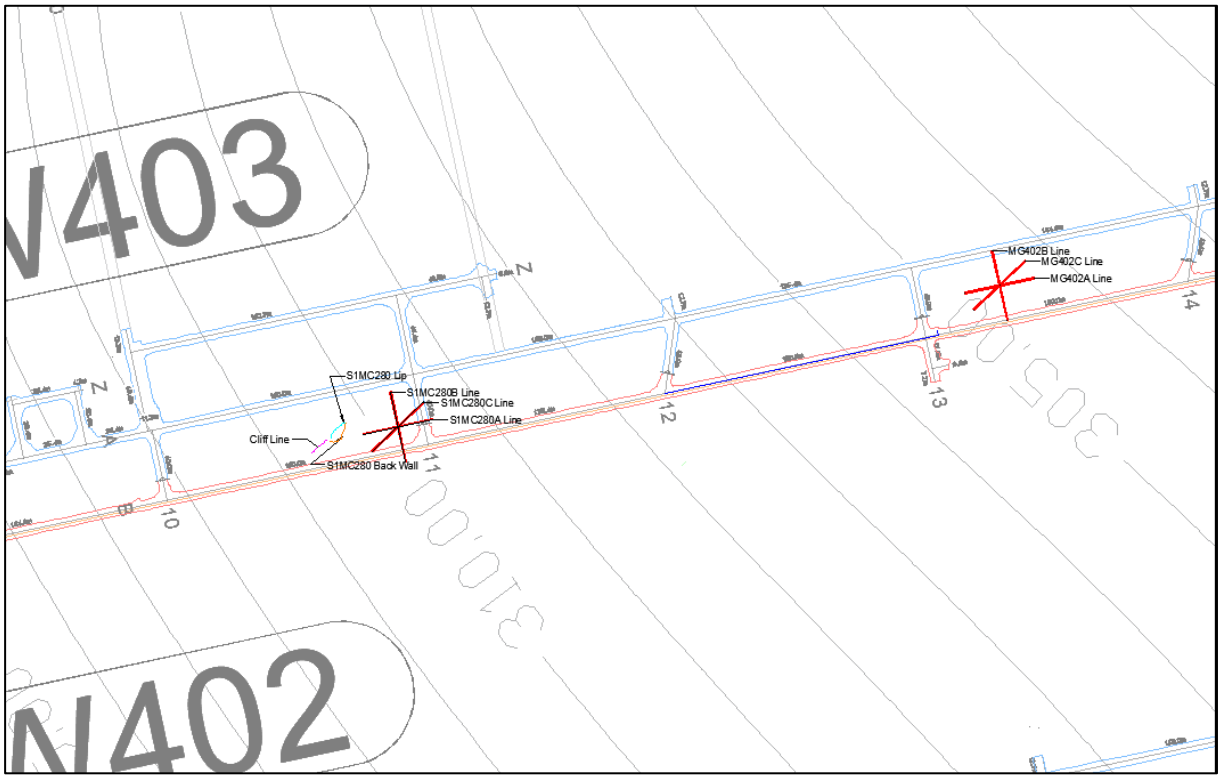
A Subsidence Monitoring Site will be installed on the surface inbye S1MC280 itself. The centre of this site is approximately 30m inbye of Site S1MC280 and will provide subsidence monitoring during mining of LW402 and LW403. This Monitoring Site is in addition to the Subsidence Monitoring Lines outlined in the UG4 LW401-408 Subsidence Monitoring Program and consists of 3 ground transect lines. These lines are arranged to have a longitudinal line, a line across the chain pillar, and a line of similar orientation to Site S1MC280. These lines are of the same orientation as the Early Warning Monitoring Site described previously.

The location relative to Site S1MC280 and the Early Warning Site is shown in **Figure 10**. The location selected is inbye of S1MC280 has been selected as adjacent to the site itself and as close as practicable to the site without directly impacting the rock shelter. The site is in similar position as S1MC280 over the MG402 10-11CT Chain Pillar and will experience similar movements to those at S1MC280.

The subsidence lines will be composed of survey marks comprised of either stations set in rock or star pickets. Prior to installation of the survey marks, a Ground Disturbance Permit (GDP) must be completed and approved by MCO's Environment and Community Manager (E&C Manager) or delegate to consider the presence of Aboriginal heritage sites and other potentially sensitive features.

Prior to the commencement of LW402, the subsidence lines will be installed and surveyed in three dimensions to establish the baseline to assess the nature of any future ground movements.

Figure 10: S1MC280 Subsidence Monitoring Site



The UG Technical Services Manager is responsible for ensuring the implementation of the subsidence parameters monitoring program. The UG Registered Mine Surveyor is responsible for ensuring the surveys of the ground transects are completed as required and the data is verified, processed and maintained.

A detailed layout of the S1MC280 Subsidence Monitoring Site is shown in **Figure 11**. The subsidence parameters monitoring program for the site is outlined in **Table 6** and **Table 7**.

Figure 11: S1MC280 Subsidence Monitoring Site Detailed

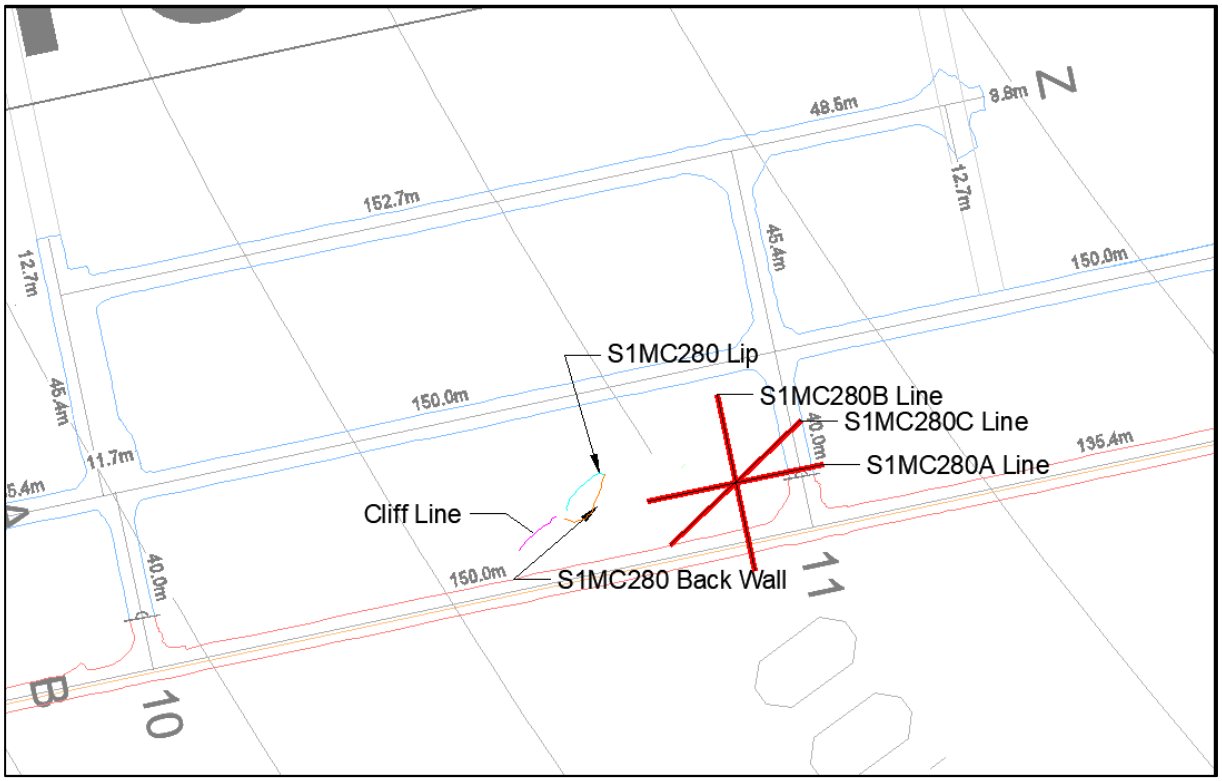


Table 6: S1MC280 Subsidence Monitoring Site Program

Monitoring Component	Description
S1MC280A Line	Longitudinal monitoring line adjacent to S1MC280 40m Length. Points to be installed at 5m spacing
S1MC280B Line	Perpendicular monitoring line adjacent to S1MC280 40m Length. Points to be installed at 5m spacing
S1MC280C Line	Monitoring line adjacent to S1MC280. Orientation parallel to Site S1MC280 40m Length. Points to be installed at 5m spacing

Table 7: S1MC280 Subsidence Monitoring Site Program

Monitoring Component	Parameters	Frequency
S1MC280A Line S1MC280B Line S1MC280C Line	3D Monitoring parameters include: • Easting; • Northing; • Vertical Subsidence; • Tilt; • Strain.	• Prior to commencement of Longwall 402 extraction. • When LW Mining in LW402 and LW403 is within 200m Inbye and 200m Outbye of the monitoring site centre point On the Dayshift Immediately Following the LW Face Position 200m Inbye the Centre Point 150m Inbye the Centre Point 100m Inbye the Centre Point 50m Inbye the Centre Point At the Centre Point 50m Outbye the Centre Point 100m Outbye the Centre Point 150m Outbye the Centre Point 200m Outbye the Centre Point

This monitoring will be actively reviewed by the Technical Committee outlined in **Section 5** and inform the TARP outlined in **Section 5**.

5.0 TRIGGER ACTION RESPONSE PLAN

5.1 TECHNICAL AND STEERING COMMITTEES

A Technical Committee will be formed onsite at the commencement of LW402 to ensure the monitoring data is collected and actively reviewed. This Technical Committee will review the monitoring data and compare with the MSEC modelling predictions at the 'Early Warning' Monitoring Site and at Site S1MC280.

The Technical Committee will utilise the monitoring data outlined in **Section 4**, the 'Early Warning' Monitoring Site TARP outlined in Attachment 3, and the Site S1MC280 Subsidence TARP outlined in Attachment 4 to inform the Site S1MC280 Steering Committee to recommend any actions required. The Steering Committee will review the recommendations of the Technical Committee and implement the Site S1MC280 TARP. The members of the Technical and Steering Committees are outlined in **Table 8** and **Table 9**.

Table 8: S1MC280 Technical Committee

Organisation	Position	Contact Name	Phone Number
MCO	Underground Technical Manager - Chair	Mr Liam Mildon	02 6376 1614
	Underground Statutory Surveyor	Mr James Hord	02 6376 1610
	Underground Geotechnical Engineer	Mr Alex Wright	02 6376 1612
SCT	Principal Geotechnical Engineer	Dr Ken Mills	02 4222 2777
MSEC	Mine Subsidence Engineer	Mr Peter DeBono	02 9413 3777

Table 9: S1MC280 Steering Committee

Organisation	Position	Contact Name	Phone Number
MCO	Underground Operations Manager - Chair	Mr Elliot Baume	02 6376 1500
	MCO General Manager	Mr Brian Wesley	02 6376 1500
	MCO Environment and Community Manager	Mr Trent Cini	02 6376 1436
	Underground Technical Manager	Mr Liam Mildon	02 6376 1614
	Underground Mine Manager	Mr Jeff Savage	02 6376 1610

5.2 TRIGGER ACTION RESPONSE PLAN

A Trigger Action Response Plan (TARP) has been developed for both the "Early Warning' Monitoring Site and Site S1MC280 Heritage Site. These TARPS have been developed by MCO in consultation with SCT and MSEC.

These TARPS are based on measurable subsidence impacts at both sites and are outlined in **Attachment 3** and **Attachment 4**.

5.3 TRIGGER ACTION RESPONSE PLAN REVIEW

The TARP - Early Warning Subsidence Monitoring Site and the TARP - S1MC280 Subsidence Monitoring were reviewed by the technical committee following the completion of longwall mining in LW402.

This review recommended the subsidence monitoring lines continue to be surveyed but the strains measured on them are not used as TARP triggers. Consequently, the strain-based TARP triggers have been removed from the TARP - Early Warning Subsidence Monitoring Site and the TARP - S1MC280 Subsidence Monitoring. No change to the subsidence monitoring program outlined in **Section 4.0** has been made.

6.0 REFERENCES

Mine Subsidence Engineering Consultants (2022), *Moolarben – Longwalls 401 to 408 Assessment Proposed Pillar Monitoring Lines for Site S1MC280 TARP.*

Mine Subsidence Engineering Consultants (2022), *Moolarben – Longwalls 401 to 408 Assessment of 40m Pillar Widening at S1MC280.*

SCT Operations (2021), *Moolarben Subsidence Assessment Review, Assessment of Impacts and Protection Options for Aboriginal Heritage Site S1MC280.*

SCT Operations (2022), *Mitigation Measures at Heritage Site S1MC280: External Props.*

SCT Operations (2022), *Guidance and Monitoring of Mitigation Measures at Heritage Site S1MC280.*

SCT Operations (2022), *Mitigation Measures at Heritage Site S1MC280: Wire Cut Slot Design.*

SCT Operations (2023), *Monitoring of Wire Cut Slot at Heritage Site S1MC280.*

Bruce K Hebblewhite (2023), *Peer Review of Yancoal Moolarben Coal "UG4 Longwalls 401 to 408 S1MC280 Subsidence Monitoring and Mitigation Plan".*

SCT Operations (2023), *Review of TARPS for Subsidence Monitoring Data from Early Warning Subsidence Monitoring and S1MC280 Sites.*

ATTACHMENT 1

MOOLARBEN COAL OPERATIONS – LONGWALLS 401 TO 408 SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENT FOR S1MC280 HERITAGE SITE

Suite 402, Level 4, 13 Spring Street
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Chatswood NSW 2057
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enquiries@minesubsidence.com
www.minesubsidence.com

4 November 2022

Moolarben Coal Operations Pty Ltd
Locked Bag 2003
Mudgee NSW 2850

Reference: MSEC1165-400

For the attention of Liam Mildon, UG Technical Services Manager

Dear Liam,

RE: Moolarben Project Stage 1 – Longwalls 401 to 408
Assessment of 40m Pillar widening at S1MC280

Further to your email of 6 June 2022, Mine Subsidence Engineering Consultants (MSEC) have undertaken an assessment for pillar widening at Aboriginal heritage site S1MC280. The Aboriginal heritage site is located within the UG4 mining area. MSEC prepared report No. MSEC1165 in support of the extraction plan application for Longwall 401 to 408 within UG4.

Site S1MC280 includes a rock shelter with hand stencils, artefacts and grinding grooves and has jointing at 5 m to 10 m spacing with some collapsed rock. The site is located centrally above the chain pillar between Longwalls 402 and 403 as shown in Figure 1.

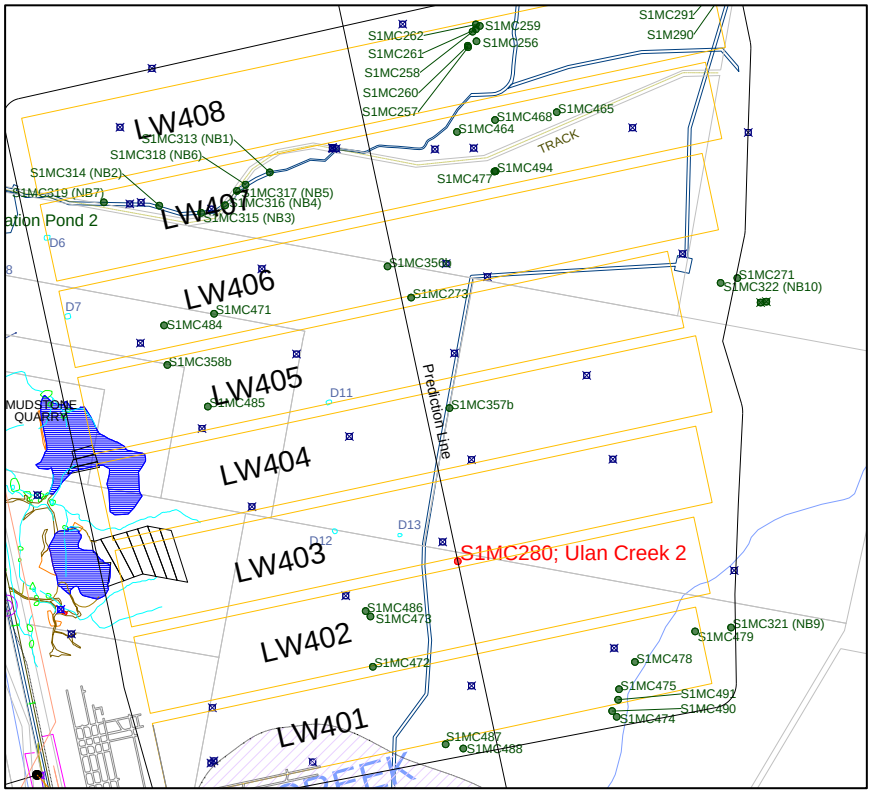

Figure 1 Location plan

The rock shelter faces north west with dimensions of approximately 14 m width and 6.5 overhang depth and is located to the north west of a topographical high point. The shelter is at the northern end of a sandstone outcrop with heights between approximately 3 m to 5 m, extending to the south west above the Longwall 402 maingate. The sandstone transitions to a steep slope above Longwall 402. The location of the sandstone outcrop and mapped shelter is shown in Figure 2 overlaid on a shaded relief diagram with 1 m surface contours.

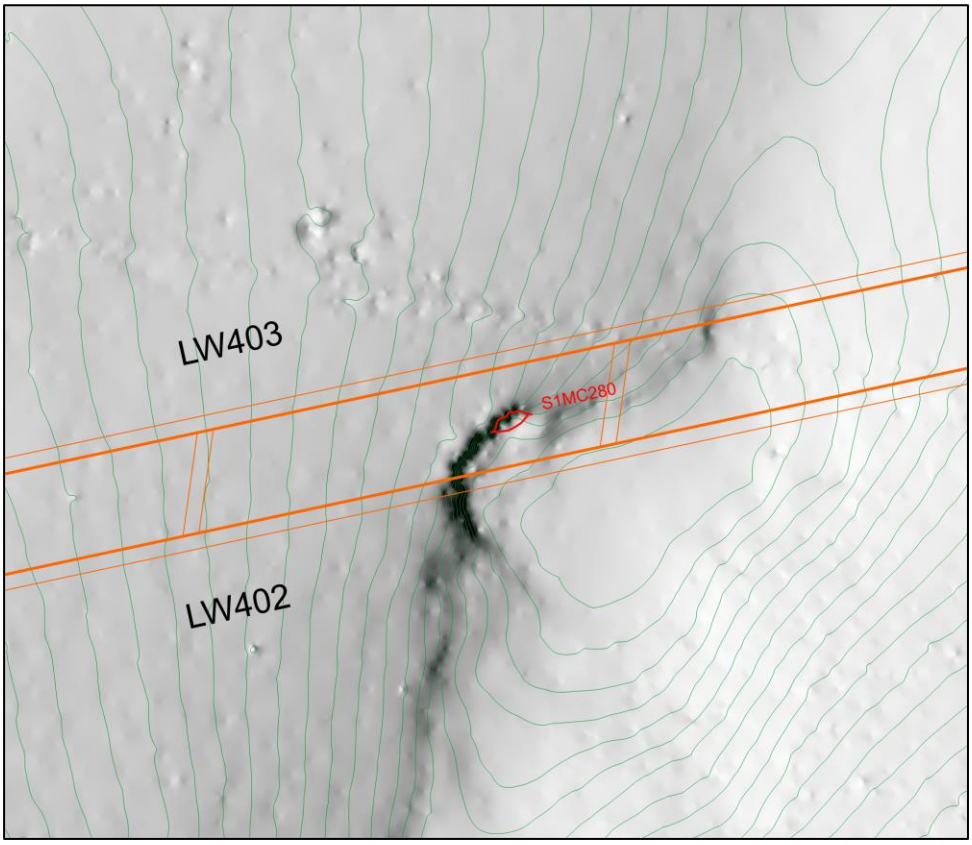

Figure 2 S1MC280 location

The proposed pillar widening comprises a 40 m increase in pillar width. The widening is proposed at the Longwall 403 tailgate, increasing the approved 35m pillar width to 75 m. The longitudinal length of the widened pillar is approximately 100 m either side of site S1MC280. The layout of the proposed pillar widening is shown in Figure 3.

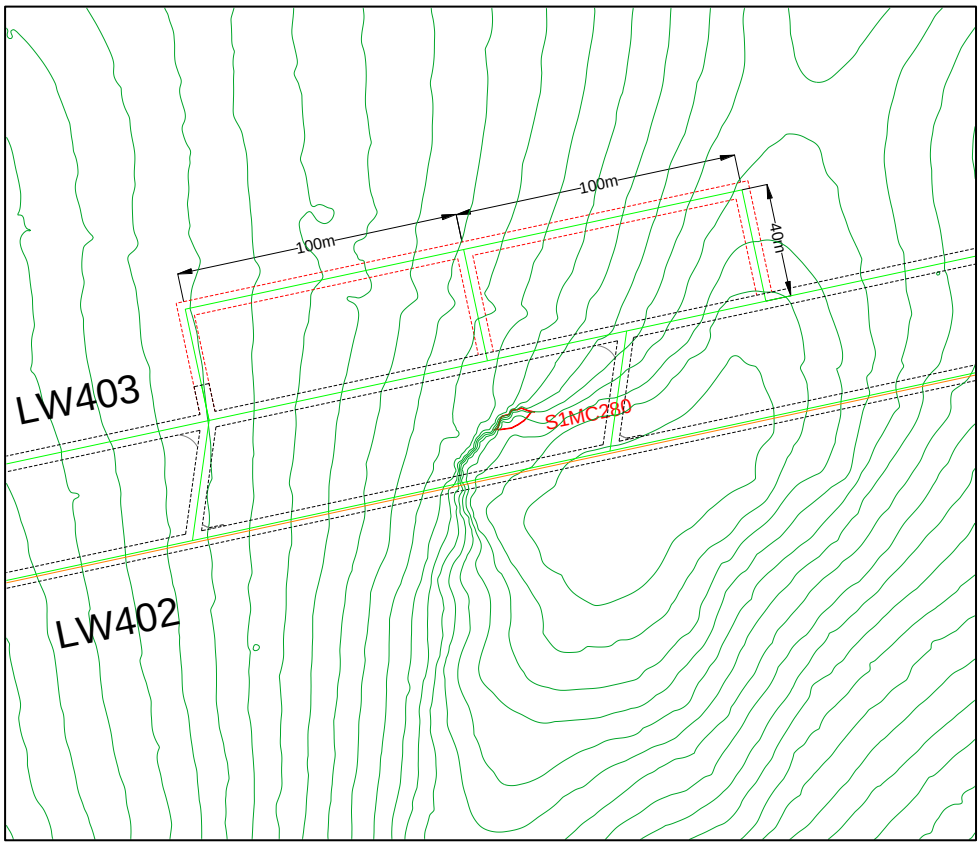

Figure 3 Proposed pillar widening at S1MC280

Subsidence predictions were undertaken for the 40m pillar widening case and compared to the predicted subsidence parameters for the Longwall 401 to 408 extraction plan. Report No. MSEC1165 outlines the predicted subsidence parameters and impact assessment for Aboriginal heritage Site S1MC280 for the Longwall 401 to 408 extraction plan.

A comparison of maximum predicted subsidence parameters at Site S1MC280 for the approved 35m pillar width and the pillar widening cases are summarised below in Table 1. A detailed summary of maximum predicted subsidence parameters at Site S1MC280 is provided in the attached Table A.

Table 1 Predicted Maximum Subsidence Parameters at Aboriginal Heritage Site S1MC280 after Longwall 408

Pillar Widening Case (m)	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})	Maximum Predicted Total Conventional Tensile Strain (mm/m)
No Widening (35m Pillar)	150	4.0	0.3	<0.01	2.5
40m Widening (75m Pillar)	100	5.0	0.2	<0.01	1.5

Note: predicted tensile strain is based on 10 times predicted hogging curvature.

It can be seen in Table 1 that there is a reduction in the maximum predicted subsidence parameters for the 40m pillar widening compared to the extraction plan with no pillar widening. It is noted that predicted maximum subsidence parameters for the Aboriginal heritage sites are based on the maxima within a 20m radius of the single

point site location. This typically provides a reasonable planar area for a heritage site which is typically identified by a single point location, and also provides a reasonable estimate of predicted subsidence parameters which can vary considerably at low magnitudes.

The contours of predicted vertical subsidence near site S1MC280 for the extraction plan with no pillar widening are shown in Figure 4. The contours of predicted vertical subsidence near site S1MC280 based on 40m pillar widening are shown in Figure 5.

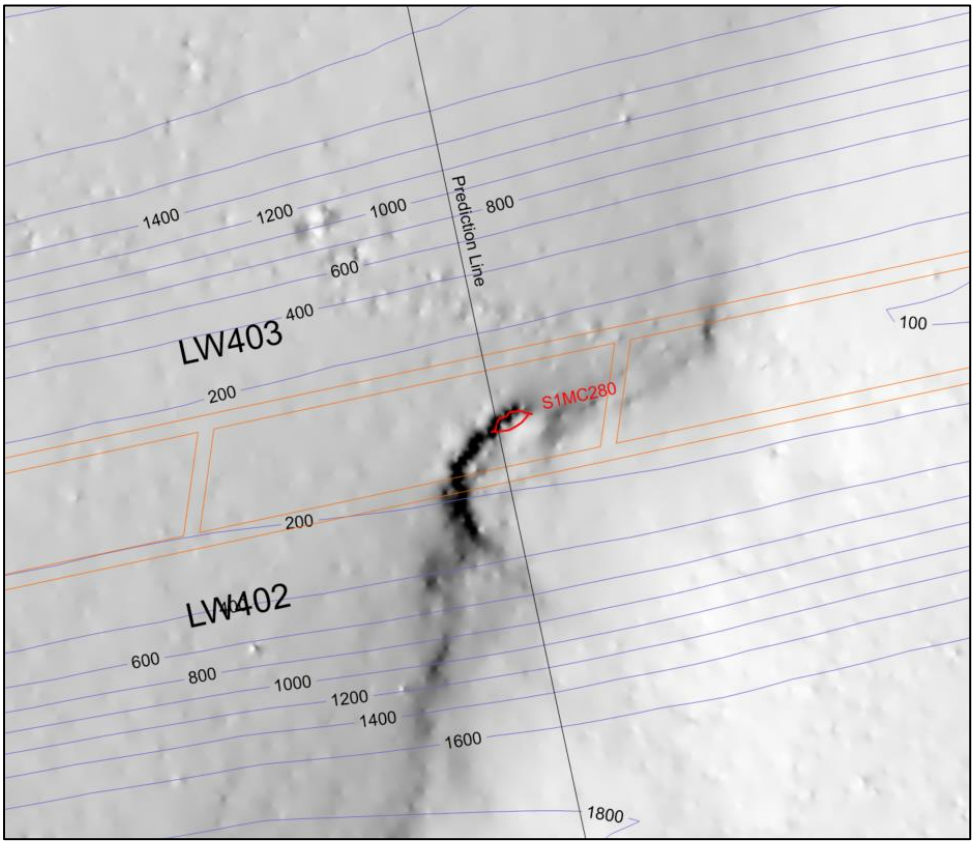

Figure 4 Predicted vertical subsidence contours with no pillar widening

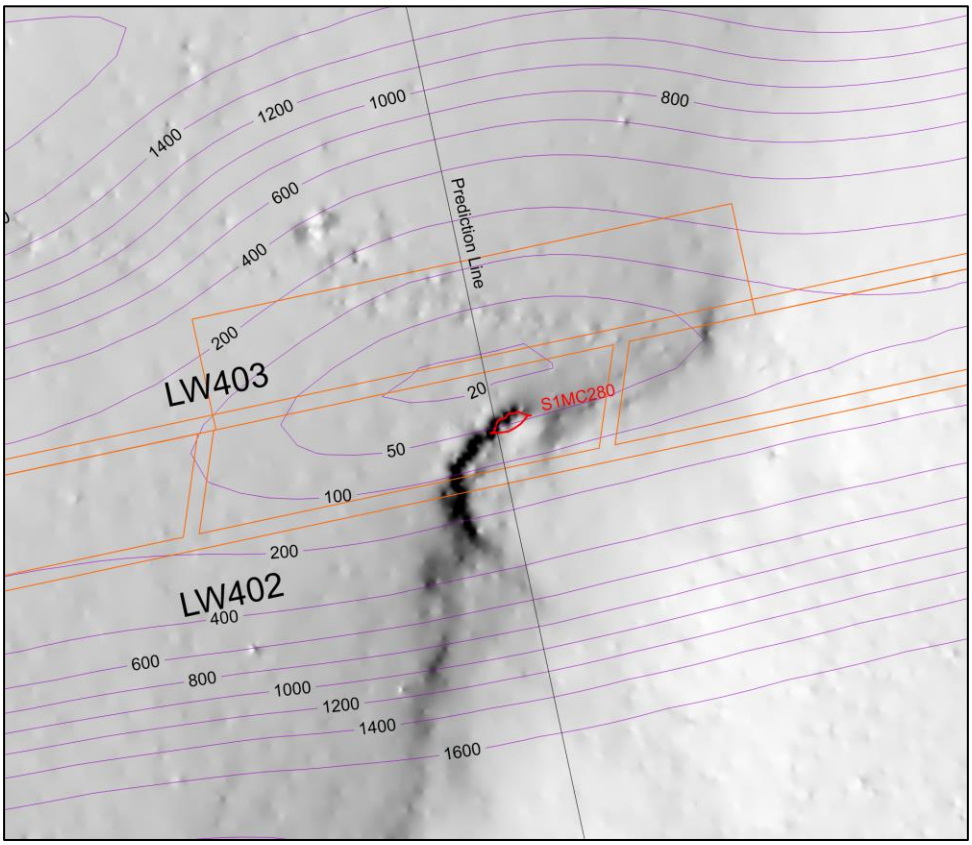

Figure 5 Predicted vertical subsidence contours for 40m pillar widening (purple) and 87m widening (green)

To show a comparison of the variation in predicted subsidence parameters across the longwall panels for the pillar widening case, the predicted subsidence parameters have been determined along a prediction line transverse to the longwall layout and through the location of Site S1MC280. The location of the prediction line is shown in Figure 4 and Figure 5. The results are shown below in Figure 6 and Figure 7.

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line S1MC280 due to Longwalls 401 to 408

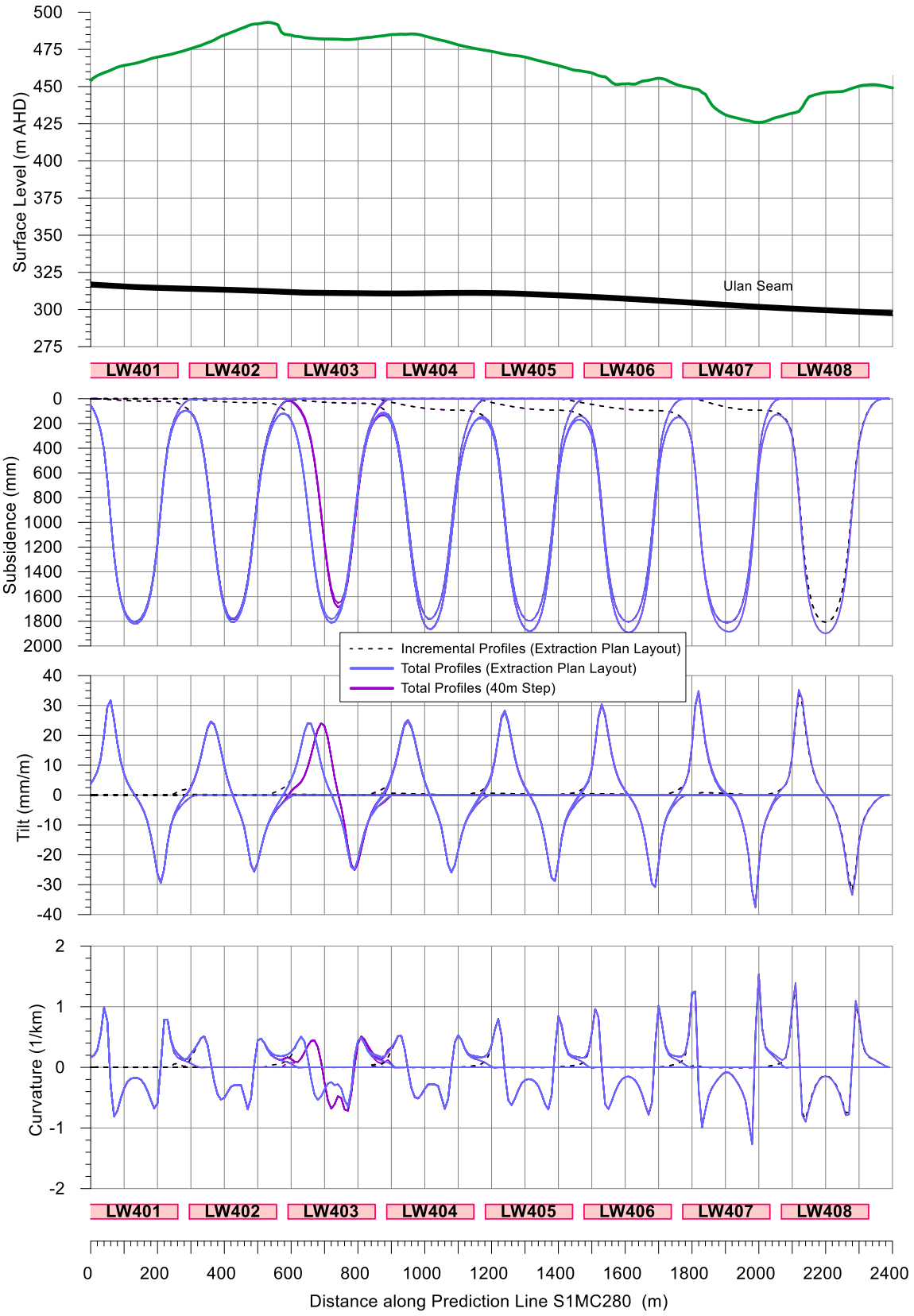

Figure 6 Predicted subsidence parameters along transverse prediction line (all longwalls)

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line S1MC280 due to Longwalls 401 to 408

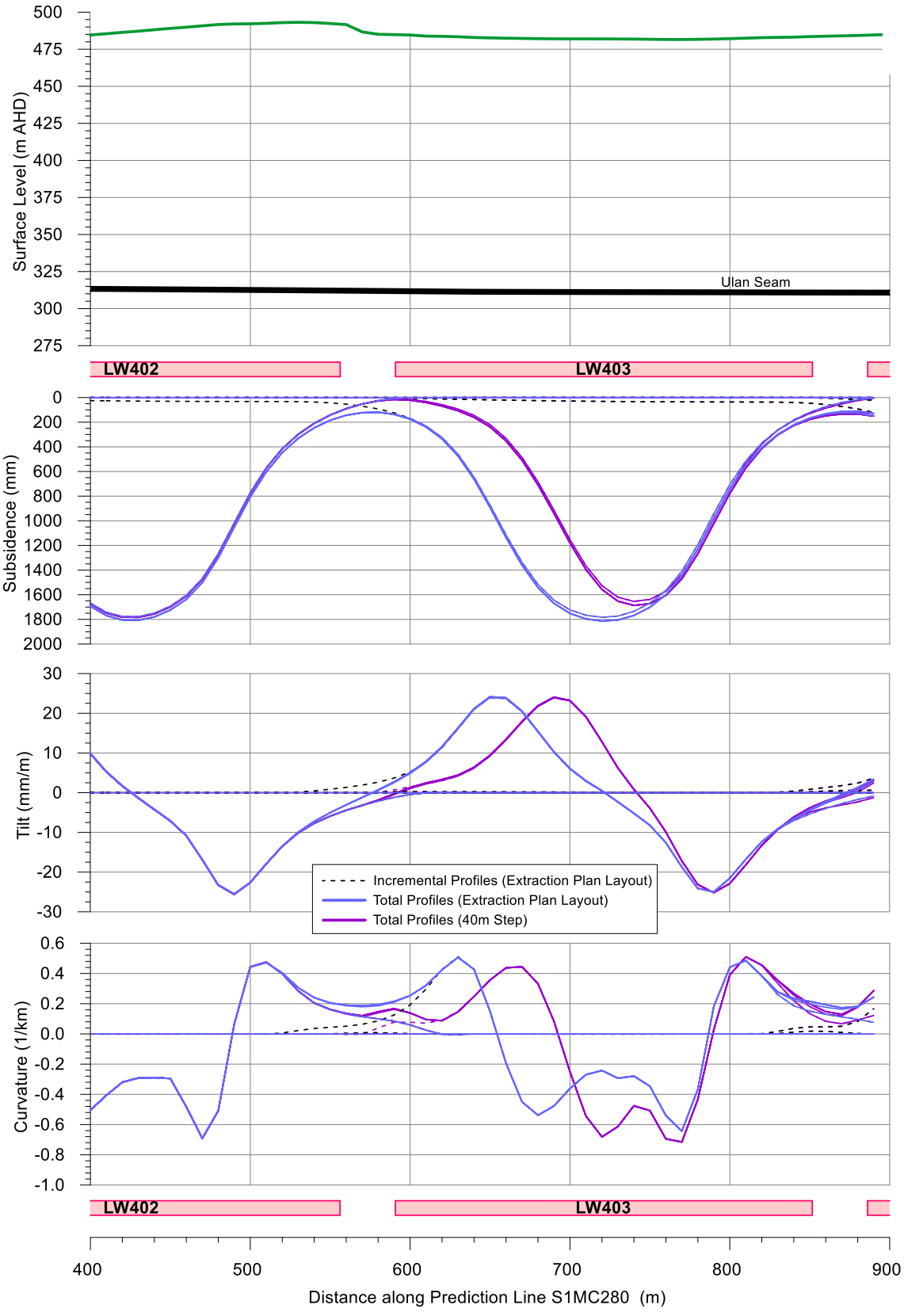

Figure 7 Predicted subsidence parameters along transverse prediction line (Longwall 402 and 403)

The variation in predicted total hogging curvature along the prediction line in Figure 6 and Figure 7, at the edges and centre of the pillar, are summarised in Table 2. The conventional tensile strains based on 10 times the predicted hogging curvature are also shown in Table 2. The parameters in Table 2 are for comparison between pillar widening cases only and do not represent final subsidence predictions for Site S1MC280, which are rounded to represent the accuracy of the prediction model.

Table 2 Predicted Maximum Subsidence Parameters along Prediction Line S1MC280 after Longwall 408

Location	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})		Maximum Predicted Total Conventional Tensile Strain (mm/m)	
	No Widening (35m Pillar)	40m Widening (75m Pillar)	No Widening (35m Pillar)	40m Widening (75m Pillar)
402 Maingate	0.19	0.15	1.9	1.5
Pillar Centre (S1MC280)	0.19	0.12	1.9	1.2
403 Tailgate	0.215	0.17	2.2	1.7

Note: predicted tensile strain is based on 10 times predicted hogging curvature.

It can be seen in Figure 4 to Figure 7 and in Table 2 that above the centre of the pillar at site S1MC280 the predicted vertical subsidence, tilt and curvature based on the 40 m pillar widening are significantly lower than those based on no pillar widening.

Based on the 40 m pillar widening, there is a significant reduction in the predicted subsidence parameters at site S1MC280 compared to the extraction plan with no pillar widening. The presence of the step on the Longwall 403 side of S1MC280 is considered to provide some additional protection for the site, however given that the sandstone outcrop extends from Site S1MC280 to the south west and is mined beneath by Longwall 402, the step is considered to result in only a marginal reduction in the likelihood of impact to Site S1MC280. Additional mitigation measures to isolate the site from the subsidence effects of Longwall 402 would result in a more significant reduction in the likelihood of impact to Site S1MC280.

I trust that this letter report is of assistance. If you have any questions, please do not hesitate to email or call me on (02) 9413-3777.

Yours sincerely,

Peter DeBono
Mine Subsidence Engineering Consultants

Table A - Maximum Predicted Subsidence Parameters for Aboriginal Heritage Site S1MC280

Pillar Widening Case	Description	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW401 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW402 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW403 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW404 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW405 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW406 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW407 (mm)	Maximum Predicted Subsidence based on the Extraction Plan Layout after LW408 (mm)	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW401
No Widening (35m Pillar)	Shelter with Artefacts and Grinding	< 20	100	150	150	150	150	150	150	< 0.5
40m Widening (75m Pillar)		< 20	100	100	100	100	100	100	100	< 0.5

Table A - Maximum Predicted Subsidence Parameters for Aboriginal Heritage Site S1MC280

Pillar Widening Case	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW402	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW403	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW404	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW405	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW406	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW407	Maximum Predicted Tilt based on the Extraction Plan Layout (mm/m) LW408	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW401	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW402	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW403
No Widening (35m Pillar)	5.0	4.0	4.0	4.0	4.0	4.0	4.0	< 0.01	0.2	0.2
40m Widening (75m Pillar)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	< 0.01	0.2	0.2

Table A - Maximum Predicted Subsidence Parameters for Aboriginal Heritage Site S1MC280

Pillar Widening Case	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW404	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW405	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW406	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW407	Maximum Predicted Hogging Curvature based on the Extraction Plan Layout (mm/m) LW408	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW401	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW402	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW403	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW404	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW405
No Widening (35m Pillar)	0.2	0.2	0.2	0.3	0.3	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
40m Widening (75m Pillar)	0.2	0.2	0.2	0.2	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table A - Maximum Predicted Subsidence Parameters for Aboriginal Heritage Site S1MC280

Pillar Widening Case	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW406	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW407	Maximum Predicted Sagging Curvature based on the Extraction Plan Layout (mm/m) LW408	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW401	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW402	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW403	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW404	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW405	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW406	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW407
No Widening (35m Pillar)	< 0.01	< 0.01	< 0.01	< 0.5	1.5	2.0	2.0	2.0	2.0	2.5
40m Widening (75m Pillar)	< 0.01	< 0.01	< 0.01	< 0.5	1.5	1.5	1.5	1.5	1.5	1.5

Table A - Maximum Predicted Subsidence Parameters for Aboriginal Heritage Site S1MC280

Pillar Widening Case	Maximum Predicted Tensile Strain based on the Extraction Plan Layout (mm/m) LW408	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW401	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW402	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW403	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW404	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW405	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW406	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW407	Maximum Predicted Comp. Strain based on the Extraction Plan Layout (mm/m) LW408
No Widening (35m Pillar)	2.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
40m Widening (75m Pillar)	1.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

ATTACHMENT 2

MOOLARBEN COAL OPERATIONS – LONGWALLS 401 TO 408 SUBSIDENCE PREDICTIONS FOR 'EARLY WARNING' MONITORING SITE

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4 November 2022

Moolarben Coal Operations Pty Ltd
Locked Bag 2003
Mudgee NSW 2850

Reference: MSEC1165-400

For the attention of Liam Mildon, UG Technical Services Manager

Dear Liam,

RE: Moolarben Project Stage 1 – Longwalls 401 to 408
Assessment proposed pillar monitoring lines for site S1MC280 TARP

Further to your email of 31 October 2022, Mine Subsidence Engineering Consultants (MSEC) have undertaken an assessment for proposed pillar monitoring ahead of longwall extraction near Aboriginal heritage site S1MC280 within the UG4 mining area. The proposed monitoring will form part of a management plan for site S1MC280. MSEC prepared report No. MSEC1165 in support of the extraction plan application for Longwall 401 to 408 within UG4.

Site S1MC280 includes a rock shelter with hand stencils, artefacts and grinding grooves and has jointing at 5 m to 10 m spacing with some collapsed rock. The site is located centrally above the chain pillar between Longwalls 402 and 403 as shown in Figure 1.

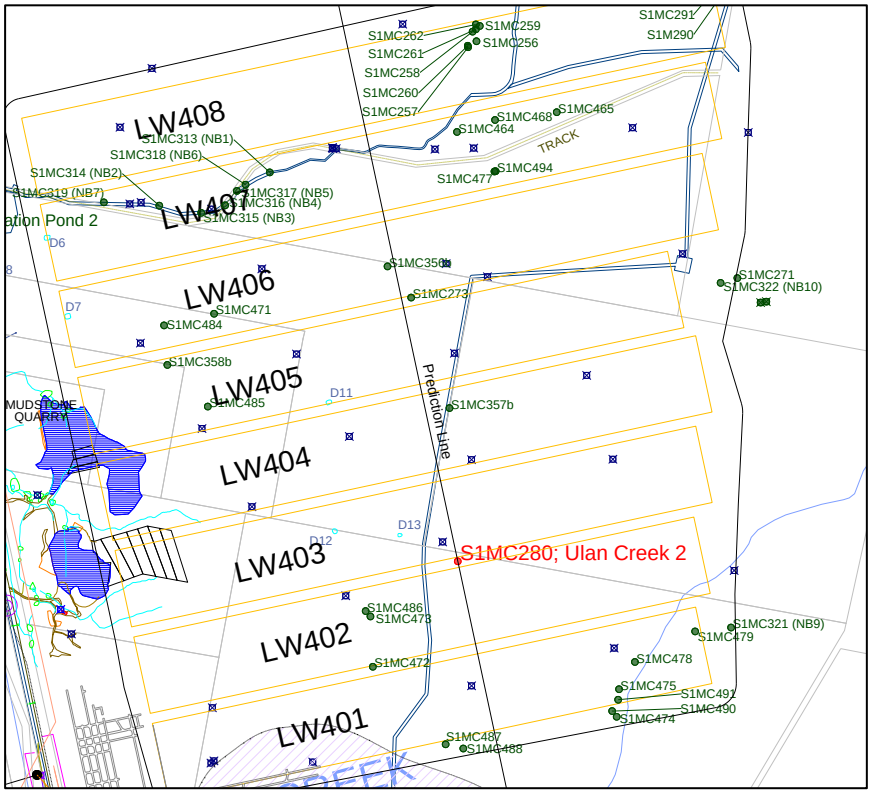

Figure 1 Location plan

A management plan is being prepared for site S1MC280. In addition to monitoring and mitigation measures at the location of S1MC280, a series of three monitoring lines will be installed ahead of S1MC280 to observed the subsidence movements at an equivalent location prior to longwall extraction near the site. The location of the monitoring lines will be above the chain pillar between Longwalls 402 and 403 at approximately 420 m from the commencing end of Longwall 402. The location of S1MC280 is approximately 800 m from the commencing end of Longwall 402. The locations of the proposed monitoring lines and site S1MC280 are shown below in Figure 2.

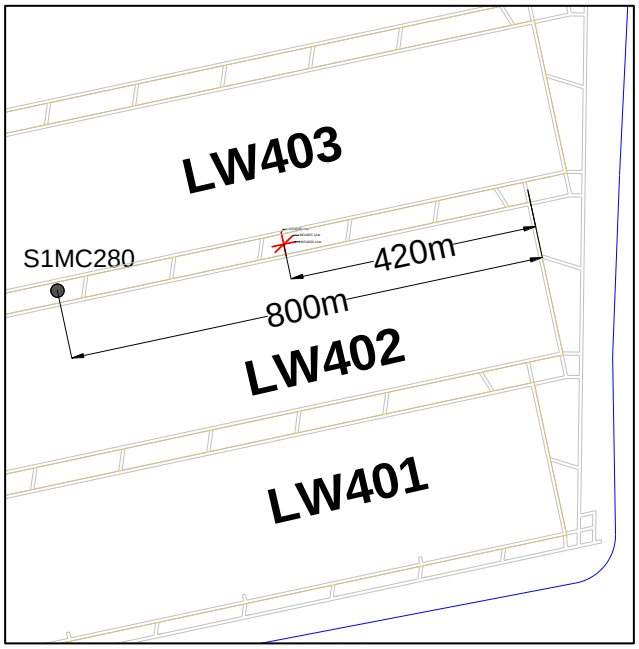

Figure 2 S1MC280 and monitoring site location

The proposed monitoring lines will include three lines of approximately 40 m length each. Two of the lines will be located parallel and perpendicular to the longwall and chain pillar, and the third line will be oriented at a similar angle to the longwall as the face of the shelter at S1MC280. The proposed lines are shown in Figure 3.

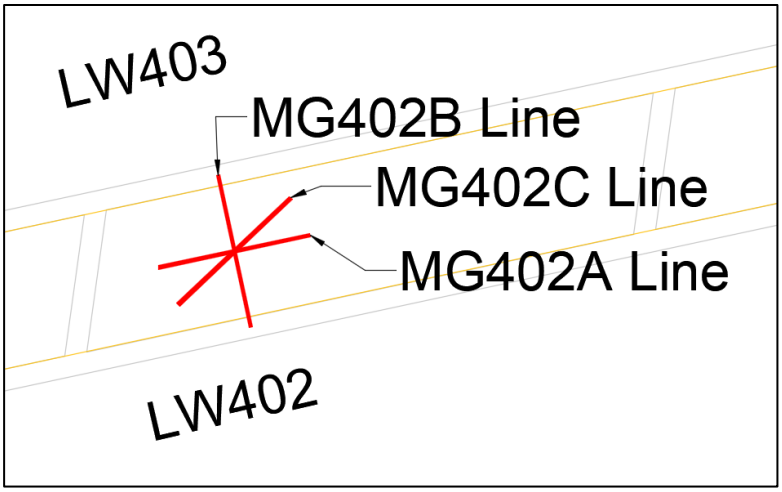

Figure 3 Pillar monitoring lines

Subsidence predictions were undertaken for the three pillar monitoring lines shown in Figure 3. The predicted subsidence, tilt and curvature for each of the lines are shown in Figure 4, Figure 5, and Figure 6. The predicted conventional strain based on a relationship of 10 times curvature is also show in these figures. The predicted subsidence parameters at the completion of each longwall are shown as blue lines, and the predicted parameters for each 20m of extraction of Longwall 402 are shown as purple lines.

The predictions indicate that along MG402A Line tilts of greater than 1mm/m could develop during extraction and both tension (positive/hogging curvature) and compression (negative/sagging curvature) are expected to develop. along MG402B and C, tilt towards Longwall 402 of up to 5.5mm/m and net tension (positive/hogging curvature) are predicted.

The increases in the predicted subsidence parameters are expected to be observed between approximately 420 m and 540 m from the commencing end of Longwall 402. The development of the subsidence parameters is therefore expected to be observed when the Longwall 402 face position is close to the monitoring lines to approximately 100 m beyond the monitoring lines.

I trust that this letter report is of assistance. If you have any questions, please do not hesitate to email or call me on (02) 9413-3777.

Yours sincerely,

Peter DeBono
Mine Subsidence Engineering Consultants

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along MG402A Line due to Longwalls 401 to 408

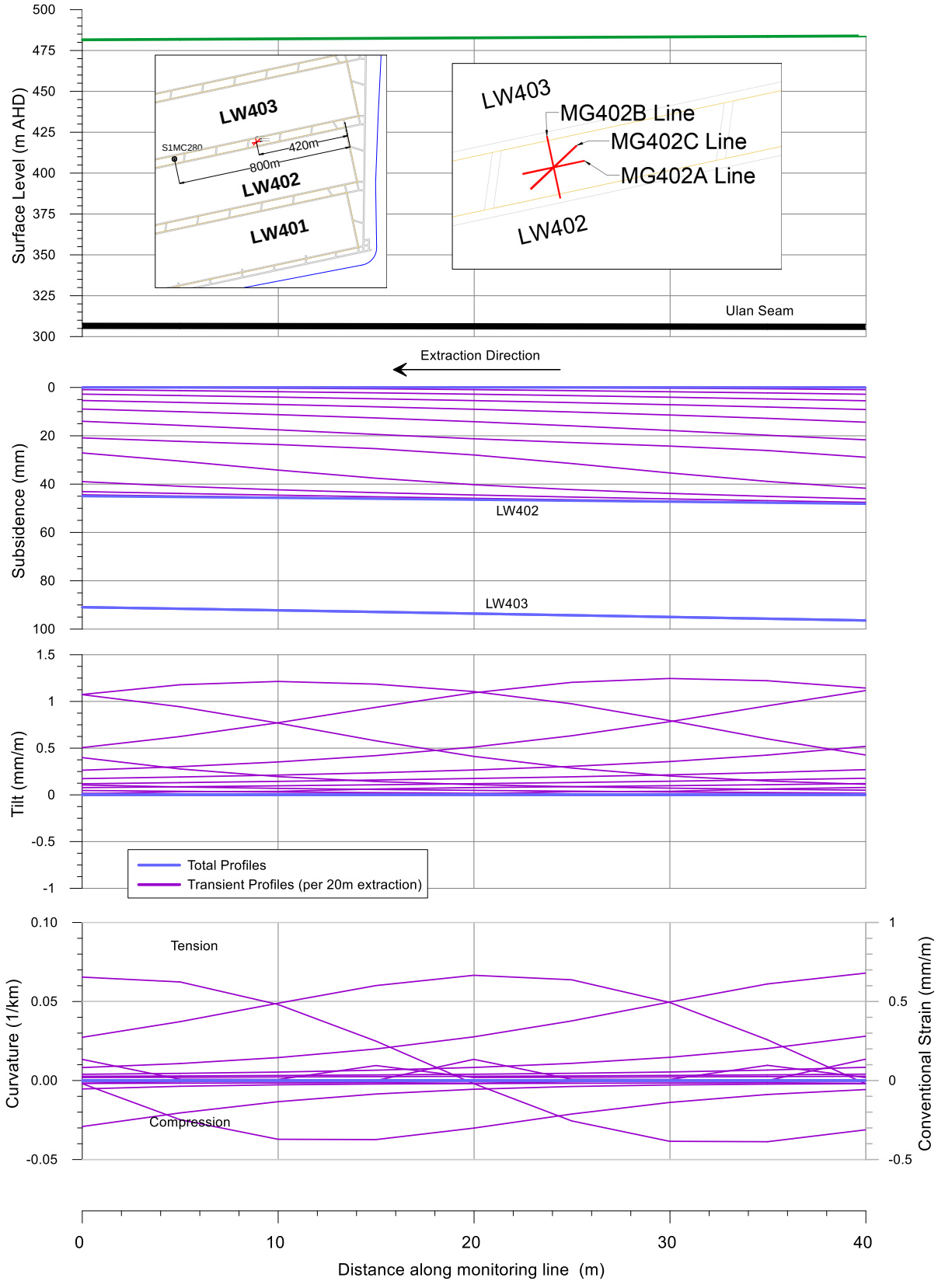

Figure 4 Predicted subsidence parameters along MG402A Line

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along MG402B Line due to Longwalls 401 to 408

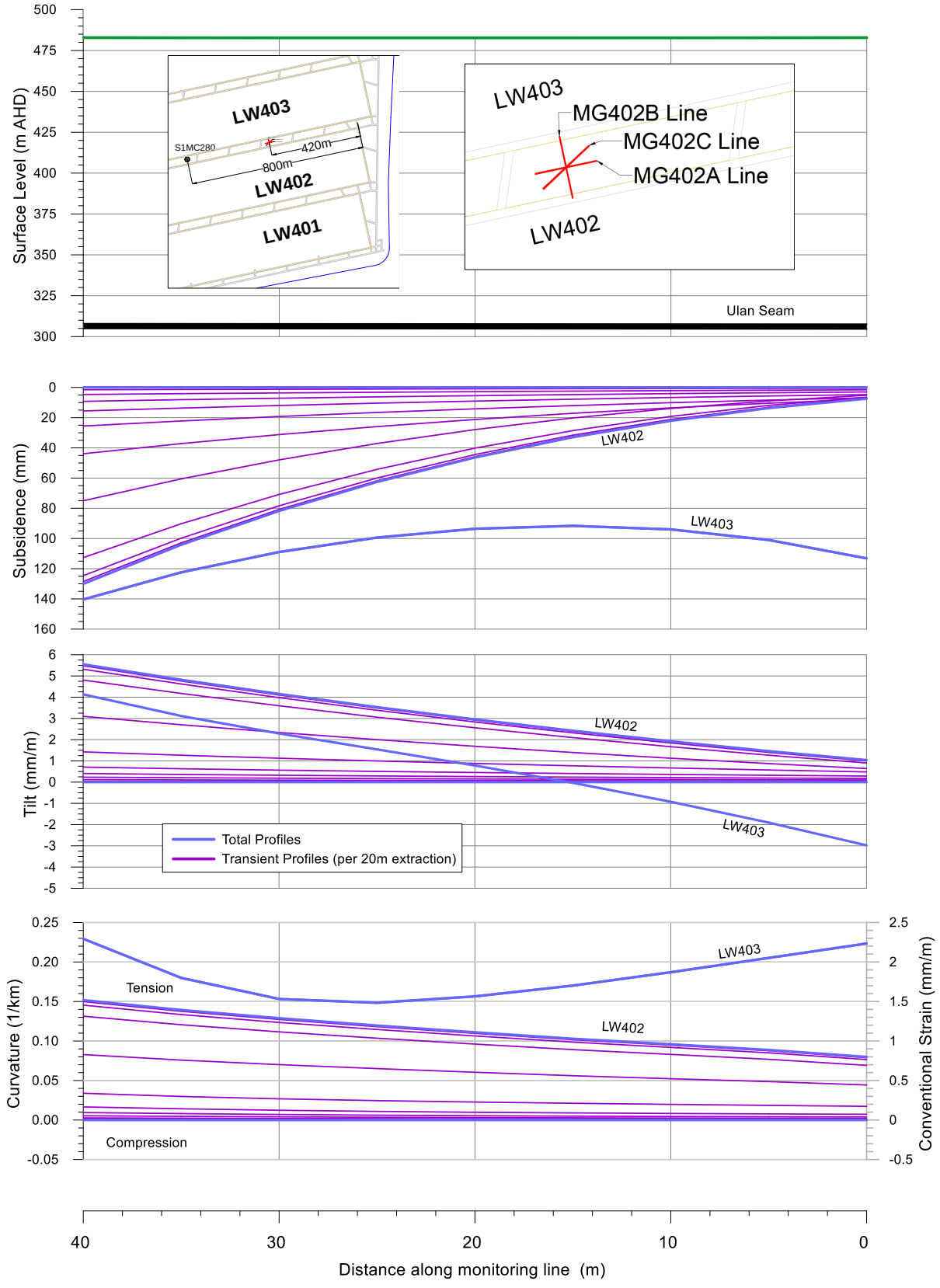

Figure 5 Predicted subsidence parameters along MG402B Line

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along MG402C Line due to Longwalls 401 to 408

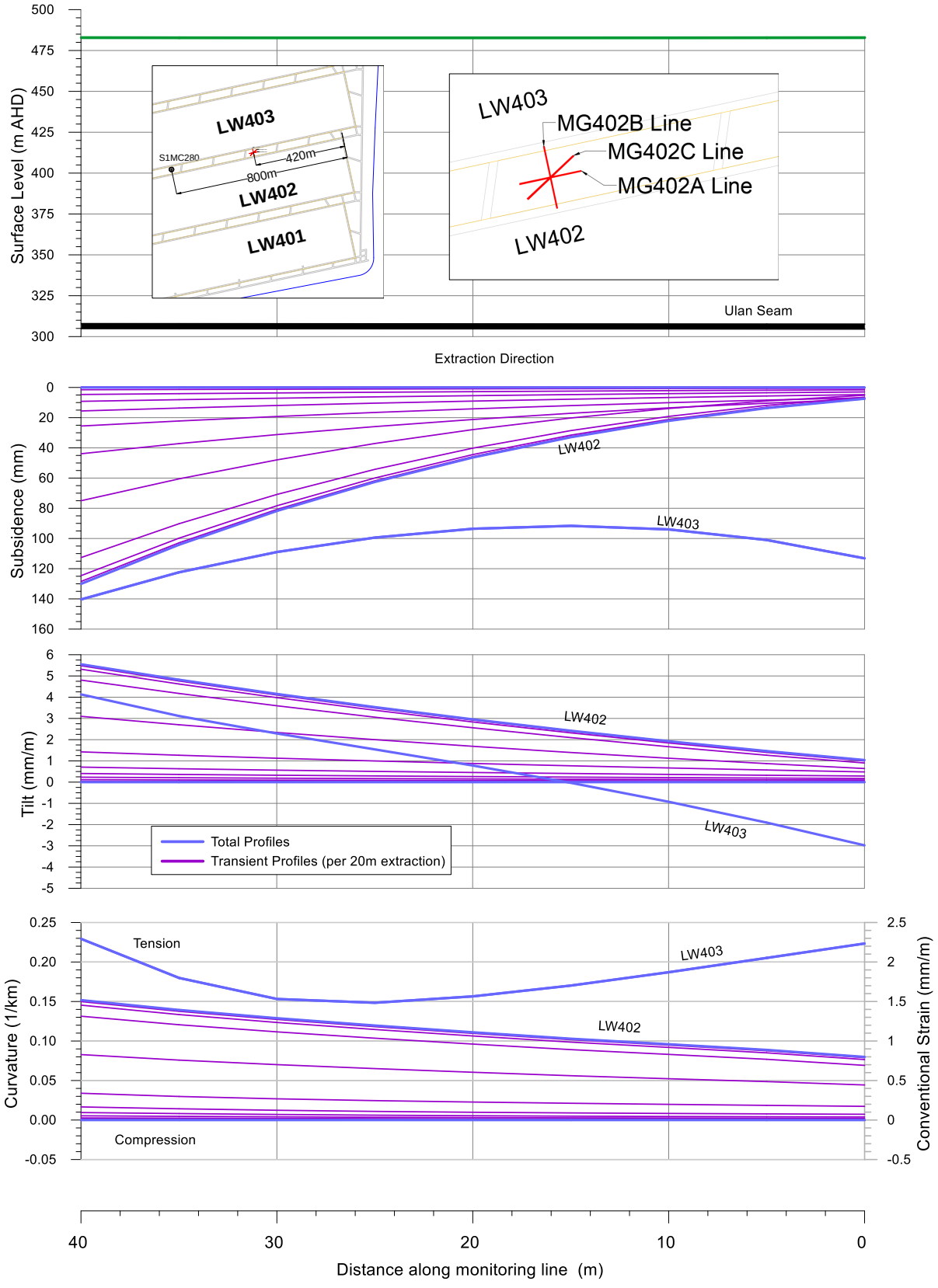

Figure 6 Predicted subsidence parameters along MG402C Line

ATTACHMENT 3

UG4 LONGWALLS 401 TO 408
TARP - 'EARLY WARNING' SUBSIDENCE MONITORING SITE

TARP – 'EARLY WARNING' SUBSIDENCE MONITORING SITE

Condition	Normal		Level 1	Level 2	Level 3
	Baseline Conditions	**Active Mining Predicted Impacts**			
Trigger		Subsidence Monitoring at 'Early Warning' Site • Vertical Subsidence @ MG402A Line Centre <150mm • Tilt @ Site Centre <4mm/m	Observed Subsidence Parameters Greater than Predicted • Vertical Subsidence @ MG402A Line Centre >150mm and <200mm • Tilt @ Site Centre >4mm/m and <6mm/m	Observed Subsidence Parameters Greater than Predicted • Vertical Subsidence @ MG402A Line Centre >200mm and <250mm • Tilt @ Site Centre >6mm/m and <8mm/m	Observed Subsidence Parameters Greater than Predicted • Vertical Subsidence @ MG402A Line Centre >250mm • Tilt @ Site Centre >8mm/m
Action	Establish baseline subsidence monitoring lines, including: 3D Monitoring of • MG402A Line • MG402B Line • MG402C Line Parameters to include: • Easting; • Northing; • Vertical Subsidence; • Tilt; • Strain	Conduct monitoring as described Baseline Condition On the Dayshift Immediately Following the LW Face Position 200m Inbye the Centre Point 150m Inbye the Centre Point 100m Inbye the Centre Point 50m Inbye the Centre Point At the Centre Point 50m Outbye the Centre Point 100m Outbye the Centre Point 150m Outbye the Centre Point 195m Outbye the Centre Point (at MG402 12CT) LW Mining in LW402 and LW403 is to Hold at MG402 12CT* until the monitoring data collected above has been reviewed by the Site S1MC280 Steering Committee and the associated TARP level assessed LW Mining to continue if TARP level assessed to be Normal	LW Mining in LW402 and LW403 is to Hold at MG402 12CT until the monitoring data has been reviewed by the Site S1MC280 Steering Committee and the associated TARP level assessed LW Mining to hold at MG402 12CT* until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions	LW Mining in LW402 and LW403 is to Hold at MG402 12CT until the monitoring data has been reviewed by the Site S1MC280 Steering Committee and the associated TARP level assessed LW Mining to hold at MG402 12CT* until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions Actions to specifically include Review Implementation of additional Vertical Stress Relief Slots at Site S1MC280 Review LW Face Position in relation to Site S1MC280 Review LW Recovery Face Position	LW Mining in LW402 and LW403 is to Hold at MG402 12CT until the monitoring data has been reviewed by the Site S1MC280 Steering Committee and the associated TARP level assessed LW Mining to hold at MG402 12CT* until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions Actions to specifically include Implementation of additional Vertical Stress Relief Slots at Site S1MC280 Review LW Face Position in relation to Site S1MC280 Review LW Recovery Face Position
Frequency	Prior to the commencement of LW402	As Outlined Above	As per Normal Condition	As per Normal Condition	As per Normal Condition
Position of Decision Making		Site S1MC280 Steering Committee	Site S1MC280 Steering Committee	Site S1MC280 Steering Committee	Site S1MC280 Steering Committee

* The hold point position may vary nominally from MG402 12CT if longwall mining conditions prohibit stopping at MG402 12CT. Varying this hold point will be reviewed and determined by the S1MC280 Steering Committee if required

ATTACHMENT 4

UG4 LONGWALLS 401 TO 408
TARP - S1MC280 SITE MONITORING
TARP - S1MC280 SUBSIDENCE MONITORING

TARP - S1MC280 SITE MONITORING					
Condition	**Normal**		**Level 1**	**Level 2**	**Level 3**
	Baseline Conditions	**Active Mining Predicted Impacts**			
Trigger		No Significant Subsidence Impacts Slot Width Monitoring – Closure of Vertical Slots < 2mm – Tilt < 5mm/m – S1MC280 Overhang Closure <10mm	No Significant Subsidence Impacts and Slot Width Monitoring – Closure of Vertical Slots =>2mm and <4mm – Tilt >5mm/m and <7mm/m – S1MC280 Overhang Closure >10mm and <15mm	No Significant Subsidence Impacts and Slot Width Monitoring – Closure of Vertical Slots =>4mm and <8mm – Tilt >7mm/m and <9mm/m – S1MC280 Overhang Closure >15mm and <20mm	Significant Subsidence Impact* at Site S1MC280 or Slot Width Monitoring – Closure of Vertical Slots =>8mm – Tilt >9mm/m – S1MC280 Overhang Closure >20mm
Action	Establish baseline data, including: • Pre-extraction condition of Site S1MC280 prior to LW402 Mining • Implement LW403 TG Shortening Plan • Implement Site S1MC280 Stress Relief Vertical Slots • Establish Baseline Monitoring at Site S1MC280 – Visual Monitoring – Slot Width Monitoring – Stress Change Borehole Monitoring – Tilt Monitoring – Closure Monitoring	Conduct monitoring as described in **Section 4**, including: • Visual Monitoring • Slot Width Monitoring • Stress Change Borehole Monitoring • Tilt Monitoring • Closure Monitoring • Slot Width Monitoring Calliper • Borehole Camera LW Mining to continue if TARP level assessed to be Normal	Continue monitoring • Visual Monitoring • Slot Width Monitoring • Stress Change Borehole Monitoring • Tilt Monitoring • Closure Monitoring • Slot Width Monitoring Calliper • Borehole Camera Hold LW Face Position and advise Site S1MC280 Steering Committee of Level 1 TARP Trigger Review MSEC Subsidence Modelling Data and update the MSEC model with the Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions including • Implementation of Additional Stress Relief Slots LW Mining to continue based on S1MC280 Steering Committee review and decision	Continue monitoring • Visual Monitoring • Slot Width Monitoring • Stress Change Borehole Monitoring • Tilt Monitoring • Closure Monitoring • Slot Width Monitoring Calliper • Borehole Camera Hold LW Face Position and advise Site S1MC280 Steering Committee of Level 2 TARP Trigger Review MSEC Subsidence Modelling Data and update the MSEC model with the Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions including • Implementation of Additional Stress Relief Slots • Review LW Face Position in relation to S1MC280 • LW Final Recovery Position • Review Implementation of Temporary Standing Support under Overhang at S1MC280 after consultation with Registered Aboriginal Parties and if determined to be safe to do so • LW Mining to continue based on S1MC280 Steering Committee review and decision	Continue monitoring • Visual Monitoring • Slot Width Monitoring • Stress Change Borehole Monitoring • Tilt Monitoring • Closure Monitoring • Slot Width Monitoring Calliper • Borehole Camera Hold LW Face Position and advise Site S1MC280 Steering Committee of Level 3 TARP Trigger Review MSEC Subsidence Modelling Data and update the MSEC model with the Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions including • Implementation of Additional Stress Relief Slots • Review LW Face Position in relation to S1MC280 • LW Final Recovery Position • Implementation of Temporary Standing Support under Overhang at S1MC280 after consultation with Registered Aboriginal Parties and if determined to be safe to do so • LW Mining to continue based on S1MC280 Steering Committee review

Frequency	Prior to LW402 Extraction • Baseline condition of Site S1MC280 • LW403 TG Shortening Plan Implemented in Mine Design Change Prior to LW Extraction past MG402 12CT • Site S1MC280 Stress Relief Vertical Slots Implemented • Visual Monitoring • Slot Width Monitoring • Stress Change Borehole Monitoring • Tilt Monitoring • Closure Monitoring	Daily from during LW Mining in LW402 and LW403 when face is between 200m Inbye to 200m Outbye S1MC280 • Visual Monitoring • Slot Width Monitoring • Tilt Monitoring • Closure Monitoring As Required by the Technical Committee • Stress Change Borehole Monitoring • Slot Width Monitoring Calliper • Borehole Camera	Daily from during LW Mining in LW402 and LW403 when face is between 200m Inbye to 200m Outbye S1MC280 • Visual Monitoring • Slot Width Monitoring • Tilt Monitoring • Closure Monitoring As Required by the Technical Committee • Stress Change Borehole Monitoring • Slot Width Monitoring Calliper • Borehole Camera	Daily from during LW Mining in LW402 and LW403 when face is between 200m Inbye to 200m Outbye S1MC280 • Visual Monitoring • Slot Width Monitoring • Tilt Monitoring • Closure Monitoring As Required by the Technical Committee • Stress Change Borehole Monitoring • Slot Width Monitoring Calliper • Borehole Camera	Daily from during LW Mining in LW402 and LW403 when face is between 200m Inbye to 200m Outbye S1MC280 • Visual Monitoring • Slot Width Monitoring • Tilt Monitoring • Closure Monitoring As Required by the Technical Committee • Stress Change Borehole Monitoring • Slot Width Monitoring Calliper • Borehole Camera
Position of Decision Making		• Site S1MC280 Steering Committee	• Site S1MC280 Steering Committee	• Site S1MC280 Steering Committee	• Site S1MC280 Steering Committee

*Significant Site Impact is outlined in in Table 2 and is defined as

- overhang collapse; or
- cracking of sandstone that coincides with the Aboriginal heritage feature(s) of the site that make it significant; or
- rock fall that damages the Aboriginal heritage feature(s) of the site that make it significant that cannot be attributed to natural weathering or deterioration.

TARP - S1MC280 SUBSIDENCE MONITORING

Condition	Normal		Level 1	Level 2	Level 3
	Baseline Conditions	**Active Mining Predicted Impacts**			
Trigger		Subsidence Monitoring on S1MC280 Lines • Vertical Subsidence @ S1MC280A Line Centre <100mm • Tilt @ S1MC280A Line Centre <5mm/m	Observed Subsidence Parameters Greater than Predicted • Vertical Subsidence @ S1MC280A Line Centre >100mm and <150mm • Tilt @ S1MC280A Line Centre >5mm/m and <7mm/m	Observed Subsidence Parameters Greater than Predicted • • Vertical Subsidence @ S1MC280A Line Centre >150mm and <200mm • Tilt @ S1MC280A Line Centre >7mm/m and <9mm/m	Observed Subsidence Parameters Greater than Predicted • Vertical Subsidence @ S1MC280A Line Centre >200mm • Tilt @ S1MC280A Line Centre >9mm/m
Action	Establish baseline subsidence monitoring lines, including: 3D Monitoring of • S1MC280A Line • S1MC280B Line • S1MC280C Line Parameters to include: • Easting; • Northing; • Vertical Subsidence; • Tilt; • Strain	Conduct monitoring as described Baseline Condition On the Dayshift Immediately Following the LW Face Position 200m Inbye the Centre Point 150m Inbye the Centre Point 100m Inbye the Centre Point 50m Inbye the Centre Point At the Centre Point 50m Outbye the Centre Point 100m Outbye the Centre Point 150m Outbye the Centre Point 200m Outbye the Centre Point Site S1MC280 Technical Committee to review the data within 24 hours of survey and assess associated TARP level LW Mining to continue if TARP level assessed to be Normal	Conduct monitoring as described Baseline Condition LW Mining to hold until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions	Conduct monitoring as described Baseline Condition LW Mining to hold until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions Actions to specifically include Implementation of additional Vertical Stress Relief Slots at Site S1MC280 Review LW Face Position in relation to Site S1MC280 Review LW Recovery Face Position Review Implementation of Temporary Standing Support under Overhang at S1MC280 after consultation with Registered Aboriginal Parties and if determined to be safe to do so	Conduct monitoring as described Baseline Condition LW Mining to hold until: Review MSEC Subsidence Modelling Data and update the MSEC model with the Subsidence Monitoring Data Site S1MC280 Technical Committee to assess potential for impact on Site S1MC280 based on updated MSEC Model and advise Steering Committee on recommended actions Actions to specifically include Review LW Recovery Face Position Implementation of additional Vertical Stress Relief Slots at Site S1MC280 Review Implementation of Temporary Standing Support under Overhang at S1MC280 after consultation with Registered Aboriginal Parties and if determined to be safe to do so
Frequency	Prior to the commencement of LW402	As Outlined Above			
Position of Decision Making		Site S1MC280 Steering Committee	Site S1MC280 Steering Committee	Site S1MC280 Steering Committee	Site S1MC280 Steering Committee