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Attention: Phil Fletcher

GEOTECHNICAL ASSESSMENT, IMPACT ON STEEP NATURAL SLOPES ADJACENT GLENNIES CREEK AND HUNTER RIVER BY LONGWALL MINING ULD SEAM

EXECUTIVE SUMMARY

This report addresses potential ground slope stability impacts caused by the mining of the Upper Liddell (ULD) seam at the Ashton Coal Underground Mine, in particular the potential for any ground instability to result in a blockage, or partial blockage, of Glennies Creek or the Hunter River.

The Pikes Gully (PG) seam, which lies about 30m above the ULD, has previously been mined in longwall panels and is understood to subcrop near the base of the slope adjacent to Glennies Creek. Seam dip is down to the west at about 5°-7°. The proposed ULD panels are offset 60m to the west of the PG seam longwall panels.

Based on an inspection of the site by the undersigned, mining of PG seam has resulted in surface deformation, though has not adversely impacted the stability of natural slopes adjacent Glennies Creek or the Hunter River.

The risk of slope stability has been assessed using a classification system that has been formulated by the Australian Geomechanics Society on landslide risk management. This assessment found there is a very low-low risk of instability of the natural slopes leading to blockage or partial blockage of the rivers as a result of mining the ULD seam.

No monitoring programmes are required beyond those ordinarily adopted for management of subsidence impacts caused by underground longwall mining. Regrading and sealing of any cracks that develop post mining should be carried out to reduce the likelihood of shallow slumping occurring on steep slopes.

1 INTRODUCTION

This Technical Report has been prepared in support of an application by Ashton Coal Operations Limited (ACOL) for an extraction plan for Longwalls 1 to 8 (LW1-8) in the Upper Liddell Seam (ULD) and forms an addendum to the Extraction Plan prepared by AECOM.

A general description of the site locality and Extraction Area is provided in the Extraction Plan. The Extraction Plan also describes the operation of the underground mine to date and details of the proposed mine plan for LW1-8 in the ULD seam.

Assessment of potential subsidence movements related to LW1-8 ULD has been prepared by SCT Operations Pty Ltd (SCT). SCT's analysis and results are contained, in full, as an Appendix to the Extraction Plan.

1.1 SCOPE OF WORK

This report specifically addresses potential ground slope stability impacts caused by the mining of the ULD seam within LW1-8, in particular the potential for any ground instability to result in a blockage or partial blockage of Glennies Creek or the Hunter River.

1.2 METHODOLOGY

The assessment was based on a walkover assessment of the site by the undersigned, a review of the proposed mine layout plan and surface slope contours and a review of predicted subsidence movements by SCT.

2 DEFINITION OF SLOPES

According to an email sent by Don Kay, (Mine Subsidence Engineering Consultants, (MSEC) on 3 August 2011 (Reference 2), the following slope definitions are currently used by MSEC and are considered to be industry standard:

Steep Slopes - An area of land having a natural gradient ranging between 18.4^{o} and 45^{o} (1V:3H to 1V:1H) or (33.3% to 100%).

Very Steep Slopes - An area of land having a natural gradient ranging between 45^{o} and 63^{o} (1V:1H to 2V:1H) or (100% to 200%).

Cliff - A continuous rock face that is greater than 20 m in length having a minimum height of 10 m and slope greater than 63.4^{o} (2V:1H or 200%).

Rock Outcrop - A discontinuous rock face that is less than 20 m in length having a minimum height of 10 m and slope greater than 63.4^{o} (2V:1H or 200%).

3 SITE DESCRIPTION

3.1 TOPOGRAPHY

The attached site plan has been prepared by AECOM and shows shaded existing surface slope contours in relation to the proposed longwall panels. The plan shows the ground across the proposed LW1-8 generally slopes down to the west and towards Bowmans Creek at around 2° to 3°. Two slope areas have been considered in this assessment.

Area 1 Slope Adjacent Glennies Creek

Glennies Creek runs to the east of LW1 and at its closest point is about 210m (horizontal distance) from LW1 with the crest of the slope down to Glennies Creek about 80m to the east of LW1. The maximum ground slope is about 32° (63%) and the slope is about 40m high. Based on the definitions provided above, this slope would be considered as 'steep' by MSEC. The 'steep' portion of the slope runs for about a 600m length almost parallel to LW1. North and south of this steep slope, shallower slope gradients exist.

Area 2 Slope Adjacent Hunter River

The Hunter River runs about 160m at its closest point to the Hunter River, adjacent to the corner of LW3. Natural ground slopes adjacent the Hunter River slope down to the south with a maximum gradient of about 12°-15° (21% to 27%) near the south end of LW4 and LW5. According to the above definitions, the maximum slope gradients adjacent the Hunter River would not be defined as steep.

Note; the incised channel banks to Bowmans Creek shown on the site plan would be defined as 'steep' though have not been considered in this assessment, as Bowmans Creek will be diverted prior to underground mining below the creek.

3.2 GEOLOGY

Reference to the Camberwell 1:100,000 geological series sheet indicates the area is underlain by coal seams, siltstone, lithic sandstone, shale and conglomerate of the Vane subgroup.

The mine area is located to the west of the Camberwell anticline, a fold trending north-northwest causing the strata to dip with a shallow inclination down to the west. The PG Seam subcrops near the toe of the slope adjacent Glennies Creek. The underlying ULD seam runs beneath the creek and does not subcrop.

4 SITE OBSERVATIONS AND INFERRED SUBSURFACE CONDITIONS

Observations gained during a site walkover are summarized below. Observations were restricted to the steep slope adjacent Glennies Creek and slopes near the Hunter River.

Glennies Creek

- The steep slope down to Glennies Creek was grass covered with scattered mature trees. Some shallow incised drainage lines ran down the slope.
- The slope has a maximum height of about 40m and the maximum measured slope angle was about 32° (63%).
- From the toe of the slope to Glennies Creek is a flat alluvial plain of minimum width 40m-50m (estimate).
- The slope contained no outcropping bedrock
- Subsurface conditions below the slope are not known, though expected to comprise a thin (possible 2m-3m clayey soil cover over rock near the crest of the slope, likely increasing near the base of the slope to possibly 3m-4m of clayey soil cover). It is possible the soil would also contain some component of gravel up to possible boulder size material. Alluvial soils (sands/gravels/clays etc) associated with Glennies Creek are likely to lap against the toe of the slope.
- There was no evidence of past or existing instability on the slope.

Photograph 1 *Looking south at Natural Slope Adjacent Glennies Creek*

Photograph 2 *From Top of Slope Looking Towards Glennies Creek. Pegs are for monitoring ground subsidence movement*

Hunter River

- Slopes down to the Hunter River were uniform and assessed to be a maximum of about 15° (27%).
- The maximum slope height (from hill crest to Hunter River) was about 30m to 40m.
- Shallow drainage lines ran down the slope, some outcropping bedrock was observed in the eroded drainage lines.
- Subsurface conditions are not known though expected to comprise thin (possibly 1m-2m) clayey soil cover over rock.
- There was no evidence of past or existing instability on the slope.

5 GROUND SUBSIDENCE PREDICTIONS

5.1 GLENNIES CREEK

The initial subsidence predictions for mining the PG seam indicated:

- Less than 100mm of slope translation to the east and
- 100mm slope crest rotation to the west

The revised subsidence predictions following mining the ULD seam for LW1 (closest longwall panel to the Glennies Creek slope), as discussed in Reference 3, are provided below.

Table 1 *Summary of Subsidence Affects from Proposed Mining in ULD Seam.*

Panel	Incremental Subsidence from Mining ULD Seam (m)	Incremental Max Tilt (mm/m)	Incremental Max Strain (mm/m)	Maximum Subsidence (85% of Combined Seam Thickness (m)	Max Tilt (mm/m)	Max Strain (mm/m)
LW1	2.9	183	73	4.4	235	94

5.2 HUNTER RIVER

The initial subsidence prediction by SCT for the area near the slopes that run down to the Hunter River indicated ‘there is likely to be significant surface cracking evident on the slopes associated with the proposed mining due to a relative down slope movement of the upper section of the slope of several hundred millimetres’ and ‘a lateral translation of the entire slope of up to about 10mm for each longwall panel is expected in a down slope direction’.

The southern end of longwall panels 4 and 5 are located near the steepest slopes adjacent Hunter River. Subsidence predictions for LW4 and LW5 following mining the ULD Seam from Reference 3 are provided below.

Table 2 *Summary of Subsidence Affects from Proposed Mining in ULD Seam.*

Panel	Incremental Subsidence from Mining ULD Seam (m)	Incremental Max Tilt (mm/m)	Incremental Max Strain (mm/m)	Maximum Subsidence (85% of Combined Seam Thickness (m)	Max Tilt (mm/m)	Max Strain (mm/m)
LW4A	2.4	93	37	3.9	128	51
LW4B	2.4	110	44	3.9	151	60
LW5	2.5	76	30	4.0	103	41

6 SLOPE STABILITY ASSESSMENT

Potential slope movement hazards considered for slopes adjacent the Hunter River and Glennies Creek are sumarised below.

- Hazard 1 Shallow slumping of near surface soils.
- Hazard 2 Deep circular/overall slope failure.
- Hazard 3 Overall slope failure caused by block sliding along a low strength plane.

The likelihood of each event occurring due to subsidence movements and also resulting in a blockage or partial blockage of either Glennies Creek or the Hunter River has been assessed using a qualitative classification system.

The classification system has been formulated by the Australian Geomechanics Society on landslide risk management and published in the Australian Geomechanics, Volume 42 No 1, March 2007.

Table 3 summarises the qualitative assessment of the likelihood of the identified slope hazards occurring and impacting the element at risk and consequences should the slope instability occur. It is noted that the likelihood assessment is based on the hazard occurring as a direct result of the proposed mining of the ULD seam.

The likelihood of Hazard 1 occurring due to increased infiltration related to opening of cracks around subsidence areas will increase due to mining, however, the likelihood of this hazard occurring and resulting in a blockage or partial blockage of the rivers is assessed to be rare-barely credible as detailed below.

Infilling and regrading of cracked areas should, however, be carried out post mining to reduce the risk of shallow slumping along steep slopes, in particular the area around the steep slopes adjacent Glennies Creek.

Table 3 *Summary of Qualitative Risk Assessment*

Landslide Hazard	Description	Assessed Likelihood	Assessed Consequences	Risk
1	Shallow slumping of near surface soils resulting in blockage or partial blockage of Glennies Creek	Rare	Major	Low
1	Shallow slumping of near surface soils resulting in blockage or partial blockage of Hunter River	Barely Credible	Major	Very Low
2	Deep circular/overall slope failure resulting in blockage or partial blockage of Glennies Creek	Barely Credible	Major	Very Low
2	Deep circular/overall slope failure resulting in blockage or partial blockage of Hunter River	Barely Credible	Major	Very Low
3	Overall slope failure caused by block sliding along low strength plane resulting in blockage or partial blockage of Glennies Creek	Barely Credible	Major	Very Low
3	Overall slope failure caused by block sliding along low strength plane resulting in blockage or partial blockage of Hunter River	Barely Credible	Major	Very Low

The above assessment indicates the assessed risk to the Hunter River and Glennies Creek from the identified slope hazards is 'Very Low-Low' and is therefore acceptable as defined in Table 4.

Table 4 *Risk Level Implications (Practice Note Guidelines For Landslide Risk Management, 2007)*

Risk Level		Example Implications*
VH	Very High risk	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than the value of the property.
H	High Risk	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	Moderate Risk	May be tolerated in certain circumstances (subject to regulators approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable
L	Low risk	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	Very Low Risk	Acceptable. Manage by normal slope maintenance procedures.

NOTE: * *The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.*

Tolerable Risks are risks within a range that society can live with so as to secure certain benefits. It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible[(1)]

Acceptable Risks are risks which everyone affected is prepared to accept. Action to further reduce such risk is usually not required unless reasonably practicable measures are available at low cost in terms of money, time and effort

7 SUMMARY

The risk of longwall mining the ULD Seam causing slope instability on slopes adjacent the Hunter River and Glennies Creek is assessed as Very Low-Low in accordance with the Landslide Risk Management Guidelines prepared by the Australian Geomechanics Society.

No monitoring programmes are required beyond those ordinarily adopted for management of subsidence impacts caused by underground longwall mining. Regrading and sealing of any cracks that develop post mining should be carried out to reduce the likelihood of shallow slumping occurring on steep slopes, particularly in the area around the steep slopes adjacent Glennies Creek.

Yours faithfully,

Geotech Solutions Pty Ltd

Paul Lambert

Principal Engineering Geologist

REFERENCES

(1) 'Practice Note Guidelines for Landslide Risk Management 2007'. Australian Geomechanics, Volume 42 No 1, March 2007.

(2) Email from Don Kay, (Mine Subsidence Engineering Consultants) dated 3 August 2011.

(3) Draft Subsidence Assessment for Upper Liddell Seam, Longwalls 1-8 Extraction Plan, Reference ASH3657 by SCT, dated 19 October 2011.

ATTACHMENTS

Practice Note Guidelines for Landslide Risk Management 2007

Site Plan Showing Ground Slopes

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or L (5)
B - LIKELY	10^{-2}	VH	VH	H	M	L
C - POSSIBLE	10^{-3}	VH	H	M	M	VL
D - UNLIKELY	10^{-4}	H	M	L	L	VL
E - RARE	10^{-5}	M	L	L	VL	VL
F - BARELY CREDIBLE	10^{-6}	L	VL	VL	VL	VL

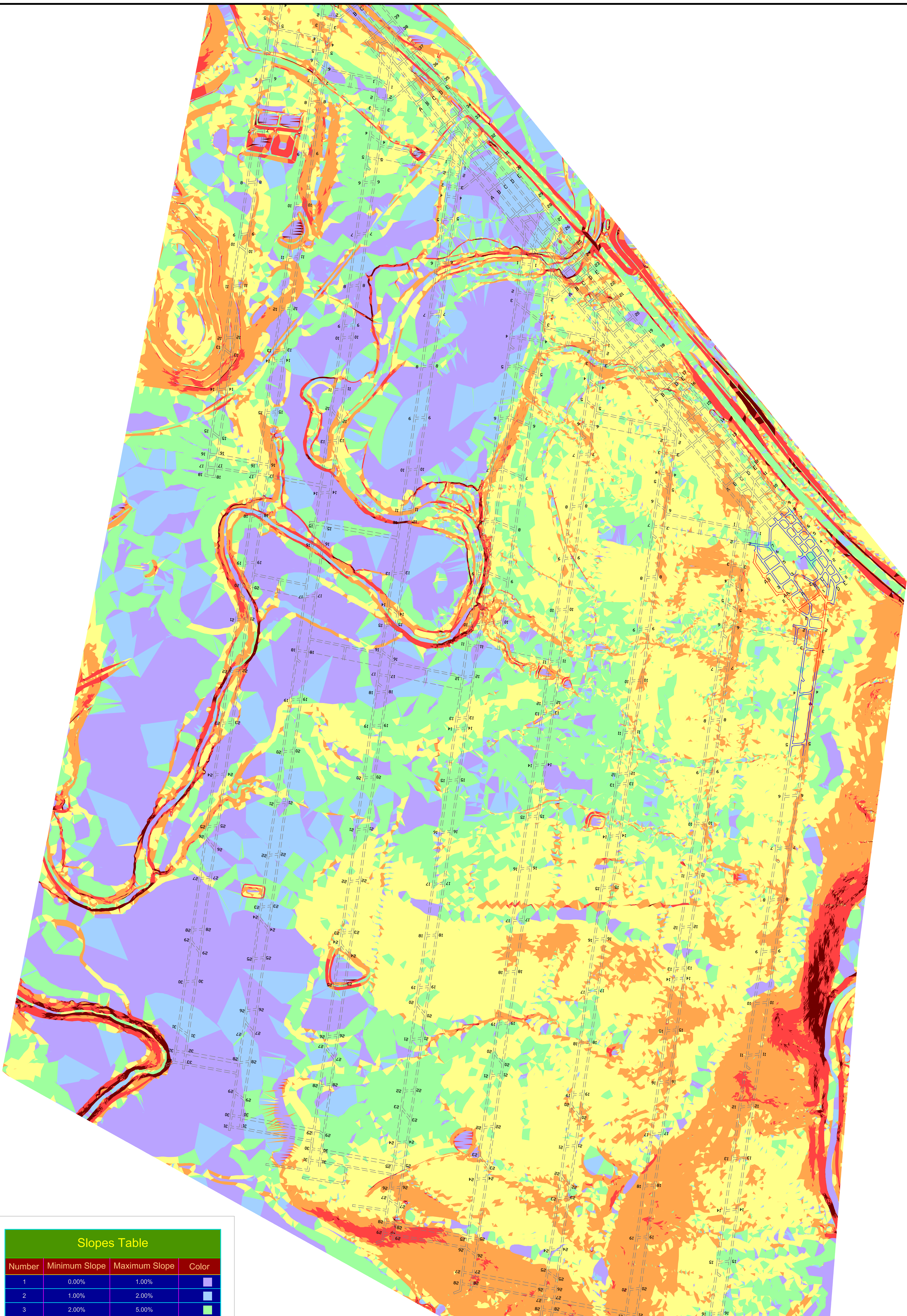
Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.

(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.



Slopes Table

Number	Minimum Slope	Maximum Slope	Color
1	0.00%	1.00%	
2	1.00%	2.00%	
3	2.00%	5.00%	
4	5.00%	10.00%	
5	10.00%	25.00%	
6	25.00%	50.00%	
7	50.00%	200.00%	

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ASHTON UNDERGROUND MINE
Surface Slopes

Drawing No.	Revision No.
A–9620	

Date	Scale:	Drawn	Checked	Approved	Sheet Size
25/08/11	1:5000	JIP			A1