

WAMBO COAL PTY LIMITED



LONGWALL 24 FIRST WORKINGS MODIFICATION

MODIFICATION REPORT

For the Modification of DA 305-7-2003 (MOD 18)
Reorientation of the First Workings for Longwall 24
of the Approved South Bates Extension Underground Mine

APPENDIX A

First Workings Stability Review

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Lee Earnshaw
Senior Underground Mining Engineer
Peabody Energy Australia

Report No.: WAMBO61/01

Lee,

SUBJECT: Longwall 24 to 26 First-Workings Pillar Stability Review

1. INTRODUCTION

Mine Advice Pty Ltd (Mine Advice) has been retained by Peabody Energy Australia (Peabody) to review the first-workings stability of chain, perimeter, barrier, and main heading pillars associated with Longwall's (LW's) 24 to 26 at North Wambo Underground (NWU) Mine – South Bates Extended (SBX) workings (refer **Drawing 1** in **Appendix A**).

As requested, the proposed pillars have been reviewed in accordance with the NSW Work Health and Safety (Mines) Regulation 2014 and NWU's development consent conditions. Specifically, Clause B6 which states:

"The Applicant may carry out first workings within the underground mining areas of the approved mine plan, other than in accordance with an approved Extraction Plan, provided that the Resources Regulator is satisfied that the first workings are designed to remain stable and non-subsiding in the long-term, except insofar as they may be impacted by approved second workings."

"Note: The intent of this condition is to ensure that first workings are built to geotechnical and engineering standards sufficient to ensure long term stability, with negligible direct subsidence impacts."

NB: the first-workings pillar stability review has been undertaken according to the Client-supplied mine plan (refer **Drawing 1**) and WWA Ply cover depth contours (refer **Drawing 2**).

The design methodology used for the first-workings pillar stability assessment will be that of the University of New South Wales (UNSW) Pillar Design Procedure (PDP), specifically the Generalised Rectangular Power pillar strength formulae (**Galvin et al 1999**) divided by Full Tributary Area Loading (FTAL) to provide a Factor of Safety (FoS) against core pillar failure. It is assumed that the reader is familiar with the UNSW PDP and as such it will not be described in detail herein (apart from those aspects of the methodology relating directly to its use at SBX).

It is noted that two pillar stability assessments have been previously undertaken for the SBX mining area, the first covering LW's 17 to 25 as part of the South Bates Underground Extension Project (SBUEP) Geotechnical Feasibility Study (**Mine Advice 2016**), and the second covering LW's 23 to 25 but in a

different layout/orientation (**Mine Advice 2020**). To avoid any unnecessary repetition, this report will reference the findings of previous assessments wherever possible.

2. GEOTECHNICAL AND OPERATIONAL DESIGN INPUTS

This section of the report summarises the key geotechnical and operational design inputs relating to the first-workings stability of coal pillars associated with LW's 24 to 26, including the S10 Main Headings (Mains).

The inputs are based on information contained within previous assessments and design reports relating to the SBX mining area (including **Mine Advice 2016** and **2020**) as well as various mine plans and drawings supplied by the Client. As this review relates exclusively to first-workings pillars, only those inputs that relate to first-workings pillar stability will be detailed:

- Nominal roadway height = 3.0 m
- Nominal roadway width = 5.4 m
- Assumed average overburden density = 2,500 kg/m³
- Assumed vertical pressure gradient = 0.025 MPa/m
- Assumed Abutment Angle = 21°

The above design inputs will now be used to review the first-workings stability of the coal pillars associated with LW's 24 to 26, including the S10 Mains.

3. ANALYSES

As discussed, the design output of the UNSW PDP is a FoS against core pillar failure calculated by dividing pillar strength by average pillar stress. All factors being equal a FoS of 1.0 represents a 50% chance that the pillar will fail and 50% chance the pillar will not fail. A significant attribute of the UNSW PDP is that a pillars' FoS can be linked directly to a probability of failure (PoF) via statistical analysis of the founding empirical database.

Although there are no prescriptive requirements in NSW relating to the selection of an appropriate FoS or PoF for different design situations, the following guidelines are indicated by the UNSW (based on South African experience) and have been commonly adopted for use in Australia (**Gale and Hebblewhite 2005**):

- for bord and pillar production panels where there is to be no future retreat extraction, an acceptable probability of failure is 3 in 1,000 (i.e. FoS $\approx$ 1.54)
- for life of mine workings (e.g. main headings and barrier pillars), an acceptable probability of failure is 1 in 1,000,000 (i.e. FoS $\approx$ 2.11)

It should be noted that first-workings FoS calculated for chain, perimeter, and barrier pillars bound on either side by large solid abutments are likely to be much greater than the above guidelines for bord and pillar production panels. This is to be expected considering the pillars are ultimately designed for Abutment Loads that will be present during and following longwall extraction. As discussed, the second-workings stability of chain, perimeter, and barrier pillars will not be discussed in this report.

Finally, the first-workings stability of coal pillars is typically assessed according to FTAL to surface. On the basis that this assessment relates to first-workings stability only, the UNSW PDP FoS values will be calculated by dividing pillar strength by average pillar stress calculated according to Tributary Area Theory (TAT).

First-Workings Stability of Chain Pillars

The UNSW PDP analyses for both the nominal and smallest chain pillar dimensions confirm that the TG24 to MG26 chain pillars (refer **Drawing 1**) will remain long-term stable under Development Loading. With a minimum FoS of 2.4 and a minimum w/h ratio of 4.0 (refer **Table 1**), the pillars are assessed to be statistically 'indestructible'. On this basis it is practically impossible that the formation of the TG24 to MG26 chain pillars will result in any appreciable surface subsidence during Development Loading (first-workings).

Panel	Depth (m)	Pillar Centres (m)		w/h Ratio	UNSW PDP Generalised	
		Width	Length		FoS	PoF
TG24	105	22.6	100.0	5.7	5.1	<1 in 10,000,000
TG24*	60	22.6	30.0	8.2	6.6	<1 in 10,000,000
MG24	135	30.0	100.0	8.2	6.0	<1 in 10,000,000
MG24*	100	30.0	30.0	8.2	5.1	<1 in 10,000,000
MG25	200	30.0	100.0	8.2	4.0	<1 in 10,000,000
MG25*	85	30.0	17.4	4.0	3.1	<1 in 10,000,000
MG25*	150	30.0	22.4	5.7	2.4	<1 in 10,000,000
MG26	240	30.0	100.0	8.2	3.4	<1 in 10,000,000
MG26*	180	30.0	30.0	8.2	3.1	<1 in 10,000,000

TABLE 1. First-Workings Stability Review of TG24 to MG26 Chain Pillars (*denotes the smallest pillar(s) in the panel)

Further to the assessment of first-workings pillar stability, it is also noted that the Client-proposed chain pillar dimensions are compliant with the NSW Work Health and Safety (Mines) Regulation 2014 specifically, Schedule 3 Part 1 Clause 15 1 (a) and (b) and the requirement that the shortest horizontal dimension of a pillar is greater than one tenth of the thickness of the cover (to the surface), or 10 metres, if the thickness of the cover is less than 100 m.

First-Workings Stability of Perimeter Pillars

The UNSW PDP analyses for the shortest perimeter pillar dimensions confirm that the LW24 to LW26 perimeter pillars (refer **Drawing 1**) will remain long-term stable under first-workings Development Loading. With a minimum FoS of 4.6 and a minimum w/h ratio of 8.2 (refer **Table 2**), the pillars are assessed to be statistically indestructible. On this basis it is practically impossible that the formation of the LW24 to LW26 perimeter pillars will result in any appreciable surface subsidence during Development Loading.

Panel	Depth (m)	Pillar Centres (m)		w/h Ratio	UNSW PDP Generalised	
		Width	Length		FoS	PoF
LW24	85	30	117.2	8.2	9.8	<1 in 10,000,000
LW25	150	30	113.5	8.2	5.5	<1 in 10,000,000
LW26	180	30	113.5	8.2	4.6	<1 in 10,000,000

TABLE 2. First-Workings Stability Review of LW24 to LW26 Perimeter Pillars

Further to the assessment of first-workings pillar stability, it is also noted that the Client-proposed perimeter pillar dimensions are compliant with the NSW Work Health and Safety (Mines) Regulation 2014 specifically, Schedule 3 Part 1 Clause 15 1 (a) and (b) and the requirement that the shortest horizontal dimension of a pillar is greater than one tenth of the thickness of the cover (to the surface), or 10 metres, if the thickness of the cover is less than 100 m.

First-Workings Stability of Panel-End Barrier Pillars

The UNSW PDP analyses confirm that the LW24 to LW26 panel-end barrier pillars will remain long-term stable under first-workings Development Loading. With a minimum FoS of 7.3 and a minimum w/h ratio of 5.9 (refer **Table 3**), the pillars are assessed to be statistically indestructible. On this basis it is practically impossible that the formation of the LW24 to LW26 panel-end barrier pillars will result in any appreciable surface subsidence during Development Loading. NB: it is noted that for simplicity the panel-end barrier pillars have been conservatively assessed as rectangular pillars utilising their minimum width (refer **Drawing 1**), rather than their much larger trapezoidal dimensions.

Panel	Depth (m)	Pillar Centres (m)		w/h Ratio	UNSW PDP Generalised	
		Width	Length		FoS	PoF
LW24	85	61.6	257	18.7	47.0	<1 in 10,000,000
LW25	85	23.2	257	5.9	7.3	<1 in 10,000,000
LW26	100	103.9	257	32.8	131.2	<1 in 10,000,000

TABLE 3. First-Workings Stability Review of LW24 to LW26 Panel-End Barrier Pillars

Further to the assessment of first-workings pillar stability, it is also noted that the Client-proposed panel-end barrier pillar dimensions are compliant with the NSW Work Health and Safety (Mines) Regulation 2014 specifically, Schedule 3 Part 1 Clause 15 1 (a) and (b) and the requirement that the shortest horizontal dimension of a pillar is greater than one tenth of the thickness of the cover (to the surface), or 10 metres, if the thickness of the cover is less than 100 m.

First-Workings Stability of Main Heading Pillars

Main heading pillars are typically designed for FTAL where they are separated from secondary extraction production panels by suitably designed barrier pillars. In this regard, it is noted that the last three S10 Mains pillars (13 to 16 C/T) between A and B Headings lie marginally inside the Abutment Influence Zone (AIZ) associated with the extraction of LW23 in the existing SBX workings (refer **Figure 1**). The AIZ, calculated using the Abutment Load Distribution Function (**Peng and Chiang 1984**), is the estimated distance from a goaf edge that a vertical abutment stress will be present (refer **Equation 1**).

of 4.1 and a minimum w/h ratio of 6.9 (refer **Table 4**), the pillars are assessed to be statistically 'indestructible'. On this basis it is practically impossible that the formation of the S0 Mains pillars will result in any appreciable surface subsidence during Development Loading (first-workings).

Panel	Depth (m)	Pillar Centres (m)		w/h Ratio	UNSW PDP Generalised	
		Width	Length		FoS	PoF
S10 Mains	115	26.0	90.0	6.9	5.6	<1 in 10,000,000
S10 Mains*	115	26.0	36.2	6.9	4.1	<1 in 10,000,000
S10 Mains*	70	26.0	30.0	6.9	6.6	<1 in 10,000,000

TABLE 4. First-Workings Stability Review of the S10 Main Headings Pillars (*denotes the smallest pillar(s) in the panel)

Further to the assessment of first-workings pillar stability, it is also noted that the Client-proposed main headings pillar dimensions are compliant with the NSW Work Health and Safety (Mines) Regulation 2014 specifically, Schedule 3 Part 1 Clause 15 1 (a) and (b) and the requirement that the shortest horizontal dimension of a pillar is greater than one tenth of the thickness of the cover (to the surface), or 10 metres, if the thickness of the cover is less than 100 m.

4. SUMMARY

This report has reviewed the first-workings stability of the coal pillars associated with LW's 24 to 26 in the SBX workings at NWU. Overall it can be concluded that the proposed chain, perimeter, panel-end barrier and main headings pillars will be sufficient to ensure long term stability during first-workings (Development Loading) and it is considered practically impossible that their formation will result in any appreciable direct surface subsidence impacts (again, following first-workings development).

Please do not hesitate to contact the undersigned should you have questions or require further information.

Yours sincerely,



Guy Reed
Principal Geotechnical Engineer

5. REFERENCES

Gale, W. and Hebblewhite, B.K. (2005). **Systems Approach to Pillar Design. Final Report** - ACARP Project C9018.

Galvin, J.M., Hebblewhite, B.K. and Salamon, M.D.G. (1999). **University of New South Wales Coal Pillar Strength Determinations for Australian and South African Mining Conditions**. Proceedings of the Second International Workshop on Coal Pillar Mechanics and Design. NIOSH Information Circular 9448, pp. 63-71.

Peng, S.S., and Chiang, H.S. (1984). **Longwall Mining**. Wiley, 708 p.

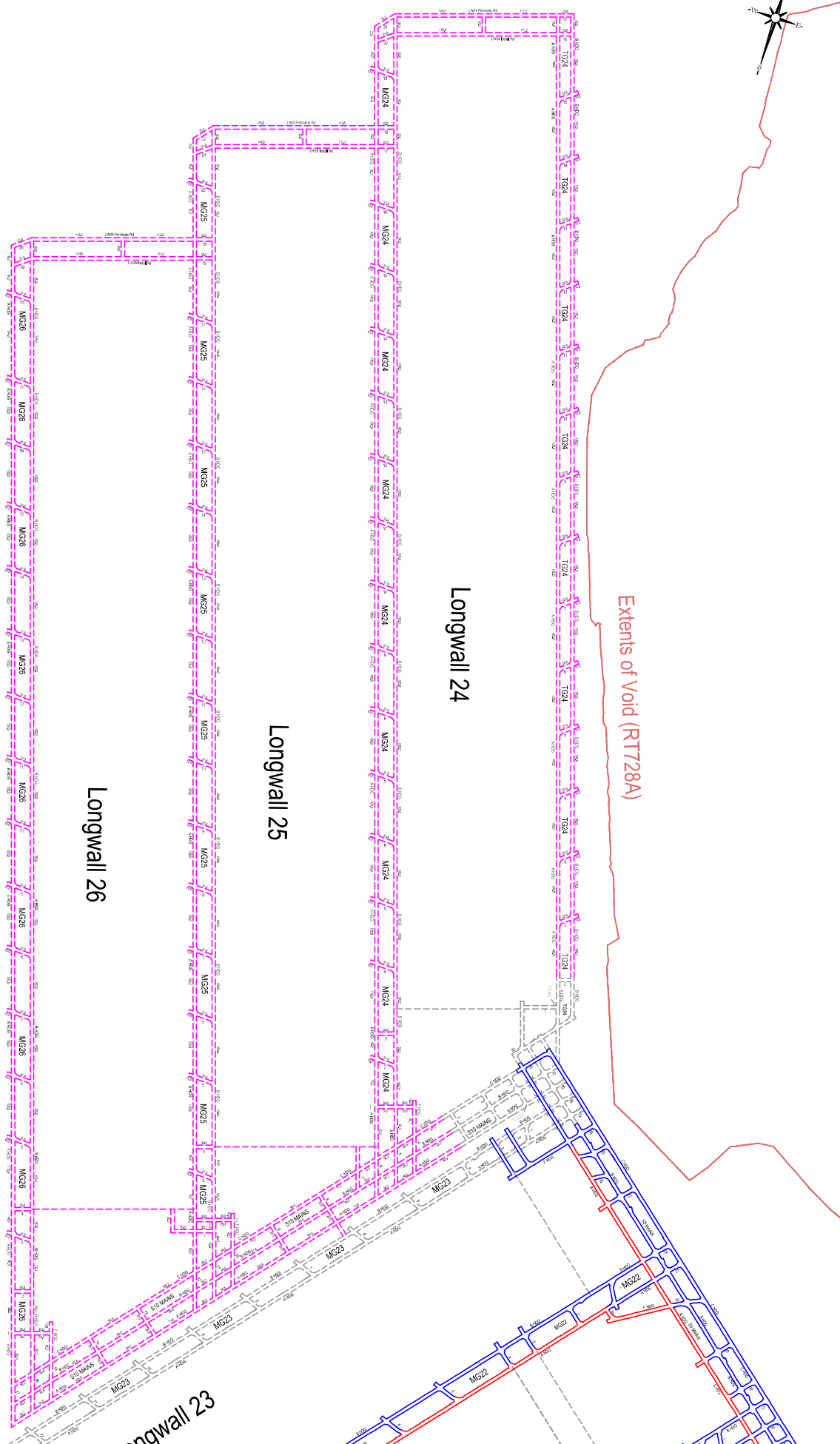
Mine Advice Pty Ltd (2016). **Preliminary Coal Pillar Design Recommendations for the South Bates Underground Extension Project**. Commercial consulting report to Peabody Energy Australia Limited dated September 20th.

Mine Advice Pty Ltd (2020). **South Bates Whybrow Seam Extended – Longwall 23 to 25 Pillar Stability Review**. Draft commercial consulting report to Peabody Energy Australia Limited dated August 4th.

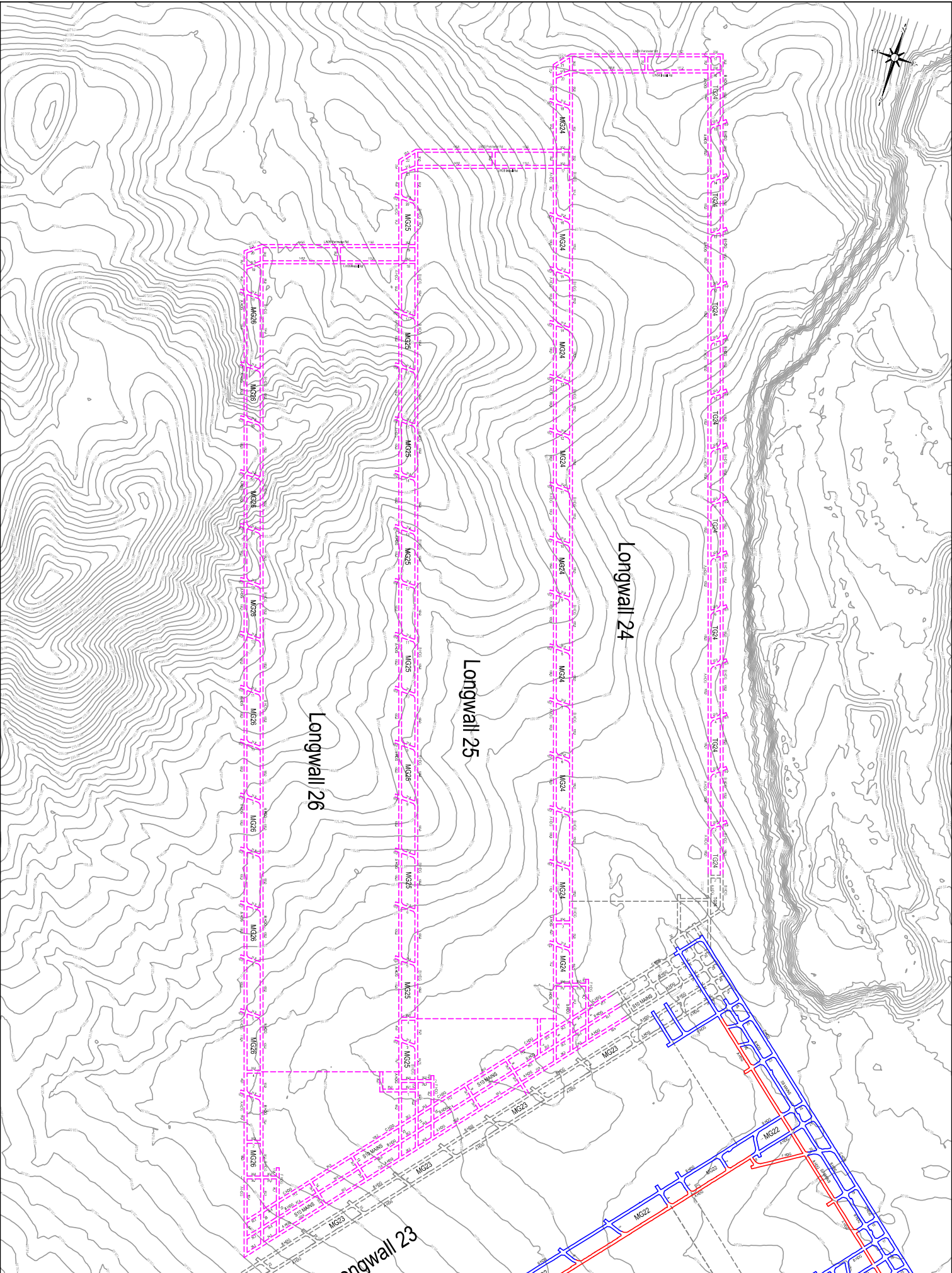
APPENDIX A

Drawing 1: Mine Workings Overview

Drawing 2: Whybrow Seam Cover Depth



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**MINE
ADVICE**

7/17 Babbala Close, Berrisfield NSW 2322
ABN 15 152 928 222

**PEABODY ENERGY AUSTRALIA
NWU - SOUTH BATES EXTENDED WORKINGS
WHYBROW SEAM COVER DEPTH**

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