**Date:** 29 October 2018

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**Report No:** DPE-HUME-2018-2

**From:** Dr Ismet Canbulat

**RE:** **Response to "Responses to reviews of the Hume Coal Project by Galvin and Associates, and Professor Ismet Canbulat"**

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## 1 BACKGROUND

Hume Coal Pty Limited has lodged development applications for both the Hume Coal Project and its associated Berrima Rail Project. I was appointed by the NSW Government Department of Planning and Environment (DPE) to review the "Mine Plan" and "Subsidence Risks" associated with the proposed mine plan. I conducted the review and submitted my report on 22 December 2017 (Canbulat, 2017). This review report was not intended to provide detailed numerical modelling, nor was it intended to ascertain design dimensions for the proposed mine. Instead, it sought to highlight some critical design considerations using numerical modelling.

Following submission of the report, Hume Coal responded with a draft report, detailing a number of technical arguments regarding my review report. An "experts meeting" was also held at the DPE on 28 March 2018. This meeting was chaired by Emeritus Professor Ted Brown and sought to discuss the comments made by Hume Coal, Emeritus Professor Jim Galvin (DPE expert), and myself in our respective reports. The minutes of this meeting are provided in Appendix 1.

This current report is prepared as a response to Hume Coal's latest response report entitled "Response to reviews of the Hume Coal Project by Galvin and Associates and Professor Ismet Canbulat". The Hume Coal response report provided additional information, most notably a numerical modelling study conducted by Dr Keith Heasley and interpretation of the results conducted by Mine Advice. Therefore, a short review of the new material is also presented.

In my response I do not intend to go into an academic argument regarding coal pillar design or other aspects of the proposed layout. In line with my statements at the experts meeting, it is my opinion that even if the proposed web-pillars fail, the expected subsidence would be relatively low. Therefore, Hume Coal should select a safe, practical and conservative mine layout, use reasonable input parameters, and produce a mine plan which will satisfy the imposed subsidence criteria with a subsidence management plan.

## 2 INFORMATION PROVIDED

I have been provided the following information by the DPE:

1. Draft response to the review of Hume Coal's mining proposal by Professor Ismet Canbulat. Hume Coal Project. Dated 1st March 2018. By Alex Pauza.

2. Response to the reviews of the Hume Coal Project by Galvin and Associates, and Professor Ismet Canbulat. Hume Coal Project. Dated 11th July 2018. By Alex Pauza.

3. Hume Coal Project – Expert Meeting 28 March 2018. Record of Meeting. By Clay Preshaw.

4. Summary Independent Peer Review: Report on "Pillar Design Analysis Using LaModel" by Dr Keith Heasley (29 May 2018). Report No. 1509/02.4. Dated 18 August 2018. By Dr Bruce Hebblewhite.

5. Summary Independent Peer Review: Report on "Interpretation of the Numerical Modelling Study of the Proposed Hume Project EIS Mine Layout" by Mine Advice – Dr Russell Frith (June 2018) – HUME22/1. Report No. Report No. 1509/02.5. Dated 19 August 2018. By Dr Bruce Hebblewhite.

As the first response report by Hume Coal was in draft format, the proceeding review has been made only in relation to the final combined report submitted by Hume Coal.

## 3 NUMERICAL MODELLING BY KEITH HEASLEY

I was an early user of the LaModel software, having used it since its advent in the 1990s. Since then, I have known Dr Keith Heasley, whose expertise is well-recognised internationally in the fields of numerical modelling and rock mechanics. LaModel has been used extensively to assess pillar stabilities and potential surface subsidence in most coal producing countries. I therefore fully endorse the use of 3D LaModel in assessing the Hume Coal project and Dr Keith Heasley's role in carrying out this assessment.

I offer the following comments, made without any relative priority or level of importance on the modelling study conducted by Dr Heasley:

- Surface subsidence due to pillar failures is different where high extraction mining methods are used (i.e., longwall and pillar extraction mining methods). Since the failed pillars can still provide some form of resistance to the overlying rock mass, there is no free collapse of the overburden (van der Merwe and Madden, 2010). Also, in the case of pillar failure, a significant amount of subsidence will only occur if the overburden also fails. In most cases of pillar failures, some level of sliding occurs between the jointed blocks and bedding planes, which determines the total amount of surface subsidence. Therefore, overburden stability becomes a critical factor if the layout relies on the bridging capabilities of the component units in the overburden. In the case of the Hume Coal project, it is agreed by all experts that a complete failure of the overburden is highly unlikely due to the thick competent Hawkesbury Sandstone, which is known to span long distances (as stated in the Hume Coal report). It is for this reason that the overburden was modelled as an elastic material in my earlier numerical models and in Dr Heasley's study. In the assessment of surface subsidence with elastic overburden, back analysis and some degree of conservatism can only be achieved by introducing bedding planes in the overburden and modifying the overburden stiffness. In my earlier study, I used 20m thick bedding planes (for the main unit Hawkesbury Sandstone) with low cohesion and friction angles. In Dr Heasley's study, a lamination thickness of 20m and 40m of frictionless layers were used. Comparing frictionless beddings and beddings with some low level of friction is an academic exercise. I therefore endorse the use of 20m and/or 40m lamination thicknesses in LaModel. Overburden lamination thicknesses greater than this range may be unrealistic.

- Another critical consideration in modelling of the web-pillars is accurate estimation of pillar stress. I concur with the findings of Dr Heasley. In my earlier study, I stated that in a conservative case (i.e., using elastic material properties), the web-pillar stress is approximately 90% of the tributary area load at 170m depth. In Dr Heasley's study, the 2D modelling results presented in Table 3 indicate pillar stresses between 89% and 98% (with an average of approximately 94%) of the tributary area load on the centre web-pillar for varying depth, lamination thickness and rock mass elastic modulus. As expected, Table 3 also reveals that the excessive loads are transferred onto the intra-panel barrier (barrier) pillars. Lower stresses are also evident on the outer web-pillars due to presence of stiffer barrier pillars located adjacent to them.

- The 3D stresses presented in Table 4 of Dr Heasley's report indicate lesser average stresses than 2D stresses on the middle of the centre pillar compared to the tributary area load. For varying depths, lamination thickness and rock mass modulus, the 3D average stresses range between 85% to 95% (with an average of approximately 89%) of the tributary area load on the centre web-pillars. As also mentioned in the Hume Coal report, this is due to the distribution of 3D stresses onto other pillars adjacent to the web-pillars. It is evident however that the stress distribution is not significantly greater in the 3D models compared to the 2D model results (i.e., less than 5% on averages). Note that the ARMPS-HWM program does not consider the roadway located adjacent to the chain pillars which indicates marginally lower ARMPS stability factors than those shown in Table 4 due to the subtle increase in pillar loading. This is considered in calculation of tributary area loads.

- Another important conclusion from Tables 3 and 4 of Dr Heasley's report is that 3D models are significantly better in modelling stresses compared to 2D models. This is because 3D models offer superior representations of stress distributions. I therefore endorse the use of 3D modelling.

- A critical assumption in Dr Heasley's study is that the materials used as pillar elements are elastic, perfectly-plastic. As Dr Heasley points out in his report, proposed pillars with low width to height (w/h) ratios would almost certainly be strain-softening after failure. Dr Hebblewhite also points this out in his recent review report, asserting that the results may have been slightly more adverse than with the Mark-Bieniawski coal model. I fully concur with those statements. Considering the size of the web-pillars and the fact that the stress distribution on pillars is not uniform (i.e., stresses are higher at the edges compare to the centre of a pillar), strain-softening elements are better suited than elastic, perfectly-plastic materials. In addition, if the pillars do not reach their peak strength, as stated by Dr Heasley, this modelling study is no different than an elastic modelling of pillar behaviour, which may not be an appropriate assumption for these relatively narrow, low w/h ratio web-pillars.

- Stage 5 of Dr Heasley's study presents a worst-case scenario of removal of web-pillars in a panel, which indicates subsidence magnitudes between 16mm and 24mm. Stability of the barrier pillars to control subsidence is critical in the case of Hume Coal as they are part of the designed system. It is understood that the barrier pillars in the proposed panels are designed with the assumption of double abutment loading in ARMPS HWM, i.e., goaf on either side of the barrier pillars. Modelling of a single panel without the web-pillars represents only a single abutment loading scenario (i.e., goaf is only on one side of the barrier pillars). Although I employed a similar approach in my earlier report, excluding all web-pillars represents a very conservative approach. The purpose of my modelling was mainly to assess the barrier pillar stability under worst-loading conditions. As mentioned above, failed pillars can still provide some form of resistance to the overlying rock mass. Therefore, removing all web-pillars in all panels may not be representative of realistic conditions. Using strain-softening elements in all pillars, including at the edges of barrier pillars, may have represented a more realistic approach.

- The subsidence results presented in Table 4 are also agreeable in terms of relative change in magnitudes of subsidence for different lamination thicknesses and elastic modulus. The table indicates that at depths of 80m, 120m, and 160m, the maximum subsidence between the stiffest and softest models vary by 13%, 9%, and 15% respectively with an average of 13% (excluding the failed pillar and failed sections). This subtle variation would be expected as the overburden was modelled as an elastic rock mass; therefore, changing the elastic modulus and lamination thicknesses does not make a significant difference. For example, a 13% increase or decrease in subsidence would only make a ± 2.6mm variation over 20mm subsidence for varying overburden stiffnesses.

- Note that the ARMPS safety factors presented in Table 4 are not repeatable and are therefore not assessed.

- Throughout the response report, the importance of back analysis is highlighted by quoting previously published papers. Although it appears that a "very simple back-analysis" was also conducted against the Berrima Colliery by Dr Heasley, the subsidence values obtained from the modelling of the proposed layout is at best approximately 2.4 times less than the ~10mm figure reported at Berrima when the pillars are stable. When the failure of pillars was modelled, the maximum subsidence was 23mm, which is 2.3 times greater than the reported at Berrima. When conducting a back analysis, it is a standard practice to use the back analysed input parameters. Assuming other input parameters and stating that more conservative parameters are used in later analyses may not be appropriate under all circumstances.

- Further to the above, no details of the Berrima Colliery back analysis were presented in Dr Heasley's report. The findings presented consisted solely of three lamination thicknesses and elastic modulus. If elastic, perfectly-plastic coal material properties were also assumed in the back analysis, this assumption may not be true for the total extraction panel(s). In addition, super-stiff overburden strata may indicate low subsidence magnitudes for an isolated panel. However, high stiffness overburden may result in increased load transfers onto the barrier pillars (as evidenced by reported LaModel results for Hume Coal), which may, in turn, impact their stability. These details should have been included in the report to review.

- In addition, Hume Coal's response report did not include the details of the Berrima subsidence data. It is not evident whether the quoted subsidence values from Berrima were from an isolated panel or a series of panels. Readings from a single, isolated panel may produce subsidence magnitudes significantly lower than from a series of panels, as demonstrated in my report. Therefore, particulars of the Berrima subsidence data (and/or subsidence data from the other, neighbouring mines) should be obtained for the completeness of the back analysis.

## 3.1 Summary

Dr Keith Heasley is a well-recognised researcher in the fields of numerical modelling and rock mechanics. LaModel is an appropriate numerical modelling code to assess pillar stabilities and potential surface subsidence for Hume Coal. I therefore fully endorse the use of 3D LaModel in assessing the Hume Coal project and Dr Keith Heasley's role in carrying out this assessment. However, the following studies will ensure the completeness of the numerical modelling study and that the residual risks are minimised:

- The results of the numerical modelling study conducted by Dr Keith Heasley appear to be reasonable for the material properties used in the assessment. However, in my opinion, strain-softening elements, with relatively low residual strength properties would be better suited in this case. Therefore, for the benefit of the project, I recommend a further study using strain-softening elements in 3D LaModel to estimate the subsidence magnitudes at varying depths.

- Once strain-softening elements are implemented in models, the stability of the pillars should be investigated as the subsequent entries are extracted to ensure that pillar failures are not expected and do not cause a safety concern in active panels. Based on the results of the ARMPS HWM design methodology, this appears to be an unlikely event. However, the mining height and the depth of the proposed Hume Coal panels may not entirely within the database of ARMPS HWM (see the below section).

- The back analyses of Berrima Colliery can be expanded. The input parameters used for back analysis are not presented. If elastic, perfectly-plastic coal material properties were also assumed in the back analysis, this assumption may not be true for the total extraction panel(s). It is also noted that super-stiff overburden strata (as identified but not used in the back analysis) may indicate low subsidence magnitudes for isolated panels. However, high stiffness overburden may result in increased load transfers onto the barrier and other adjacent pillars (as evident in reported LaModel results for Hume Coal), which may, in turn, impact their stability and increase the magnitude of subsidence. These details should be included in the report to review.

- In my opinion, unless the points above are in detail there are, along with the associated subsidence, particularly in the web and barrier pillars.

## 4 CORE ISSUE #6

Hume Coal's response report makes the following general technical arguments:

- The models' characterisation of barrier pillars is not described.
- Given the lack of a description of barrier pillar characterisation in the report, the reader is unable to determine whether or not the barrier pillars (which are of critical importance in the design) have been assigned the strength properties of full-width pillars despite being modelled as half-width pillars due to model symmetry. Pillar strength is not linearly related to pillar width - so two pillars that are X metres wide can have a far lower strength than one whole pillar that is 2X metres wide. It was stated at the mining experts meeting that the barrier pillars have been correctly characterised, however there is no evidence to support this in the report.
- The characterisation of web-pillars is based on the UNSW power-law pillar strength formula despite arguments from both Galvin and Associates and Canbulat that it is inappropriate to use this formula for pillars at these geometries.
- There is no description of any attempt to calibrate overburden properties to observations from a suitably analogous site.

- It is unclear how the overburden has been modelled and whether the stiffness of the overburden is reduced by modelling only a 20m thick overburden unit with a surcharge load, when in reality the overburden is 80-170m thick under self-weight.
- Unrealistic backfill volumes are assumed. Cemented backfill is modelled despite Hume Coal proposing to use uncemented backfill.
- One of the models incorporates a mine layout that differs significantly from the dimensions proposed by Hume Coal, without explanation as to why this model was included.
- The results of the subsidence settlement modelling contain curious anomalies and appear to be inconsistent with the overall simplicity of the model.
- The report contains a number of areas that appear contradictory, both internally, and with the Galvin and Associates report. For instance, the two subsidence models in the Canbulat report appear to present conflicting results.
- The Canbulat report draws an implicit and inappropriate parallel between the Hume Coal project and mines with very different geology in the Vaal Basin in South Africa, in order to draw important and likely erroneous conclusions about long-term pillar stability.

The following sections respond to the technical arguments raised by the Hume Coal Project report, where the details of the above points can be found.

- **Pillar characterisation and model calibration**: As explained in my earlier report (and above), I used a strain-softening constitutive model employing Mohr-Coulomb failure criterion for coal and elastic overburden. Calibration of input parameters to be used in numerical models is a common approach; in my report I used UNSW formula to estimate the coal input parameters. Once the input parameters are assigned to coal (i.e., all coal materials), the finite difference and finite element codes (FLAC and RS2) calculate the stress levels and determine the behaviour (i.e., failed or unfailed material depending on the stress-strain curve) of each element in all coal materials, including web and barrier pillars.

- The pre-determined material properties using a back analysis may vary depending on the mesh density. As my study was not intended to be a comprehensive design study for Hume Coal, assigning a set of strength parameters for coal materials, including pillars, is a reasonable assumption.

- The modelling of half barrier pillars is, in several instances, called into question by the Hume Coal report. This was also raised and discussed at the experts meeting. When the layout and loading conditions are symmetrical, the application of repeating geometries (otherwise known as symmetry boundaries, roller boundaries, or restrain boundaries) is recognised in numerical modelling as one of the first principles. In this approach, once a symmetry boundary is applied, the model assumes a repeating geometry on the boundaries where the symmetry has been applied. Symmetry boundaries are used (i) to save run times in modelling of repeating geometries with improved accuracy and (ii) to avoid the boundary effects. In modelling of the Hume Coal layouts, I used symmetry boundaries in assessing different layouts, as shown in model layouts and mentioned in Section 5.1.1 of my report. Using symmetry does not limit or reduce the accuracy of models. It rather allows the user to utilise a higher density mesh (due to the reduced size of the model), which, in turn, improves the accuracy of models. In the case of half barrier pillar geometries which Hume Coal refers to, the model indicates that an identical layout (i.e., not only the barrier pillar but all pillars and panels) is repeated on the other side of the symmetry boundaries.

- As I did not have the Berrima subsidence data, it is correct to say that I made no attempt to calibrate the input parameters for numerical models. Therefore, I relied entirely on Mine Advice's estimation of rock mass properties. In their response report, Hume Coal claims that Mine Advice made no recommendation to use the overburden parameters they determined in numerical modelling studies. I emphasise that the input parameters for numerical modelling were determined in a manner almost identical to what Mine Advice detailed. Further calibration of those input parameters using back analysis is acceptable, as done by Dr Heasley, but can only be accomplished if the data is available.

- In addition, Table 3 of Dr Heasley's report makes evident the fact that increasing the overburden elastic modulus from 8.2 GPa to 23.2 GPa (2.8 times higher) for lamination thicknesses of 20m and 40m at 80m cover depth decreases the web-pillar stresses by less than 5%. A similar trend is also noted for a lamination thickness of 40m at 120m cover depth. In both cases the excessive loads are transferred onto the barrier pillars as the rock mass elastic modulus increased. Note that this comparison is not possible for the results of other depths contained within Dr Heasley's study.

- Furthermore, as presented in the EIS, there were only 25 strain-gauged elastic modulus tests conducted on Hawksbury Sandstone. It appears that the elastic modulus of the overburden in Dr Heasley's study were based on the minimum, average and maximum values obtained from these tests. A total of 25 tests was considered to be too low to make accurate decisions with regard to the input parameters for a detailed numerical modelling study.

- Arguments against the use of the UNSW pillar strength formulae have also been raised by Hume Coal, on several occasions, in both their reports and during the experts meeting. I worked on the subject of coal pillar design since April 1993, an epoch which includes 3 to 4 years with Prof Salamon, who also developed the UNSW pillar strength formulae. I am aware of its limitations, as well as the limitations of other formulae developed in Australia, USA, and South Africa. Generally speaking, pillar strength formulae produce similar results for square pillars, including UNSW (Salamon et al., 1996) and Bieniawski (Bieniawski, 1992) formulae. When rectangular pillars are considered, the strength of coal pillars should also increase. However, the extent of strength increase has been a topic of discussion for many years. Salamon et al., (1996) states that the effect of pillar length on overall pillar strength is insignificant when the w/h ratio of pillars is 3.0 or lower. A marginal strength increase will occur when the w/h ratio of pillars is between 3 and 6 and when the w/h ratio of a pillar is > 6, the full strength increase will occur as determined by the hydraulic radius concept (Wagner, 1974). The limiting w/h ratios are said to be open to personal judgement. The Mark-Bieniawski formula (Mark and Chase, 1997), which is an extension of the original Bieniawski (1992) formula, suggests higher pillar strengths for all w/h ratios, depending on the length of pillars. In my opinion, whilst this may be true for pillars with large w/h ratios; when considering low w/h ratio web-pillars, as per Hume Coal's case, the confinement generated between roof and floor can be lower, which could possibly lead to lower pillar strengths than calculated by the Mark-Bieniawski formula. The Bieniawski formula is another conservative option, which I could have employed; however, it would have made only marginal changes, if any, to the Mohr-Coulomb strength parameters as the average strength increase over the proposed web-pillars using the Bieniawski formula compared to the UNSW formula is approximately 6%. Application of the Mark-Bieniawski formula in a 3D mechanistic-based LaModel may be reasonable as the model accounts for the stress distributions along the length of pillars. However, it is difficult to verify this in the present case as the model layout includes varying pillar dimensions, resulting in none-systematic load distributions (i.e., inbye and outbye end of the pillars produce different loads, strengths and thus safety factors). Nevertheless, considering the extensive and successful use of LaModel in designing highwall pillars, it may be a reasonable approach for active panels; but certainly not conservative.

- It is also imperative to understand that although I used UNSW formula to estimate the input parameters for coal material properties, the method employed is not a precise back analysis. Therefore, the back analysed parameters are not determinate values and may not necessarily change significantly for a different empirical strength formula used for back analysis. The analysis is also mesh size dependent. This is evident in similar back analyses studies conducted by Zipf (2005) and Perry et al., (2015) using the Mark-Bieniawski formula. Their input parameters, for strain-softening constitutive models employing Mohr-Coulomb failure criterion for coal, are similar or, in some instances, even lower than the input parameters I utilised. Note that inelastic material properties for the overburden were also utilised by both authors while I used elastic overburden materials. In addition, it should be emphasised that both of those earlier studies by Zipf (2005) and Perry et al., (2015) also used strain-softening elements rather than elastic, perfectly-plastic elements in assessing pillar stabilities in highwall mining. This is because for narrow web-pillars, strain-softening material properties are more appropriate.

- It is also of note that Mark-Bieniawski formula was not initially developed based on a database of highwall mining cases. It is an analytical model that was developed for the design of rectangular pillars in retreat mining by Mark and Casey in 1995. It was first applied to highwall mining stable cases by Zipf and Bhatt (2004), who also published the underlying database that was based on data provided in the ground control plans in the US (not specified if those cases were stable cases but assumed to be). Zipf and Bhatt (2004) stated that the calculated stability factors were estimates only, and judgment of individual plans is not implied. Based on the reasonable distribution of the calculated stability factors of the cases (in 45 % of the cases, it appeared that stability factor exceeded 1.6; while in 31%, the stability factor appeared to range from 1.3 to 1.6) using the Mark-Bieniawski formula, it was concluded that its use was reasonable in designing practical highwall mining pillars. It is also an important fact that in the highwall mining database less than 12% of the known cases had mining heights of 2.1m or greater. It is not known how many of those cases were close to the proposed 3.5m mining height in Hume Coal. Mining height plays a critical role in determining the stiffness of the ribs of the web-pillars. Also, the maximum depth in the database was 155.2m (excluding one unknown case). The other dimensions of the proposed Hume Coal mine plan appear to be within the range of the database. I raise these concerns not to disparage the use of the Mark-Bieniawski formula, but to highlight its limitations when applied to Hume Coal. Whilst it is accepted that the UNSW formula has limitations, the Mark-Bieniawski formula also has limitations, especially when attempting to apply it to Hume Coal.

- **Overburden thickness**: I used bedding thicknesses (i.e. joint densities) of 10m and 20m for Ashfield Shale and Hawkesbury Sandstone respectively. Low levels of cohesion and friction in bedding planes using joint elements were also applied. This assumption was based on Mine Advice's statement in the EIS which reads "*At Hume, the Hawkesbury Sandstone is observed to contain conglomerate, fine to coarse grained sandstone and siltstone units in beds ranging from thinly bedded to thickly bedded (0.06m to >2m)*". The bedding plane thickness represents the overburden stiffness and thus the magnitude of subsidence. Dr Heasley utilised bedding thicknesses of 20m and 40m in his modelling study. LaModel models the overburden as a horizontal stack of plates with cohesionless and frictionless interfaces. A comparative study of frictionless and low friction bedding planes may be conducted; however, in my opinion, 20m thick bedding planes with some level of cohesion and friction are akin to the 20m and 40m cohesionless and frictionless interfaces in LaModel. Nonetheless, I do not agree with the assertion that the difference in my results and those of Dr Heasley's are due entirely to overburden calibration. As explained above, it is likely that the differences were primarily caused by the assumed constitutive models (i.e., strain-softening vs elastic, perfectly-plastic elements). In addition, I modelled Ashfield Shale with reasonably soft material properties; a varying overburden material property cannot be modelled in LaModel. Furthermore, the stress states in different units have been assumed as proposed by Mine Advice using the Tectonic Stress Factors (TSF) for major and minor horizontal stresses, which cannot be done in LaModel. However, these variations can be modelled and may be accounted for in LaModel by changing the overburden stiffness, as Dr Heasley did.

- **Backfill volumes**: I did not attempt to calculate the reject yield and amount of backfill that can be placed.

- **Mine layout and geology**: As described in my report, Figure 16 was produced to demonstrate that the elastic pillar settlement calculations are correct when the pillars behave in an elastic manner; however, when the pillars are in an inelastic state the calculations may underestimate subsidence magnitudes. I am aware that this layout was not proposed by Hume Coal, nor was this suggested in my report. In the EIS report, Mine Advice assumed tributary area loading in estimating the elastic settlement of web-pillars to estimate the magnitude of subsidence. The only way for those web-pillars to be subjected to tributary area loading is when the panel is excessively wide, as used in Figure 16. Two models were then compared using Figure 16; one using elastic elements and the other using inelastic elements. The results confirmed that subsidence magnitudes vary depending on the state of web-pillars.

- As the study was only a comparative assessment of subsidence magnitudes, I used the same layout – a 0.5m floor and 3.0m thick coal roof at a depth of 170m, as per other models and Mine Advice's elastic subsidence calculations in EIS. If Hume Coal is suggesting that the modelling layout I implemented in my comparative study is wrong; the same comment should be made with respect to the LaModel study conducted by Dr Heasley. This is because LaModel cannot model different roof and floor materials as it is present in shallow parts of the mine. In my opinion, those minor variations can only make insignificant changes and do not influence the overall system behaviour substantially. For example, the coal roof may be a relevant factor in assessing the roof stability in entries, but provided that the roof is stable, may have minimal impact on surface subsidence.

- **Anomalous results**: The title of the x-axis in Figure 21 should be distance along surface, which was correctly interpreted by Hume Coal. However, the interpretation of the results presented in Figures 21 and 22 are not correct. This is due to the erroneous statement made in my previous report that the modelled layout was as shown in Figure 13. All layouts in Figures 19 to Figures 24 in my previous report contained 50m wide barrier pillars on either side with symmetrical boundaries (i.e., 100m wide barrier pillars) to isolate the four modelled panels. The extraction sequence was only same as provided in Figure 13. The web-pillar panel dimensions varied for different depths (as presented in Table 8), as stated in my previous report. The panels were mined in subsequent mining steps, resulting in non-symmetrical subsidence profiles in earlier panels which become symmetrical when the final, 4th panel is extracted. The purpose of these models was to demonstrate that in the case of web-pillars going into an inelastic state, the subsidence will increase as the number of panels increased. The modelled layout is shown in Figure 1 below. This should resolve most of the questions raised by Hume Coal in this section.

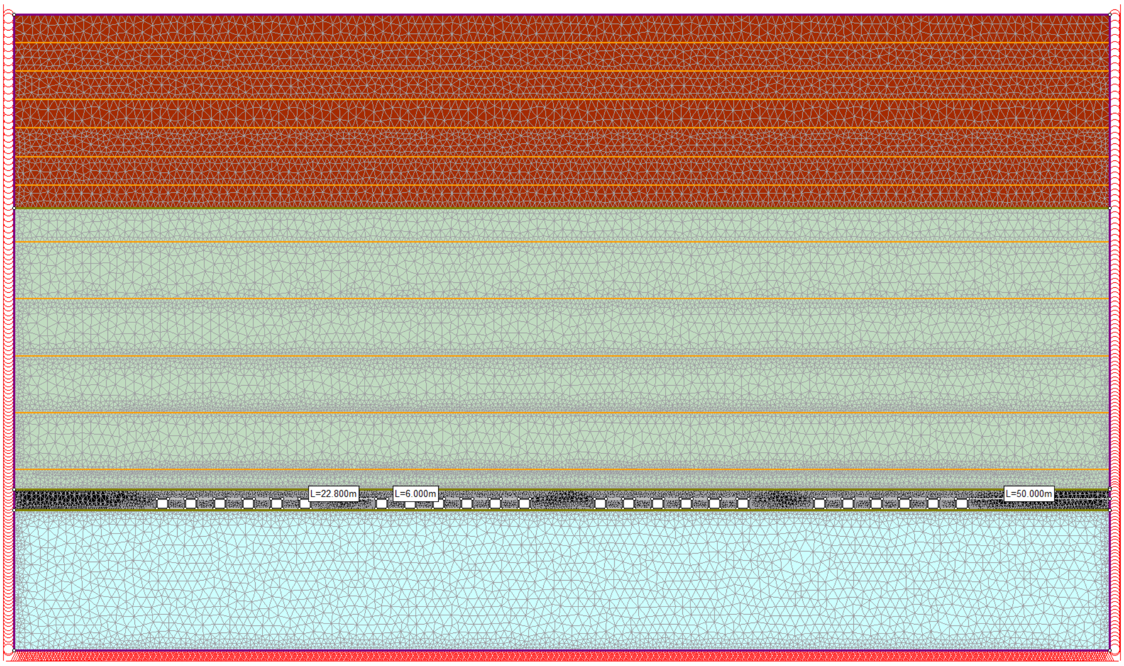

**Figure 1. Correct panel layout used to produce Figures 18 to 22**

- **Potentially conflicting results:** Figure 17 and Figure 18 were produced to indicate that when pillars go into an inelastic state, the subsidence can be higher than predicted by the elasticity theory. Therefore, Figure 18 can only be used for comparison purposes with Figure 17. On the other hand, Figure 24 represents the proposed layout with barrier pillars in-between the panels. Figure 18 and Figure 24 should not be compared as they do not represent the same layout.

- In addition, page 54 of Hume Coal report states that "*Firstly, this is a misrepresentation of the EIS, since Mine Advice never assumed full-tributary area loading on the webs….*". The report goes on to say that only elastic settlement calculations using the tributary area loading were conducted. The modelling results which I presented in my earlier report (Figures 17 and 18) also make this assumption to demonstrate that the web-pillars will be strain-softening under tributary area loading, therefore, the elastic settlement calculations using tributary area loading may not be appropriate as they are only applicable when pillars are in an elastic state. The reason modelling of panels presented in Figures 17 and 18 is to ensure that the pillars are subjected to tributary area theory.

- **Assigning probabilities to numerical modelling FOS:** The probabilities of failure were not assigned to the numerical modelling Factor of Safety (FoS), but the loads were extracted from the models and used in UNSW formula. Contrary to the belief that the UNSW formula is only applicable to pillars that are subjected to tributary area load, Salamon et al., (2006) stated that it is reasonable to estimate pillar stresses by using numerical models to calculate the FoS using the empirical strength formulae. Once the FoS is calculated using a specific formula, and if a probability of stability can be assigned to that formula (i.e., as in UNSW formula), it is reasonable to calculate the probability of stability of a given FoS. In fact, LaModel has a similar analytical approach; but because probability of stabilities cannot be assigned to the Mark-Bieniawski formula, those calculations cannot be performed.

- **Calibration of web pillars using UNSW pillar strength index**: This has been addressed by virtue of my responses to the above question. In my opinion, the pillars may not be as strong as predicted using the Mark-Bieniawski formula due to an emphasis on the contribution of length to strength of low w/h ratio pillars. Choosing between the UNSW or Bieniawski formula would not alter the results significantly as both formulae predict an average difference of 6% for the proposed layouts.

- **Relative stability of deep vs shallow pillars**: Pillar stability is determined by many parameters. These parameters include their size, inherent strength, loading environment, contact conditions, and overburden stiffness. In the case of Hume Coal, numerical models suggest relatively lower strengths at deeper depths than at shallower depths. There may be various valid reasons for this, including due to varying geometry of pillars and panels. However, using different cases or input parameters (particularly in loading environments and pillar roof/floor conditions), it is possible that shallower workings can be less stable compared to deeper sections due to a lack of confining stresses. Additionally, it can also be observed in Dr Heasley's study that LaModel predicts lower safety factors (and greater subsidence magnitudes) for pillars at 160m compared to 80m for relative elastic modulus and lamination thicknesses.

- **Gateroad (chain) pillar stability**: I calculated the stability of gateroad chain pillars using a simple model. I am satisfied with Dr Heasley's 3D models. However, as discussed above, implementation of strain-softening elements can improve the models to a significant extent.

- **Contradictory model outcomes**: As expected, the loading environment in extensively wide panels will be different than in narrower panels. However, as explained in Section 3, in comparing the LaModel stress results, the stress reduction in narrower panels may not be significantly higher; it depends entirely on the stiffness of the overburden and panel widths. A review of the pillar stresses presented in Dr Heasley's report confirms this notion. Also, it is of note that as my study aimed only to highlight the critical factors in design, I did not attempt to change the overburden stiffness parameters. If the stiffness of overburden changes, the stresses acting on pillars will reduce when compared to tributary area load.

- **Unconsolidated rib spall vs. unconsolidated backfill**: In numerical modelling, once the model reaches equilibrium, the stress acting on a pillar will not change; therefore, backfilling of entries after extraction in a static loading environment will not provide any benefit. However, spalling of pillars in backfilled panels will be minimised depending on the backfill height. In this case, backfill will certainly provide confinement to the pillar. Without backfilling, as the pillars spall, the size of pillars will alter, and the loading environment will be adjusted (i.e., no longer a static loading environment). Under these circumstances, spalling may provide some form of confinement to the pillar. However, the degree of confinement will depend on the size of pillars, amount of spalling, and mining height.

- **Time-dependent rib-spall**: Time to failure of coal pillars is another subject that can be debated extensively. Nevertheless, I will attempt to concisely address this question.

  The exact failure mode of coal pillars is not known with certainty, particularly in old, sealed panels. The majority of cases in the collapsed pillar databases were discovered due to associated surface subsidence. Therefore, "failure" can be defined as a total failure of pillars that causes some degree of surface subsidence. There may be many other cases where the pillars might have completely spalled but remained unnoticed due to very low-levels of associated surface subsidence.

  An important assumption made in the studies by Salamon and Munro (1967), Salamon et al., (1996), and Salamon et al. (2006), for practical reasons, was that the behaviour of pillars is not time dependant. Therefore, the established formulae do not provide an associated probability of survival for the long-term stability of coal pillars. By definition, the coal pillar strength formulae developed in those studies assume that pillars do not suffer from excessive spall, their height stays constant, and the floor remains stable within the expected life of panels. The FoS and associated probability of stability calculated using these formulae therefore refer to intact coal pillars. When the initial dimensions of pillars begin to alter due to spalling or increased mining height over time, the assessment of their long-term stability becomes more complex.

Previous researchers discussed possible pillar failure modes and identified the following four conventional long-term failure modes of a pillar system:

1. Pillar spalling
2. Roof failures
3. Pillar foundation (floor) failure
4. Any combination of the above

Pillar rib spalling can be caused by many factors. These factors include the loading environment of pillars, discontinuities (e.g., cleats, joint sets), bedding planes, the composition of coal (e.g., clay minerals), pillar/roof/floor contact conditions, weathering, water, time, etc. Hume Coal's report argues that the spalling model developed by Salamon et al., (1996) only applies to cases (e.g., the Vaal Basin), where clay minerals in the coal seam caused the failure of pillars. This statement is not entirely accurate as the clay minerals are the casual factor for pillar spalling in the Vaal Basin.

As the pillar ribs weaken due to any of the casual factors above, spalling occurs and the effective size of the pillar decreases. The spalling process discussed in Salamon et al., (1998) and Canbulat (2010) can therefore be applied to all spalling pillars, irrespective of the casual factors. Although the exact time to failure of pillars cannot currently be estimated with any acceptable certainty due to a lack of data regarding the rate of spalling, these methodologies can be used to estimate the long-term stability of pillars. These methodologies determine the maximum amount of possible rib spalling (i.e., when the aprons of the spalled material reach the roof) and assess the FoS of the core of a pillar. If the core is large enough and with a reasonable FoS, pillars can be defined as long-term stable (or *infinitely* stable) using a stochastic analysis.

In addition, van der Merwe (2003) analysed pillar collapses in different coal seams and areas of South Africa. He concluded that the majority of pillars collapsed by a process of progressive scaling.

Years to centuries may elapse before spalling is able to trigger a pillar failure. Van der Merwe and Madden (2010) comment in this regard; *"Given sufficient time, any act of removing material from underneath the surface of the Earth will result in subsidence"*. The magnitude of subsidence will be determined by the amount of spalling, the size of the core of a pillar, and the overburden stiffness between the barrier pillars. I accept that the rate of spalling in the Wongawilli Seam may be very slow and it may take centuries for the pillars to fail but it will eventually happen, even if the pillars are not loaded at the levels of tributary area load. In my opinion, the crux of Hume Coal's assessment should be to demonstrate the potential consequences of failure rather than ascertaining whether the pillars will fail or not.

## 4.1 Summary

- I erroneously stated in my previous report that the modelled layout is as shown in Figure 13. All layouts in Figures 19 to Figures 24 in my previous report contained 50m wide barrier pillars on either side with symmetrical boundaries (i.e., 100m wide barrier pillars) to isolate the modelled four panels. This resulted in a misinterpretation of the results. Aside from this, most of Hume Coal comments have been addressed above. However, should there be any further inquiries relating to my responses, I am prepared to address them in due course.

- It appears that the elastic modulus of the overburden in Dr Heasley's study were based on the minimum, average and maximum values obtained from these tests. A total of 25 tests were considered to be low to make accurate decisions with regard to the input parameters for a detailed numerical modelling study. More test results from all parts of the mine will provide better understanding of the overburden modulus.

- Years to centuries may elapse before spalling is able to trigger a pillar failure. The magnitude of subsidence will be determined by the amount of spalling, the size of the core of the pillar and the overburden stiffness between the barrier pillars. I accept that the rate of spalling in the Wongawilli Seam may be very slow and it may take centuries for the pillars to fail but it will eventually happen. In my opinion, Hume Coal should demonstrate the potential consequences of failure rather than ascertaining whether the pillars will fail or not.

## 5 MINE ADVICE'S INTERPRETATION OF NUMERICAL MODELLING RESULTS

Again, in this review I do not intend to go into an academic argument regarding the results presented in this section of the report. I generally agree with the concepts and additional insights into numerical modelling results. I only offer the following comments and questions, made without any relative priority or level of importance on the modelling study conducted by Mine Advice:

- It is evident that Mine Advice had access to the LaModel results; therefore, their report presents more results than were available in the original LaModel report.
- P5 – recommended ARMS stability factors: As I highlighted in my previous report, the ARMPS recommended stability factors refer to stability in active mining zones, which gives no indication as to the long-term stability of pillars. Assuming somewhat conservative design input parameters may or may not be appropriate to estimate long-term pillar stability.
- P6 point (i) – the drives being limited to 120m: Whilst Dr Heasley's study indicate that the load distribution onto the adjacent pillars in 3D is true, the magnitude of the stress distribution is not significant according to the results. However, 3D modelling in this case is better suited than 2D modelling.
- P7 to 9 pillar loading: As I explained above, numerical models are the best tools to calculate pillar loads, irrespective of the panel spans; i.e., there is no need to use a pressure-arch loading model. The loads calculated in numerical models can be used to calculate the FoS of pillars.
- Chapter 3: This section presents the details of the LaModel results and its limitations in the absence of horizontal stress and vertical joints in the overburden. As concluded in the second last paragraph on P12 by Mine Advice, if LaModel input parameters are properly back analysed there is no need to model horizontal stress or vertical discontinuities. Even if the overburden contains those features, their impact can be back analysed by altering the overburden stiffness parameters. In my opinion, significant vertical discontinuities present uncertainty and are residual risks and their existence should therefore be considered in any given layout. It is unknown if the Berrima panel(s) contained any significant vertical discontinuities. Thus, the appropriateness of the back analysis is unknown regarding the vertical discontinuities. It is of note that LaModel assumes horizontal stack of plates with cohesionless and frictionless interfaces, horizontal stresses would have minimal impact on the results even if it were possible to model.
- A useful concept of Ground Reaction Curve was explored in Sections 3 and 4. I will provide no comment other than to say the proposed concept appears to be reasonable.
- P14: I accept the quote from Esterhuizen. However, it is impossible to assess the credibility of the back analysis. As I indicated above, no details of the Berrima Colliery back analysis were presented by Dr Heasley or Mine Advice in their respective reports (other than dimensions of a panel and the approximate subsidence values). Only three lamination thickness for varying elastic modulus were presented as findings by Dr Heasley. If elastic, perfectly-plastic coal material properties were also assumed in the back analysis, this assumption may not be appropriate for a total extraction panel. If different types of elements were used, they need to be presented together with the subsidence lines for the completeness of the back analysis. Those material properties used in the Berrima case should also be incorporated in the modelling of Hume Coal layouts. In addition, super-stiff overburden strata may indicate low subsidence magnitudes for isolated panels. However, high stiffness overburden may result in increased load transfers onto the barrier pillars in subsequent panels (as evident in reported LaModel results for Hume Coal), which may, in turn, impact their stability. This needs to be investigated. As highlighted above, it appears in the back analysis of Berrima case the quoted subsidence values were from an isolated panel. Although it is not mentioned in the LaModel results, it is highly unlikely that the proposed barrier pillars will completely isolate the panels from each other. Therefore, their loading profiles will be different than the Berrima case.

- P18: As also mentioned by Mine Advice, in the design of barrier pillars, ARMPS HWM program assumes that the barrier pillars are subjected to abutment loads with the assumption that the web-pillars within the panels failed. It is expected that LaModel, which models elastic pillars up to peak strength and never drops the strength lower than that will result in significantly higher safety factors for barrier pillars, even if the web-pillars are assumed to have failed in an isolated panel (i.e., modelled as worst-case). However, it is highly likely that if the failure of two, three, or more subsequent panels were modelled, the safety factor of the barrier pillar(s) located in the middle of the failed web-pillars will be lower than ARMPS HWM. This is because unless explicit goaf or strain-softened elements are modelled within the failed panels, all the loads will distribute onto the barrier pillars under elastic overburden at 3.5m mining height (the loading environment might be somewhat different in low mining heights as the total closure of the panel might arrest some of the surcharge loads). This loading environment would be similar to Figure 5 of the Mine Advice report but without the web-pillars in panels.

- P18 and 20: As I mentioned above, if a credible back analysis of the model inputs were conducted, the back analysed input parameters should be used in models. So-called conservative input parameters other than the back analysed parameters might be misleading and may or may not be appropriate.

- Tables 7, 8 and 9: As also stated by Mine Advice, ARMPS HWM mining does not consider the roadway located adjacent to the chain pillars due to the nature of highwall mining. However, this limitation should be considered in Hume Coal's design as it is a 3D geometry, as identified by numerical models. Although, this difference does not make any significant difference, it reduces to some extent the safety factors for the proposed layout below the values recommended by the third decimal point for depths of 120m and 160m.

- Figures 13, 14 and 15: It is not clear how the safety factors from 3D models were extracted and plotted in these figures. It appears that the safety factors are extracted from specific elements on pillars, which may explain the subtle discrepancy between the results presented by Dr Heasley in Table 4 and in these figures for the inbye end of the panels. If so, it only represents the safety factors for that specific element and not for the pillar. Adjacent elements may indicate different safety factors.

- Figures 18 and 19: The above comments also apply to Figures 18 and 19. It is also interesting to note in these figures that the pillar safety factor goes below the ARMPS and 2D modelling results due to load sharing in less stiff overburden loading environments, which was also highlighted by Dr Heasley in his report.

- The variation of stress distributions on outer and centre pillars have been discussed to a significant extent by previous researchers, mostly for the purposes of designing bord and pillar layouts. Therefore, further discourse is unnecessary. Based on my experience, the loading of the centre pillar has mostly been used in designing coal pillars.

- P30 $S_{max}$=23.5mm in the panel failure case: I agree fully with the statement that the surface subsidence of 20mm or 23.5mm will not be substantial. However, it needs to be appreciated that if the web-pillars in one panel fail, there is a high likelihood that the web-pillars in adjacent panels will also fail. This will result in more loads on barrier pillars, which will result in more surface subsidence than 23.5mm.

- Section 4 Displacement-based stability criteria: I agree with Dr Hebblewhite's view that this section presents a detailed technical discussion. I also believe that it exceeds Professor Brown's anticipated response, which he envisaged at the experts meeting. A detailed review of this section will take a significant amount time and resources, requiring detailed data from every single panel referenced in this section. I am not confident if it will add any benefit to the Hume Coal design.

- Section 5 Weathering of the Hawkesbury Sandstone: Further review of the available data presented in this section: I consider weathering of Hawksbury Sandstone a residual risk. More data should be collected and analysed to assess the potential impacts of weathering on surface subsidence.

### 5.1 Summary

- It appears that detail regarding the Berrima Colliery subsidence data is absent; therefore, it is impossible to assess the credibility of the back analysis. It is not apparent whether the quoted subsidence values from Berrima were from an isolated panel or series of panels. A single, isolated panel may result in significantly less subsidence magnitudes than a series of panels. Therefore, further details of the Berrima subsidence data (and/or subsidence data from the other neighbouring mines) should be obtained for the completeness of the back analysis.

## 6 CONCLUSIONS

Dr Keith Heasley is a well-recognised researcher in the fields of numerical modelling and rock mechanics. LaModel is an appropriate numerical modelling code to assess pillar stabilities and potential surface subsidence for Hume Coal. I therefore fully endorse the use of 3D LaModel in assessing the Hume Coal project and Dr Keith Heasley's role in carrying out this assessment.

However, the following studies will ensure the completeness of the numerical modelling study and that the residual risks are minimised:

- The results of the numerical modelling study conducted by Dr Keith Heasley appear to be reasonable for the material properties used in the assessment. However, in my opinion, strain-softening elements, with relatively low residual strength properties would be better suited in this case. Therefore, for the benefit of the project, I recommend a further study using strain-softening elements in 3D LaModel to estimate the subsidence magnitudes at varying depths.

- Once strain-softening elements are implemented in models, the stability of the pillars should be investigated as the subsequent entries are extracted to ensure that pillar failures are not expected and do not cause a safety concern in active panels. Based on the results of the ARMPS HWM design methodology, this appears to be an unlikely event. However, the mining height and the depth of the proposed Hume Coal panels are not entirely within the database of ARMPS HWM.

- The back analyses of Berrima Colliery can be expanded. The input parameters used for back analysis are not presented. If elastic, perfectly-plastic coal material properties were also assumed in the back analysis, this assumption may not be true for the total extraction panel(s). It is also noted that super-stiff overburden strata (as identified by the back analysis) may indicate low subsidence magnitudes for isolated panels. However, high stiffness overburden may result in increased load transfers onto the barrier and other adjacent pillars (as evident in reported LaModel results for Hume Coal), which may, in turn, impact their stability and increase the magnitude of subsidence. These details should be included in the report to review.

- The assumption that the web-pillars will never fail may not be an appropriate assumption to make in this case. Therefore, the associated surface subsidence in the case of web-pillar failures in the long-term should be assessed with realistic input parameters.

- It appears in Hume Coal's report that details regarding the Berrima Colliery subsidence data is absent. It is not apparent whether the quoted subsidence values from Berrima were from an isolated panel or series of panels. A single, isolated panel can result in significantly less subsidence magnitudes than a series of panels. Therefore, further details of the Berrima subsidence data (and/or subsidence data from the other neighbouring mines) should be obtained for the completeness of the back analysis.

- Although Hume Coal confers a significant degree of importance to the overburden stiffness and laboratory results obtained during the project, only 25 strain-gauged elastic modules tests were conducted on Hawksbury Sandstone. This is insufficient for the purposes of making accurate conclusions and decisions for the entre mine. Therefore, more data may be required to ensure that the input parameters are reliable.

In line with my statements at the experts meeting, it is my opinion that even if the proposed web-pillars fail, the expected subsidence would be relatively low. However, failure of the web-pillars might create significant problems, particularly if the panels are flooded. In my experience, pumping large volumes of water from flooded workings could be a significant problem if there is no storage space; adding pillar failures to this problem can be a significant challenge. This needs to be further assessed. Whether this can be done at the project stage or during mining is a decision of the DPE.

Finally, although my previous study was limited and was not intended to assist Hume Coal for design purposes, it served as a useful initial assessment of the results presented in Hume Coal's report.

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|---|---|
| **Report to:** | Paul Freeman<br>Team Leader, Resource Assessments<br>NSW Department of Planning and Environment<br>320 Pitt Street, Sydney NSW 2000<br>(02) 9274 6587 |
| **Title:** | Response to “Responses to reviews of the Hume Coal Project by Galvin and Associates, and Professor Ismet Canbulat” |
| **Report No:** | Report No: DPE-HUME-2018-2 |
| **Author:** | Dr Ismet Canbulat |
| **Date:** | 29 October 2018 |
| **Signature:** | |

***Disclaimer***

*Ismet Canbulat is employed as Professor and Kenneth Finlay Chair of Rock Mechanics at The University of New South Wales (UNSW) Sydney. In accordance with policy regulations of UNSW regarding external private consulting, it is recorded that this report has been prepared by the author in his private capacity as an independent consultant, and not as an employee of UNSW. The report does not necessarily reflect the views of UNSW, and has not relied upon any resources of UNSW.*

# Appendix 1: Minutes of the experts meeting

**Hume Coal Project – Expert Meeting 28 March 2018**

**Record of Meeting**

Attendees:

| | |
|---|---|
| *Independent Chair* | Emeritus Professor Ted Brown |
| *Experts engaged by the Department* | Emeritus Professor Jim Galvin<br>Professor Ismet Canbulat |
| *Experts engaged by Hume Coal* | Dr Russell Frith<br>Professor Bruce Hebblewhite |
| *Department representatives* | Mr Clay Preshaw – Director Resource and Energy Assessments<br>Mr Paul Freeman – Team Leader Resource and Energy Assessments |
| *Hume Coal representatives* | Mr Greig Duncan – Project Director<br>Mr Alex Pauza – Manager Mine Planning |

## Introduction – Independent Chair

- The meeting is being independently facilitated.
- It is an open discussion of technical matters.
- The participants were asked to be respectful and to keep to the point.

## General comments about the proposal – Dr Russell Frith

- The project has evolved from being a longwall mine to an underground "highwall" mine.
- The 'pine feather' method is designed as a non-caving low-impact mining method, and the EIS pillar design methodology (ARMPS-HWM) was adopted from highwall mining due to the similarities in layout geometry.
- The design is assessable and the method has been successfully used in the United States.

## Discussion Points – Independent Chair, Department Experts and Hume Coal Experts

### Pillar stability

- The proposed web pillars and barrier pillars have been conservatively designed so that the pillars and overburden behave as a system.
- Localised yielding of a web pillar would not necessarily lead to global instability.
- The experts generally agree that the stability of the system as a whole is the key factor, not the strength of the web pillars.

### Geotechnical numerical modelling presentation – Mr Alex Pauza

- The pillar design in the EIS is based on a 2D empirical design methodology and presents what is considered to be the worst-case web pillar loading scenario as a design input.
- The company has since undertaken a 2D and 3D numerical modelling exercise to provide an independent and supplementary method of assessing pillar stability.
- The geotechnical model in the EIS is based on a 2D design and presents the worst-case scenario.
- The company has since undertaken a 3D modelling exercise to provide a higher level of confidence in the predictions of surface subsidence and pillar stabilities.
- The 3D model has been calibrated to Berrima Colliery data and then de-rated.
- The 3D model will be included in the Response to Submissions (RTS) and generally is likely to show increased pillar stability and greater overburden load distribution.
- Based on Mr Pauza's presentation, the experts generally agree that the company's approach to the numerical modelling is appropriate and will assist the Department in its assessment process.

# Appendix 1: Minutes of the experts meeting

Subsidence issues

- The experts generally agree that subsidence is likely to be negligible-minor and is not the key assessment issue.
- Even if all web pillars are artificially removed, the 3D model is likely to predict that the change in subsidence would be very minor.

Other safety

- Barrier pillars are wide, and any ‘offline cutting’ is unlikely to significantly affect stability.
- Unventilated workings may affect underground safety in the event that machinery fails and is required to be recovered.
- The experts generally agree that the proposed mining method is flexible and could be modified throughout operations, however safety issues would be further considered following the submission of the RTS.

Closing – Clay Preshaw

- The mine design and safety of the underground workings remain as important issues for the Department.
- The RTS will be provided to the Department’s experts for further advice before the assessment is finalised.
- The Department will also provide the RTS including Hume Coal’s response to DP&E’s expert reports to the Resource Regulator and seek feedback.
- A further meeting with the various experts and/or the Resource Regulator may be necessary before the Department finalises its assessment.