Critique of Hume Coal's Environmental Impact Statement.

(to accompany the submission prepared by R. C. Nolan)

1. Introduction. The Wongawilli Seam, which Hume Coal proposes to extract within Authorisation A349, has been mined elsewhere within what is generally termed the South Western Coalfield, being that portion of the Sydney Coal Basin. The adjacent Loch Catherine Colliery and the nearby Berrima Colliery were the most recent. Berrima Colliery closed only a few years ago.

I have visited the underground workings of Berrima Colliery, when it was forming but not extracting pillars, i.e. first workings only. I remember it as a mainly dry mine, with water **seepage** only from the roof strata, normally only along igneous dykes and roof bolts, when they penetrated the seam roof to the overlying Hawkesbury Sandstone.

Later, the mine sought and was granted permission by the NSW Mines Department to also extract pillars. Then, the immediate roof failed, goaf was formed and groundwater in the overlying Hawkesbury Sandstone **flowed** into the void. Prior to mining ceasing, much of the groundwater had been drained from above those "pillared areas" and, presumably, it is still draining into the abandoned mine.

The latter conditions are those which Hume Coal planned to avoid, when selecting their proposed mining method. They wished to maintain the roof, as for first workings in Berrima Colliery, so that mining would not affect the aquifers within the Hawkesbury Sandstone, from which nearby land-owners extracted groundwater.

If one believes the arguments and conclusions of most of the assessments within this Environmental Impact Statement (EIS), one could only conclude that they have failed their objective.

I believe that they have misinterpreted some aspects of the proposal and my conclusion is that mining could proceed without all of the adverse conditions stated. That is why I support their proposal.

My review of Hume Coal's Environmental Impact Statement has concentrated on those sections with I have some experience. That comprises some 50 years as a Coal Geologist, 40 years living and working in the Southern and South-Western Coalfields and some geological supervision of drilling water bores within the Hawkesbury Sandstone.

The sections discussed include:-

- the study team
- geology,
- hydro-geology, particularly within the Hawkesbury Sandstone,
- groundwater quality and inflows,
- coal-mining principles, including general Strata Control and Mine Subsidence, plus
- the geological nature of nearby surface swamps.

2. The Study Team. No geologists are listed as part of the study team, which was supervised by Hume Coal's Director, Environmental Officer and Mine Planner. EMM Consulting personnel prepared the EIS, assisted by Specialists for the Groundwater Model and for the Groundwater and Subsidence Assessment.

3. Geology. Few details are provided of the geology of the coal seam and its overlying and underlying sediments. Where given, descriptions, test data and references of the varying geological sequences often are for similar strata or coal seams outside, rather than inside, Hume Coal's area.

Figure 2.4 in Section 2.1.2 of the Subsidence Assessment provides one of the few illustrations of the geological sequence by including photographs of core from borehole DDH 13. The strata overlying the coal seam, which will be the overburden to the proposed mine, is described simply as "Hawkesbury Sandstone dominated by Quartzose Sandstone or with Rare Siltstone Inter-beds". No mention is made of the frequency or extent of the latter inter-beds, which Hume Coal's Hydro-geologists had previously suggested as being useful aquitards.

Later sections record details of water assessment boreholes and of tests conducted on them and the groundwater encountered. However, although separate groundwater flows were noted and tested as they were encountered, the total Hawkesbury Sandstone was considered by the Hydro-geologists as one aquifer. No regard was taken to previous investigations by John Lees, who gave a presentation to Hume Coal's Water Advisory Group and proposed Units A, B and C of the Hawkesbury sandstone, with varying characteristics and groundwater quality and yield. It would have been enlightening and very useful for mine planning, to see cross sections which included the three major sub-divisions, their groundwater yields and quality and the current water bores which pump water from those separate aquifers or groups of aquifers. The significance of those units is their varying geology and, consequently, there varying water yields and quality

During hydro-geological testing, groundwater samples were taken from the total section drilled and/or otherwise tested. That practice would have combined water from the iron-rich, upper section with the much better quality water from the lower sequence.

The **Wongawilli Coal** is the coal seam proposed for extraction. It is described as having zero to 8.5 metres thickness, of which only the lower 3.5 metres will be extracted. In places, the upper section of the seam has been removed during emplacement of the overlying Hawkesbury Sandstone (HS) but, usually, up to 5 metres of carbonaceous sediments, including more than one metre of shale, overlays the proposed mining section and separates it from the major aquifers within the HS.

Nowhere does the EIS show the variations of the mining section, which determines the quality of Run-of-mine coal, or of the overlying seam section, which governs the ability to support the roof for the life of the mine and to prevent in-flows of nearby groundwater. For example, the "more than one metre of shale" could be an effective aquitard.

The strengths of various strata are quoted from **McNally and McQueen, 2000.** The names of the authors and the date of publication emphasises that the quoted data are not for geological strata within Hume Coal's project data. I later refer to a number of references which do not appear to be appropriate.

Page 106 of Volume 1 reports an "estimated recoverable resource" of approximately 50 million tonnes of Run-of-Mine (ROM) coal, of which about 55% will be treated to metallurgical coal specifications and approximately 45% will be "marketed as thermal coal". There is no certified estimate of coal reserves provided to support these estimates, which are essential to justify the economic viability of the project and they should be included in the EIS.

4. Hydro-geology. Section 5.2.5 of Volume 1 summarises the Hydro-geology of the site and Section 7.2.4 discusses Groundwater Resources.

The former section refers to low permeability groundwater systems associated with the Robertson Basalt and Wianamatta Group shales. The latter is correct but jointing within the Robertson Basalt provides ample space for the storage and transmission of groundwater. It is a major **aquifer** within the southern Sydney Basin. This error is repeated in a later paragraph, where “spring discharge is observed at the contact between the basalt and underlying Wianamatta Group Ashfield Shale (**McLean & David 2006**).” Surely, this emphasises that the basalt is an aquifer and porous. Also, on page 148 of Section 7.2.4 Groundwater Resources, its Hydraulic Conductivity is quoted as 6m/day, one of the highest in the geological sequence, and its baseflow “was calculated to be up to 30% of annual rainfall”, hardly features of impervious rocks.

The report Includes “fractured rock” as a significant water storage feature in the Hawkesbury Sandstone. Most of the so-called “fractured rock” has been inferred from the presence of ironstone features which were assumed to be in-filled fractures. Surface exposures in our local area show that most ironstone occurrences have sedimentary origin and that most of the groundwater is within porous sandstone beds.

Hume Coal’s geologists have advised me that fracturing from the surface is common in some parts of the project area. Those areas appear to be the western areas, which were previously drilled for “deeply weathered sandstone resources” in 1994 (**McRae and Ferguson, 1994)** where Hume Coal report unsaturated Hawkesbury Sandstone.

There are localised water bearing zones within the Permian Coal Measures and the Shoalhaven Group. The Wongawilli Coal seam itself is a significant aquifer but its hydro-geological details are not reported in detail. Is the seam recharged at outcrop? Is its horizontal conductivity such that it will recharge the mining void? Will its water-bearing properties have any effect on the so-called “depressurisation of the coal seam” after extraction?

Hydraulic Conductivities of major stratigraphic sequences are quoted on Table 6.1 from Coffey, 2016 (page 108 of Volume 4A) and in Table 7.5. The values for basalt and the Wianamatta Group shales/siltstones were “derived from Government Records and Reports” and reported respectively as 6 metres/day and 0.9 metres per day. I previously referred to the value for the basalt. The value quoted for the Wianamatta Group is worthless as its quoted value could represent any portion of any sedimentary rock type within 100 metres of sediments. The values are not defined as horizontal or vertical conductivity. Most importantly, that value of 0.9 metres/day is very much higher than the top of the range for shales quoted in my Hydro-geological Reference (Basic Groundwater Hydrology, by R.C. Heath, U.S. Geological Survey) of about 0.0001 metres/day.

Similarly, values within the Illawarra Coal Measures should be related to particular strata, preferably to those that may be required as aquitards, to prevent groundwater ingress to the mine workings. Only a range of values is quoted, from 0.01 metres/day to 0.9 metres/day. It is not known whether they are horizontal or vertical conductivities, or what strata the extreme values are for. I assume that 0.9m/day is of the cleanest, brightest section of the coal seam and that 0.01 metres/day is of shales within the seam but, again, that value is much higher than the best likely in shale, i.e. of 0.0001 m/day.

On Table 3, of Coffey 2016, the stratigraphic sequence is divided into 13 units for the Model and horizontal, vertical and ratios of Hydraulic Conductivity are recorded for each unit. Contrary to their/my previous comments:-

- horizontal conductivity within the 5 units of the Hawkesbury Sandstone, comprising the upper 97 metres, ranges from 0.01 to 0.6 m/day and vertical conductivity from 0.0005 to 0.001 m/day.
- the thinner, probably siltier units, near the base of the Hawkesbury Sandstone, have horizontal conductivity values of .005 m/day. and vertical values of 0.001 m/day.
- vertical/horizontal conductivity ratio ranges from 0.2 for the silty units to .0017 for the major sandstone unit,
- the interburden to the Wongawilli Seam and the Hawkesbury Sandstone, has 0.005 metres/day horizontal conductivity and 0.001

vertically. The latter value is equivalent to about one metre vertically every 3 years, whereas horizontal flow is five times that. These 2 metres of interburden would appear to be a valuable aquitard, preventing groundwater from draining into the mine workings, but is not mentioned in detail either here or in other sections.

- the 4 metres of Wongawilli Seam above the mined section has horizontal conductivity of 0.005 m/day and vertical conductivity of 0.001 m/day. Together with the interburden above, these units could form an aquitard, 6 metres thick and with a theoretical penetration time of more than 16 years.
- the recorded horizontal conductivity of the Wongawilli Seam is 0.005 m/day and vertical conductivity is 0.001m/day. Surprisingly, those values of the most coal-rich, proposed mining section, are identical to the upper seam section and the overlying inter-burden, which presumably are siltier and less porous.

Figure 4.5, which follows that section, presumably plots those recorded conductivities but reports that few of them were determined within Hume Coal's area.

5. Groundwater Quality. In 2012, prior to Berrima Colliery closing, a report was prepared by Pells Consulting, which included details of the mine's "Discharge into the Wingecarribee River". It quoted the mine's prediction that "approximately 3 megalitres of groundwater is expected to seep into the mine each day - - - - approximately 98% (of which) would continue to be discharged to the Wingecarribee River".

Pells stated that "a key issue appears to be the fact that the discharge typically contains about 3 milligram per litre of manganese", as that exceeded acceptable values.

I mention that because it was one of the reasons given by the local Coal Action Group for abandonment of that mine. It may well have been a major factor. Therefore, it was interesting to read in the EIS that Manganese levels in surface water entering tributaries to the Wingecarribee River were also above recommended limits. High manganese and iron values relate to sedimentary ironstone features, particularly in the upper portion of the Hawkesbury Sandstone.

6. Swamps On page 151 of Volume 1, Long Swamp is quoted as a Temperate Highland Peat Swamp, because it is listed as such in the NSW TSC Act. My local geological experience is that the swamp is at the unconformable interface between the overlying Hawkesbury Sandstone (HSs) and the underlying Illawarra Coal Measures. Its base is the coal measures and not sandstone.

Proof of the basal sediments is afforded by an old adit into a coal seam on the side of the swamp. The swamp formed when erosion through the weathered Hawkesbury Sandstone (HS) plateaued at the more resist Coal Measures. Aquifers within the lower HS were exposed and they formed springs which fed the swamp and created an environment suited for the formation of peat, which now conceals the adit. (Reference: verbal advice of a nearby landowner and NSW Mines Department Records).

Although the integrity of that swamp, and of similar swamps nearby, relies on groundwater from the base of the Hawkesbury Sandstone, they are, as the EIS states, “approximately 9km to the south-west of the project area” and are not likely to be affected by any activities within that area.

7. Groundwater Inflows. Section 7 of Data Analysis in Volume 1, discusses groundwater inflows to the Berrima Mine Void as “a calibration aid for numerical modelling”. Does this mean that the rate and amount of flow into that area of pillar extraction was the basis for the Hume Coal Model? If so, it seems very dubious.

8. Mine Subsidence Assessment. Appendix L of Volume 7 assesses Subsidence effects likely from the designed underground mine. That report does not refer to Berrima Colliery nearby, which is unusual because its seam section, overburden and mining history are very similar to what is proposed here. Instead, most of its supporting data and investigations are from outside this area and, in some cases, average data for geological sequences are quoted. For example:-

- figure 2.2 shows **Generalised Stratigraphy of the Wianamatta Group across the Sydney Basin, from Lovering, 1954.**

- reference is made to **Pells. 2004,** which discusses Hawkesbury Sandstone only in the Sydney Area,
- it includes figure 5.8, from **Coffey, 2016**, which was originally from **Tammetta, 2001** and is from particular Hawkesbury Sandstone sequences within unidentified project areas the Sydney Area.
- Table 2.1 includes local data but the averages for all strata are then compared with averages elsewhere, including for the Hawkesbury Sandstone on the site of the Sydney Opera house.

None of those references are pertinent to the Hume Coal Project.

The report also accepts that “depressurisation” will occur, and that there is “direct hydraulic connection of the coal seam aquifer with other near-surface, water-bearing strata”, despite proving that the roof and all overlying strata will barely subside and, in Appendix A following, showing that an upper, low porosity seam section effects the aforementioned “hydraulic connection”. That portion of the seam could be a significant aquitard and its variation and hydraulic parameters could have suggested to the author that “direct hydraulic connection” was not always present.

9. Justification for Mining Design. This Appendix A of the previous report refers, on page 16 and on Figure 10, to 18 metres of “massive conglomerate in the near-seam overburden”, and suggests that it would “span the 26 metres mine cavity”. It references **Frith and Cavanaugh**, which I suspect investigated mainly the ultra-strong conglomerates of the Newcastle Coalfield. Like the previous references, this is unlikely to be applicable to the vastly differing Triassic sequence in this area.

Using a conglomerate/sandstone strength factor of seven, the report suggests that 80 to 120 metres of the total Hawkesbury Sandstone would similarly span the required mine cavity.

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