Advice to decision maker on coal mining project

IESC 2014-056: Muja South Extension (EPBC 2009/5014) – Expansion

Requesting agency	The Australian Government Department of the Environment
Date of request	5 August 2014
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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 to provide advice on Griffin Coal Mining Company's Muja South Extension in Western Australia (WA).

This advice draws upon aspects of information in the Draft Public Environment Report, 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.

Griffin Coal is proposing to develop the Muja South Extension open-cut coal mine (Muja South), located 18 km south-east of the town of Collie, in the South West of WA. Existing mining operations at Muja ceased in 2010, and the Muja South Extension will re-mine the existing Muja mine void (along with the Chicken Creek and Centaur mine voids) in order to target deeper coal seams over a total disturbance area of 2683 ha.

The upper Collie River catchment and Collie Basin groundwater resources are already subject to significant impacts from existing land uses in the area. Historic land clearing and a long history of coal mining (since 1898) have resulted in degraded surface water and groundwater quality, changes to surface water–groundwater connectivity, altered surface water hydrology, groundwater drawdown and impacts on associated water-dependent resources. Currently operating coal mines in the Basin include the Premier Coal Mine and Griffin Coal's Ewington Coal Mine.

Muja South is located in the Collie River East Branch (CREB) catchment within the upper Collie River catchment. The Upper Collie Water Allocation Plan (Department of Water (DoW) 2009) governs the management of surface water and groundwater resources in the area. The Muja South Extension proposes to extract up to 63 GL/y of groundwater (predicted average dewatering over the life of the mine is 34 GL/y).

Identified water-related assets in the Muja South area include the CREB and the Chicken Creek damplands.

<u>Key potential impacts</u>

In the context of Muja South lying within a heavily impacted catchment in an area that has been mined since 1898, potential impacts on water resources may be significant in terms of volumes and timing of extractions from groundwater and release of extracted groundwater to surface water. These impacts would include:

- Long-term groundwater drawdown affecting groundwater dependent ecosystems.
- The accumulation of saline, acidic, metalliferous groundwater in mine voids.
- Altered hydrology and water quality in the re-aligned Chicken Creek.
- The loss of the Chicken Creek damplands.
- Long-term impacts of mine water discharge to the hydrology, geomorphology, water quality, riparian vegetation communities and instream fauna of the CREB and associated permanent pools.
- Substantial contribution to cumulative groundwater and surface water impacts in the region.

<u>Assessment against information guidelines</u>

The proposal did not discuss water resources as a Matter of National Environmental Significance (MNES). As outlined in the Significant Impact Guidelines (Commonwealth of Australia 2013), the value of the water resource for all uses, including environmental outcomes, needs to be considered. A comprehensive approach to assessing surface water and groundwater systems, their interactions and water balance, and linkages to ecosystems and ecosystem components and processes, should be undertaken to ensure that all impacts of the project on water resources can be understood. This should include impacts on biological diversity or species dependent on the water resource, for example the water rat *Hydromys chrysogaster* or *Banksia* spp.

There are gaps in the assessment and study approach which constrain understanding of the risks and impacts of the Muja South Extension. The documentation contains factual inconsistencies between and within reports. The impacted nature of the environment in the Collie Basin does not justify a less detailed environmental assessment.

The IESC, in line with its Information Guidelines (2014), has considered whether the proposed project assessment has used the following:

Relevant data and information: key conclusions

The proponent's groundwater monitoring data was collected over a limited timeframe and would not be adequate to assess temporal variability. Relevant data or information is needed to predict the potential impacts of the Muja South Extension including information on water-related assets (e.g. Chicken Creek damplands, Collie River riparian vegetation, irrigation water supply), surface water geomorphology, additional seasonal sampling and species-level identification to assess changes in macroinvertebrate community composition. For example the documentation contained limited hydrological information and no ecological information in relation to the dominant ecosystems.

Application of appropriate methodologies: key conclusions

The proponent has incorporated historical and operational mines in the area into the groundwater model. This incorporation will allow reasonable estimates of cumulative impacts. Methodologies that need improvement are: modelling of mine pit lakes to ensure all processes that contribute to pit lake filling are adequately represented, including groundwater level recovery post-mining and its influence on inflow to, or outflow from, the pit; and provision of a site water balance including recharge in order to identify and design the infrastructure needed and manage mine closure.

Reasonable values and parameters in calculations: key conclusions

Justification is needed to support the proponent's approach in relation to the calibration, exclusion of recharge from, and limited extent and boundary conditions of, the groundwater model. For example the groundwater model extent did not include the entire mine site. Justification is also needed in relation to classification of the CREB flow regime and calibration of the surface water model.

Advice

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

Question 1: Is the information provided in the draft PER including attachments, sufficient to assess all of the potential impacts of the proposal on water resources and any ecological functions associated with the water resources (i.e. groundwater or surface water dependent native vegetation)? If not, could you please identify the gaps in knowledge and/or recommend further studies that should be undertaken?

Response

1. No. Information necessary to assess water-related impacts was either not provided, was inconsistent, or used inadequate methodologies, for example groundwater level recovery after mine closure was not modelled.

2. The following studies or information should be provided to inform the assessment of impacts associated with the project:

   a. more recent groundwater monitoring data (beyond the six months of 2006–2007 data) and installation of additional groundwater monitoring bores

   b. details of the former and future geochemical sampling and testing programme

   c. a hydrological model for the CRSB including flow regime characterisation

   d. geomorphic assessment of Chicken Creek, CREB, CRSB and associated pools including existing sedimentation and erosion processes

   e. contextual information on the surface water quality dataset such as the location of sampling sites

   f. a site water balance to inform the development of a site water management system

   g. aquatic ecology surveys in Chicken Creek, the CREB and CRSB

   h. further characterisation of the complex ecohydrology (relationship between hydrology and ecosystems) of the Chicken Creek damplands.

3. The following shortcomings were identified in the methodologies adopted for models:

a. The groundwater model:

i. conceptualised the Premier Sub-Basin as being hydrologically disconnected from surrounding groundwater resources

ii. did not include recharge

iii. the domain did not include the full extent of the mine pit and was too small to show the full extent of drawdown impacts.

b. The modelling of the final void pit lakes is highly simplified and insufficient details are provided regarding the data and assumptions used. Detail is needed on groundwater recovery times and groundwater contamination risks.

c. The hydrological model for the CREB was calibrated on a single event recorded in a different sub-catchment. There was also a discrepancy in modelled peak flows in Chicken Creek that needs to be resolved. In addition, there was no evidence to support assumptions about the ecohydrology and environmental water requirements of the Chicken Creek damplands.

4. There is conflicting information in the PER that needs to be clarified, for example:

a. The groundwater assessment report (at Appendix 3 of the PER) uses different mine void dimensions to those stated in the PER.

b. The CREB is classified as ephemeral in some parts of the PER and perennial in other parts.

<u>Explanation</u>

Groundwater

5. The groundwater assessment used data collected between August 2006 and February 2007. The timeframes of this assessment do not allow an adequate assessment of annual variability and will not accurately reflect existing conditions. Given declining piezometric head and groundwater quality trends noted in the Muja South assessment and other studies in the area (SKM 2010b) longer term and up-to-date groundwater data for the project is needed.

6. The Muja South groundwater monitoring network is currently targeted along the northern and eastern margin of the proposed mine site with limited bores along the southern and western margin. This network of bores does not allow the full scale of drawdown impacts to be adequately monitored. Additional monitoring bores need to be installed at an adequate depth and spatial array to supplement the existing Muja South monitoring network. Data from the existing basin-wide monitoring bore network should also be used in the Muja South assessment to improve understanding of groundwater in the region.

7. Further justification of the conceptualisation of the Premier Sub-Basin is needed. The Premier Sub-Basin is conceptualised as being hydrogeologically disconnected from surrounding groundwater resources, such as shallow aquifers and potential aquifers associated with weathered or fractured basement rock beyond the Collie Basin. This conceptualisation is not sufficiently supported by groundwater data. It is also inconsistent with shallow water table mapping in the Muja South assessment which suggests groundwater connection between the Collie Basin and the surrounding area.

Groundwater Model

8. Further justification is needed to support the conceptualisation, construction and parameterisation of the Muja South FEFLOW model. In particular:

a. The groundwater model domain is constrained to the Collie Basin and does not include the entire project site and void area. The model domain needs to be extended to encompass the entire proposed mining area, Collie Basin, and any water-related assets outside the basin such as parts of the CREB. Groundwater and surface water interaction at the CRSB and CREB need to be taken into account when the domain is extended. This will allow an assessment of drawdown including potential impacts to CRSB pools.

b. The use of no-flow boundaries for the entire model needs to be justified, particularly given the potential for groundwater connection with the surrounding region. The use of no-flow boundaries limits the predicted extent of drawdown impacts and consequently excludes consideration of impacts to groundwater dependent ecosystems (GDEs) and other water-related assets outside of the model domain including pools in the CRSB and the upper Collie River.

c. The proponent states that vertical leakage between layers is the primary vertical flow mechanism in the basin, transmitting more groundwater than faults, but no evidence is provided for this. The proponent has not included the hydraulic characteristics of faults in the numerical model. Other groundwater models for the Collie Basin incorporate discrete faults with specific hydraulic conductivity values. To justify the proponent's approach and to determine the implications of differing model approaches in relation to fault characterisation, a comparison between model parameterisation and predictions should be provided and significant differences addressed.

d. Groundwater recharge needs to be included to provide a comprehensive water balance in the model. Regional recharge processes are complex and are likely to make a significant contribution to the overall water balance. Their omission limits the confidence that can be placed in the model predictions. Recharge also influences the timeframes for post mine groundwater recovery and therefore should be included in the model.

e. Further information on model calibration should be provided. How model calibration and model predictions are impacted by the use of no recharge conditions should be explored. A comparison of calibrated and observed/measured hydraulic parameters across layers should be given. A supporting uncertainty and sensitivity analysis should be undertaken.

f. The model should use recent groundwater data that reflects existing conditions when generating a variable starting head level for predictions. The model used a uniform starting head value of 210 m AHD, which the proponent notes was "commonly" 5–10 m different from observed head values (which as discussed in Paragraph 5 are over five years old). This discrepancy should be addressed to improve confidence in model predictions.

g. The discrepancy in the dimensions of the two mine voids between the Groundwater Assessment report (incorporated into the groundwater model) and the main PER needs to be clarified.

h. Estimates of groundwater recovery under a range of scenarios should be provided to inform the development of adequate post mine groundwater monitoring, management and mitigation measures.

Final Void/Pit Lakes Model

9. The proponent has used the Mine Water Filling Model (MIFIM) (Banks 2001) to predict water level recovery in the two final voids under a range of potential climate and surface water supplementation scenarios. The MIFIM model provides a highly simplified representation of the wider groundwater system and it is unclear how the MIFIM model interacts with the groundwater

model. Further information and clarification of model assumptions, construction and parameterisation are needed to support predictions. In particular:

a. Groundwater inflow rates to the final voids in the MIFIM model are head dependent and initial inflow rates were derived from the FEFLOW model. As the FEFLOW model does not include recharge it is unclear how the MIFIM model is able to represent groundwater recovery in the Collie Basin and how this may affect modelled scenarios.

b. The assumption of “no initial groundwater inflow and no recharge from rainfall” to the northern void should be quantified and supported by evidence.

c. The groundwater catchment for each pit is simulated as a 5 km radius around the final void. This assumption needs to be supported by evidence and consideration of all water balance components should be demonstrated including: recharge sources; other voids in the region; and groundwater level recovery.

d. Existing climate trends and future predictions should be considered in the MIFIM model scenarios and the final void risk assessment. The PER referred to declining rainfall trends for the Collie region in particular winter rainfall. However these trends and predictions of future changes have not been considered in the climate scenarios for the MIFIM, and may result in underestimation of pit lake water level recovery times.

e. The proponent predicts that to maintain the target water level in the southern void in equilibrium with evaporation, it will require diversion of all flows from Chicken Creek (modelled as 2.1 GL/yr on average) and a further 400 ML/y from the CREB (based on average rainfall). Clarification is needed regarding the water balance used in this estimate.

10. Pit lake water quality predicted under different MIFIM model scenarios needs to consider the risk of acid and metalliferous drainage and associated geochemical processes such as increased mobility of metals from waste rock and overburden. Modelling of potential acid generation in the final landform including toxicant fate and transport would allow assessment of risks and inform the design of effective mitigation and management measures.

11. Further modelling is needed on groundwater recovery times, groundwater contamination risks, and surface water inflows and potential outflows (such as from flood events). A solute transport model coupled with the groundwater flow model should be considered to predict the fate and transport of contaminants from the pit lakes into the groundwater system.

Geochemistry, Acid and Metalliferous Drainage Risks

12. Waste rock is noted to be highly sodic, potentially acid forming, and contains elevated levels of some metals. These characteristics introduce potential risks to surface water and groundwater quality. To better assess the likelihood and severity of this risk the following information should be provided:

a. Details and results of the geochemical sampling and testing that has already been carried out and the proposed kinetic testing and leachate testing for metals and toxicants.

b. Volumes of non-acid forming and potentially acid forming materials in waste rock.

c. Proposed management strategies and details of measures to prevent acid generation.

d. Evidence to demonstrate the long-term stability of conceptual emplacement and capping design to prevent exposure of potentially acid forming materials, such as geotechnical and erosion modelling, water ingress monitoring, and infiltration and runoff modelling.

Surface Water

13. Clarification of the flow regime (ephemeral or perennial) is needed for the CREB, to assess the potential impacts of the project on the receiving environment. Flow regime classification should be consistent with published literature (e.g. Kennard *et al*. 2010) and existing gauge data should be reviewed in this context. The presentation and analysis of flow data as percentiles rather than averages would also aid understanding of flow characteristics.

14. The flow regime should be described and a hydrological model developed for the CRSB. The CRSB has the potential to be affected by groundwater drawdown and potential impacts to the pools and flow regime need to be considered.

15. Confidence in the CREB hydrological model could be improved by calibrating the hydrological model against a range of flow events using data from both the Camballan Creek and Buckingham Mill stream gauge stations. The current hydrological model calibration is not adequate as it is calibrated against a single 10 year Annual Recurrence Interval (ARI) event at Camballan Creek which is located in a different sub-catchment.

16. In the hydrological model of Chicken Creek the discrepancy in peak flows between the Worley Parsons study (10. 5 m^3/s) and the proponent's model (19 m^3/s) for the 20 year ARI event needs to be resolved. This is important to ensure:

    a. The adequate design and construction of the Chicken Creek diversion.

    b. An adequate assessment of potential downstream impacts arising from the diversion of Chicken Creek.

17. An assessment of existing geomorphic processes and condition of Chicken Creek, the CREB, the CRSB and pools associated with both rivers is needed. These surface water features have the potential to be affected by construction activities, water discharges, creek diversion, and groundwater drawdown. Geomorphology studies should include channel morphology; cross-sections and long-sections; sediment supply; particle size analysis; composition and transport of sediment; the influence of in-stream and riparian vegetation; and the effect of the existing hydrological regime in shaping and maintaining geomorphic processes and habitat.

Surface Water Quality

18. Contextual information is needed on the water quality data set including clarification of how the ANZECC guideline values were applied. This would give confidence to the representativeness of the dataset provided and confirm the proponent's characterisation of existing surface water quality conditions. In particular:

    a. The location of sampling sites; number of samples collected; date of sample collection; and the duration of the monitoring program are needed to assess the representativeness of the monitoring data.

    b. Presentation of metals data in total and dissolved fractions would aid understanding of current and future risks to aquatic biota.

    c. An explanation of the toxicant water quality trigger values adopted by the proponent is needed. The ANZECC trigger values presented in the PER are inconsistent with those in the ANZECC guidelines (2000) for some metals.

    d. The partitioning of results by flow would aid understanding of seasonal water quality variation.

Site Water Balance

19. A site water balance needs to be developed to inform a site water management system. This needs to be developed with reference to the IESC's Information Guidelines in order to: identify and design site infrastructure; quantify mine water demand; identify appropriate water sources; manage the water generated, stored and used on site; and define and quantify discharge scenarios. The water balance should include all key inputs, outputs and transfers of water within the mine water management system, consider seasonal and long-term climate variations, and project development stages.

Ecology

20. No targeted aquatic ecology studies were undertaken for the Muja South Extension. Seasonal sampling for macroinvertebrates including species-level identification is needed to assess changes in community composition resulting from Muja South (SKM, 2010a p.71).

21. A comprehensive assessment of surface water and groundwater systems; their interactions and water balance; and conceptualisation of linkages to ecosystems should be undertaken to ensure that all potential impacts on water-related assets can be assessed.

22. The aquatic ecological values of pools in the CREB, particularly Duderling and Buckingham Bridge pools, need to be assessed through surveys of macroinverteberates, fish, turtles and frogs, and trapping for the water rat *Hydromys chrysogaster*. Consideration should be given to habitat requirements of all fauna (e.g. feeding and breeding habitat, refugia).

23. The current design of the Muja South proposal includes the removal of a large portion of the Chicken Creek damplands within the proposed pit area and flow supplementation in other areas. The ecohydrology of the damplands is complex. They are seasonally inundated wetlands with areas of groundwater recharge and evapotranspiration that support a complex mosaic of vegetation communities with varying levels of groundwater dependence. The description of the existing condition of the damplands lacks detail and is not well supported by appropriate field surveys. To predict impacts caused by water loss or alteration of the hydrology of this system, further characterisation of the damplands including spatial and seasonal variability in surface water-groundwater interactions and use of these water sources by the vegetation communities should be provided.

Question 2: Please discuss whether the potential (direct and indirect) impacts on water resources that have been identified in the draft PER have been adequately addressed, in particular, surface water and groundwater quality, extent and flows, and the potential ecological impacts that are directly associated with the water resources. If not, please provide further discussion on the potential impacts of the proposal, and the likelihood of these impacts occurring.

Response

24. There are several issues with the Muja South Extension documentation that affect confidence in the assessment of impacts on water resources. Some impacts may be under or over estimated while others are lacking details necessary to fully understand the nature and scale of the impact.

25. The key water-related impacts of the proposal are the following:

    a. Long-term groundwater drawdown impacts affecting groundwater dependent permanent pools in the CREB and further afield on the CRSB.

b. The accumulation of saline, acidic, metalliferous groundwater in mine voids which has the potential to move into the surrounding groundwater systems via throughflow and discharge to surface waters.

c. Altered hydrology, water quality and ecological systems in the re-aligned Chicken Creek and the loss of the Chicken Creek damplands.

d. Long-term impacts of mine water discharge to the hydrology, geomorphology, water quality, riparian vegetation communities and instream fauna of the CREB and associated permanent pools.

e. Contribution to cumulative groundwater and surface water impacts in the region including groundwater drawdown and altered hydrology.

<u>Explanation</u>

Groundwater

26. During the Muja South project lifetime most groundwater-related assets will already be impacted by projected drawdown from existing approved projects. However the significantly larger scale and impact of Muja South comparative to other projects in the region will affect groundwater recovery and have long-term impacts to groundwater levels and quality.

    a. Predicted total groundwater extraction over the life of the project is 746 GL with approximately 155 GL being extracted over the first three years. These volumes of extraction will result in significant groundwater drawdown. There remains uncertainty regarding effects of this drawdown on water-related assets including the CRSB, particularly outside of the groundwater model area, and therefore the nature and likelihood of such impacts cannot be determined from the information provided. In addition to increasing the extent of the groundwater model domain (Paragraph 8), and installation of additional monitoring bores to provide greater spatial and temporal coverage (Paragraph 6), mitigation of drawdown impacts should be considered along with further development of beneficial use scenarios as discussed in response to Question 3 (Paragraph 38).

    b. The Muja South pit lakes are predicted by the proponent to have poorer water quality than other pit lakes in the Sub-Basin. Groundwater quality impacts and fate of contaminants released into groundwater from pit lakes have not been adequately addressed in terms of impacts to water-related assets. The PER states that the final void pit lakes are likely to form groundwater through-flow environments with plumes of poor quality groundwater extending from the pit lakes towards discharge areas including the CREB and Duderling pool. The risks to aquatic ecosystems in the CREB as a result of contaminated groundwater-fed baseflow (particularly during dry periods) have not been assessed. The likelihood of these impacts occurring depends on mine void management and filling scenarios which have not been finalised.

27. Additional consideration of impacts to water resources is required.

    a. Acid drainage risks associated with final void filling may affect groundwater quality and have not been addressed in modelling. As a result, the impacts to groundwater quality may have been underestimated.

    b. Impacts to long-term groundwater quality and recovery of groundwater levels in the Collie Basin are not discussed in detail in the PER as outlined below. Groundwater inflow is important to maintaining water levels in the 15 existing pit lakes in the Collie Basin (some of which are being re-mined). Groundwater drawdown at these locations as a result of the project has the potential to result in declining water levels or drying of these pit lakes. However no information regarding impacts to existing pit lakes has been provided. Long-term groundwater quality implications of prolonged drawdown and subsequent water table recovery in these pit lakes as a result of the project should be considered.

Surface Water

28. The PER discusses the volume of discharges to the Collie River, but does not discuss the impact of the increased volume on river geomorphology, water quality, ecosystems or downstream water users in detail. Muja South will discharge up to 61 GL/yr to the CREB increasing annual average flows at Buckingham Mill by between 67 and 325 per cent, with an average 165 per cent increase. These volumes will impact on the hydrology and flow regime within the CREB. In order to understand the impacts of the proposal on the hydrology of the CREB a graphical representation of the daily or monthly differences in flow volume resulting from Muja South discharges should be presented together with changes to water height and velocity. Changes to sediment transport and erosion capacity, observed declining rainfall trends, and associated reduced flows in the CREB should also be considered.

29. Potential water quality impacts of the Chicken Creek re-alignment need to be considered as the re-alignment has the potential to affect water quality through altered geomorphology and changes to substrate.

30. The PER provides a table of indicative water quality discharge criteria but does not assess the potential impacts to the downstream environment. An assessment of downstream water quality impacts resulting from the mine water discharge should include impacts to aquatic ecosystems and to water held in Wellington Dam.

Ecology

31. The PER identifies long-term impacts to pools along the CREB due to mine water discharges. As a result of mine water discharges to the CREB over the life of the mine these intermittently-connected pools are expected to change to depressions in the river bed beneath a continuous flowing (run) habitat. This will cause an associated change in vegetation health and/or composition and changes to in-stream faunal community composition as some invertebrates rely on seasonal low flows which will be changed by mine discharges. Discharge volumes will change over time and eventually cease while long-term groundwater drawdown impacts will continue, causing continuous impacts to water-dependent species.

32. Potential impacts to the water rat (*Hydromys chrysogaster)* have not been assessed. The water rat occupies habitats in the vicinity of permanent water and in the south west of Western Australia has been shown to prefer areas with riparian vegetation, good water quality and complex habitat structure (DEC, 2012). The species constructs nests in logs or digs tunnels into river banks (DEC, 2012). It is a species of conservation interest in Western Australia where it is recognised as a species with a fragmented population in need of monitoring (SKM 2010a, p. 33). There is limited data on the spatial distribution of the water rat along the Collie River or its tributaries although its presence has been documented in Coolangatta Pool on the CREB (SKM 2010a, p.36). The water rat requires stable water levels without erosive flows. Reduced baseflows or groundwater drawdown leading to drying of pools over summer could lead to the loss of local populations (SKM 2010a, p. 113).

33. Direct and indirect impacts on the Chicken Creek damplands due to groundwater drawdown and direct excavation need to be further investigated. Groundwater levels (5 to 15 metres) in the vicinity of Chicken Creek are within rooting depth and have the potential to support a range of water-dependent species including *Banksia littoralis* and *B. ilicifolia* which are recorded in the

project area. The ecology of these damplands is not well understood and should be documented prior to excavation. The extent of groundwater dependency of the Chicken Creek damplands should be evaluated based on the techniques described in the Australian GDE Toolbox (Richardson et al. 2011).

Cumulative Impacts

34. The Muja South Extension represents, in the proponent's own words, a "step-change" from historical and existing coal mining operations within the Collie Basin. This has implications for the scale of Muja South's contribution to cumulative impacts. For example: the combined mine pit area is significantly larger than historic operations in the Basin; the final void depth is correspondingly larger, requiring increased pit dewatering and drawdown and impacting regional groundwater recovery; predicted maximum discharge volumes to the CREB are significantly greater (more than three times the volume) than existing Premier Mine discharges.

35. Cumulative mine discharges would result in average annual flows in the CREB at Buckingham Mill increasing from 19 GL/yr to a maximum of 100 GL/yr. Changes to hydrology will impact water-related assets in the CREB. The timing of mine water discharges will affect the natural flow regime of the CREB affecting species dependent on the present regime. In order to understand the nature and likelihood of such impacts additional detail and a revised impact assessment are needed addressing constant or variable (i.e. stored and released under certain flow conditions) discharge scenarios and management of water prior to discharge (where and how water will be stored and treated prior to release).

Question 3: Based on an assessment of the potential impacts, please provide advice on the adequacy of the management and monitoring measures being proposed to avoid and/or mitigate the risks, in particular, whether the measures being employed are the most appropriate and effective approach, and/or if there are any additional monitoring or management measures that should be employed.

Response

36. The proposed management and monitoring measures are not considered adequate to mitigate the risks to water resources given the size and scale of the proposal. The effectiveness of monitoring and management measures could be improved through:

    a. Extending the groundwater monitoring network beyond predicted drawdown areas, including to the CRSB.

    b. Expanded risk assessment to determine the most appropriate options for final void management.

    c. Additional solute modelling, coupled with groundwater modelling to assess the fate and transport of contaminants that might be released from pit lakes into groundwater.

    d. Further development of proposed beneficial use options for extracted groundwater and details regarding the treatment of groundwater and waste streams.

    e. Further information on the treatment and storage of water prior to discharge to the CREB.

    f. Provision of details regarding the surface water monitoring program.

    g. Ecohydrological studies to support the effectiveness of proposed augmentation of the pools and damplands in mitigating impacts of groundwater drawdown.

h. Details of proposed monitoring triggers and management responses for the management of GDEs.

Explanation

Groundwater

37. The groundwater monitoring network should extend to the limits of predicted impacts and over sufficient time to cover seasonal and interannual variability and address the existing conditions prior to commencement. More spatially and temporally representative hydrostratigraphic and potentiometric data, including from outside the current model domain, and assessment of groundwater-surface water interactions along the CRSB, would improve model confidence and assessment of the potential impacts of the proposal on water-related assets.

38. The management, beneficial use, and disposal of extracted groundwater have not been addressed in detail. While some beneficial use options identified by the proponent require treatment, no treatment methodology has been specified to reduce salinity or metals concentrations nor has management of potential waste streams been addressed. Further information is needed to ensure that risks are adequately characterised and mitigated including additional work to determine feasibility of potential beneficial uses. A plan is needed for the management of water produced during the life of operations incorporating the proposed location of water treatment infrastructure.

39. The final voids risk assessment considered three management options for the final mine voids including: permanent dewatering (pumping) to prevent the formation of a pit lake or groundwater throughflow environment; partial groundwater level recovery allowing the formation of a pit lake without supplementation from surface water; and filling of the pits to the historic water table level using water from Chicken Creek and the CREB.

40. The proponent’s preferred option is to fill the void to inundate potential acid forming (PAF) materials and limit acid generation, and to allow groundwater throughflow to provide baseflow to pools in the CREB. However residual risks of this option are significant and include the acidification of the pit lake water and concentration of salinity and metals in the pit lake. This may lead to groundwater contamination and discharge to surface water including the CREB, with potential impacts to GDEs and aquatic ecosystems. Void management will also have ongoing impacts to the regional groundwater system and this has not been fully explored in the PER.

41. The risk assessment should be expanded to consider backfill of voids and include an assessment for potentially impacted water-related assets. It should also include groundwater resource recovery and quality; existing pit lake water levels and quality; GDEs; and surface water. Details of the risk assessment were not provided but should include:

    a. Groundwater recovery rates and equilibrium levels under different final void management options.

    b. Timeframes for acid generation and implications for a range of groundwater recovery scenarios and timeframes for other contaminant levels, transport and fate.

    c. Implications for drawdown and recovery at other pit lakes in the Collie Basin.

    d. Potential flood risks arising from diversion of surface water resources into final voids should be addressed and appropriate mitigation measures considered. Once pit lake water levels have reached equilibrium significant flood events risk overtopping of the pit lake impacting on downstream water quality and water-related assets.

Surface Water

42. The PER states that water to be discharged to the CREB will be treated and presents indicative water quality targets but does not explain how water will be treated or stored. Details of water storage and treatment should be provided.

43. Muja South will substantially alter the hydrology of the CREB through mine water discharges. No mitigation measures are proposed for this impact. The proponent should consider beneficial use options for extracted mine water in further detail as discussed in Paragraph 38.

44. The proponent has committed to determining the existing surface water quality condition as part of its surface water monitoring programme. However the design of the monitoring programme has not been provided. The monitoring programme needs to address the concerns raised in response to Question 1 in relation to data validation, presentation and representativeness. Data collection should occur before the operation commences and be of sufficient quality and timespan for valid comparison with post-disturbance data. 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.

Ecology

45. The proponent proposes to mitigate impacts to water levels in CREB pools and the remaining area of the Chicken Creek damplands by artificially augmenting water levels. Evidence from ecohydrological studies should be provided to document and justify the effectiveness of this mitigation measure. The PER states that it may not be possible to maintain the remaining dampland vegetation even if water is regularly pumped back.

46. The PER states that water-dependent vegetation along the CREB will be affected by changes to the hydrological regime caused by mine water discharges but does not propose any specific mitigation measures for this impact.

    a. The Operational Environmental Management Plan includes surveys of GDEs but no specific corrective measures are proposed if impacts are detected.

    b. The Operational Environmental Management Plan includes a management action to control weeds where necessary but it is not clear if this measure is to be implemented on the mine site, or if it also extends to the downstream affected environment of the CREB.

    c. The PER should include specific mitigation measures for the vegetation changes expected to occur along the CREB, including weed control measures.

Date of advice	10 September 2014
Source documentation available to the IESC in the formulation of this advice	Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council for Australia and New Zealand (ARMCANZ). 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Volumes 1 and 2. Paper 4 of the National Water Quality Management Strategy. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council for Australia and New Zealand, Canberra. Barnett, B. et al. 2012. *Australian groundwater modelling guidelines.* Waterlines report. National Water Commission, Canberra.

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