BYRNES GEOTECHNICAL

REF:JG-01
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Mr M Rowlands
Manager Underground Studies
Jellinbah Group Pty Ltd
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Dear Mike,

The following is a review of a report entitled “Subsidence prediction report for the Meadowbrook Underground Project” prepared by Gordon Geotechniques Pty Ltd in March 2022. It is understood that this report is to be used in your EIS submission to the Queensland Government.

Summary

The report provides a set of subsidence deformation parameters that should represent the typical outcome. Depending on the risk profile adopted when applying the parameters, the possible range of outcomes could be +/- 25%.

Recent case study data from some NSW and Qld longwall mines highlight a weakness in the hydrogeological model that was initially adopted. While that model remains valid for assessing mine water inflows, its usefulness for assessing impacts on shallow groundwater systems is now highly questionable. It is noted that a model with a low permeability fracture connection from the mine to the surface in all areas has now been considered.

Site characterisation/Engineering geology

The geometry of the coal seams (thickness, depth, relative level) is clearly presented and there are adequate discussions on the lithologies and strengths of the immediate roof and floor of the target seams to justify the application of empirical prediction tools.

Subsidence prediction

I agree that SDPS is an appropriate program to visualise subsidence. I have used SDPS for over 20 years in both EIS and mine-operational applications and have found it possible to obtain the required input parameters in the same way as in the report. The presentation of Bowen Basin data in Figures 23,25, & 26 is particularly valuable and the resulting transparency provides the opportunity for independent assessment of the predictions. The manipulation to give a confidence level is a valid use of the data. The comparison with the worst-case NSW data is also noteworthy. The discussion on multiple seam extraction is valid and appropriate.

<u>Limitations to predictions</u>

I agree with the comments in this section regarding the suitability of the predictions for assessing significant impacts of subsidence on the environment prior to mining commencing and using the Subsidence Management Plan to ensure that improvements to the prediction methodology are made in response to monitoring data.

<u>Subsurface cracking</u>

Since 1995 and the work of Bai and Kendorski, and especially over the last 5 years, there have been some major changes in the models for subsurface fracturing. Bai and Kendowski identified 4 zones (Caved, Fractured, Dilated/discontinuous, and Constrained Zones with only the Constrained Zone unaffected by subsidence cracking. These workers proposed that the thickness of these zones could be estimated from the thickness of the extracted coal seam. As longwall technology evolved and longwall faces became wider it was recognised by other workers (Ditton/Merrick) that these estimates do not include a panel width parameter which is anomalous given that panel width is an important factor in the prediction of surface deformations.

Working in the Bowen Basin, Seedsman (2019, 2020) developed an alternative model for longwall fracturing based on geotechnical engineering considerations. I concluded that if the vertical subsidence at the surface is supercritical then there will be a fracture connection all the way to the seam. This connection, referred to as the Enhanced Conductivity Zone (ECZ), will have very high conductivity closer to the seam (level of the Caved zone) and decrease with height above the seam unless there is a spanning unit present. A transient ECZ is present ahead of, and parallel to, the longwall face and this will have much higher hydraulic conductivities that the ones that form along the sides of the extraction. The hydraulic conductivity will decrease as the longwall face passes as the goaf pile develops. If the roof rocks are moisture sensitive the caved zone may reconsolidate and its conductivity drop to very low levels. The strata in the disturbed zone, although they have moved downwards, retain their overall bedding structure and have a relatively low hydraulic conductivity.

An implication of this model is that groundwater analysis should include consideration of the possibility of a low conductivity fracture connection to the surface. I note that the Gordon Geotechnics report recognises this possibility (page 50) and that this scenario has been considered in the groundwater report.

To date, hydraulic conductivity values have not been allocated to the Seedsman (2019) model. In the interim and subject to critical hydrogeological review, it may be possible to use the following chart to estimate values. This chart is simply a re-plotting of the data in Figure S1 of Gale (2008). For the predicted subsidence at Meadowbrook of 2.5 m, this chart indicates that the hydraulic conductivity of the near surface rocks will be in the order of 10^{-6} m/s, which is likely to be 1 or 2 orders of magnitude lower than the likely pre-mining values.

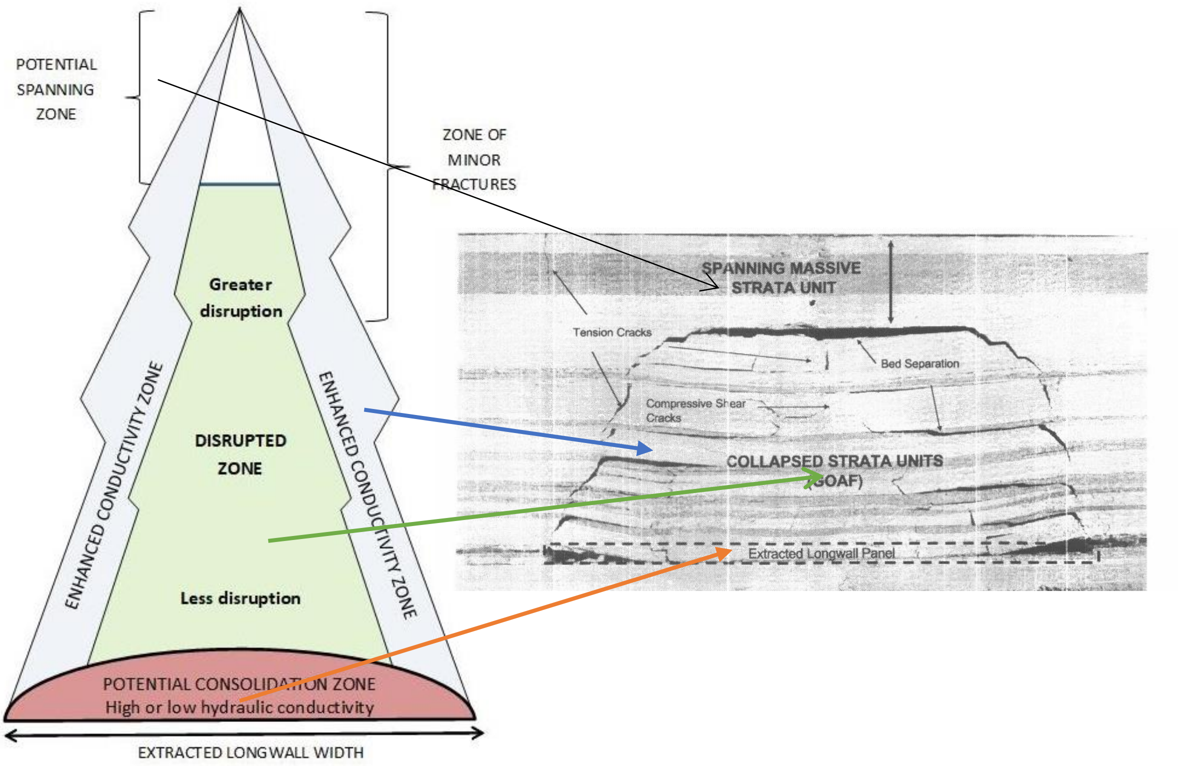

Figure 1 Geotechnical model for longwall fracturing and how it relates to physical models.

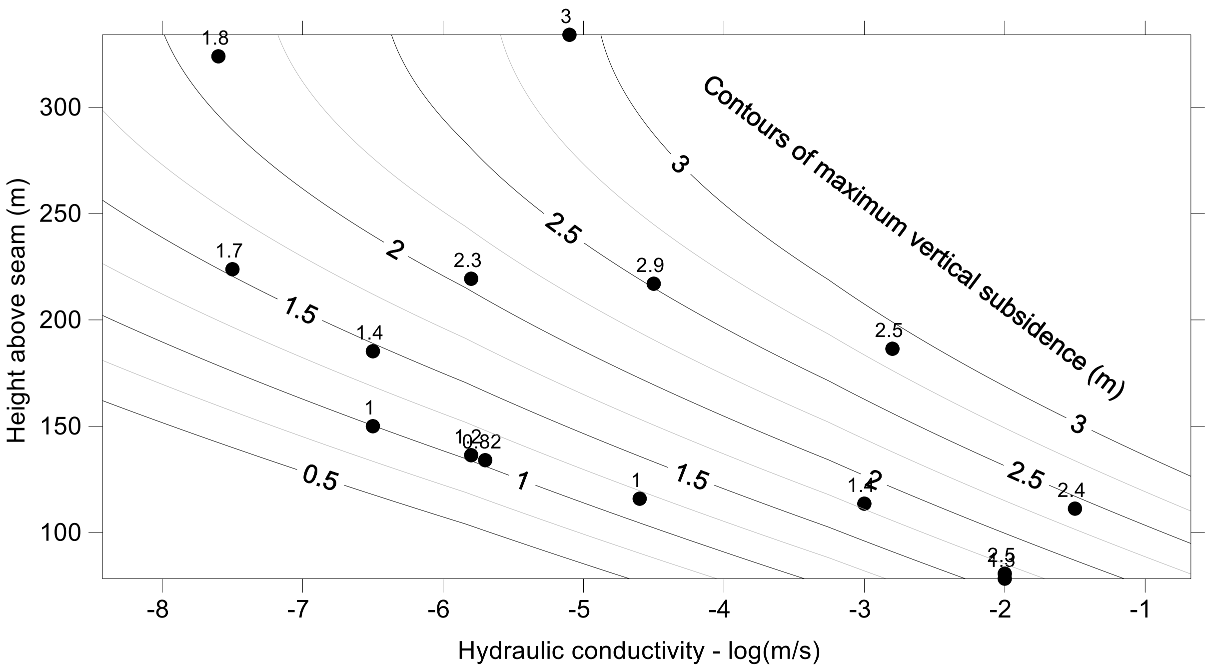

Figure 2 Chart to estimate average hydraulic conductivity as a function of height above seam and maximum vertical subsidence (original data digitised from Gale 2008)

Surface cracking

The discussion on surface cracking is valid and appropriate. It is stressed that surface cracks as discussed in this section of the report do not continue down to the seam. Associated conductivity values could be considered in the context of fracture flow – in which case 10^{-6} m/s would be associated with hairline fractures of 0.2 mm width spaced at about 5 m spacings.

Yours truly

Ross Seedsman
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