Submission from J Kite

Jeff Kite to: csg.review 26/04/2013 09:09 PM

History: This message has been replied to and forwarded.

Please accept the attached document as a submission to the CSG Review

Thank you

Jeff Kite

Submission to Chief Scientist - Final.doc

REVIEW OF COAL SEAM GAS ACTIVITIES IN NSW

Please accept this as a submission to the above review by the NSW Chief Scientist and Engineer. My name is Jeffrey Kite and I live at 1248 Thunderbolts Way, Bowman (Gloucester), NSW. I am a retired Water Resources Engineer, having spent 25 years working for the Western Australian Government water utility and (mostly) the water resources management agency between 1975 and 2000.

I have lived in Gloucester for the past 7 years. I am president of the Gloucester Environment Group and a member of the Barrington Gloucester Stroud Preservation Alliance. However, I make this submission as a concerned resident of Gloucester.

Introduction

I have lived in Gloucester for the main period that AGL has carried out exploration for coal seam gas and received conditional approval from both State and Federal Governments. So I make this submission effectively using the AGL Gloucester Gas Project (GGP) as a 'case study'. As you may be aware, we also have one existing coal mine close by at Stratford and another further away near Stroud Road at Duralie. Both of these mines are now owned, as I understand it, by the State-owned Chinese company Yancoal.

The Stratford mine is currently subject to environmental impact assessment (EIA) for a major expansion and a mine proposed by Gloucester Resources Ltd and known as Rocky Hill Coal Mine (RHCM), is to have its environmental impact statement (EIS) go on exhibition for public submissions on 2 May 2013.

I'm making this submission due to my concerns relating to water and particularly groundwater issues associated with the AGL Gloucester Gas Project. I am aware that this review relates to CSG and therefore does not include the Stratford Expansion Project (SEP). However a major area of concern for me is the critical issue of **cumulative impacts** which I believe is handled very poorly by both the current State and Federal legislation and associated Government agencies.

I will also comment on the failure of State and Federal Government processes and agencies to effectively carry out the environmental impact assessment of the AGL project prior to conditional approval.

I'm aware that representatives of the Independent Scientific Committee (as reported by the ABC) in their presentation to the current Senate Inquiry, noted that for "new coal seam gas proposals …… the quality of environmental assessments provided by companies has varied widely so far". I believe that the groundwater sections in the AGL EIS and Yancoal (SEP) EIS are far from adequate.

Cumulative Impacts of CSG and Coal Mines

The Gloucester valley is very different to the Hunter valley. By comparison, it is a very narrow valley and at Gloucester is well defined by small ranges known as The

Bucketts and Mograni and hills further to the south. The existing Stratford coal mine is located on the eastern "half" of the approximately north/south valley. The Stage 1 proposals for the both the AGL GGP and Gloucester Resources RHCM will also be located in the eastern half of the valley.

You can stand on a small hill on Bucketts Way near Gloucester and look to the south to see the existing Stratford overburden dumps getting bigger every day, look straight ahead to what I understand to be the "hub" of the GGP and look to the north to see where the proposed Rocky Hill open-cut will "swallow up" prime agricultural land including the largest dairy farm in the district. These projects are bunched together such the proposed GGP will have CSG extraction wells effectively overlying the two mines except of course where there is or will be open-cuts. The unique Gloucester valley, will be irrepairable damaged from many perspectives if these projects go ahead.

As you are no doubt aware, the EIA processes do not handle cumulative impacts at all well. This applies both to projects that overlap as well as the future expansion of individual projects. I have provided some details of my concerns in relation to cumulative impacts of projects and groundwater modelling (for the SEP) in Attachment 1. A considerable amount of the information presented in Attachment 1 also formed part of the submission by the Gloucester Shire Council on Yancoal's Stratford Extension Project. I am the author of the groundwater section of GSC's submission to the NSW planning agency.

I recall when EIA was a new and developing area, that the WA EPA Act had overall, a very good process of EIA enshrined in new legislation (1986), although it didn't include consideration of cumulative impacts. However at national conferences where the States where talking about EIA, NSW spoke in glowing terms about how the state had integrated the EIA process with the State planning process.

However, when the officer in charge of EIA in the NSW planning agency spoke to us last year, he said that they only consider EIA on a project by project basis. Looking at cumulative impacts was not part of his responsibility. We note that the Director General's Requirements do mention the need for a review of cumulative impacts for some projects including the SEP. However this section of EISs is handled poorly by proponents from what I have seen, as described in Attachment 1 for the SEP and GGP

A major concern is the way that proponents for different projects use different modelling techniques for groundwater and make different assumptions. It is very difficult, if not impossible, to really understand the nature and extent of cumulative environmental impacts in this situation.

The Gloucester Shire Council is calling for an integrated project to model surface and groundwater processes across the three coal/coal seam gas mining projects in the Gloucester Valley. A draft brief has already been written. I strongly support this proposal. I expect that the proponents will not want to do this and will find a range of reasons why it couldn't be done. However, I believe that the integrated modelling and integrated review of environmental impacts is absolutely essential for the proper consideration of groundwater and surface water issues.

For more information on cumulative impacts and groundwater modelling, please refer to Attachment 1. It covers mostly technical issues associated with groundwater. I think it strongly supports the need for further consideration of groundwater issues by State and Federal governments, as government processes have failed to adequately deal with them, especially when you consider the premature approval by both Governments of the AGL GGP.

AGL Gloucester Gas Project

As mentioned above, this project already has conditional approval by the State and Federal Governments. It is my view that neither Government should have approved this project considering the level of doubt over groundwater issues alone.

I don't really want to get into the politics, as I know that this is not part of your Review's terms of reference. But as I understand it, State Government approval for the GGP was suddenly given about a week before the previous State Labour Government went into caretaker mode prior to the State election. Maybe the reason for this untimely announcement will become clear through the ICAC inquiries.

The Federal Government approval was given around the same time that constraints were applied which would make AGL's planned expansion of the Camden CSG development extremely difficult. Hon Minister Tony Burke, in his media conference to announce conditional approval, stated something to the effect that this approval is different to other Federal approvals under their environmental legislation because there are so many strict conditions that still need to be met by AGL in relation to groundwater modelling.

When the quality of information about groundwater issues in AGL's EIS is considered, it is difficult to understand why **any** approval could have been granted. It maybe that Mr Burke has other information available to him that the community does not have and therefore cannot possibly be aware of. If this is so, this information should be made available to the public. However, my understanding is that there is no further formal (legislative) opportunity for community input once the project is given conditional approval.

As recently as Wednesday 10 April, AGL put a full page advertisement in the Gloucester Advocate stating that **"Our water studies are comprehensive, thorough and independently reviewed".** The advertisement goes on to talk about the "independent peer review" on groundwater by well-respected consultant Richard Evans of SKM. The report AGL is referring to is the "Peer Review of Groundwater Studies- Report to Gloucester Community Consultative Committee" on the Gloucester Coal Seam Gas Project dated 3 May 2012.

I encourage you to read this report. My view is that Dr Evan's report **is very good**. However rather than support AGL, by anybody's judgement, I believe the report is very highly critical of AGL's groundwater work as reported in the EIS. AGL is obviously aware of what the document says, but does not seem to really understand what the implications are.

To list some of the problems:

- One of the main objectives of the Parsons Brinckerhoff "Phase 2 Groundwater Investigations" (PB, 2012) report was to "Prepare a comprehensive technical report that includes a revised conceptual model of groundwater" processes. Clearly, Dr Evans does not believe that this has been achieved.

- The conceptual model presented is very simplified and does not meet normal standards for such a model. Dr Evans says that the conceptual model:
    - Is spatially limited – Prof Pells (see reference below) calculates that it encompasses only 0.25% of the project area;
    - Is vertically limited – only covers down to 300-350m (the Figure in PB representing the model only goes down to 250m) while the target coal seams are mainly in the range 300 – 1000m;
    - Does not consider faults, fractures or shear zones of which there are many;
    - Lumps all the interburden between 150 to 1000m into one category of material ie assumes uniform lithology, which is definitely not the case;
    - Does not include a preliminary water balance which is a fundamental requirement of conceptual models;
    - Only identifies incoming water paths, not outgoing water paths;
    - Does not define model boundaries to be used for the conceptual model or the detailed numerical model;
    - Does not consider the "natural" (current) conditions versus the developed state ie the situation when the CSG wells are operating and causing a drawdown in pressures;
    - Does not adequately cover rainfall and aquifer recharge processes; and
    - Does not consider the continuity (or more likely the lack of continuity) of coal seams.

  Dr Evans report also states that in <u>some</u> instances it is considered that the PB (2012) report has:
    - drawn the wrong conclusion from the data, or
    - omitted some work/calculations which would improve conceptual understanding".

- All that Dr Evans report really concludes is that with an enormous amount of work, AGL should be able to complete a proper conceptual model and then with additional data, we understand AGL is currently collecting to meet Dr Evans' recommendations, be able to move on to a detailed numerical model.

- Dr Evans sums up in Chapter 5, "however it is emphasised that based on the data presented in the PB report, none of these represent criticisms that cannot be readily addressed or the conceptual model revised to take account of the comments. The review has not identified any issues which necessarily indicate the project represents a high or unacceptable risk from a "**hydrogeological impact perspective" – "not that this was the scope of the review, as it is the role of the numerical modelling to assess the location and magnitude of impacts".** (my emphasis)

- If the role of the EIS is not to "assess the location and magnitude of impacts" what is it? It seems very hard to believe that the State and Federal

Governments would even give **conditional** approval for a project that does not have a tool to properly assess the location and size of impacts.

- It is unclear what Dr Evans means with the terminology "high or unacceptable risk from a **hydrogeological impact** perspective". It may just mean that technically speaking, the gas is present and can be abstracted from the coal seams by wells. It seems implicit that he is not commenting on the risks from the perspective of the magnitude of environmental impacts as he is only reviewing the "…..conceptualisation presented in the PB (2012) report……"

- On this point Dr Evans concludes that "….. the **conceptualisation** presented in the PB 2012 report is **broadly** considered to be appropriate, and the **fundamentals** of the conceptual model are **reasonable**." (my emphasis). Dr Evans has chosen his words carefully. Again, it would appear that Dr Evans does not conclude that the PB report is "comprehensive and thorough". I would suggest that no project would be invested in from a financial viewpoint if this was the conclusion of the economic analysis.

The report by academic and consultant Prof. Philip Pells "Gloucester CSG Project – Impacts on Groundwater: Review of Aspects of the Phase 2 Report by Parsons Brinkerhoff", 15 February 2012, is also very critical of AGL's groundwater assessment. He states that "The PB report includes valuable information……. However, we think the analyses given in this review demonstrates that it is not a comprehensive groundwater investigation." If it has not been done already, I would strongly recommend that this Review of CSG Activities consider all the information provided and conclusions drawn by Prof. Pells in the above report.

I acknowledge that AGL accepts that it is required to do a much more detailed numerical model before the final project implementation approval. However the conceptual work alone described above is an important forerunner to this. I also acknowledge that AGL has done a lot more investigation work since the PB report was published but so far as I know, I don't have access to this work.

From the assessment above, AGL has a very long way to go before they will have a suitable numerical model. We can only assess the situation based on the published information that we have access to and I'm not aware that the essential preliminary stage of having an acceptable conceptual model has been completed yet. We await AGL's provision of information about this.

Another area of great uncertainty for the GGP is the number and location of the CSG wells. The community has no useful information on this and the amount of groundwater that will be extracted with the gas must also be considered highly uncertain based on the limited pump testing completed.

Disposal of Produced Water

The community still does not know what AGL will do with its "produced water". This is also a critical part of the project. With respect to this, I draw your attention to the information I provided in a press release written 2 weeks ago as President of the

Gloucester Environment Group (a group with a very wide terms of reference including water quality monitoring).

I was responding to an article in the Gloucester Advocate entitled "Gas company dismisses water quality threat". I quote that in regard to "……..AGL's response to the ABC's recent Four Corners program on Coal Seam Gas. The Gloucester Environment Group (GEG) has reviewed the comments by AGL in this article and is concerned that there appear to be factual errors in the information as reported.

With respect to water quality in the Avon River, AGL has stated that it is a "known saline catchment". GEG has been recording electrical conductivity (EC), a measure of salinity, in the river at three points since 2009. The aim was to provide a baseline that can be used to compare changes to salinity and other water quality parameters over time. The sampling site with the highest recorded EC is just to the south of Jacks Road.

With the river flowing, the highest recorded EC is 540 units (micro Siemens per centimetre) with an average over 18 samples between 2009 and 2013 of 355 units. This is a relatively small sample size but I note that Stratford Coal's data for 2011 for a site not far upstream gives an average EC of 257 units.

The Australian Drinking Water Guidelines set the maximum salinity (measured as total dissolved solids) for fresh domestic drinking water as 500 milligrams per litre which is approximately 770 EC units, well above the recorded EC levels for the river.

The Avon River is therefore not saline but fresh. I acknowledge that there is brackish to saline shallow groundwater in the catchment and that the river has a higher salinity than the Gloucester, Barrington and Manning Rivers. However it is incorrect to describe it as a saline catchment.

(I note that Dr Evans also states that the "EC levels during periods of baseflow range between 300 to 600 micro Siemens per centimetre. This is not brackish or saline and certainly capable of sustaining ecosystems.")

The article goes on to state that by discharging their treated "slightly salty" groundwater would "actually improve the quality of the water in the Avon River Catchment". As indicated above, to improve the salinity of the river, AGL would need to desalinate the water to better than drinking water standards. The "produced water" is not only saline but also includes many other chemicals that can be a problem in drinking water or in water for ecological purposes.

GEG considers that as a matter of principle, no coal seam gas project, coal mine or any other industrial development, should be given approval to discharge process water into a river system, especially in a catchment used for public and private domestic water supply.

With respect to the impact of the Gas Project on water table levels, GEG is very concerned about the veracity of the modelling done by AGL consultants and the conclusions drawn, including conclusions about the connectivity of shallow and deeper aquifers. We acknowledge that AGL is working on a more detailed numerical

model however a necessary step is for AGL to first develop a robust conceptual model, as identified in their "independent peer review" consultant's report.

GEG strongly supports the proposal by the Gloucester Shire Council for a comprehensive and integrated surface and groundwater modelling study of the Gloucester basin. This study needs to assess the cumulative impacts of the AGL Gas Project, Yancoal's Stratford coal mine expansion and the Rocky Hill coal mine. No further approvals should be given for any project implementation, including AGL's Stage 1, until the outcome of this study is known."

Investigation bores in the Project Area

As mentioned in Attachment 1, the complexity of the hydrogeology is well known and is illustrated by the intensive exploratory drilling, test fracking of holes, 2D and 3D geophysical investigations and now a wide ranging aeromagnetic investigation. The Figure in Attachment AD, Enclosure 1 of the SEP EIS at the end of Appendix A, shows the location of the huge number of bores drilled during exploration.by the CSG and coal mining companies.

Dr Evans states that: "The NSW Department of Trade Investment Resources and Energy require that all exploratory and production wells be constructed to hydraulically isolate the target formation from overlying aquifers. AGL are required to follow these conditions as a condition of their licence. **Provided these requirements are followed** (my emphasis), the potential for inter-aquifer leakage via the drill hole is eliminated. Also AGL will be undertaking hydraulic testing of the cemented seals around the well annulus prior to any hydraulic fracturing or development work (AGL email dated 16th March 2012)."

The three proponents were planning about 900 new holes during one 12 month period alone. There has also been considerable earlier CSG investigations by Lucas, other companies and past Government agencies undertaking coal resource investigations.

Some parts of the northern Gloucester valley resemble a pincushion with many bores at close spacings drilled to a variety of depths. Even if AGL has done a very professional job with their drilling and will undertake hydraulic testing of the cemented seals, we cannot be confident that a professional job has been done for other nearby bores. The Government agency referred to above apparently mostly depends on reports by drilling contractors to ensure that the bores are properly constructed.

Some years ago, I spoke to a senior government hydrogeologist after AGL had completed their initial stage of drilling investigation holes, all of which had been fracked. I queried whether his inspectors had specifically been on site during the fracking of the bores. He responded in the negative. At this time, as I understand it, there was also no requirement for AGL to declare what chemicals were used in the fracking process.

I would think that it is unlikely that we can have a high level of confidence about where the fracking fluids end up and where the gas pathways could lead.

Other Groundwater Issues

There are many other issues of concern in relation to groundwater that I could write much more about. Some of these issues have been referred to elsewhere in this report. These include:

- Fracking;
- Vertical hydraulic conductivity/connectivity; and
- A Conceptual model needed for AGL that includes huge 180 metre deep open-cuts

I have included in Attachment 2, the part of the submission made that relates to water, for the AGL EIS by the Barrington Gloucester Stroud Preservation Society. I was the author of this part of the submission. This document was written in January 2010. I note that much of the document is still highly relevant.

Conclusions

- There is considerable evidence that the information presented relating to groundwater issues in the EIS for the AGL GGP and to a lessor extent, the EIS for Yancoal SEP, with respect to groundwater issues, falls well short of the information required to undertake effective environmental impact assessment;
- For the Gloucester area, cumulative impacts of coal mining and CSG extraction are likely to be significant with respect to their impacts on surface and groundwater but cannot be adequately assessed using the information provided by AGL and Yancoal in their EISs.
- Considering how much uncertainty there is on groundwater issues, it is very difficult to understand how the NSW State and Federal Governments could give conditional approval to Stage 1 of the AGL GGP;
- Current State and Federal legislation does not ensure that groundwater impacts are adequately addressed. Improvements to legislation, guidelines and EIA processes are urgently required to ensure that these impacts are properly assessed.

Jeffrey Kite BE (Civil) Grad Dip Nat Res MIEAust CPEng (Retired)

ATTACHMENT 1

Note:

1. A considerable amount of the information presented here also formed part of the submission by the Gloucester Shire Council on Yancoal's Stratford Extension Project. I am the author of the groundwater section of GSC's submission.
   .
2. Yancoal has responded to some of these issues in their Response to Submissions document and some changes have been made. However much of their response is considered to be inadequate, as it did not address many of the specific issues raised.

Stratford Extension Project

Major Concerns with Groundwater Modelling

There are major concerns with the approach and technical aspects of the groundwater modelling and therefore with the associated conclusions in the Main Report and Appendix A. These conclusions relate to both the cumulative impact associated with AGL's proposed Gloucester Gas Project, the proposed Rocky Hill Coal Mine and the existing mine and proposed Yancoal Stratford Extension Project and the cumulative impact of future Yancoal expansions. I understand that this review is not looking at coal mine developments, however most of the points raised here also relate to future extensions by the GGP and RHCM.

In AGL's Response to Submissions, we are told that we should be confident about the models results as the model has been properly calibrated. However as Dr Evans says (see main report) in his report on the AGL model (while recognizing that the latter is only a conceptual model), the modelling does not consider the "natural" (current) conditions versus the developed state ie the situation when the CSG wells are operating and causing a drawdown in pressures. I would think that the SEP modelling could be similarly criticised when the very limited extent of data and information identified through drilling and testing is recognised.

Technical Issues Relating to the SEP Groundwater Model:

1) Modelling the Gloucester Stroud basin is fraught with difficulties because of the structural complexity of the geology and the relationships between the aquifers;

2) The complexity of the hydrogeology is well known and is illustrated by the intensive exploratory drilling (see Figure in Attachment AD, Enclosure 1 of the SEP EIS at the end of Appendix A, which is a plan showing the location of the huge number of bores drilled during exploration.). This means that groundwater modellers have to make huge oversimplifications about the nature and hydraulic properties of the strata;

3) The degree of vertical connection between aquifers is an area of significant disagreement between groundwater consultants. Vertical connection is a critical issue in groundwater modelling with AGL arguing that the connection is minimal. The Yancoal consultants say they agree with AGL on this issue, but they clearly include some vertical connectivity in their model. In Figure A-25 of the SEP EIS they also show the coal seams as nearly vertical, which can add significantly to vertical connectivity. As well, no models used for the Gloucester area have even tried to consider the effect of the extensive fracturing and faulting;

4) Clearly open-cuts up to 180 metres deep provide direct connection between aquifers to that depth. There are also major questions about the quality of construction and Government regulation of the huge number of exploratory bores and AGL's future production bores drilled more recently (with a significant number being fracked) as well as bores drilled since coal exploration started in the 1960s/1970s (see also the main part of this submission);

5) The model used for the Yancoal EIS appears to only consider periods of permanent base flow in watercourses as groundwater contours do not drop below streambeds. This is supported by Figure A-25 which shows the model including baseflows in the streams. However, the consultants accept elsewhere that the streams are ephemeral. Critical conditions for say, riverine vegetation and vegetation accessing groundwater when there is no surface water, will be during drought sequences both within and between years and these are not assessed;

6) For impacts by Yancoal alone, no consideration is given to the future expansions of new open-cuts which can certainly be expected both to the north and south (at least);

Groundwater Model Outputs and Conclusions Drawn in EIS including Cumulative Impacts:

Notwithstanding the issues identified above, I have considered the model outputs. The outputs will be particularly affected by the assumption of permanent baseflows in the creeks and the overall vertical and horizontal hydraulic connectivity.

Section A6.1.6 refers to Figures A-57, which shows watertable contours for the project operating alone while Figure A-58 shows watertable contours for **all 3 projects** operating at the same time at the "end" of the current Yancoal project.

It appears that the maximum watertable drawdown for the project operating alone is around 70 metres in the Stratford East Open Cut. However the open cut will be 180 metres deep. Therefore the watertable at this time should reflect that depth. This anomaly cannot be readily understood.

Figure A-58 shows watertable drawdowns in the order of 170 metres close to Stratford Village. This is presumably partly the result of **a concentration of CSG bores** in this area. In Section A6.1.8 in the third paragraph it is stated "CSG activity would cause pronounced drawdown in the watertable between the Project and Stratford." The impact on Stratford bores could be much more, not 1-2 metres as stated in the EIS.

In Attachment AD, the Consultant acknowledges that the drawdown for the Stratford project operating alone, will be up to 170 metres in the Stratford East Open Cut when the Layer 11 coal seam is being mined.

Attachment AD also contains the most concerning drawdown contours of all for **cumulative impacts.** The last set of groundwater contours show a maximum drop of about 1700 metres centered just south east of Stratford with huge drawdowns over a very large area. A 1700 metre drawdown in potentiometic head seems ridiculously high since as far as I am aware, no CSG wells will be anywhere near that deep. However, this is what the document states. Note the assumed "nest" of CSG in this area. In their Response to Submissions, Yancoal has advised that this would be a "worst case scenario". So far as I'm aware, this was not indicated in the EIS. Even it was, why would you only show the worst case scenario?

Although not stated as far as I can see, this drawdown or any major drawdown is likely to mean continuing drops in the watertable as downward vertical flow is induced by the depressurisation of deeper aquifers. It is well known that this is a common phenomenon for these situations. Figure A-58 also shows that drawdowns on the western side of the area impacted is limited by a roughly north-south line just to the east of Stratford village. This seems very convenient but highly questionable when you consider the above.

So far as I can see, there is no proper review and discussion of these critical issues in the EIS. There's information about the impacts of such a drawdown given in the Main EIS Report or Appendix A. Section A6.1.8 just states blandly that "Based on the modelling results, **cumulative effects** are expected to be substantially greater than would be produced by the Project acting alone" with the Main Report making a similar comment.

Conclusions based on concerns with Groundwater Modelling:

- The veracity of the groundwater modelling used in the Yancoal EIS needs to be reviewed by Government regulators and independent experts;

- The **cumulative impacts** on groundwater of the Yancoal Project, the Rocky Hill project and particularly the AGL gas project, are highly significant. Related impacts on the ecology and other beneficial uses, such as private wells in Stratford, are therefore also potentially highly significant;

- The impacts related to the AGL gas project, as presented in this EIS, need to be taken up as part of the final approval process of conditions by Government regulators.

- None of the proponents for the Yancoal expansion, the AGL gas project and the Rocky Hill mine, can adequately assess the **cumulative impact** because they are using different data and different models to suit their own purposes. There needs to be a comprehensive and integrated groundwater modelling study undertaken by an independent steering committee, before any further approvals are given.

Other Groundwater Issues

Complexity of the Hydrogeology

An overarching issue is the complexity of the hydrogeology in the Gloucester – Stroud area. To quote from the NSW Geological Survey's review of the area in 1991 (ie 22 years ago) as reported by Pell Consulting in February 2012:

"*The Gloucester Basin (technically the Stroud Gloucester Syncline) is about 55 km long with a width of 24 km at its widest point. The syncline is a fault-bounded trough; the structure is complex…. Coal seams in the trough are characterised by a considerable degree of lateral splitting, only 6 of the 20 or more seams can be correlated across the syncline. Faulting and folding have significantly reduced the potential for development of these resources.*"

Pell's report goes on to talk about how the groundwater model for the AGL Gloucester Gas Project has had to be greatly simplified because of the complexity of the stratigraphy and the paucity of field data. He also criticises AGL for:

"Concluding that faults play no role in groundwater movement, and do not even displace the stratigraphic units in the model, is contrary to almost all experience in hydrogeology and groundwater engineering."

Some faults may be able to prevent cross flows from aquifers but certainly not shear zones. Heritage Consulting have had to make similar over-simplifications in their modelling, including not considering faults and shear zones. The main output of groundwater modelling is maps showing drawdown contours for the watertable and/or potentiometric (pressure) heads due to groundwater abstraction. Proper assessment of the impacts of coal and CSG mining due to the pumping of very large quantities of groundwater is dependent on having confidence in the knowledge of the hydrogeology as represented through the groundwater modelling. We have major problems with these aspects of the EIS (as well as the work done by AGL and Rocky Hill) which significantly affects many of the comments on issues below.

The complexity of the hydrogeology is visually illustrated by Enclosure 1 of the EIS at the end of Appendix A, which is a plan showing the location of the huge number of bores drilled during exploration. It shows the immense difficulty the geologists had in unravelling the complex structural geology to assess the coal reserves and allow for mine planning. The advice I have from an experienced geologist who worked in this location, is that he knows of no other exploration programme that has drill holes so close together.

It is further illustrated by the massive investigations undertaken by AGL by drilling bores,testing fracking holes, 2D & 3D geophysical investigations and now a huge aeromagnetic investigation using a blimp. The same geologist mentioned above has indicated that AGL probably neglected to consider the numerous shear zones in their initial investigations. As a result, they have needed to continually repeat their seismic

testing to find blocks that can be drilled without contributing further to the huge cost of their drilling programme.

In conclusion, as stated in Section 8 of our report on Cumulative Impacts, none of the proponents for the Yancoal expansion, the AGL gas project and the Rocky Hill mine, can adequately assess the cumulative impact because they are using different data and different models to suit their own purposes. There needs to be a comprehensive and integrated groundwater modelling study undertaken by an independent steering committee, before any further approvals are made.

Cumulative Impact Related to Incremental Expansion of Stratford Mine*:*

This issue relates to the incremental expansion of Yancoal's Stratford Coal Mine (SCM). According to readily available geological mapping of the Gloucester-Stroud Syncline and Gloucester Coal's Annual Reports, the coal resources that may be mined in the valley are huge. Since the mine commenced in 1995, there have already been many expansions to the project.

Pumping of groundwater flowing into the coal mining open cut pits (that is, dewatering of the pits) to allow for mining activities, requires the extraction of large quantities of groundwater that will flow into the pits as they are excavated. This EIS only covers the impacts of the existing operation plus the new pits associated with the current expansion. The impacts of the extraction from shallow aquifers and therefore the watertable, together with the pumping from deeper aquifers intersected by pit excavation, will be widespread and is likely to have a significant impact on a range of beneficial uses of groundwater, including impacts on ecosystems which use that groundwater**.**

Again, it is not possible to properly assess the medium and long term impacts on groundwater when this EIS only covers the latest expansion. We can be sure that part way through the development of this expansion, there will be an application for more pits to the north and south of those currently proposed. Ongoing exploration is very briefly mentioned in Section 2.3 of the EIS. In fact, extensive drilling exploration has already been completed south of Pages Road and north to Fairbairns Road, which will connect up to the Rocky Hill development.

Impact on Surface Water

The EIS states that the open cuts will be placed no closer than 40 metres to the creeks. This appears to be the plan to avoid any significant impacts from dewatering activities. The groundwater modelling indicates that there will only be small drawdowns in the vicinity of the creeks.

However, this is based on an analysis which appears to assume that average flows will always occur in the creeks, despite the EIS acknowledging that the creeks are ephemeral. During very dry periods, it would be expected that creeks would be dry for long periods with no base flow. Riverine vegetation is likely to be groundwater dependent at these times. Drawdowns due to mine dewatering are likely to cause the water table to drop ell below the creek bed. It is difficult to believe that a 180 metre

deep pit 40 metres from the creek, will not have a very significant impact on the creek.

This is even more likely when a future pit is excavated to the north as part of future expansions by Yancoal and/or the **AGL wellfield** is operating. This may have a major impact on the health of riverine vegetation which appears to be in reasonable condition for Dog Trap Creek. If vegetation dies and as proposed, there are periods of increased flows in the creeks due to increased catchment areas, major erosion of the bed and banks can be expected.

ATTACHMENT 2

This is a copy of the submission made on the AGL EIS in relation to water. I was the author of this part of the submission. This document was written in January 2010. I note that much of the document is still highly relevant.

Production Water

The disposal of produced water generated by the extraction of CSG is addressed in some detail in the concept plan. The preferred option to partially purify the produced water using reverse osmosis, to sell the treated water for local agricultural use and to separately dispose of the solids removed is attractive on the face of it. There are a number of issues that have not been addressed adequately or in some cases at all.

Treated Water Quality

No commitment is made to treating the water to any specified standard. It is said that it will be treated to 'acceptable standards' without saying what standard or to whom it might be acceptable.

In the illustrative example of Stage One development 2ML per day would be processed, which initially contains TDS of 2000 mg/L to yield 250 KL per day of brine which would contain 3 tonnes of solids. This implies that the treated water of 1.75 ML/day would carry the remaining 1 tonne of solids and so contain about 570 mg/L TDS. In terms of TDS alone such water would be suitable for stock drinking water and could be suitable for irrigation of some crops depending on the nature of the soil that the crop was grown in. As the soils of the area often have high clay content the risk of damaging the soil with sodium salts needs to be evaluated before any farmer plans long-term irrigation.

The volume of the produced water and its solid content is based on few trial wells and cannot be extrapolated to the whole gas field.

No reference is provided about the existing quality of water in the local rivers. Monitoring by local groups suggests that the TDS varies with rainfall between 110 and 260 mg/L. Discharging high volumes of water with much higher TDS will impact the rivers. How significant the impact will be requires further study.

No data has been supplied on the pH of the produced or treated water nor is there any analysis of the solid content. So the possibility of the long-term application of treated water producing a harmful accumulation of metals or other toxins in the soil or stock is unknown, as is the effect on local waterways.

Treated Water Disposal

The direct discharge of treated water into local waterways is foreshadowed in the case of demand for irrigation being reduced because of rain. No analysis is provided of how often or how much such discharge might be. We have already seen how miners in the district can be unduly optimistic about containing waste water during wet spells. This matter is put off to a future study.

The possibility that farmers may not want the treated water due to unsuitable quality, irrigation being uneconomic or any other reason is not considered. In that case there would be little option but to discharge the balance into the rivers.

Thus we are left with the possibility that under full development of the project up to 5.25 ML per day (using the proponent's figures) of water of unknown quality will be discharged into local waterways for 15 years or more. It may be that the volume of produced water and its dissolved solids has been underestimated. This discharge would be on top of the water already discharged by Gloucester Coal's Stratford mine, a cumulative impact that is not considered.

To give approval in principle to this project before any study is conducted as to the likelihood, or volume of discharge, or its consequences to the river systems would be irresponsible. Given the multitude of uncertainties it is hard to understand how water management is rated only a medium priority in the Executive Summary.

Groundwater

The concept plan concedes that the geology of the concept area is complex and highly faulted. Coal miners in the area have confirmed this in their diggings. The proposal gives very little information about the depth and flow of aquifers. The hydrology of the valley is generally poorly understood.

The following opinion by Professor Alex Grady outlines the extent of this problem. (Professor Grady has 35 years as a geologist specialising in structural geology and also has extensive experience as a geological field mapper. He has extensive field experience in NSW, South Australia, Western Australia, the Northern Territory, New Zealand and Eastern Indonesia. He was during that time a Member of the Australasian Institute of Mining and Metallurgy and of the Geological Society of Australia and retains membership of the Geological Society of Australia.)

> The area in question has been intensely faulted, involving several intersecting arrays of often closely spaced faults. This is the kind of geological situation in which the rocks are usually strongly fractured (fractures due to compaction-contraction during lithification, together with those due to brittle failure during folding and faulting). This gives rise to secondary porosity/permeability - which can vary considerably from place to place. Most particularly, such effects can produce locally high porosity/permeability zones in rock units that have low primary porosity/permeability (producing what are called "fractured rock aquifers").
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> There are sandstone stratigraphic units within the geological sequence, ones that could well be fairly good local aquifers (although the water quality might not be particularly good). The sedimentary units in the Gloucester Valley area are not pure "layer cake stratigraphy", ie, sedimentary units are not perfectly continuous (in extent or thickness - particularly from east to west). This applies also to the character of the mapped rock units, eg the distribution of potentially good sedimentary aquifers. The fact that their drilling activity in the pilot project area didn't intersect any doesn't preclude their existence within the proposed Gas Field area.
>
> The complexity of the faulting is likely to have juxtaposed the coal seams with potential sandstone aquifers in many places. This has the potential to make the coal seams 'leaky' in such places.

The proponent asserts that their test wells did not "appear to have affected the water levels in alluvial aquifers". The inference being offered that this is some sort of

evidence that the same situation would apply across the gas field is not supported by current knowledge of the geology.

Prof. Grady is also of the opinion that:

> Their report of what happened to neighbouring core drill holes (DDH20C and "an unnamed core hole " about 400m north of LMG03) suggest greater permeability/porosity than they otherwise admit, within the coal seam sequences (not just within the coal seams).

The proponent makes much of the efforts they will make to case and seal each well into its surrounding strata. The possibility that fraccing may open up communications between wells (old or new) or between permeable strata that were previously isolated is not considered.

A monitoring regime to detect production wells that are extracting water from aquifers is proposed. The remedy offered if that problem is identified is to shut down the well. No indication is given how many wells might be so affected, probably because nobody knows.

The proponent intends to devise contingency measures if other adverse impacts are detected. Whether the monitoring regime is capable of detecting such problems, such as water or gas flows other than out of the wells, in a reasonable time is unclear, as is what might be done about it. If fraccing has opened an undesirable communication pathway then shutting down a well is not going to fix it unless the pathway is only to that well.

All the indications are that a detailed hydrological study would be required to determine the impact of the project upon ground water because at present there is no solid information about it and there are indications that there will be effects. The proponent has committed to such a study but only after stage 1 GFDA is providing data (see 26.2.1 #12). Likewise the Groundwater Management Plan has been put off until after approval. How is this possible given the uncertain environment?

The monitoring installations will only collect useable data once the wells of GFDA 1 are established and in production. They can only be put into production once the CPF and pipeline are available unless all the gas will be flared locally. So in practice the hydrological study will be undertaken after the project is approved and operational.

Is the proponent prepared to gamble a huge capital investment on the outcome of such a retrospective study? Or are they assuming that no matter what the outcome of the study, no matter what environmental consequences may be revealed, they will not be compelled to take any action that would seriously compromise production?

Conclusion and Recommendations

An independent study of the disposal of produced water and of groundwater hydrology is required. This should be conducted before the concept plan is approved unless the State Government is prepared to gamble along with the proponent that no serious harm can come to the environment as a result of the uncertain water management of the project.