

Advice to decision maker on coal mining project

IESC 2014-049: Taroborah Coal Project (EPBC 2012/6262) - New Development

Requesting agency	The Australian Government Department of the Environment The Queensland Department of Environment and Heritage Protection
Date of request	07 May 2014
Date request accepted	07 May 2014
Advice stage	Assessment

Context

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 and the Queensland Department of Environment and Heritage Protection to provide advice on the Shenhua International Group Pty Ltd (the proponent), Taroborah Coal project in Queensland.

This advice draws upon aspects of information in the Draft Environmental Impact Statement (EIS), 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 Taroborah Coal project is a greenfield open cut and underground coal mine on the western fringe of the Bowen Basin, approximately 22 km west of Emerald and 20 km east of Anakie, in Queensland. The total coal resource proposed to be extracted over the 22 year life of the project is approximately 202 million tonnes of Run of Mine (ROM) coal. The project will involve a seven year open cut mining operation, followed by a 15 year underground longwall operation producing a maximum of 5.75 million tonnes per annum of ROM coal. The project disturbance area is 5195 ha in size (within the 7966 ha Mining Development License 467) and lies within the Nogoia River catchment area of the Fitzroy River Basin. The project area intersects two major tributaries of the Nogoia River; these are Retreat Creek and Taroborah Creek.

The IESC notes that, while the potential impacts of the Taroborah Coal project are primarily of local significance, the documentation included within the EIS contains a high degree of uncertainty and therefore many of the potential impacts cannot be determined or quantified.

Assessment against information guidelines

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

Relevant data and information: key conclusions

Surface water flow and an assessment, or estimation, of the baseflow component of Retreat and Taroborah Creeks are not provided. This data is needed to enable prediction of impacts to seasonal flows within, and interactions between, surface water and groundwater systems, including predictions of surface water baseflow losses. A description of boundary conditions used within the groundwater model is needed to improve confidence in the model's impact predictions. A targeted assessment of water dependent ecosystems is needed. This should include identification of springs and semi permanent pool locations, depth to water table mapping and representative ecosystem sampling.

All inputs and outputs for the site water balance including their seasonal and annual variation are necessary to improve confidence in predicted water availability onsite, the spill risk for mine water storages and the proposed mine site water management system's performance under wet and dry conditions.

Application of appropriate methodologies: key conclusions

The proponent's groundwater model is based on a groundwater conceptualisation that prevents lateral groundwater flow across the eastern and western bounding faults, which restricts groundwater drawdown extent. The groundwater model would benefit from data to support the approach of "turning off" cells within layers three to ten. Additionally, Retreat and Taroborah Creeks in proximity to the project area are represented by large cells (up to 500 m), which limit the groundwater model's ability to predict impacts to surface and groundwater interactions.

The cumulative impact assessment is limited and does not adequately consider impacts associated with nearby coal mines, in particular the Teresa Coal Mine project, which may have groundwater drawdown contours that overlap with the Taroborah Coal project.

Reasonable values and parameters in calculation: key conclusions

Justification and scientific evidence is needed to support the proponent's parameterisation of the subsidence fracturing and enhanced permeability extents utilised in the groundwater model. The current extent may result in an underestimation of groundwater and surface water impacts.

Advice

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

Question 1: What does the Committee consider are the key uncertainties and risks of the project in relation to water resources and water-related assets?
--

Response

1. There are uncertainties within the Taroborah Coal project assessment documentation including:
 - a. The hydrogeological conceptualisation (including the understanding of faults and flow paths, boundary conditions, connectivity and recharge), representation of faults as boundaries, the incorporation of subsidence induced fracturing, seasonality, and surface water and groundwater interaction within the groundwater model.
 - b. The performance of the site water balance under a range of climatic scenarios.
 - c. The total impact of subsidence on surface water flow and quality, including the ability to determine variations from the pre-development condition.

2. The Taroborah Coal project poses a risk to the flow regimes of Retreat Creek, Taroborah Creek, and the lower reaches of Centre Creek and to water dependent ecosystems which rely upon these surface water systems. Private groundwater bores, which are predicted to experience drawdown of up to 29.7 m, are also at risk.

Explanation

Groundwater model

3. The following uncertainties reduce confidence in the groundwater model predictions:
 - a. The draft Environmental Impact Statement (EIS) does not contain any pre-existing or recent exploration data to justify that there is no hydraulic connectivity across the faults. The effect of “turning off” cells may result in an unrealistic lack of connectivity between upper (layers one and two) and lower (three to ten) layers, resulting in an under-estimation of groundwater drawdown extent.
 - b. It is unclear how the fault boundary conditions have been incorporated into the groundwater model and there is no description of any groundwater flow boundaries throughout the model domain, or their influence on model predictions.
4. Confidence in groundwater model predictions is reduced by the low number (three listed within the EIS) of hydraulic conductivity measurements within the coal seams. Confidence in the model is further reduced by the prescription of calibrated horizontal hydraulic conductivity values for the coal seams that are an order of magnitude lower than the values identified during the field study. Significantly lower calibrated hydraulic conductivity values than those measured in the field may result in an underestimation of the drawdown extent and groundwater mine inflow predictions.

Subsidence induced fracturing

5. The proponent's approach to modelling subsidence induced fracturing and deformations in the strata overlying longwall panels presents the following concerns:
 - a. The influence of subsidence cracking on groundwater flow is likely to be under represented in the groundwater model. Fracturing induced by subsidence has been represented up to 90 m above the base of layer eight. However, evidence from other longwall mines and research² suggests that subsidence induced deformations above longwall panels can extend up to 60 times the mined longwall panel height towards the surface, which in this case would be up to 210 m.
 - b. The proponent has not provided an assessment of the impact of fracturing within the Tertiary clay/mud units which act as an aquitard between the Tertiary Basalt and Aldebaran Sandstone. These units have been mapped with opposing flow directions. An increase in connectivity between the Tertiary Basalt and the Aldebaran Sandstone may result in changes to groundwater flow, quality and quantity within these hydrogeological units.
 - c. Groundwater flow within the Aldebaran Sandstone is predicted to be in a southward direction, which is attributed to recharge by leakage from the Quaternary Alluvium associated with Retreat Creek. Subsidence induced fracturing may increase recharge rates within the Aldebaran Sandstone and subsequently increase mine water inflows beyond those predicted by the groundwater model.

Surface water and groundwater interaction

6. There is a low level of confidence in the proponent's prediction of impacts to surface water and groundwater interactions. The groundwater model is unable to predict impacts to seasonal

variations in surface and groundwater interactions. Additionally, the EIS presents conflicting evidence as to whether creeks within the model domain are ephemeral or perennial. Confidence in the groundwater model's ability to characterise surface and groundwater interactions is further reduced by the uncertainties surrounding groundwater flow boundaries and the size of river cells. In particular, cells representing Retreat Creek and a large proportion of Taroborah Creek have grid sizes of up to 500 m in proximity to the project area.

7. The groundwater model predicts that the Taroborah Coal project will result in a reduction in baseflow to rivers across the model domain of approximately 0.9 ML/day and will result in an increased leakage from rivers in the model domain of 0.9 ML/day. Both of these functions will result in a decrease of 657.44 ML/year of water provided to downstream reaches of surface water systems. However, the scale of this impact cannot be quantified because surface water flow or baseflow data for surface water courses has not been provided within the EIS.

Water related ecological assets

8. Many of the ecological water related assets within the project area and surrounding region are not clearly identified and therefore the full suite of potential ecological impacts cannot be determined. Total existing and post mining baseflow provision to Retreat, Centre and Taroborah Creeks has not been estimated or measured. Given the groundwater model is unable to predict seasonal reductions in groundwater availability, baseflow related impacts to riparian vegetation and groundwater dependent ecosystems (GDEs) associated with the alluvium of Retreat, Centre and Taroborah Creeks cannot be determined.
9. The location of springs and semi-permanent pools has not been identified within the EIS, and therefore impacts to these water related assets and ecosystems are unknown. The EIS (Appendix 19, p. 97) indicates that springs and semi-permanent pools occurring on the tributary to Retreat Creek provide refugia for macroinvertebrates, amphibians and fish. This tributary also supports the riparian Silver-leaved Ironbark Woodland community which may be dependent on groundwater. Impacts would be expected to include, a reduction in groundwater availability for springs due to drawdown; changes to the surface flow regime and timing of flows for semi-permanent pool replenishment; increased periods of drying out within semi-permanent pools; and scouring of surface drainage flow channels leading to increased sedimentation within semi-permanent pools.

Private groundwater users

10. The project poses a risk to private users of groundwater. Drawdown within privately owned bores is predicted to reach a maximum of 29.7 m below the existing water table, which includes bores that are utilised as domestic, stock and irrigation water sources.

Water balance

11. There is uncertainty surrounding the Taroborah Coal project's mine water requirements under a range of climatic conditions, which may result in the potential risk of uncontrolled discharges and requirements for supplementary water supplies. Specifically, the water balance has been modelled under mean rainfall conditions, does not identify mine water requirements during dry or wet conditions and under-represents early and recent climatic data, including significant flood events in 2008 and 2011.

Subsidence impacts to surface water

12. Subsidence modelling predicts surface depressions will develop and will form ponds with volumes up to 12.5 ML, covering approximately 28.8 ha of the proposed project area. When at full capacity, combined pond volumes are predicted to total 53 ML, or a surface runoff capture of six

per cent across the project area. The proponent's assessment of subsidence impacts does not include consideration of scouring of subsided surface drainages; storage within surface tension cracks; increased capacity within surface water infrastructure; and surface water runoff reductions from drainage lines impacted by subsidence. Given the above, there is low confidence in the assessment of subsidence impacts to Retreat Creek as impacts may be underestimated. Further, the assessment does not consider the potential for scouring to cause increased sedimentation and a deterioration of water quality.

Question 2: What does the Committee consider are the features of a monitoring and management framework that would address these uncertainties and risks?

Response

13. The proponent's monitoring and management framework is still under development. The inclusion of the following components would aid in addressing the residual uncertainties and risks:
- a. A complete water balance informed by adequate data and tested against ongoing monitoring.
 - b. A detailed sampling programme for surface water, groundwater and sediment, including regular monitoring, water quality targets, groundwater level triggers, corrective actions and reporting requirements.
 - c. A systematic approach to identification of GDEs in which the groundwater conceptualisation is used to identify areas of shallow groundwater and groundwater discharge.
 - d. A final landform management plan.

Explanation

Water Balance

14. A complete site water balance should be presented, showing all inputs and outputs and stores of water in the system over the whole mine life. The water management system performance under a variety of conditions, including seasonal wet/dry and long-term climate trends, should be provided and the potential for water excesses or shortages assessed. If additional sources of water supply could be required, they should be clearly identified. The preferred discharge option for excess water from site should be confirmed and appropriate infrastructure designed, for example, location and sizing of pumps. Ongoing monitoring of climate (rainfall and evaporation), groundwater inflows and onsite water use should be carried out, and the results used to verify and, if necessary, update the water balance during the mine life.

Surface water and groundwater

15. Features of a monitoring and management framework, not including measures already committed to by the proponent, should include:
- a. Revision of the proposed surface water monitoring locations to un-impacted surface water course reaches. This would improve the suitability of baseline surface water quality data.
 - b. Installation of surface water flow meters within Retreat Creek and Taroborah Creek to determine existing seasonal flow dynamics and baseflow estimates.
 - c. Continued water quality and quantity monitoring for a period that will provide a comprehensive baseline (24 months) prior to the commencement of construction activities, to provide representative existing surface water and groundwater quality and quantity conditions.

- d. Regular surface water sampling for physicochemical properties, for example, pH, dissolved oxygen, suspended and dissolved sediments. Monitoring should be conducted in accordance with published guidelines³.
- e. Implementation of a regular schedule for monitoring of groundwater quality and quantity parameters throughout the life of the project.
- f. Identification of surface water and groundwater quality trigger levels with associated remedial actions to be undertaken should these triggers be exceeded.
- g. Commitments to monitor, mitigate and manage impacts to private groundwater users resulting from bore drawdown.
- h. Ongoing visual and photographic monitoring of subsidence within and in the vicinity of surface drainages, semi-permanent pools, springs and the large dam located within the predicted extent of subsidence. Subsidence monitoring is needed to identify any necessary mitigation or remediation, confirm that land subsidence does not appreciably increase with time and that the proposed remedial works are effective. Monitoring should be conducted in accordance with the requirements of a subsidence management plan.

Water related ecological assets

- 16. Details of ongoing GDE and/or spring monitoring locations, and monitoring frequency, have not been provided. A GDE and spring monitoring programme would need to include regular groundwater and surface water monitoring, including flow and water persistence within semi-permanent pools, to aid an assessment of the importance of seasonal water variations to these assets. A programme such as this would allow the development of stress indicators and trigger values to determine when impact mitigation and management measures should be introduced.
- 17. A systematic approach to identification of GDEs should be taken in which the hydrogeological conceptualisation is used to identify areas of shallow groundwater (less than 20 metres below ground level) and groundwater discharge. The location of springs needs to be incorporated in future assessment documentation or management plans.
- 18. Stygofaunal sampling carried out in 2011 did not identify stygofauna. However, these samples were taken from deeper, consolidated, hydrogeological units and did not include sampling from likely stygofauna habitat in alluvium. Recent bores have been installed within the alluvium which should be sampled to determine the presence of stygofauna.

Final Landform

- 19. The proponent has not detailed 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 lakes to provide a representative indication of groundwater quality and identify any leaching of highly saline or acidic material.
 - b. Modelling of salt stratification and contaminant enrichment within the final void lakes.
 - c. Water quality criteria for the final void lake.
 - d. Development of a final void management plan, prior to the completion of open cut mining, which incorporates the above measures.

Question 3: Have cumulative impacts with other developments on a local scale that impact water resources been sufficiently addressed?

Response

20. The cumulative impact assessment does not adequately consider local scale cumulative impacts to water resources from coal mines located within the Nogoia River Catchment.

Explanation

21. Six projects at varying stages of development are located within 50 km of the Taroborah Coal project (in order of proximity): Teresa, Valeria, West Emerald, Athena, Kestrel and Minerva. Other than the Teresa Coal project, the proponent has not provided an assessment of whether impacts from these mines are likely to contribute to cumulative impacts associated with the Taroborah Coal project.
22. The consideration of cumulative impacts between the proposed project and the Teresa Coal project is limited to a statement of distances between drawdown extents that are not substantiated by documented evidence or reference to the Teresa Coal EIS. This approach does not consider cumulative losses, or seasonal losses, in baseflow to surface water systems of the Nogoia River Catchment, which are likely to be most noticeable during the dry season.
23. The groundwater model for the Taroborah Coal project is 40 km by 40 km and is oriented such that the Teresa Coal project area does not fall within the model domain. However, based on the Teresa Coal project's existing publicly available groundwater model report⁴, groundwater drawdown caused by that project extends into the Taroborah Coal project's groundwater model domain and should therefore be represented in the Taroborah Coal project's groundwater model. Given the above, cumulative groundwater drawdown impacts of the two projects are unable to be quantified unless the Taroborah groundwater model takes into account the Teresa Coal project.
24. The following features would enable a more comprehensive cumulative impact assessment within the Nogoia River catchment:
- a. Identification of the regional geology, hydrogeological regime and hydrogeological connectivity between project areas.
 - b. Collection of data from other projects in relation to groundwater drawdown, water tables, surface water hydrology and surface and groundwater interactions.
 - c. Utilisation of appropriately robust and repeatable methodologies to determine the significance of impacts.
 - d. Determination of monitoring, mitigation and management measures to avoid or minimise and report on potential cumulative impacts.

Question 4: Are additional measures and commitments required to mitigate and manage impacts to water resources and water-related assets?

Response

25. Measures to mitigate and manage impacts that would support the proponent's existing commitments and the framework outlined in Question 2, include: improving the groundwater model's geological conceptualisation, calibration, ability to predict impacts to seasonal variations and impacts caused by subsidence induced fracturing; identification of ecological assets; and providing an informed hydrological conceptualisation.

Explanation

Groundwater model

26. Several uncertainties have been presented in paragraphs one to six (Question 1), which reduce confidence in the groundwater model's prediction of impacts to groundwater resources. The following measures would aid in addressing these uncertainties and improve confidence with the model predictions:
- a. Evidence to support the proponent's approach to modelling large basin scale faults by "turning off" cells on the far side (relative to the project area) of faults. Evidence to support this groundwater modelling approach would include:
 - i. A geological conceptualisation that identifies groundwater flow, connectivity, and key geological structures in an east to west direction.
 - ii. Groundwater and hydrogeological data from either side of the faults, including water table depth and groundwater head for hydrogeological units.
 - iii. Evidence from comparable fault zones that have been analysed, to explain the assumptions made in representing the influence of faults within the numerical groundwater model.
 - iv. A full description of flow boundaries, and boundary conditions used to parameterise faults, within the groundwater model.
 - v. Sensitivity of the model to variations in fault representation.
 - vi. Peer review of the model construction and geological conceptualisation.
 - b. Further field measurements of hydraulic conductivity within the target coal seams. These would be beneficial calibration targets for future versions of the model, given hydraulic conductivity for the coal seams was estimated using only three permeability tests (one from the A seam and two from the B seam).
 - c. Ongoing transient calibration of the groundwater model, utilising seasonal groundwater data gathered from recently installed monitoring bores. This is needed to enable the model to predict impacts to, and variations in, seasonal groundwater levels and baseflows to surface water systems. Following commencement of mining, groundwater mine inflow monitoring data could be used as a transient calibration target.
 - d. Improved resolution of river cells would provide finer scale impact predictions, therefore aiding the assessment of potential impacts to individual GDEs and springs.
 - e. A variety of potential subsidence induced fracturing scenarios and parameters should be considered for the layers above longwall panels. These scenarios should be supported by evidence and an assessment provided of the resulting changes to recharge, mine inflows and river baseflows.

Water related ecological assets

27. The use of groundwater by riparian vegetation should be evaluated using techniques from the Australian Groundwater Dependent Ecosystem Toolbox (AGDET)⁵. Use of the AGDET would allow an improved assessment of the impacts of groundwater drawdown and subsidence on any identified vegetation GDEs. For example, the assessment of GDEs within the EIS only considered surface expressions of groundwater as potential GDEs. However, vegetation within and in

proximity to the proposed project area contains deep rooted species that have the potential to use groundwater and should be considered as potential GDEs.

28. The location, size and the ecosystems supported by semi-permanent pools and springs within the Taroborah Coal project area should be identified. Pools should be monitored for their duration of persistence and for water quality pre and post wet season.

Surface water

29. A number of streams across the proposed project area appear to be supported by shallow groundwater. A depth to water table map is needed to inform the hydrological conceptualisation for the surface water catchments of Retreat Creek and Taroborah Creek.

Date of advice	12 June 2014
-----------------------	--------------

Source documentation available to the IESC in the formulation of this advice	AustralAsian Resource Consultants 2014, Environmental Impact Statement for Taroborah Coal Project. Prepared for Shenhua International Group Pty Ltd. Available from: http://www.taroborah.com.au/download-the-eis
---	--

References cited within the IESC's advice	<p>¹ Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals available at: http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf</p> <p>² Kendorski, FS (2006) Effect of Full-Extraction Underground Mining on Ground and Surface Waters A 25-Year Retrospective. 25th International Conference on Ground Control in Mining, Morgantown, West Virginia, USA, 2006.</p> <p>³ ANZECC and ARMCANZ (2000) Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy (NWQMS). Document 4 and 7. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council for Australia and New Zealand, Canberra.</p> <p>⁴ GHD (2013) Teresa Coal Project Appendix I – Mine Technical Report, Hydrogeology Report. May 2013. Available From: http://www.newemeraldcoal.com/wp-content/uploads/2014/02/Volume-2_Appendix-I.1-I.2.pdf</p> <p>⁵ Richardson, et al (2006) The Australian Groundwater Dependent Ecosystems Toolbox. National Water Commission, Canberra.</p>
--	---
