

Advice to decision maker on coal mining project

IESC 2014-047: Carroona Coal Project – New Development

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| Requesting agency | The New South Wales Mining and Petroleum Gateway Panel |
| Date of request | 8 April 2014 |
| Date request accepted | 8 April 2014 |
| Advice stage | Gateway Application |

Context

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the New South Wales Mining and Petroleum Gateway Panel to provide advice on Coal Mines Australia's Carroona Coal Project in New South Wales. The Carroona Coal Project has been referred to the IESC at the 'Gateway' Stage due to its location on identified Biophysical Strategic Agricultural Land (BSAL) as legislated under the *NSW Environmental Planning and Assessment Act 1979*.

The Carroona Coal Project assessment area covers 11,900 ha and includes 2,215 ha of verified BSAL on the Liverpool Plains. The 30-year project proposes to extract up to ten million tonnes per annum of saleable thermal coal using longwall methods from the target Hoskissons coal seam within the Gunnedah Basin. Sixty-seven longwall panels are proposed beneath Nicholas Ridge and Doona Ridge, either side of the Mooki alluvial plain. Although most of the riparian vegetation along the Mooki River has been cleared, there are some remnant river red gums (*Eucalyptus camaldulensis*) in the riparian zone. There are two high priority groundwater dependent ecosystems, Terda Springs and Treloar Springs, located about 30 km from the proposed longwalls. Groundwater beneath the Liverpool Plains is highly utilised, supporting agriculture, town water supply and other industries. The closest large regional centre is Gunnedah, 40 km north-west of the Carroona Coal Project.

This advice draws upon information in the Application for a Gateway Certificate, including the preliminary groundwater and subsidence assessments, 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.

Assessment against information guidelines

The IESC recognises that the Application for a Gateway Certificate addresses the criteria specified as part of the Gateway process and does not contain the level of analysis expected for a subsequent development application and accompanying environmental assessment. The IESC recommends that

any further project assessment documentation includes the type of information that enables a robust assessment of impacts on water resources such as that outlined in the Information Guidelines¹:

Relevant data and information: key conclusions

Incomplete information has been provided regarding: identification of water related ecological assets; and water quantity (flow/level/pressure) and quality data for all hydrological units, particularly groundwater within the Oxley Basin and surface waters.

Application of appropriate methodologies: key conclusions

A preliminary groundwater model has been developed using appropriate software, largely based on the NSW Office of Water Upper Namoi Groundwater Flow Model. The key concerns with the model include its performance for non-alluvial units, hydraulic parameters, representation of multiple units as single layers and boundary conditions.

Reasonable values and parameters in calculations: key conclusions

The hydraulic parameters used in the preliminary groundwater model, particularly for vertical hydraulic conductivity, are lower than other estimates within the region. Higher vertical hydraulic conductivities could result in larger, but less laterally extensive, drawdowns in overlying units. Future groundwater modelling should consider a range of hydraulic conductivity values based on literature within the Namoi Catchment, including the Namoi Catchment Water Study and the Shenhua Watermark Coal Project and constrain calibrated values within reasonable ranges.

Advice

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

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| Question 1: It would be appreciated if the IESC could advise on the potential likelihood and significance of any impacts of the proposal on water resources. |
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Response

1. Impacts to water resources remain largely uncertain due to limited information available at the Gateway stage. Potentially significant impacts to water resources result from:
 - a. Groundwater drawdown in the target coal seams and overlying hydrological units, with potential impacts to water levels in private bores, baseflows in the Mooki River and groundwater dependent ecosystems including high priority springs; and
 - b. Predicted subsidence of up to 3.1 m above longwall panels, which is likely to impact the hydraulic properties of overlying strata, potentially reduce surface water flows and quality, and could impact water infrastructure.
2. Uncertainty around the likelihood and significance of impacts is due to deficiencies in groundwater modelling, lack of quantification of impacts to surface water and incomplete identification and consideration of potential impacts to ecological assets. Recommendations for future work to improve confidence in the assessment of impacts are made in response to Question 4.

Explanation

Groundwater drawdown and water take

3. The Caroon Coal Project will dewater the target Hoskissons coal seam and induce fracturing above the longwall panels. The most significant groundwater impacts are to the Triassic and Permian groundwater units within the Gunnedah Basin, with predicted water take of up to 2,301 ML/year. This water take is predicted to induce leakage from overlying 'highly productive' aquifers of the Oxley Basin, Liverpool Ranges Basalt and Upper Namoi Alluvium.

Baseflow

4. The Caroon Coal Project is expected to induce a loss of baseflow to the Mooki River of up to 0.7 ML/day, primarily between Caroon and Breeza. This reduction is about one third of the low flow (70th percentile) in the Mooki River at Breeza. As such, there is likely to be an increased duration and/or frequency of no flow periods at and downstream of Breeza. The loss of baseflow could be as high as 0.9 ML/day when considered in a cumulative sense with the neighbouring Shenhua Watermark Project. Impacts to ecological assets and surface water users as a result of the modelled reduction in baseflow to the Mooki River have not been presented.

Water related assets

5. The *Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2012* identifies two high priority groundwater dependent ecosystems (GDEs); Terda Spring and Treloar Spring, located near the western margin of the groundwater model. The modelled drawdown impact on these springs is below the model accuracy limits (<0.01 m).
6. Given the depths to groundwater in the Upper Namoi Alluvium, it is possible that the river red gums (*Eucalyptus camaldulensis*) along the Mooki River access groundwater and could be affected by groundwater drawdown.
7. Groundwater beneath the Liverpool Plains has been subject to extensive use by agriculture. The Caroon Coal Project is predicted to result in potentially significant impacts to private groundwater bores including:
 - a. Up to 185 m drawdown for bores accessing the 'less productive' groundwater units within the Gunnedah Basin. Impacts on private bores screened within the Gunnedah Basin, but not on BSAL, have not been presented.
 - b. Drawdown of between 2 m and a maximum of 13.77 m, at 27 private bores accessing the overlying 'highly productive' aquifers of the Jurassic Oxley Basin.
8. Refinement of groundwater modelling and a second stage bore census will better inform predictions of impacts to these assets.

Uncertainty in groundwater modelling

9. There is a low level of confidence in prediction of groundwater impacts at this stage, due to uncertainties in groundwater modelling. Key uncertainties in groundwater modelling include:
 - a. Significant differences between observed and modelled data and lack of targets for calibration for hard rock hydrogeological units.
 - b. The vertical hydraulic conductivity values used in the calibrated model are lower than other regional estimates, which could have a significant influence on the transmission of impacts from the coal seams to overlying units.

- c. Lack of evidence to support the boundary conditions used, as discussed in response to Question 2.
- d. Lack of groundwater (pressure and quality) monitoring data for aquifers associated with Jurassic and Triassic sediments.

Subsidence

10. The potential impacts to water resources as a result of the predicted subsidence are not well quantified, but may include:
- a. Increased permeability, connectivity and potential for leakage between streams, alluvium and hard rock hydrogeological units;
 - b. Surface cracking, ponding, changes to stream morphology, streambed scouring and increases in areas subject to flooding. As a result, water quality may be reduced, including an increased sediment load. Direct subsidence-induced impacts to the Mooki River and Quirindi Creek are unlikely, but there are likely impacts to smaller drainage channels in their respective catchments; and
 - c. Potential structural damage to water infrastructure.

Question 2: It would be appreciated if the IESC could advise on the boundary conditions used in the groundwater model.

Response

11. The boundary conditions are largely fit for purpose for a preliminary groundwater model. The conditions used appear to have the following key limitations:
- a. The exclusion of runoff (and interflow) to streams has not been supported by evidence and may not accurately represent interactions between surface water and groundwater;
 - b. The no flow condition imposed along the western margin of the model domain does not appear to be consistent with the predicted groundwater drawdown in the Permo-Triassic units across this boundary; and
 - c. Evidence has not been presented to demonstrate that the model boundaries are beyond the probable area of influence of cumulative impacts from the Caroon Coal Project, the neighbouring Shenhua Watermark Project and existing groundwater use.
12. These limitations should be tested through a boundary condition sensitivity analysis.

Explanation

13. Stream flow routing cells have been used to represent streams across the MODFLOW-SURFACT model domain. These cells allow for leakage from surface water to groundwater and groundwater-fed baseflow to streams. However, the proponent has only modelled baseflow to each reach of the Mooki River and has not included interflow or runoff to each reach. Given the large contributing catchment area and variable depth to groundwater beneath the Mooki River across the model domain, this may be a limitation. It is recommended that field data is used to inform a conceptualisation of the relative contributions to streamflow from runoff / interflow and baseflow at various locations within the catchment. The behaviour of stream flow routing cells within the numerical model should then be amended as required to reflect this conceptualisation.
14. Edges of the model domain are designated no flow boundaries.

- a. Drawdowns of up to 50 m are predicted in the Permian coal measures across the western boundary of the model domain. Whilst groundwater is inferred to flow along, rather than across this boundary at the water table, evidence has not been provided that this is the case for any deeper confined piezometric surface. As such, the application of a no flow condition to the western margin of the model domain may not be appropriate.
 - b. Bores near the northern boundary are stated to be beyond the probable influence of the Caroon Coal Project. However, if there is the potential for cumulative impacts to these bores, further work should be undertaken to improve their calibration results. The current no flow condition across the northern margin may be better represented by a generalised head condition, which allows for variations in groundwater heads as a result of groundwater use over time.
15. To address the above uncertainties regarding boundary conditions, it is recommended that a range of conditions should be trialled and the resulting model performance tested, with the results documented in any future project assessment documentation.

Question 3: It would be appreciated if the IESC could advise on the appropriateness of the proposed mitigation measures.

Response

16. The proponent has committed to 'make good' any impacts on private bores, through deepening of existing wells or bores, relocation of the bore and/or provision of an alternate water supply. Mitigation and management measures that might be invoked under the groundwater Trigger Action Response Plan should address potential impacts to groundwater resource quality and quantity, as well as water related assets. These measures should be identified and their effectiveness assessed in future project assessment documentation.
17. The primary mitigation measure for surface subsidence is the proponent's design of subsidence control zones. This modification of longwall panel design is likely to reduce the severity of impacts from subsidence. The effectiveness of additional mitigation measures for subsidence-induced impacts to water resources is uncertain and should be supported by further case studies outlined in paragraph 19.

Explanation

Groundwater

18. The proponent has committed to develop a Groundwater Management Plan prior to the commencement of longwall mining operations, which would include a Trigger Action Response Plan, with groundwater level triggers and appropriate management response and mitigation measures. Groundwater quality triggers have not been discussed.

Subsidence

19. A variety of additional mitigation measures are proposed to be included within individual Property Subsidence Management Plans, including infilling of cracks, regrading of the surface and erosion protection measures such as planting vegetation and providing rip-rap. Case studies would assist in determining the effectiveness of these mitigation measures in limiting impacts to water resources and water related assets.

Question 4: The IESC may also recommend further studies that should be undertaken if relevant.

Response

20. Consistent with the IESC's Information Guidelines¹, future project assessment documentation should include a: surface water assessment; site water balance; ecological assessment; risk assessment; and cumulative impact assessment. Further work should be undertaken to improve confidence in the groundwater and subsidence impact assessments, including: additional monitoring; investigation into the height of fracturing; further groundwater modelling, including sensitivity analysis; and the identification of mitigation measures and assessment of their effectiveness.

Explanation

Surface water

21. Water quality, quantity and aquatic ecological survey information is needed to determine the potential impacts to the Mooki River. The spatial and temporal variation in the losing/gaining nature of the Mooki River, particularly between Caroona and Breeza, should be assessed and any changes to this nature as a result of the Caroona Coal Project predicted over time.
22. A flood assessment needs to be provided. Flood modelling should inform the assessment of impacts to surface water but is also needed to support the proponent's commitment not to mine beneath the floodplain².
23. A quantitative assessment of water retention volumes in subsidence-induced ponds and the loss of flows from surface cracking in the Mooki River and Quirindi Creek catchments should be undertaken. This would be of particular benefit where ponds are proposed to be used to increase farm dam storage capacity as a mitigation measure for the potential reduction in access to groundwater as a result of drawdown.
24. Sediment and/or erosion risks should be assessed and include potential risks from surface cracking, ponding and flooding as a result of subsidence. Impacts should be assessed over time, including until the system has equilibrated (for example, ponds have filled with sediment, or erosion is stabilised by vegetation).
25. A surface water monitoring and management programme needs to be developed and included in future project assessment documentation. This programme should include an outline of the proposed measures to monitor, manage and mitigate surface water impacts during the operational phase and following the completion of the Caroona Coal Project.

Water balance

26. A water balance needs to be included within future project assessment documentation. The documentation should quantify and discuss existing and proposed changes in stores and flows between hydrological units, including surface waters, alluvium and the underlying hydrogeological units.
 - a. The site water balance should be utilised to determine whether the Caroona Coal Project may need to discharge waste water during the mine life. Should discharge be required, the proponent needs to identify preferred discharge points and provide frequency, timing, water quality and water quantity parameters for proposed discharges.
 - b. The proponent should provide the location and volumetric requirements of any proposed bore fields or surface water extraction points that may be required to supplement mine water

requirements. The proposed water extraction should then be incorporated into the groundwater model and site water balance.

Water related assets

27. Water-related assets in the project area should be identified through fauna (including stygofauna, macroinvertebrates, frogs and fish), flora and habitat surveys as they relate to surface water and groundwater. Predicted impacts to all identified assets should be documented, with monitoring, mitigation and management options identified.
28. A systematic approach to assessment of GDEs is recommended in which:
 - a. The hydrogeological conceptualisation identifies areas of shallow groundwater (less than 20 metres below ground level) and groundwater discharge.
 - b. Vegetation overlying areas of shallow groundwater should be investigated to determine potential groundwater dependence. Techniques from the Australian GDE Toolbox³ may then be applied to confirm groundwater use by vegetation and groundwater discharge to surface water bodies.
29. Whilst the preliminary groundwater model predicts that high priority GDEs are unlikely to be impacted, additional investigation into Terda and Treloar springs is recommended to allow an assessment of potential impacts, including:
 - a. Confirmation of source aquifers and spring surveys or provision of existing survey information to inform a conceptualisation of spring hydrogeology;
 - b. Representation within the groundwater model by appropriate boundary conditions and determination of spring flow depletion by modelled water budgets; and
 - c. Design of a monitoring and management programme, as appropriate, informed by the above information.

Risk assessment

30. A stand-alone assessment of the risks to water resources and water related assets should be undertaken. This assessment should quantitatively assess the likelihood and consequence of identified impacts and the residual risk following application of proposed mitigation measures.

Groundwater

31. The existing groundwater monitoring network should be extended to monitor potential impacts to existing users' water works and other water related assets such as high priority GDEs. Additional monitoring bores should target aquifers within the Gunnedah and Oxley Basins.
32. A full chemical analysis of the groundwater quality parameters should be undertaken, including major ions, heavy metals, turbidity and dissolved oxygen. Further, water quality should be sampled for all groundwater units likely to be impacted, including those within the Oxley Basin. Water quality data is needed to support the claim that the Caroon Coal project will not change the beneficial use of any water resource.
33. The extent of the floodplain and the alluvium (Narrabri and Gunnedah formations) within the proposed project area should be clearly defined. Buffer distances between the alluvium and the proposed longwalls in three dimensions should be shown. Explicit definition of this spatial relationship would inform an assessment of potential direct and subsidence related impacts to the alluvium.

34. In its advice on the Shenhua Watermark Coal Project⁴, the IESC recommended a local-scale investigation into groundwater gradients and flow, with particular regard to effects of predicted 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.

Groundwater model

35. Future groundwater modelling for the Carroona Coal Project should use representative hydraulic conductivity values based on field measurements within the Namoi Catchment, including those reported in the Namoi Catchment Water Study and the Shenhua Watermark Coal Project.
36. Sensitivity and uncertainty analyses and peer review should be undertaken. Sensitivity analyses should consider the hydraulic properties of layers 1-3 which are shown to have greatest influence on drawdown within the Upper Namoi Alluvium.
37. The groundwater flow dynamics of faults and their influence on the hydrogeological system should be investigated, documented and included in the model as appropriate.
38. Metered pit inflows and monitoring network data should be used to verify and revise the numerical modelling as required.
39. The groundwater model would benefit from separation of the aquifers associated with the Pilliga Sandstone, Purlawaugh Formation and Digby Formation from surrounding units. The representation of Jurassic units, and multiple Permo-Triassic units, as single layers within the groundwater model may currently under-represent the ability of these aquifers to transmit groundwater flow.
40. The groundwater model should include the nearby Shenhua Watermark Project to enable a thorough assessment of cumulative impacts.

Subsidence

41. The potential for fractures to extend into Jurassic and Quaternary age hydrogeological units needs to be investigated. Similarly, the potential for 'far-field' subsidence effects should also be considered.
42. The likely impacts to surface water quantity and quality and hydraulic properties of hydrogeological units as a result of subsidence should be quantified. The potential for subsidence to increase connectivity between surface waters, the alluvium and the underlying hydrogeological units, as well as the effect of increased connectivity on alluvial drawdown, should be considered. The potential for resultant impacts to water users including ecological assets should be assessed.
43. A comprehensive assessment of baseline landform condition, including a survey of existing drainage lines, should be undertaken before the project commences.
44. The Northern Inland Catchments, which includes the Namoi subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the Carroona Coal Project should be made accessible to this Bioregional Assessment to assist the knowledge base for regional scale assessments.

Date of advice 14 May 2014

Source documentation available to the IESC in the formulation of this advice Short, T and Thomson, T (2014) Carooona Coal Project Gateway Application Agricultural Impact Assessment. A report prepared for Coal Mines Australia Pty Ltd by La Tierra Pty Ltd, Brisbane, Australia, March 2014.

References cited within the IESC's advice

¹ IESC (2014). Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals. April 2014. Available at: <http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf>

² Bailey, S (2012). NSW Approvals Process for Carooona Coal Project. Presentation to Carooona Coal Project Community Consultative Committee. BHP Billiton, December 2012.

³ Richardson, et al (2011). The Australian Groundwater Dependent Ecosystems Toolbox. National Water Commission, Canberra.

⁴ IESC (2013). Advice to Department of Sustainability, Environment, Water, Population and Communities on Watermark Coal Project (EPBC 2011/6201). 27 May 2013. Available at: <http://iesc.environment.gov.au/advice/pubs/iesc-advice-watermark-2013-023.pdf>
