

## Advice to decision maker on coal mining project

### IESC 2014-043: Liddell Coal Operation (EPBC 2013/6908) – Expansion

<b>Requesting agency</b>	The Australian Government Department of the Environment
<b>Date of request</b>	4 March 2014
<b>Date request accepted</b>	4 March 2014
<b>Advice stage</b>	Assessment

#### Advice

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment to provide advice at the Preliminary Documentation stage on the Liddell Coal Operation (the proposed project) in New South Wales.

This advice draws upon aspects of information in the Preliminary Documentation, together with the expert deliberations of the IESC. The project documentation and information accessed by the IESC are listed in the source documentation at the end of this advice.

The proposed project is located within the Upper Hunter Valley of New South Wales within the Singleton and Muswellbrook local government areas, approximately 25 km northwest of the Singleton township. The proponent is proposing to extend two existing open cut pits (South Pit and Entrance Pit) in a southward direction to extend the life of mining operations to 2023, at the existing extraction rate of eight million tonnes per annum. The proposed project area is bordered on the eastern side by Bowmans Creek, to the south by the modified Bayswater Creek, and to the west by the man-made Lake Liddell. Bayswater Creek is fed by managed releases from Lake Liddell.

The IESC recognises that the proposed project is situated within the highly modified Hunter River Catchment, and the scale of the proposed extension is small in comparison with surrounding coal mining operations. However, Bowmans Creek is in good condition, contains habitat values for threatened species and is proposed to be utilised as an environmental offset. Given the issues raised within the advice below, the proposed project poses a risk to the hydrological and ecological values of the Bowmans Creek system.

The IESC, in line with its Information Guidelines<sup>1</sup>, has considered whether the proposed project assessment has used the following:

Relevant data and information: key conclusions

Relevant data or information that would aid in predicting or determining the potential impacts of the proposed project includes:

- Identification and clear representation of lateral and vertical extents of connective subsidence cracking caused by remnant underground mines that underlie Bowmans Creek and its alluvium.
- Confirmation of success of in-filling of surface subsidence cracks within the Bowmans Creek river bed.
- A depth to measured and modelled groundwater contour map for the proposed project area and Bowmans Creek showing the existing groundwater level and modelled water level contour maps, at suitable time intervals, for the full recovery period.
- Monitoring, management and mitigation measures to prevent impacts being caused by throughflow from the predicted highly saline final void water into alluvial aquifers or surface water systems.
- Geochemical testing and characterisation of coal and overburden material to be placed within backfill, to inform an assessment of salinity and acid forming potential.

Application of appropriate methodologies: key conclusions

The proponent has provided a regional groundwater model that allows the consideration of changes or impacts to the regional water balance. The proponent's assessment documentation would benefit from clarification and justification of the issues outlined below:

- The potential impacts to Bowmans Creek, the associated alluvium and any dependent ecosystems have not been assessed against high or low rainfall periods.
- The existing and identified groundwater monitoring bores are not positioned to provide a representation of potential groundwater impacts in all directions. Management and mitigation measures, which have not been provided, will need to be detailed to address identified impacts.
- An assessment of potential impacts to Bayswater Creek, its alluvium or any dependent ecosystems, has not been included within the assessment documentation. The potential for remnant subsidence cracking to exist underneath Bayswater Creek has not been addressed.

Reasonable values and parameters in calculation: key conclusions

Justification and/or further information are needed to support the proponent's approach or conclusions in relation to the following:

- Estimations of groundwater pit inflows, which do not accurately reflect modelled or measured values, have been utilised to develop the site water balance. As such there is insufficient evidence to support water balance conclusions that no discharges will occur throughout the mine life.
- Hydrographs presented in the groundwater impact assessment indicate varying levels of connectivity, though this does not appear to have been built into the groundwater model. The groundwater model may therefore underestimate groundwater flow and drawdown, particularly within the Bowmans Creek Alluvium.

The IESC's advice, in response to the requesting agency's specific questions is provided below.

*Question 1: Does the Committee consider that the quality of the groundwater model is commensurate with the risks of the project?*

1. There are deficiencies in the groundwater model, which mean that the impacts to water resources as a result of the project remain uncertain. The predicted impacts to Bowmans Creek and the associated alluvium may be underestimated. In particular, the extent of both connective cracking and the influence of relict underground mine workings on groundwater model predictions are unknown. Uncertainty within the groundwater model predictions would be reduced by addressing the following issues:
  - a. Subsidence cracking induced leakage: The proponent notes that past underground mining underneath Bowmans Creek has resulted in connective subsidence cracking in the river bed and beneath the alluvium. Connective cracking between the underground mines and Bowmans Creek is built into the groundwater model. However, the location, hydraulic conductivity values and lateral extent of cells that represent connective subsidence cracking have not been provided. These would be needed to determine if the groundwater model adequately predicts the leakage rate that would occur from Bowmans Creek through connective cracking. An underestimation of leakage from the Bowmans Creek system would also cause the groundwater model to underestimate drawdown within the Bowmans Creek Alluvium, reductions in baseflow contribution to Bowmans Creek and estimates of pit inflows. This would affect the viability and ecological value of the proposed Bowmans Creek riparian corridor offset.
  - b. Calibration: Many of the groundwater model predicted values differ from measured/observed data by a significant amount. Calibration data has been primarily gathered from regional bores outside of the proposed project area. The proponent has not undertaken any permeability testing on the target coal seams within the project area. Information gathered locally would provide evidence on the accuracy of the groundwater model predictions. Ongoing transient calibration should be undertaken utilising data gathered from recently installed dewatering flow monitors.
  - c. Interconnectivity: The proponent's groundwater conceptualisation assumes limited connectivity between Permian hydrogeological units, the regolith and the alluvium. Hydrographs presented in the groundwater impact assessment indicate varying levels of connectivity, though this does not appear to have been built into the groundwater model. The groundwater model may therefore underestimate groundwater flow and drawdown, particularly within the Bowmans Creek Alluvium. The underestimation of flow may be exacerbated by combining the coal seams with low hydraulic conductivity interburden within individual model layers, as evidenced by the high sensitivity of these layers to changes in hydraulic conductivity.
  - d. Baseflows: The proponent has not provided groundwater model steady state or future prediction values for baseflows within Bowmans Creek. Flow data has been historically measured along Bowmans Creek and is used to estimate baseflows in the project assessment documentation. A comparison of the measured and modelled baseflows would reduce uncertainty in groundwater model predictions. The proponent should also consider calibrating the groundwater model against measured baseflow values.
  - e. Predictions: The groundwater impact assessment does not provide measured or modelled groundwater elevation mapping or data, prior to, or following the proposed project. The model also lacks a detailed assessment of groundwater drawdown recovery at regular future

intervals following the end of mining. The provision of groundwater level and drawdown recovery predictions would provide a better indication of the potential groundwater impacts.

- f. Peer review: The peer reviewer noted three primary concerns that have not been addressed within the groundwater impact assessment. These include:
- i. full site water balances for each of the 12 groundwater model realisations and discussion on variability between the results;
  - ii. assessment of the level of agreement between simulated and measured baseflows within Bowmans Creek, and;
  - iii. documentation detailing the way in which underground fractured zones have been or should be modelled.

These concerns have not been addressed within the Preliminary Documentation. Addressing the concerns raised by the peer reviewer would reduce uncertainty in the groundwater model predictions.

2. Impacts to Bayswater Creek and its alluvium, which forms the southern border of the proposed project, have not been reported within the groundwater impact assessment. Predicted groundwater related impacts to this creek system should be identified and future iterations of the groundwater impact assessment updated accordingly. This includes where remnant underground mines underlie the Bayswater Creek or alluvium and dewatering of the target coal seams may induce leakage from the river bed or alluvium through subsidence cracking.

*Question 2: Does the Committee consider that additional information is required to assess impacts on surface water resources? It is noted that much of the surface water infrastructure that will be used for this proposal is already in place (as part of existing approved mining operations).*

3. Whilst much of the surface water infrastructure that will be used for this proposal is already in place as part of existing approved mining operations, this infrastructure will change over the proposed life of the mine as the mining pits progress further south. The following information is needed to fully assess impacts on surface water resources:
  - a. Annual groundwater inflows used as inputs to the site water balance do not match those predicted by the most recent groundwater model. The site water balance, discharge scenarios and assessment of impacts on receiving watercourses need to be updated to reflect revised pit inflow estimates throughout the mine life, as well as the potential for remnant subsidence induced cracking to increase connectivity between Bowmans and Bayswater Creeks and the proposed open cut pits. In turn, the technical surface water assessment report should be updated and included within the Preliminary Documentation.
  - b. No information has been provided about the need to relocate licensed discharge points as mining progresses, nor are any changes proposed to the discharge regime. Future iterations of the project assessment documentation or updates to site water management plans should clarify all proposed modifications to licensed discharge points, including location, flow rates, proposed timing for discharge point relocations and water quality triggers for contaminants including heavy metals and potentially acid forming materials.
  - c. The flood assessment considered the risk to mining voids from flooding along Bowmans and Bayswater creeks. The flood assessment would benefit from the consideration of the risk of flooding to overburden emplacement areas, rejects emplacement stores and mining infrastructure areas.

4. The proponent's statements that uncontrolled discharge will not occur are not substantiated, given the inconsistency between water inflow values predicted in the groundwater model and utilised in the site water balance. The risk of uncontrolled discharge is of particular note towards the end of the proposed mine life given the additional groundwater inflows that are predicted and the limited capacity in relict underground storages at this time. The proponent should discuss the management measures proposed to prevent or mitigate any uncontrolled discharges, once the water balance assessment has been updated.

*Question 3: What does the Committee consider are the likely impacts of the proposed action on surface and groundwater resources, in particular, changes to surface and/or groundwater dynamics and resources?*

5. Leakage through historical cracking: The proposed dewatering of remnant underground mines to enable the excavation of Entrance Pit has the potential to induce leakage, through relict connective subsidence cracking, from the Bowmans Creek stream bed and its associated alluvium. This has the potential to result in: a reduction in, or ceasing of, stream flows; greater than predicted alluvial drawdown; and impacts to ecosystems dependent on this water resource.
  - a. Extent: The proponent states "While infilling and closure of cracks undoubtedly occurred at surface, it is not known whether cracking subsequently closed at depth". There is limited evidence in the Preliminary Documentation detailing the level of infilling, the success of any infilling or the pervasiveness of connective cracking that underlies Bowmans Creek and its associated alluvium. The proponent should summarise the results of existing reports on subsidence in the region within the assessment documentation to reduce uncertainty surrounding the extent of remnant subsidence cracking.
  - b. Loss of stream flows: The proponent notes that historical connective subsidence cracking due to underground mining resulted in Bowmans Creek ceasing to flow in some reaches. Underground workings have been allowed to flood and impacts to Bowmans Creek and its alluvium have not been recorded since. However, the proposed project will require relict underground workings to be dewatered. There is a significant risk that these underground workings have achieved a new groundwater equilibrium around subsidence cracks and that dewatering will again result in high levels of leakage, such that Bowmans Creek may once again cease to flow.
6. Surface and groundwater connectivity: The proposed dewatering underneath the Bowmans Creek is predicted to cause an increase in leakage from the alluvium that peaks at about 30 ML/year. The proponent assumes that this flow will be lost from baseflows to Bowmans Creek. With the limited flow data provided for stream and baseflows, it is difficult to determine the accuracy of predicted reductions in Bowmans Creek baseflow. Confidence in predicted changes to baseflow would be improved if the proponent utilised historical flow data from flow gauging stations in close proximity to the proposed project area, to calibrate and demonstrate the accuracy of the groundwater model.
7. Final landform: The proponent states that the salinity within South Pit is predicted to rise significantly to approximately 14 000 parts per million following the cessation of mining and that this saline water is predicted to flow to the surrounding hard rock aquifers. The proponent's final landform may cause impacts to alluvial and surface water resources as a result of contaminants leaching from emplacement areas and groundwater throughflow from the predicted highly saline South Pit. The extent of potential impacts may be exacerbated by increased vertical hydraulic conductivity associated with unidentified areas stated to occur in proximity to the Davis Fault and dyke structures.

8. Groundwater: Drawdown within the Permian coal measures is predicted to extend beyond the proponent's proposed project boundary, however limited discussion is provided in relation to the potential impacts of the predicted drawdown to surrounding water users and assets. An assessment of the potential impacts of the changing groundwater level on surrounding water dependent assets, including the resulting changes to ground and surface water interactions, would be a beneficial inclusion to the project assessment documentation. The proponent should also consider assessing the impacts of the predicted drawdown within a cumulative context following the recommended updates outlined in Question 1.

*Question 4: Could the Committee comment on the likely severity of impacts to Bowmans Creek, its alluvial aquifer and riparian vegetation? What mitigation measures might be effective?*

9. The proposed project is likely to have an adverse impact on the Bowmans Creek system. Impacts to Bowmans Creek and its alluvium, including reduced baseflow and interruption or changes to the flow regime, may be severe if they are not properly assessed and avoided, mitigated and/or managed. Impacts to the hydrology of Bowmans Creek are detailed in response to Question 3.
10. The major impacts to Bowmans Creek and the Bowmans Creek Alluvium are predicted to occur in the year 2021, once mining extends beyond the Davis Fault and dyke structure. The most obvious ways to prevent the predicted significant leakage through relict subsidence cracking would be to modify the mine plan such that it does not cross the Davis Fault or to avoid dewatering underground workings underneath Bowmans Creek. Mitigation measures for impacts to water resources more generally are addressed in response to Question 6.
11. The Bowmans Creek riparian corridor consists of a band of vegetation 50 - 100 m wide, dominated by river oak (*Casuarina cunninghamiana*) with some mature forest red gum (*Eucalyptus tereticornis*). The Preliminary Documentation does not recognise this riparian vegetation as a Groundwater Dependent Ecosystem (GDE). This assessment is not supported by evidence (for example, no depth to groundwater contour mapping is provided) and is contradicted by both the inclusion of an evapotranspiration component in the water balance and reports of groundwater in the Bowmans Creek Alluvium at less than 6 metres below ground level during the stygofaunal survey. These depths are within the range at which groundwater use by trees is likely<sup>2</sup>. The proponent should undertake an assessment of potential impacts on the riparian vegetation if drawdown within the Bowmans Creek Alluvium, or leakage through connective cracking, is greater than predicted. This is important to support the proponent's planned maintenance and rehabilitation of the Bowmans Creek riparian corridor, as an environmental offset to provide habitat for species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), such as the spotted-tailed quoll (*Dasyurus maculatus*).
12. Consideration of potential ecological impacts due to changes to surface and groundwater interactions along Bowmans Creek, particularly during low rainfall periods, is not provided within the project assessment documentation.

*Question 5: What does the Committee consider are the key uncertainties and risks of the project in relation to water resources that will need to be managed to appropriately mitigate impacts to water-related assets? What does the Committee consider are the features of a monitoring and management framework that would address the uncertainties and risks of the project identified by the Committee to address these uncertainties?*

13. Key risks of the proposed action include the potential for impacts to Bowmans Creek, its alluvium and ecosystems that are dependent upon this water resource; and impacts to surface and groundwater resources potentially caused by throughflow of highly saline water from the final void to the surrounding groundwater environment. These risks are outlined in Questions 3 and 4.

14. Uncertainty exists in the proponent's assessment documentation. In particular,
  - a. The groundwater model predictions may underestimate reductions in baseflow provision to Bowmans Creek and drawdown within the alluvium, and;
  - b. The site water balance utilises data from an early version of the groundwater model (which has since been updated) to inform water balance and surface water impact predictions.

15. Key features of a monitoring and management framework are outlined in Question 6.

*Question 6: Are there additional measures and commitments the Committee would recommend to mitigate and manage impacts to water-related assets?*

16. The proponent has made commitments to update existing groundwater and surface water management plans, which should be completed prior to the commencement of the proposed project. Additional features which would appropriately be included within these plans are detailed in the headings below.
17. Ecology: The proposed project area lies within the "Green and Golden Bell Frog Upper Hunter Key Population" area. The species is difficult to detect, however there is a confirmed record from Lake Liddell and numerous other records from the surrounding area including the adjacent Mt Owen mining complex. Therefore a targeted survey for the green and golden bell frog within all potential habitat in the project area is warranted<sup>3,4</sup>.
18. Aquatic ecological surveys (in Bayswater and Bowmans Creeks) were carried out on only one occasion, in July 2012. Surveys in warmer months are likely to yield more species, especially of fish, and are recommended to gain a more comprehensive understanding of the fauna of Bowmans Creek.
19. Groundwater: The proponent's groundwater monitoring bore network is limited to the eastern boundary of the proposed project area. The addition of monitoring bores along the southern project boundary would be beneficial to provide a better representation of groundwater quantity and quality surrounding the proposed project area.
20. To reduce uncertainty in groundwater model predictions, the model should be updated utilising site specific data as it becomes available. Specifically, utilising pit inflow data gathered from flow monitors, recently fitted to dewatering bores within the Permian coal seams, as a transient calibration target would be beneficial.
21. Longer term impact predictions (beyond 2030) would also provide greater confidence in the predicted groundwater level recovery of the Bowmans Creek Alluvium.
22. The IESC recommends that the numerical model be updated to address the matters discussed in Question 1.
23. Surface water: Following updates to the surface water assessment and site water balance model, the proponent should provide details of management and mitigation measures that would be put in place in the event of uncontrolled discharges. Management and mitigation measures should include the identification of downstream water related assets that may be impacted and contingency actions to be implemented in the event that management or mitigation measures fail. Further information that would be of benefit if included in the surface water management plan is detailed within Question 2.
24. Final landform: The proponent has provided limited detail regarding the proposed measures to manage and mitigate the risks posed by the final landform following the completion of the proposed project. The proponent should demonstrate that the legacy issues and risks to water

resources as a result of the final landform have been assessed, will be mitigated and managed, including:

- a. Design of a monitoring bore network within emplacement areas surrounding the final pit lake to provide a representative indication of groundwater quality to identify any leaching of highly saline or acidic material. This would ideally include monitoring bores within the southern, western and northern sides of the proposed final landform.
- b. Geochemical characterisation of tailings and rejects proposed to be placed in backfill to assess the potential risks of groundwater, alluvium or surface water contamination caused by throughflow transport, particularly along the Davis Fault and dyke structure.
- c. Modelling of salt stratification within the final void lake.

25. The Hunter Subregion within the Northern Sydney Basin has been identified for Bioregional Assessment. Data and relevant information from the proposed project should be made accessible to this Bioregional Assessment to assist the knowledge base for regional scale assessments.

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**Date of advice**      10 April 2014

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**Source documentation available to the IESC in the formulation of this advice**      SLR Consulting Australia Pty Ltd, Umwelt (Australia) Pty Ltd and Sinclair Knight Merz 2014. Preliminary Documentation EPBC Act Referral 2013/6908. February 2014.

SLR Consulting Australia Pty Ltd, 2013. Proposed Modification to DA 305 -11-01 Environmental Assessment. Liddell Coal Operations Extension Project. September 2013.

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**References cited within the IESC's advice**      <sup>1</sup> 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://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf>

<sup>2</sup> Eamus et al. (2006). A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation *Australian Journal of Botany*, 2006, 54: 97–114.

<sup>3</sup> Department of Environment and Climate Change NSW (2007). Management Plan for the Green and Golden Bell Frog Key Population in the Upper Hunter. Department of Environment and Climate Change, Sydney NSW.

<sup>4</sup> White, A.W. and Pyke, G.H. (1996). Distribution and conservation status of the Green and Golden Bell Frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30: 177 – 189.

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