

Advice to decision maker on coal mining project

IESC 2015-066 and IESC 2015-067: Watermark Coal Project (EPBC 2011/6201) – New Development

Requestor	Minister for the Environment, the Hon Greg Hunt MP	
Date of request	26 February 2015 (2015-066)	23 March 2015 (2015-067)
Date request accepted	27 February 2015 (2015-066)	26 March 2015 (2015-067)
Advice stage	Approval	

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) was requested by the Minister for the Environment on 26 February 2015 to provide advice on the Watermark Coal Project proposed by Shenhua Watermark Coal Pty Ltd in New South Wales, which is addressed in this advice IESC 2015-066. On 23 March 2015, the Minister requested further advice in relation to questions raised by the community, which is addressed in IESC advice 2015-067 ([Attachment A](#)) and should be read in conjunction with this advice IESC 2015-066. The requests were published by the Commonwealth regulator and are publicly available by searching for EPBC 2011/6201 under the 'referrals' page at www.environment.gov.au/node/18622.

The IESC previously provided advice on the proposed project to the former Commonwealth Department of Sustainability, Environment, Water, Population and Communities on 27 May 2013 (IESC 2013-023; see [Attachment B](#)). In developing these new advices (IESC 2015-066 and IESC 2015-067) the IESC has considered additional information including the proponent's response (Hansen Bailey, 2013c) to the earlier advice of the IESC on the proposed project (IESC 2013-023). In January 2015, the project was approved with conditions by the New South Wales Planning Assessment Commission (PAC). The review and determination reports prepared by the PAC, the assessment reports prepared by the New South Wales Department of Planning and Environment (DPE) and relevant available analyses have also been considered in preparing these advices. The project assessment documentation and additional published information accessed by the IESC are listed in the source documentation at the end of IESC advice 2015-067 ([Attachment A](#)).

The proposed project is a new open cut coal mine and associated facilities located west of Breeza, 35 kilometres south-west of Gunnedah on the Liverpool Plains in the Namoi Valley. Coking and thermal coal would be extracted from the Hoskissons and Melvilles coal seams of the Permian Black Jack Group within the Gunnedah Basin at a rate of up to 10 million tonnes per annum of run-of-mine coal for a period of 30 years.

IESC 2015-066 Advice

The IESC's advice, in response to the Minister's specific questions of 26 February 2015, is provided below.

Question 1: Following consideration of the listed documentation, would the IESC make any revisions to their previous advice? Including, but not limited to:

- a) the groundwater modelling predictions over time; and
- b) the conclusions drawn with regard to the assessment of impacts to groundwater dependent ecosystems; and what consequences could result if impacts extend beyond that predicted, particularly in regards to EPBC-listed ecological communities in the area.

Response

1. Yes. A number of the matters raised in IESC 2013-023 have been examined or explained in the additional information including the groundwater conceptualisation, influence of faults and sensitivity analysis of the water balance modelling. However there remain some information gaps which need to be addressed.
 - a. In relation to numerical groundwater modelling predictions, the source documentation is considered to be sufficiently robust to draw conclusions as to the most likely impacts on the Upper Namoi Alluvium, particularly the Gunnedah Formation, at a regional scale. If the proposed project is approved, additional monitoring and finer-scale groundwater modelling should be undertaken as mining progresses to improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of the finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.
 - b. In relation to conclusions drawn with regard to the assessment of impacts to groundwater dependent ecosystems (GDEs), there remains an unassessed risk to GDEs within the groundwater drawdown extent where groundwater is less than 20 m below the surface. Potential impacts to GDEs have been ruled out by the proponent as the ecological communities considered were deemed not wholly dependent on groundwater. However, by definition (Richardson et al., 2011), GDEs include ecosystems that opportunistically use groundwater and potential impacts should be considered for all GDEs.
 - c. It is considered unlikely that groundwater drawdown will extend beyond that predicted in the sensitivity and uncertainty analyses in the Environmental Impact Statement (Hansen Bailey, 2013a; EIS). Although considered unlikely, if drawdown impacts were to extend further than predicted, direct and indirect consequences to GDEs, including EPBC-listed ecological communities (such as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland) remain uncertain as GDEs have not been surveyed and vegetation mapping has not been provided outside the proposed project boundary.

Explanation

2. The matters from IESC 2013-023 listed below have been responded to or are expected to be addressed through the implementation of NSW Government consent conditions (PAC, 2015).
 - a. Water quantity impacts at a regional scale have been assessed in the context of water licensing and extraction limits defined in water sharing plans, which the NSW regulator uses as an alternative approach to undertaking regional water balance modelling.

- b. The predicted salt loads from the proposed project are likely to have a negligible impact on salinity at a regional scale and therefore a regional salt balance is not needed.
 - c. The impact of climate variability on site water management was considered in the sensitivity analysis on the site water balance in the proponent's response to submissions (Hansen Bailey, 2013b; RTS).
 - d. Information has been provided that addresses the influence of faults within the proposed project area, the representation of these faults within the numerical groundwater model and their effect on model outcomes, as well as the sensitivity of the model to zones of high hydraulic conductivity. It is therefore considered that additional work on faults would not substantially add to the utility of the model in predicting impacts. However, if the proposed project receives approval, the improved characterisation and representation of faults should be included in ongoing revisions to the model, particularly in finer-scale models for each pit (as described in response to Question 3a of this advice IESC 2015-066).
 - e. Constant conditions across the northern boundary included in the numerical groundwater model, whilst not explicitly representing seasonal variations, are unlikely to significantly affect predictions of impacts from mining, due to the distance of the boundary from the predicted groundwater drawdown extent.
 - f. The distribution and range of hydraulic conductivities within the coal seams utilised in the numerical groundwater model are considered appropriate and representative. The values used are consistent with local field and laboratory data.
 - g. A flood mitigation plan which considers the impact of a 1,000 year average recurrence interval flood event would be addressed by design of a levee to mitigate a probable maximum flood, as per the NSW Government consent condition 25 (PAC, 2015).
3. The key matters in IESC 2013-023 that need further information are outlined below. These could be addressed through collection of additional data before and during operations, with subsequent comparison and updates to predictions and regular reporting, review and action taken.
- a. A targeted monitoring programme as discussed in response to Question 3a of this advice (IESC 2015-066).
 - b. Finer-scale numerical groundwater modelling, with a particular focus on the conceptualisation and parameterisation of the fresh and weathered Permian strata in the zone between the proposed pits and the Upper Namoi Alluvium as discussed in response to Question 3a of this advice (IESC 2015-066).
 - c. Identification and assessment of potential impacts to water dependent ecosystems and salt-sensitive biota within and beyond the proposed project boundary as discussed below in paragraphs 4-7.
 - d. Assessment of local-scale cumulative impacts as discussed below in paragraph 8.
 - e. Assessment of long-term impacts associated with the final landform as discussed below in paragraphs 9-10.

Water dependent ecosystems

4. The potential impacts to water dependent ecosystems as a result of the predicted hydrological impacts remain uncertain due to insufficient survey effort. Little information has been provided that clearly identifies: ecological assets beyond the proposed project boundary that are dependent (either fully or partially) on surface water and groundwater systems; their current

condition; and how these assets may be impacted by both the proposed project and any cumulative impacts.

5. In order to better understand the potential impacts to GDEs, a systematic assessment of GDEs including EPBC-listed ecological communities is needed.
 - a. Areas of shallow groundwater (less than 20 m below ground level) and groundwater discharge should be identified from the hydrogeological conceptualisation.
 - b. Vegetation and wetland mapping, and fauna (such as stygofauna, macroinvertebrates and fish), flora and habitat surveys should be overlaid to identify areas of potential GDEs.
 - c. Techniques from the Australian GDE Toolbox (Richardson et al., 2011) should then be applied to confirm groundwater use by vegetation and other biota and identify groundwater discharge to surface water bodies.
6. Groundwater levels along Native Dog Gully are within two metres of the surface (Hansen Bailey, 2013a, App U, Table 1), so riparian vegetation associated with Native Dog Gully should be assessed for groundwater dependence and potential groundwater drawdown impacts.
7. Potential impacts to GDEs associated with the Mooki River have not been well characterised. There is no consideration of the potential ecological impact of groundwater drawdown on the instream community in the Mooki River. The combined impacts of loss of streamflow as well as changes to water quality, particularly salt loads during 'first flush' events on Native Dog Gully and the Mooki River, should be further considered. This consideration should be informed by finer-scale modelling of the Mooki River, Native Dog Gully and associated alluvium in the vicinity of the eastern and southern pits supplemented by appropriate continuous or event-based monitoring of water quality and aquatic biota (see response to Question 3a in this advice IESC 2015-066).

Assessment of cumulative impacts

8. There is a risk of cumulative impacts to the south of the proposed project area, where the maximum alluvial groundwater drawdown as a result of the proposed project is predicted and there is the potential for groundwater drawdown associated with the proposed Caroon Coal Project. To better understand cumulative impacts, further investigation into local connectivity between the Permian and alluvial groundwater systems, particularly the properties of the fresh and weathered Permian strata in the zone between the proposed pits and the Upper Namoi Alluvium is warranted. A local-scale investigation into this connectivity should be undertaken by the proponents of this project and the Caroon Coal Project, as per IESC advice on both projects (IESC 2013-023 and IESC 2014-047). If the project is approved, this investigation could occur before mining of the southern pit, and be built into the water management plan protocol with nearby mine owners as per the NSW Government consent condition 26c (vi) (PAC, 2015).

Final landform

9. Given the local long-term salinity risk associated with the proposed final void, the design should be supported by ongoing hydrological modelling that takes into account new information gathered during mining. This information should include additional characterisation of the spatial extent and hydraulic properties of Quaternary sediments, which may intersect the western edge of the final void (GHD, 2011) and uncertainty analysis that incorporates the potential influence of climate variability.
10. The rehabilitation management plan will also be critical to manage long-term risks associated with the void and final landform. Potential 'worst-case' scenarios should be considered and

addressed within this plan, such as the potential for the void water level consistently rising above local groundwater levels, void overtopping, and local-scale salinity associated with groundwater seepages not being successfully managed by the existing rehabilitation methods.

Question 2: Could the IESC comment specifically on the conclusions drawn that the zone of depressurisation in the Permian is unlikely to extend beyond that described; and what regional implications may occur if the depressurisation in the Permian extends to, or beyond, those impacts predicted?

Response

11. The extent of depressurisation in Permian and alluvial aquifers is considered unlikely to extend beyond that described in the sensitivity and uncertainty analysis in the EIS. This conclusion is based on two factors.
 - a. The proponent's groundwater conceptualisation and numerical model parameterisation are considered reasonable based on the available field data, sensitivity and uncertainty analysis in the EIS, information provided in response to a review by UNSW (DPE, 2014, App C) and consistency with additional modelling scenarios proposed by Dr Col Mackie (Hansen Bailey, 2014, App A).
 - b. Other issues in relation to the numerical groundwater model, such as the representation of the Leard Formation, Benelabri Formation and drawdown contours for layer 11, are considered unlikely to have a significant impact on predictions.
12. Whilst considered unlikely, if depressurisation in the Permian extends beyond that predicted, the regional implications relate to increased impacts to water level or pressure of the groundwater resource associated with the Upper Namoi Alluvium and potentially other users of the Upper Namoi Alluvium. A robust monitoring programme is needed to ensure that potential exceedance of triggers relating to predicted impacts to water resources and associated ecosystems, such as groundwater drawdown, are detected early, as discussed in the response to Question 3 of this advice (IESC 2015-066).
13. Whilst considered unlikely, if impacts did extend beyond those predicted in the sensitivity and uncertainty analysis in the EIS, there is no likelihood of transmission of impacts to the Great Artesian Basin (GAB) because of the clear geological and spatial separation between the mine site and the aquifers of the GAB (see paragraph 23 of this advice IESC 2015-066).

Explanation

Conceptualisation and parameterisation

14. The proponent's conceptualisation, recharge and hydraulic conductivity estimates and their reported uncertainty assessment are justified, given the current understanding of the groundwater system and available data, including measured parameters. However, as additional information is collected from targeted monitoring the numerical groundwater model should be revised so that accurate predictions drive any necessary action in a timely manner.

Permian/weathered zone

15. The proponent has conceptualised the weathered zones, including those between the proposed pits and the Upper Namoi Alluvium, as zones of enhanced hydraulic conductivity. This approach is more likely to overestimate than underestimate potential impacts to the Upper Namoi Alluvium.

16. Studies by the Bureau of Rural Sciences (Macauley & Kellett, 2009) in a similar geological environment have concluded that saprolite acts as a continuous impermeable blanket over the GAB, and prevents hydraulic connection between the alluvium and the GAB sequence. Whilst there is no GAB sequence within the numerical groundwater model domain, the saprolite in this domain has the potential to form a similar low permeability layer, which would limit the transmission of groundwater impacts to the Upper Namoi Alluvium.
17. Calibrated parameters for the numerical groundwater model are within the bounds of measured parameters from pumping tests and smaller scale field and laboratory tests. There are relatively few hydraulic conductivity measurements available for the Permian strata. Model calibration, parameterisation and reliability are therefore expected to be better in the Upper Namoi Alluvium for which more data is available. For this reason, as understanding of the hydraulic characteristics of Permian strata is improved through time-series data from additional targeted monitoring, especially in the zones between the pits and the alluvium, modelling should be refined to enable early warnings of trigger exceedances and inform management options, as discussed in response to Question 3a of this advice (IESC 2015-066).

Alluvium and colluvium

18. The proponent conceptualises groundwater within the Upper Namoi Alluvium as occurring within two distinct systems: the poor quality, lower yielding Narrabri Formation and the fresher, highly productive Gunnedah Formation. While it is very likely that there is significant local-scale variation in the hydraulic parameters and connectivity of the alluvial sediments, the simplification made in the proponent's conceptualisation is appropriate at the regional scale and is consistent with previous modelling studies in the region.
19. Geological mapping (GHD, 2011) indicates zones of colluvial and alluvial deposits around the proposed western pit, which have on some occasions been referred to as 'paleochannels' (P8, for example). Hydrogeological data presented in the EIS, although limited, suggests that these zones have relatively low hydraulic conductivity and high salinity (the latter also a strong indicator implying low hydraulic conductivity and little natural throughflow of groundwater). The numerical groundwater model has represented these deposits as weathered material, with enhanced hydraulic conductivity. This approach is appropriate and likely to overestimate any potential impacts on the Upper Namoi Alluvium.
20. Better definition and parameterisation of the hydrogeology and geology at a local-scale, particularly in relation to the alluvium and colluvium, should inform finer-scale numerical groundwater modelling discussed in response to Question 3a of this advice (IESC 2015-066) to improve confidence in the prediction of local groundwater drawdown effects and clear identification and response to mine-induced impacts.

Sensitivity and uncertainty analysis

21. The sensitivity analysis and uncertainty analysis within Hansen Bailey (2013a) provide investigation of uncertainties associated with key variables: hydraulic conductivity, storativity and recharge. These analyses provide a good estimate of the median impact and improve confidence in impact predictions. Additional Monte Carlo simulations would improve the reliability of estimations for the extremes of the predictive interval.

Numerical groundwater model - representation of hydrostratigraphy and groundwater drawdown

22. There are several minor issues with the presentation of information relating to model layers and possible issues with the representation of hydrostratigraphic units in the model, as outlined below. Confidence in the model's predictions would be improved if more information were

provided relating to the model layers, but it is considered that resolution of these issues would not have a substantial impact on model predictions.

- a. Groundwater drawdown contours have not been provided for model layer 11 (described as representing the Watermark to Maules Creek Formations), which underlies layers 1 and 2 in the northern and eastern area of the model. Presentation of modelled drawdown in this layer for all scenarios would assist in confirming that there is a low likelihood of drawdown in the overlying Upper Namoi Alluvium to the north-east of the proposed project area.
- b. The Leard Formation is not described as being incorporated into any of the numerical model layers. It is presumed that it has been included in layer 11. Given that this stratum is located deep in the groundwater system in the vicinity of the mine and does not have high hydraulic conductivity, it is unlikely that its inclusion or otherwise would have a significant impact on the model's predictions.
- c. The Benelabri Formation is shown in the EIS to overlie the Clare Sandstone. However in relevant literature it is described as underlying the Clare Sandstone. This inconsistency is not likely to impact the model results.

Great Artesian Basin

23. The areas of Pilliga Sandstone immediately to the south and west of the proposed project area are outliers and are not hydraulically connected to the Pilliga Sandstone aquifer of the GAB, which outcrops approximately 66 km to the west of the proposed project area. Therefore any impact to groundwater in the Pilliga Sandstone in the proposed project area is not expected to be transmitted to the GAB.

Question 3a: Is the IESC satisfied the proposed surface water and groundwater monitoring programmes are robust and any potential impacts on water resources and water related assets (including the Upper Namoi Alluvium and Permian) will be detected? Is there appropriate spatial and temporal coverage?

Response

24. No. The proposed monitoring programme has not changed from that used to obtain baseline information and its spatial and temporal coverage is not considered sufficient to:
 - a. Enable derivation of appropriate trigger values for water quality.
 - b. Ensure early warnings of impacts exceeding predictions in time to implement corrective action and management strategies.
 - c. Determine exceedance of triggers in a quantifiable and robust manner, and to be capable of determining the contribution of the proposed project to any observed impacts, as distinct from those caused by other users and climatic conditions.
 - d. Obtain the additional data needed to reduce uncertainties in the numerical groundwater model predictions.
 - e. Detect post-mining impacts.
25. Noting that the NSW Government consent condition 26c(iv) (PAC, 2015) requires monitoring of post-mining groundwater recovery to continue for at least ten years, the additional information provided by the proponent is unclear as to the scale and extent of water monitoring following the cessation of mining.

26. A staged approach to further monitoring would be appropriate to be undertaken in line with the proposed mine plan, particularly in the Permian strata and weathered zone in the area between the mine pits (in particular the eastern and southern pits) and Upper Namoi Alluvium. This monitoring should be undertaken in conjunction with development of finer-scale groundwater models focussing on each pit, with more detailed definition of strata, seasonal variation and boundary conditions. Improved understanding of the hydrogeological system gained during operations in one pit should be used to assess potential impacts associated with the next pit. The knowledge gained during operations should be used to inform the assessment of potential impacts from the final landform, including the proposed void and potential seepages and determination of mitigation or management strategies.
27. Suggested expansions to surface water and groundwater monitoring spatial coverage are identified below. Commitments for surface water and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy (ANZECC and ARMCANZ, 2000). Where additional sites have been identified, monitoring should begin immediately to establish baseline conditions before mining commences.

Explanation

Surface Water

28. The surface water monitoring programme should be designed to:
- a. Establish the flow regime in ephemeral water courses and monitor any changes to the flow resulting from the proposed project.
 - b. Enable determination of exceedance of site-specific water quality triggers in Watermark Gully, Native Dog Gully and the Mooki River and subsequent initiation of management options.
 - c. Improve the local-scale understanding of surface-groundwater interactions along the Mooki River in the vicinity of the proposed project area, to inform finer-scale groundwater modelling discussed in paragraph 26 of this advice (IESC 2015-066).
 - d. Enable detection, monitoring and management of impacts to salt-sensitive biota within and downstream of the project area. Current lack of surveys for water-dependent and salt-sensitive biota hampers determination of suitable monitoring protocols.
29. This monitoring programme should include:
- a. Event-based water quality monitoring and continuous monitoring of flow and electrical conductivity (EC) in Native Dog Gully to provide context for water quality measurements.
 - b. Monitoring of water flow and quality (including continuous monitoring of EC) in Watermark Gully downstream of the eastern pit to detect any impacts from runoff from the overburden emplacement area.
 - c. The addition of selenium, aluminium and molybdenum to the suite of dissolved metals tested on a regular basis in watercourses downstream of the proposed project area to determine whether runoff from overburden emplacement areas presents any risk to water resources or water-related assets.

Groundwater

30. The monitoring programme should be designed to:

- a. Enable clear determination of any exceedance of early-warning triggers, before reaching limits for groundwater drawdown in the Upper Namoi Alluvium as defined in NSW Government consent condition 25 (PAC, 2015).
 - b. Enable groundwater pressures and quality impacts from the proposed project to be differentiated from impacts as a result of other groundwater users and climatic conditions.
 - c. Reduce numerical groundwater model uncertainty to enable improved predictions of likely impacts, and subsequent management options.
31. This monitoring programme would include:
- a. Monitoring of control wells located well outside zones of potential mining-induced impacts.
 - b. Monitoring of groundwater levels and quality to inform assessment of recharge into and any flow from the Narrabri Formation to the Gunnedah Formation within the Upper Namoi Alluvium.
 - c. Monitoring and determination of the influence of other groundwater and surface water takes including nearby mines in the vicinity of the proposed project.
32. Additional multi-level (nested) monitoring wells should be installed to the north and south of the eastern pit, followed by the area to the south of the southern pit (where mining is not proposed to begin for 17 years), to identify any changes in groundwater pressure and provide information to reduce uncertainty in parameter estimation and predictions from finer-scale groundwater models noted in paragraph 26 of this advice (IESC 2015-066). Tests should be undertaken during monitoring well installation to obtain additional data on hydraulic parameters. The nested monitoring points should be located in each significant hydrogeological layer, particularly the Permian and weathered zone, correlating to those created in updated groundwater models. This would assist in early detection of unexpected depressurisation and clear identification and response to mine-induced impacts.
33. The additional information (Hansen Bailey, 2014, App A) has identified the need for more monitoring wells to be installed and located within the predicted zone of depressurisation to assess the extent and rate of depressurisation against numerical groundwater model predictions. Even though groundwater drawdown is not predicted in the Upper Namoi Alluvium to the north of the eastern pit, additional multi-level (nested) monitoring wells should be placed in this area to confirm model predictions and provide an early warning of any variation from predicted depressurisation in this area.

Question 3b: Could the IESC provide advice on the appropriate management responses if triggers are exceeded?

Response

34. Groundwater, surface water and ecological triggers and subsequent management responses are proposed to be developed within management plans in the post approval process. The IESC is unable to comment on their appropriateness as the plans are not yet available.
35. Where triggers and limits are exceeded, management responses for surface water and groundwater should be clearly stated within an enforceable adaptive management framework. Management responses may include, but should not be limited to, the elements listed below.
- a. Ecotoxicity testing of discharges and surface waters to assess bioavailability of contaminants in these mixtures.

- b. Water allocation and engineering management options including: water treatment; dam sizing; increasing the capacity of the water management system; and redesign, capping and revegetation of overburden. The proponent suggests cut off measures and reinjection of water into depressurised aquifers to mitigate groundwater drawdown. A stronger rationale is needed for reinjection with consideration given to: the goals of the option; the likely sources of water for reinjection; the suitability of the water with regards to matching water quality at the injection site; the potential impacts to both the injection site and the source site; and evaluation of the reinjection against alternative management options such as purchasing additional groundwater licences or altering the mine plan.
- c. Mine plan management options including limiting depth and lateral extents of mining to reduce effects of depressurisation.
- d. Regular ongoing assessment, validation, recalibration and peer review of models to reduce uncertainties in model predictions and to enable proposed management processes.
- e. Regulatory options where groundwater drawdown limits are exceeded and reassessment of suitability of approval limits and triggers.

Groundwater

36. In light of the results of the sensitivity and uncertainty analysis undertaken for the EIS it would have been beneficial to have a corresponding uncertainty analysis for the scenarios posed by Dr Col Mackie and referenced by the PAC (Scenarios 3, 6, 7, and 11 in Hansen Bailey, 2014, App A) in order to understand more fully the potential for exceeding the conditions relating to groundwater drawdown impacts in the Upper Namoi Alluvium set in the NSW Government consent (PAC, 2015). In the absence of such an uncertainty analysis, strong emphasis should be placed on developing:
- a. A monitoring programme that enables early warnings of greater depressurisation than predicted.
 - b. Robust enforceable management protocols (for proponent and regulator) for action to be taken in time so that limits are not exceeded.

Surface Water

37. The mitigation and management measures that will be employed if salt loads exceed the site-specific trigger values in Watermark Gully, Native Dog Gully or the Mooki River should be proposed by the proponent based on its assessment of salt-sensitive biota as discussed in paragraph 28.d of this advice (IESC 2015-066).
38. Excess salt loads from sediment dam spills can be mitigated by increasing the size of sediment dams or the mine water system to reduce the volume and frequency of overflow. Contingency measures should be developed to prevent the release of sediment dam water in extreme rainfall events if the water quality, particularly salt load and total suspended solids, is not suitable for release.
39. The Mine Rehabilitation Plan should consider measures to prevent impacts to the biota of Native Dog Gully and the Mooki River from long-term saline seepage from the eastern and southern mining areas. Measures could include:
- a. Monitoring overburden emplacement area runoff as discussed in paragraph 29.b of this advice (IESC 2015-066) to refine estimates of long-term salt loads.

- b. Design of overburden emplacement areas based on updated hydrogeological information gained during mining, including capping and revegetation to minimise seepage.

Date of advice 27 April 2015

IESC 2015-067 Advice

The IESC's advice, in response to the Minister's additional request of 23 March 2015 concerning questions raised by the community, is provided below.

Questions from Ms Juanita Hamparsum

Question 1: Has the revised information provided by the proponent addressed all of the Committees advice issued on 27 May 2013?

Response

40. No, not all matters have been addressed at this stage. A number of the matters raised in IESC 2013-023 have been examined or explained in the additional information or would be addressed through the implementation of NSW Government consent conditions (PAC, 2015) including: the groundwater conceptualisation; likely impacts on the Upper Namoi Alluvium, particularly the Gunnedah Formation, at a regional scale; the influence of faults; and sensitivity analysis of the water balance modelling.
41. The key matters in IESC 2013-023 that need further information are outlined below. These could be addressed through collection of additional data before and during operations with subsequent comparison and updates to predictions as needed, and regular reporting, review and action taken, if the mine is approved:
 - a. A targeted monitoring programme.
 - b. Finer-scale numerical groundwater modelling, with a particular focus on the conceptualisation and parameterisation of the fresh and weathered Permian strata in the zone between the proposed pits and the Upper Namoi Alluvium.
 - c. Identification and assessment of potential impacts to water dependent ecosystems, including EPBC-listed communities (such as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland), and salt-sensitive biota within and beyond the proposed project boundary.
 - d. Assessment of local-scale cumulative impacts.
 - e. Long-term impacts associated with the final landform.

Question 2: What are the key uncertainties and risks of the project and/or potential impacts on groundwater and surface water resources?

Response

42. The key potential impact associated with the proposed project is change to groundwater pressure and/or level within the Upper Namoi Alluvium groundwater resource. The IESC considers that impacts to the highly productive Upper Namoi Alluvium groundwater resource are likely to be less than those predicted in the numerical groundwater model sensitivity and uncertainty analysis of the Environmental Impact Statement (Hansen Bailey, 2013a; EIS). An uncertainty analysis would be needed to judge whether groundwater impacts to the Upper Namoi Alluvium may exceed those predicted using Dr Col Mackie's preferred scenarios (Hansen Bailey, 2014, App A), which constitute the groundwater drawdown limit in the NSW Government consent conditions (PAC, 2015). There is also the potential for local-scale impacts to surface water quality and long-term salinity changes associated with the final landform.

43. The main factors that influence groundwater drawdown in the Upper Namoi Alluvium are recharge and hydraulic parameters, particularly for weathered and unweathered Permian strata between the proposed pits and the Upper Namoi Alluvium. These factors influence the potential for drawdown in the Permian sequence to be transmitted to the overlying Upper Namoi Alluvium.
44. There is uncertainty as to the potential impacts to aquatic ecosystems as a result of the hydrological impacts predicted, due to insufficient survey effort. Little information has been provided that clearly identifies: ecological assets beyond the proposed project boundary that are dependent (either fully or partially) on surface water and groundwater systems; their current condition; and how these assets will be impacted by both the proposed project and any cumulative impacts. Should the project be approved, these information needs could be met by targeted additional data collection and improvements to the monitoring and management programme before and during operations.

Question 3: The proponent has concluded that there is a low risk of direct hydraulic connection between the Upper Namoi Alluvium and the Permian sequence and has therefore concluded that the floodplain alluviums will not be impacted. Does the Committee agree with this conclusion?

Response

45. The proponent's numerical groundwater model, which the IESC considers to be reasonable, demonstrates a direct hydraulic connection between the Upper Namoi Alluvium and the Permian strata and predicts groundwater drawdown within the floodplain alluviums as a result of the proposed project. The magnitude and extent of groundwater drawdown in the alluvial aquifers is considered unlikely to be significant, based on predictions described in the sensitivity and uncertainty analyses in the EIS. To improve confidence in groundwater drawdown predictions over time, additional data should be gathered on the hydraulic connectivity between the Permian strata and the Upper Namoi Alluvium (as discussed in response to Question 3a within IESC 2015-066).

Question 4: Is justification and verification of the conceptual groundwater model adequate? Has the proponent adequately addressed the uncertainty of hydraulic connectivity and impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers? Are the confidence levels around the predicted impacts to these structures sufficiently high to be relied upon to make a decision around matters of national environmental significance?

Response

46. Yes. The proponent's groundwater conceptualisation is considered to be adequate on the basis of alignment of the range of modelled parameter values with field data and the consistency of the proponent's conceptualisation with previous hydrogeological studies in the region. Should the project be approved, further verification resulting from additional monitoring and finer-scale modelling (as described in IESC 2015-066, paragraph 26) would improve confidence in predictions.
47. Yes. The numerical groundwater model sensitivity analysis and uncertainty analysis within the EIS, information provided in response to a review by UNSW (DPE, 2014, App C) and additional modelling scenarios proposed by Dr Col Mackie (Hansen Bailey, 2014, App A), have reasonably addressed uncertainties associated with the model including potential variability of hydraulic conductivity. These analyses improve confidence that impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers are not likely to exceed those predicted in the sensitivity and uncertainty analyses in the EIS.

48. Yes. The proponent's documentation is considered to be sufficiently robust and confidence levels surrounding the current numerical groundwater modelling are considered to be sufficient to draw conclusions surrounding the most likely range of groundwater drawdown impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers. There remains an unassessed risk to GDEs, which include EPBC-listed ecological communities (such as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland) within the groundwater drawdown extent. Potential impacts to GDEs have been ruled out by the proponent as the GDEs considered were deemed not wholly dependent on groundwater. However, by definition (Richardson et al., 2011), GDEs include ecosystems that opportunistically use groundwater and potential impacts should be considered for all GDEs. Additionally, potential impacts to water dependent ecosystems beyond the proposed project area remain uncertain due to insufficient survey effort.

Question 5: Are the revised groundwater models and the relevant data, assumptions and analyses valid and adequate to assess the potential impacts to groundwater?

Response

49. Yes. The revised groundwater models, relevant data, assumptions and analysis are considered to be adequate to assess the potential hydrological impacts to groundwater. The proponent's groundwater conceptualisation and model parameterisation are considered to be reasonable based on the available field data, sensitivity and uncertainty analysis in the EIS, information provided in response to a review by UNSW (DPE, 2014, App C) and consistency with additional modelling scenarios proposed by Dr Col Mackie (Hansen Bailey, 2014, App A). Should the project progress, additional monitoring and finer-scale groundwater modelling would improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of the finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.

Question 6: Are there additional measures and commitments required to monitor, mitigate and manage impacts resulting from changes to surface or groundwater resources?

Response

50. Yes, the IESC has identified additional measures that should be implemented to monitor, mitigate and manage the potential impacts to water resources and water-related assets.
51. The spatial and temporal coverage of the surface water, groundwater and ecological monitoring programmes should be expanded to ensure monitoring is sufficient to:
- a. Enable derivation of appropriate trigger values for water quality and ecological values for each water resource.
 - b. Ensure early warnings of impacts exceeding predictions, in time to implement corrective action and management strategies.
 - c. Determine exceedance of triggers in a quantifiable robust manner, and to be capable of determining the contribution of the proposed project to any observed impacts, as distinct from those caused by other users and climatic conditions.
 - d. Obtain the additional data needed to reduce uncertainties in the numerical groundwater model predictions.
 - e. Detect post-mining impacts.

52. IESC 2015-066 makes specific suggestions for expanding the proposed surface water and groundwater monitoring spatial coverage (see paragraphs 26-33). An ecological monitoring programme should be informed by surveys of water-dependent and salt-sensitive biota within and downstream of the project area.
53. If triggers and limits are exceeded, management responses for surface water and groundwater should be clearly stated within an enforceable adaptive management framework and may include, but should not be limited to, the elements listed below.
- a. Ecotoxicity testing of discharges and surface waters to assess bioavailability of contaminants in these mixtures.
 - b. Water allocation and engineering management options including: water treatment; dam sizing; increasing the capacity of the water management system; and redesign, capping and revegetation of overburden. The proponent suggests cut off measures and reinjection of water into depressurised aquifers to mitigate groundwater drawdown. A stronger rationale is needed for reinjection with consideration given to: the goals of the option; the likely sources of water for reinjection; the suitability of the water with regards to matching water quality at the injection site; the potential impacts to both the injection site and the source site; and evaluation of the reinjection against alternative management options such as purchasing additional groundwater licences or altering the mine plan.
 - c. Mine plan management options including limiting depth and lateral extents of mining to reduce effects of depressurisation.
 - d. Regular ongoing assessment, validation, recalibration and peer review of models to reduce uncertainties in model predictions and to enable initiation and/or variation of proposed management processes.
 - e. Regulatory options where groundwater drawdown limits are exceeded and reassessment of suitability of approval limits and triggers.

Question 6(a): Has the proponent adequately addressed the salinity risks associated with the project at a local and regional scale?

Response

54. Yes at the regional scale but not at the local scale. The current lack of adequate surveys identifying water-dependent and salt-sensitive biota prevents an assessment of the risk of sediment dam saline discharges and long-term seepages at the local scale. Salt-sensitive biota within and downstream of the proposed project area should be identified, assessed for potential impacts and monitored.
55. The predicted salt loads from the proposed project are likely to have a negligible impact on salinity at a regional scale. As such the regional-scale salinity risk is considered to have been adequately addressed.

Question 6(b): Are there additional measures and commitments required to monitor, mitigate and manage impacts resulting from salinity impacts?

Response

56. Yes, the IESC has identified additional measures that should be implemented to manage the potential impacts from salinity at the local scale. Additions to the monitoring programme should include the elements listed below.

- a. Identification, establishment of trigger values and monitoring of salt-sensitive biota within and downstream of the proposed project area.
 - b. Event-based water quality monitoring and continuous monitoring of flow and electrical conductivity (EC) in Native Dog Gully to provide context for water quality measurements, establish the flow regime, and monitor changes to the regime as a result of the proposed project.
 - c. Monitoring of water flow and quality (including continuous monitoring of EC) in Watermark Gully downstream of the eastern pit to detect any impacts from runoff from the overburden emplacement area.
57. The surface water management plan should detail the mitigation and management measures that will be employed if salt loads exceed the site-specific trigger values in Watermark Gully, Native Dog Gully or the Mooki River.
58. Management responses may include, but should not be limited to: water treatment; dam sizing; increasing the capacity of the water management system; and redesign, capping and revegetation of overburden.

Question 7: Are there any significant gaps in the scientific data presented that should be obtained to increase the confidence levels around the predicted impacts? If so, what data should be obtained?

Response

59. In relation to numerical groundwater modelling predictions, the scientific data is considered to be sufficiently robust to draw conclusions as to the most likely impacts on the Upper Namoi Alluvium, particularly the Gunnedah Formation, at a regional scale. Should the project progress, additional monitoring and finer-scale groundwater modelling would improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.
60. A staged approach to further monitoring would be appropriate to be undertaken in line with the proposed mine plan, particularly in the Permian strata and weathered zone in the area between the mine pits (in particular the eastern and southern pits) and Upper Namoi Alluvium. This monitoring should be undertaken in conjunction with development of finer-scale groundwater models focussing on each pit, with more detailed definition of strata, seasonal variation and boundary conditions. Improved understanding of the hydrogeological system gained during operations in one pit should be used to assess potential impacts associated with the next pit. The knowledge gained during operations should be used to inform the assessment of potential impacts from the final landform, including the proposed void and potential seepages and determination of mitigation or management strategies.
61. Additional information on the following matters would improve confidence levels around the potential impacts to water resources. The IESC considers that these information needs could be met by targeted additional data collection and improvements to the monitoring and management programme before and during operations.
- a. Identification of GDEs beyond the proposed project boundary and an assessment of their current condition, any potential impacts from the proposed project, and any cumulative impacts.
 - b. An assessment of the potential ecological impact of the project on the instream community in the Mooki River. The combined impacts of loss of streamflow as well as changes to water

quality, particularly salt loads and dissolved metals during 'first flush' events on Native Dog Gully and the Mooki River should be further considered.

- c. A thorough assessment of the risk to water resources and water-related assets from runoff from overburden emplacement areas. This assessment should be informed by the monitoring of surface water quality in Watermark Gully downstream of the eastern pit and the addition of selenium, aluminium and molybdenum to the suite of metals tested on a regular basis in watercourses downstream of the proposed project area.

Question 8: Are the proposed management responses to groundwater alluvium interception adequate? If not, are there additional measures and commitments required to mitigate and manage impacts?

Response

- 62. The adequacy of these measures cannot be determined at this stage as management responses have not been stated explicitly. To ensure management responses are adequate, clear trigger and limit exceedance levels and robust regulatory enforcement mechanisms should be established.

Explanation

- 63. Groundwater triggers and subsequent management responses are proposed to be developed within water management plans in the post approval process. The IESC is unable to comment on their appropriateness, as the plans are not yet available.
- 64. The additional information (Hansen Bailey, 2014, App A) has identified the need for more monitoring wells to be installed and located within the predicted zone of depressurisation to assess the extent and rate of depressurisation against numerical groundwater model predictions. Even though groundwater drawdown is not predicted in the Upper Namoi Alluvium to the north of the eastern pit, additional multi-level (nested) monitoring wells should be placed in this area to confirm model predictions and provide an early warning of any variation from predicted depressurisation in this area.
- 65. In light of the results of the sensitivity and uncertainty analysis undertaken for the EIS it would have been beneficial to have a corresponding uncertainty analysis for the scenarios posed by Dr Col Mackie and referenced by the PAC (Scenarios 3, 6, 7, and 11 in Hansen Bailey, 2014, App A) in order to understand more fully the potential for exceeding the conditions relating to groundwater drawdown impacts in the Upper Namoi Alluvium set in the NSW Government consent (PAC, 2015). In the absence of such an uncertainty analysis, a strong emphasis should be placed on developing:
 - a. A monitoring programme that enables early warnings of greater depressurisation than predicted.
 - b. Robust, enforceable management protocols (for proponent and regulator) for action to be taken in time so that limits are not exceeded.

Question 9: Are the proposed management responses to increasing salinity levels adequate? If not, are there additional measures and commitments required to mitigate and manage impacts?

Response

- 66. The adequacy of these measures cannot be determined at this stage as proposed management responses are to be included in the water management plan.

67. Yes. The IESC has identified additional measures to mitigate and manage the potential impacts from salinity at the local scale as per paragraphs 56-58 of this advice (IESC 2015-067).

Question 10: Has the proponent adequately assessed the cumulative impacts to the region in the context of all current, proposed and possible extractive industry projects?

Response

68. The proponent appropriately utilised the Namoi Catchment Water Study (SWS, 2012) to assess potential cumulative impacts to groundwater in the context of the current and proposed projects included within the bioregional assessment coal and coal seam gas resource assessment for the Namoi subregion (Northey, Pinetown and Sander, 2014). To better understand cumulative impacts, further investigation into local connectivity between the Permian and alluvial groundwater systems, particularly the properties of the fresh and weathered Permian strata in the zone between the proposed pits and the Upper Namoi Alluvium is warranted. Further investigation into the potential cumulative impacts to surface water and GDEs, as identified in SWS (2012), could also be undertaken.
69. There is a risk of cumulative impacts to the south of the proposed project area, where the maximum alluvial groundwater drawdown as a result of the proposed project is predicted and there is the potential for groundwater drawdown associated with the proposed Caroon Coal Project. A local-scale investigation into this connectivity should be undertaken by the proponents of this project and the Caroon Coal Project, as per IESC advice on both projects (IESC 2013-023 and IESC 2014-047). If the project is approved, this investigation could occur before mining of the southern pit and be built into the water management plan protocol with nearby mine owners as per the NSW Government consent condition 26c (vi) (PAC, 2015).

Question 11: Has the proponent adequately assessed the cumulative impacts to the bioregion?

Response

70. It is not considered necessary for the proponent to assess cumulative impacts to the bioregion. The proponent has referred to data sources specific to the Namoi catchment, such as aspects of the proposed framework for assessing the cumulative risk of mining on natural resource assets in the Namoi Catchment (Eco Logical, 2011) and the Namoi Catchment Water Study (SWS, 2012). The Australian Government's bioregional assessment of the Namoi subregion will provide additional information and analyses to further assess potential cumulative impacts.
71. Data and relevant information from the proposed project, including that collected during the life of the mine, should be made accessible for this Bioregional Assessment to assist the knowledge base for regional-scale assessments.

Questions from Ms Fiona Simson, President NSW Farmers

Question 1: Has the information provided by the proponent addressed concerns raised by the IESC in its advice issued on 27 May 2013?

Response

72. No, not all matters have been addressed at this stage. A number of the matters raised in IESC 2013-023 have been examined or explained in the additional information or would be addressed through the implementation of NSW Government consent conditions (PAC, 2015) including: the groundwater conceptualisation; likely impacts on the Upper Namoi Alluvium,

particularly the Gunnedah Formation, at a regional scale; the influence of faults; and sensitivity analysis of the water balance modelling.

73. The key matters in IESC 2013-023 that need further information are outlined below. These could be addressed through collection of additional data before and during operations, with subsequent comparison and updates to predictions as needed and regular reporting, review and action taken, if the mine is approved:
- a. A targeted monitoring programme
 - b. Finer-scale numerical groundwater modelling, with a particular focus on the conceptualisation and parameterisation of the fresh and weathered Permian strata in the zone between the proposed pits and the Upper Namoi Alluvium
 - c. Identification and assessment of potential impacts to water dependent ecosystems, including EPBC-listed communities (such as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland), and salt-sensitive biota within and beyond the proposed project boundary.
 - d. Assessment of local-scale cumulative impacts.
 - e. Long-term impacts associated with the final landform.

Question 2: Is the conceptual groundwater model appropriate and adequate? Does the Committee consider that any changes should be made to the conceptual groundwater model?

Response

74. Yes, the proponent's groundwater conceptualisation is considered to be appropriate and adequate to assess potential groundwater drawdown impacts to groundwater resources as a result of the proposed project. This view is based on the alignment of the range of modelled parameter values with field data and the consistency of the proponent's conceptualisation with previous hydrogeological studies in the region. Should the project be approved, further verification resulting from additional monitoring and finer-scale groundwater modelling (as described in IESC 2015-066, paragraph 26) would improve confidence in predictions.

Question 3: Are the revised groundwater models, relevant data, assumptions and analysis adequate to assess the potential impacts to groundwater at a local and regional scale?

Response

75. Yes. The revised groundwater models, relevant data, assumptions and analysis are considered to be adequate to assess the potential hydrological impacts to groundwater. The proponent's groundwater conceptualisation and model parameterisation are considered to be reasonable based on the available field data, sensitivity and uncertainty analysis in the EIS, information provided in response to a review by UNSW (DPE, 2014, App C) and consistency with additional modelling scenarios proposed by Dr Col Mackie (Hansen Bailey, 2014, App A). Should the project progress, additional monitoring and finer-scale groundwater modelling would improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.

Question 4a: What are the key uncertainties and risks of the project and/or potential impacts on groundwater and surface water resources?

Response

76. The key potential impact associated with the proposed project is change to groundwater pressure and/or level within the Upper Namoi Alluvium groundwater resource. The IESC considers that impacts to the highly productive Upper Namoi Alluvium groundwater resource are likely to be less than those predicted in the numerical groundwater model sensitivity and uncertainty analysis within the EIS (Hansen Bailey, 2013a). An uncertainty analysis would be needed to judge whether groundwater impacts to the Upper Namoi Alluvium may exceed those predicted using Dr Col Mackie's preferred scenarios (Hansen Bailey, 2014, App A), which constitute the groundwater drawdown limit in the NSW Government consent conditions (PAC, 2015). There is also the potential for local-scale impacts to surface water quality and long-term salinity changes associated with the final landform.
77. The main factors that influence drawdown in the Upper Namoi Alluvium are recharge and hydraulic parameters, particularly for weathered and unweathered Permian strata between the proposed pits and the Upper Namoi Alluvium. These factors influence the potential for drawdown in the Permian sequence to be transmitted to the overlying Upper Namoi Alluvium.
78. There is uncertainty as to the potential impacts to aquatic ecosystems as a result of the hydrological impacts predicted, due to insufficient survey effort. Little information has been provided that clearly identifies: ecological assets beyond the proposed project boundary that are dependent (either fully or partially) on surface water and groundwater systems; their current condition; and how these assets may be impacted by both the proposed project and any cumulative impacts. Should the project be approved, these information needs could be met by targeted additional data collection and improvements to the monitoring and management programme before and during operations.

Question 4b: What additional measures and commitments could be required or undertaken to monitor, mitigate and manage impacts resulting from changes to surface or groundwater resources at a local and regional scale?

Response

79. The IESC has identified additional monitoring and management measures that should be implemented to monitor, mitigate and manage the potential impacts to water resources and water-related assets at a local and regional scale.
80. The spatial and temporal coverage of the surface water, groundwater and ecological monitoring programmes should be expanded to ensure monitoring is sufficient to:
- a. Enable derivation of appropriate trigger values for water quality and ecological values for each water resource.
 - b. Ensure early warnings of impacts exceeding predictions, in time to implement corrective action and management strategies.
 - c. Determine exceedance of triggers in a quantifiable robust manner and to be capable of determining the contribution of the proposed project to any observed impacts, as distinct from those caused by other users and climatic conditions.
 - d. Obtain the additional data needed to reduce uncertainties in the numerical groundwater model predictions.
 - e. Detect post-mining impacts.

81. IESC 2015-066 makes specific suggestions for expanding the proposed surface water and groundwater monitoring spatial coverage (see paragraphs 26-33). An ecological monitoring programme should be informed by surveys of water-dependent and salt-sensitive biota within and downstream of the project area.
82. If triggers and limits are exceeded, management responses for surface water and groundwater should be clearly stated within an enforceable adaptive management framework and may include, but should not be limited to, the elements listed below.
- a. Ecotoxicity testing of discharges and surface waters to assess bioavailability of contaminants in these mixtures.
 - b. Water allocation and engineering management options including: water treatment; dam sizing; increasing the capacity of the water management system; and redesign, capping and revegetation of overburden. The proponent suggests cut off measures and reinjection of water into depressurised aquifers to mitigate groundwater drawdown. A stronger rationale is needed for reinjection with consideration given to: the goals of the option; the likely sources of water for reinjection; the suitability of the water with regards to matching water quality at the injection site; the potential impacts to both the injection site and the source site; and evaluation of the reinjection against alternative management options such as purchasing additional groundwater licences or altering the mine plan.
 - c. Mine plan management options including limiting depth and lateral extents of mining to reduce effects of depressurisation.
 - d. Regular ongoing assessment, validation, recalibration and peer review of models to reduce uncertainties in model predictions and to enable initiation and/or variation of proposed management processes.
 - e. Regulatory options where groundwater drawdown limits are exceeded and reassessment of suitability of approval limits and triggers.

Question 5a: Has the revised information adequately addressed any salinity risks associated with the project at a local and regional scale?

Response

83. Yes, at the regional scale, but not at the local scale. The current lack of adequate surveys identifying water-dependent and salt-sensitive biota prevents an assessment of the risk of sediment dam saline discharges and long-term seepages at the local scale. Salt-sensitive biota within and downstream of the proposed project area should be identified, assessed for potential impacts and monitored.
84. The predicted salt loads from the proposed project are likely to have a negligible impact on salinity at a regional scale. As such the regional-scale salinity risk is considered to have been adequately addressed.

Question 5b: Are there additional measures and commitments required to monitor, mitigate and manage impacts resulting from salinity impacts?

Response

85. Yes, the IESC has identified additional measures that should be implemented to monitor, mitigate and manage the potential impacts from salinity at the local scale. Additions to the monitoring programme should include the elements listed below.

- a. Identification, establishment of trigger values and monitoring of salt-sensitive biota within and downstream of the proposed project area.
 - b. Event-based water quality monitoring and continuous monitoring of flow and electrical conductivity (EC) in Native Dog Gully to provide context for water quality measurements, establish the flow regime, and monitor changes to the regime as a result of the proposed project.
 - c. Monitoring of water flow and quality (including continuous monitoring of EC) in Watermark Gully downstream of the eastern pit to detect any impacts from runoff from the overburden emplacement area.
86. The surface water management plan should detail the mitigation and management measures that will be employed if salt loads exceed the site-specific trigger values in Watermark Gully, Native Dog Gully or the Mooki River.
87. Management responses may include, but should not be limited to: water treatment; dam sizing; increasing the capacity of the water management system; and redesign, capping and revegetation of overburden.

Question 6a: Has the proponent adequately addressed the uncertainty of hydraulic connectivity and impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers?

Response

88. Yes. The numerical groundwater model sensitivity analysis and uncertainty analysis within the EIS, information provided in response to a review by UNSW (DPE, 2014, App C) and additional modelling scenarios proposed by Dr Col Mackie (Hansen Bailey, 2014, App A), have reasonably addressed uncertainties associated with the model including potential variability of hydraulic conductivity. These analyses improve confidence that impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers are not likely to exceed those predicted in the sensitivity and uncertainty analyses in the EIS.
89. As described in the IESC 2015-066 (paragraph 26) the proponent should undertake further monitoring and finer-scale groundwater modelling as the project progresses to further reduce uncertainty. This will improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.

Question 6b: Are the confidence levels around the predicted impacts to these structures sufficiently low to be relied upon to make a decision around matters of national environmental significance?

Response

90. In relation to groundwater modelling predictions, the source documentation is considered to be sufficiently robust to draw conclusions to the most likely range of groundwater drawdown impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers. However, there remains an unassessed risk to GDEs and the proponent should undertake further monitoring and finer-scale groundwater modelling as the project progresses, as described in IESC 2015-066 (paragraph 26), to further improve confidence and ensure that accurate predictions drive any necessary action in a timely manner to keep impacts within the bounds of those originally predicted.

91. While the confidence levels around predicted groundwater drawdown impacts to the Gunnedah Formation, Narrabri Formation and Permian 'hard rock' aquifers are reasonable, there remains an unassessed risk to GDEs, which include EPBC-listed ecological communities (such as White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland) within the groundwater drawdown extent. Potential impacts to GDEs have been ruled out by the proponent as the GDEs considered were deemed not wholly dependent on groundwater. However, by definition (Richardson et al., 2011), GDEs include ecosystems that opportunistically use groundwater and potential impacts should be considered for all GDEs. Additionally potential impacts to water dependent ecosystems beyond the proposed project area remain uncertain due to insufficient survey effort.

Question 6c: Are there any significant gaps in the scientific data presented that should be obtained to increase the confidence levels around the predicted impacts? If so, what data should be obtained?

Response

92. In relation to numerical groundwater modelling predictions, the scientific data is considered to be sufficiently robust to draw conclusions as to the most likely impacts on the Upper Namoi Alluvium, particularly the Gunnedah Formation, at a regional scale. Should the project progress, additional monitoring and finer-scale groundwater modelling would improve confidence in predictions and support clear identification and response to mine-induced impacts at a local scale. Calibration and validation of finer-scale models would only be feasible with observations of the actual responses of the local groundwater system to the proposed project.
93. A staged approach to further monitoring would be appropriate to be undertaken in line with the proposed mine plan, particularly in the Permian strata and weathered zone in the area between the mine pits (in particular the eastern and southern pits) and the Upper Namoi Alluvium. This monitoring should be undertaken in conjunction with development of finer-scale groundwater models focussing on each pit, with more detailed definition of strata, seasonal variation and boundary conditions. Improved understanding of the hydrogeological system gained during operations in one pit should be used to assess potential impacts associated with the next pit. The knowledge gained during operations should be used to inform the assessment of potential impacts from the final landform, including the proposed void and potential seepages and determination of mitigation or management strategies.
94. Additional information on the following matters would improve confidence levels around the potential impacts to water resources. The IESC considers that these information needs could be met by targeted additional data collection and improvements to the monitoring and management programme before and during operations.
- a. Identification of GDEs beyond the proposed project boundary and an assessment of their current condition, any potential impacts from the proposed project, and any cumulative impacts.
 - b. An assessment of the potential ecological impact of the project on the instream community in the Mooki River. The combined impacts of loss of streamflow as well as changes to water quality, particularly salt loads and dissolved metals during 'first flush' events on Native Dog Gully and the Mooki River should be further considered.
 - c. A thorough assessment of the risk to water resources and water-related assets from runoff from overburden emplacement areas. Monitoring of surface water quality in Watermark Gully downstream of the eastern pit, and the addition of selenium, aluminium and molybdenum to the suite of metals tested on a regular basis in watercourses downstream of the proposed project area..

Question 7: Are the proposed management responses to groundwater alluvium interception adequate? If not, are there additional measures and commitments required to mitigate and manage impacts?

Response

95. The adequacy of these measures cannot be determined at this stage as mitigation and management responses have not been stated explicitly. To ensure management responses are adequate, clear trigger and limit exceedance levels, and robust regulatory enforcement mechanisms should be established.

Explanation

96. Groundwater triggers and subsequent management responses are proposed to be developed within water management plans in the post approval process. The IESC is unable to comment on their appropriateness, as the plans are not yet available.
97. The additional information (Hansen Bailey, 2014, App A) has identified the need for more monitoring wells to be installed and located within the predicted zone of depressurisation to assess the extent and rate of depressurisation against numerical groundwater model predictions. Even though groundwater drawdown is not predicted in the Upper Namoi Alluvium to the north of the eastern pit, additional multi-level (nested) monitoring wells should be placed in this area to confirm model predictions and provide an early warning of any variation from predicted depressurisation in this area.
98. In light of the results of the sensitivity and uncertainty analysis undertaken for the EIS it would have been beneficial to have a corresponding uncertainty analysis for the scenario posed by Dr Col Mackie and referenced by the PAC (Scenarios 3, 6, 7, and 11 in Hansen Bailey, 2014, App A) in order to understand more fully the potential for exceeding the conditions relating to groundwater drawdown impacts in the Upper Namoi Alluvium set in the NSW Government consent (PAC, 2015). In the absence of such an uncertainty analysis, a strong emphasis should be placed on developing:
- a. A monitoring programme that enables early warnings of greater depressurisation than predicted.
 - b. Robust enforceable management protocols (for proponent and regulator) for action to be taken in time so that limits are not exceeded.

Question 8: Are the proposed management responses to increasing salinity levels adequate? If not, are there additional measure and commitments required to mitigate and manage impacts?

Response

99. The adequacy of these measures cannot be determined at this stage as the proposed mitigation and management responses are to be included in the water management plan.
100. The IESC has identified additional measures to mitigate and manage the potential impacts from salinity at the local scale as per the response to Question 5(b) above (paragraphs 85-87 of this advice IESC 2015-067).

Question 9: The proponent has concluded that there is a low risk of hydraulic connection between the Upper Namoi Alluvium and the Permian sequence and has therefore concluded that the floodplain alluviums will not be impacted. Does the Committee agree with this conclusion?

Response

101. The proponent's numerical groundwater model, which the IESC considers to be reasonable, demonstrates a direct hydraulic connection between the Upper Namoi Alluvium and the Permian strata and predicts groundwater drawdown within the floodplain alluviums as a result of the proposed project. The magnitude and extent of groundwater drawdown in the alluvial aquifers is considered unlikely to be significant, based on predictions described in the sensitivity and uncertainty analyses in the EIS. To improve confidence in groundwater drawdown predictions over time, additional data should be gathered on the hydraulic connectivity between the Permian strata and the Upper Namoi Alluvium (as discussed in response to Question 3a within IESC 2015-066).

Date of advice 27 April 2015

Source documentation available to the IESC in the formulation of IESC advice 2015-066 and 2015-067	<p>Acworth R and Timms W, 2009. Evidence for connected water processes through smectite-dominated clays at Breeza, New South Wales. <i>Australian Journal of Earth Sciences</i> 56 (1) 81-96.</p> <p>Barrett C, 2010. Upper Namoi Groundwater Sources – Resource Condition Assessment Report 2010, NSW Office of Water, Sydney.</p> <p>Barrett C, 2012. Upper Namoi Groundwater Source – Status Report 2011, NSW Office of Water, Sydney.</p> <p>BHP Billiton, 2015. Carooona Coal Project Gateway Application Submission Documentation.</p> <p>Department of Planning and Environment, 2014a. Secretary's Environmental Assessment Report. Watermark Coal Project SSD-4975. State of NSW May 2014.</p> <p>Department of Planning and Environment, 2014b. Secretary's Environmental Assessment Report Addendum. Watermark Coal Project SSD-4975. State of NSW November 2014.</p> <p>Greeve A, Andersen M and Acworth R, 2010. Investigations of soil cracking and preferential flow in a weighing lysimeter filled with cracking clay soil. <i>Journal of Hydrology</i> 393 (2010) 105-113.</p> <p>Hansen Bailey, 2013a. Watermark Coal Project Environmental Impact Statement. Report prepared for Shenhua Watermark Coal Pty Ltd. February 2013.</p> <p>Hansen Bailey, 2013b. Watermark Coal Project Response to Submissions. Report prepared for Shenhua Watermark Coal Pty Ltd. November 2013.</p> <p>Hansen Bailey, 2014. Watermark Coal Project Response to Planning Assessment Commission Review Report. Report prepared for Shenhua Watermark Coal Pty Ltd. October 2014.</p> <p>Hillier J, Timms W and Merrick N, 2010. Peer review of the Upper Namoi Alluvium Numerical Groundwater Model for the MDBA.</p> <p>IESC 2013-023. Advice on Watermark Coal Project available at: http://www.iesc.environment.gov.au/committee-advice/proposals/watermark-coal-project-new-development-project-advice</p> <p>IESC 2014-047. Advice on Carooona Coal Project available at: http://www.iesc.environment.gov.au/committee-advice/proposals/carooona-coal-project-new-development-project-advice</p> <p>Kelly B, Merrick N, Dent B, Milne-Horne W and Yates D, 2007. Groundwater Knowledge and Gaps in the Namoi Catchment Management Area. National Centre for Groundwater Management, University of Technology, Sydney. March 2007.</p> <p>Northey J, Pinetown K and Sander R, 2014. Coal and coal seam gas resource assessment for the Namoi subregion. Product 1.2 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.</p>
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Advice to decision maker on coal mining project

Proposed action: Watermark Coal Project (EPBC 2011/6201) – New Development

Requesting agency	Department of Sustainability, Environment, Water, Population and Communities
Date of request	17 April 2013
Date request accepted	17 April 2013
Advice stage	Environment Impact Assessment (draft)

Advice

The Committee was requested to provide advice to the Commonwealth regulator on the Watermark Coal Project in New South Wales at the Environmental Impact Assessment (draft) stage. This advice draws upon aspects of information in the draft Environmental Impact Statement, together with the expert deliberations of the Committee. The draft Environmental Impact Statement and information accessed by the Committee are listed in the source documentation at the end of this advice.

The proposed project is a new development for an open cut coal mine, producing up to 10 million tonnes per annum of Run of Mine coal for up to 30 years, located 25 km from Gunnedah and immediately west of Breeza in Northern New South Wales. The site is adjacent to the Mooki River, which is a major tributary of the Namoi Catchment. The target coal seams are contained within the Black Jack Group of the late Permian strata of the Gunnedah Basin and include the Hoskissons and Melvilles seams. The disturbance area for the proposed project covers 4,084 ha.

Cumulative impacts on the Namoi Catchment

The Committee encourages the regulator to consider the water related impacts of the proposed project in a cumulative assessment context such as that presented in the Namoi Catchment Water Study. This Study presents a range of coal seam gas and coal mining development scenarios. The Study provides predictions of surface water losses and groundwater drawdown which should be used to provide context to individual project impact assessments.

A regional water balance is an important component of a cumulative assessment and the Committee suggests, in relation to the Watermark project, that defined regional boundaries can be logically drawn, i.e. groundwater from the Liverpool Range to Gin's Leap and surface water from the project site to the Boggabri gauging station.

The Committee considers that the proposed project is likely to enhance the risk of salinity in the region. The proposed project is likely to result in salinity impacts from overflow of water storages, seepage from the backfilled and proposed open mine voids, connectivity between the alluvium and Permian strata and the removal of woodland from the proposed project site. A regional perspective on salinity is important to properly assess the significance of such impacts and this should be addressed through the development of a regional salt balance.

The Committee, in line with its Information Guidelines¹, has considered whether the proposed project assessment has used the following:

Relevant data and information: key conclusions

In the main, the proponent has used relevant data and information, with the exception of the areas

noted below. The proponent has referred to data sources specific to the Namoi catchment, such as aspects of the proposed framework for assessing the cumulative risk of mining on natural resource assets in the Namoi catchment (Eco Logical, 2011) and the Namoi Catchment Water Study (Schlumberger, 2012).

However, the documentation provided would benefit from further information in relation to:

- Downstream aquatic ecosystems, assets and receptors;
- Groundwater dependence of vegetation communities (including the critically endangered White Box Yellow Box Blakey's Red Gum Woodland and Derived Native Grassland and endangered ecological communities found on site);
- Evidence for the assertion of no hydraulic connection to the Great Artesian Basin;
- Evidence for the low hydraulic conductivities modelled in the coal seams and their distribution;
- Evidence for groundwater model assumptions relating to constant irrigation use and constant conditions across the northern boundary; and
- Evidence for faulting and the role of faults in impeding or transmitting groundwater flow.

Appropriate methodologies which have been applied correctly: key conclusions

The proponent has selected appropriate methodologies in their environmental assessment, including a semi-quantitative risk assessment and appropriate use of software for the modelling of groundwater, flooding and the site water balance. The numerical groundwater modelling has undergone sensitivity and uncertainty analysis and peer review. However, the water budget across the groundwater model domain does not constitute a regional water balance and a regional salt balance has not been provided. Further, the Committee has concerns with respect to the application of these methodologies in some circumstances.

With respect to the application of these methodologies:

- The effectiveness of control measures used to address preliminary risks cannot be determined as these controls will be embedded in management plans which have not been provided;
- Insufficient justification and verification has been provided for the groundwater conceptualisation, particularly with regard to interconnectivity between the Upper Namoi Alluvium and Permian sequence, which decreases confidence in conclusions drawn from the numerical groundwater model; and
- No sensitivity analysis has been performed on the site water balance to date and there has been no consideration of the potential impacts of climate variability, which results in a reduced level of confidence in the modelled results.

Reasonable values and parameters in calculation: key conclusions

The values and parameters used in calculations by the proponent appear plausible, with the exceptions and differences noted above and following:

- Climate data from early and recent years are underrepresented in the realisations modelled in the site water balance;
- Calculations of additional site water supply requirements have used average rather than maximum values and have not considered water availability; and

- The proponent classifies the Hoskissons and Melvilles coal seams as aquitards, whereas Schlumberger (2012) classified these coal seams as aquifers.

Question 1: Does the Committee consider that the proponent has provided sufficient information on the water resources and its management to assess likely significant impacts from its proposed action? If the information is considered insufficient for that purpose, what advice regarding areas of inadequacy can the Committee provide?

102. The Committee considers that applying a water balance model is the most appropriate basis for assessing potential changes in water resources and impacts on aquatic ecosystems, assets and receptors. The deficiencies in the regional and site water balances make a comprehensive assessment of likely significant impacts as a result of the proposed project difficult. Further areas where the assessment documentation could benefit from additional information are outlined below and have been addressed in questions 3, 4, 5, 6, 8 and 9.

- a. In relation to the site water balance, the earliest and latest periods of historical data are underrepresented in the realisations modelled. The Committee has limited confidence in the predicted lack of release of mine water and recommends that, in order to minimise downstream water quality and ecological impacts, the proponent:
 - i. Undertake sensitivity analysis on the site water balance;
 - ii. Use the results of the site water balance sensitivity analysis, as well as predicted available water determinations, surface water availability and any applicable access rules to ensure that water supply licences will meet site water requirements under a full range of foreseeable conditions;
 - iii. Design mine water storages to contain a 1:1000 year average recurrence interval storm event; and
 - iv. Develop contingency plans to deal with the event of an emergency discharge of water from a mine water dam.
- b. In relation to a regional water balance, the Committee recommends that a regional water balance be developed to allow for assessment of significant impacts. This water balance should:
 - i. Extend across the regional surface and groundwater systems to defined monitoring points, beyond which there will be no measurable impacts as a result of the proposed project, e.g. groundwater to Gin's Leap and surface water to the Namoi River at Boggabri gauging station;
 - ii. Detail the set of water stores and the flow of water between those stores under current conditions within this region;
 - iii. Assess the change as a result of the proposed project to the quantity or quality of water within any store or flow of water between these stores;
 - iv. Take into account a range of foreseeable climatic scenarios; and
 - v. Undergo sensitivity analysis.
- c. Significant impacts are also likely as a result of the proposed project's increase in salt loads downstream of the proposed project site, into a catchment already at risk from salinity. The project assessment documentation would therefore benefit from the inclusion of a local and regional salt balance. A salt balance should:

- i. Detail the set of salt stores and the transfer of salt between those stores under current conditions within this region;
- ii. Assess the change as a result of the proposed project to the quantity of salt within any store or transfer of salt between these stores;
- iii. Take into account a range of foreseeable climatic scenarios; and
- iv. Undergo sensitivity analysis.

Question 2: Is the assessment of the current condition of the ground and surface water environments in and surrounding the project area accurate?

103. The assessment that surface and groundwater systems are generally in poor condition is accurate and supported by evidence. The Mooki River adjacent to the proposed project boundary is highly degraded and riparian vegetation is absent. Further, in terms of usage, the Upper Namoi Alluvium is a very important groundwater source in New South Wales and its stress has been well documented.

104. Insufficient information has been provided by the proponent that clearly identifies outside of the proposed project boundary: aquatic ecosystems, assets and receptors that are dependent on surface and groundwater systems; their current condition and how these assets and receptors will be impacted by both the proposed project; and any additional cumulative impacts.

Question 3: Are the various models used to assess the potential impacts of the project on ground and surface water, in and outside the project area, appropriate for the purpose and acceptable as compared to known industry best practice? Are the data and assumptions on which the models were based valid and accurate? Have all reasonably foreseeable scenarios been modelled (e.g. low flow periods, climate change, simultaneous flooding events in surrounding water bodies etc.)?

105. The surface water balance and flood models and the numerical groundwater model used by the proponent are fit for purpose and consistent with best industry practice.

- a. The data and assumptions for these models are accurate and valid, with the exception of the issues detailed below in relation to the numerical groundwater modelling.
 - i. Insufficient justification and verification has been provided for the hydrogeological conceptualisation, particularly with regard to the nature of faulting and interconnectivity between the Upper Namoi Alluvium and Permian sequence, which decreases confidence in conclusions drawn from the numerical groundwater model.
 - ii. The assumptions of constant conditions at the northern boundary and constant groundwater use are both inaccurate. These assumptions limit the predictive ability of the model as it does not accurately represent the current conditions.
 - iii. The extent of the Gunnedah Formation has been determined by the proponent based on geophysical surveys, but there has been no field verification of the results. Without verification, confidence is limited in the predicted groundwater drawdown impacts on the Gunnedah Formation and resulting impacts on groundwater users.
 - iv. Hydraulic conductivities for target coal seams have not been adequately justified. The parameters used have unknown spatial distribution and extend over a large range, with some values orders of magnitude lower than those used by Schlumberger (2012) and other groundwater studies including the same Permian sequence for previous referrals in the Namoi Catchment. The Committee considers that the large range of hydraulic conductivities could overly influence the model's predicted zone of depressurisation and

that further evidence is required to justify the parameters used by the proponent.

- v. Insufficient evidence has been provided to justify the presence of faults and their behaviour in transmitting or preventing groundwater flow in the groundwater model. The modelled results appear to show that the extent of groundwater drawdown is limited by these faults. Further work should be carried out to confirm both the existence of these faults and their ability to act as hydraulic barriers. This assessment should include the potential for fractures and faults to transmit water, particularly from the Upper Namoi Alluvium.
- b. Not all reasonably foreseeable scenarios have been considered by the proponent in their modelling.
 - i. The site water balance modelling has not considered the potential for increasing climate variability.
 - ii. The assessment of cumulative impacts has only considered Scenario 2 of the Namoi Catchment Water Study and therefore has excluded other foreseeable scenarios, including Scenario 3.

Question 4: Are the model output data valid, accurate and representative of the systems they are modelling (including the ephemeral waterways)? Have the output data been presented and interpreted in an appropriate, relevant way, relative to the likely impacts of the proposal, including for the flow regimes of ephemeral waterways within and surrounding the project boundary? What level of confidence can be applied to the results and conclusions presented in the EIS?

106. The Committee has identified concerns relating to input data, assumptions, sensitivities and the number of scenarios modelled for groundwater and water balance modelling, which decrease confidence in the outputs from these models. With respect to presentation and interpretation of model outputs:

- a. Site water balance results have been presented in full only for long-term average conditions, which does not allow for interpretation of the performance of the mine water management system under climate extremes previously experienced in the region;
- b. Predicted groundwater drawdowns have not been presented for all model layers and the drawdown contours presented have not been adequately discussed. In particular:
 - i. Groundwater drawdown within the coal seams is likely to be greater than predicted by the proponent, as low hydraulic conductivity values have not been adequately justified and could be influencing the limited drawdown extent;
 - ii. It is difficult to determine the validity of the modelled impact of the faults, if any, on groundwater movement, in particular the role of these faults in impeding groundwater drawdown; and
 - iii. Groundwater drawdown for the rest of the Permian sequence in this area have not been presented by the proponent, but are modelled in the Namoi Catchment Water Study. The Committee considers that drawdown contours for these Permian units should be presented. If no drawdown is predicted by the model for these units, then an explanation should be provided as to why this will not occur; and
- c. Model outputs should be presented with an understanding of their sensitivity or uncertainty and referenced in terms of the impact to any water dependent assets.

Question 5: Has the EIS comprehensively identified, assessed and quantified all potential impacts of

the proposal on water systems within and outside the project area? If not, what impacts have not been covered and/or what information is required?

107. Whilst the proponent has identified most potential impacts on water resources, the assessment and quantification of these impacts is not comprehensive. In addition to the information gaps identified in the assessment against the Information Guidelines and under questions 1,2, 3, 4, 6, 8 and 9, the project assessment documentation would be improved by including additional information on the following potential impacts:

- a. The detailed design and construction details of pump site on the Mooki River and the diversion on Watermark Gully, including flood extents and flow velocities, to ensure that these constructions are stable and will not result in erosion or changes to downstream turbidity;
- b. Predicted flood extents along the Mooki River which extend into the Eastern mining area. Proposed mitigation actions need to be clarified;
- c. Impacts on dryland salinity as a result of the proposed direct removal of woodland; and
- d. The intersection of the current water table, potential groundwater drawdown and the depth of the root zone of protected vegetation communities.

Question 6: Is the assessment of the nature and extent of post-rehabilitation impacts on ground and surface waters accurate?

108. Post-rehabilitation, both the final void and seepage from backfilled pits present potentially significant long-term environmental hazards, which have not been adequately addressed by the proponent.

- a. The Western mining area void will have an area of 100 ha and depth of 60 metres. There are significant differences in the time to reach equilibrium and the water level at which this is achieved when the void is modelled from a groundwater or surface water perspective. As such, the Committee has limited confidence in the prediction that the void will not overtop. The Committee considers that voids are a long-term environmental legacy and backfilling of voids and pit lakes represents best environmental practice.
- b. The Southern and Eastern mining area voids are proposed to be backfilled and predicted to recover relatively quickly. The proponent has modelled seepage from these mining areas, which they predict to be 0.08 ML/day 2,000 years after mining. Sensitivity analysis shows that the salt loads from this seepage from the Southern mining area could reach up to 17 kg/ha/day. The Committee recommends that the proponent investigate the potential impacts from seepage on downstream aquatic ecosystems, assets and receptors; commence long-term monitoring; and prepare a mitigation and management plan to address any potential impacts.

Question 7: Has the cost-benefit analysis (page 55) properly considered the potential negative impacts of the proposal on water resources? If not, what would be required to address this?

109. It is not within the Committee's terms of reference to consider the adequacy of cost-benefit analyses. However, in light of the question asked, the one-page cost-benefit analysis on page 55 of the draft Environmental Impact Statement is not comprehensive and methodologically robust. It includes only the environmental benefits and socio-economic costs of the chosen project alternative and notably not the environmental costs, including potential negative impacts on water resources.

Question 8: Does the Committee find the water management, mitigation and monitoring measures

proposed to be appropriate, accurate, reasonable and effective? To what degree, if any, do the proposed mitigation and management measures reduce impacts?

110. The proposed control measures typically include management and mitigation actions, which are yet to be articulated in management plans. As such, the effectiveness of these measures cannot be determined at this stage. The Committee makes recommendations for mitigation and management in Question 8d and monitoring is discussed in Question 8b.

8a: Are the water storages proposed during operation sufficient to ensure no contamination of downstream surface waters?

111. No. There is potential for contamination of downstream surface waters from mobilisation of accumulated seepage (see Question 6), emergency release from mine water storages (see Question 1) and overflow of sediment dams. The key contaminant of concern is salt.

- a. Sediment dams that collect runoff from overburden emplacement areas are designed to overflow to ephemeral streams (although the frequency, quality and volumes of these predicted events are unknown). The proponent intends to mitigate impacts through treatment with a flocculant, or by moving the excess water to other storages on site where possible. Treatment with a flocculant will only control solids and other potential contaminants, including salt, are not proposed to be treated. These mitigation actions are insufficient without a full understanding of the potential impacts of these saline releases on downstream aquatic ecosystems, assets and receptors.
- b. The Committee recommends that the proponent provide estimates of the frequency, quality and quantity of discharges of water (particularly saline water) proposed from the site, including potential emergency discharges, seepage and overflows from sedimentation dams. Further, the environmental assessment would benefit from a thorough investigation of the impacts of these discharges on the regional salt and water balance and downstream aquatic ecosystems, assets and receptors, including access to flows in the unregulated Mooki River water source.

8b: Is baseline water monitoring data sufficient to provide an accurate and representative baseline against which changes may be determined during and after mining operations?

112. Ground and surface water monitoring data has been collected by the proponent in and adjacent to the proposed site on a regular basis for over two years, which will be used in addition to New South Wales Government monitoring data to determine a baseline at these locations. The Committee recommends that, should the proposed project go ahead:

- a. Baseline monitoring of surface and groundwater systems continue during and post operations, as potential impacts of salt water seepage are predicted to extend beyond 2,000 years into the future;
- b. Extensions to the groundwater monitoring network should be made in the alluvium and target coal seams both within and beyond the predicted zone of depressurisation; as the Committee is concerned that the proponent's predicted zone of depressurisation is limited;
- c. Extensions to the groundwater monitoring network should also ensure that there is sufficient baseline information in aquifers which have a lower monitoring bore density including the Jurassic sediments of the Surat Basin and the Clare Sandstone; and
- d. The proponent provide for additional monitoring sites as required for investigations recommended by the Committee on the water balance (Question 1), groundwater modelling (Question 3), seepage (Question 6), salt balance (Question 8a) and interconnectivity

(Question 9).

8c: Are the parameters to be measured in ground and surface water monitoring appropriate and sufficient to cover the likely water quality impacts?

113. The water quality parameters measured in the proponent's ground and surface water monitoring program are appropriate. In order to manage potential risks to downstream assets and receptors as a result of loss of catchment flows, overflow of sediment dams, mobilisation of accumulated seepage from backfilled voids and potential emergency discharge, the Committee recommends that ongoing baseline water quality sampling is carried out on a monthly basis, as well as after any significant rainfall events at the 12 sites nominated by the proponent, including the ephemeral Watermark Gully.

8d: Are there any other mitigation measures that could be implemented to further reduce any impacts?

114. The Committee recommends that the proponent develop:

- a. A comprehensive sediment control plan,
- b. A detailed flood mitigation plan which prevents flooding of the Eastern pit under a 1 in 1000 year flood event; and
- c. Surface and groundwater management plans that include:
 - i. Regular quality and quantity monitoring, as outlined above;
 - ii. Site-specific quality and quantity triggers which are sensitive enough to provide an early warning of potential deviations from a defined baseline, but buffer seasonal climate variations; and
 - iii. Appropriate management actions for each trigger and backup mitigation actions should the proposed management action not be effective.

115. The proponent intends to mitigate their impacts on biodiversity through the revegetation of offset areas. Revegetation has the potential to control dryland salinity as well as conserve biodiversity. The Committee recommends that the proponent and regulator consider potential effects on local or regional dryland salinity when choosing offset sites.

Question 9: There are a number of other mines either existing or proposed in the area surrounding the proposed Watermark Coal Project. The existence and operating management of these mines within this area raises the possibility of cumulative impacts. Does the Committee identify any particular concerns relating to cumulative impacts?

116. The Committee identifies the following concerns relating to cumulative impacts, noting that the surface and groundwater systems likely to be impacted are in a poor / stressed condition,; :
- a. The sensitivity analysis performed by Schlumberger (2012) showed that the groundwater drawdown as a result of cumulative impacts in the Upper Namoi Alluvium Zone 7 is predicted to exceed 2 m, which is significant as the average saturated thickness of the alluvium in this zone is only 13 m (noting that Schlumberger have a low level of confidence in the prediction due to limited data);
 - b. The proponent has not addressed cumulative impacts on hard rock groundwater, despite the modelling by Schlumberger (2012) of cumulative groundwater drawdown in extensive areas of the Gunnedah water management area of greater than 10 m;

- c. The proponent has not addressed cumulative impacts on surface water flow, despite modelled loss in flows by Schlumberger (2012), which show a cumulative reduction in flow in the Namoi River near Narrabri, equivalent to about half the current surface water extraction from the regulated Namoi River below Keepit Dam;
- d. The proponent has not addressed cumulative impacts on water quality, despite the predicted increase in salt loads to ephemeral water courses as a result of the proposed project and existing risk of salinity within the catchment; and
- e. There is no link provided by the proponent between these likely cumulative impacts and water dependent assets and receptors.

117. The Committee recommends that adoption of the following will provide for a more robust cumulative impact assessment:

- a. A broader consideration of the Namoi Catchment Water Study's findings, particularly with respect to the use of scenario 3 and impacts to surface water and the Gunnedah-Oxley Basin; and
- b. A local-scale focused investigation into groundwater gradients and flow, with particular regard to effects of predicted groundwater drawdown in the Permian sequence, based on connectivity between the Permian sequence, the alluvium and surface water. This investigation should be undertaken before projects proceed that are predicted to impact on the Upper Namoi Alluvium Zone 3, Zone 8 or Zone 7 in particular.

118. The Northern Inland Catchments, which includes the Namoi catchment, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible for this Bioregional Assessment to assist the knowledge base for regional scale assessments.

Date of advice	27 May 2013
Source documentation available to the Committee in the formulation of this advice	Hansen Bailey Pty Ltd 2013. Watermark Coal Project Environmental Impact Statement. Prepared for Shenhua Watermark Pty Ltd. February 2013.
References cited within the Committee's advice	<p>¹ Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources available at: http://www.environment.gov.au/coal-seam-gas-mining/project-advice/pubs/iesc-information-guidelines.pdf</p> <p>Eco Logical Australia 2011. Proposed Framework for Assessing the Cumulative Risk of Mining on Natural Resource Assets in the Namoi Catchment, 14 Sep 2011.</p> <p>Schlumberger Water Services 2012. Namoi Catchment Water Study Independent Expert Final Study Report. Prepared for Department of Trade and Investment, Regional Infrastructure and Services, New South Wales. Report no. 50371/P4-R2 FINAL.</p>