Appendix 1

Minister's Terms of Reference for the Review

Original Terms of Reference for the Review (superseded):

Request to the Planning Assessment Commission

Watermark Coal Project

Section 23D of the *Environmental Planning and Assessment Act 1979*
Clauses 268R and 268V of the *Environmental Planning and Assessment Regulation 2000*

I, the Minister for Planning and Infrastructure request the Planning Assessment Commission to:

1. Carry out a review of the Watermark Coal Project, and:
   a) consider the EIS of the project, the issues raised in submissions, the formal response to submissions, any advice from the Gateway Panel on the project, and any other relevant information provided on the project during the course of the review;
   b) assess the merits of the project as a whole, paying particular attention to the:
      - impacts of the project on strategic agricultural land, as identified in the *New England North West Strategic Regional Land Use Plan*, including the impacts on existing agricultural land use in the areas surrounding the project;
      - water resource impacts of the project, including direct and indirect impacts on the Upper Namoi alluvial aquifer and downstream surface water resources;
      - health and amenity impacts of the project, with a specific focus on whether all reasonable and feasible noise and dust mitigation measures are being employed to avoid and/or minimise these impacts;
      - biodiversity impacts of the project, with a specific focus on the resident koala population and the proposed koala translocation program, and the adequacy of the proposed biodiversity offset strategy;
      - impacts of the project on local and regional infrastructure and the demand for services; and
      - long term land use impacts of the project and the suitability and feasibility of the proposed rehabilitation strategy, including the final landform, final void and the proposed rehabilitation of agricultural land;
   c) recommend further measures to avoid, minimise and/or offset the potential impacts of the project (if required); and
   d) provide advice on the suitability of the site for the project and whether the project is in the public interest.

2. Conduct public hearings during the review as soon as practicable after the Proponent provides its formal response to submissions on the project.

3. Submit its final report on the review to the Department of Planning and Infrastructure within 2 months of the public hearings, unless the Director-General of the Department of Planning and Infrastructure agrees otherwise.

Brad Hazzard

The Hon Brad Hazzard MP
Minister for Planning and Infrastructure

08 MAY 2013

Sydney 2013

Revised Terms of Reference for the Review (current):

Request to the Planning Assessment Commission Watermark Coal Project

Section 23D of the *Environmental Planning and Assessment Act 1979*
Clauses 268R and 268V of the *Environmental Planning and Assessment Regulation 2000*

I, the Minister for Planning and Infrastructure request the Planning Assessment Commission to:

1. Carry out a review of the Watermark Coal Project, and:
   a) consider the EIS for the project, the issues raised in submissions, the formal response to submissions, any advice from the Gateway Panel on the project, and any other relevant information provided on the project during the course of the review;
   b) consider the Department of Planning and Infrastructure's preliminary assessment report,
   c) assess the merits of the project as a whole, paying particular attention to the:
      - impacts of the project on strategic agricultural land, as identified in the *New England North West Strategic Regional Land Use Plan*, including the impacts on existing agricultural land use in the areas surrounding the project;
      - water resource impacts of the project, including direct and indirect impacts on the Upper Namoi alluvial aquifer and downstream surface water resources;
      - health and amenity impacts of the project, with a specific focus on whether all reasonable and feasible noise and dust mitigation measures are being employed to avoid and/or minimise these impacts;
      - long term land use impacts of the project and the suitability and feasibility of the proposed rehabilitation strategy, including the final landform, final void and the proposed rehabilitation of agricultural land; and, if necessary,
   d) recommend further measures to avoid, minimise and/or offset the potential impacts of the project.

2. Conduct public hearings during the review as soon as practicable after the Department of Planning and Infrastructure provides a copy of its preliminary assessment report for the project to the Planning Assessment Commission.

3. Submit its final report on the review to the Department of Planning and Infrastructure within 6 weeks of the public hearings, unless the Director-General of the Department of Planning and Infrastructure agrees otherwise.

The Hon Brad Hazzard MP
Minister for Planning and Infrastructure

Sydney 15.11 2013

Appendix 2

Summary of the Issues raised at the Public Hearing

Copies of the submissions, together with any copies of presentations and speeches made during the public hearing that were later provided to the Commission in written form, are available on the Commission's website, http://www.pac.nsw.gov.au. A brief summary of the issues raised at the public hearing is provided below.

Issues	Summary of key points raised at the Public Hearing
Comments supporting the project	
Social and Economic	• The mine will provide regional training, employment and population growth and associated increases in services available in Gunnedah. • Mining royalties will contribute to the NSW State Government economy. • The mine provides indirect economic benefits to local businesses in the area. • Improved economic diversity • Professionalism in the mining industry has helped to improve work safety practices in other industries as well. • Need for the resource noting the relatively small contribution of the renewable energy sector and the need for coking coal. • Better to use this coal than to use coal of a poorer quality from elsewhere. • Some suggested they would like to see the mine go ahead, but only if there are no impacts to water resources and the rural community, the importance of ensuring the mine was held accountable for its actions and impacts was also emphasised. • Some suggested mining can coexist with agriculture in this region as it has done in the past. • The mining sector's (and the applicant's) contribution to charities and health services was recognised. • It was suggested the mining accounts for less than 2% of total water consumption.
Concerns and objections to the project	
Agriculture	• The high agricultural productivity of the region was emphasised. • The Liverpool Plains are said to support some of the world's most fertile soils, along with East Texas and the Ukraine. These fertile soils are said to be rare in Australia, with capacity to support both summer and winter cropping. • There is significant concern that mining may impact on this productive agricultural region. • The ability of the agricultural industry to sustain production was compared with the relatively short life of the mine. • Area said to be a significant food bowl and increasingly important given climate change and growing population. • Agriculture is already facing challenges of climate change and food security for a growing population, so cannot afford additional risk posed by mining. • It was suggested that mining cannot coexist with the Liverpool Plains. • Loss of agricultural production to biodiversity offset sites. • The Liverpool Plains should be afforded the highest protection from mining. • Buffers considered inadequate.
Water resources	• Surface and groundwater impacts not considered to be adequately assessed. • Inconsistencies identified in the EIS and data modelling, have not explored all

<table>
<tr><th>Issues</th><th>Summary of key points raised at the Public Hearing</th></tr>
<tr><td></td><td>plausible scenarios.
Risks to key water resources critical to the high agricultural productivity of the region, including:
groundwater drawdown impacts;
competition for water licences;
pollution from potential discharge of mine water;
potential risks of impacts from the final void, including loss of catchment and saline water leakage/discharge.
Uncertainties in the mine water balance.
Conditions considered inadequate.
Questioned why the final Namoi Water Study documents have still not been publicly released.
Water so precious in this country it is not worth taking any risks, no one can guarantee the aquifers will be protected.</td></tr>
<tr><td>Flooding</td><td>Concerns about the risk of greater flooding impacts.
Flooding has not been adequately addressed by the applicant.</td></tr>
<tr><td>Biodiversity</td><td>Concerns for the koala population, including:
that the koala population is already suffering from losses associated with recent droughts and disease outbreaks;
that the population is significantly smaller than has been estimated by the applicant;
that translocating the proposed number of koalas would have a significant impact on the Gunnedah Koala population and success is uncertain – likely other koalas already occupy translocation sites;
loss of habitat connectivity and associated restrictions on the population;
Concerns about the impacts on endangered ecological communities.
Concerns that very little habitat for Koalas and other threatened species is protected in reserves in this region.
The Koala Plan of Management considered inadequate.
Concern that biodiversity offsets proposed are not adequate and/or appropriate.</td></tr>
<tr><td>Air</td><td>Concern about the health impacts of airborne dust.
Dust impacts on produce, particularly cotton.
Dust deposition and contamination of rainwater collected from roofs.</td></tr>
<tr><td>Adequacy of the assessment provided by the applicant</td><td>The Environmental Impact Statement is inadequate and outdated.
Questions about the data modelling, including the wind directions used.
The community has been forced to spend millions of dollars identifying the inadequacies in the applicant's assessment and re-examining each new version.
A Health Impact Assessment was called for.</td></tr>
<tr><td>Social and Economic</td><td>The economic benefits have been significantly overstated and the costs understated.
The economic analysis methodologies questioned.
Project not viable at current coal prices, marginal at best with no net benefit.
Short term benefits with risks of long term impacts to sustainable water supplies.
Difficulty in gauging whether all the economic benefits will be achieved.
Concern that money will be going overseas instead of the local or state</td></tr>
</table>

Issues	Summary of key points raised at the Public Hearing
	economy, it was suggested that mining royalties are not high enough and mining companies do not pay sufficient taxes. • Concerns about the social impacts on the community, loss of place and displacement of residents. • Impacts and uncertainties for neighbours who have put investment decisions on hold. • Loss of culturally significant places and indigenous landscape. • Lack of security in mining jobs and lack of transition planning for mine employees when coal prices fall. • Concern that adaptive management often fails. • The need for guidelines and a more transparent process for developing Voluntary Planning Agreements was emphasised. • Loss of rate base to Councils where offset areas are proposed to be established.
Lighting	• Impacts of lighting on dark night skies, particularly for Siding Springs Observatory and the need to manage lighting to minimise light spill.
Climate Change	• Concerns about the project contributing to climate change. • Alternative energy sources were said to be available. • Lack of consideration for the Precautionary Principle.
Heritage	• Both Aboriginal and European heritage were noted. • A number of families have properties and other ties to the region that extend back for many generations, including to the earliest periods of European settlement. • Breeza's history, including its associations with bushranger Ben Hall were noted. • Aboriginal heritage surveys have not been adequate, hasn't followed Burra Charter, potential for impacts on megafauna records. • Ginding grooves need further investigation.
Cumulative	• It was suggested that allowing this mine would open the floodgate to many more mines as there is an extensive coal resource in the area. • Some properties may also be impacted by the Caroona project, if it proceeds. • It was noted that many mines are extended beyond the initial mining period.
Process and Government systems	• Assessment process skewed to big business and government, biased in favour of developer and not considered fair or robust. • Lack of transparency from the applicant, the Department of Resources and Energy and the Department of Planning and Environment. • Concerns that the Government and the EPA in particular, have limited capacity and resources to protect people, enforce compliance, take regulatory action. • Penalties for non-compliance are not substantive and do not provide adequate deterrence. • Concerns over the independence and reporting structure for the PAC, the Land and Water Commissioner and the Chief Scientist. • Concerns about the 2013 amendments to the Mining SEPP (*State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*). • Concerns about the way exploration licences are issued. • Objections to the lack of merit appeal rights. • The need for a stronger and better resourced Independent Planning

Issues	Summary of key points raised at the Public Hearing
	Assessment Commission.
Other	• Food and water supplies are more important than prosperity. • Noise impacts • Blasting impacts, including on health • Visual impacts • Traffic impacts • Impacts from coal trains • The ability to rehabilitate the site for either biodiversity or agricultural uses was questioned.

Appendix 3

Summary of Meetings

<u>Briefing from Department of Planning and Environment representatives</u>, 6 June 2014

Strategic context – noting the proximity to the black soil, but that the proposed open cut mining areas are on the red soil, the slightly higher country off the plains. The resource was said to be a significant metallurgical resource. Mineral Resources planned for this area to be one of the next areas for resource extraction. Department of Planning and Environment representatives consider the situation to be very different to the Hunter, with options for open cut mining limited to a handful of key sites such as the Leard Forest Precinct and this site. The resource on this Watermark site was said to be an isolated open cut resource, with scope for underground mining in the future.

The Departments representatives noted the following in relation to the potential impacts of the mine

Aboriginal heritage, grinding groves on site. A large number of groups are registered with the mine in relation to Aboriginal heritage activities/impacts.

Groundwater – mine would be elevated above plains so not expected to impact on groundwater associated with the alluvial floodplain.

Soil and Agriculture – The exploration licence has been amended to prohibit mining on the black soil. The quantity of BSAL (biophysical strategic agricultural land) on the site has been questioned and the Commission may wish to look at this. Has been considered in detail with the Office of Agriculture and both agencies are now satisfied the quantity of BSAL on the site has been correctly mapped by the Applicant. It was noted that the Applicant had finished its study of this issue before the protocols regarding BSAL were put in place. The Department is satisfied the further extensive soil sampling is not necessary.

Some BSAL will be impacted, this is not prohibited in the Strategic Agricultural Land Use Plans, it is a trigger to be referred to the Gateway Panel and should try to minimise loss of BSAL, but accepts that some loss of BSAL may be an unavoidable consequence of mining. There was also BSAL within the offset areas, but these have since been removed from the offset package. The debate about whether BSAL should be included in offset land was noted.

Uncertainty regarding whether it is possible to rehabilitate the land to the standard required for agriculture was noted. Office of Agriculture now said to be reasonably comfortable with the proposed rehabilitation, following some initial concerns regarding the soil balance for the site.

Water salinity – the mine water will be highly saline, however it will not be released/discharged from the site. Some water that has come in contact with sediments around the site will be discharged, however the levels of sediment and salinity are not expected to cause significant issues.

Local Councils – the Department of Planning and Environment has consulted with both Gunnedah and Liverpool Plains Shire Councils. Both Councils are now satisfied with the Voluntary Planning Agreements they have negotiated with the Applicant, and are in favour of the mine.

<u>Meeting with Gunnedah Shire Council representatives</u>, 26 June 2014

Bulunbulun Road has been an issue in discussions between Council and the applicant. Council is now comfortable with the condition recommended by the Department of Planning and Environment, which provides for monitoring to be used to determine the maintenance contributions payable. Council is considering different monitoring options including licence plate recognition technology.

Council noted the considerable time and resources spent by Councillors and staff to give the project adequate consideration, noting that the rate payers are paying for this.

Council noted that it is meeting with the NSW Land and Water Commissioner on 28 July 2014.

Council indicated the area is a coal mining district, as it has known of the coal mining potential for many decades. The key issues for the community are concerns about water and the need to maintain a long term sustainable water resource.

Council raised concerns about the Voluntary Planning Agreement process noting that it yields inconsistent results. In this instance Council indicated that the applicant has been reasonable, but advised it has had issues with other companies.

Gunnedah's population and economic decline in the 1990s, was noted and attributed to the loss of the abattoir, combined with drought and then the impact of flooding, along with earlier closure of some underground mining operations in the area. Certain Councillors support any opportunities for young people in the community and for the overall survival of the town. It was suggested that the community was largely interested in making a living. It was noted that the mine would not only include positives, pressures on infrastructure were predicted. The visual and water impacts seen in the Hunter region were of concern to Council. The apparent success of some of the rehabilitation efforts undertaken at some more local mines was also noted.

Council noted that an air quality monitoring network needs to be established now, so baseline data can be collected, before air quality issues potentially arise. Council suggested that the Upper Hunter Air Quality Network has set a precedent for this level of monitoring. Council indicated the mines should fund the network, but that it needed to be overseen by government.

In relation to Koalas Council indicated there has been a lot of work done in the area, including an analysis of population numbers and more recently a koala management study and plan are being developed. Council indicated it had a health koala population, but that drought caused a decline and numbers are potentially overestimated in some areas now. Council agreed it would supply some supplementary information to the PAC on the koalas in the next couple of weeks.

Council reemphasised the impact of the drought in the 1990s and indicated that the town needs a diversity of jobs. Gunnedah was said to be the oldest coal mining town in the region, with farmers and miners working together historically, although it was noted mining was mainly small underground operations previously.

In relation to the conditions recommended by the Department of Planning and Environment, Council raised concerns with the use of 'negligible' in relation to groundwater. Council also noted the conditions did not specify timeframes for the VPA.

Meeting with Liverpool Plains Shire Council representatives, 26 June 2014

Council noted that although the mine would not be in its LGA, the Shire will be impacted by the mine.

Council is supportive of sustainable development, in this instance it is concerned about the water balance and the potential for impacts on the black soil plains. Council acknowledge that no one can give guarantees and indicated the applicant has done all it can to be sure of the impacts.

There is planning approval for a MAC Village at Werris Creek. The social and road impact of 1,500 people was noted.

Council noted that there is potential to have coal trains running past every ten minutes, with delays at rail crossing of 5 -6 minutes an issue for emergency vehicles. Council advised that overpasses or bypasses of major towns were needed. Council also noted concerns about dust and noise impacts of trains travelling through residential areas.

Council indicated that in general the community is looking forward to the extra jobs the mine would produce.

The Council believe that more mine workers will live in the Liverpool Plains LGA, rather than Gunnedah – as the Liverpool Plains LGA is closer.

Council is concerned about the costs it will incur in handling complaints about the mine and wants compensation for this.

In relation to the Voluntary Planning Agreement – it noted that the costs for the indoor sports stadium were agreed to in 2012, but that it wants to revisit this as costs have gone up since then.

Council also raised concerns about the impact on roads – particularly noting that workers travelling between the Mine and Tamworth would use roads in the Liverpool Plains Shire Council roads. Council is concerned directions regarding travel routes would be hard to enforce and is sought contributions for mine related traffic.

In relation to the draft conditions before the Commission, the Council noted that the wording of conditions regarding the Community Consultative Committee did not specifically refer to Liverpool Plains Shire Council – only “Council” (which was understood to mean Gunnedah Shire Council). As the Council is currently represented on the CCC (and it finds it useful to be involved) it sought to have this specified in the conditions. The predictive nature of the economic and social impact modelling was noted and Council indicated it wanted to have a role in how these impacts are monitored and managed. Council noted that while it is keen to see the project proceed it is very divisive both in the school and business community.
<u>Meeting with Office of Agricultural Sustainability and Food Security representatives</u>, 3 July 2014 Two of the representatives present confirmed they had visited the site with the applicant and representatives for the Department of Planning and Environment. Was obvious when on site where the Liverpool Plains are and it’s clear the site is not on the Liverpool Plains, although it’s good quality agricultural land on the slopes. The Commission noted the applicant has proposed a 150 m buffer to the Liverpool Plains and sought the Office of Agriculture’s advice on whether this buffer would be sufficient. Office of Agriculture confirmed a buffer for soil is not meaningful, but would be important for the protection of groundwater aquifers – an area that the Office of Water would need to advise on. The importance of the water supply for agriculture was noted and the potential cumulative impacts on water were seen as the biggest potential issue for agriculture. The concern about the potential for future modifications or extensions to the mine to encroach on the black soil plains and associated water supplies was also noted. The applicant has justified its BSAL calculations based on the definition that was available at the time the field work was done, but this definition has since been updated. It was acknowledged that there has been a policy transition over the life of this application. The Office has accepted that while the BSAL information may not be entirely accurate, they don’t see BSAL as the only measure of the agricultural value of the site (although it is a particular focus for the Mining and Petroleum Gateway Panel). Having visited the site the office is satisfied it understands the soils on the site and it is clear the soil is not the highly productive black soils of the Liverpool Plains. Nonetheless the soils are reasonably good although represent a relatively small parcel of the broader agricultural region. The office is not convinced that mine sites can be successfully rehabilitated back to productive agricultural land. The detail of how this might be achieved is yet to be provided – in future management plans and the only example where any production has been achieved has not yet been proven to be stable and has required irrigation to achieve results. Of the eight concerns the Office raised in its correspondence in February, 5 have been included in conditions to ensure they are addressed
<u>Meeting with NSW Environment Protection Authority representative</u>, 15 July 2014 The Commission noted that the terms of reference for the review particularly refer to the health and amenity impacts of the project. The EPA advised it has considered the noise, dust, final void and water management for the project. Noise is typical of the area and the prevalence of temperature inversions would be an issue for managing noise. The Land and Environment Court decision on Warkworth was noted and the EPA advised that the review of noise policy is ongoing. The EPA advised it has been firm in requiring all reasonable and feasible measures to be included in the project. As a result of the additional measures the applicant has now committed to, particularly the use a smaller number of larger trucks, the mine has nearly halved the number of residences that would be significantly impacted. The EPA highlighted that the mine was predicted to exceed the standard noise levels in certain years – rather than all years and that if higher noise levels were to be set, these should only apply during those smaller number of years when the impact is predicted to

occur – rather than the full 30 year life of the mine.

Other options considered, including noise bunds and additional cladding of the Coal Handling and Processing Plant would not provide significant improvements. The CHPP is a very low noise contributor. Due to the topography of the area, the development of noise bunds would be likely to produce just as many impacts as they are predicted to save. The EPA indicated it is generally satisfied the applicant has done all that is reasonable and feasible in the traditional sense to minimise noise and dust impacts, apart from the adoption of new technologies which can be conditioned.

The EPA advised there would be opportunities to identify further ways to reduce impacts during the 30 year life of the mine and particularly during first 5 years before many of the residences are predicted to receive greater impacts. The EPA indicated it would push for ongoing consideration of ways to provide constant improvement. Options for a regular review (every 2-3 years) of compliance, new technologies and opportunities to improve performance in relation to noise and dust was discussed.

The EPA had some concerns that the applicant may not understand that predictive and real-time monitoring and management may require complete shutdown of the mine in certain situations. The Commission agreed this is now a standard requirement for mines.

It was noted that the water available to the mine may not be sufficient for dust management at certain times. The EPA confirmed that the applicant has options to use chemical suppressants and/or scale back mining operations if the water available for dust suppression is not adequate.

The design for a regional air quality monitoring network was said to include a site that is remote from mining.

Blasting impacts were expected to be typical of mining. Mines should be required to monitor NOx emissions and the EPA indicated that regulation of NOx emissions is currently being considered by the EPA with a view to develop some licence conditions for NOx.

The Commission noted the Draft Assessment undertaken by the Department of Planning and Environment discusses the regulation of noise and dust impacts on land that is not occupied by a house. The EPA advised its limits generally apply to residences.

The lack of any formal policy on final voids was noted.

The Commission noted that some farmers are concerned about the potential for the mine to discharge saline water. The EPA confirmed it has looked at the proposed water balance and understand the mine would store any excess water in pit. It was noted that this may impact on the operations of the mine. The EPA advised any discharge point licenced would be for diverted runoff water from sediment dams, rather than dirty water that had entered the pits.

Meeting with Office of Environment and Heritage representative, 15 July 2014

Commission noted that questions have been raised about the size of the koala population in question.

OEH advised it doesn't have a population number, but that more important than the population size is the management response. OEH previously made this point to Gunnedah Council regarding the broader population, noting that the regional vegetation mapping was insufficient to inform the Council's proposed Koala Plan of Management. OEH is soon to release a vegetation mapping base layer for exhibition which will help with this.

The ARC Linkage study that is supported by the applicant will provide landscape context to better define the critical refuge habitats and populations.

OEH advised it is generally satisfied with the overall package provided in the Koala Plan of Management. It will be critical that the management and monitoring is publicly available with updates provided at least annually and perhaps more frequently.

Had thought that Offset area 6 would provide some good habitat and connectivity for Koalas but this has changed with the removal of the BSAL from the offset area.

The applicant will still need to apply for translocation approval for the Koalas.

The potential for any further work to be done prior to the determination of the application was considered and the establishment of a Koala Management Working Group was agreed to be something which should be developed as early as possible.

Key threats to Koalas were suggested to be habitat fragmentation, roads, dogs, drought and the cumulative effects of all of these.

OEH emphasised the need to establish baseline data for koalas on site and at any proposed translocation sites as early as possible.

The process for the Koala Management was said to have been developed, however there are some uncertainties in relation to timing and the draft conditions don't appear to have adopted certain aspects of the plan – such as the working group.

The Commission noted that the koalas are important, including in this location and that the correct mechanisms will need to be provided to ensure the best management of the koalas.

The Commission noted that as there are three separate pits there are opportunities to identify milestones that need to be achieved, linked to the various phases of the project.

In relation to biodiversity issues more broadly, OEH confirmed that the only residual issue is the Koala Plan of Management, as it is satisfied with the broader biodiversity offset arrangements being provided. In relation to the management of the koalas there is no clear preferred approach, so the plan will need to be adaptive and supported by rigorous publicly available monitoring results. The governance model is seen as a critical issue

Meeting with NSW Office of Water representatives, 15 July 2014

The NSW Office of Water representatives assured the Commission that the water impacts of the project are expected to be manageable. The Office of Water acknowledged there is always some level of uncertainty in any modelling undertaken, but emphasised that the model is not a static piece of work, rather that it would be refined over time as monitoring results become available. In this regard there are said to be some advantages to the sequence of mining proposed. The Office of Water explained that the eastern and western pits are expected to have lower levels of water impacts. As mining would commence in the eastern pit, before moving to the southern pit, the Office of Water considered that the mine could be adaptively managed in response to any unexpected monitoring results. The Commission was advised that the water monitoring regime and mine response mechanisms would be a critically important aspect of the mine's operation.

The Commission noted that the NSW Irrigator's Council had engaged a groundwater engineer. The concerns raised by the groundwater engineer, about the information provided on water impacts, were provided to the NSW Office of Water for consideration prior to the meeting.. The NSW Office of Water had considered the concerns raised and discussed each one. Ultimately the representatives advised that NOW did not consider these issues to be of consequence at this stage, reiterating that monitoring information and adaptive management would be available as mining progressed.

Record of site inspection and briefing from the applicant, Wednesday 25 June 2014

Attendees during the site visit and/or briefing representing the applicant where:
Mr Liu Xiang – Chairman; Mr Wang Ningbo – CEO; Paul Jackson – Project Manager; Mark Howes – Environmental Manager; James Bailey – Hanson Bailey – Consultant; Dianne Munro – Hanson Bailey – Consultant; James Tomlin – AGE – Water Sub-Consultant; Clayton Richards – SLR – Soil Sub-Consultant; Katrina Wolf – Cumberland – Koala Sub-Consultant; Melissa Walker – GHD –Sub-Consultant; Debbie Watson – Community Liaison Officer – Event Co-Ordinator/Driver; Zhao Liang – Mining Engineer – Translator; Grayson Wolfgang – Asset Management Co-ordinator – Driver; Jiao Zongfu – Senior Geology Manager – Geology advice; Li Gen – Senior Mechanical and Electrical Manager – Observer; Lijie Liu – Senior Mining Manager – Observer

The applicant gave an overview of the project, escorted the Commission to one of the grinding grove stones on the site and accompanied the Commission across the site and along local roads through the site. The presentation provided by the applicant is available on the Commission's website for the project, see www.pac.nsw.gov.au.

Record of inspections with the NSW Land and Water Commissioner, Monday 7 July 2014
In addition to inspecting the area from public roads the NSW Land and Water Commissioner also arranged for the Commission to visit two private properties which provided a good vantage point of the region and views of the mine site from the black soil plains. Attendees at those properties were: Mr Andrew Pursehouse, Mr Tim Duddy, Ms Susan Lyle and Ms Juanita Hamparsum These representatives provided some description of the topography, water systems, geology and soils. As expressed during the public hearing, these representatives also raised their strong concerns about impacts on water resources, as well the potential for dust to impact on agricultural production. The NSW Land and Water Commissioner, Mr Jock Laurie reiterated the importance of the black soil plains and water resources. The Commissioner highlighted this mine's location above the black soil plains. The Commissioner also noted the local concern about dust impacts on production, noting potential risks were both to impeding plant growth and to contaminating crops.

Appendix 4

Independent Expert Advice to the Commission from Dr Colin Mackie

Mackie Environmental Research Pty. Ltd.
ABN 62077235164

193 Plateau Rd.
Bilgola NSW 2107

Telephone: **(02) 89190182**

Planning Assessment Commission
GPO Box 3415
Sydney NSW 2001

14/08/2014

Att. G. Kibble AO, G. Payne AM, B. Gilligan

Re: Proposed Watermark Coal Mine – Groundwater Environmental Impact Assessment

Further to instructions, I have conducted a review of the reported groundwater impacts associated with the Shenhua Watermark Project. The proponent Shenhua Watermark Coal P/L (SWC) has prepared a detailed Environmental Impact Statement that provides information relating to aquifer mapping, strata hydraulic properties testing, design and development of a groundwater flow model, simulation of mining operations and quantification of groundwater related impacts. Since the model is the platform from which all impacts have been assessed, I have essentially overviewed the translation from a conceptual groundwater flow model to the numerical model, and undertaken an appraisal of the numerical model. This has necessarily included a check of model input and output computer files.

In preparing this report, I have included descriptions of various model attributes or processes, and commentary associated with a number of concerns which I have numbered for referencing purposes. In addition, I have attempted to expand upon the responses to questions formerly put to the proponent in relation to the modelling process[1].

1. Background to groundwater flow modelling

There are two main groundwater systems:

- ***the unconsolidated Upper Namoi alluvial systems*** of Quaternary-Tertiary age comprising the Narrabri Formation and the older Gunnedah Formation. The Narrabri Formation is reported to behave as an aquitard due to the high silt and clay content. In contrast, the underlying Gunnedah Formation is recognised as a major aquifer comprising a mixed assemblage of gravels, sands and silts and offering high storage and recharge characteristics. The systems are exploited for irrigation water supply;
- ***the consolidated (hard rock) Permian coal measures*** comprising interbeds of sandstone, siltstone and claystone, together with the main coal seams. These strata generally exhibit low storage and slow recharge characteristics. An exception is the Clare sandstone which apparently exhibit increased storage and higher permeabilities compared to the remaining Permian strata.

The proposed mining operations include three open cut pits – the Eastern Pit , the Southern Pit and the Western Pit (see Figure 1) which will be excavated in that order. On completion of mining in the Eastern Pit, waste rock from the Southern Pit will be dumped in the Eastern Pit void. Dumping will continue until the Eastern Pit final landform is established at elevations that will be higher than the pre-mining landform. There will be no open water void in this pit. The same process will be repeated in the Southern Pit while the Western Pit will retain an open water void.

[1] Questions put to the proponent are attached while responses are contained in a letter prepared by AGE, addressed to Shenhua Australia, dated 22/07/14, and provided to the PAC.

The total duration of mining is approximately 30 years comprising 17 years in the Eastern Pit followed by 7 years in the Southern Pit followed by 6 years in the Western Pit.

The mine pits are situated on elevated Permian hard rock terrain while the surrounding broad valleys host the unconsolidated alluvial systems. The Eastern and Southern mine pits will have a minimum pit crest set back (buffer zone) from the Narrabri Formation about 150 m[2]. A much greater setback prevails for the underlying Gunnedah Formation. Western pit is at least 3 km set back from the Narrabri Formation.

The Eastern Pit will be mined down to an elevation of about 225 mRL. The nearest alluvial lands to this pit are located to the north-east and host a water table at an elevation of about 265 mRL. Consequently the mine pit will generate a groundwater sink with a maximum head difference of about 40 m. Southern Pit will be mined down to an elevation of 195 mRL. The alluvial lands to the south of this pit host a water table at an elevation of about 290 mRL resulting in a groundwater sink with head difference of about 95 m. Western Pit will be mined down to an elevation of about 245 m resulting in a groundwater sink with only a small head difference with respect to the alluvial lands. Southern pit is considered to be the dominant groundwater attractor and the pit most likely to induce the highest drawdowns in the alluvial systems. In order to assess the cumulative impacts of these three pits on the regional groundwater resources, the proponent has developed a conceptual model and a numerical groundwater flow model.

Figure 1: Project area and pit locations (from EIS Figure 9)

2. The conceptual flow model

The conceptual model prepared by Australian Groundwater and Environmental Consultants (AGE) is summarised in the following Figure 2. Fundamentally, rainfall and runoff provide inflows to the groundwater system by recharging the alluvial and hardrock aquifer systems through a process of infiltration and percolation through the vadose zone. While evapotranspiration acts to reduce the rate of percolation through the shallow soil zone, periods of sustained rainfall ultimately result in additions to groundwater storage. Falls in groundwater storage occur where pumping bores draw groundwater. Future falls in storage will occur when the mine pits penetrate the water table and act as drains or sinks.

[2] The actual set back may be higher if the pit floor is taken as the reference point See AGE, 2013 page 42

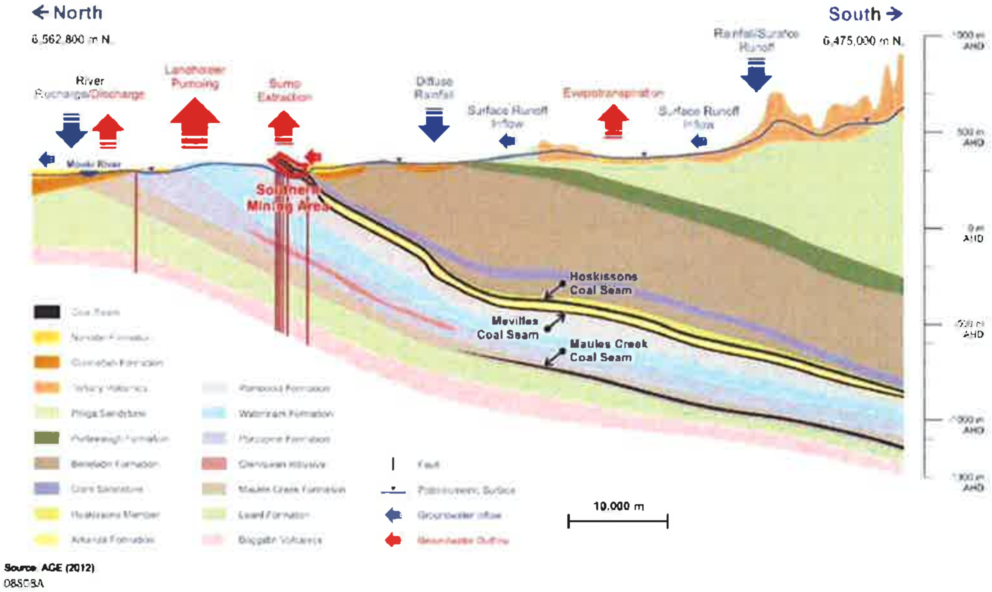

Figure 2: Conceptualisation of surface water and groundwater systems (EIS Figure 26)

Reductions in pore pressures within specific strata like the coal seams will induce groundwater flow (often described as leakage) from adjacent strata. This conceptualisation is standard.

3. Groundwater flow model

There are essentially three stages of numerical modelling that include:

1. a pre-mining calibrated model on which the mining process is imposed;
2. a mining process model representing the development of the three mine pits;
3. a post mining model that examines the period of water table recovery.

3.1 Pre-mining calibrated model

The groundwater model utilises a finite difference based scheme known as Modflow Surfact and simulates a vast area of some 6825 sq.km. The mesh accommodates 11 layers with cells of differing dimensions across the model. Finer discretisation has been adopted in the horizontal plane in areas around and close to the proposed mining area where 50 x 50 m cell dimensions have been uniformly employed. More distant areas host cells with much larger dimension (500 x 500 m). In the vertical plane, the discretisation varies from about 1 m cell thickness where layers pinch out, to more than 50 m thickness in some areas.

The model covers an exceptionally large area presumably to ensure that the Namoi alluvial aquifer systems are completely included. Given the proposed depth of mining below the water table, it is improbable that impacts would ever extend to the model boundaries. Hence large areas of the model could be regarded as superfluous to the assessment of impacts. While this is unlikely to affect model predictions, it undoubtedly results in longer model run times than might otherwise be the case.

The Modflow Surfact code has been used in the unsaturated-variably saturated mode meaning the vadose zone or zone above the water table has been simulated using the so called van Genuchten parameterisation. This type of simulation presents significant challenges since not only are the standard groundwater flow parameters required, but an additional suite of parameters characterising the vadose zone are also required. The standard saturated zone parameters include horizontal and vertical hydraulic conductivity (Kh, Kv), elastic storage (Ss) and specific yield (Sy) while the additional parameters include air entry (α), desaturation rate (β) and residual saturation (Rs).

The saturated zone parameters have been assessed through extensive field testing which has included falling/rising head tests, short term pumping tests, packer tests and airlift tests. Laboratory core testing has also been conducted in order to understand the likely lower bound for strata hydraulic conductivities in the absence of fracture enhancement. The overall database for saturated zone properties is reasonable. In addition, a number of historical groundwater studies in the region have apparently provided additional data. The areal distribution of these material properties has been further assessed through the model calibration process.

Concern 1: In contrast to the saturated zone properties, there is no reference anywhere in the EIS to the vadose zone parameters yet they are fundamental to the operation of the model and prediction of the water table. The same parameter values have also been assigned to all layers of the model which seems counter-intuitive since there are notable differences in lithologies and in the measured hydraulic properties of different strata under saturated conditions. I am not aware of any testing pertaining to the Namoi alluvial aquifers to support the adopted vadose zone values, nor any data to support these same properties in consolidated rocks like the Clare Sandstone or the coal seams. The adopted values are considered to be based entirely on conjecture while the use of the same properties for all strata has no factual basis.

In support of the adopted van Genuchten parameters and in response to questions put, the proponent has indicated that '*the drain boundary condition is the dominant influence on the simulated water levels, not the unsaturated zone parameters. It is only relatively distant from the drains cells representing mining that the influence of the hydraulic parameters becomes more influential on the predicted water level*'[3].

This perspective conflicts with the commonly held view that both saturated and unsaturated zone properties can influence to varying degrees, the calculation of the water table at any location in a groundwater model which is not a prescribed head boundary condition. By way of example, Figure 3 illustrates a simple vertical section Modflow Surfact model with saturated flow parameters in a broadly similar range as the Watermark model and unsaturated flow parameters identical to that model. A pre-mining water table has been uniformly set at an elevation of 110 m and a mine pit with a minimum elevation of 20 m has been represented by 'drain' cells at the left end of the section. A pore pressure distribution (contours in metres pressure head of water) has been calculated at 1000 days after commencement of mining. Figure 3 shows the water table defined by the zero pore pressure contour rising steadily away from the pit.

Figure 4 shows the same saturated zone parameterisation but with different van Genuchten parameters applied to the unsaturated zone. Clearly the zone near the mine pit shows a different water table geometry to Figure 3 indicating that the water table is influenced in this case by the van Genuchten parameters.

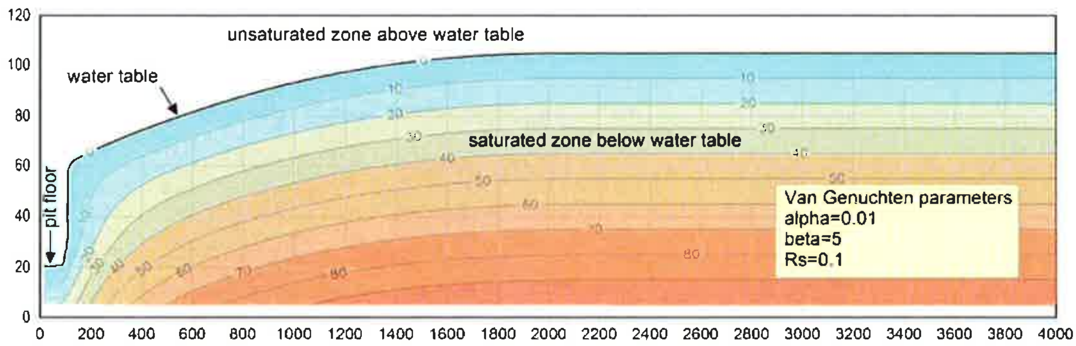

Figure 3: Vertical section model illustrating the water table after 1000 days for the nominated van Genuchten parameters

[3] see Question 3 response in AGE, 2014

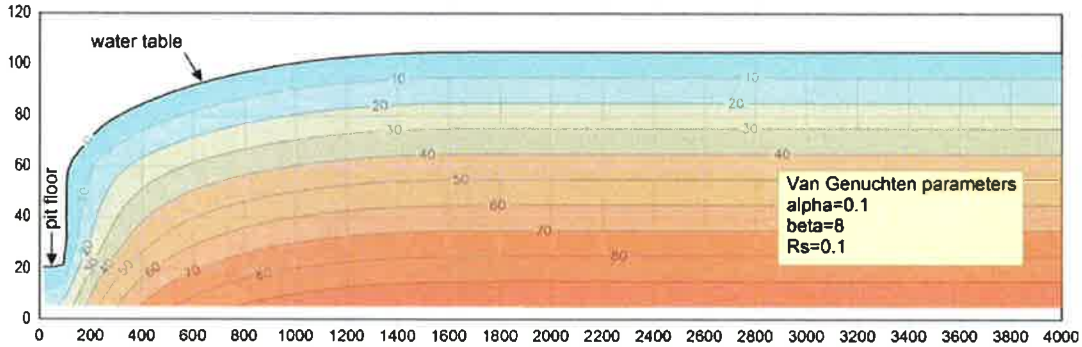

Figure 4: Vertical section model with different van Genuchten parameters and different water table geometry

3.2 Mining process model

The mining phase model adopts the pre-mining model water table as the starting position. The mining model utilises a so-called 'drain' boundary condition to represent the removal of groundwater from model cells located within the proposed mine pit areas. This type of boundary mimics an agricultural drain and the manner in which it operates is illustrated in the following Figure 5. Basically the rate of removal of groundwater is governed by a cell conductance term and a pressure head which is calculated by the model. This pressure head is the difference between the head in the aquifer and a prescribed drain elevation.

Drain cells representing the open cut pits in the Watermark model have been assigned to all model layers from surface down to and including the Melvilles seam (model layer 10) with activation times aligned with the planned stripping schedule for each pit. Hence 10 of the 11 model layers within each pit become 'dry' at some stage.

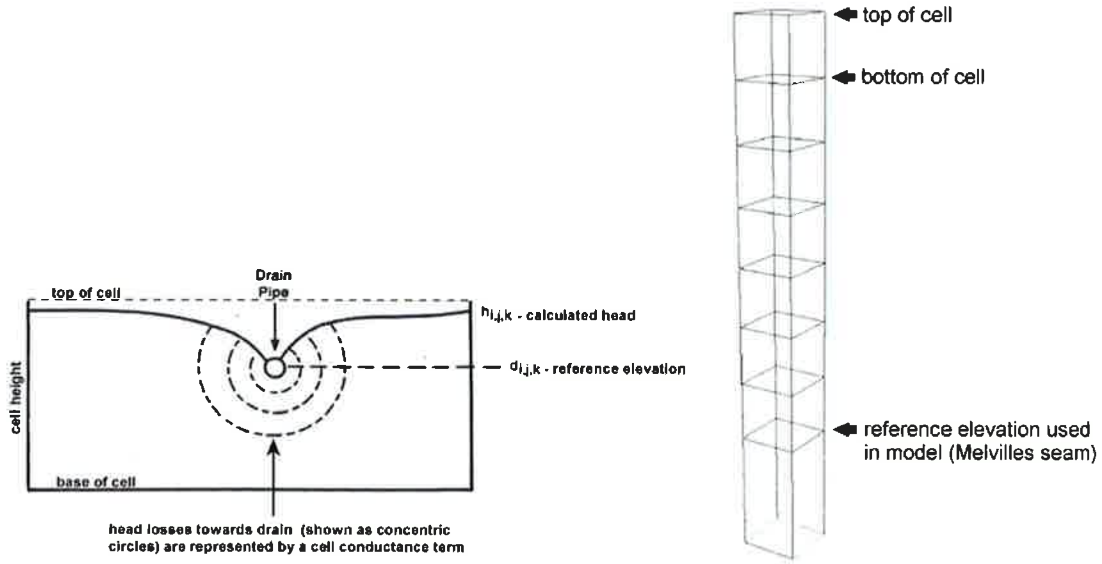

Figure 5: Cross section (left) through a drain cell showing the calculated head ($h_{i,j,k}$) and the reference elevation ($d_{i,j,k}$) from the Modflow reference manual. A vertical column of cells (right) shows the adopted reference elevation in the Watermark model.

Concern 2: Inspection of the supplied model data files reveals the reference elevations of drain cells within each of the mine pits have been set to the lowest drain cell (layer 10 - Melvilles seam) of a vertical column of cells. That is, for all drain cells above layer 10, the reference elevation is below the base of the cells. This is an unconventional use of drain reference elevations that may lead to quite different outcomes in either the calculated heads or the volumetric balances of the model, or both when compared to the conventional assignment of drain elevations. The conventional procedure requires the reference elevation to be set at or above the bottom of the cell in which a drain boundary is specified. Indeed the popular Graphical User Interfaces (GUI)[4] for Modflow Surfact normally warn the user if the reference elevation is set below the base of the cell.

As mining progresses down dip in each pit, the pit shell will be backfilled with waste rock material. This process has been simulated by stopping the EIS model every 3 months, resetting both the hydraulic properties in cells consumed by spoils and rainfall recharge to these same spoils emplacement areas, and introducing additional drain cells scheduled for mining in down dip pit areas. This procedure has resulted in partial recovery of water levels in modelled spoils immediately up dip of simulated mining and probably contributes to the rapid recovery of pit water levels reported in the EIS. This recovery could have a direct impact on the regional drawdown by prematurely halting outward expansion of the depressurisation wave that might otherwise occur in dry and drought periods which are evident in the historical rainfall record.

Southern Pit appears to be the pit that has the potential to induce greatest drawdown impact on the surrounding alluvial aquifers. It is also the nearest pit to a bore water supply identified as GW0155505. In response to a formal request, the proponent prepared two vertical cross sections through the Southern pit – one for the mining model presented in the EIS which includes recharge to spoils, and one for a simulation that does not include recharge to spoils and is identified as the Watermark Staged Transient (WST) simulation.

Concern 3: Figure 6 represents the EIS model with pore pressures indicated by the white contours. Close inspection of the zero pore pressure (water table) contour in the Southern Pit shows a highly erratic surface. Normally a relatively smooth surface that reflects the floor of the mined coal seam, would be expected (see Figure 7 for dewatered pit profile). The erratic surface identified in Figure 6 may be indicative of more general problems possibly associated with recharge to spoils, or to unconventional assignment of drain cells or possibly discretisation issues. It is important to identify the reason for this behaviour since it may have implications for regional water table drawdown and mine water inflows.

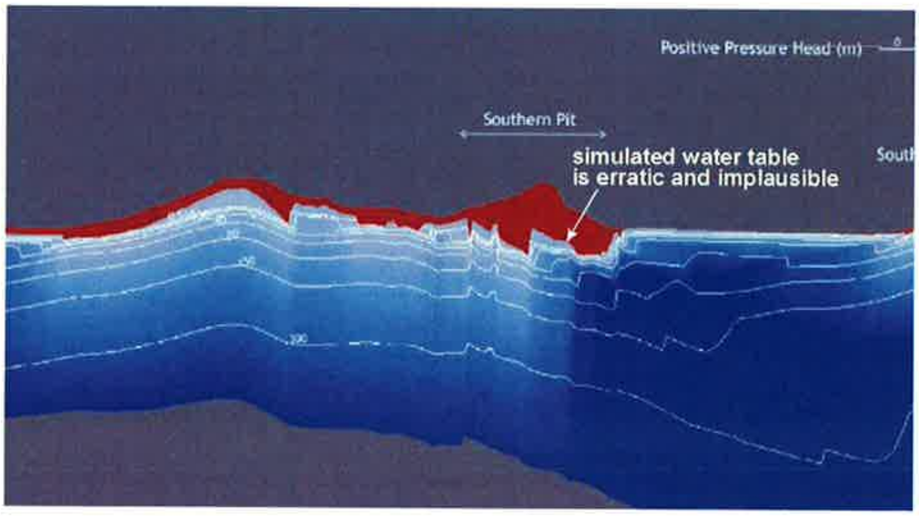

Figure 6: EIS Mining model provided by the proponent showing the vertical pore pressure distribution

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[4] A GUI is a software program that assists in the assembly of the model data files by providing graphical representations of the data, and option menus for data inputs instead of purely text based entries.

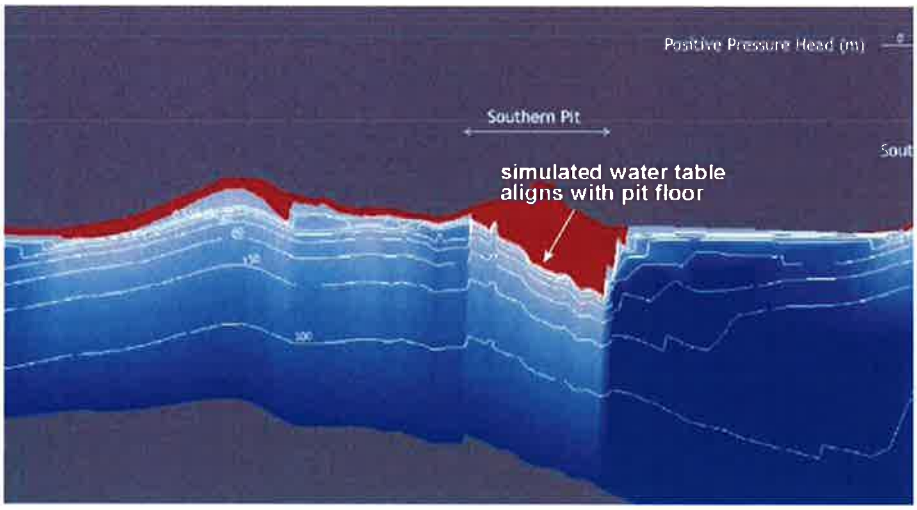

Figure 7: WST model cross section provided by the proponent showing the vertical pore pressure distribution without recharge to spoils

Mine water inflows for both the EIS model and the WST model have been prepared by the proponent and are represented as Figure 8.

Concern 4: While the EIS model inflows exhibit a relatively smooth trend line, the same cannot be said for the WST model where highly erratic behaviour is evident for the Eastern and Western pits. This erratic behaviour includes correlatable 'spikes' in the inflows across all three pits simultaneously (red arrows) suggesting underlying instability or abnormal behaviour in the model which needs to be resolved.

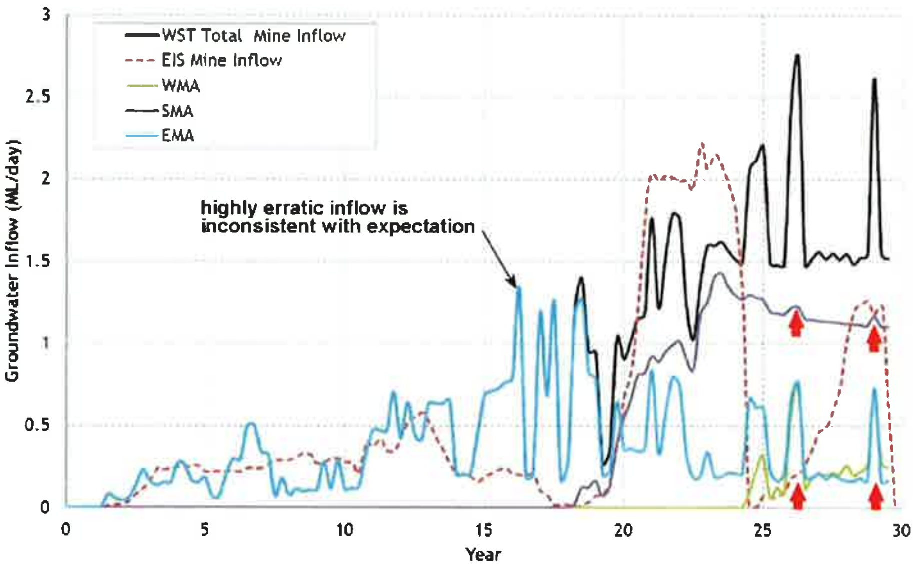

Figure 8: Pit inflows generated by WST model showing highly erratic behaviour. Note the simultaneous occurrence of inflow 'pulses' across all three pits (red arrows).

3.3 Recovery model

The recovery models are transient simulations but these simulations may not provide the ultimate a steady state within the simulation period. Since it is desirable to understand the long term (ultimate) impacts of mining on the regional groundwater systems, a steady state simulation would be useful.

4. Conclusions

I have carefully considered the groundwater flow models and the responses to questions put to the proponent in respect of certain attributes of those models. Given the uncertainty associated with a number of these (and other) attributes, I am unable to accept that the reported groundwater head equipotentials, drawdowns, pit inflows and water table recovery estimates calculated by the proponents models, properly represent the impacts on the groundwater systems that would arise from the project.

The following course of action is recommended to resolve the uncertainties:

1. The WST model be run with drain reference elevations set at or just above the base of respective drain cells;
2. The WST model be run using the variably saturated 'pseudo soil' option available within Modflow Surfact thereby negating the need for vadose zone parameters (drain reference elevations unchanged);
3. The WST model be run using both the pseudo soil option and the adjustments to drain reference elevations.
4. A steady state recovery model simulation be run to assess long term impacts.

If outcomes from the above differ significantly when compared to EIS reported outcomes, then it may be necessary to re-visit regional drawdown impacts, pit inflows and implications for the mine water management system.

Yours sincerely

Mackie Environmental Research Pty. Ltd.

C. Mackie

References:

AGE, 2014. Letter addressed to Shenhua Australia, dated 22/07/14, and provided to the PAC as the response to questions raised by Mackie Environmental Research.

Watermark Coal Project – Environmental Impact Statement, February 2013 (main volume) authored by Hansen Bailey P/L;

Watermark Coal Project – Environmental Impact Statement (Appendix S) Surface Water Impact Assessment, February 2013 authored by WRM Water and Environment P/L;

Watermark Creek Coal Project – Environmental Impact Statement (Appendix T) Groundwater Impact Assessment, January 2013 authored by Australian Groundwater and Environmental Consultants P/L;

Watermark Coal Project – Environmental Impact Statement (Appendix W) Geochemical Assessment of Overburden/Interburden and Coal Rejects Materials, February 2013 authored by RGS Environmental P/L;

NSW Planning and Environment – State Significant Development Assessment Watermark Coal Project (SSD-4975), May 2014

Mining and Petroleum Gateway Panel – Shenhua Watermark Coal Project Advisory Report

Kalf and Associates Pty. Ltd., Shenhua Watermark Coal Project – Adequacy review of groundwater assessment Stage 1. Prepared for Dept. of Planning and Infrastructure, December 2012

ATTACHMENT 1 – Questions prepared by Dr. C. Mackie, Mackie Environmental Research, 16/07/2014

QUESTIONS RELATING TO GROUNDWATER IMPACT ASSESSMENTS
WATERMARK PROJECT

The focus of my review is the groundwater model that underpins all predictions of groundwater related impacts for the project. This type of review necessarily requires checks on the model structure, material properties, boundary conditions and solution convergence error bands.

The modelling process undertaken by the proponent has comprised three stages (1) a pre-mining steady state simulation to generate a pre-mining water table, (2) a simulation of 30 years of mining that included material properties and rainfall recharge changes to reflect emplaced spoils, and (3) a post mining transient recovery model.

On 20th June a request was made to the proponent for an additional groundwater flow simulation model to be run. That model in contrast to the reported model, did not include spoils material properties changes. Instead it assumed that no recovery of groundwater levels occurred in any mine pit during the 30 years mine life. This scenario was considered to reflect a plausible low rainfall recharge case. In order to minimise confusion I refer to this requested model hereinafter as the Watermark Staged Transient (WST) simulation while the EIS model is simply referred to as the 'reported' model.

I have assumed that the models supplied to me (as data files) have been assembled in a diligent manner having regard for the layer geometries, material properties distributions, boundary conditions (including operational constraints) and iterative solver convergence parameters and volumetric balances.

Questions arising from the review to date are as follows:

> Comment 1 - The model data files indicate all simulations have been conducted assuming saturated-unsaturated (vadose zone) flow conditions. Vadose zone modelling normally requires a very high level of discretisation in the model grid with cell dimensions typically being sub metre. Indeed benchmark studies generally have cell dimensions which are sub deci metre (0.1m) in order to determine the water table elevations and associated saturations. The Watermark model clearly exceeds these dimensions.
>
> Question 1: What assurance can the proponent give that the model grid is sufficiently discretised to generate estimates of the water table, pressure head distributions and saturations with reasonable accuracy?
>
> Comment 2 - The proponent has directed a considerable effort towards parameterisation of model layers. These parameters include horizontal and vertical hydraulic conductivity (Kh, Kv), elastic storage (Ss) and specific yield (Sy)[5]. The model data files indicate all simulations have been conducted using the so called Van Genuchten parameterisation for the vadose zone which includes a further three parameters - air entry (α), desaturation rate (β) and residual saturation (Rs). There is no reference in the report to these three parameters yet they are fundamental to model operation and prediction.
>
> Question 2a: Can the proponent provide relevant test data in support of the adopted Van Genuchten parameterisation?
>
> Comment 3 - A check of the model data files indicates the above noted Van Genuchten parameters are the same value for every model layer ie, α=0.01, β =5, Rs=0.1. This uniform assignment of properties seems counter intuitive since both the geological conditions and the saturated hydraulic properties (Kv, Kh, Ss, Sy) differ from layer to layer.
>
> Question 3: Can the proponent provide an explanation as to why the values are identical across all model layers?
>
> Comment 4 - The reported model simulates each of the mine pits with hydraulic properties changes to represent spoils emplacement and re-saturation as mining progresses. This has been implemented by sequentially stopping the model calculation process, modifying relevant

[5] See Table 9.2 page 150 of AGE,2013 for adopted model parameters.

model cell properties then initiating the subsequent stage by assigning the model head distribution from the previous stage[6].

Question 4: How was the saturation distribution (normally output in the .DDN file for vadose zone simulations) re-entered for each stage of the simulation period?

Comment 5 - South Pit appears to be the pit that has greatest drawdown impact on the surrounding alluvial aquifers. It is also the nearest pit to a bore water supply identified as GW0155505.

Question 5a – Is the drawdown plot at 30 years derived from the WST model and provided as drawing G1501 pac-review_30Y_DD (pdf file) a representation of the water table noting that the Gunnedah Formation (drawing title) is not continuous across the region?

Question 5b – How was the drawdown calculated?

Question 5c: Could the proponent provide a vertical section plot for the reported prediction model at the cessation of all mining, aligned between E245670,N6524200 and E245670,N6548200 (model column 125) and showing zero pore pressure (water table) and all positive pressures as contours?

Question 5d: Could the same section be generated for the requested WST simulation model that does not include material property changes (ie continuous simulation), at the cessation of all mining?

Question 5e: As a means of checking both model outputs could the proponent also provide a cross section between the same coordinates for each of the above noted models, showing saturation and particularly the shallowest 100% saturation horizon (approximating the water table)?

Comment 6 - Interrogation of the recovery phase of the reported model at selected model cells located within West pit indicates rates of water table recovery that seem implausible. For example, the recovery response at the model cell located at the intersection of row 92 and column 69 (see Figure 1 below) indicates just 1 day into the recovery phase, a water table elevation that is about 13 m above the pit floor (see Figure 2 below).

Question 6a: What are the model factors that promote this extraordinarily rapid recovery?

Question 6b: Can the proponent provide examples of other mine voids of similar scale that have exhibited such rapid recoveries?

Question 6c: Do similarly rapid recoveries occur in the East and South pits?

Question 6d: Would a slower rate of recovery have implications for the regional water table drawdown?

[6] See Section 10.3.8, page 269 of AGE, 2013

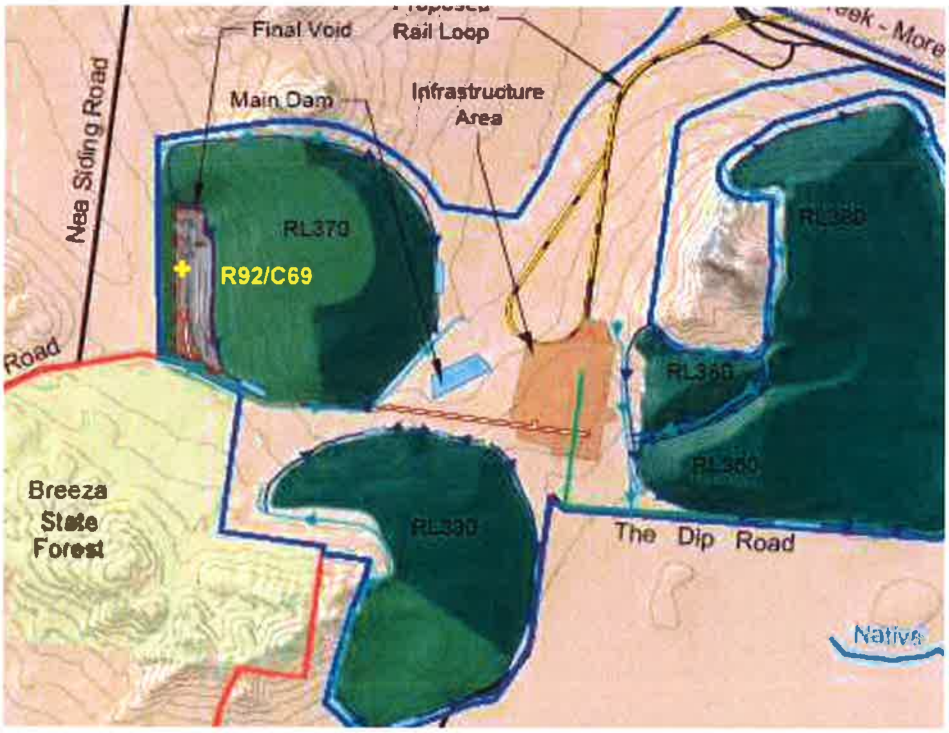

Figure 9: Approximate location of observation point R92/C69 for pit lake recovery

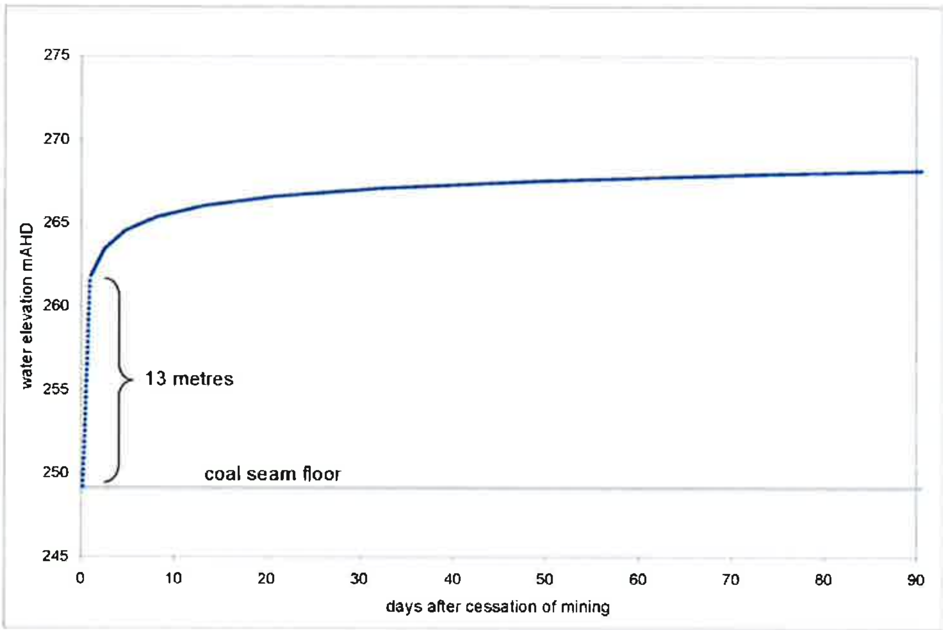

Figure 10: Water table recovery trend at R92/C69 extracted from the supplied recovery model HDS file

Comment 7 - West pit lake is reported to equilibrate at an elevation of 303m AHD[7]. This elevation is below the pit crest and consequently the pit lake is reported to act as a

[7] See Figure 10.43, page 267 of AGE 2013

groundwater sink. Figure 10.42 illustrates the contributing factors which include an evapotranspiration surface that extends across the pit floor post mining, rainfall recharge at a rate of 90% of annual rainfall to open void areas below the pit crest, rainfall recharge at 5.5% of annual recharge to the remaining spoils areas and continuing groundwater inflows from surrounding strata. The applied evaporation rate across the pit lake is stated to be 1972mm/annum or 12% higher than the pan evaporation rate of 1752mm/annum. This rate seems unusually high. A commonly accepted simple relationship between Pan evaporation and a surface water body exposed to the same weather elements (at surface) suggests pit lake evaporation is about 0.75 of Pan evaporation or about 1314 mm/annum. Evaporation from a partially recovered water body deeper in the pit would be expected to be lower since air movement is normally lower and humidity is often higher.

Question 7: Can the proponent provide measured data or references in support of the adopted pit lake evaporation rate being 12% higher than the pan rate?

Comment 8 – Figure 10.6[8] summarises the water make for each of the three mine pits for the reported model.

Question 8: Can the proponent provide a summary of mine water make to the different pits similar to Figure 10.6 for the WST model?

Comment 9 - There are numerous faults incorporated into the model which act to compartmentalise flows. These faults have been represented by the horizontal flow barrier package which requires specification of a parameter that incorporates the width and the hydraulic conductivity. It is reported that the conductivities of the faults were determined through the calibration process[9]. However inspection of the relevant data file (.HFB) indicates all faults have the same assigned conductance term (fault zone width x hydraulic conductivity) of 1.0E-8.

Question 9a: Are these values derived from the calibration process?

Question 9b: What field information supports the notion that the faults are flow barriers?

Question 9c: Would the regional drawdown induced by the mine pits in the WST model be greater if the fault-flow barriers were absent?

Comment 10: The model predictions of heads and fluxes assume the solutions are within acceptable error tolerances. That is, adjusting the parameters with the aim of reducing prediction errors further, should not lead to significant differences in predicted heads or fluxes. Acceptability of predictions is commonly assessed by examining the volumetric budget. However volumetric budgets can often be misleading. For example, the WST model simulation using the supplied parameter settings for the PCG5 solver (column 2 of Table 1) delivers volumetric budget errors in the range –0.05% to +0.05%. The resulting cumulative water make from all mine pits at the end of mining is 9189.73 GL (obtained from the .OUT file assuming drain cells are only associated with the mine pits). Adjusting the solver parameters to alternate values given in column 3 of Table 1, delivers volumetric budget errors that range from –0.04% to +0.03% with a significantly different cumulative water make of 7679.95 GL or about 16% lower than the above. Further adjustment on HCLOSE suggests an even greater difference.

[8] See Figure 10.6, page 218 of AGE 2013
[9] See Section 8.4.7, page 117 of AGE 2013

Table 1: Summary of parameter adjustments to PG5 solver

Parameter	AGE WST model	Re-simulation
MXITER – max. number of iterations	300	100
ITER1 – max. inner iterations	80	80
BFACT – back tracking factor	0.5	0.15
RESRED – back tr. force factor	10	0.5
HCLOSE – head change criterion	0.1	0.05

Question 10a: Were any similar comparisons of fluxes undertaken for the reported model?

Question 10b: If such differences are evident in the WST model, what are the implications for the reported model(s) in relation to regional groundwater impacts?

Question 10c: What are the implications for mine site water management?

Appendix 5

Dr Mackie's questions to the Applicant and the Applicant's response

QUESTIONS RELATING TO GROUNDWATER IMPACT ASSESSMENTS

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[1] See Table 9.2 page 150 of AGE,2013 for adopted model parameters.

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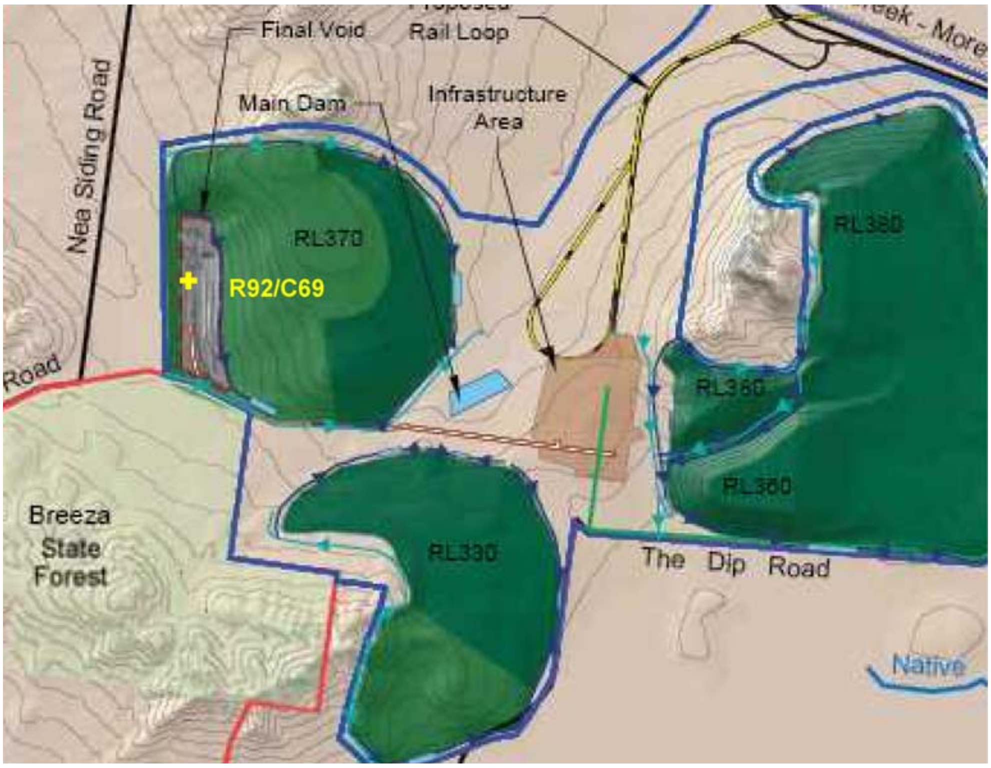

Figure 1: Approximate location of observation point R92/C69 for pit lake recovery

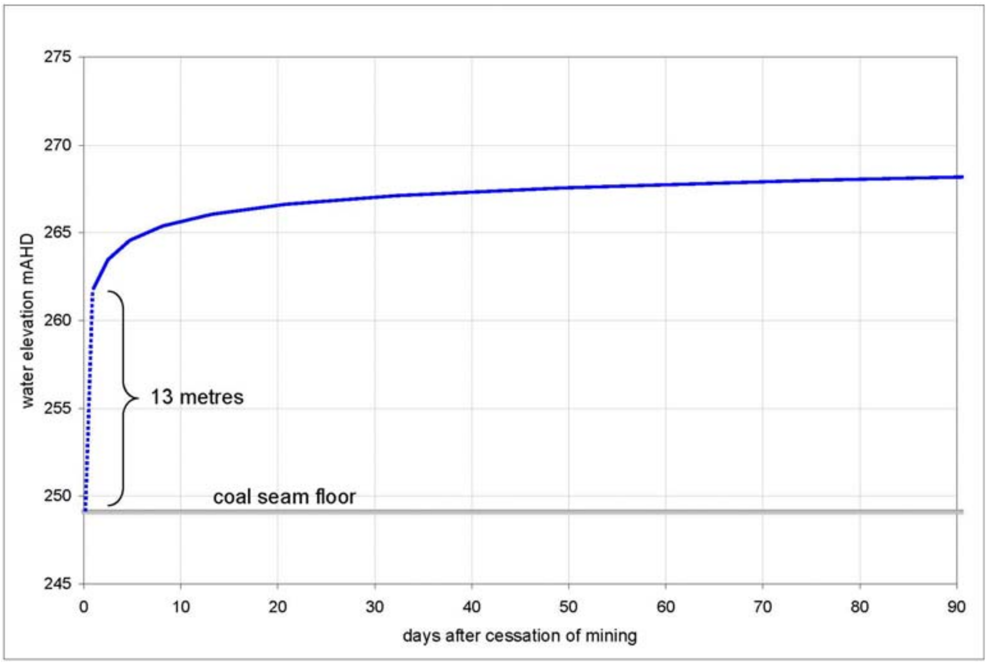

Figure 2: Water table recovery trend at R92/C69 extracted from the supplied recovery model HDS file

Comment 7 - West pit lake is reported to equilibrate at an elevation of 303m AHD[3]. This elevation is below the pit crest and consequently the pit lake is reported to act as a groundwater sink. Figure 10.42 illustrates the contributing factors which include an evapotranspiration surface that extends across the pit floor post mining, rainfall recharge at a rate of 90% of annual rainfall to open void areas below the pit crest, rainfall recharge at 5.5% of annual recharge to the remaining spoils areas and continuing groundwater inflows from surrounding strata. The applied evaporation rate across the pit lake is stated to be 1972mm/annum or 12% higher than the pan evaporation rate of 1752mm/annum. This rate seems unusually high. A commonly accepted simple relationship between Pan evaporation and a surface water body exposed to the same weather elements (at surface) suggests pit lake evaporation is about 0.75 of Pan evaporation or about 1314 mm/annum. Evaporation from a partially recovered water body deeper in the pit would be expected to be lower since air movement is normally lower and humidity is often higher.

Question 7: Can the proponent provide measured data or references in support of the adopted pit lake evaporation rate being 12% higher than the pan rate?

Comment 8 – Figure 10.6[4] summarises the water make for each of the three mine pits for the reported model.

Question 8: Can the proponent provide a summary of mine water make to the different pits similar to Figure 10.6 for the WST model?

Comment 9 - There are numerous faults incorporated into the model which act to compartmentalise flows. These faults have been represented by the horizontal flow barrier package which requires specification of a parameter that incorporates the width and the hydraulic conductivity. It is reported that the conductivities of the faults were determined through the calibration process[5]. However inspection of the relevant data file (.HFB) indicates all faults have the same assigned conductance term (fault zone width x hydraulic conductivity) of 1.0E-8.

Question 9a: Are these values derived from the calibration process?

Question 9b: What field information supports the notion that the faults are flow barriers?

Question 9c: Would the regional drawdown induced by the mine pits in the WST model be greater if the fault-flow barriers were absent?

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[3] See Figure 10.43, page 267 of AGE 2013
[4] See Figure 10.6, page 218 of AGE 2013
[5] See Section 8.4.7, page 117 of AGE 2013

Sundry additional questions for the future

Comment 10: The model predictions of heads and fluxes assume the solutions are within acceptable error tolerances. That is, adjusting the parameters with the aim of reducing prediction errors further, should not lead to significant differences in predicted heads or fluxes. Acceptability of predictions is commonly assessed by examining the volumetric budget. However volumetric budgets can often be misleading. For example, the WST model simulation using the supplied parameter settings for the PCG5 solver (column 2 of Table 1) delivers volumetric budget errors in the range –0.05% to +0.05%. The resulting cumulative water make from all mine pits at the end of mining is 9189.73 GL (obtained from the .OUT file assuming drain cells are only associated with the mine pits). Adjusting the solver parameters to alternate values given in column 3 of Table 1, delivers volumetric budget errors that range from –0.04% to +0.03% with a significantly different cumulative water make of 7679.95 GL or about 16% lower than the above. Further adjustment on HCLOSE suggests an even greater difference.

Table 1: Summary of parameter adjustments to PG5 solver

Parameter	AGE WST model	Re-simulation
MXITER – max. number of iterations	300	100
ITER1 – max. inner iterations	80	80
BFACT – back tracking factor	0.5	0.15
RESRED – back tr. force factor	10	0.5
HCLOSE – head change criterion	0.1	0.05

Question 10a: Were any similar comparisons of fluxes undertaken for the reported model?

Question 10b: If such differences are evident in the WST model, what are the implications for the reported model(s) in relation to regional groundwater impacts?

Question 10c: What are the implications for mine site water management?

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JST/tl (P2513.Watermark)
22 July 2014

Project Manager-Watermark
Shenhua Australia
via email

Attention: Mr. Paul Jackson

Dear Paul,

RE: PROPOSAL FOR WATERMARK PROJECT SUPPORT TO PLANNING ASSESSMENT COMMISSION PROCESS

This letter responds to questions raised by the Third Party Reviewer, Dr Colin Mackie, who the Planning Assessment Commission (PAC) engaged to review the Watermark Project groundwater study.

Question 1: What assurance can the proponent give that the model grid is sufficiently discretised to generate estimates of the water table, pressure head distributions, and saturations with reasonable accuracy?

Answer: MODFLOW SURFACT was the first version of MODFLOW to simulate flow in the unsaturated zone. SURFACT allows rewetting of dry cells, which was a long standing challenge when using earlier versions of MODFLOW to represent mining projects. This ability to rewet desaturated cells was the primary reason SURFACT was used for the project. The objective of the modelling was not to represent accurately flow within the unsaturated zone, but rather focussed on the impacts on the saturated sequences. Two large regional models were developed for the project and it would have been impractical and considered unnecessary at the time to further refine the model grid to more accurately represent flow within the unsaturated zone. The fact that the model converged to an accurate solution indicates the grid size was suitable.

Question 2a: Can the proponent provide relevant test data in support of the adopted Van Genuchten parameterisation?

Answer: The van Genuchten parameters adopted in the model were selected as they were within the measured ranges published by van Genuchten (1980), van Genuchten and Nielsen (1985), Kool, Parker and van Genuchten (1986), Vosten, van Genuchten (1988), van Genuchten, Leij (1989), Gerke, van Genuchten (1993) and Simunek, van Genuchten (1997).

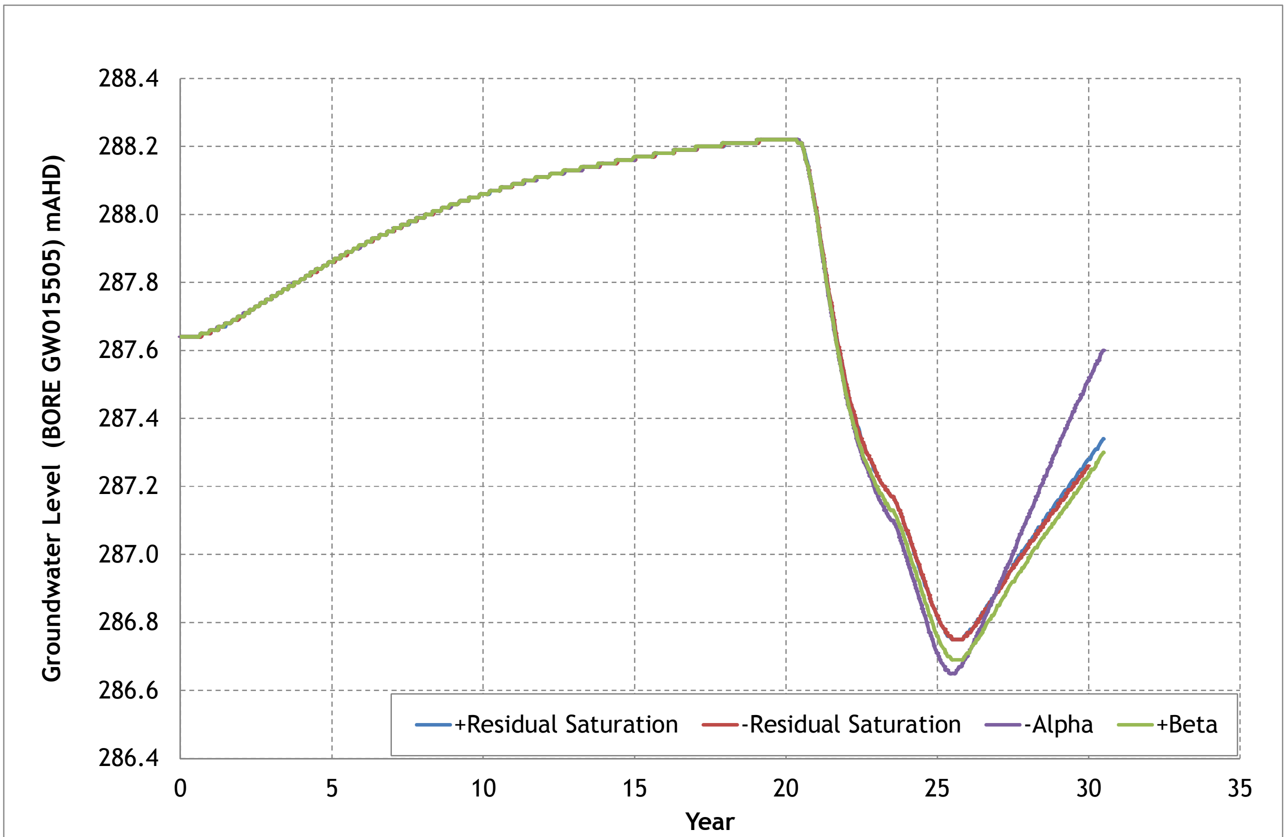
Question 3: Can the proponent provide an explanation as to why the values are identical across all model layers?

Answer: The values were identical because there is not an extensive data set of van Genuchten parameters for Australian conditions to justify varying the parameters. Also, as the groundwater systems immediately adjacent to the mining areas depressurise, the drain boundary condition is the dominant influence on the simulated water levels, not the unsaturated zone parameters. It is only relatively distant from the drains cells representing mining that the influence of the hydraulic parameters becomes more influential on the predicted water level. The van Genuchten parameters were considered relatively insensitive and not varied in the model.

To demonstrate this, a sensitivity analysis was undertaken on the van Genuchten parameters used in the model. The sensitivity analysis varied the parameters above and below the values adopted in the model based on ranges in the published literature as follows:

- α: 0.005 – 0.05 (0.01 in model)
- β: 1.5 – 7.5 (5.0 in model)
- Rs: 0.05 – 0.15 (0.10 in model)

The figures below show how the van Genuchten parameters influence the predicted water level at bore GW015505, one of the bores predicted by the EIS model to be impacted by the project. The models where α was increased and β reduced failed to converge.



Question 4: How was the saturation distribution (normally output in the .DDN file for vadose zone simulations) re-entered for each stage of the simulation period?

Answer: At the end of each stage, the simulated hydraulic heads were read from the OUT file and re-entered into the .BAS files for the next stage. The model then recalculated the saturation distribution in the first timestep.

Question 5a: Is the drawdown plot at 30 years derived from the WST model and provided as drawing G1501 pac-review_30Y_DD (pdf file) a representation of the water table noting that the Gunnedah Formation (drawing title) is not continuous across the region?

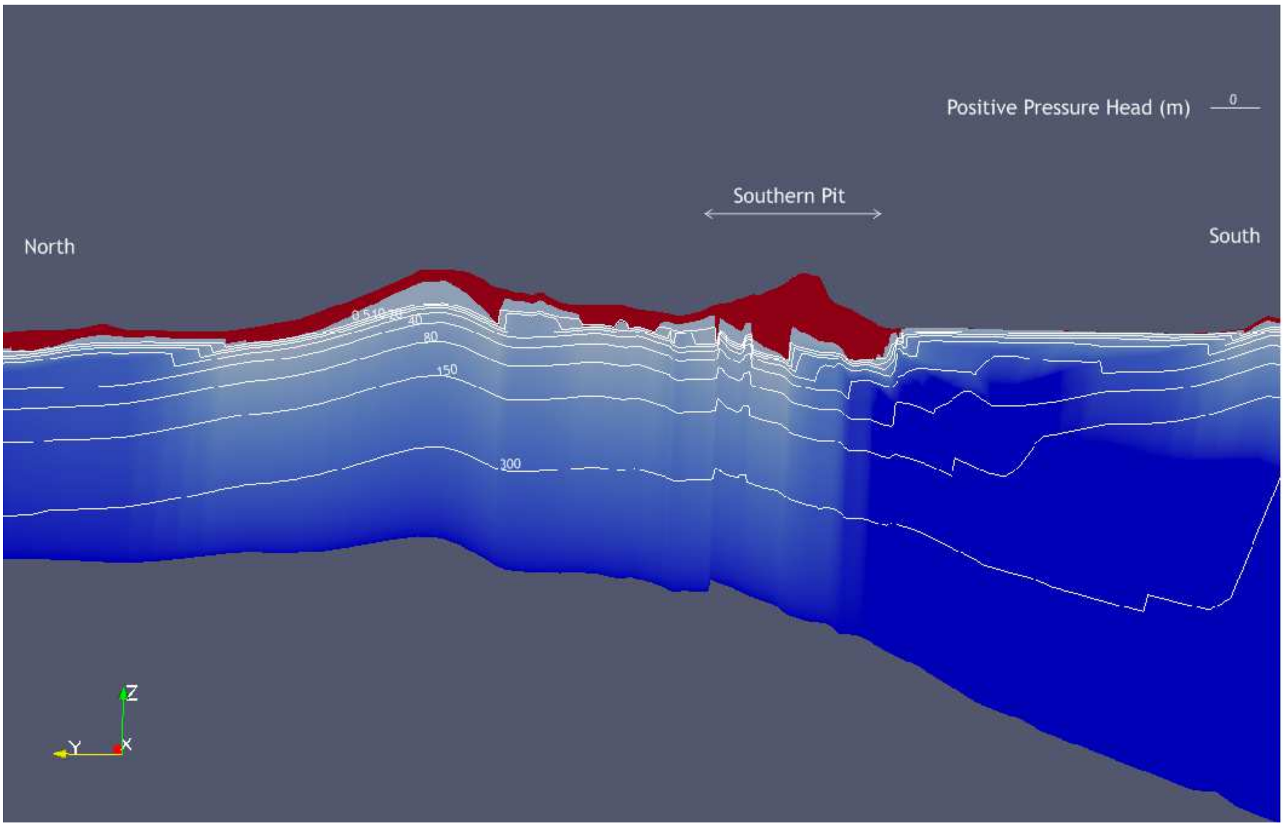
Answer: The drawing provided showed predicted hydraulic heads in Layer 2 representing the Gunnedah Formation. This drawing therefore shows drawdown in the potentiometric surface, however an examination of the water table surface in Layer 1 indicated it is essentially the same as Layer 2.

Question 5b - How was the drawdown calculated?

Answer: Drawdown was calculated as the difference in water levels between two complementary models. The first model included the mining progression; whist the second model removed the drain cells representing mining. Drawdown was calculated by subtracting the potentiometric heads predicted by each model. This process effectively removed the drawdown created by pumping of private bores so the drawdown from the mining could be identified only.

Question 5c: Could the proponent provide a vertical section plot for the reported prediction model at the cessation of all mining, aligned between E245670,N6524200 and E245670,N6548200 (model column 125) and showing zero pore pressure (water table) and all positive pressures as contours?

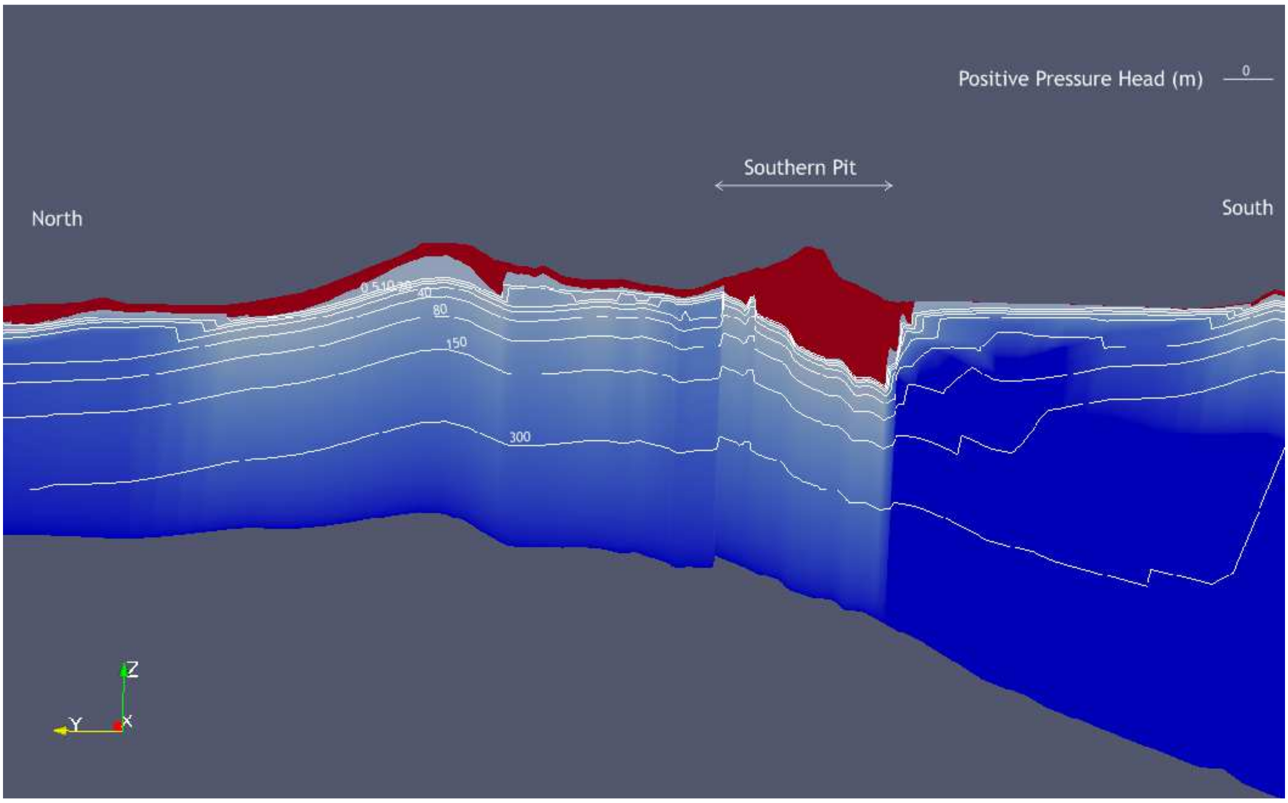
Answer: The requested section for the EIS model is below.



The red cells are completely unsaturated cells where the simulated water level occurs below the floor of the cell.

Question 5d: Could the same section be generated for the requested WST simulation model that does not include material property changes (ie continuous simulation), at the cessation of all mining?

Answer: The requested section for the WST model is below.



Question 5e: As a means of checking both model outputs, could the proponent also provide a cross section between the same coordinates for each of the above noted models, showing saturation and particularly the shallowest 100% saturation horizon (approximating the water table)?

Answer: The red cells highlighted above are completely unsaturated cells and the 0 m pressure contour approximates the water table.

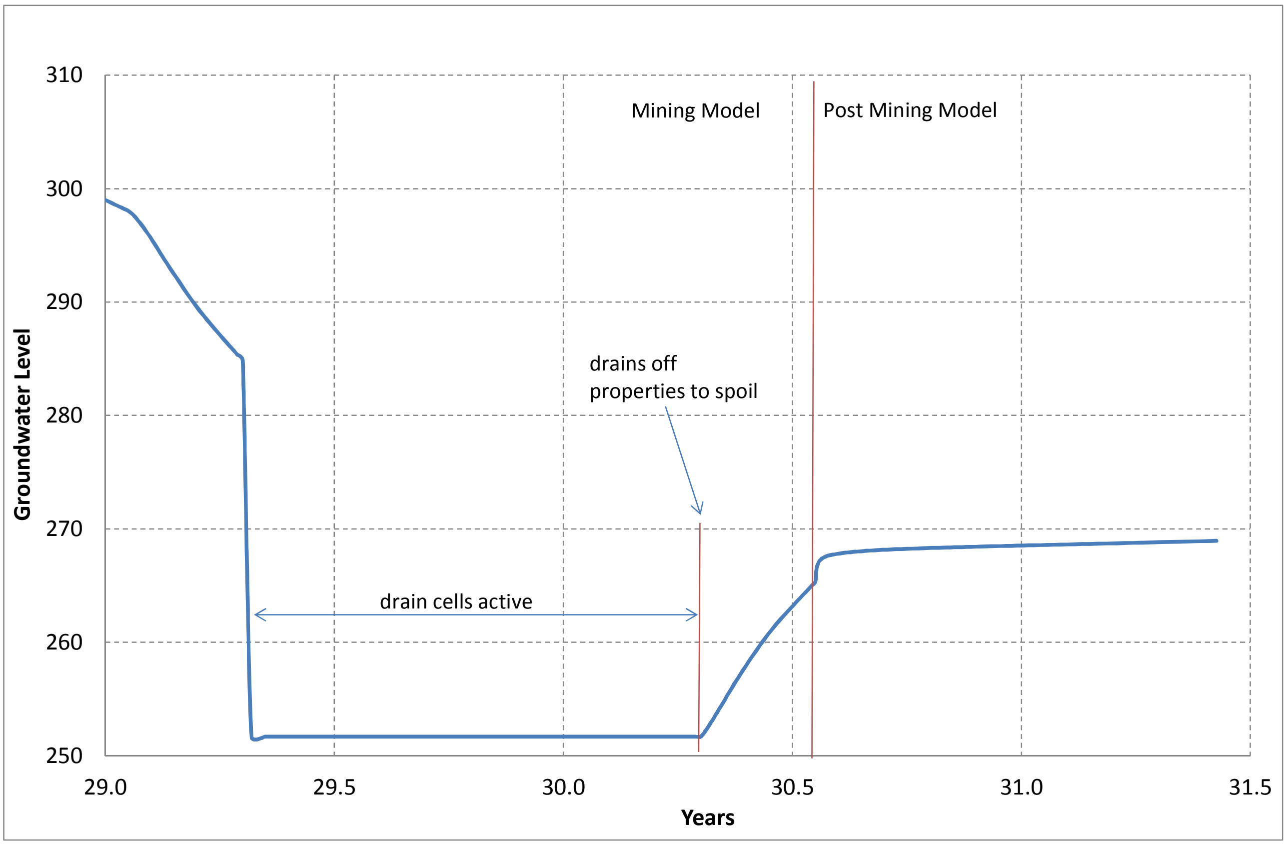
Question 6a: What are the model factors that promote this extraordinarily rapid recovery?

Answer: When considering the predicted water level recovery within the voids the Third Party Reviewer should be aware additional modelling was undertaken responding to submissions on the EIS. This is on the Department of Planning and Environment website (Section 4.3.15).

During the response to submissions stage further model runs were undertaken to determine why the groundwater model predicted a higher equilibrium water level in the final void than the model the surface water consultant WRM developed using the OPSIM code.

It was found that the groundwater model adopted a lower rate of direct rainfall to the final void and a less extensive zone of evaporation, compared with the OPSIM model. The groundwater model was updated to more closely reflect the OPSIM model, and the stabilised water level in the final void predicted to be about 280 m AHD after approximately 1,500 years. This updated version of the model was provided to the Third Party Reviewer.

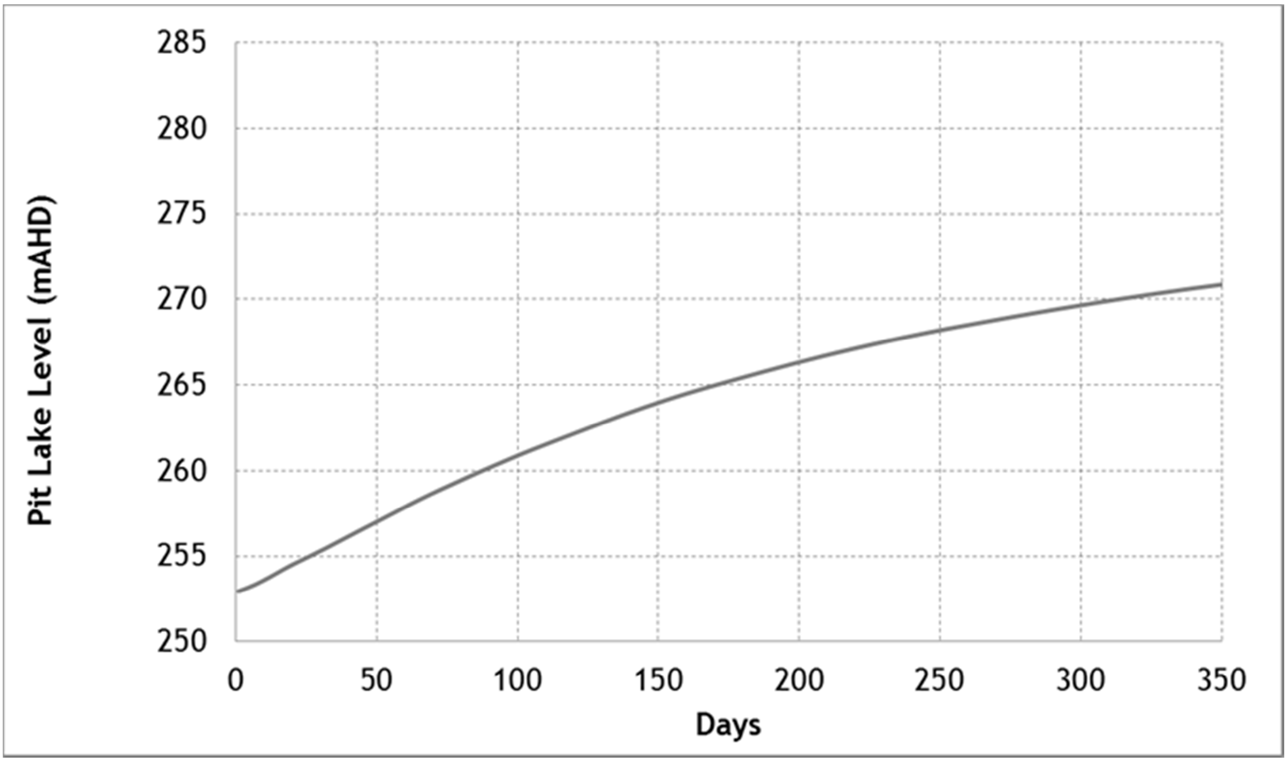
The rapid recovery simulated by the model at cell R92/C69 is due to a number of factors. The figure below shows the water levels recorded in this cell prior to, and at the end of mining and assists in explaining the response.



The drains cells are active on this cell for a period of one year, then are turned off for one quarter and the cells properties changed to spoil (K – 100 m/day, storage 1) before closure of the mine. During this final quarter, the water level within the cell begins to rebound, as the drains are not active. At the end of mining, there is a small rapid rise in water levels of about 2 m, not 13 m as it appears without the mining stage data. This short rapid rise is considered due to the sudden changes in hydraulic parameters used to represent open void that promote flow from strata surrounding the final void due to the high hydraulic conductivity.

It is also important to note the floor of the coal is not the floor of the open void in the recovery model because there is some backfilling associated with re-profiling the low wall and high wall. At cell R92/C69, the final void is backfilled to 257.3 m AHD.

The most appropriate location to assess the final void recover is at the deepest point within the final void. The graph below shows the water level recovery at this point. At this point, there is about 2 m of spoils over the coal seam floor (251 mAHD) and the water level shows a slow recovery from 253 mAHD due to the high storage and the influence of the EVT package.

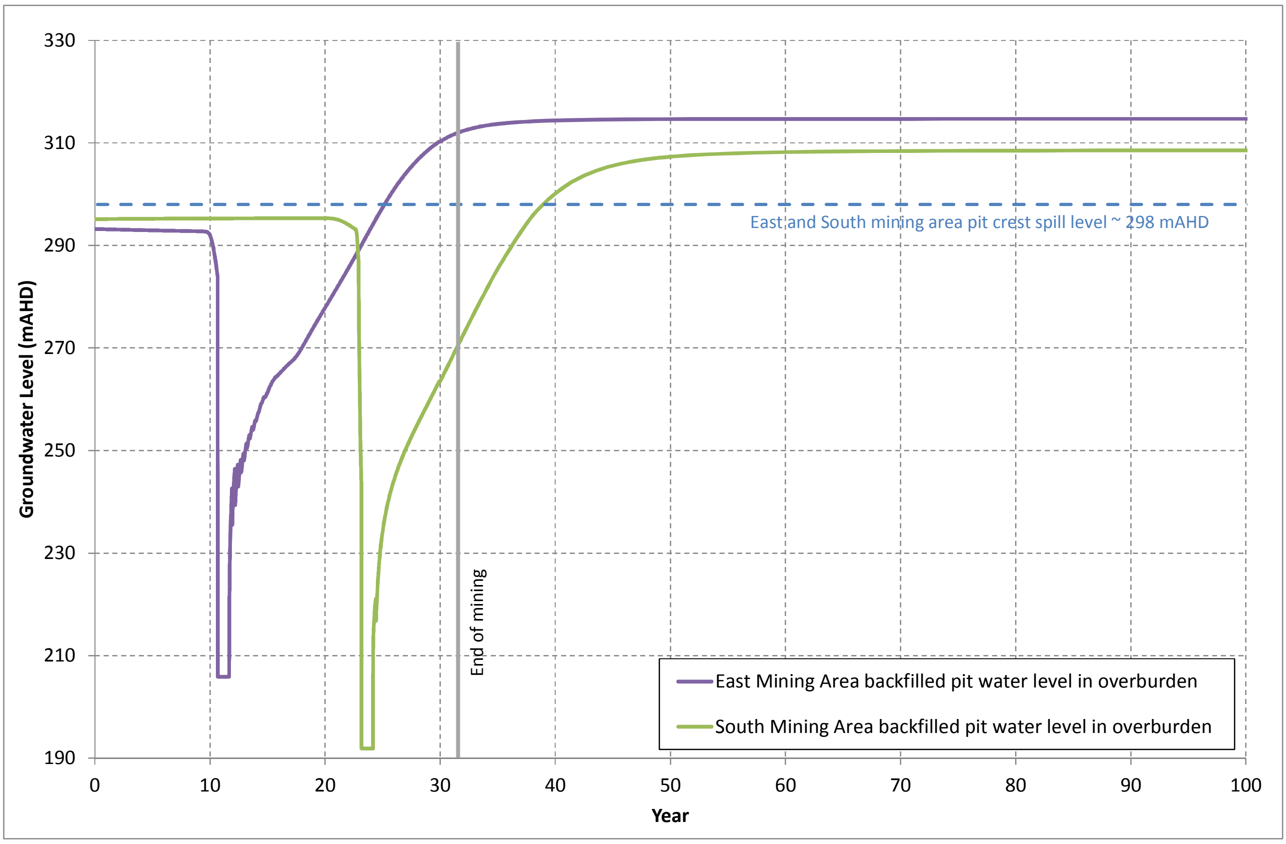


Question 6b: Can the proponent provide examples of other mine voids of similar scale that have exhibited such rapid recoveries?

Answer: No this is a modelling artefact and not representative of recovery within the void.

Question 6c: Do similarly rapid recoveries occur in the East and South Pits?

Answer: Recovery within the Eastern and Southern Mining Areas is faster than the open void as the backfilled areas have a lower storage and do not have EVT acting below the 2 m extinction depth. The graph below shows the water level recovery simulated by the EIS model in the Eastern and Southern Mining Areas (source Figure 10.46 from EIS report).



The water level recovery graphs shown are simulated heads at cells R119, C282, and R199,C112. Whilst the graphs show a more rapid rate of recovery immediately following removal of drain cells and backfilling, this is equivalent to about 29 m over 84 days.

Question 6d: Would a slower rate of recovery have implications for the regional water table drawdown?

Answer: In theory, it is logical that if recovery of the water levels within the final voids is slower than predicted, then there is potential for long term drawdown more extensive. However, the period and rate of recovery predicted by the groundwater model is considered very slow at about 1500 years to reach an equilibrium water level in the voids. The groundwater model for the EIS simulated annual average rainfall conditions and did not represent high intensity rainfall events. During these high intensity events, rainfall greatly exceeds evaporation, and therefore the inputs to the final void lake are greater than the outputs. There is potential during these events for the lake level to rise rapidly, whereas the groundwater model averages these high intensity events and allows evaporation to remove a disproportionate amount of water. The OPSIM water balance model that was based on daily rainfall and evaporation records, predicted the void would recover more quickly and within 300 years. Therefore, the drawdown resulting from the slow void recovery in the groundwater model is considered very conservative.

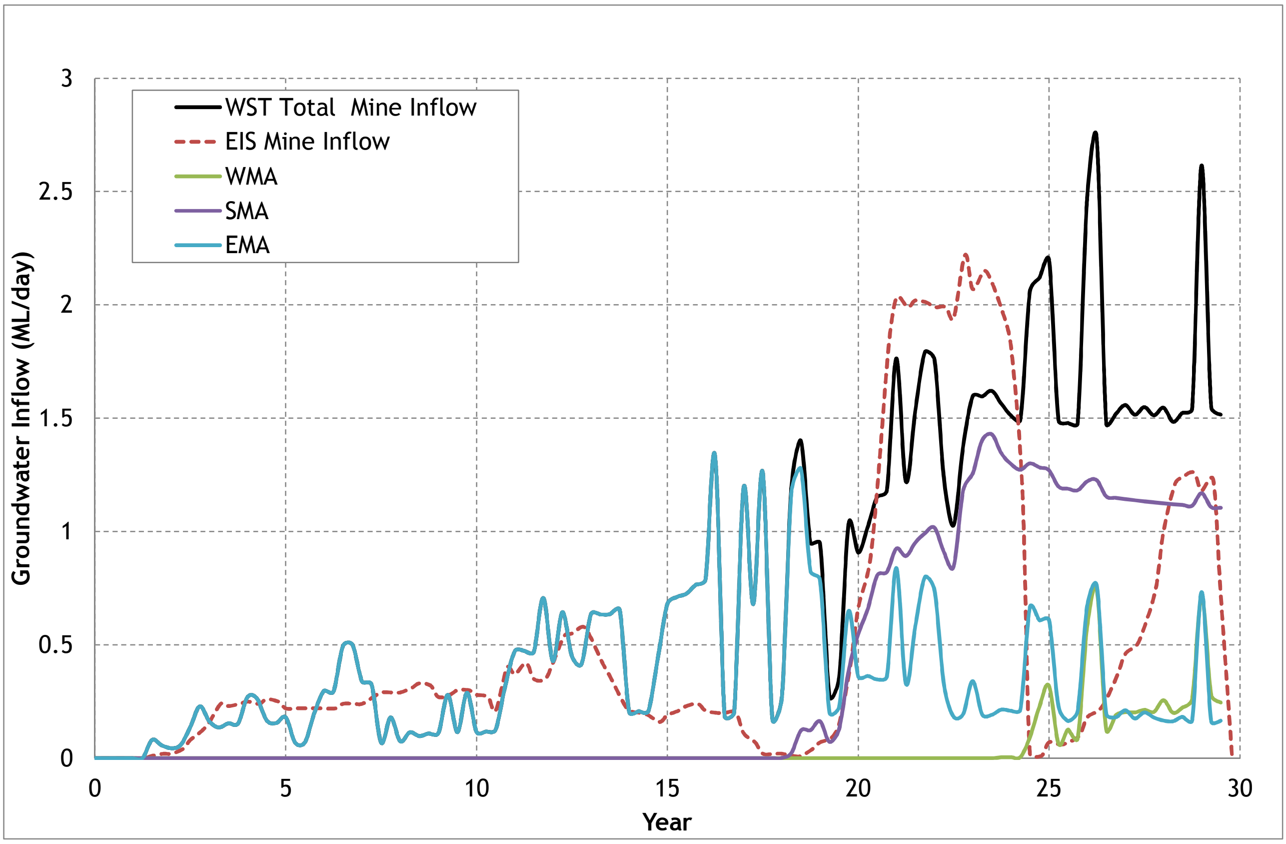
Question 7: Can the proponent provide measured data or references in support of the adopted pit lake evaporation rate being 12% higher than the pan rate?

Answer: The EIS groundwater model used point potential evapotranspiration data[1] sourced from Bureau of Meteorology to represent evaporation from the water surface in the final void. The Bureau defines point potential evapotranspiration as the *"evapotranspiration that would take place, under the condition of unlimited water supply, from an area so small that the local evapotranspiration effects do not alter local airmass properties".* The Bureau supply the data as a grid pattern across Australia with a point every 9.5 km based on climate records from 1961 to 1990. There are two data points within the project lease area that have point potential values of 1975 and 1982mm/year.

As the project site is approximately 30 km from the township of Gunnedah, where a slightly lower mean evaporation rate of 1752 mm has been recorded it was considered more representative to use data available at the site in the modelling. The data was not corrected with a pan factor and therefore the evaporation rate from the lake void is considered conservatively high.

Question 8: Can the proponent provide a summary of mine water make to the different pits similar to Figure 10.6 for the WST model?

Answer: Provided below. It should be noted leaving the Eastern and Southern Pits open is not proposed by the client.



[1] http://www.bom.gov.au/climate/averages/climatology/gridded-data-info/metadata/md_ave_et_1961-90.shtml

Question 9a: Are these values derived from the calibration process?

Answer: Yes, setting all faults at 1 X 10^{-8} m/day achieved the optimal calibration of the model.

Question 9b: What field information supports the notion that the faults are flow barriers?

Answer: GHD (2012) reported *"faulting has been observed in a number of cores and inferred from geological modelling and seismic traverses. Drilling has revealed evidence of faulting such as truncation of seams, fault gouge structures, slickensides, polished surfaces and abundant defects."* (Appendix 1 EIS report).

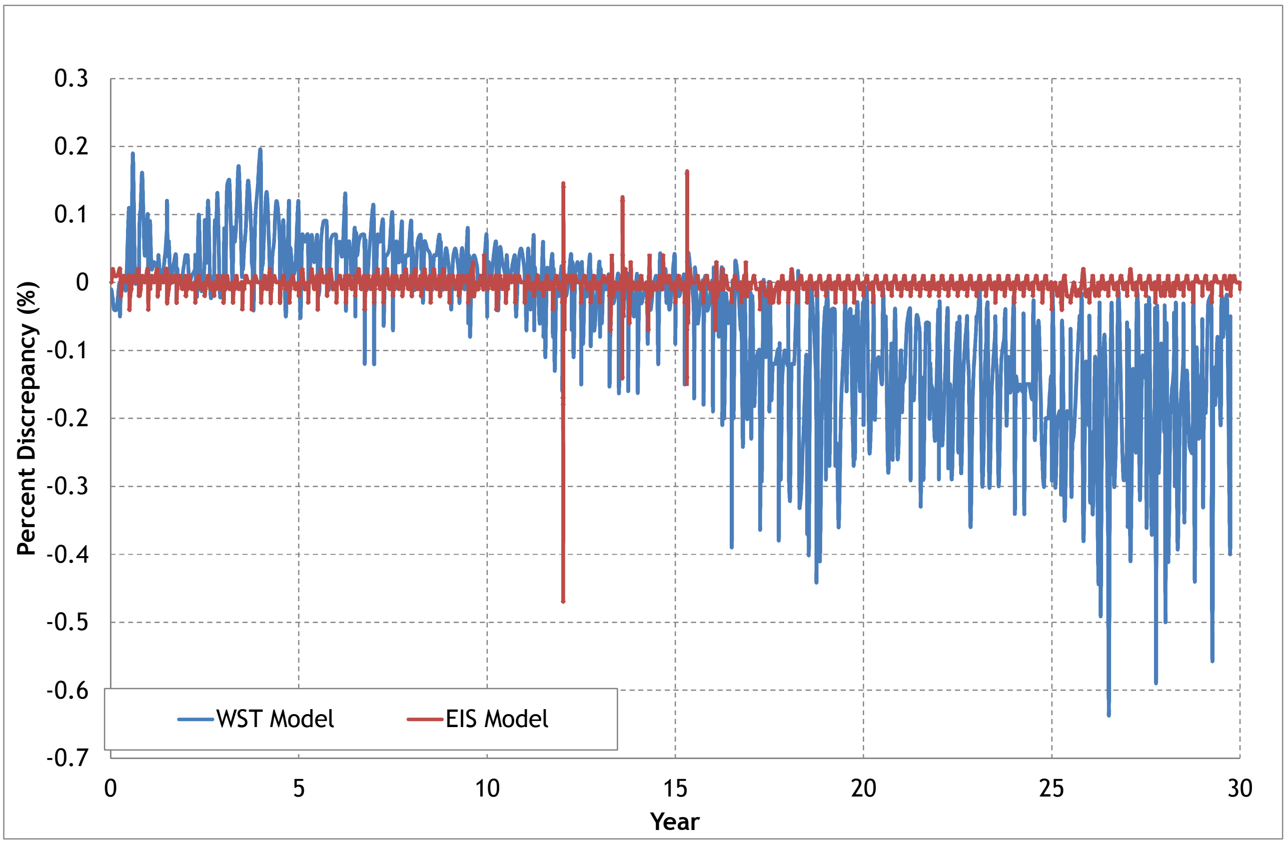
Question 9c: Would the regional drawdown induced by the mine pits in the WST model be greater if the fault-flow barriers were absent?

Answer: The groundwater model matched the observed water levels best when faults were in the model, suggesting compartmentalisation of the groundwater system. Whilst the faults appear to have some influence on groundwater levels, the sensitivity analysis for the EIS included a scenario removing the faults from the model to assess the impacts (Section 11). Figure 11.11 in the EIS shows the 1 m drawdown is only slightly more extensive than the base case when the faults are removed from the model. A similar result would be expected for the WST model.

The uncertainty analysis (Appendix 8) conducted for the EIS also scrutinised the faults by separating each into them into 25 zones for assignment of the hydraulic characteristic value. Appendix 8 in the EIS includes the predicted drawdown percentiles from the uncertainty analysis.

Question 10a: Were any similar comparisons of fluxes undertaken for the reported model?

Answer: The WST model provided to the Third Party Reviewer adopted a HCLOSE value of 0.1. This ensured the model ran quickly and we could provide drawdown results to the Third Party Reviewer promptly. The models reported in the EIS had much tighter convergence criteria to ensure volumetric water budgets were accurate. The percent discrepancies compiled were with the recommended limits in the Australian Modelling Guidelines of 1% for each stress period and cumulatively. The graph below shows the percentage discrepancy in the water budgets for the WST and EIS models and highlights the accuracy in the EIS water budget.



Question 10b: If such differences are evident in the WST model, what are the implications for the reported model(s) in relation to regional groundwater impacts?

Answer: None, water budgets are considered accurate.

Question 10c: What are the implications for mine site water management?

Answer: None, water budgets are considered accurate.

If you have any queries please do not hesitate to call.

Yours faithfully,

JAMES S. TOMLIN
Principal Hydrogeologist/Director
Australasian Groundwater and Environmental Consultants Pty Ltd

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