

## Advice to decision maker on coal mining project

### IESC 2014-044: Red Hill Mining Lease Project (EPBC 2013/6865) - Expansion

<b>Requesting agency</b>	The Australian Government Department of the Environment, and The Queensland Office of the Coordinator-General
<b>Date of request</b>	4 March 2014
<b>Date request accepted</b>	4 March 2014
<b>Advice stage</b>	Assessment

#### Advice

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) was requested by the Australian Government Department of the Environment and the Queensland Office of the Coordinator-General to provide advice on the Red Hill Mining Lease Project in Queensland, at the draft Environmental Impact Statement (EIS) stage.

This advice draws upon aspects of information in the draft 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 project is located approximately 20 km north of the town of Moranbah in the Bowen Basin, Central Queensland. The proposed Red Hill Mining Lease project will expand production from the existing Goonyella Riverside and Broadmeadow (GRB) mine complex (which includes both open cut and underground mining operations) by 14 million tonnes per annum (mtpa) of product coal to a combined total of 32.5 mtpa.

The proposed project includes development of a new Red Hill underground mine (RHM) with an estimated mine life of 25 years. The project also includes expansion of the existing Goonyella Riverside Mine (GRM) to provide infrastructure for the future RHM. The third aspect of the proposed project is the Broadmeadow (BRM) Extension involving the extension of three longwall panels into the Red Hill mining lease application. The EIS study area covers the combined GRB mine complex and extends over 25,989 ha, while the Red Hill Mining Lease Project area is 3,967 ha. The ephemeral Isaac River and its tributaries, Goonyella Creek and 12 Mile Gully, cross the proposed RHM, and Eureka Creek crosses the GRB mine complex.

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

Relevant data and information: key conclusions

Limited detail on site data, and the use of literature values, reduces confidence in key parameters of the groundwater model, including hydraulic conductivity and recharge values, which are the drivers for flow within the model. As a result, confidence in model predictions is low.

Seasonal variability in groundwater levels, particularly in the shallow alluvium, has not been established. This information is needed to understand existing groundwater conditions, provide the relevant data to adequately conceptualise the groundwater regime and establish, if present, the nature and extent of surface water and groundwater interactions. Further, establishment of the degree of groundwater use by vegetation, including the Brigalow (*Acacia harpophylla*) Threatened Ecological Community (TEC), is warranted considering the depth to groundwater in the data provided.

There is limited data to assess impacts of the project to the Isaac River. Additional water quality and aquatic ecology survey information covering appropriate seasonal variations would allow changes in water quality, quantity and flow regime to be assessed, and appropriate management responses to be developed.

Comprehensive and representative geochemical studies and sampling, including kinetic testing, will be important to ensure that risks of potentially acid forming material and metaliferous drainage are adequately identified and management.

Application of appropriate methodologies: key conclusions

Limited groundwater monitoring on the site has resulted in uncertainty around the groundwater conceptualisation. Exclusion of geological structures including faulting, and uncertainty regarding impacts of subsidence fractures on groundwater, also reduce confidence in the conceptual model.

Uncertainties identified in the conceptual model will reduce confidence in the construction of the numerical groundwater model. Sensitivity analysis of the numerical model to faulting and potentially extensive subsidence fracturing would improve model confidence. The Isaac River has not been included in the groundwater model and therefore potential impacts to the river may not be accurately realised or predicted.

Water quality modelling would improve understanding of impacts on water quality and water-related assets within the mixing zone downstream of the discharge point. Further information is needed to support the derivation of modified water quality objectives.

Expanded hydrological studies would assist in understanding of flow losses, including impacts to aquatic ecology and riparian vegetation, and implications for ecological flow requirements.

Stygofaunal surveys should be undertaken in accordance with established guidelines.

Reasonable values and parameters in calculations: key conclusions

There are uncertainties and limitations around parameters used for recharge and hydraulic conductivity that need to be clarified. These parameters determine the degree of groundwater flow within a system and need to be adequately characterised and understood. There was insufficient data to undertake transient model calibration and as a result the model is only calibrated in steady state, further reducing the confidence in predictions.

Ponding within the Isaac River channel should be addressed in estimated total ponding volumes, along with flow captured within sand beds after subsidence voids are in-filled. Assumptions and

parameters used in the Isaac River sediment transport model should also be further supported with monitoring data.

Adoption of modified water quality objectives (WQOs) which exceed background salinity and guideline values for some toxicants requires further justification.

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

*Question 1: Are the groundwater models adequate to assess the potential impacts on groundwater, interactions with surface water, water resources and water dependent assets (including listed threatened species and communities and groundwater dependent ecosystems) and users of that surface water and groundwater?*

- a. *Does the Committee agree with the proponent's interpretation of the conceptual groundwater model and its appropriateness to the risks of the project? If not, is there an alternative interpretation of the conceptual groundwater model?*
  - b. *Did the EIS satisfactorily identify the key uncertainties and risks around outputs of the groundwater modelling in relation to impacts on water resources? Is the IESC satisfied that the model parameterisation and construction were reliable and that the range of uncertainty in predictions is appropriately quantified and addressed?*
1. The conceptual and numerical groundwater models are not considered adequate to assess potential impacts on water resources or other water-related assets, and do not deal fully with the uncertainty of predictions. While there might be alternative interpretations for the conceptualisation of the groundwater regime within the region, the current conceptualisation and numerical modelling can be further strengthened by addressing the points outlined below. There are limitations around the parameters used for recharge and hydraulic conductivity.

Conceptualisation:

- a. Existing groundwater flow directions, groundwater levels and the extent of formations, both in the form of maps and specific values, are either missing or only partially addressed in the proponent's conceptual model. The proponent notes the likely variability in the spatial extent of the Quaternary alluvium, Tertiary sediments and Tertiary basalts. Given this variability, the distribution, extent and hydrogeological conceptualisation of these potential water bearing units need to be characterised, as the units have been identified as potential water resources in the region. In particular, the characterisation of the Tertiary sediments throughout the site as predominantly of a clay nature, and the application of a corresponding low hydraulic conductivity throughout the model domain should be further justified.
- b. The proponent notes the structural complexity including igneous intrusion and faults at the western edge of the mine area and faulting within the Permian strata. Due to this complexity, consideration of the effect of subsidence in combination with faulting would allow a better assessment of potential impacts on surface and groundwater resources.
- c. The Isaac River runs over the mine site longwall panels. The river is not represented in the conceptual or numerical model, and its exclusion reduces the model's ability to predict surface and groundwater interactions and potential impacts to surface water resources.
- d. The groundwater monitoring network described by the proponent may not provide optimal coverage of all hydrostratigraphic units across the project area, and the resulting data may not be sufficient to support a robust conceptual model. The IESC recommends that the proponent include additional monitoring bores at an appropriate spatial and depth distribution to allow reasonable representation across all relevant formations. This will increase

confidence in the conceptualisation of the groundwater regime and allow risks to groundwater due to drawdown or contamination to be better addressed. Additional groundwater monitoring should also be undertaken to determine seasonal variability within the alluvium to better characterise the extent of surface-groundwater interactions.

2. Numerical Groundwater Model: Uncertainties identified in the conceptual model will reduce confidence in the construction of the numerical model. In addition, limitations and uncertainties with model parameters have been identified. These include:
  - a. The volume of recharge applied to the model is unclear; the input values, including their derivation should be provided.
  - b. Some of the hydraulic conductivity parameters are derived from literature values. The use of site specific values would be preferable. The proponent refers interchangeably to hydraulic conductivity and permeability, however the correct term should be used.
  - c. There was insufficient data to undertake transient model calibration, and as a result the model is only calibrated in steady state, and confidence in transient predictions is low.

*Question 2: Did the EIS satisfactorily identify the key uncertainties, and risks around outputs of the subsidence modelling in relation to impacts on water resources? Is the IESC satisfied that the model parameterisation and construction were reliable and that range of uncertainty in predictions are appropriately quantified and addressed?*

- a. *The proponent has concluded that there is a low risk of direct hydraulic connectivity between the surface and the coal seam as a result of subsidence. Does the Committee agree with this conclusion?*
3. While the proponent has used a recognised method for predicting the magnitude of ground surface subsidence, other subsidence impacts, including the risk of direct hydraulic connectivity between the ground surface and the coal seam, are not addressed within the subsidence model. As a result of these limitations, the predicted impacts on water resources are not adequately quantified or addressed. In the absence of supporting evidence, IESC is unable to agree with the conclusion that there is a low risk of direct hydraulic connectivity between the surface and the coal seam.
4. The proponent notes that the parameters for subsidence modelling rely in part on subsidence measurements from similar operations and environments. The representativeness of such measurements is not discussed. Validation of predictions against monitoring data from neighbouring mines would reduce uncertainty regarding subsidence predictions, and resulting ponding volumes and geomorphic impacts to watercourses, such as bank erosion and avulsion.
5. The proponent has only predicted subsidence in terms of vertical displacement. Other subsidence related impacts which should be addressed include:
  - a. Potential chain pillar compaction;
  - b. Subsurface fracturing height above the mined longwall panels and the hydraulic connectivity of the fracture network;
  - c. Size and distribution of surface cracking and potential unconventional subsidence movements; and
  - d. The impact of faults on subsidence movements, and resulting impacts to aquifers and groundwater flow paths.

6. The proponent's subsidence prediction report identifies a "mitigated" subsidence case where only 3.9 m of coal is extracted in areas proximal to the Isaac River; however it is unclear whether, or under what circumstances, such mitigation would be required. Surface subsidence monitoring and triggers for mitigation need to be provided in order to ensure that risks to surface water resources and aquatic ecosystems are adequately managed. Monitoring of surface subsidence should also include monitoring of cracking and potential unconventional subsidence movements.
7. Hydraulic connectivity of subsidence fractures: The proponent's subsidence modelling does not address the potential for direct hydraulic connectivity between the ground surface and the coal seam; as a result impacts on shallow groundwater resources, surface water resources including the Isaac River, ecosystems and human users may be underestimated. Both the height of fracturing and the hydraulic conductivity of the fracture network should be further substantiated.
  - a. The vertical extent and hydraulic connectivity of subsidence fractures may not be adequately addressed in the groundwater modelling. In particular, the modelled increase in vertical conductivity of only one order of magnitude compared to *in situ* conductivity may underestimate the potential effect of a free-draining fracture network in the longwall goaf. On the western side of the project, where the depth of cover is reduced and mining beneath the Isaac River is proposed, it is probable that the fracture zone from the longwall extraction will extend much closer to the surface and potentially impact directly on the Isaac River and shallow groundwater resources. The impact of known faulting on vertical groundwater flow paths has also not been evaluated, and there is potential for subsidence induced tension and shear stresses to open faults to groundwater flow.
  - b. Geotechnical modelling to predict the extent of subsidence induced fractures, and the degree of connectivity throughout the fracture network over time would allow impacts to groundwater and surface water resources to be more precisely evaluated. Such modelling will indicate the likelihood of connectivity between the goaf and surface watercourses. Potential impacts on flood behaviour and volume, hydrology and water quality of affected watercourses can then be re-assessed to quantify:
    - i. The loss of surface water to groundwater;
    - ii. Any additional volume of water that would need to be dewatered from the underground mine and discharged from the mine water management system; and
    - iii. Potential impacts of altered hydrology and water quality on water-related assets and downstream water users.
  - c. Monitoring of sub-surface subsidence fracturing would reduce uncertainty around potential impacts and enable adaptive management of risks to groundwater resources and changes to surface-groundwater connectivity. Both direct measurement of borehole deformation and fracturing, in addition to monitoring of changes to aquifer properties and enhanced vertical permeability, would be beneficial. Management options including reducing coal extraction thickness or use of narrower longwall panels should be considered and described.

*Question 2b. The Subsidence Hydrology report concludes that the proposed worst case scenario for the volume of surface water captured within subsided longwall panels is 9500 ML. Does the Committee agree with this prediction? Does the Committee agree that the proponent must provide measures to minimise and/or mitigate the capture of this water?*

8. The proponent has undertaken three studies to assess potential impacts resulting from subsidence: calculation of the volume of voids created by subsidence; erosion and avulsion risks to the Isaac River including calculation of the predicted time before subsidence voids will fill with sediment; and an assessment of the hydrological impact of subsidence on 12 Mile Gully, which

the proponent has assessed to be the most significantly affected catchment. The proponent has suggested that partial drainage of voids in the 12 Mile Gully catchment be considered to reduce impacts on the hydrology of 12 Mile Gully; however, the IESC suggests that mitigation measures would be more comprehensively informed by consideration of the following matters.

- a. Volume of subsidence voids: The proponent has assessed that the total storage volume of the subsidence voids is approximately 9,500 ML. This volume is likely to be underestimated, as the 1,309 ML of subsidence voids predicted within the Isaac River channel are not included in this calculation on the basis that these are expected to fill with sediment, although they are not predicted to fill completely for approximately 40 years. Even when subsidence voids are completely infilled with sand, water may continue to be retained in the sand bed within the subsidence voids. The following factors also contribute to uncertainty of the total storage volume:
  - i. Subsidence voids smaller than two hectares are excluded from the calculation, which would lead to an underestimation of storage volume; and
  - ii. Inherent uncertainties of the subsidence prediction model described in Points 3 to 5 above.
- b. Geomorphic impacts of subsidence: The proponent has predicted the probability of subsidence voids infilling in the Isaac River RHM Reach based on the assumption that the sediment discharge is equivalent to the river's sediment transport capacity; and that the Isaac River is transport limited rather than sediment supply limited. The proponent also notes that there may be a period, possibly over decades, where there will be minimal sediment yield. The sediment budget analysis for the Isaac River RHM Reach should be reassessed to confirm that it would remain transport limited. The time to infill subsidence depressions within the Isaac River may be underestimated in a supply limited system.
  - i. The maximum annual sediment transport provided in the integrated quantity quality model (IQQM) model used by the proponent to predict sediment transport rates and infill times is significantly higher than the upper limit of annual sediment input calculated by the SedNET model undertaken for the Fitzroy River Basin by the Queensland Government. As the calculation of the sand available in the Isaac River over time is not calibrated, the differences between sediment yield in the IQQM and SedNET modelling should be reconciled.
  - ii. The proponent assumes that within subsidence voids, hydraulic parameters such as stream velocity will reduce sufficiently to trap all bed sediments. Further information is needed to justify this assumption, as bed sediments may be transported beyond subsidence voids during high flow events, and therefore the timeframe for infilling of subsidence voids is likely to be underestimated. Sediments are also likely to be scoured from subsidence voids during high flow events.
  - iii. The IESC suggests that the proponents also assess and quantify the probability and timeframe for filling of voids in the 12 Mile Gully and Goonyella Creek channels to enable the duration of potential impacts to be more accurately quantified.
- c. The scale of potential bank erosion and avulsion impacts in the Isaac River and other streams impacted by subsidence, without and with the implementation of mitigation measures, has not been assessed quantitatively. Quantitative modelling of potential geomorphic impacts, considering a range of flood scenarios, would enable the full extent of subsidence-induced impacts to be identified and inform the design of mitigation and management measures.

- d. Hydrological impact of subsidence voids: Total annual loss of flow to the Isaac River as a result of predicted subsidence should be quantified in order for the risks to water-related assets to be assessed, and the need for mitigation measures to be evaluated comprehensively. The IESC suggests consideration of the following:
  - i. Water losses through subsidence induced surface cracking, groundwater drawdown and or surface and groundwater interconnectivity; and
  - ii. Inclusion of subsidence voids in the Isaac River and the Goonyella Creek catchment in the hydrological model.
- e. The 12 Mile Gully hydrological model predicts that, without mitigation, ponding will reduce flows from this catchment by approximately 52 per cent annually. The assessment of potential impacts should be expanded to quantify changes to both the volume and timing of flows and consider human users downstream of the confluence of 12 Mile Gully with the Isaac River.
- f. The proponent offsets the flow reduction in 12 Mile Gully with increased discharges from Eureka Creek through the GRB mine complex, however the discharge rate is not consistent with the conclusions of the mine water balance study. The frequency and volume of discharges may be substantially different from the flow offset discussed in the 12 Mile Gully hydrological model, and therefore the IESC suggests that potential flow offsets be reassessed based on the findings of the mine water balance. Post mining effects on flow reduction and altered timing should also be addressed.
- g. The proponent concludes that mitigation should only be considered for the 12 Mile Gully catchment and only to partially drain the larger subsidence voids, as the works required to completely drain the subsidence voids would represent a large and potentially unnecessary degree of physical disturbance. However, mitigation to address flow losses to the Isaac River and tributaries should be designed, and the associated negative impacts assessed, in order to better inform decisions on the need for mitigation measures.
- h. Pre-development flows appear to be below the 90 per cent flow target defined in the Environmental Flow Objectives (EFO) for the Isaac River under the statutory *Water Resource (Fitzroy Basin) Plan 2011*. A further reduction in flow from the Isaac River catchment as a result of the proposed project is likely to further affect flow rates. The achievement of EFO is an important measure for determining the necessity of mitigation measures.

*Question 3: Does the Committee consider the EIS adequately addresses the impacts to water resources? What are the likely impacts on surface and groundwater resources, in particular geomorphological changes that may affect surface habitat for listed threatened species and communities?*

9. The IESC considers that the likely impacts of the proposed project on watercourses including the Isaac River, riparian vegetation and aquatic ecosystems, as a result of subsidence and mine discharges are uncertain and therefore are not adequately addressed in the EIS. Likely impacts to water resources are outlined below.
10. Cumulative impacts: Cumulative impacts within the region are expected to be significant given the number and extent of other coal mining and coal seam gas (CSG) projects in the Bowen Basin and the comparative scale of this proposed project.
  - a. Significant CSG operations are proposed or currently exist in the region. Existing groundwater drawdown from production at the existing Moranbah Gas Project has not been considered in the groundwater model. Further, significant CSG extraction as part of the

proposed Bowen Gas Project on the project site has not been taken into consideration in modelling scenarios and as such model predictions of impacts have the potential to be underestimated.

- b. The proponent concludes that the proposed project is expected to have negligible cumulative impacts on surface water quality because mine water releases will be undertaken in accordance with a number of state government initiatives designed to manage cumulative impacts from mines in the Fitzroy basin. However, the IESC notes that the 2012-2013 Pilot Mine Water Release Scheme evaluation report (Marsden Jacob and Gilbert and Sutherland, 2013) concluded that mine water discharges had “an attributable effect” on electrical conductivity values at the Isaac River’s Deverill monitoring site, south of the proposed development area. The proposed project is predicted to further increase the salinity of discharges. Analysis of the cumulative impacts of proposed development within the Isaac River catchment would be improved by specific consideration of the following matters: altered flow regimes; drawdown of alluvial groundwater; degraded water quality captured in subsidence voids; increased turbidity and sedimentation from land disturbance; and the influence of significant discharge events which are likely to scour sediments and contaminants accumulated in subsidence voids and transport them further downstream.
11. Water Discharges: The proponent has concluded that the proposed project will generate a water surplus in nine of the proposed project’s 23 operating years. However, further clarity around key elements of the site water balance would improve confidence in the proponent’s conclusions, in particular:
- a. The volume of rainfall runoff and wastewater discharged from the proposed project’s Mining Infrastructure Area (MIA) (including run-of-mine (ROM) pads and crushing facilities), Coal Handling and Preparation Plant (CHPP), product stockpiles, product load-out areas, waste disposal areas, and accommodation camp, under a range of climatic scenarios;
  - b. Identification of the existing or new sediment and mine-affected water storage dams that will receive water captured from the proposed project’s waste disposal areas, conveyor, CHPP, product stockpile and load-out areas, and accommodation camp;
  - c. The potential 10 ML Incidental Mine Gas (IMG) (i.e. CSG) co-produced water management dam should be included within the site water balance model along with potential locations;
  - d. The additional volume of water to be managed due to the expansion of the GRB mine;
  - e. Electrical Conductivity (EC) values used in the salt balance should be reconciled with groundwater quality sampling results;
  - f. Numerical values for predicted changes in the volume, frequency or timing of discharges as a result of the proposed project. In this regard, a 2 per cent increase in the use of available discharge opportunities is predicted under the project case water balance; however, the volume and timing of water discharges associated with this increase are not specified;
  - g. It is unclear whether the water balance has incorporated the predicted subsidence-induced reduction in flow volume and altered flow patterns within the Isaac River. Reductions in natural discharge along the Isaac River would reduce opportunities for discharge of mine affected water, and discharge scenarios for the proposed project should incorporate the findings of the proponent’s subsidence hydrology report;
  - h. The results of model validation, calibration and sensitivity analysis; and
  - i. Discharge water quality, for parameters in addition to electrical conductivity.



12. The proponent's site water balance indicates that exceedances of the discharge flow trigger and receiving water electrical conductivity limits can occur. Mitigation measures to prevent exceedances have not been proposed by the proponent.
13. The proponent has not evaluated the capacity of the mine water management system to discharge mine-affected water in a manner which enables WQOs for the Isaac River (DEHP, 2013) to be achieved. Discharges of mine-affected water with elevated concentrations of water quality stressors and toxicants are likely to increase risks to aquatic ecosystems and other water-related assets. Water quality modelling would need to be undertaken to:
  - a. Identify and quantify the concentrations of contaminants within mine-affected water proposed for discharge, which exceed baseline concentrations and WQOs for the Isaac River;
  - b. Inform the assessment of potential impacts on ambient water quality in the Isaac River; and
  - c. Assess the need for treatment facilities and the design of those facilities, if required.
14. The proponent proposes to store surplus mine-affected water in one of the 'low priority pits' when capacity in the Red Hill MIA Dam is exceeded, and this water may later be discharged to Eureka Creek and the Isaac River. Water stored in mine pits is substantially more saline than *in situ* groundwater and water abstracted from the underground mine. The salinity of mine-affected water discharges is likely to be increased by mixing the proposed project's mine-affected water with pit water, resulting in increased salinity in mine discharges.
15. Leachate: The proponent's geochemical study recommends conducting kinetic leach column testing during the mining phase of the project, however, this is not included amongst the proponent's commitments. Kinetic testing should be undertaken at the assessment stage to understand the likelihood of acid generation or potential toxicants in drainage from stored mineral waste, and to the design of appropriate monitoring and mitigation.
16. The proponent refers to a number of previous studies from the existing GRB mine and has designed the geochemical study on the basis that the geochemistry of waste from the proposed project will be similar and that the RHM does not represent a significant increase in waste materials to be stored within the broader GRB mine. However the geochemical assessment approach may not be representative of likely waste materials and spatial variability within the study area, and the sampling and testing methodologies may not adequately address the risks of the proposed project to water resources and water-related assets. The study design, including sampling regime, should be reviewed and additional representative sampling and testing may be required to understand potential impacts and design appropriate storage and mitigation measures.
17. The proponent states that runoff and seepage water from mineral waste materials is predicted to contain low dissolved metal concentrations. However, the proponent's data indicates that leachate from mine wastes may contain elevated concentrations of a number of metals. Quantification of the concentration and loading of contaminants that may leach from waste materials and comparison with appropriate guidelines would assist in identifying risks to downstream aquatic ecosystems.
18. Mineral waste management and disposal are discussed for waste produced from the Red Hill CHPP, however a rejects stockpile will also be maintained at the RHM MIA to contain waste from crushing and sizing operations prior to loading of raw coal on the conveyor to the CHPP. The likely quantity of waste stored at this location, and details of proposed transportation and handling, runoff and leachate management, and final storage of this material have not been provided. Given potential risks from rejects material, further detail should be provided to reduce uncertainty and ensure that risks are adequately managed and mitigated.

19. Flooding: The flood extent maps for the project case suggest that at the northernmost extent of the proposed Red Hill levee, flood mitigation would rely on the unsubsided area above the chain pillar between longwall panels to limit the extent of flooding. The significance of this feature has not been discussed in the study; in particular, in regards to potential impacts and mitigation measures required for subsidence voids that are shallower than predicted, or if flood waters impact the integrity of this feature; and/or if chain pillars compact to a greater degree than anticipated. Further, the flood study has not considered the potential impact of local flooding in longwall panels RH101 and RH102, and the interaction of this with regional flooding in the Isaac River. The following measures would enable risks to water resources to be more comprehensively assessed and inform the placement and design of the flood levee:
- a. Sensitivity analysis, which incorporates a range of subsidence void depths and compaction of chain pillars within the floodplain; and
  - b. Analysis of the interaction of local flooding in longwall panels RH101 and RH102 with regional flooding in the Isaac River.
20. A new bridge is proposed across the Isaac River to access the eastern part of the mine. The proponent states that the bridge will be designed to provide “minimal obstruction to flood flows” and therefore, the bridge has not been incorporated into the flood model. Structures within the floodplain may increase afflux and change flood behaviour. Given the potential for significant flooding on the site, clarification of the bridge’s flood immunity (design average recurrence interval (ARI)) would enhance confidence in the proponent’s flood study conclusions.
21. If the bridge changes peak flood surface levels, this may be accompanied by a change in the timing and/or magnitude of flood volume entering and leaving the local floodplain during the flood event. Alterations to flood volume and timing could impact environmental assets or other beneficial uses downstream of the proposed development, and should be assessed.
22. Water quality: The proponent has adopted modified WQOs for EC, aluminium, copper and chromium. The following information would enable evaluation of their appropriateness for a new development in the Isaac River catchment:
- a. Explanation to support the adoption of the modified EC WQOs which exceed baseline EC levels and the WQOs in the *Environment Protection (Water) Policy 2009* (EPP) for protection of aquatic ecosystem values in the Isaac River (DEHP, 2013); and
  - b. Information on how the modified WQOs for dissolved aluminium, copper and chromium were derived. It is noted that the modified WQOs exceed local objectives in the EPP and ANZECC and ARMICANZ (2000) guidelines for protection of aquatic ecosystems (95per cent protection levels).
  - c. A risk assessment of the likely ecological impacts of the proposed modified WQOs is needed.
23. Assessment of the following matters would improve understanding of risks to downstream water quality and aquatic ecosystems, and identification of appropriate mitigation measures.
- a. As it constitutes a new development within the Isaac River catchment, assessment of potential impacts of discharges on existing water quality conditions should be undertaken for the Red Hill Mining Lease, in order to understand the proposed project’s impacts on WQOs and water-related assets.
  - b. Assessment of potential impacts of mine-affected water discharges on aquatic ecosystems is needed. The proponent has concluded that discharges in accordance with the proposed water quality and flow objectives will result in negligible potential for adverse impacts to

receiving watercourses and water-related assets, but there appears to be limited evidence to support this conclusion. Discharges of mine-affected water with electrical conductivity values of up to 10,000 µs/cm and unspecified, potentially elevated, concentrations of toxicants may adversely affect aquatic ecosystems downstream of the discharge location.

- c. Quantification of the mixing zone under a range of flow conditions in the Isaac River would enable risks to water resources and water-related assets to be robustly evaluated.
  - d. Consideration of the effect on water quality of groundwater drawdown in the alluvium/tertiary sediments within affected watercourses is needed to inform the assessment of risks to water-related assets. Any alteration of ponding or flow regimes within affected watercourses is likely to be accompanied by changes to water quality. Such changes may include decreased dissolved oxygen, increased turbidity, changes to toxicant speciation and concentration of contaminants.
  - e. Understanding of subsidence induced changes to ambient water quality would be improved by assessment of the impacts of the increased volume of ponded water that will be discharged from terrestrial and riverine areas during 'first flush' events and the scouring of ponded areas during significant rainfall events. During these events, a large volume of poor quality water and some proportion of eroded sediments scoured from subsidence ponds, are likely to be discharged downstream. This effect is likely to be repeated along the length of the Isaac River that is impacted by subsidence.
  - f. An evaluation of subsidence-induced flood impacts on water quality would enable a more comprehensive assessment of flood-related water quality impacts. The proposed development is predicted to increase velocity and stream power upstream of subsided areas during flood events up to the 1:50 ARI event. This is likely to increase erosion across subsided areas and consequentially the turbidity and sediment load in receiving waterways during these events.
24. Ecology and GDEs: The aquatic ecology survey was carried out on only one occasion (May 2011) during a dry period when all streams had minimal flow or had retreated to isolated pools. No sampling was done in 12 Mile Gully due to the absence of water. Wet season aquatic ecology surveys at the same sites as the May 2011 survey and also in 12 Mile Gully would provide a more robust data set on which to base an assessment of the impacts of groundwater drawdown, subsidence, and discharge of mine-affected water.
25. The proponent states that no significant change in water quality is expected from subsidence, and that the impact of subsidence on aquatic ecosystems will be beneficial because the ponds will create new refuge habitat for macroinvertebrates and fish. However, impacts on the flow regime have not been considered. Further, the proponent predicts that new pond habitats are predicted to infill over time, which would result in potential beneficial impacts not being realised. The proponent's conclusions regarding potential impacts to the environmental values of the Isaac River are not supported by an assessment of impacts with respect to the water quality and flow requirements of the macroinvertebrate and fish communities.
26. The groundwater report states that groundwater discharge from the alluvium and Tertiary sediments occurs, amongst other potential mechanisms, through evapotranspiration from vegetation growing in the creek beds and along the banks. This is inconsistent with the proponent's assessment that groundwater is too deep to support GDEs, and that potential drawdown as a result of the proposed project is unlikely to impact on listed threatened species. There is no consideration of the potential groundwater dependence of the riparian EPBC Act-listed *Acacia harpophylla* (Brigalow) woodland along Goonyella Creek and 12 Mile Gully. In addition, there is potential that *Eucalyptus populnea* and other eucalypt woodland along the Isaac

River also use groundwater. The Isaac River riparian corridor has ecological value due to its provision of north-south connectivity to a large tract of vegetation at the Burton Range approximately 10 kms to the north-west of the project.

*Question 4: Are there additional measures and commitments required to mitigate and manage impacts to water dependent assets including ecological and human users of water?*

27. Surface water resources: An expanded water quality survey for the proposed project is needed, which details dedicated monitoring locations, the number of samples collected at each location, and frequency of sampling. In addition to sites currently monitored, the sampling program should also include reaches of 12 Mile Gully and Goonyella Creek upstream of the development area.
28. Incorporation of the following mitigation and management measures in addition to those already discussed would enable risks to water resources and water-related assets to be better understood, minimised and managed:
- a. Increase the storage capacity and improve mine water management to avoid:
    - i. releasing mine-affected water in circumstances that that will cause an exceedance of WQOs for the Isaac River (DEHP, 2013);
    - ii. the need to store water in mine pits. Water generated by the proposed project, which cannot be stored within purpose-built mine-affected water dams, should be treated (as discussed in Point 13) and discharged, rather than stored in mine pits;
  - b. Ensure that tailings and potentially acid forming materials are not stored in the 'low priority pits' used for water storage;
  - c. Inclusion of additional downstream water quality and ecological monitoring sites to identify and assess the full extent of the water quality mixing zone and the impacts on water-related assets. Implementation of these sites would also inform the assessment of cumulative impacts on water quality and aquatic ecosystems;
  - d. Select water quality monitoring sites that are accessible during wet season flow periods and/or use automated water quality monitoring equipment to collect data / samples;
  - e. Include monitoring sites to measure changes to water quality due to subsidence (i.e. in subsided terrestrial and watercourse areas) and groundwater drawdown;
  - f. Continue water quality monitoring through the dry season in persistent ponds to quantify any changes to refuge sites. At present, it appears that monitoring is only proposed in response to rainfall events sufficient to trigger flow;
  - g. The surface and groundwater monitoring plans should be consistent with the National Water Quality Management Strategy; and
  - h. Release of water derived from dewatering, or other construction activities, directly to waterways should be avoided unless it can be demonstrated that the release will not adversely impact on downstream environmental values.
29. Ecology and GDEs: The use of groundwater by riparian vegetation, particularly the EPBC Act-listed *Acacia harpophylla* (Brigalow) woodland along Goonyella Creek and 12 Mile Gully, needs to be evaluated using techniques from the Australian Groundwater Dependent Ecosystem Toolbox (Richardson et al., 2011).

30. The stygofaunal survey was carried out using a 150 µm net mesh size which is too large for the capture of stygofauna. The IESC supports the aquatic ecology consultant's recommendation that a review of the stygofauna sampling strategy be undertaken and a second round of post-wet sampling be conducted by experienced personnel using WA Guideline-compliant equipment which includes 50 µm mesh and a solid framed net. A minimum of 10 groundwater bores should be sampled, with a focus on shallow alluvial aquifers within the EIS study area.

<b>Date of advice</b>	10 April 2014
<b>Source documentation available to the Committee in the formulation of this advice</b>	<p>BHP Billiton Mitsubishi Alliance (BMA) 2013. Red Hill Mining Lease Project Environmental Impact Statement.</p> <p>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 &amp; Agriculture and Resource Management Council for Australia and New Zealand, Canberra</p> <p>Department of Environment and Heritage Protection (2013). <i>Model Water Conditions for Coal Mines in the Fitzroy Basin</i>, State of Queensland, Brisbane</p> <p>Marsden Jacob Associates and Gilbert Sutherland (2013) <i>Improving Mine Water Management for the Fitzroy Basin: Final Report on the Effectiveness of the 2012-2013 Pilot Mine Water Release and Evaluation of Market Based Mechanisms (Parts A &amp; B, Deliverables 3 and 5)</i>, Department of State Development, Infrastructure and Planning, Brisbane</p> <p>Richardson, et al (2011) <i>The Australian Groundwater Dependent Ecosystems Toolbox</i>. National Water Commission, Canberra.</p>
<b>References cited within the Committee's advice</b>	<p><sup>1</sup> Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources available at: <a href="http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf">http://iesc.environment.gov.au/pubs/iesc-information-guidelines.pdf</a></p>