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PILLAR STABILTY AND SUBSIDENCE ASSESSMENTS FOR THE 205 PANEL EXTENSION, 100 CROSS PANEL, 420 PANEL, 121 PANEL AND 122 PANEL

1.0 INTRODUCTION

It is the intention of Airly mine to extend its development consent for a period of 20 months to allow greater time for the Environmental Impact Assessment process. Over that period mining has been proposed in the 205 Panel Extension, 100 Cross Panel, 420 Panel, 121 Panel and 122 Panel.

Bord and pillar mining is proposed for all the workings during this period. In this report the stability of the pillars and subsequent expected subsidence, tilt and strains are assessed. Airly has adopted subsidence criteria that would result in "minimal subsidence impact". The subsidence assessments are judged within this concept.

Two pillar design options are proposed for all the panels. One option is for first workings on 35 m x 35 m centres with 5.5 m bords, followed by splitting where possible to form 35 m x 17.5 m (centres) pillars and/or quartering to form 17.5 m x 17.5 m (centres) pillars. Bord widths of 6 m have been assumed where pillars are split and/or quartered. The other option is for 35 m x 20.5 m centres with bord widths of 5.5 m followed by splitting where possible to form 20.5 m x 17.5 m (centres) pillars.

Figures 1 and **Figure 2** show the mining panels in relation to the location of creeks and a mining exclusion zone under creeks < 40 m in depth which has been proposed in the subsidence impact report (**Golder Associates, 2013**) for first workings on 35 x 35 m centres and 35 x 20.5 m centres respectively. **Figure 3** and **Figure 4** show the mining panels in relation to the Depth of Cover (DoC) contours and areas of potential flooding post-mining of the deeper areas determined by Airly's hydrological consultants (**GHD, Personal Communication October 2013**) again for first working pillars on 35 x 35 m and 35 x 20.5 m centres respectively.

2.0 SUBSIDENCE CRITERIA

The overriding aims of the mine design at Airly are to minimise impact in an environmentally sensitive area while improving the feasibility of the mine. In order to limit the surface and sub-surface impacts due to mining, Airly has adopted subsidence criteria that results in "minimal subsidence impact". Due to the

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similarities in topography and corporate and community expectations, the Clarence Colliery vertical subsidence limits have been adopted as practical and proven criteria. These criteria are:

- Vertical subsidence to be nominally limited to 100mm but shall not exceed 125mm,
- A maximum tilt of 2.5mm/m and
- A maximum strain of 2.0mm/m.

These limits have proven to cause no adverse mining induced subsidence effects at Clarence Colliery and are considered appropriately conservative, given the lack of site specific data for Airly.

3.0 PILLAR DESIGN METHODOLOGY

The stability of the pillars has been assessed using the FoS approach utilising the pillar strength formulae developed by the University of New South Wales (**Salamon, *et al*, 1996**).

Width to height ratio, applied in conjunction with the FoS approach, is a useful indicator of design reliability. This is seen in **Figure 5** (**Hill, 2010**), which presents the FoS versus pillar w/h ratio relationship for a combined database of failed South African and Australian bord and pillar panels, plus a database of highwall mining (CHM) failed pillar cases. The three databases are highly complementary in nature, reflecting the range of experiences of their respective industries. For example, the Australian data provides insight with regard to pillar behaviour at relatively high w/h ratios and furnishes the failed case at the w/h ratio of 8.2. In contrast, the South African coal industry has traditionally been characterised by geometries involving lower w/h ratios, which is partly reflected in the maximum w/h ratio of only 3.7 for a South African failed case. Similarly, CHM pillar cases cover the lower end of the range of w/h ratios, from 0.6 to 1.4.

There are no failed cases in this combined South African and Australian database with a w/h ratio of greater than 8.2, even at a very low Factor of Safety, and there is only one case at a w/h ratio of greater than 5. The highest Factor of Safety assigned to a bord and pillar collapse is 2.1 and this was associated with a w/h ratio of only 2.2. Although there are failed CHM pillars with Factors of Safety of >2, all of them have w/h ratios of <2.

A limit envelope can be defined for the database of failed cases, illustrated by the curve and given by the following equation:

$$\text{w/h ratio} = 22.419e^{-1.148*(\text{Factor of Safety})} \quad [1]$$

Beyond this envelope, there is no precedent for failure within these databases. It is worth noting that the exclusion of the CHM pillar data would not materially change the shape of this limit envelope.

In the case of long life (>5 years) pillars, then it is generally considered prudent to design outside the envelope defined by this equation, even though there are many examples of stable pillars that fall within it.

Furthermore, in the case of critical, long-life pillars, it is considered prudent to allow an additional margin beyond this curve. Golder Associates generally suggests a 20% margin, which is defined by the second (i.e. outer) curve in **Figure 1** and the following equation:

$$\text{w/h ratio} = 26.903e^{-0.957*(\text{Factor of Safety})} \quad [2]$$

A probability of failure can be determined when using the University of New South Wales empirical pillar design approach. Where mining is proposed in the vicinity of cliff lines a probability of failure of 1 in

1,000,000 or better is warranted. This equates to a nominal FoS of 2.11 when using the empirical pillar design formulae.

4.0 SUBSIDENCE PREDICTION METHODOLOGY

Subsidence associated with bord and pillar mining has been estimated using an analytical technique that has been successfully used to predict subsidence at Clarence Colliery.

Given that the pillars are designed to remain long-term stable, it is considered reasonable to estimate subsidence on the basis of elastic convergence for first workings. The methodology used to estimate the expected surface subsidence is based on the geomechanical properties of the strata and estimates of the average stress change using elastic theory. The predicted subsidence consists of three components, namely pillar, roof and floor compression. The equations used to determine these three components are shown below.

$\Delta_{pillar} = \sigma_{net}h/E_{pillar}$
$\Delta_{roof} = \sigma_{net}w/E_{roof}$
$\Delta_{floor} = \sigma_{net}w/E_{floor}$
$\Delta_{total} = \Delta_{pillar} + \Delta_{roof} + \Delta_{floor}$

Where:

Δ_{pillar} = pillar compression (mm)
Δ_{roof} = roof compression above pillar (mm)
Δ_{floor} = floor compression below pillar (mm)
σ_{net} = net pillar stress increase (MPa)
h = pillar height (2.8m)
w = pillar width (m)
E_{pillar} = Young's Modulus for coal (estimated at 2GPa)
E_{roof} = Young's Modulus for immediate roof material (estimated at 7GPa)
E_{floor} = Young's Modulus for immediate floor material (estimated at 5GPa)

Subsidence at Clarence Colliery has been observed to increase once flooding of panels occurs. Subsidence post-flooding at Clarence has been successfully predicted by reducing the modulus of the roof and floor strata to approximately half their value and this has been done for the Airly analyses. It is noted that the prediction that flooding will occur is related to different proposed mining methods in the deeper areas of the Airly deposit. Flooding may not result related to just the bord and pillar mining methods that are proposed in this report. Nevertheless, the subsidence analyses in this report include an assessment of subsidence post-flooding, where flooding has been predicted in the longer term.

An empirical methodology derived by **Holla (1991)** for the Western coalfield has been used to predict strains and tilts. These apply the following formulae and 'K' factors:

- Tensile strain, $+E_{max}$ = 1,000 x K1 x S_{max} / H
- Compressive strain, $-E_{max}$ = 1,000 x K2 x S_{max} / H
- Tilt, G_{max} = 1,000 x K3 x S_{max} / H

where:

- K1 (tensile strain) = 1.2 to 1.5
- K2 (compressive strain) = 0.9 to 2.5
- K3 (tilt) = 3.1 to 5.0
- S_{max} is the maximum vertical subsidence (m)

- H is the Depth of Cover (m)

It should be noted that the Holla relationships were developed for wider extraction spans than are being proposed for these analyses and are likely to be conservative for the extraction spans typical of bord and pillar workings.

5.0 PANEL 205 EXTENSION ANALYSIS

The depth of cover varies between a minimum of 40 m to a maximum of 180 m and no flooding is predicted long term (see **Figure 3**). A creek crosses the panel and a mining exclusion zone affects a small part of the panel (see **Figure 1**). A cliff zone also affects part of the panel, coinciding with the 80 m DoC contour in this area of the panel and extending to a maximum of 150 m.

5.1 35 m x 35 m Pillars with Splitting and/or Quartering

The stability outcomes for the 35 m x 35 m first workings pillars are summarised in **Table 1** for the applicable depth range**.** A mining height of 2.8 m has been assumed.

Table 1: Summarised Stability Outcomes for Coal Pillars on 35 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
40	30.2	10.5	1.4	21.5
80			2.8	10.7
110			3.9	7.8
140			4.9	6.1
180			6.3	4.8

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 180m, given also their w/h ratio of 10.5. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio.

The stability outcomes for the 17.5 m x 17.5 m pillars are summarised in **Table 2** for the applicable depth range, again assuming a mining height of 2.8 m.

Table 2: Summarised Stability Outcomes for Coal Pillars on 17.5 m x 17.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
40	12.6	4.1	2.3	5.4
80			4.6	2.7
100			5.8	2.2
110			6.4	2.0
140			8.1	1.5

It is concluded that the Factor of Safety (FoS) of the split and quartered pillars is adequate to ensure long term stability up to a maximum depth of 110 m. No split and quartering of pillars is recommended at greater depths. However in the part of the panel where there is a cliff zone, the split and quartered pillars should be limited to a DoC of 100 m to ensure an adequate probability of failure.

Given that quartering of pillars are only applicable to a depth range up to 110 m outside of cliff line zones and 100 m inside them the stability of split pillars above this depth has been assessed. The stability outcomes for the 35 m x 17.5 m pillars are summarised in **Table 3** for the applicable depth range, again assuming a mining height of 2.8 m.

Table 3: Summarised Stability Outcomes for Coal Pillars on 35 m x 17.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
110	13.5	4.1	5.05	2.7
120			5.5	2.4
139			6.4	2.11
140			6.4	2.1
150			6.9	2.0

It is concluded that the Factor of Safety (FoS) of the split pillars is adequate to ensure long term stability up to the maximum depth of 139 m for the panel where cliff zones are present. Outside the cliff line zones pillar splitting is applicable to the maximum depth for the panel of 150 m, however. Note that the minimum pillar width is less than one tenth depth at a depth of cover greater than 115 m.

The expected subsidence levels using the methodology described for the 35 m centre pillars for the representative depth range are summarised in **Table 4**.

Table 4: Analytical Subsidence Estimates for 35 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
40	1.0	1.4	0.4	4.6
80	2.0	2.8	0.8	9.2
120	2.9	4.1	1.2	13.8
140	3.4	4.8	1.4	16.1
180	4.4	6.2	1.8	20.8

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.14 and 0.17 mm/m, with compressive strains estimated at between 0.10 and 0.29 mm/m and tilts 0.36 to 0.58 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected. Indeed the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

The expected subsidence levels for the 17.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 5**.

Table 5: Analytical Subsidence Estimates for 17.5 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
40	1.0	2.3	1.3	6.9
50	1.2	2.8	1.6	8.6
80	2.0	4.5	2.6	13.8
100	2.5	5.7	3.2	17.2
110	2.7	6.2	3.5	19.0

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.21 and 0.26 mm/m, with compressive strains estimated at between 0.16 and 0.43 mm/m and tilts 0.53 to 0.86 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 6**.

Table 6: Analytical Subsidence Estimates for 35 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
110	2.7	4.9	2.2	11.6
120	2.9	5.3	2.4	12.7
140	3.4	6.2	2.8	14.8
150	3.7	6.6	3.0	15.8

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.13 and 0.16 mm/m, with compressive strains estimated at between 0.10 and 0.26 mm/m and tilts 0.32 to 0.53 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

5.2 35 x 20.5 m Pillars with Subsequent Splitting

The stability outcomes for the 35 m x 20.5 m first workings pillars are summarised in **Table 7** for the applicable depth range assuming a mining height of 2.8 m.

Table 7: Summarised Stability Outcomes for Coal Pillars on 35 m x 20.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
40	16.1	5.4	1.6	9.9
80			3.2	5.0
110			4.5	3.6
140			5.7	2.8
180			7.3	2.2

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 180m. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probabilities of failure are additionally sufficient for the cliff lines located above this panel.

The stability outcomes for the 20.5 m x 17.5 m pillars are summarised in **Table 8** for the applicable depth range, again assuming a mining height of 2.8 m.

Table 8: Summarised Stability Outcomes for Coal Pillars on 20.5 m x 17.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
40	12.9	4.1	2.2	6.0
80			4.3	3.0
110			5.9	2.2
120			6.5	2.0
140			7.5	1.7

It is concluded that the Factor of Safety (FoS) of the split pillars is adequate to ensure long term stability up to a maximum depth of 110 m where cliff lines are present above the panel and 120 m where there are no cliff zones. No splitting of pillars is recommended at greater depths.

The expected subsidence levels using the methodology described for the 35 m x 20.5 m centre pillars for the representative depth range are summarised in **Table 9**.

Table 9: Analytical Subsidence Estimates for 35 m x 20.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
40	1.0	1.6	0.6	4.0
80	2.0	3.2	1.2	8.0
120	2.9	4.8	1.8	12.0
140	3.4	5.6	2.1	13.9
180	4.4	7.2	2.7	17.9

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.15 mm/m, with compressive strains estimated at between 0.09 and 0.25 mm/m and tilts 0.31 to 0.50 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected and the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

The expected subsidence levels for the 20.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 10**.

Table 10: Analytical Subsidence Estimates for 20.5 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
40	1.0	2.1	1.1	6.0
50	1.2	2.6	1.4	7.5
80	2.0	4.2	2.3	12.1
110	2.7	5.8	3.1	16.6
120	2.9	6.3	3.4	18.1

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.18 and 0.23 mm/m, with compressive strains estimated at between 0.14 and 0.38 mm/m and tilts 0.47 to 0.75 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

6.0 100 CROSS PANEL ANALYSIS

The depth of cover varies between a minimum of 100 m to a maximum of 160 m and no flooding is predicted long term (see **Figure 3**). A cliff zone also affects most of the panel, coinciding with the 100 m DoC contour and extending to the maximum depth of the panel of 160 m.

6.1 35 m x 35 m Pillars with Splitting and/or Quartering

The stability outcomes for the 35 m x 35 m first workings pillars are summarised in **Table 11** for the applicable depth range**.** A mining height of 2.8 m has been assumed.

Table 11: Summarised Stability Outcomes for Coal Pillars on 35 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
100	30.2	10.5	3.5	8.6
140			4.9	6.1
150			5.3	5.7
160			5.6	5.4

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 160m, given also their w/h ratio of 10.5. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probability of failure of pillars beneath the cliff line is also less than 1 in 1,000,000.

As noted previously, quartering of pillars is only applicable to a maximum depth of 110 m where there are no cliff zones and 100 m where cliff zones are present above panels (see **Table 2**), so no quartering of pillars is recommended for this panel. Splitting of pillars is only recommended to a maximum depth of 139 m (see **Table 3**) where cliff lines are present above panels and no splitting of pillars is recommended at depths greater than this. It is noted again that the minimum pillar width is less than one tenth depth at a depth of cover greater than 115 m.

The expected subsidence levels using the methodology described for the 35 m centre pillars for the representative depth range are summarised in **Table 12**.

Table 12: Analytical Subsidence Estimates for 35 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	3.5	1.0	11.5
140	3.4	4.8	1.4	16.1
160	3.9	5.5	1.6	18.5

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.14 and 0.17 mm/m, with compressive strains estimated at between 0.10 and 0.26 mm/m and tilts 0.36 to 0.58 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 13**.

Table 13: Analytical Subsidence Estimates for 35 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	4.4	2.0	10.5
139	3.4	6.2	2.7	14.7

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.13 and 0.16 mm/m, with compressive strains estimated at between 0.10 and 0.26 mm/m and tilts 0.32 to 0.53 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

6.2 35 x 20.5 m Pillars with Subsequent Splitting

The stability outcomes for the 35 m x 20.5 m first workings pillars are summarised in **Table 14** for the applicable depth range and mining height of 2.8 m.

Table 14: Summarised Stability Outcomes for Coal Pillars on 35 m x 20.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
100	16.1	5.4	4.1	4.0
140			5.7	2.8
150			6.1	2.6
160			6.5	2.5

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 160m. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probability of failure of pillars beneath the cliff line is also less than 1 in 1,000,000.

As noted previously, splitting of pillars is only applicable to a maximum depth of 120 m in the absence of cliff zones and 110 m where they occur above panels (see **Table 8**). Splitting of pillars is therefore only recommended for this panel between the minimum DoC of 100 m to a maximum DoC of 110 m.

The expected subsidence levels using the methodology described for the 35 m x 20.5 centre pillars for the representative depth range are summarised in **Table 15**.

Table 15: Analytical Subsidence Estimates for 35 m x 20.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	4.0	1.5	10.0
140	3.4	5.6	2.1	13.9
160	3.9	6.4	2.4	15.9

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.15 mm/m, with compressive strains estimated at between 0.09 and 0.25 mm/m and tilts 0.31 to 0.50 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels for the 20.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 16**.

Table 16: Analytical Subsidence Estimates for 20.5 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	5.3	2.8	15.1
110	2.7	5.8	3.1	16.6

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.18 and 0.23 mm/m, with compressive strains estimated at between 0.14 and 0.38 mm/m and tilts 0.47 to 0.75 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

7.0 PANEL 420 ANALYSIS

The depth of cover varies between a minimum of 40 m to a maximum of 170 m and flooding is predicted long term in the far NW corner of the panel at the shallow DoC (see **Figure 3**). Cliff lines occur between a depth of 120 m to 170 m.

7.1 35 m x 35 m Pillars with Splitting and/or Quartering

The stability outcomes for the 35 m x 35 m first workings pillars are summarised in **Table 17** for the applicable depth range**.** A mining height of 2.8 m has been assumed.

Table 17: Summarised Stability Outcomes for Coal Pillars on 35 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
50	30.2	10.5	1.8	17.2
100			3.5	8.6
120			4.2	7.2
170			6.0	5.1

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 170m, given also their w/h ratio of 10.5. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probability of failure of pillars beneath the cliff line is also less than 1 in 1,000,000.

As noted previously, quartering of pillars is only applicable to a maximum depth of 100 m (see **Table 2**), so no quartering of pillars is recommended for this panel at depths greater than this. Splitting of pillars is only recommended to a maximum depth of 150 m where no cliff zones are present (see **Table 3**) and no splitting of pillars is recommended at depths greater than this for all panels. The FoS of split pillars falls below 2.11 (a probability of failure of 1 in 1,000,000) at a depth of 140 m, however (see **Table 3**). Given that cliff lines occur at a depth of cover between 120 m and 170 m, no splitting of pillars is recommended below a depth of 139 m for this panel. It is noted again that the minimum pillar width is less than one tenth depth at a depth of cover greater than 115 m.

The expected subsidence levels using the methodology described for the 35 m centre pillars, over the representative depth range are summarised in **Table 18**.

Table 18: Analytical Subsidence Estimates for 35 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
50	1.2	1.7	0.5	5.8
80	2.0	2.8	0.8	9.2
110	2.7	3.8	1.1	12.7
140	3.4	4.8	1.4	16.1
170	4.2	5.9	1.7	19.6

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.14 and 0.17 mm/m, with compressive strains estimated at between 0.10 and 0.29 mm/m and tilts 0.36 to 0.58 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars, over the representative depth range are summarised in **Table 19**.

Table 19: Analytical Subsidence Estimates for 35 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
110	2.7	4.9	2.2	11.6
139	3.4	6.2	2.7	14.7

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.13 and 0.16 mm/m, with compressive strains estimated at between 0.10 and 0.26 mm/m and tilts 0.33 to 0.53 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The depth range for the analytical subsidence for the 17.5 m x 17.5 m centre pillars are covered in **Table 5.** The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.21

and 0.26 mm/m, with compressive strains estimated at between 0.16 and 0.43 mm/m and tilts 0.53 to 0.86 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

7.2 35 x 20.5 m Pillars with Subsequent Splitting

The stability outcomes for the 35 m x 20.5 m first workings pillars are summarised in **Table 20** for the applicable depth range assuming a mining height of 2.8 m.

Table 20: Summarised Stability Outcomes for Coal Pillars on 35 m x 20.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
50	16.1	5.4	2.0	7.9
100			4.1	4.0
120			4.9	3.3
170			6.9	2.3

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 170m. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probabilities of failure are additionally sufficient for the cliff lines located above this panel.

The stability outcomes for the 20.5 m x 17.5 m pillars are summarised in **Table 21** for the applicable depth range, again assuming a mining height of 2.8 m.

Table 21: Summarised Stability Outcomes for Coal Pillars on 20.5 m x 17.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
50	12.9	4.1	2.7	4.8
100			5.4	2.4
110			5.9	2.2
120			6.5	2.0
140			7.5	1.7

It is concluded that the Factor of Safety (FoS) of the split pillars is adequate to ensure long term stability up to a maximum depth of 110 m due to the presence of cliff lines at the 120 m depth contour. No splitting of pillars is recommended at greater depths in this panel.

The expected subsidence levels using the methodology described for the 35 m x 20.5 m centre pillars for the representative depth range are summarised in **Table 22**.

Table 22: Analytical Subsidence Estimates for 35 m x 20.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
50	1.2	2.0	0.8	5.0
110	2.7	4.4	1.7	11.0
140	3.4	5.6	2.1	13.9
170	4.2	6.8	2.6	16.9

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.15 mm/m, with compressive strains estimated at between 0.09 and 0.25 mm/m and tilts 0.31 to 0.50 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected and the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

The expected subsidence levels for the 20.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 23**.

Table 23: Analytical Subsidence Estimates for 20.5 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
50	1.2	2.6	1.4	7.5
80	2.0	4.2	2.3	12.1
110	2.7	5.8	3.1	16.6

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.18 and 0.23 mm/m, with compressive strains estimated at between 0.14 and 0.38 mm/m and tilts 0.47 to 0.75 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

8.0 PANEL 121 ANALYSIS

The depth of cover varies between a minimum of 30 m and a maximum of 130 m, with no flooding predicted long term (see **Figure 3**). Cliff lines occur between a depth of 80 m and 130 m (see **Figure 1**).

8.1 35 m x 35 m Pillars with Splitting and/or Quartering

The stability outcomes for the 35 m x 35 m first workings pillars are summarised in **Table 24** for the applicable depth range**.** A mining height of 2.8 m has been assumed.

Table 24: Summarised Stability Outcomes for Coal Pillars on 35 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
30	30.2	10.5	1.1	28.6
60			2.1	14.3
100			3.5	8.6
130			4.6	6.6

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 130m, given also their w/h ratio of 10.5. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probability of failure of pillars beneath the cliff line in this area is also less than 1 in 1,000,000.

Quartering of pillars will only be applicable to a maximum depth of 100 m as a cliff line is located between a depth of 80 m and 130 m (see **Table 2**). Split pillars will have an adequate FoS and probability of failure between a depth of 100 m and the maximum depth in this panel of 130 m (see **Table 3**). It is noted again that the minimum pillar width for split pillars is less than one tenth depth at a depth of cover greater than 115 m.

The expected subsidence levels using the methodology described for the 35 m centre pillars for the representative depth range are summarised in **Table 25**.

Table 25: Analytical Subsidence Estimates for 35 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.0	0.3	3.5
50	1.2	1.7	0.5	5.8
80	2.0	2.8	0.8	9.2
100	2.5	3.5	1.0	11.5
130	3.2	4.5	1.3	15.0

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.14 and 0.17 mm/m, with compressive strains estimated at between 0.10 and 0.29 mm/m and tilts 0.36 to 0.58 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 26**.

Table 26: Analytical Subsidence Estimates for 35 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	4.4	2.0	10.5
110	2.7	4.9	2.2	11.6
130	3.2	5.8	2.6	13.7

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.16 mm/m, with compressive strains estimated at between 0.09 and 0.26 mm/m and tilts of 0.33 to 0.53 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The depth range for the analytical subsidence for the 17.5 m x 17.5 m centre pillars are covered in **Table 5.** The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.21 and 0.24 mm/m, with compressive strains estimated at between 0.16 and 0.39 mm/m and tilts 0.53 to 0.79 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

8.2 35 x 20.5 m Pillars with Subsequent Splitting

The stability outcomes for the 35 m x 20.5 m first workings pillars are summarised in **Table 27** for the applicable depth range assuming a mining height of 2.8 m.

Table 27: Summarised Stability Outcomes for Coal Pillars on 35 m x 20.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
30	16.1	5.4	1.2	13.2
100			4.1	4.0
120			4.9	3.3
130			5.3	3.1

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 130m. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probabilities of failure are additionally sufficient for the cliff lines located above this panel.

The stability outcomes for the 20.5 m x 17.5 m pillars are summarised in **Table 28** for the applicable depth range, again assuming a mining height of 2.8 m.

Table 28: Summarised Stability Outcomes for Coal Pillars on 20.5 m x 17.5 m Centres

Depth (m)	Pillar Stability Parameters			
	Strength (MPa)	Minimum w/h Ratio	Stress (MPa)	Factor of Safety
30	12.9	4.1	1.6	8.0
100			5.4	2.4
110			5.9	2.2
120			6.5	2.0
130			7.0	1.8

It is concluded that the Factor of Safety (FoS) of the split pillars is adequate to ensure long term stability up to a maximum depth of 110 m due to the presence of cliff lines at the 80 m depth contour. No splitting of pillars is recommended at greater depths in this panel.

The expected subsidence levels using the methodology described for the 35 m x 20.5 m centre pillars for the representative depth range are summarised in **Table 29**.

Table 29: Analytical Subsidence Estimates for 35 m x 20.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.2	0.5	3.0
80	2.0	3.2	1.2	8.0
110	2.7	4.4	1.7	11.0
130	3.2	5.2	2.0	12.9

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.15 mm/m, with compressive strains estimated at between 0.09 and 0.25 mm/m and tilts 0.31 to 0.50 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected and the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

The expected subsidence levels for the 20.5 x 17.5 m centre pillars are summarised in **Table 30**.

Table 30: Analytical Subsidence Estimates for 20.5 m x 17.5 m Centre Pillars

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.6	0.8	4.5
80	2.0	4.2	2.3	12.1
110	2.7	5.8	3.1	16.6

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.18 and 0.23 mm/m, with compressive strains estimated at between 0.14 and 0.38 mm/m and tilts 0.47 to 0.75 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected and the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

9.0 PANEL 122 ANALYSIS

The depth of cover varies between a minimum of 30 m and a maximum of 110 m, with flooding predicted in the long term (see **Figure 3**). Cliff lines occur between a depth of 100 m and 110 m (see **Figure 1**).

9.1 35 m x 35 m Pillars with Splitting and/or Quartering

The stability outcomes for the 35 m x 35 m first workings pillars are summarised in **Table 24** for the applicable depth range**.** A mining height of 2.8 m has been assumed.

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 130 m, given also their w/h ratio of 10.5. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probability of failure of pillars beneath the cliff line in this area is also less than 1 in 1,000,000.

Quartering of pillars will only be applicable to a maximum depth of 100 m as a cliff line is located between a depth of 100 m and 110 m (see **Table 2**. Split pillars will have an adequate FoS and probability of failure between a depth of 100 m and the maximum depth for this panel of 110 m (see **Table 3**).

The expected subsidence levels pre-flooding using the methodology described for the 35 m centre pillars for the representative depth range are summarised in **Table 25**.

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.14 and 0.17 mm/m, with compressive strains estimated at between 0.1 and 0.29 mm/m and tilts 0.36 to 0.58 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels post-flooding using the methodology described for the 35 m centre pillars over the representative depth range are summarised in **Table 31**.

Table 31: Analytical Subsidence Estimates for 35 m Centre Pillars Post-flooding

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.0	0.3	6.5
50	1.2	1.7	0.5	10.8
80	2.0	2.8	0.8	17.3
100	2.5	3.5	1.0	21.7
110	2.7	3.8	1.1	23.8

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.26 and 0.33 mm/m, with compressive strains estimated at between 0.20 and 0.54 mm/m and tilts 0.67 to 1.08 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars for the representative depth range pre-flooding are summarised in **Table 26**.

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.16 mm/m, with compressive strains estimated at between 0.09 and 0.26 mm/m and tilts 0.33 to 0.53 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The expected subsidence levels for the 35 m x 17.5 m centre pillars over the representative depth range post-flooding are summarised in **Table 32.**

Table 32: Analytical Subsidence Estimates for 35 m x 17.5 m Centre Pillars Post-flooding

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
100	2.5	4.4	2.0	18.3
110	2.7	4.9	2.2	20.2

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.22 and 0.27 mm/m, with compressive strains estimated at between 0.16 and 0.46 mm/m and tilts 0.57 to 0.92 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The depth range for the analytical subsidence for the 17.5 m x 17.5 m centre pillars pre-flooding are covered in **Table 5.** The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.21 and 0.24 mm/m, with compressive strains estimated at between 0.16 and 0.39 mm/m and tilts 0.53 to 0.79 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

The post-flooding expected subsidence for the 17.5 m x 17.5 m centre pillars are summarised in **Table 33**.

Table 33: Analytical Subsidence Estimates for 17.5 m x 17.5 m Centre Pillars Post-flooding

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.7	1.0	9.0
50	1.2	2.8	1.6	15.0
100	2.5	5.7	3.2	29.9

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.36 and 0.45 mm/m, with compressive strains estimated at between 0.27 and 0.75 mm/m and tilts 0.93 to 1.49 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range and no surface impacts are therefore to be expected.

9.2 35 x 20.5 m Pillars with Subsequent Splitting

The stability outcomes for the 35 m x 20.5 m first workings pillars are summarised in **Table 27** for the applicable depth range, assuming a mining height of 2.8 m.

It is concluded that the Factor of Safety (FoS) of the pillars is adequate to ensure long term stability, up to the envisaged representative maximum depth of 110m. There is no precedent for pillar failures with the FoS noted at the proposed w/h ratio. The probabilities of failure are additionally sufficient for the cliff lines located above this panel.

The stability outcomes for the 20.5 m x 17.5 m pillars are summarised in **Table 28** for the applicable depth range, again assuming a mining height of 2.8 m.

It is concluded that the Factor of Safety (FoS) of the split pillars is adequate to ensure long term stability up to the maximum depth of 110 m for this panel, noting the presence of cliff lines at the 80 m depth contour.

The expected subsidence levels pre-flooding using the methodology described for the 35 m x 20.5 m centre pillars for the representative depth range are summarised in **Table 29**.

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.12 and 0.15 mm/m, with compressive strains estimated at between 0.09 and 0.25 mm/m and tilts 0.31 to 0.50

mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected and the levels of subsidence predicted are generally below the resolution of conventional subsidence measurements.

The expected subsidence levels post-flooding using the methodology described for the 35 m x 20.5 m centre pillars over the representative depth range are summarised in **Table 34**.

Table 34: Analytical Subsidence Estimates for 35 m x 20.5 m Centre Pillars Post-flooding

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.2	0.5	5.3
80	2.0	3.2	1.2	14.2
110	2.7	4.4	1.7	19.6

The magnitudes of tensile strain estimates associated with these levels of subsidence vary between 0.21 and 0.27 mm/m, with compressive strains estimated at between 0.16 and 0.44 mm/m and tilts 0.55 to 0.88 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected subsidence levels pre-flooding for the 20.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 30**.

The magnitudes of tensile strain estimates associated with these low levels of subsidence vary between 0.18 and 0.23 mm/m, with compressive strains estimated at between 0.14 and 0.38 mm/m and tilts 0.47 to 0.75 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

The expected post-flooding subsidence levels for the 20.5 m x 17.5 m centre pillars for the representative depth range are summarised in **Table 35**.

Table 35: Analytical Subsidence Estimates for 20.5 m x 17.5 m Centre Pillars Post-flooding

Depth (m)	Vertical Virgin Stress (MPa)	Average Pillar Stress (MPa)	Stress Change (MPa)	Total Compression (mm)
30	0.7	1.6	0.8	7.9
80	2.0	4.2	2.3	21.0
110	2.7	5.8	3.1	28.8

The magnitudes of tensile strain estimates associated with these levels of subsidence vary between 0.32 and 0.40 mm/m, with compressive strains estimated at between 0.24 and 0.66 mm/m and tilts 0.82 to 1.32 mm/m. The magnitudes of subsidence, tilts and strains predicted are well below those expected to result in surface damage over the representative depth range. No surface impacts are therefore to be expected.

10.0 SUMMARY

The proposed 35 m x 35 m (centres) and 35 x 20.5 m (centres) first working pillars will be long term stable in all of the proposed panels. Probabilities of failure will be adequate where cliff lines are undermined. Subsidence, tilt and strains will be well below the levels expected to cause surface damage, this includes the 122 Panel post the expected flooding.

In the extension to Panel 205, there will be a small mining exclusion zone associated with a creek that is marked on **Figure 1**. Quartering of the 35 m x 35 m pillars is recommended to a maximum depth of cover of 100 m where cliff lines are located above the panel and 110 m in areas where there are no cliff lines. Splitting of the 35 m x 35 m centre pillars is recommended at a DoC from 100 m where there are cliff lines to a maximum depth of cover of 139 m in these areas. Where there are no cliff lines splitting of the 35 m x 35 m pillars is recommended from a depth of cover of 110 m to a maximum of 150 m, noting that the minimum pillar width of spilt pillars is less than one tenth depth at a DoC of >115 m. Splitting of the 35 m x 20.5 m pillars is recommended to a maximum DoC of 110 m where there are overlying cliff lines and 120 m where there are not (noting again that these split pillars will have a minimum width to depth ratio of less than one tenth depth at a DoC of > 115 m). At the DoC noted subsidence, tilt and strains for both quartered and split pillars have been estimated to be well below the levels that are expected to cause surface damage

In Panel 100 Cross no quartering of the 35 m x 35 m pillars is recommended. Splitting of the 35 m x 35 m pillars is recommended between the minimum DoC of 100 m to a maximum of 139 m. Splitting of the 35 m x 20.5 m pillars is recommended between the minimum DoC of 100 m to a maximum of 110 m. The subsidence, tilt and strains associated with split pillars in this panel are predicted to be well below the levels that are expected to result in surface damage at the DoC specified.

In Panel 420 quartering of the 35 m x 35 m pillars is recommended to a maximum depth of cover of 100 m. Splitting of the 35 m x 35 m pillars is recommended at DoC of from 100 m to a maximum of 139 m in order to give adequate protection to cliff lines above this panel, noting again that the minimum pillar width of spilt pillars is less than one tenth depth at a DoC of >115 m. Splitting of the 35 m x 20.5 m pillars is only recommended to a depth of 110 m due to the presence of cliff lines overlying this panel. At the DoC noted subsidence, tilt and strains for both quartered and split pillars have been estimated to be well below the levels that are expected to cause surface damage.

In Panel 121 quartering of the 35 x 35 m pillars is recommended to a maximum DoC of 100 m to ensure adequate probabilities of failure beneath the cliff line. Splitting of the 35 m x 35 m pillars is recommended between 100 m and the maximum depth for this panel of 130 m, noting again that the minimum width of split pillars is less than one tenth depth at a DoC of > 115 m. Splitting of the 35 m x 20.5 m is again only recommended to a maximum depth of 110 m due to the presence of overlying cliffs. At the DoC noted subsidence, tilt and strains for both quartered and split pillars have been estimated to be well below the levels that are expected to cause surface damage.

In Panel 122 quartering of the 35 m x 35 m pillars is also recommended to a maximum DoC of 100 m to ensure adequate probabilities of failure beneath the overlying cliff line. Splitting of the 35 m x 35 m pillars is recommended between 100 m and the maximum depth for this panel of 110 m. At the DoC noted subsidence, tilt and strains for both quartered and split pillars have been estimated to be well below the levels that are expected to cause surface damage even after the post-mining flooding that has been predicted long term for this panel.

11.0 REFERENCES

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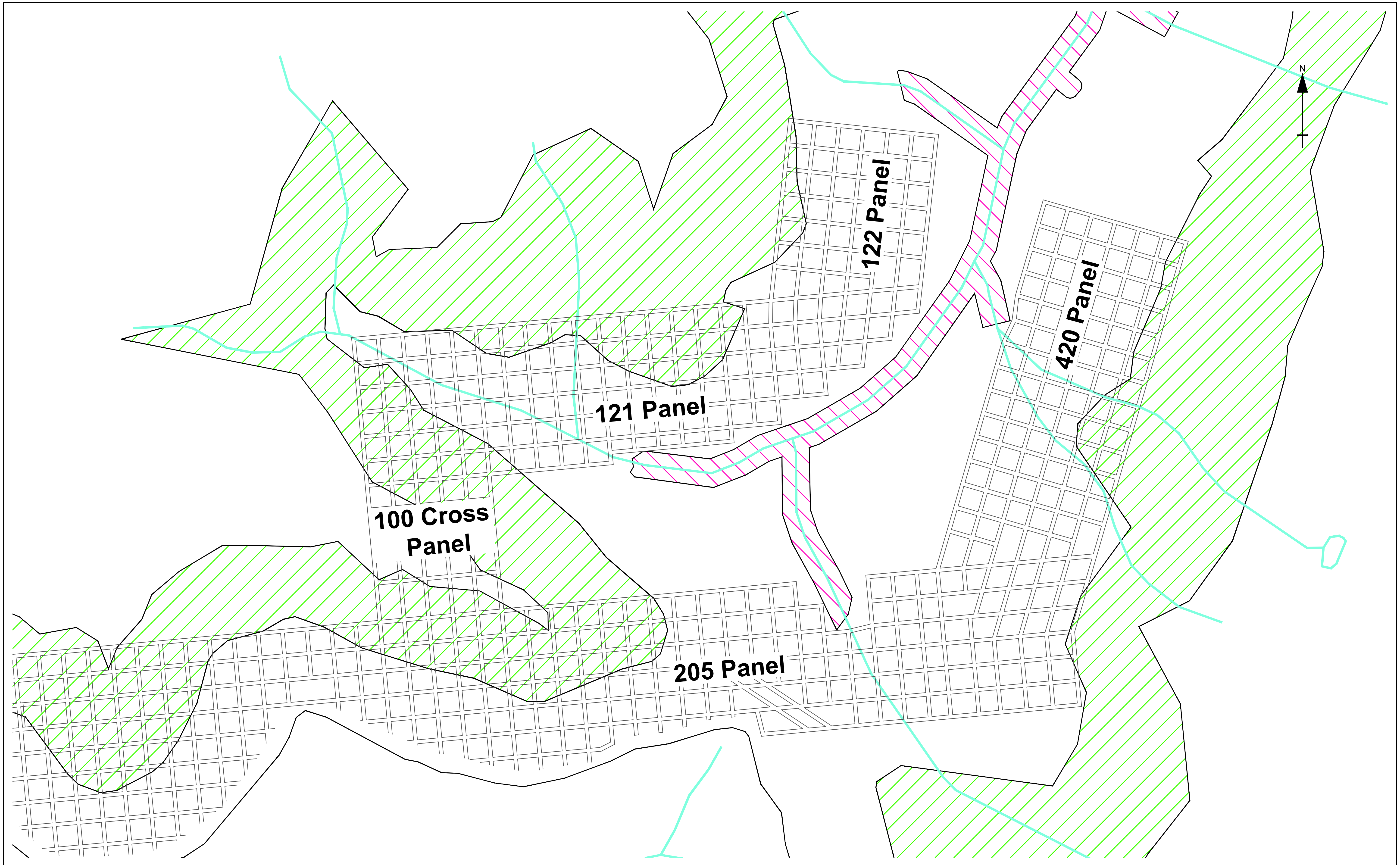
Yours sincerely,

Golder Associates Pty Ltd

R. Trueman

Bob Trueman

Principal Mining Engineer



Key:
- Cliff line zone
- Creek exclusion zone
- Creeks

Golder Associates

Engineer:	B. Trueman	Client:	Airly Mine
Drawn:	B. Richardson	Title:	Copy of Mine Plan Showing Cliff Line Zone, Creek Exclusion Zone and Location of Creeks in Relation to 121, 122, 205, 420 and 100 Cross Panels with 35 x 35m centre pillars
Date:	12.06.14		

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Ref:	127621105-109-R	Revision No:	1
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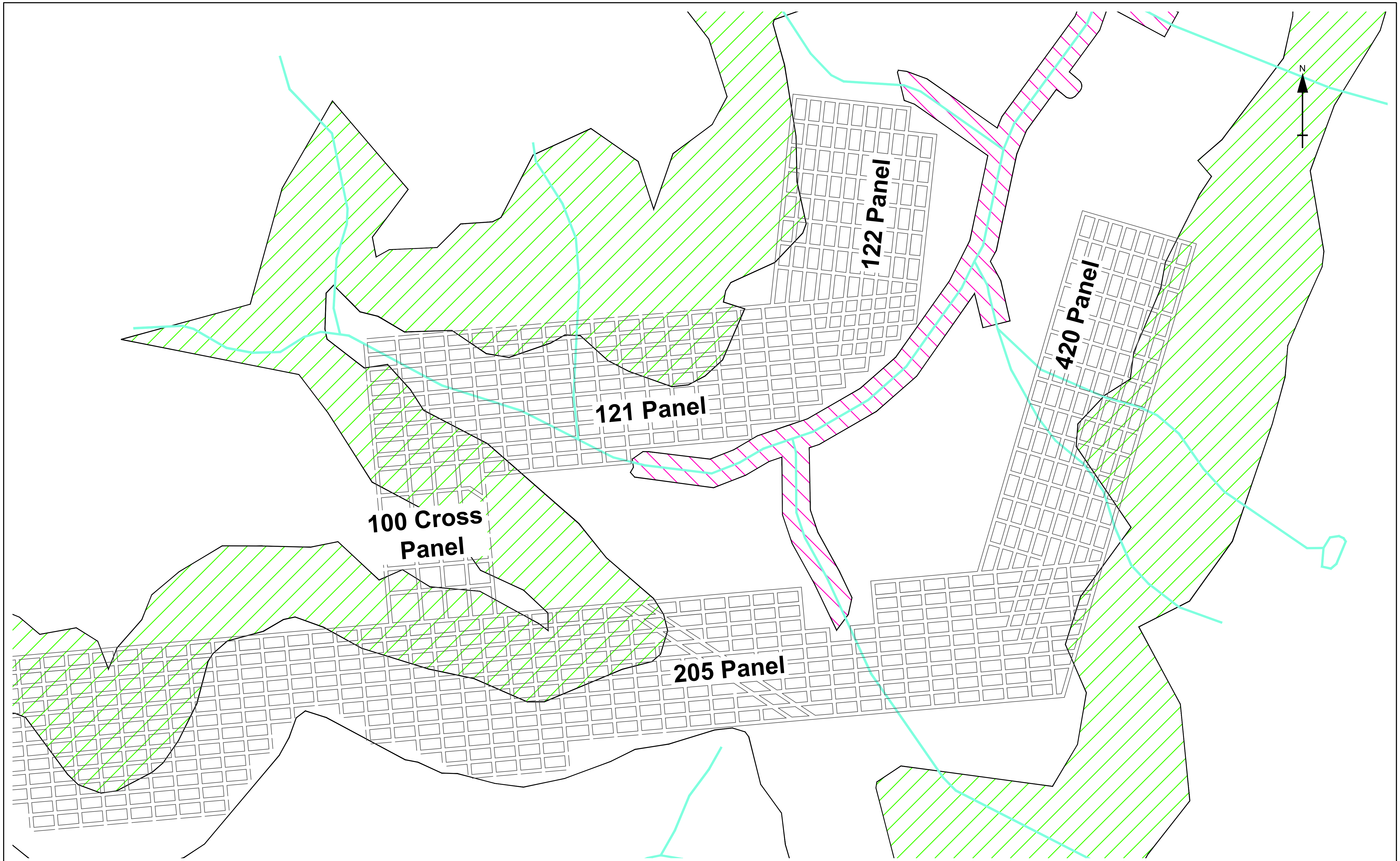

Key:
- Cliff line zone
- Creek exclusion zone
- Creeks

Golder Associates

Engineer:	B. Trueman	Client:	Airly Mine
Drawn:	B. Richardson	Title:	Copy of Mine Plan Showing Cliff Line Zone, Creek Exclusion Zone and Location of Creeks in Relation to 121, 122, 205, 420 and 100 Cross Panels with 35 x 20.5m centre pillars
Date:	12.06.14		

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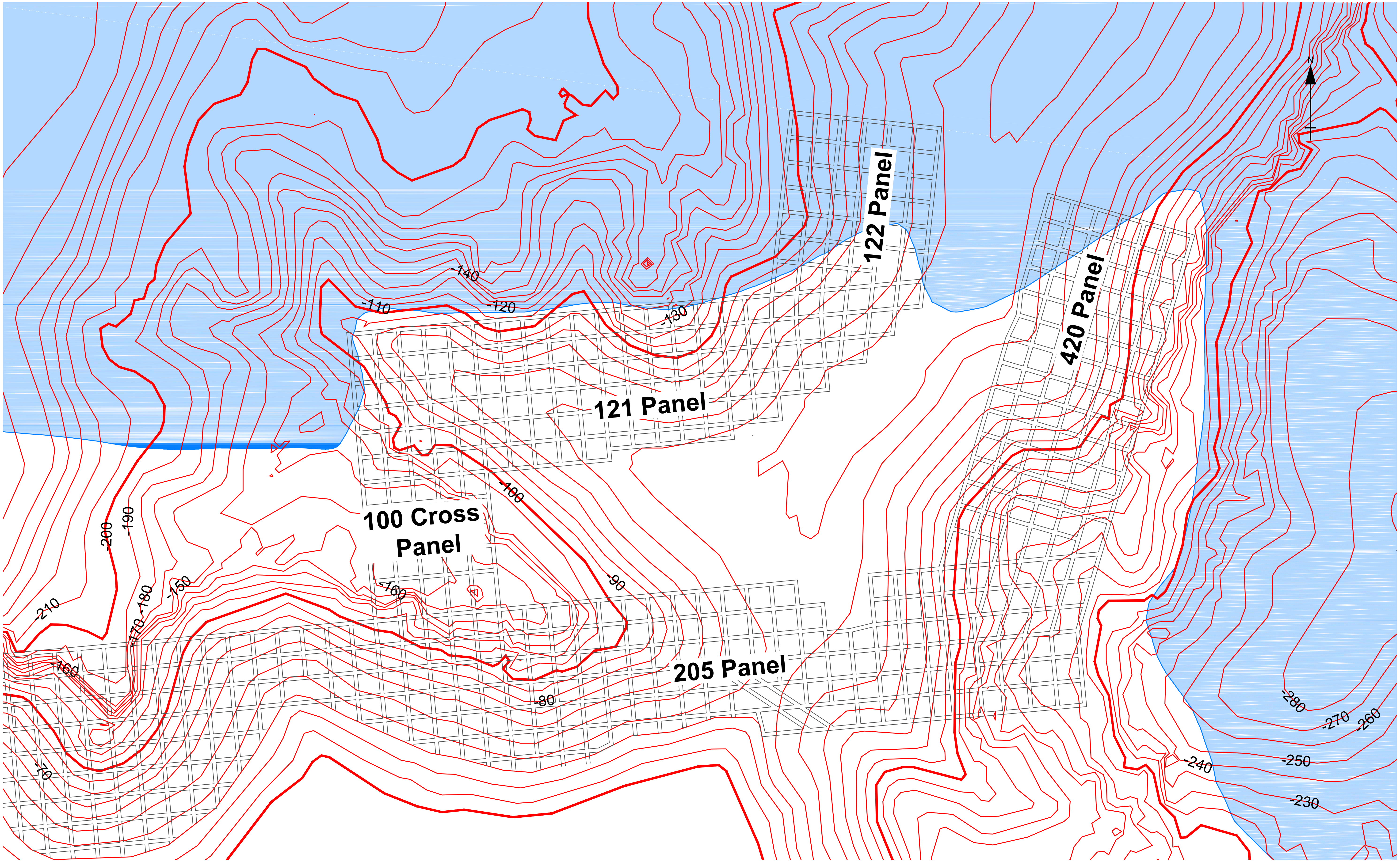
Ref:	127621105-109-R	Revision No:	1
Scale:	NTS	Figure No:	2



Key:

- Areas of potential flooding greater than 1m above the seam floor post mining of the deeper areas
- Depth of Cover contours (m)

Engineer:	B. Trueman	Client:	Airly Mine
Drawn:	B. Richardson	Title:	Copy of Mine Plan Showing Depth of Cover and Areas of Potential Flooding in Relation to 121, 122, 205, 420 and 100 Cross Panels with 35 x 35m centre pillars
Date:	12.06.14		

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Ref:	127621105-109-R	Revision No:	1
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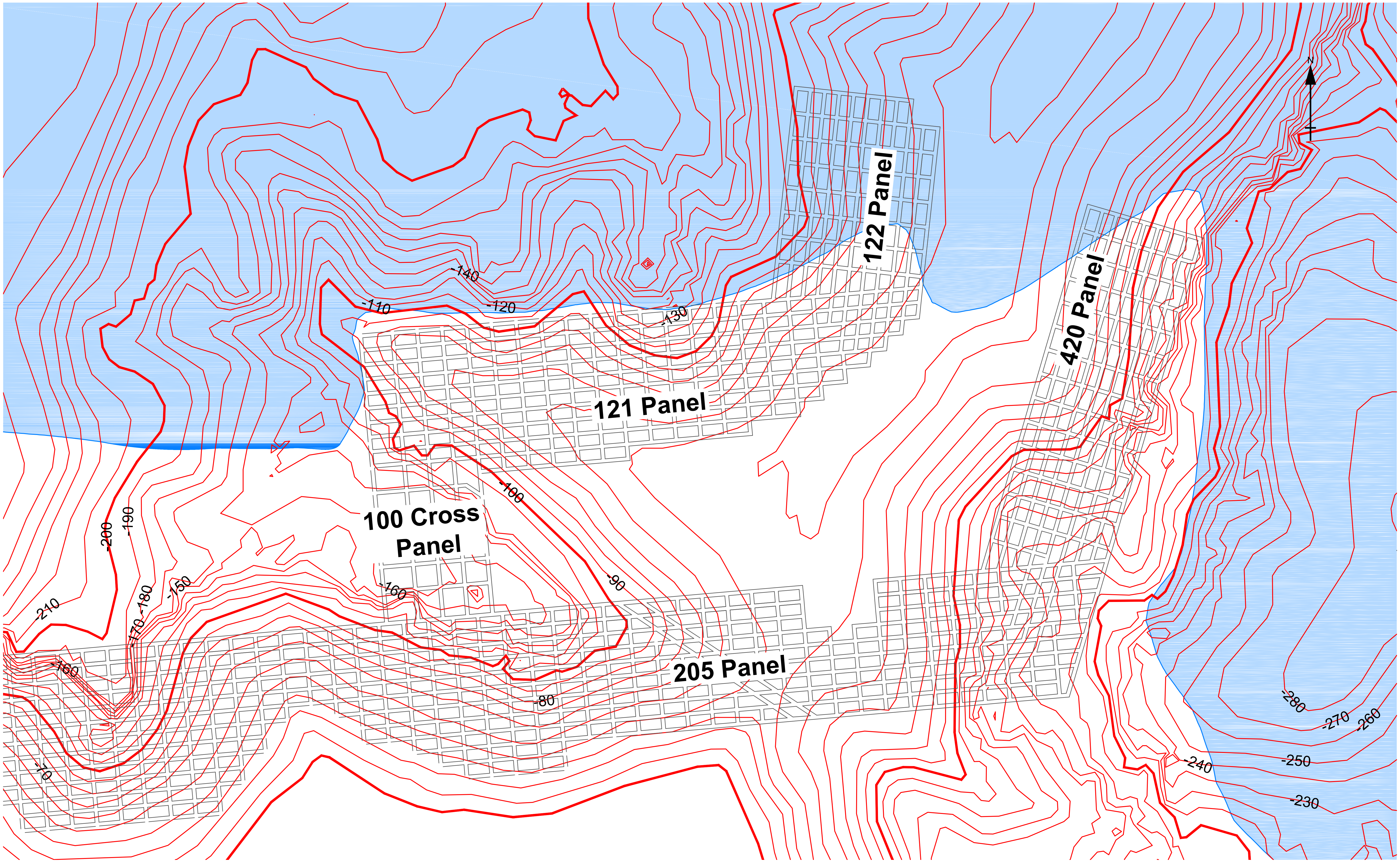

Key:

- Areas of potential flooding greater than 1m above the seam floor post mining of the deeper areas
- Depth of Cover contours (m)

Engineer:	B. Trueman	Client:	Airly Mine		
Drawn:	B. Richardson	Title:	Copy of Mine Plan Showing Depth of Cover and Areas of Potential Flooding in Relation to 121, 122, 205, 420 and 100 Cross Panels with 35 x 20.5m centre pillars		
Date:	12.06.14				
GOLDER ASSOCIATES PTY. LTD. www.golder.com		Ref:	127621105-109-R	Revision No:	1
		Scale:	NTS	Figure No:	4

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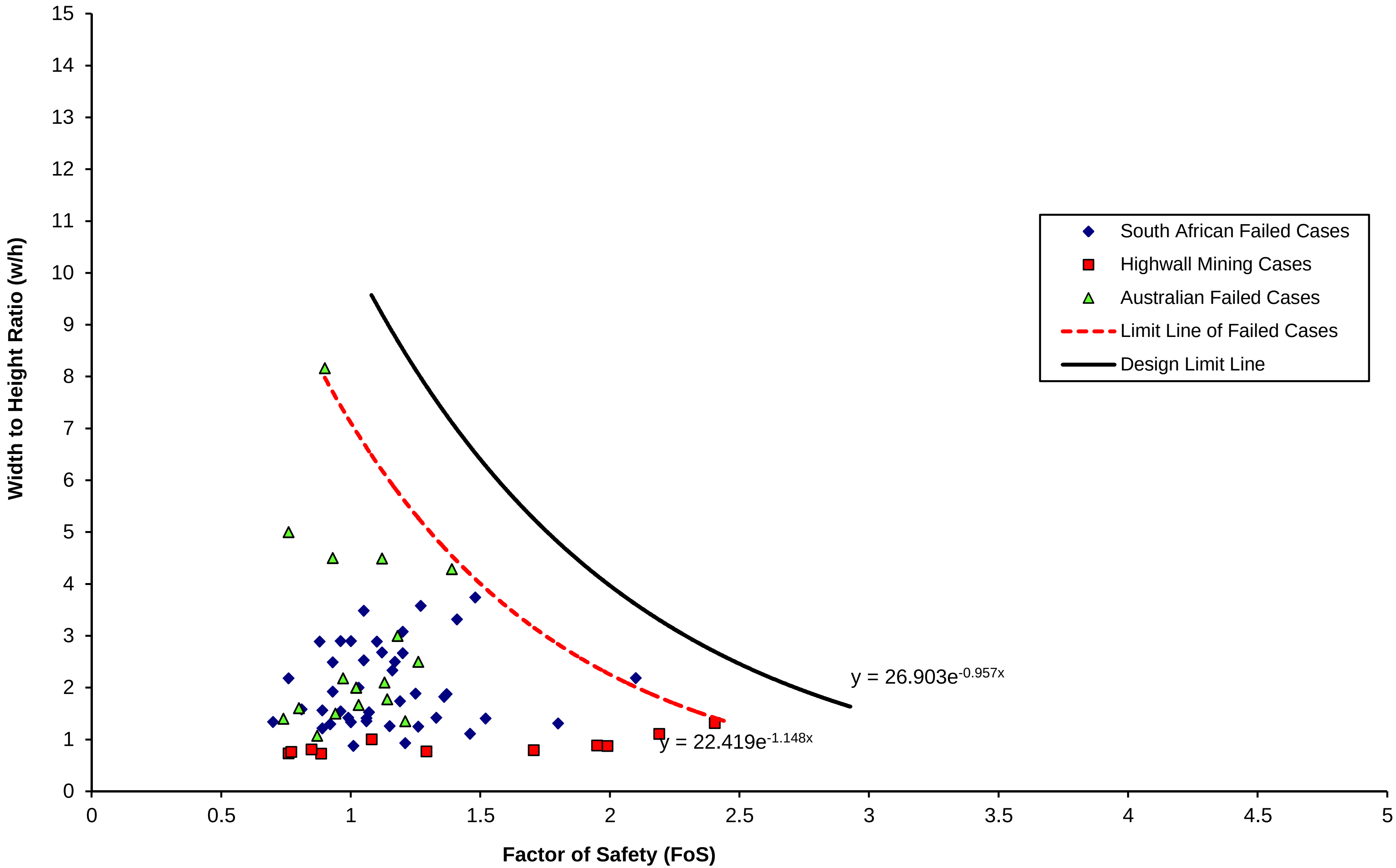

Engineer:	B. Trueman	**Client:**	Airly Mine	
Drawn:	B. Richardson	**Title:**	Failed Pillar Database Showing Proposed Design Limit Line (Hill, 2010)	
Date:	12.06.14			
GOLDER ASSOCIATES PTY. LTD.		**Ref:**	127621105-109-R	**Revision No:** 1
www.golder.com		**Scale:**	N/A	**Figure No:** 5